Estimating Use, Density, and Productivity of Eastern Wild Turkey in Alabama

by

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Abstract

An important component of effectively managing wildlife is understanding the size and structure of their populations. The optimal management action for a population will often change depending on its current size and demographic structure. Regular monitoring enables managers to assess a population's status and reduce uncertainty surrounding the impacts of available management options. In the absence of monitoring, managers rely on expert knowledge about populations to make management decisions. Many southern states, including Alabama, manage eastern wild turkey (*Meleagris gallopavo silvestris*) according to indefensible estimation methods such as those based on expert opinion or opportunistic roadside surveys. There is little confidence in the accuracy of these estimates and they lack any measure of precision. Surveys, based on counts, designed to monitor turkey population size and structure would provide better information on which to base management decisions. I explored the use of gobble count and camera trap surveys in conjunction with occupancy as a means for monitoring wild turkey populations. Estimates of use, density, and productivity produced from these methods can better inform managers about the populations they are managing and can reduce uncertainty in management decisions.

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CHAPTER I: INTRODUCTION

An important component of effectively managing wildlife is an understanding of the size and structure of their populations. The optimal management action for a population will often change depending on its current size and demographic structure (Lyons et al. 2008). Regular monitoring enables managers to assess a population's status and reduce uncertainty surrounding the impacts of available management options (Williams 1997). In the absence of monitoring, managers rely on expert knowledge about populations to make management decisions. Many southern states, including Alabama, manage eastern wild turkey (*Meleagris gallopavo silvestris*; hereafter turkey) using estimates of population size and structure that are based on expert opinion of population density or harvest rate and sex ratio (ADCNR 2014, MDWFP 2016). In the case of Alabama, estimates of turkey density are based on broad land cover data but there is little confidence in the accuracy of these estimates and they lack any measure of precision. Surveys, based on counts, designed to monitor turkey population size and structure would provide better information on which to base management decisions. At this time, there are several survey options for estimating the size and structure of turkey populations found in the peer-reviewed literature (Wunz 1990, Butler et al. 2007, Rioux et al. 2009).

Auditory surveys (e.g., gobble counts) and camera trapping are two potential methods for obtaining count data. Auditory surveys have been commonly used as an index for population trends and assessing changes in populations over time or between areas (Bart and Schoultz 1984, Petraborg et al. 1953, Sayre et al. 1978). Using gobble counts, turkey researchers have been able to monitor range expansion, trends in population growth, distribution within an area, and gobbling activity prior to the hunting season (Porter and Ludwig 1980, Tefft 2016). Camera surveys have primarily been applied to studies of mammalian species, but their utility in monitoring avian populations should not be overlooked (Kucera and Barret 2011). The behavior of turkeys is well suited for camera trapping because they congregate in wildlife openings where they spend significant time foraging for food on the ground (Dickson 1992), which increases the ease with which researchers can capture them on camera. Camera trapping may be able to provide reliable and accurate data for assessment of turkey populations (Damm 2010). However, any method for surveying wildlife populations is subject to biases associated with imperfect detection (MacKenzie 2006). When false absences are not accounted for, it can lead to under-estimation of population size and undetected spatial or temporal heterogeneity in population density (MacKenzie 2006). Therefore, it is necessary to account for imperfect detection when attempting to produce unbiased estimates of populations that reflect changes over time.

Additionally, it is important to account for heterogeneity in density across a landscape and incorporate it into estimates of turkey populations. Further, it is not possible to make inferences about a system without first estimating what changes in observations may be due to random variations in detectability (MacKenzie et al. 2002). Failing to incorporate imprecision and bias that results from responses to fine-scale landcover characteristics leads to greater potential for errors in management decisions (Romesburg 1981, Anderson 2001). Data collected from gobble count and camera surveys are well suited for occupancy analysis which can account for heterogeneity in detection and density across a landscape. By incorporating additional landcover parameters that affect population abundance and distribution into estimation methods, managers can increase precision and reduce the uncertainty of population estimates.

In addition to current population size and structure, management decisions can incorporate how vital rates are related to population change (Miller et al. 1998). One such vital rate, poult production, may have significant impacts on turkey population growth over time (Vangilder and Kurzejeski 1995, Roberts et al 1995, Byrne et al. 2015). In the absence of high adult survival, low poult production can lead to insufficient recruitment of poults into the fall population, which will lead to a reduction in the population growth rate. Reductions in growth rate will then affect turkey populations in subsequent years. Surveys to estimate population size and structure can be used to track changes in poult to hen ratio, which is a measurement of productivity (Vangilder and Kurzejeski 1995). This information allows managers to make better decisions that can maintain sustainable turkey populations into the future.

I used occupancy and N-Mixture estimators in conjunction with gobble count and camera surveys to estimate the distribution, abundance, and structure of wild turkey populations in Alabama. I estimated detection rates during both surveys and described the variability in each survey due to weather, time, and other survey-related factors. I estimated the distribution and abundance of male wild turkeys on four wildlife management areas across Alabama prior to and during the breeding season using gobble count surveys. I also estimated the distribution, abundance, and productivity of wild turkeys on managed wildlife openings during the summer brood rearing season using camera surveys. For both surveys, I modeled sources of variation in distribution and abundance of turkeys in relation to landcover characteristics that I hypothesized would influence turkey ecology.

Literature Cited

Alabama Department of Conservation and Natural Resources. 2014. Full Fans & Sharp Spurs: Wild Turkey Report 2014. Alabama Department of Conservation and Natural Resources. Montgomery, Alabama, USA.

Anderson, D. R. 2001. The need to get the basics right in wildlife field studies. Wildl. Soc. Bulletin 29(4):1294-1297.

Bart, J., and J. D. Choultz. 1984. Reliability of singing bird surveys: changes in observer efficiency with avian density. Auk 101(2):307–318.

Butler, M. J., W. B. Ballard, M. C. Wallace, and S. J. Demaso. 2007. Road-based surveys for estimating wild turkey density in the Texas Rolling Plains. J. of Wildl. Manage. 71(5):1646-1653.

Byrne, M. E., M. J. Chamberlain, and B. A. Collier. 2015. Potential density dependence in wild turkey productivity in the southeastern United States. Proc. Nat. Wild Turkey Symp. 11: 329-351.

Damm, P. E. 2010. Using automated cameras to estimate wildlife populations. Thesis. Auburn University, Auburn, Alabama, USA.

Dickson, J. G. 1992. The Wild Turkey: Biology and Management. Stackpole Books. Mechanicsburg, Pennsylvania, USA.

Kucera, T. E., and R. H. Barrett. 2011. A history of camera trapping. Pages 9-26 in Camera Traps in Animal Ecology. Springer. Tokyo, Japan.

Lyons, J. E., M. C. Runge, H. P. Laskowski, and W. L. Kendall. 2008. Monitoring in the context of structured decision-making and adaptive management. J. of Wildl. Manage. 72(8):1683-1692.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83(8):2248-2255.

MacKenzie, D. I. 2005. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Academic Press. London, UK.

Miller, D. A., G. A. Hurst, and B. D. Leopold. 1998. Reproductive characteristics of a wild turkey population in central Mississippi. J. Wildl. Manage. 62(3):903-910.

Mississippi Department of Wildlife, Fisheries, and Parks. 2016. Spittin' & Drummin': Mississippi Wild Turkey Report. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi, USA.

Petraborg, W. H., E. G. Wellein, and V. E. Gunvalson. 1953. Roadside drumming counts a spring census method for ruffed grouse. J. Wildl. Manage. 17(3): 292-295.

Porter, W. F., and J. R. Ludwig. 1980. Use of gobbling counts to monitor the distribution and abundance of wild turkeys. Proc. Nat. Wild Turkey Symp. 4:61-68.

Rioux, S., M. Bélisle, and J. F. Giroux. 2009. Effects of landscape structure on male density and spacing patterns in wild turkeys (Meleagris gallopavo) depend on winter severity. Auk 126(3):673-683.

Roberts, S. D., J. M. Coffey, and W. F. Porter. 1995. Survival and reproduction of female wild turkeys in New York. J. Wildl. Manage. 59(3):437-447.

Romesburg, H. C. 1981. Wildlife science: gaining reliable knowledge. J. Wildl. Manage. 45(2):293-313.

Sayre, M. W., R. D. Atkinson, T. S. Baskett, and G. H. Haas. 1978. Reappraising factors affecting Mourning Dove perch cooing. J. Wildl. Manage. 42(4):884-889.

Tefft, B. C. 2016. Wild Turkey Status Report and Spring Turkey Hunter Survey 2015. Rhode Island Dep. Rhode Island Department of Environmental Management, West Kingston, Rhode Island, USA.

Williams, B. K. 1997. Approaches to the management of waterfowl under uncertainty. Wildl. Soc. Bulletin 25(3):714-720.

Wunz, G. A. 1990. Relationship of wild turkey populations to clearings created for brood habitat in oak forests in Pennsylvania. Proc. Nat. Wild Turkey Symp. 6:32-38.

Vangilder, L. D., and E. W. Kurzejeski. 1995. Population ecology of the eastern wild turkey in northern Missouri. Wildl. Monographs 130:3-50.

CHAPTER II: USING GOBBLE COUNT SURVEYS TO ASSESS MALE WILD TURKEY POPULATIONS

Introduction

Eastern wild turkeys (*Meleagris gallopavo silvestris*; hereafter turkeys) are an important game species throughout their range. Many southern states manage turkeys using estimates of population size and structure that are based on expert opinion of density or harvest rate and sex ratio (ADCNR 2014, MDWFP 2016). The optimal management action for a population will change depending on its current size and structure (Lyons et al. 2008). Accurate, precise, estimates of population size enable managers to assess a population's status and reduce uncertainty surrounding the impacts of available management options (Williams 1997).

In the absence of monitoring, managers often rely on expert knowledge about populations to make decisions about their management. Current estimates of turkey populations in Alabama are based on the availability of forest in each county (ADCNR 2014). Biologists use expert knowledge about turkey density and estimates of the percentage of forested and non-forested habitat within each county to estimate population size. However, preferences demonstrated by turkeys for different land cover types likely affects their abundance and distribution across a landscape. Finer-scale forest characteristics such as forest type, area, or stand age (Miller et al. 1999, Kennamer et al. 1980) can affect use of areas by turkeys. Numerous other habitat and environmental variables could cause additional variation in population distributions (Lambert et al. 1990, Dickson et al. 1978, Erxleben et al. 2011). These landcover characteristics will also vary across landscapes at multiple scales, adding to potential bias in estimates. Additionally, estimates of turkey populations based only on infrequent estimates of landcover are not likely to be useful for monitoring response to management or changes in environmental conditions.

A survey program that regularly monitors turkey populations would be able to assess changes in populations over time and space. One common approach is the use of auditory surveys (i.e., gobble counts). Such methods have been commonly implemented for monitoring turkeys and other gamebird species (Rioux et al. 2009, DeMaso et al. 1992, Evans et al. 2007). Reliable gobbling activity of males during the breeding season makes wild turkeys an excellent candidate for the use of auditory surveys. These surveys are much less expensive than other options such as capture-mark-recapture, telemetry, or camera surveys. Additionally, unlike methods that rely on capture and marking, gobble counts do not directly impact the individuals being observed (Bull 1981).

Auditory survey data can be utilized in a variety of ways. It has been commonly used as an index for population trends and assessing changes in populations over time or between areas (Bart and Schoultz 1984, Petraborg et al. 1953, Sayre et al. 1978). In the case of turkey gobble counts, researchers have been able to monitor range expansion, trends in population growth, distribution within an area, and gobbling activity prior to the hunting season (Porter and Ludwig 1980, Tefft 2016). An inherent issue with auditory surveys is that environmental and ecological factors affect observations (Dawson 1981). Weather, time of day, time of year, or observer ability could decrease the probability of detecting turkeys during counts. Occupancy analysis treats the probability of detection as a nuisance parameter, decoupling its effect from probability of use and density (MacKenzie et al. 2002).

In its most basic application, gobble count data can be used to estimate the distribution of wild turkeys within an area with presence-absence data (MacKenzie et al. 2002). However, survey periods can be broken up into seasons to account for the dynamics of gobbling activity and distribution of individuals across time (MacKenzie et al. 2003). These estimates of occupancy can be used as an index to abundance and how it changes within and among years (MacKenzie and Nichols 2004).

Additionally, estimates of abundance can be obtained using presence-absence data (Royle and Nichols 2003) or counts of individuals (Rioux et al. 2009, Royle 2004). N-Mixture models require counting individuals during a sampling period, which can be difficult to achieve with auditory gobbling surveys. Gobbling can be variable among ages and individuals (Hoffman 1990, Palmer et al. 1990), making it difficult to obtain an accurate count of males from gobbling alone. The Royle-Nichols model of occupancy uses presence/absence data to achieve the same objective, avoiding issues in obtaining accurate count data, but it does rely on a strong assumption of the relationship between occupancy and abundance.

Occupancy analysis also can provide information about the factors that influence habitat use by wild turkeys. Relationships among occupancy, the dynamics of occupancy, and covariates of interest can be estimated to offer insight into the characteristics of sites, such as landcover, and use by wild turkeys. If such relationships exist, failure to account for them may lead to bias in population estimates. Quantifying these relationships and incorporating them into the estimation process will increase the accuracy of the current population estimation methods in use in many states. Knowledge about how turkeys relate to different landcover types can also be used in a more applied context, informing land management choices to better suit turkey populations.

The goal of my study was to examine differences in the distribution and density of turkeys in varying landcover types across Alabama while accounting for factors that affect detection. My objectives were to 1) increase precision and accuracy of population estimates by identifying and estimating influences of weather, timing, and study area on the probability of detecting turkeys during a survey; 2) estimate wild turkey probability of use and density within my study areas; and 3) identify potential sources of bias in estimates of turkey use and density due to landcover characteristics.

Study Area

Gobble counts surveys were performed on 4 study areas located throughout the state of Alabama. The sites were chosen because they represented landscapes that are important to wild turkey in Alabama. J.D. Martin Skyline WMA (Skyline) was in northeast Alabama, along the border of Tennessee and approximately 44 km northeast of Huntsville, Alabama (N34.92575, W-86.06264). This area was known as the Cumberland Plateau and was part of the Southwestern Appalachian Mountains. Skyline was composed of 24,577 ha that encompassed plateaus at elevations at about 450-520 m with slopes that can descend 300 m. Skyline was owned and managed by the Alabama Department of Conservation and Natural Resources. Vegetation was predominately mixed oak (*Quercus* spp.) and chestnut oak (*Quercus montana*) as well as agriculture at the lower elevations. Beech (*Fagus* spp.)-yellow poplar (*Liriodendron tulipifera*), sugar maple (*Acer saccharum*)-basswood (*Tilia Americana*)-ash (*Fraxinus* spp.)-buckeye (*Aesculus* spp.) forests characterized the middle and lower slopes (Griffith et al. 2001). There were over 300 wildlife openings within WMA boundaries that ranged in size between 500 m^2

and 100,000 m^2. The majority of openings were located in the western and southern regions of the WMA.

Oakmulgee WMA (Oakmulgee) was in western Alabama, 30 km south of Tuscaloosa, AL and 80 km southwest of Birmingham, Alabama (N32.937257, W-87.414938). Oakmulgee was composed of 18,009 ha and was owned and managed by a cooperative agreement between the U.S. Forest Service and ADNCR. The WMA was in the Fall Line Hills region of the Southeastern Plains, whose terrain was mostly oak (*Quercus* spp.)-hickory (*Carya* spp.)-pine (*Pinus* spp.) although longleaf pine (*Pinus palustris*) was being re-introduced throughout the region (Griffith et al. 2001). There were approximately 100 wildlife openings evenly distributed throughout the WMA that ranged in size from 400 m^2 to 11,000 m^2.

The Scotch study area (Scotch) was on private land and was formerly a WMA in eastern Alabama, 116 km north of Mobile, Alabama, 26 km east of the and Mississippi border (N31.848744, W-87.902205). Scotch was approximately 8,093 ha. Scotch was found in the Southern Hilly Gulf Coastal plain ecoregion of the Southeastern Plains (Griffith et al. 2001). While native vegetation of the area would be oak-hickory-pine forests, Scotch became a production site for short-rotation pine. Due to timber harvest, cover changed frequently from planted pine of various age classes to clear cuts and new plantings. There were 38 wildlife openings within the study area that range in size from 300 m^2 to 15,000 m^2. Openings were more concentrated in the central and western regions of the study area.

Barbour WMA (Barbour) was in eastern Alabama, 68 km south of Auburn, Alabama, and 36 km west of the Georgia border (N31.977320, W-85.435939). The management area was composed of 11,418 ha of land located in the Southern Hilly Gulf Coastal Plain region of the

Southern Plains. This region was characterized by a rolling topography of low hills with irregular plains. Landcover was mostly forest and woodland comprised of oak-hickory-pine forests, with some pasture and cropland (Griffith et al. 2001). There were approximately 250 wildlife openings located throughout the WMA property, with a larger portion being found in the western region. Opening sizes ranged between 300 m^2 and 140,000 m^2.

Methods

To determine survey sites, each study area was divided by a grid system of 4-km^2 (400 ha) cells. This grid cell size reduced the possibility of double sampling turkeys at adjacent points because the distance between points was greater than the distance gobbling activity can be heard at (Healy and Powell 1999). To ensure broad coverage of available habitat on each study area, cells were selected at random from each land cover class in proportion to their availability. The land cover composition of each cell was determined based on 2011 National Land Cover Data (Homer et al. 2015). The composition of grids was classified based on a categorical classification of land cover (<5%, 5-25%, >25-50%, >50%-75%, >75%-100%). Cells with center points that were outside the management area boundaries or otherwise inaccessible by road were excluded. I set out to survey at least 1 cell from each class, with a total of 20 cells selected on each study area except on Scotch WMA where all 18 available cells were sampled (Appendix A). The number of cells exceeded the number of classes for each study area, so a class was not sampled only when all cells were inaccessible for surveys. Once a cell from each class was selected, additional cells were randomly selected from each class in proportion to their availability on the management area until 20 total were selected.

Gobble count surveys were performed to estimate area used by male wild turkeys prior to and during the hunting season. Survey weeks were grouped into seasons to account for the movement and deaths of individuals throughout the sampling period. Both years had an early- (Weeks 1-4), mid- (Weeks 5-9), and late- (Weeks 10-13) season. An Extra season (Weeks 14-16) was added in 2016 to better coincide with the breeding bird survey. Due to changing gobbling behavior that led to extremely low detection, surveys conducted during this 2016 Extra Season were excluded from analysis. Gobble count surveys were conducted within the WMA boundary on roadsides at the nearest accessible point to the center of each grid cell. Surveys were conducted from 0.5 h before sunrise to 1.5 h after sunrise, which is the period of peak gobbling activity during the day (Bevill 1975). To reduce bias due to weather, surveys were not performed on days with rain or when wind speeds could prevent surveyors from hearing gobbling activity (Davis 1971).

Surveys were conducted at each site once each week throughout the sampling period. Each survey was preceded by a 1-minute waiting period before starting the count to prevent any incidental noise eliciting gobbling activity. Each stop was divided into 3 survey intervals, two 4-minute periods of passive listening and a single 1-minute period preceded by elicitation with a crow call. The estimated direction, distance, number of gobbles, and number of gobbling turkeys were recorded during each survey segment. Temperature, cloud cover, precipitation, wind speed, and human activity were recorded during each survey interval. Cloud cover, precipitation, and wind speed were quantified according to ordinal scales of intensity (Table 2.1, Table 2.2).

Gobbling activity was simplified into an encounter history with 1 occasion per survey segment indicating whether a turkey was detected (1), not detected (0), or a survey was not performed (.). Surveys were conducted for 13 weeks in 2015 and 16 weeks in 2016. Final encounter histories were comprised of a total of 78 occasions for each site.

Geospatial data for roads and managed wildlife openings; as well as, wildlife opening perimeters were provided by the ADCNR where available and were truthed using Garmin GPS map76x (Garmin, Canton of Schaffhausen, Switzerland) in the field. Not all roads and wildlife openings were represented in the initial information provided by the ADCNR and were later modified using aerial imagery (NAIP 2015, NAIP 2016) in ArcGIS (version 10.3.1; ESRI, Redlands, CA, USA). Land cover type and distribution were obtained from 2011 National Land Cover Data (NLCD, Homer et al. 2015). Correlation of variables was analyzed by creating a correlation matrix in Excel 2013 (Microsoft, Redmond, WA, USA). Correlation coefficients (r) were calculated and reported for all landcover characteristics to identify potential problems with collinearity between covariates. Covariates with strong collinear relationships were not used in the same model.

I developed *a priori* models to describe my hypothesis regarding factors affecting detection, occupancy, and density. A multiple season occupancy estimator was used to calculate the dynamics of site use and its relation to site characteristics and sampling (detection) covariates (MacKenzie 2006). Models for detection and occupancy were compared using “robust design occupancy estimation with psi, epsilon” parameterization (MacKenzie et al. 2003) in Program MARK (White and Burnham 1999). This analysis allowed for the estimation of detection probability (p), probability of use by turkeys (ψ), and probability of site extinction (ε). Royle-Nichols models for density (λ) were compared using the unmarked package (Fiske and Chandler 2011) in Program R (R Core Team 2016).

I followed a hierarchical framework for comparing models. Models of detection were compared first by using null models for occupancy (ψ) and extinction (ε). Covariates for detection included year, day of the year, minutes from sunrise, temperature at time of survey, an ordinal designation for wind intensity, an ordinal designation for sky cover, and frequency of disturbance events. The best approximating models (cumulative AIC weight (Σw) > 0.9) for detection were then used in my analyses of use and density. Covariates used in analyzing use and density include percentage area covered by NLCD classification, proportion of forested area dominated by hardwood or pine, number and proportion of wildlife openings, percentage area covered by wildlife openings, and density of roads. Additional analysis of time related models were compared using the multi-season occupancy estimator. Odds ratios for covariate effects were calculated by taking the exponent of the betas returned from my logistic linear models.

All *a priori* models of occupancy and abundance were compared using Akaike Information Criterion and estimates were generated using multiple model inference (Burnham and Anderson 2002). Model-averaged estimates of occupancy and density based on the landcover characteristics were generated for every 4-km^2 cell overlaying the management areas. The site-specific estimates for each grid cell were then averaged to estimate use and density across each study area. Density estimates were expressed as the mean and mode of a Poisson distribution.

Results

Over 2 years, observers conducted 4,676 surveys at 78 sites on 4 wildlife management areas in Alabama. Surveys were conducted over 13 weeks in 2015, from March 4 through May 30. In 2016, an additional 3 weeks were added, with surveys occurring from March 5 through

June 15. In 2015, turkeys were detected on 30 of the 58 sampled sites (51.7%). In 2016, turkeys were detected on 32 of the 60 sampled sites (53.3%). Eleven sites had observed gobbling activity in both years. Turkeys were detected in 231 of 4,676 surveys intervals across both years (1.1%). During the additional 3 weeks of 2016 (31 May through 15 June) only 1 detection occurred.

The top model for detection of male turkeys was based on temperature, wind intensity, and study area (Table 2.3). For every 1° C increase in temperature during the time of the survey, an observer was 0.937 times as likely (0.909-0.967; 95% C.L.) to hear gobbling in the area. For every ordinal unit increase in wind intensity during the time of the survey, an observer was 0.765 times as likely (0.628-0.933; 95% C.L.) to detect gobbling. Detection probability of male turkeys was lowest at Skyline WMA (p = 0.257; 0.161-0.385, 95% C.L.) and highest at Barbour WMA (p = 0.454; 0.215-0.714, 95% C.L.).

When examining correlation coefficients among covariables (Table 2.4), I found that percent area hardwood and percent area pine demonstrated a strong negative correlation. Percentage of forested area composed of pine trees and percentage of forested area composed of hardwood trees also had a strong negative correlation. Percent forested area showed a strong negative correlation with percent area associated with brood foraging area (%Food).

The best approximating model for male turkey use was based on season (Table 2.5), and received nearly 3 times as much weight as the next best model. Use did not differ between early (1 March through 28 March) and late seasons (25 April through 30 May) (β = 0.005, -0.580-0.590; 95% C.L.). A survey grid cell was 1.896 times as likely (0.114-3.229; 95% C.L.) to be occupied by a gobbler in mid-season (29 March through 24 April) when compared to early season. The best model based on landcover characteristics described variation in probability of use according to the percent forest cover, the proportion of forest composed of pine trees, and an interaction term (Table 2.5). As the percentage of forested habitat increased, probability of use was 0.966 times as likely (0.935-0.998; 95% C.L.), when pines were absent. Due to the interaction, as the proportion of forested area composed of pine trees increased, probability of use decreased at lower percentages of forest cover and increased at higher percentages of forest cover (Figure 2.1). Additional models that described variation in male turkey were based on similar characteristics of forested cover and composition as well as the percent area classified as shrub or developed land (Table 2.5).

Model averaged probability of use for a grid cell averaged across the entire survey period was 0.331 (0.299-0.363; 95% C.L.). Peak use by males occurred during mid-season with a probability of 0.406 (0.374-0.437; 95% C.L.) compared to 0.290 (0.258-0.322; 95% C.L.) in early season and 0.298 (0.266-0.329; 95% C.L.) in late season. Probability of grid cell use was similar among study areas (Table 2.6).

Among models considered for the Royle-Nichols estimation of abundance (Table 2.7), the best approximating model was based on the percentage of an area that was forested and the proportion of forested area made up of pine (Table 2.7). For every percent increase in grid cell area occupied by non-pine forested habitat, log of density of male turkeys decreased by a factor of 0.945 (0.932-0.957; 95% C.L.). As the proportion of forested area composed of pine trees increased, log of density decreased at lower percentages of forest cover and increased at higher percentages of forest cover (Figure 2.2). Estimates of average density of gobblers in a cell were described by a Poisson distribution of densities with a mean of 0.816 (0.706-0.925; 95% C.L.) and a mode of 0. Mean density estimates were similar for all study areas (Table 2.8).

Discussion

Occupancy analysis can provide information about the factors influencing use, but it is first necessary to account for variation in estimates due to changes in detection probability (MacKenzie 2002). The best model for detection indicated a relationship between the probability of hearing male turkeys during a survey, wind intensity, temperature at the time of the survey, and study area (Table 2.3). Similar weather factors have been identified as influencing gobble count data (Porter and Ludwig 1980, Hoffman 1990, Kienzler et al. 1996) with few exceptions (Scott and Boeker 1972). Ambient noise caused by high winds could hamper the ability of observers to identify gobbling activity (Simons et al 2006) due to either decreased bird activity or a decrease in the ability of an observer to hear gobbles (Johnson et al 1981). Temperature change may be an indicator of timing within the year and the associated change in turkey gobbling. Studies have reported that as temperature increases further into spring and hens begin to incubate, males may decrease their gobbling activity (Vangilder and Kuzejeski 1995, Miller et al 1997a). Using gobble count data as an index to turkey populations without accounting for such effects of weather on data collection can yield poor estimates (Bull 1981). Differences in detection between study areas may be related to varying detection probabilities between the landcover types at each site (Pacifici et al. 2008). These differences may also be attributed to variation in turkey behaviors related to landcover, human activity, or turkey condition, each of which may vary among study areas (Miller et al. 1997a, Miller et al. 1997b).

My results also indicated that fine scale landcover variables in addition to percent area forested explained variation in use and density. Turkey use and density correlated with the percent cover and composition of forested areas, the number and size of managed wildlife openings, and a quadratic function of shrub area. Similar fine scale indicators of variation in use and abundance have been demonstrated in other studies of wild turkeys. Rioux et al. (2009) saw variable densities depending on forest cover and the amount of edge habitat that was present in an area. Female turkeys have also been shown to use pine and mixed-pine hardwood landcover with greater frequency than would be expected by chance (Thogmartin 2001). Dickson et al. (1978) reported greater turkey populations with increased proportion of area in openings. The variety of landcover variables that affect turkey use and density indicate that the connection between landcover and turkey abundance is more complicated than the relationship on which current estimates are based. While the assessment that forested and non-forested area is important to estimating turkey density, it does not explain the variation in use and density that I observed. Future population estimates should incorporate additional fine scale landcover relationships to increase their precision.

For many species, as abundance increases, the use of an area increases as well, which makes it possible to track a population's growth over time by monitoring the proportion of area used (MacKenzie and Nichols 2004). This relationship between use and abundance has been used to monitor populations of Great Argus Pheasant (O'Brien and Kinnaird 2008), primates (Keane et al. 2012), and multiple tropical mammal species (Ahumada et al. 2013). My results showed no evidence for a difference in probability of use between the 2 years of observations. This lack of change in use suggests that population size of gobbling males was relatively stable for the 2 years of this study.

My results indicated that probability of use changed according to the timing within the breeding season which is consistent with other studies that showed male turkeys shift their habitat and space use according to the time of the year (Miller et al. 1999, Hoffman 1991). It would be possible to track changes in population size by comparing differences in use between years, but is made more difficult because of this fluctuation in use through the breeding season. Timing of the movement and deaths of individuals within a season needs to be accounted for it is necessary to use gobble counts as an index to population change.

My density estimates from the Royle-Nichols abundance estimator indicated density of male gobblers to be 0.816 (0.695-0.936; 95% C.L) per 4km^2 grid cell. The ADCNR turkey density map indicates that I should expect between 4.6-6.2 adult gobblers per 4km^2 across the same areas (ADCNR 2014). These two estimates differ greatly and would lead to very different assessments of turkey populations within the state of Alabama. This difference may be attributed to the lack of fine scale landcover information being incorporated into the ADCNR's estimates. Alternatively, my density estimates may underestimate male turkey density due to the size of my grid cells. I selected 4-km^2 grid cells to avoid double counting individuals at adjacent survey sites, but if this cell size is larger than the average home range size for male turkeys on my study area, it would not be an appropriate scale at which to extrapolate turkey density and lead to underestimation.

While there is support for using population estimates based on expert opinion (Drescher et al. 2013), it is often accompanied by the suggestion to validate estimates with empirical data (Doswald et al. 2007, Iglecia et al. 2012). My research shows that while the ADCNR was correct in placing importance on the impact of forested and non-forested areas, the expected densities within each differed from what was observed in the field. Additionally, not all landcover characteristics that correspond with variation in turkey densities were taken into account in the original ADCNR estimates. To increase the precision of estimates of wild turkeys across the state, I suggest updating the expected turkey densities with information collected from current turkey populations within the state as well as incorporating additional landcover characteristics that I identified as correlating with changes in turkey density.

Management Implications

My results support that, when designed to meet the assumptions of occupancy analysis, gobble count surveys are a versatile tool that can provide information about density, distribution, and growth of turkey populations. I was able to identify fine scale landcover characteristics that can be used to refine and increase the precision of future population estimates. Through the estimation of probability of use, I also showed how gobble counts can be used to monitor changes in use or density from year to year. This information may be useful for state agencies to inform hunters and stakeholders about the status of the male wild turkey populations. The methods I used also provide information about the timing of gobbling activity and its frequency throughout the year, which could help inform hunters about how to best increase their chances of an enjoyable hunting experience.

Literature Cited

Ahumada, J. A., J. Hurtado, and D. Lizcano. 2013. Monitoring the status and trends of tropical forest terrestrial vertebrate communities from camera trap data: a tool for conservation. Plos one 8(9): e73707.

Alabama Department of Conservation and Natural Resources. 2014. Full Fans & Sharp Spurs: Wild Turkey Report 2014. Alabama Department of Conservation and Natural Resources. Montgomery, Alabama, USA.

Bart, J., and J. D. Choultz. 1984. Reliability of singing bird surveys: changes in observer efficiency with avian density. Auk 101(2):307–318.

Bevill, W. V. 1975. Setting spring gobbler hunting seasons by timing peak gobbling. Proc. Nat. Wild Turkey Symp. 3:198-204.

Bull, E. L. 1981. Indirect estimates of abundance of birds. Studies in Avian Bio. 6:76–80.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference. Second edition. Springer-Verlag, New York, New York, USA.

Dawson, D. G. 1981. Counting birds for a relative measure (index) of density. Studies in Avian Bio. 6:12-16.

Davis, J. R. 1971. Spring Weather and Wild Turkeys. Alabama Conservation 41:6-7.

Demaso, S. J., F. S. Guthery, G. S. Spears, and S. M. Rice. 1992. Morning covey calls as an index of Northern Bobwhite density. Wildl. Soc. Bulletin 20(1):94–101.

Dickson, J. G., C. D. Adams, and S. H. Hanley. 1978. Response of turkey populations to habitat variables in Louisiana. Wildl. Soc. Bulletin 6(3):163-166.

Doswald, N., F. Zimmermann, and U. Breitenmoser. 2007. Testing expert groups for a habitat suitability model for the lynx (Lynx lynx) in the Swiss Alps. Wildl. Bio. 13(4):430-446

Drescher, M., A. H. Perera, C. J. Johnson, L. J. Buse, C. A. Drew, and M. A. Burgman. 2013. Toward rigorous use of expert knowledge in ecological research. Ecosphere 4(7):art83

Erxleben, D. R., M. J. Butler, W. B. Ballard, M. C. Wallace, M. J. Peterson, N. J. Silvy, W. P. Kuvlesky Jr., D. G. Hewitt, S. J. DeMaso, J. B. Hardin, and M. K. Dominguez-Brazil. 2011. Wild turkey (Meleagris gallopavo) association to roads: implications for distance sampling. European J. of Wildl. Research 57(1):57-65.

Evans, S. A., S. M. Redpath, F. Leckie, and F. Mougeot. 2007. Alternative methods for estimating density in an upland game bird: the red grouse *Lagopus lagopus scoticus*. Wildl. Bio. 13(2):130-139.

Fiske, I., and C. Richard. 2011. unmarked: An R Package for Fitting Hierarchical Models of Wildlife Occurrence and Abundance. J. of Stat. Software 43(10):1-23.

Griffith, G. E., J. M. Omernik, J. A. Comstock, S. Lawrence, G. Martin, A. Goddard, and V. J. Hulcher. 2001. Ecoregions of Alabama and Georgia. Pages (2 sided color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, Virginia, USA.

Healy, W. M., and S. M. Powell. 1999. Wild turkey harvest management: Biology, strategies, and techniques. U.S. Fish and Wildlife Service, Biological Technical Publication BTP-R5001-1999. U.S. Dep. of the Int., Washington, D. C.

Hoffman, R. W. 1990. Chronology of gobbling and nesting activities of Merriam's wild turkeys. Proc. Nat. Wild Turkey Symp 6:25-31.

Hoffman, R. W. 1991. Spring movements, roosting activities, and home-range characteristics of male Merriam's wild turkey. Southwest Naturalist 26(3):332-337.

Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown,. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81(5):345-354

Iglecia, M. N., J. A. Collazo, and A. J. McKerrow. 2012. Use of occupancy models to evaluate expert knowledge-based species-habitat relationships. Avian Cons. and Eco. 7(2):art5

Johnson, R. R., B. T. Brown, L. T. Haight, and J. M. Simpson. 1981. Playback recordings as a special avian censusing technique. Studies in Avian Bio. 6:68–75.

Keane, A., T. Hobinjatovo, H. J. Razafimanahaka, R. K. B. Jenkins, and J. P. G. Jones. 2012. The potential of occupancy modeling as a tool for monitoring wild primate populations. Animal Con. 15(5):457-465.

Kennamer, J. E., J. R. Gwaltney, and K. R. Sims. 1980. Habitat preferences of eastern wild turkeys of an area intensively managed for pine in Alabama. Proc. Nat. Wild Turkey Symp. 4:240-245.

Kienzler, J. M., T. W. Little, and W. A. Fuller. 1996. Effects of weather, incubation, and hunting on gobbling activity in wild turkeys. Proc. Nat. Wild Turkey Symp. 7:61-68.

Lambert, E. P., W. P. Smith, and R. D. Teitelbaum. 1990. Wild Turkey use of dairy farm-timberland habitats in southeastern Louisiana. Proc. Nat. Wild Turkey Symp. 6:51-60.

Lyons, J. E., M. C. Runge, H. P. Laskowski, and W. L. Kendall. 2008. Monitoring in the context of structured decision-making and adaptive management. J. of Wildl. Manage. 72(8):1683-1692.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83(8):2248-2255.

MacKenzie, D. I., J. D. Nichols, J. E. Hines, M. G. Knutson, and A. B. Franklin. 2003. Estimating site occupancy, colonization, and local extinction when a species is detected imperfectly. Ecology 84(8):2200-2207.

MacKenzie, D. I., & J. D. Nichols. 2004. Occupancy as a surrogate for abundance estimation. Animal Biodiv. and Cons. 27(1):461-467.

MacKenzie, D. I. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Academic Press. London, UK.

Miller, D. A., G. A. Hurst, and B. D. Leopold. 1997a. Chronology of wild turkey nesting, gobbling, and hunting in Mississippi. J. Wildl. Manage. 61(3):840-845.

Miller, D. A., G. A. Hurst, and B. D. Leopold. 1997b. Factors affecting gobbling activity of wild turkeys in central Mississippi. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 51:352-361.

Miller, D. A., G. A. Hurst, and B. D. Leopold. 1999. Habitat use of eastern wild turkeys in central Mississippi. J. Wildl. Manage. 63(1):210-222.

Mississippi Department of Wildlife, Fisheries, and Parks. 2016. Spittin' & Drummin': Mississippi Wild Turkey Report. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi, USA.

O'Brien, T. G., and M. F. Kinnaird. 2008. A picture is worth a thousand words: the application of camera trapping to the study of birds. Bird Con. Int. 18:144-162.

Pacifici, K., T. R. Simons, and K. H. Pollock. 2008. Effects of vegetation and background noise on the detection process in auditory avian point-count surveys. Auk 125(3):600-607.

Palmer, W. E., G. A., Hurst, and J. R. Lint. 1990. Effort, success, and characteristics of spring turkey hunters on Tallahala Wildlife Management Area, Mississippi. Proc. Nat. Wild Turkey Symp. 6: 208-213.

Petraborg, W. H., E. G. Wellein, and V. E. Gunvalson. 1953. Roadside drumming counts a spring census method for ruffed grouse. J. Wildl. Manage. 17(3): 292-295.

Porter, W. F., and J. R. Ludwig. 1980. Use of gobbling counts to monitor the distribution and abundance of wild turkeys. Proc. Nat. Wild Turkey Symp. 4:61-68.

Rioux, S., M. Bélisle, and J. F. Giroux. 2009. Effects of landscape structure on male density and spacing patterns in wild turkeys (Meleagris gallopavo) depend on winter severity. Auk 126(3):673-683.

Royle, J. A., and J. D. Nichols. 2003. Estimating abundance from repeated presence–absence data or point counts. Ecology 84(3):777-790.

Royle, J. A. 2004. N-mixture models for estimating population size from spatially replicated counts. Biometrics 60(1):108-115.

Sayre, M. W., R. D. Atkinson, T. S. Baskett, and G. H. Haas. 1978. Reappraising factors affecting Mourning Dove perch cooing. J. Wildl. Manage. 42(4):884-889.

Scott, V. E., and E. L. Boeker. 1972. An Evaluation of Wild Turkey Call Counts in Arizona. J. Wildl. Manage. 36(2):628-630.

Simons, T. R., M. W. Alldredge, K. H. Pollock, and J. M. Wettroth. 2007. Experimental analysis of the auditory detection process on avian point counts. Auk 124(3):986-999.

Tefft, B. C. 2016. Wild Turkey Status Report and Spring Turkey Hunter Survey 2015. Rhode Island Dep. Rhode Island Department of Environmental Management, West Kingston, Rhode Island, USA.

Thogmartin, W. E. 2001. Home-range size and habitat selection of female wild turkeys (Meleagris gallopavo) in Arkansas. The American Midland Naturalist 145(2): 247-260.

Vangilder, L. D., and E. W. Kurzejeski. 1995. Population ecology of the eastern wild turkey in northern Missouri. Wildl. Monographs 130:3-50.

White, G.C., and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study 46(Sup):120-138.

Williams, B. K. 1997. Approaches to the management of waterfowl under uncertainty. Wildl. Soc. Bulletin 25(3):714-720.

World Meteorological Organization. 1970. The Beaufort scale of wind force (technical and operational aspects). Commission for Marine Meteorology, Rep. on Marine Science Affairs 3:22.

Table 2.1. Ordinal scale describing weather intensity. Categories (Code) based on cloud cover and precipitation during the time at which a survey took place.

Code	Sky condition
0	Clear sky, few clouds
1	Partly cloudy (scattered) or variable sky
2	Cloudy (broken) or overcast
3	Fog or smoke
4	Drizzle
5	Showers (intermittent rain)
6	Rain
7	Snow

Table 2.2. Beaufort wind scale (WMO 1970) (Code) based on wind speed in knots (Speed) which was measured based on visual cues (Cue).

Code	Speed	Cue
0	<1	Calm, smoke rises vertically
1	1-3	Smoke drift indicates wind direction, still wind vanes
2	4-6	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Leaves and small twigs constantly moving, light flags extended
4	11-16	Dust, leaves, and loose paper lifted, small tree branches move

Table 2.3. Models of detection (*p*) models for wild turkey gobblers, values for bias corrected AIC, relative difference in AICc, model probability (w), model likelihood (Lik), number of parameters (K), and deviance (Dev) from gobble count surveys in Alabama, spring 2015 and 2016.[1]

Model	AICc	ΔAICc	*w*	Lik	K	Dev
ψ(.) ε(.) *p*(Temp + Wind + Study)	1499.51	0.00	0.980	1.00	8	1483
ψ(.) ε(.) *p*(Temp + Wind)	1508.38	8.87	0.012	0.01	5	1498
ψ(.) ε(.) *p*(Year + SunMin^2 + DayYear^2)	1509.15	9.63	0.008	0.01	8	1493
ψ(.) ε(.) *p*(Temp)	1520.16	20.65	0.000	0.00	4	1512
ψ(.) ε(.) *p*(Study Area)	1520.31	20.80	0.000	0.00	6	1508
ψ(.) ε(.) *p*(Year + SunMin)	1521.86	22.35	0.000	0.00	5	1512
ψ(.) ε(.) *p*(Year + SunMin^2)	1523.22	23.71	0.000	0.00	6	1511
ψ(.) ε(.) *p*(Wind)	1527.23	27.72	0.000	0.00	4	1519
ψ(.) ε(.) *p*(Year + DayYear)	1528.52	29.01	0.000	0.00	5	1518
ψ(.) ε(.) *p*(Sky)	1528.93	29.41	0.000	0.00	4	1521
ψ(.) ε(.) *p*(Wind + Dist)	1529.09	29.58	0.000	0.00	5	1519
ψ(.) ε(.) *p*(Year + DayYear^2)	1530.02	30.51	0.000	0.00	6	1518
ψ(.) ε(.) *p*(Year*DayYear)	1530.58	31.07	0.000	0.00	6	1518

[1] Wind – ordinal measure of windspeed (Table 2.2). Temp – temperature in degrees Celcius. SunMin – time in minutes that survey took place in relation to sunrise. DayYear – julian day of the year the survey took place. Study – study area on which survey took place. Sky – sky cover classification during survey. Dist- frequency of disturbance events on a scale of 1-3.

Table 2.3. Models of detection (*p*) models for wild turkey gobblers, values for bias corrected AIC, relative difference in AICc, model probability (w), model likelihood (Lik), number of parameters (K), and deviance (Dev) from gobble count surveys in Alabama, spring 2015 and 2016.[2]

Model	AICc	ΔAICc	*w*	Lik	K	Dev
ψ(.) ε(.) *p*(SunMin^2)	1533.85	34.33	0.000	0.00	5	1524
ψ(.) ε(.) *p*(CInt3)	1534.34	34.83	0.000	0.00	4	1526
ψ(.) ε(.) *p*(.)	1538.31	38.80	0.000	0.00	3	1532
ψ(.) ε(.) *p*(Dist)	1540.29	40.78	0.000	0.00	4	1532
ψ(.) ε(.) *p*(Season)	1541.98	42.46	0.000	0.00	5	1532

[2] Wind – ordinal measure of windspeed (Table 2.2). Temp – temperature in degrees Celcius. SunMin – time in minutes that survey took place in relation to sunrise. DayYear – julian day of the year the survey took place. Study – study area on which survey took place. Sky – sky cover classification during survey. Dist- frequency of disturbance events on a scale of 1-3.

Table 2.4. Correlation coefficient matrix depicting the correlation (r) of habitat variables used to create models of male wild turkey use and density in Alabama, spring 2015 and 2016. [3]

	Road	*%WLO*	*WLO#*	*%Developed*	*%HW*	*%TotHW*	*%Pine*	*%Forest*	*P/F*	*HW/F*	*THW/F*
Road	1.000										
%WLO	0.076	1.000									
WLO#	0.374	0.592	1.000								
%Developed	0.149	0.012	0.137	1.000							
%HW	-0.448	0.159	0.051	-0.302	1.000						
%TotHW	-0.451	0.169	0.065	-0.284	0.995	1.000					
%Pine	0.478	-0.222	-0.112	0.023	-0.823	-0.832	1.000				
%Forest	-0.101	-0.060	-0.113	-0.458	0.451	0.458	0.019	1.000			
P/F	0.499	-0.203	-0.078	0.063	-0.860	-0.874	0.942	-0.223	1.000		
HW/F	-0.478	0.204	0.097	-0.129	0.943	0.938	-0.923	0.189	-0.933	1.000	
THW/F	-0.484	0.220	0.117	-0.095	0.926	0.934	-0.937	0.168	-0.948	0.991	1.000
%Shrub	0.421	0.112	0.323	0.262	-0.407	-0.413	0.176	-0.622	0.388	-0.313	-0.305
%Grass	0.213	-0.006	0.058	-0.010	-0.425	-0.443	0.285	-0.520	0.493	-0.393	-0.400
%Food	-0.203	0.064	-0.079	0.268	-0.232	-0.241	-0.176	-0.793	-0.021	0.022	0.038

[3] Road – meters of road in grid cell. %WLO – percent grid cell composed of wildlife openings. #WLO – number of wildlife openings in grid cell. %Developed – percent area NLCD classification "Developed". %HW - percent area NLCD classification "Deciduous". %TotHW - percent area NLCD classification "Deciduous" or "Woody Wetlands". % Pine - percent area NLCD classification "Evergreen". %Forest - percent area NLCD classification of any forest type. P/F - %Pine divided by %Forest. HW/F = %HW divided by %Forest. THW/F = %TotHW divided by %Forest. %Shrub - percent area NLCD classification "Shrub/Scrub". %Grass - percent area NLCD classification "Grassland/Herbaceous". %Food = combined %WLO, %Grass, and percent area NLCD classification "Pasture/Hay" or "Cultivated Crops".

Table 2.4. Correlation coefficient matrix depicting the correlation (*r*) of habitat variables used to create models of male wild turkey use and density in Alabama, spring 2015 and 2016. [4]

	%Shrub	*%Grass*	*%Food*
Road			
%WLO			
WLO#			
%Developed			
%HW			
%TotHW			
%Pine			
%Forest			
P/F			
HW/F			
THW/F			
%Shrub	1.000		
%Grass	0.281	1.000	
%Food	0.031	0.482	1.000

[4] Road – meters of road in grid cell. %WLO – percent grid cell composed of wildlife openings. #WLO – number of wildlife openings in grid cell. %Developed – percent area NLCD classification “Developed”. %HW - percent area NLCD classification “Deciduous”. %TotHW - percent area NLCD classification “Deciduous” or “Woody Wetlands”. % Pine - percent area NLCD classification “Evergreen”. %Forest - percent area NLCD classification of any forest type. P/F - %Pine divided by %Forest. HW/F = %HW divided by %Forest. THW/F = %TotHW divided by %Forest. %Shrub - percent area NLCD classification “Shrub/Scrub”. %Grass - percent area NLCD classification “Grassland/Herbaceous”. %Food = combined %WLO, %Grass, and percent area NLCD classification “Pasture/Hay” or “Cultivated Crops”.

Table 2.5. Models of occupancy (ψ) and detection (*p*) of wild turkey gobblers, values for bias corrected AIC, relative difference in AICc (ΔAICc), model probability (w), model likelihood (Lik), number of parameters (K), and deviance (Dev) on gobble count surveys in Alabama, spring 2015 and 2016.[5]

Model	AICc	ΔAICc	*w*	Lik	K	Dev
ψ(Season) ε(.) *p*(Study + Temp + Wind)	1491.47	0.00	0.509	1.00	10	1471
ψ(IndSeason) ε(.) *p*(Study + Temp + Wind)	1493.15	1.68	0.220	0.43	13	1466
ψ(%Forest * (Pine/Forest)) ε(.) *p*(Study + Temp + Wind)	1495.54	4.07	0.067	0.13	11	1473
ψ(%Pine) ε(.) *p*(Study + Temp + Wind)	1497.14	5.67	0.030	0.06	9	1479
ψ(%Shrub^2) ε(.) *p*(Study + Temp + Wind)	1497.47	6.01	0.025	0.05	10	1477
ψ(%Forest^2 * (Pine/Forest)) ε(.) *p*(Study + Temp + Wind)	1497.67	6.21	0.023	0.04	12	1473
ψ(%HW) ε(.) *p*(Study + Temp + Wind)	1498.23	6.77	0.017	0.03	9	1480
ψ(%Pine^2) ε(.) *p*(Study + Temp + Wind)	1498.73	7.27	0.013	0.03	10	1478
ψ(Study Area) ε(.) *p*(Study + Temp + Wind)	1498.88	7.42	0.012	0.02	11	1476
ψ(%TotHW) ε(.) *p*(Study + Temp + Wind)	1499.15	7.68	0.011	0.02	9	1481
ψ(%Developed) ε(.) *p*(Study + Temp + Wind)	1499.32	7.85	0.010	0.02	9	1481
ψ(.)ε(.) *p*(Study + Temp + Wind)	1499.51	8.05	0.009	0.02	8	1483
ψ(%HW^2) ε(.) *p*(Study + Temp + Wind)	1499.90	8.44	0.008	0.01	10	1479
ψ(#WLO) ε(.) *p*(Study + Temp + Wind)	1500.50	9.03	0.006	0.01	9	1482
ψ(%Food) ε(.) *p*(Study + Temp + Wind)	1500.73	9.26	0.005	0.01	9	1482

[5] Wind – ordinal measure of windspeed (Table 2.2). Temp – temperature in degrees Celcius. Study – study area on which survey took place. Season – season in which survey took place with no distinction between years. IndSeason – season in which survey took place with distinction between years. Road – meters of road in grid cell. %WLO – percent grid cell composed of wildlife openings. #WLO – number of wildlife openings in grid cell. %Developed – percent area NLCD classification "Developed". %HW - percent area NLCD classification "Deciduous". %TotHW - percent area NLCD classification "Deciduous" or "Woody Wetlands". % Pine - percent area NLCD classification "Evergreen". %Forest - percent area NLCD classification of any forest type. P/F - %Pine divided by %Forest. HW/F = %HW divided by %Forest. THW/F = %TotHW divided by %Forest. %Shrub - percent area NLCD classification "Shrub/Scrub". %Grass - percent area NLCD classification "Grassland/Herbaceous". %Food = combined %WLO, %Grass, and percent area NLCD classification "Pasture/Hay" or "Cultivated Crops".

Table 2.5. Models of occupancy (ψ) and detection (*p*) of wild turkey gobblers, values for bias corrected AIC, relative difference in AICc (ΔAICc), model probability (w), model likelihood (Lik), number of parameters (K), and deviance (Dev) on gobble count surveys in Alabama, spring 2015 and 2016.[6]

Model	AICc	ΔAICc	*w*	Lik	K	Dev
ψ(%TotHW^2) ε(.) *p*(Study + Temp + Wind)	1500.86	9.39	0.005	0.01	10	1480
ψ(%Shrub) ε(.) *p*(Study + Temp + Wind)	1500.95	9.48	0.004	0.01	9	1482
ψ(Road) ε(.) *p*(Study + Temp + Wind)	1500.96	9.49	0.004	0.01	9	1482
ψ(%WLO) ε(.) *p*(Study + Temp + Wind)	1501.07	9.60	0.004	0.01	9	1483
ψ(%Forest) ε(.) *p*(Study + Temp + Wind)	1501.53	10.06	0.003	0.01	9	1483
ψ(Year) ε(.) *p*(Study + Temp + Wind)	1501.56	10.10	0.003	0.01	9	1483
ψ(%Forest^2 + (TotHW/Forest)) ε(.) *p*(Study + Temp + Wind)	1501.98	10.52	0.003	0.01	11	1479
ψ(%Forest^2 + (Pine/Forest)) ε(.) *p*(Study + Temp + Wind)	1502.28	10.81	0.002	0.00	11	1480
ψ(%Forest^2 * (TotHW/Forest)) ε(.) *p*(Study + Temp + Wind)	1502.51	11.05	0.002	0.00	12	1478
ψ(%Forest^2) ε(.) *p*(Study + Temp + Wind)	1503.25	11.78	0.001	0.00	10	1483
ψ(%Forest * (TotHW/Forest)) ε(.) *p*(Study + Temp + Wind)	1517.25	25.78	0.000	0.00	11	1494
ψ(%Food^2) ε(.) *p*(Study + Temp + Wind)	1523.97	32.51	0.000	0.00	10	1503
ψ(.)ε(.) *p*(.)	1538.31	46.85	0.000	0.00	3	1532

[6] Wind – ordinal measure of windspeed (Table 2.2). Temp – temperature in degrees Celcius. Study – study area on which survey took place. Season – season in which survey took place with no distinction between years. IndSeason – season in which survey took place with distinction between years. Road – meters of road in grid cell. %WLO – percent grid cell composed of wildlife openings. #WLO – number of wildlife openings in grid cell. %Developed – percent area NLCD classification "Developed". %HW - percent area NLCD classification "Deciduous". %TotHW - percent area NLCD classification "Deciduous" or "Woody Wetlands". % Pine - percent area NLCD classification "Evergreen". %Forest - percent area NLCD classification of any forest type. P/F - %Pine divided by %Forest. HW/F = %HW divided by %Forest. THW/F = %TotHW divided by %Forest. %Shrub - percent area NLCD classification "Shrub/Scrub". %Grass - percent area NLCD classification "Grassland/Herbaceous". %Food = combined %WLO, %Grass, and percent area NLCD classification "Pasture/Hay" or "Cultivated Crops".

Table 2.6. Model-averaged estimates (ψ) and Lower and Upper 95% Confidence Limits (LCL, UCL) for probability of use for male wild turkeys across study areas. Early took place 1 March through 28 March, Mid took place 29 March through 24 April, and Late took place 25 April through 30 May

	All Study Areas			Barbour WMA			Oakmulgee WMA			Scotch WMA			Skyline WMA		
	ψ	LCL	UCL	ψ	LCL	UCL	ψ	LCL	UCL	ψ	LCL	UCL	ψ	LCL	UCL
Early	0.290	0.258	0.322	0.299	0.277	0.321	0.298	0.280	0.315	0.305	0.273	0.336	0.279	0.255	0.302
Mid	0.406	0.374	0.437	0.415	0.392	0.437	0.414	0.396	0.431	0.420	0.389	0.451	0.394	0.371	0.418
Late	0.298	0.266	0.329	0.307	0.285	0.329	0.305	0.288	0.323	0.312	0.281	0.343	0.286	0.263	0.310
Average	0.331	0.299	0.363	0.340	0.318	0.362	0.339	0.321	0.357	0.346	0.315	0.377	0.320	0.296	0.343

Figure 2.1. The effect of percentage of pine on the relationship of male wild turkey use to percentage of forested area within a 400 ha grid cell and percentage of that forested area that is composed of pine trees in Alabama, spring 2015 and 2016. Each line represents a different percentage of pine within the forest.

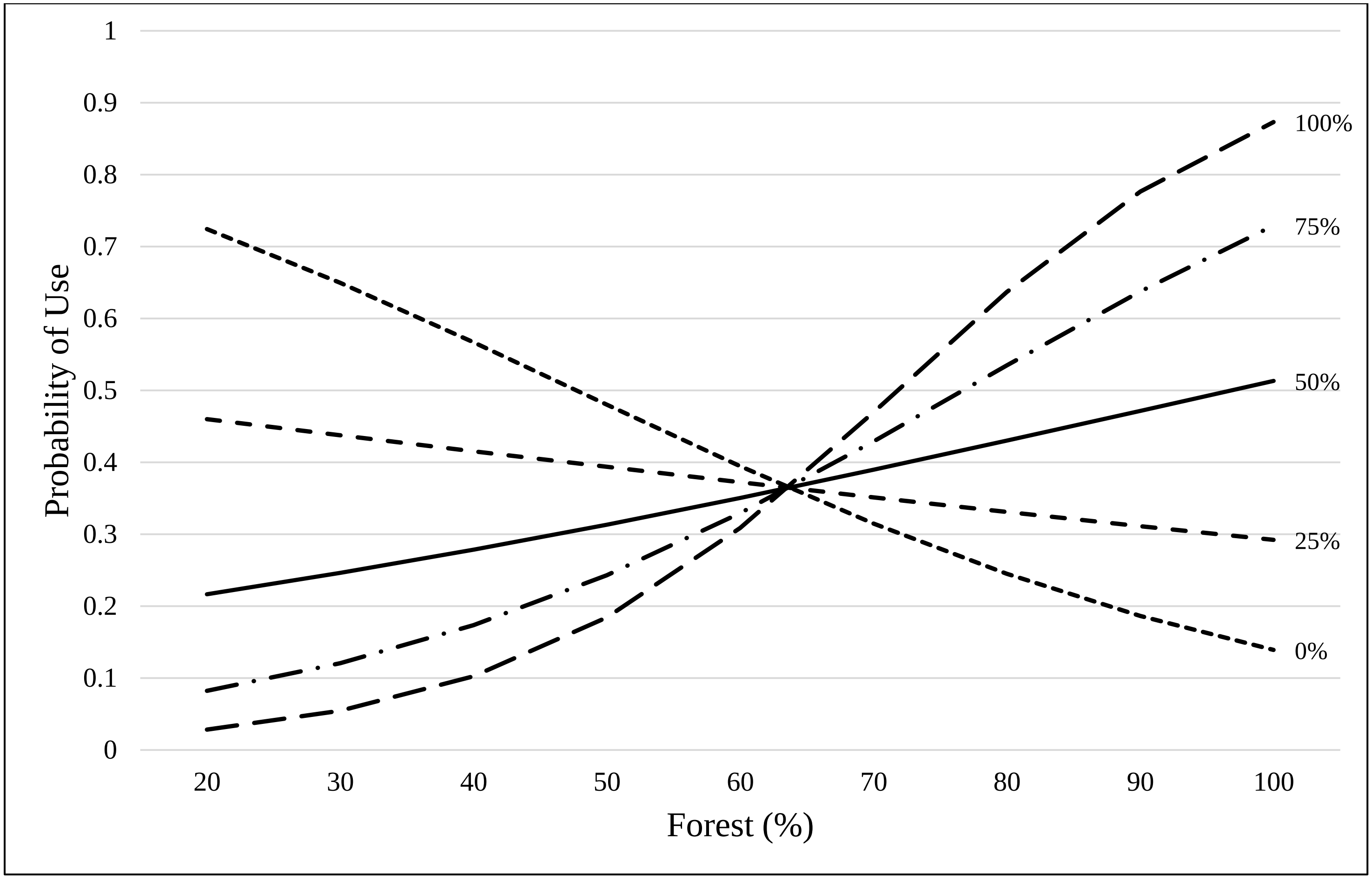

Table 2.7. Comparison of density (λ) and detection (*p*) models for wild turkey gobblers using gobble count surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[7]

Model	AIC	ΔAIC	*w*	Lik	K
λ(%Forest * Proportion Pine) *p*(Temp + Wind + Study Area)	635.41	0.00	0.642	307.70	10
λ(%Forest^2 * Proportion Pine) *p*(Temp + Wind + Study Area)	637.40	1.99	0.237	307.70	11
λ(%Forest * Proportion HW) *p*(Temp + Wind + Study Area)	642.57	7.16	0.018	311.28	10
λ(%Pine^2) *p*(Temp + Wind + Study Area)	642.62	7.21	0.017	312.31	9
λ(%Food) *p*(Temp + Wind + Study Area)	643.09	7.68	0.014	313.54	8
λ(%Food^2) *p*(Temp + Wind + Study Area)	643.60	8.19	0.011	312.80	9
λ(%WLO) *p*(Temp + Wind + Study Area)	643.72	8.31	0.010	313.86	8
λ(%Forest^2 * Proportion HW) *p*(Temp + Wind + Study Area)	644.54	9.13	0.007	311.27	11
λ(#WLO) *p*(Temp + Wind + Study Area)	644.59	9.18	0.007	314.30	8
λ(%HW) *p*(Temp + Wind + Study Area)	644.67	9.26	0.006	314.33	8
λ(%TotHW) *p*(Temp + Wind + Study Area)	645.06	9.65	0.005	314.53	8
λ(%Pine) *p*(Temp + Wind + Study Area)	645.34	9.93	0.004	314.67	8
λ(.) *p*(Temp + Wind + Study Area)	645.86	10.45	0.003	315.93	7
λ(%HW^2) *p*(Temp + Wind + Study Area)	646.17	10.76	0.003	314.08	9
λ(%Shrub^2) *p*(Temp + Wind + Study Area)	646.17	10.76	0.003	314.09	9
λ(%Forest) *p*(Temp + Wind + Study Area)	646.45	11.04	0.003	315.23	8
λ(%TotHW^2) *p*(Temp + Wind + Study Area)	646.68	11.27	0.002	314.34	9

[7] Wind – ordinal measure of windspeed (Table 2.2). Temp – temperature in degrees Celcius. Study Area – study area on which survey took place. %WLO – percent grid cell composed of wildlife openings. #WLO – number of wildlife openings in grid cell. %HW - percent area NLCD classification “Deciduous”. %TotHW - percent area NLCD classification “Deciduous” or “Woody Wetlands”. % Pine - percent area NLCD classification “Evergreen”. %Forest - percent area NLCD classification of any forest type. Proportion Pine - %Pine divided by %Forest. Proportion HW = %HW divided by %Forest. %Shrub - percent area NLCD classification “Shrub/Scrub”. %Food = combined %WLO, %Grass, and percent area NLCD classification “Pasture/Hay” or “Cultivated Crops”.

Table 2.7. Comparison of density (λ) and detection (*p*) models for wild turkey gobblers using gobble count surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[8]

Model	AIC	ΔAIC	*w*	Lik	K
λ(%Developed) *p*(Temp + Wind + Study Area)	647.75	12.34	0.001	315.87	8
λ(%Shrub) *p*(Temp + Wind + Study Area)	647.86	12.45	0.001	315.93	8
λ(Study Area) *p*(Temp + Wind + Study Area)	647.91	12.50	0.001	313.96	10
λ(%Forest + Proportion HW) *p*(Temp + Wind + Study Area)	648.17	12.76	0.001	315.09	9
λ(%Forest^2) *p*(Temp + Wind + Study Area)	648.22	12.81	0.001	315.11	9
λ(%Forest^2 + Proportion Pine) *p*(Temp + Wind + Study Area)	650.07	14.66	0.000	315.03	10
λ(%Forest^2 + Proportion HW) *p*(Temp + Wind + Study Area)	650.08	14.68	0.000	315.04	10
λ(.) *p*(.)	118.00	653.37	17.956	0.00	2

[8] Wind – ordinal measure of windspeed (Table 2.2). Temp – temperature in degrees Celcius. Study Area – study area on which survey took place. %Developed – percent area NLCD classification "Developed". %Forest - percent area NLCD classification of any forest type. Proportion Pine - %Pine divided by %Forest. Proportion HW = %HW divided by %Forest. %Shrub - percent area NLCD classification "Shrub/Scrub".

Figure 2.2. Relationship of male wild turkey density to percentage of forested area within a 4 km2 grid cell and percentage of that forested area that is composed of pine trees in Alabama, spring 2015 and 2016. Each line represents a different percentage of pine within the forest.

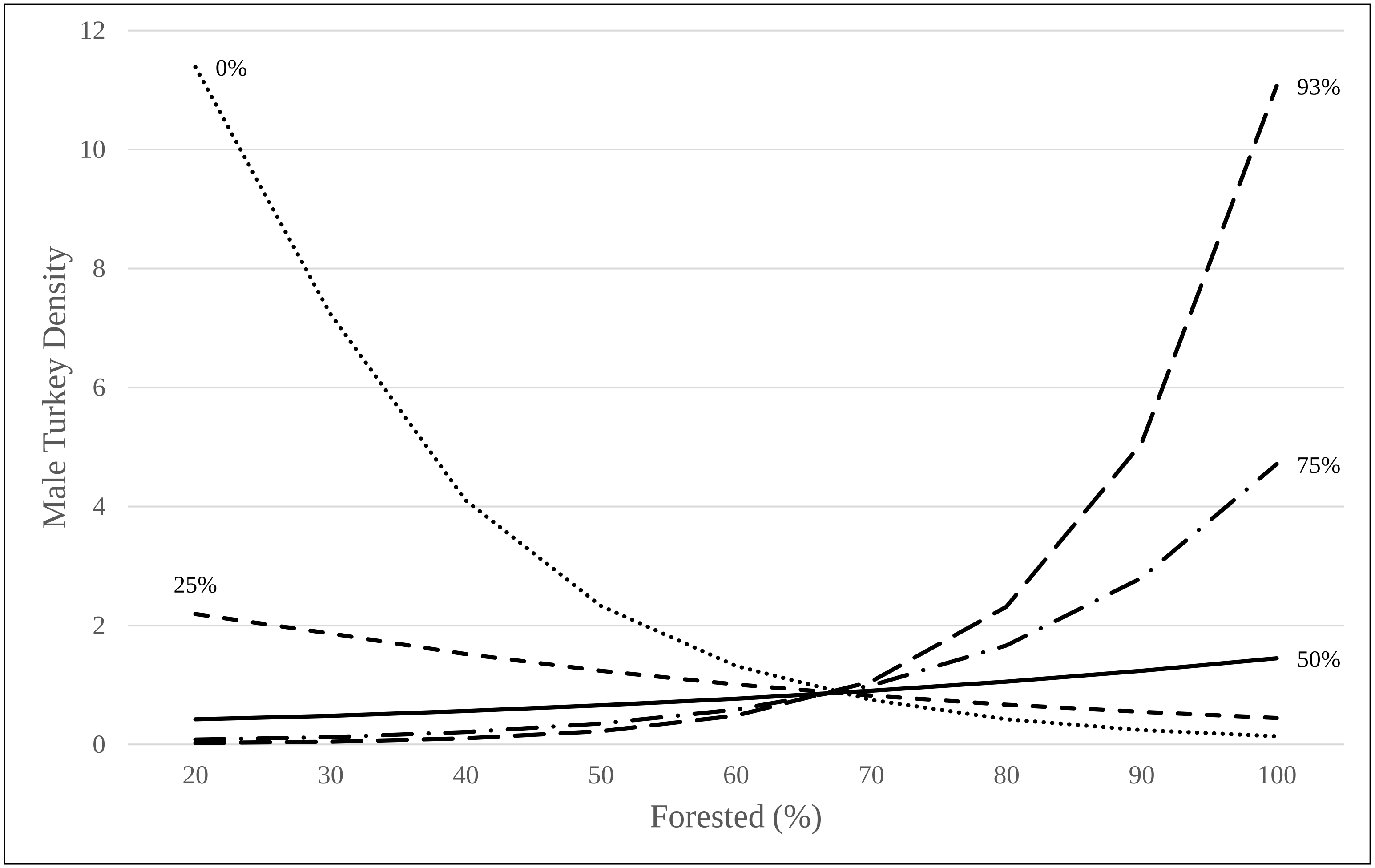

Table 2.8. Estimates of density of male turkeys estimated from gobble counts by study area in Alabama, spring 2015 and 2016. For each area, the mean male turkey density (Mean), standard deviation of the mean (SD), lower 95% confidence limit of mean density (LCL), upper 95% confidence limit of mean density (UCL), and mode of densities (Mode) were reported.

Study Area	Mean	SD	LCL	UCL	Mode
Barbour	0.983	0.143	0.70272	1.26328	0.236
Oakmulgee	0.784	0.123	0.54292	1.02508	0.115
Scotch	0.988	0.162	0.67048	1.30552	0.168
Skyline	0.709	0.076	0.56004	0.85796	0
Average	0.816	0.056	0.70624	0.92576	0

CHAPTER III: CAMERA SURVEYS AS A TOOL FOR ESTIMATING EASTERN WILD TURKEY USE, DENSITY, AND PRODUCTIVITY

Introduction

Effective management of wildlife requires knowledge of the size and structure of their populations (Lyons et al. 2008). Many states manage eastern wild turkey (*Meleagris gallopavo silvestris*; hereafter turkey) populations using estimates of population size and structure that are based on expert opinion of habitat-specific population density or harvest rate and sex ratio (ADCNR 2014, MDWFP 2016). Estimates of turkey density are based on estimates of forest cover but there is little confidence in the accuracy of these estimates and they lack any measure of precision. This limits the confidence managers can have in the decisions they make regarding turkey management. Estimates validated by empirical data about turkey populations would provide better information on which to base recurring management decisions regarding harvest and habitat management (Iglecia et al. 2012). Multiple types of count-based surveys could be used to estimate the size and structure of turkey populations (Wunz 1990, Butler et al. 2007, Rioux et al. 2009) and would provide precise estimates that inform management decisions.

In addition to current population size and structure, vital rates and how they are related to population change can be incorporated when making management decisions (Miller et al. 1998). One such vital rate, poult production, has significant impacts on turkey population growth over time (Vangilder and Kurzejeski 1995, Roberts et al 1995). Population growth rates will be lower without sufficient recruitment of poults into the fall population, which will affect the turkey populations in subsequent years. Surveys that estimate population size and structure can be used to track changes in poult per hen ratio, which is a measurement of productivity (Vangilder and Kurzejeski 1995). This information can be obtained through the same methods as estimates of population size and could allow managers to make better decisions that can maintain sustainable turkey populations into the future.

Multiple survey methods exist for monitoring turkey populations. Gobble counts are commonly used for monitoring but variability in male gobbling activity (Hoffman 1990, Palmer et al. 1990, Chapter II) may result in biased results. Roadside surveys have also been used, but the ability to detect turkeys in areas with under-developed road systems or in heavily forested areas is low. Camera surveys are an alternative method that can be used to monitor changes in occupancy and density of populations (Gerber et al. 2014, Lewis et al. 2015). Camera surveys have been primarily used to study mammalian species, but their utility in monitoring avian populations should not be overlooked (Kucera and Barret 2011). Cleared areas in forest that are actively managed for wildlife use (I.e. wildlife openings) are regularly utilized by turkeys for foraging (Dickson 1992) and provide an ideal location for camera traps. Thus, camera surveys may be able to provide a more reliable and accurate picture of turkey populations compared to estimates based on expert opinion.

Both presence/absence and count data can be obtained using camera surveys. This information can be analyzed using occupancy models to generate estimates of use (MacKenzie 2006) and density (Royle 2004) of turkeys. From density estimates of poults and hens, an index of productivity can then be generated in the form of a poults per hen ratio, which is a useful measure of recruitment of offspring into the fall population. Effects of covariates on the parameters of interest can be quantified to provide insight into the ecology of turkeys.

Information about expected turkey densities in different landcover types can be used to validate and improve the current population estimation methods in use by state agencies. This information can also be used to inform land management choices to better suit turkey populations.

Accounting for variability in detection and density due to environmental effects is important for providing precise and unbiased estimates. It is not possible to make inferences about a system without first measuring what changes in observations may be due to random variation in detectability (MacKenzie et al. 2002). Failing to incorporate imprecision and bias that results from responses to landcover characteristics leads to greater potential for errors in management decisions (Romesburg 1981, Anderson 2001). Data collected through camera surveys allows for the incorporation of sampling and landcover parameters that affect estimates, which in the end, can increase precision and reduce the uncertainty of estimates.

Camera surveys can also improve understanding of variation in the ecological processes affecting turkey populations and behavior. Productivity may be heterogeneous across landscapes due to differences in habitat suitability and environmental variables. Areas with greater availability of insects, seeds, and plant matter for foraging can sustain greater numbers of poults (Healy 1985). Shrub density and the average diameter of trees have been correlated with brood survival (Spears et al 2007). Variation in predation rate, a limiting factor on turkey productivity (Speake et al. 1985), can also be a source of heterogeneity. Increasing understanding of these types of relationships between productivity and environmental factors will allow for increased precision in estimates, which reduces the uncertainty when making management decisions (Romesberg 1981).

The goal of this study was to estimate density and productivity of turkeys in different landscapes across the state of Alabama using camera trap surveys. My objectives were to 1) identify sources of variation in detection during the camera surveys; 2) estimate use and density of males, females, poults and total turkeys counted across my study areas during the brood rearing season; 3) identify landcover characteristics that explain variation in use and density of turkeys; and 4) estimate productivity of turkeys on my study areas as poults produced per hen.

Study Area and Methods

For a description of study areas where camera surveys were conducted, see Chapter II of this thesis.

Camera surveys were conducted on each study area during the brood-rearing season (June 17 – 9 August). During this time period hens with poults had moved to brood rearing areas and were actively feeding (Godfrey and Norman 1999), but offspring were still distinguishable from adult turkeys (Barry Grand pers. comm.). Surveys were performed on 172 managed wildlife openings. Over the two years of the study, 45 openings were sampled on Barbour WMA, 47 on Oakmulgee WMA, 35 on Scotch WMA, and 45 on Skyline WMA. Sites were selected at random from all known and accessible managed wildlife openings. Sites that were within 500m of other sites were determined to have a high potential for double counting individuals. To avoid this potential bias in my analysis, when an opening was within 500m of another opening, one opening was chosen at random for use in the analysis. This removal of proximate openings led to a final total of 217 surveys conducted on 141 wildlife openings over the 2 years.

Reconyx PC85, Reconyx PC800 (RECONYX Inc., Holmen, Wisconsin), and Spartan SR1-IR (HCO Outdoor Products, Norcross, Georgia) trail cameras were used to conduct surveys.

Five days prior to deploying a camera, the tree or post for mounting the camera was selected. Approximately 5m away from the camera location, an area $1m^2$ was cleared to bare soil for bait. All vegetation within at least 5m of the bait site also was cut to ground level. Each site was baited with cracked corn or a cracked corn and sorghum mixture, raked into the soil to encourage scratching and repeated use of the area to increase the probability of detecting turkeys during the survey.

Five days after baiting, a camera was secured to the mounting location. The camera was placed between 0.75-1.5 m above ground and oriented to capture turkeys utilizing the bait pile. The camera's line of site was checked and cleared of any potential obstruction. Fresh bait was distributed at the bait site and raked into the ground. The camera was programmed to capture an image every 4 minutes from sun up until sun down and was left for at least 5 days. Each image was reviewed and the number of males, females, poults and unidentifiable turkeys was recorded. Identification of sex and age was based on plumage, presence of a beard or spurs, and size of the bird (Dickson 1992).

Locations of roads and managed wildlife openings as well as wildlife opening perimeters were provided by the ADCNR and were verified using a handheld GPS receiver (GPS map76x, Garmin International Inc., Olathe, KS, USA). Aerial imagery (NAIP 2015, NAIP 2016) in ArcGIS (version 10.3.1; ESRI, Redlands, CA, USA) was used to update information about roads and wildlife openings that were either not represented by the initial information provided by the ADCNR or no longer existed. Land cover type and distribution were obtained from 2011 National Land Cover Data (NLCD, Homer et al. 2015). The percentage cover of all available land cover classifications was quantified within a circular buffer around each wildlife opening.

Buffers with radii of 500m and 1,750m were used based on previous studies of turkey movement rates during the summer brood rearing season (Godfrey and Norman 1999, Barwick and Speake 1973). Percent cover of similar NLCD classifications were combined to create broader classifications for analysis. Percent of area forested was the total percent area of deciduous forests, mixed forests, evergreen forests, and woody wetlands. Percent of area developed was the total percent area of the 4 separate developed land classifications (Open, Low Intensity, Medium Intensity, and High intensity). Percent of area in agriculture was the total area of pasture/hay and cultivated crops. Percent of area in foraging habitat was the total percent area of agriculture, grassland, and wildlife openings. Correlations among site characteristics were calculated using Excel 2013 (Microsoft, Redmond, WA, USA). Correlation coefficients (r) for all landcover characteristics were compared to identify potential collinearity among covariates. If covariates showed a strong collinear relationship, they were not used in the same model.

Models of detection, use, and density were compared using the unmarked package (Fiske and Chandler 2011) in Program R (R Core Team 2016). A single season occupancy estimator (MacKenzie et al. 2002) was used to estimate detection probability (p) and probability of use (ψ) by turkeys. An N-mixture estimator (Royle 2004) was used to obtain estimates of detection probability (p) and abundance (λ). A Poisson distribution was used to model densities for all categories of wild turkeys. Each analysis was performed separately for males, females, poults, and the total number of turkeys captured. Encounter histories for the occupancy estimator were constructed by recording whether a turkey was detected during a sampling occasion. For the N-Mixture estimator, encounter histories were constructed by recording the maximum number of turkeys counted on a single image during a sampling occasion. Sampling occasions were hour-long periods between 0600 and 1900. If a site was surveyed in two different years, a separate encounter history was created for each year. If a camera did not record the full survey duration due to equipment or user error, all hours that were not surveyed were treated as missing values.

A priori models of detection, use, and density were compared using Akaike Information Criterion and estimates were generated using multiple model inference (Burnham and Anderson 2002). For all surveyed wildlife openings, a site-specific estimate of use and density for each class of turkey (male, female, poults, and unknown) was generated using the model-averaged estimates of covariate effects. Site-specific estimates of use for each wildlife opening were averaged to estimate mean use across study areas and standard deviations. From site-specific densities, I estimated mean and mode of density for each class of turkey across study areas. Densities for each opening were sampled with replacement according to a Poisson distribution. Density estimates were expressed as the mean and mode of a Poisson distribution. Poults per hen ratios were estimated for each opening using site-specific density distributions and were averaged across study areas. Confidence limits for density and poults per hen ratio were generated using parametric bootstrapping (Efron and Tibshirani 1994), employing 10,000 bootstrap replicates.

Results

In 2015, 125 managed wildlife openings were surveyed from 17 June through 30 July. 134 wildlife openings were surveyed from 27 Jun through 9 August 2016. Over all surveys, 296,335 time-lapse images were recorded and interpreted. Among them, turkeys were detected in 7,744 (2.6%) images. Females were the most frequently observed class of turkey, and appeared in 3,968 (51%) of photos containing turkeys. In comparison, male turkeys were observed in 2,150 photos (28%) and poults in 1,011(13%). Additionally, 1,981 turkey photos (26%)

contained turkeys that could not be easily classified into any of the three groups. Over the two years of the study, turkeys of any class were observed on 75.6% of wildlife openings surveyed. Male turkeys, female turkeys, and poults were observed on 34.3%, 65.1% , and 20.9% of wildlife opening surveyed, respectively.

There were few differences in the best approximating models for detection between the Occupancy and N-Mixture estimators. For both estimators, the best model for explaining variation in detection of all turkeys within a survey included days since bait was last replenished, study area, and a quadratic relationship with hour of the day (Table 3.1, Table 3.2). For male turkeys, detection according to the single season occupancy estimator was best estimated from the study area and the amount of days since bait was last replenished at the camera site (Table 3.3). When using the N-mixture estimator, detection of male turkeys was best explained by the year and day of the year in addition to day since bait and study area (Table 3.4). Female turkey detection was best explained by an occupancy model based on study area, a quadratic relationship of the hour of the day, and the number of days since bait was replenished (Table 3.5). The best N-mixture model was similar but study area was not an important covariate (Table 3.6). The best approximating model for poults included study area, a quadratic relationship of the hour of the day, and the number of days since bait was last replenished for both the Occupancy (Table 3.7) and N-mixture (Table 3.8) analyses.

The number of wildlife openings within a 1,750m radius was positively correlated with hardwood forests and negatively correlated with pine forests (Table 3.9). Distance to next nearest wildlife opening was negatively correlated with hardwood forest within a 1,750m radius and a positively correlated with pine forest within a 1,750m radius. Density of roads within a 1,750m radius was negatively correlated with hardwood forests and positively correlated with pine forests.

Best models for explaining landcover relationships to use widely varied among the four classes of turkeys. This variation can be seen in the important covariates, the scale at which the covariates were analyzed, and the level of parsimony among models. Use by total turkeys was best explained by a model based on the percentage of pine available within a 500m radius of the camera (Table 3.10). For every 1 percent increase in pine forest within a 500m radius, probability of use by a turkey increased 1.050 times (1.041-1.059; 95% C.L.). Three models explained poult use better than the null model according to my comparisons. The best model was based on a negative relationship between poult use and the percentage of land cover comprised of managed wildlife openings within a 500m radius of the camera point (Table 3.11). A model describing the quadratic relationship with the percentage area comprised of brood foraging habitat within a 500m radius (Table 3.11) and a model describing the percent area comprised of pine forest within a 500m radius (Table 3.11) also performed better than the null model. The best model for explaining adult male turkey use was based on percent of a 1,750m buffer composed of forested area and an interaction with the proportion of the forested area comprised of pine (Table 3.12). The next 5 best explanatory models for describing adult male use were also based on forest cover and the composition of the forest within a 1,750m radius (Table 3.12). These 6 best models for adult male use showed that when forests were composed of more pine trees compared to hardwoods, probability of use of wildlife openings was greater (Figure 3.1, Figure 3.2). The model that best explained use by females showed a positive relationship between use and percentage of pine forest within 500m (Table 3.13). Hen use was best described by characteristics of forested area within a 500m radius (Table 3.13), compared to male use which was better explained at a 1,750m radius (Table 3.12).

The model-averaged probability of use of wildlife openings by any turkey was 0.612 (0.218-1.000; 95% C.L.). Probability of opening use by male turkeys was 0.258 (0.032-0.483; 95% C.L.), and probability of use by female turkeys was 0.456 (0.284-0.627; 95% C.L.). Poult use was comparatively less than males and females with a 0.140 (0.120-0.160; 95% C.L.) probability of opening use. Use of wildlife openings by turkeys was greatest at Scotch WMA (Table 3.14). Probability of use by males was greatest at Oakmulgee WMA and use by females was greatest at Scotch WMA (Table 3.14). Poult use of wildlife openings was similar across all study areas (Table 3.14).

Top models for total turkey density (Table 3.15) and poult density (Table 3.16) were both unequivocal (ΔAIC >2). Top model describing turkey density included a quadratic term for percent area within a 500m radius composed of forest and an interaction with the proportion of that forested area composed of hardwood trees (Figure 3.3). Top model describing poult density included a quadratic term for percent area within a 1,750m radius composed of forest and an interaction with the proportion of that forested area composed of hardwood trees (Figure 3.4). The top model for male density (Table 3.17) included the percent area forested within a 500m radius with an interaction with the proportion of that forested area composed of pine trees (Figure 3.5). The top model for female density included a quadratic term for the percent area forested within a 1,750m radius and an interaction with the proportion of that forest that was comprised of hardwood trees (Figure 3.6). The next best model had a ΔAIC of 0.07 and was based on the same covariates as the top model but quantified within a 500m radius (Table 3.18).

Density of all turkeys on surveyed wildlife openings had a mean of 4.747 (4.387-5.106; 95% C.L.) with a mode of 2.524 (0.0-5.088; 95% C.L.). Male turkey density had an estimated mean of 0.850 (0.696-1.003; 95% C.L.) and mode of 0.001 (0.0-0.072; 95% C.L.). Female turkey density had an estimated mean of 1.729 (1.512-1.945; 95% C.L.) and mode of 1.119 (0.325-1.913; 95% C.L.). Poult density had an estimated mean of 1.309 (1.120-1.500; 95% C.L.) and mode of 0.069 (0.0-0.567; 95% C.L.). Oakmulgee WMA and Scotch WMA had greater densities of total turkeys than Barbour WMA and Skyline WMA (Table 3.19). Oakmulgee WMA had the greatest density of male turkeys and Scotch WMA had the greatest density of female turkeys and poults (Table 3.19). The average poults per hen ratio for all wildlife openings surveyed was estimated at 0.748 (0.570-0.925; 95% C.L.). Scotch WMA had the greatest productivity and Barbour WMA had the least, although there was overlap of confidence limits among the study areas (Table 3.20).

Discussion

Identifying and understanding the sources of variation in detection is important for determining what variability in my estimates can be attributed to changes in density rather than changing detection of individuals. A common variable in all top detection models was the number of days since bait was last replenished. For all sexes and ages, as the number of days since bait was last replaced increased, the probability of detecting a turkey on camera increased. This increase in detection was likely due to increased visitation of an area once a reliable food source was discovered. Turkeys have been shown to spend significant parts of their day in planted crops where available (Porter et al. 1980). Haines et al (2004) saw that quail concentrated their movements along roads that were baited. The probability of a turkey finding and using a bait pile increased with the amount of time that bait was on the ground.

The area used by an animal in its normal activities of food gathering, mating, and caring for young is considered its home range (Burt 1943, Powell and Mitchell 2012). No research currently exists that assesses the shifting of turkey home ranges as a response to bait. Studies of quail home ranges have shown that home range size may decrease in response to bait (Sisson et al. 2000, Haines et al. 2004), but none examined movement of home ranges. While use of bait may affect the size of wild turkey home ranges and their movement within it, it seems unlikely that turkeys shift home ranges to utilize areas they were not already using. For turkeys to find a bait pile, the bait would have be within its home range.

In addition to days since bait, a quadratic relationship of hour of the day and detection probability was also found in detection models for total turkeys, female turkeys, and poults. This indicated that there were specific times of the day when movement on wildlife opening increased, typically early in the morning and late in the afternoon. This pattern of increased foraging activity during specific parts of the day has been observed in many avian species (Verbeek 1972, Burton and Hudson 1978, Hutto 1981). Future surveys could reduce the number of pictures taken by programing cameras to operate during peak movement periods, which would reduce the time required to interpret the photos. Detection probability also varied according to study area. The cause of this difference in turkey movement behavior is difficult to identify without further research due to variability in landcover, management practices, and human activity levels among the 4 study areas.

Increasing the precision of turkey population size estimates requires an understanding of how turkey densities vary according to landcover. My comparisons of use and density models indicated that fine scale landcover characteristics helped explain the relationship between wild turkey density and landcover. These included the amount and type forest cover available and the availability of brood rearing habitat such as wildlife openings and agricultural fields. Landcover characteristics have been previously observed to correlate with differences in use of other populations studied. Hens in Mississippi used pine plantations in the spring and summer and hardwood streamside management zones in the fall (Palmer et al. 1993). Brood habitat in southeastern Minnesota was characterized by hardwoods interspersed with agricultural fields (Porter 1980). In Alabama, hens with broods used many types of openings including permanent pastures, mowed grass, grain and legume fields, and old fields (Speake 1975). Relationships of use and density with landcover were readily quantified from current landcover information and can be easily incorporated to increase precision of estimates of turkey population size over larger areas.

Different classes of turkeys varied in density depending on the variables of importance and the scale at which they are quantified. Poults, females, and total turkey use as well as male and total turkey density responded to landcover variables quantified at a 500m scale. Male turkey use and poult density were best explained when variables were quantified within 1,750m radius. Female density model weights were closely split between the two spatial scales I analyzed. This difference in spatial scale may be related to the shifting diet of the aging poults they were attending. As poults age, they shift from primarily consuming insects to a diet made up primarily of plant matter (Healy 1985). Poults may need to utilize a greater amount of area to meet such needs through the brood rearing season. The increased movement of poults would also explain why hen density was split between the two spatial scales as brood flocks have different needs than hens without broods. These results emphasize the importance of accounting for the spatial scale of information when predicting population sizes for different classes of turkeys.

Density estimates for total turkeys did not equal the summed densities of males, females, and poults. This was because unknown turkeys were only accounted for within the total turkey classification. After reviewing photos containing unknown turkeys, the primary reasons for classifying a turkey as unknown was the distance from the camera or only a partial image of the turkey was captured. If all turkeys are equally likely to be classified as unknown, this should not lead to any bias in my results and the age and sex ratios will be correct. Due to the social dynamics of male turkeys (Dickson 1992), dominant males may exclude other males from using bait piles, which could lead to male turkeys being photographed at distances that would make classification difficult. Occupancy analysis is based on the assertion that false positives such as misclassification do not occur (Royle and Link 2006), so it is critical to limit them to prevent bias. Further research is necessary to determine whether some classes of turkey are more likely to be misclassified than others.

I observed an average productivity of 0.707 poults per hen across my study areas. According to opportunistic counts that were not adjusted for detection bias, estimates of turkey productivity in the southeast have ranged between 1.08 and 2.12 poults per hen over the past ten years (ADCNR 2016, MDWFP 2016). These differences in estimates may be attributed to difference in methodology. Opportunistic roadside surveys are typically conducted to estimate productivity (Sands and Pope 2010). Poult group size and location are reported as they are encountered by both biologists, as well as private citizens. I believe that my estimates of poults per hen ratio more realistically represent wild turkey productivity in the southeast. Roadside surveys for Galliformes are prone to multiple forms of bias (Betts et al 2007, Robinson et al 2000). Information collected by untrained volunteers can be problematic because it is usually unstandardized, which lends to producing biased results (Snäll et al. 2011). If these opportunistic roadside surveys led to bias in encountering or reporting hens with broods versus unsuccessful hens, which have been shown to use habitat differently (Ross and Wunz 1990), estimates of productivity would be inflated. By taking advantage of managed wildlife openings, an area frequently used by turkeys during the summer (Sisson et al. 1991, Spears et al. 2007), I avoided potential sampling bias associated with opportunistic surveys. Camera surveys used in combination with maximum likelihood estimators such as the N-Mixture estimator allowed me to account for additional bias due to detection or landcover relationships (Royle 2004) which is not accounted for in current methods. Camera surveys are subject to potential bias associated with the spacing of survey sites and how that relates to wild turkey movement patterns. I was unable to account for the movements of individuals between survey sites which may lead to over or under representation of different classes of turkeys in the survey. Turkey movement can be accounted for by resightings of marked individuals, but the associated cost of such efforts are high.

Obtaining accurate and current population information is necessary for the informed management of wild turkey populations. Management decisions will differ depending on the current size and structure of a population. Managers must also monitor how populations respond to management decisions that are made. Multiple survey methods exist for obtaining this information (Hubbard et al. 1999, Butler et al 2007), but there are potential drawbacks (Spraker et al. 1987, Betts et al 2007). Camera surveys provide useful and precise information about turkey populations, while limiting cost and impact on survival.

Management Implications

Occupancy, density, and productivity can all be obtained when camera survey data is combined with estimators such as the N-Mixture estimator used in this study. The use of N-Mixture estimators to obtain precise population estimates has been well established for many different types of animals (Brodie and Giordano 2013, Peterman and Semlitsch 2013, Kellner et al. 2013), and the potential for use with avian species is great (Joseph et al. 2009, Schlossberg et al. 2010). Collecting useful information about a population is an important step in the process of managing wildlife. Unfortunately, managers are limited in the resources they can allot to monitoring populations. Because they can be used with N-mixture estimators to reduce bias in estimates, I suggest that camera surveys can be used for regularly monitoring wild turkey populations. Such surveys can provide estimates of density of different classes of turkey and identify variation in density according to different landcover characteristics, which will allow for estimation of population sizes over greater areas. Estimates of productivity can also be produced which can aid in anticipating variation in wild turkey populations. If estimates of productivity indicate low recruitment in a year, managers can expect a subsequent decline in adults in following years and vice versa. Productivity estimates can therefore allow managers to predict declines in the hunting population and alter their management accordingly.

Camera surveys provide precise information about turkey populations at a moderate cost compared to more involved monitoring programs such as mark-recapture. While the implementation of a camera survey requires an initial investment in trail cameras and equipment the only additional cost is the effort needed to conduct the survey and interpret the images. This could be reduced with further research into image processing software which would reduce the amount of time required to interpret images (Tack et al. 2016, Yu et al. 2013). It may also be possible to minimize the number and frequency of surveys needed to provide accurate information, further limiting costs.

Literature Cited

Alabama Department of Conservation and Natural Resources. 2014. Full Fans & Sharp Spurs: Wild Turkey Report 2014. Alabama Department of Conservation and Natural Resources. Montgomery, Alabama, USA.

Anderson, D. R. 2001. The need to get the basics right in wildlife field studies. Wildl. Soc. Bulletin 29(4):1294-1297.

Barwick, L. H., and D. W. Speake. 1973. Seasonal movements and activities of wild turkey gobblers in Alabama. Proc. Nat. Wild Turkey Symp. 2:125-134.

Betts, M. G., D. Mitchell, A. W. Diamond, and J. Bety. 2007. Uneven rates of landscape change as a source of bias in roadside wildlife surveys. J. of Wildl. Manage. 71(7):2266-2273.

Brodie, J. F., and A. Giordano. 2013. Lack of trophic release with large mammal predators and prey in Borneo. Biological Con. 163:58-67.

Burnham, K. P., and D. R. Anderson. 2002. Model selection and multimodel inference. Second edition. Springer-Verlag, New York, New York, USA.

Burt, W. H. 1943. Territoriality and home range concepts as applied to mammals. J. of Mammology 24(3):346-352.

Burton, B. A., and R. J. Hudson. Activity budgets of lesser snow geese wintering on the Fraser river estuary, British Columbia. Wildfowl 29:111-117.

Butler, M. J., W. B. Ballard, M. C. Wallace, and S. J. Demaso. 2007. Road-based surveys for estimating wild turkey density in the Texas Rolling Plains. J. of Wildl. Manage. 71(5):1646-1653.

Dickson, J. G. 1992. The Wild Turkey: Biology and Management. Stackpole Books. Mechanicsburg, Pennsylvania, USA.

Efron, B., and R. J. Tibshirani. 1994. An Introduction to the Bootstrap. CRC Press. Boca Raton, Florida, USA.

Fiske, I., and C. Richard. 2011. unmarked: An R Package for Fitting Hierarchical Models of Wildlife Occurrence and Abundance. J. of Stat. Software 43(10):1-23.

Gerber, B. D., J. S. Ivan, and K. P. Burnham. 2014. Estimating the abundance of rare and elusive carnivores from photographic-sampling data when the population size is very small. Pop. Eco. 56(3):463-470.

Godfrey, C. L., and G. W. Norman. 1999. Effect of habitat and movement on wild turkey poult survival. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 53:330-339.

Griffith, G. E., J. M. Omernik, J. A. Comstock, S. Lawrence, G. Martin, A. Goddard, and V. J. Hulcher. 2001. Ecoregions of Alabama and Georgia. Pages (2 sided color poster with map, descriptive text, summary tables, and photographs). U.S. Geological Survey, Reston, Virginia, USA.

Haines, A. M., F. Hernández, S. E. Henke, and R. L. Bingham. 2004a. Effects of roadside baiting on home range and survival of northern bobwhites in southern Texas. Wildl. Soc. Bulletin 32(2):401-411.

Healy, W. M. 1985. Turkey poult feeding activity, invertebrate abundance, and vegetation structure. J. of Wildl. Manage. 49(2):466-472.

Hoffman, R. W. 1990. Chronology of gobbling and nesting activities of Merriam's wild turkeys. Proc. Nat. Wild Turkey Symp 6:25-31.

Homer, C.G., J.A. Dewitz, L. Yang, S. Jin, P. Danielson, G. Xian, J. Coulston, N.D. Herold, J.D. Wickham, and K. Megown,. 2015. Completion of the 2011 National Land Cover Database for the conterminous United States-Representing a decade of land cover change information. Photogrammetric Engineering and Remote Sensing 81(5):345-354

Hubbard, M. W., D. L. Garner, and E. E. Klaas. 1999. Wild turkey poult survival in southcentral Iowa. J. of Wildl. Manage. 63(1):199-203.

Hutto, R. L. 1981. Temporal patterns of foraging activity in some wood warblers in relation to the availability of insect prey. Behav. Eco. and Sociobio. 9(3):195-198.

Iglecia, M. N., J. A. Collazo, and A. J. McKerrow. 2012. Use of occupancy models to evaluate expert knowledge-based species-habitat relationships. Avian Cons. and Eco. 7(2):art5

Joseph, L. N., C. Elkin, T. G. Martin, and H. P. Possingham. 2009. Modeling abundance using N-mixture models: the importance of considering ecological mechanisms. Ecol. App. 19(3):631-642.

Kellner, K. F., N. A. Urban, and R. K. Swihart. 2013. Short-term responses of small mammals to timber harvest in the United States Central Hardwood Forest Region. J. of Wildl. Manage. 77(8):1650-1663.

Kucera, T. E., and R. H. Barrett. 2011. A history of camera trapping. Pages 9-26 in Camera Traps in Animal Ecology. Springer. Tokyo, Japan.

Lewis, J. S., K. A. Logan, M. W. Alldredge, L. L. Bailey, S. VandeWoude, and K. R. Crooks. 2015. The effects of urbanization on population density, occupancy, and detection probability of wild felids. Ecol. Appl. 25(7):1880-1895.

Lyons, J. E., M. C. Runge, H. P. Laskowski, and W. L. Kendall. 2008. Monitoring in the context of structured decision-making and adaptive management. J. Wildl. Manage. 72(8):1683-1692.

MacKenzie, D. I., J. D. Nichols, G. B. Lachman, S. Droege, J. A. Royle, and C. A. Langtimm. 2002. Estimating site occupancy rates when detection probabilities are less than one. Ecology 83(8):2248-2255.

MacKenzie, D. I. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Academic Press. London, UK.

Miller, D. A., G. A. Hurst, and B. D. Leopold. 1998. Reproductive characteristics of a wild turkey population in central Mississippi. J. Wildl. Manage. 62(3):903-910.

Mississippi Department of Wildlife, Fisheries, and Parks. 2016. Spittin' & Drummin': Mississippi Wild Turkey Report. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi, USA.

Palmer, W. E., G. A., Hurst, and J. R. Lint. 1990. Effort, success, and characteristics of spring turkey hunters on Tallahala Wildlife Management Area, Mississippi. Proc. Nat. Wild Turkey Symp. 6:208-213.

Palmer, W. E., G. A. Hurst, J. E. Stys, D. R. Smith, and J. D. Burk. 1993. Survival rates of wild turkey hens in loblolly pine plantations in Mississippi. J. Wildl. Manage. 57(4):783-789.

Peterman, W. E., and R. D. Semlitsch. 2013. Fine-scale habitat associations of a terrestrial salamander: the role of environmental gradients and implications for population dynamics. PLoS One 8(5):e62184.

Porter, W. F. 1980. An evaluation of wild turkey brood habitat in southeastern Minnesota. Proc. Nat. Wild Turkey Symp. 4:203-212.

Porter, W. F., R. D. Tangen, G. C. Nelson, and D. A. Hamilton. 1980. Effects of corn food plots on wild turkeys in the upper Mississippi valley. J. Wildl. Mange. 44(2):456-462.

Powell, R. A., and M. S. Mitchell. 2012. What is a home range? J. of Mammalogy 93(4):948-958.

R Core Team. 2016. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing. Vienna, Austria.

Rioux, S., M. Bélisle, and J. F. Giroux. 2009. Effects of landscape structure on male density and spacing patterns in wild turkeys (Meleagris gallopavo) depend on winter severity. Auk 126(3):673-683.

Roberts, S. D., J. M. Coffey, and W. F. Porter. 1995. Survival and reproduction of female wild turkeys in New York. J. Wildl. Manage. 59(3):437-447.

Robinson Jr, D. A., W. E. Jensen, and R. D. Applegate. 2000. Observer effect on a rural mail carrier survey population index. Wildl. Soc. Bulletin 28(2):330-332.

Romesburg, H. C. 1981. Wildlife science: gaining reliable knowledge. J. Wildl. Manage. 45(2):293-313.

Ross, A. S., and G. A. Wunz. 1990. Habitat used by wild turkey hens during the summer in oak forests in Pennsylvania. Proc. Nat. Wild Turkey Symp. 6:39-43.

Royle, J. A. 2004. N-mixture models for estimating population size from spatially replicated counts. Biometrics 60(1):108-115.

Royle, J. A., and W. A. Link. 2006. Generalized site occupancy models allowing for false positive and false negative errors. Ecology 87(4):835-841.

Sands, J. P., and M. D. Pope. 2010. A survey of galliform monitoring programs and methods in the United States and Canada. Wildl. Bio. 16(4):342-356.

Schlossberg, S., D. I. King, R. B. Chandler, and B. A. Mazzei. 2010. Regional synthesis of habitat relationships in shrubland birds. J. Wildl. Manage. 74(7):1513-1522.

Sisson, D. C., D. W. Speake, and J. L. Landers. 1991. Wild turkey brood habitat use in fire-type pine forests. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 45:49–57.

Sisson, D. C., H. L. Stribling, and D. W. Speake. 2000. Effects of supplemental feeding on home range size and survival of northern bobwhites in South Georgia. Proc. Of Nat. Quail Symp. 4(1):128-131.

Snäll, T., O. Kindvall, J. Nilsson, and T. Pärt. 2011. Evaluating citizen-based presence data for bird monitoring. Bio. Cons. 144(2):804-810.

Speake, D. W. 1975. Habitat use and seasonal movements of wild turkeys in the Southeast. Proc. Nat. Wild Turkey Symp. 3:122-130.

Speake, D. W., R. Metzler, and J. McGlincy. 1985. Mortality of wild turkey poults in northern Alabama. J. Wildl. Manage. 49(2):472-474.

Spears, B. L., M. C. Wallace, W. B. Ballard, R. S. Phillips, D. P. Holdstock, J. H. Brunjes, R. Applegate, M. S. Miller, P. S. Gipson. 2007. Habitat use and survival of preflight wild turkey broods. J. Wildl. Manage. 71(1):69-81.

Spraker, T. R., W. J. Adrian, and W. R. Lance. 1987. Capture myopathy in wild turkeys (Meleagris gallopavo) following trapping, handling and transportation in Colorado. J. Wildl. Diseases 23(3):447-453.

Tack, J. L. P., B. S. West, C. P. McGowan, S. S. Ditchkoff, S. J. Reeves, A. C. Keever, J. B. Grand. 2016. AnimalFinder: A semi-automated system for animal detection in time-lapse camera trap images. Ecol. Informatics 36:145-151.

Wunz, G. A. 1990. Relationship of wild turkey populations to clearings created for brood habitat in oak forests in Pennsylvania. Proc. Nat. Wild Turkey Symp. 6:32-38.

Vangilder, L. D., and E. W. Kurzejeski. 1995. Population ecology of the Eastern Wild Turkey in Northern Missouri. Wildl. Monographs 130:3-50.

Verbeek, N. A. M. 1972. Daily and annual time budget of the yellow-billed magpie. Auk 89(3):567-582.

Yu, X., J. Wang, R. Kays, P. A. Jansen, T. Wang, and T. Huang. 2013. Automated identification of animal species in camera trap images. EURASIP J. on Image and Video Processing 2013:52.

Table 3.1. Comparison of detection (p) models for wild turkey using Occupancy estimator and camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for AIC, relative difference in AIC (ΔAIC), model probability (w), model likelihood (Lik), and number of parameters (K) are shown.[9]

Model	AIC	ΔAIC	w	Lik	K
p(Study Area + Hour^2 + DayBait) ψ(.)	7197.05	0.00	1.000	3590.53	8
p(Study Area + Hour^2) ψ(.)	7217.36	20.30	0.000	3601.68	7
p(Study Area) ψ(.)	7237.42	40.36	0.000	3613.71	5
p(Oak + Barb) ψ(.)	7257.98	60.92	0.000	3624.99	4
p(DayBait) ψ(.)	7293.55	96.50	0.000	3643.77	3
p(Hour^2) ψ(.)	7301.96	104.91	0.000	3646.98	4
p(Hour) ψ(.)	7311.26	114.21	0.000	3652.63	3
p(.) ψ(.)	7316.23	119.18	0.000	3656.12	2
p(Year*DayYear) ψ(.)	7320.73	123.68	0.000	3655.37	5
p(Year + DayYear) ψ(.)	7329.09	132.03	0.000	3660.54	4

[9] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Oak – survey took place on Oakmulgee WMA. Barb – survey took place on Barbour WMA. DayYear – Julian date of the survey.

Table 3.2. Comparison of detection (p) models for wild turkey using N-Mixture estimator and camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for AIC, relative difference in AIC (ΔAIC), model probability (w), model likelihood (Lik), and number of parameters (K) are shown.[10]

Model	AIC	ΔAIC	w	Lik	K
p(Hour^2 + DayBait + Study Area) λ(.)	17010.36	0.00	1.000	8497.18	8
p(Hour^2) λ(.)	17139.35	128.99	0.000	8565.68	4
p(Study Area) λ(.)	17250.34	239.98	0.000	8620.17	5
p(Oak + Barb) λ(.)	17254.15	243.79	0.000	8623.08	4
p(DayBait) λ(.)	17265.55	255.19	0.000	8629.78	3
p(Hour) λ(.)	17315.69	305.33	0.000	8654.84	3
p(.) λ(.)	17319.82	309.46	0.000	8657.91	2
p(Year + DayYear) λ(.)	17322.75	312.39	0.000	8657.38	4
p(Year*DayYear) λ(.)	17328.88	318.52	0.000	8659.44	5

[10] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Oak – survey took place on Oakmulgee WMA. Barb – survey took place on Barbour WMA. DayYear – Julian date of the survey.

Table 3.3. Comparison of detection (*p*) models for male turkey using Occupancy estimator and camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[11]

Model	AIC	ΔAIC	*w*	Lik	K
p(Study Area + DayBait) ψ(.)	2706.85	0.00	0.999	1347.43	6
p(DayBait) ψ(.)	2721.56	14.70	0.001	1357.78	3
p(Year + DayYear) ψ(.)	2724.04	17.18	0.000	1358.02	4
p(Year*DayYear) ψ(.)	2727.69	20.84	0.000	1358.84	5
p(Oak + Barb) ψ(.)	2732.40	25.55	0.000	1362.20	4
p(Study Area) ψ(.)	2733.64	26.79	0.000	1361.82	5
p(.) ψ(.)	2747.89	41.03	0.000	1371.94	2
p(Hour^2) ψ(.)	2748.52	41.66	0.000	1370.26	4
p(Hour) ψ(.)	2748.58	41.73	0.000	1371.29	3

[11] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Oak – survey took place on Oakmulgee WMA. Barb – survey took place on Barbour WMA. DayYear – Julian date of the survey.

Table 3.4. Comparison of detection (*p*) models for male turkey using N-Mixture estimator and camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[12]

Model	AIC	ΔAIC	*w*	Lik	K
p(DayBait+ Study Area + Year + DayYear) λ(.)	4280.83	0.00	0.999	2132.42	8
p(DayBait) λ(.)	4294.24	13.41	0.001	2144.12	3
p(Oak + Barb) λ(.)	4301.58	20.75	0.000	2146.79	4
p(Study Area) λ(.)	4303.11	22.28	0.000	2146.56	5
p(Year + DayYear) λ(.)	4303.87	23.04	0.000	2147.94	4
p(Year*DayYear) λ(.)	4304.39	23.55	0.000	2147.19	5
p(Hour^2) λ(.)	4305.96	25.12	0.000	2148.98	4
p(.) λ(.)	4311.29	30.45	0.000	2153.64	2
p(Hour) λ(.)	4313.22	32.39	0.000	2153.61	3

[12] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Oak – survey took place on Oakmulgee WMA. Barb – survey took place on Barbour WMA. DayYear – Julian date of the survey.

Table 3.5. Comparison of detection (p) models for female turkey using Occupancy estimator and camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for AIC, relative difference in AIC (ΔAIC), model probability (w), model likelihood (Lik), and number of parameters (K) are shown.[13]

Model	AIC	ΔAIC	w	Lik	K
p(StudyArea + Hour^2 + DayBait) ψ(.)	4996.50	0.00	0.997	2490.25	8
p(Oak + Barb) ψ(.)	5009.73	13.23	0.001	2500.86	4
p(Study Area) ψ(.)	5009.87	13.38	0.001	2499.94	5
p(DayBait) ψ(.)	5025.88	29.38	0.000	2509.94	3
p(Hour^2) ψ(.)	5030.79	34.29	0.000	2511.39	4
p(Year + DayYear) ψ(.)	5033.06	36.56	0.000	2512.53	4
p(Hour) ψ(.)	5034.61	38.11	0.000	2514.30	3
p(.) ψ(.)	5034.70	38.21	0.000	2515.35	2
p(Year*DayYear) ψ(.)	5039.77	43.27	0.000	2514.89	5

[13] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Oak – survey took place on Oakmulgee WMA. Barb – survey took place on Barbour WMA. DayYear – Julian date of the survey.

Table 3.6. Comparison of detection (*p*) models for female turkey using N-Mixture estimator and camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[14]

Model	AIC	ΔAIC	*w*	Lik	K
p(Hour^2 + DayBait) λ(.)	7386.13	0.00	0.999	3688.06	5
p(Hour^2) λ(.)	7401.10	14.98	0.001	3696.55	4
p(DayBait) λ(.)	7428.35	42.23	0.000	3711.18	3
p(Oak + Barb) λ(.)	7431.49	45.36	0.000	3711.74	4
p(Study Area) λ(.)	7433.01	46.88	0.000	3711.50	5
p(Hour) λ(.)	7438.38	52.25	0.000	3716.19	3
p(.) λ(.)	7440.00	53.87	0.000	3718.00	2
p(Year + DayYear) λ(.)	7441.88	55.75	0.000	3716.94	4
p(Year*DayYear) λ(.)	7443.58	57.45	0.000	3716.79	5

[14] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Oak – survey took place on Oakmulgee WMA. Barb – survey took place on Barbour WMA. DayYear – Julian date of the survey.

Table 3.7. Comparison of detection (*p*) models for turkey poults using Occupancy estimator and camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), number of parameters (K), and deviance (Dev) are shown.[15]

Model	AIC	ΔAIC	*w*	Lik	K
p(StudyArea + Hour^2 + DayBait) ψ(.)	1429.55	0.00	1.000	706.77	8
p(Study Area) ψ(.)	1449.73	20.18	0.000	719.86	5
p(Hour^2) ψ(.)	1457.93	28.38	0.000	724.96	4
p(Oak + Barb) ψ(.)	1468.29	38.75	0.000	731.15	3
p(DayBait) ψ(.)	1470.64	41.09	0.000	732.32	3
p(.) ψ(.)	1475.37	45.83	0.000	735.69	2
p(Hour) ψ(.)	1477.37	47.82	0.000	735.68	3
p(Year + DayYear) ψ(.)	1477.77	48.22	0.000	734.88	4
p(Year*DayYear) ψ(.)	1480.48	50.93	0.000	735.24	5

[15] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Oak – survey took place on Oakmulgee WMA. Barb – survey took place on Barbour WMA. DayYear – Julian date of the survey.

Table 3.8. Comparison of detection (*p*) models for turkey poults using N-Mixture estimator and camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), number of parameters (K), and deviance (Dev) are shown.[16]

Model	AIC	ΔAIC	*w*	Lik	K
p(Hour^2 + DayBait + Study Area) λ(.)	6751.07	0.00	1.000	3367.53	8
p(Hour^2) λ(.)	6813.00	61.93	0.000	3402.50	4
p(DayBait) λ(.)	6959.62	208.55	0.000	3476.81	3
p(Oak + Barb) λ(.)	6974.75	223.68	0.000	3483.38	4
p(Study Area) λ(.)	6976.64	225.57	0.000	3483.32	5
p(.) λ(.)	7000.44	249.37	0.000	3498.22	2
p(Hour) λ(.)	7002.41	251.34	0.000	3498.21	3
p(Year + DayYear) λ(.)	7006.51	255.44	0.000	3499.26	4
p(Year*DayYear) λ(.)	7008.35	257.28	0.000	3499.17	5

[16] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Oak – survey took place on Oakmulgee WMA. Barb – survey took place on Barbour WMA. DayYear – Julian date of the survey.

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [17]

	WLOsize	*Shape*	*WLOdist*	*WLOnum.500*	*WLOnum.1750*	*AvgWLOSize.500*	*AvgWLOSize.1750*	*%WLO.500*
WLOsize	1.00							
Shape	-0.22	1.00						
WLOdist	-0.07	0.15	1.00					
WLOnum.500	0.03	-0.21	-0.62	1.00				
WLOnum.1750	0.05	-0.16	-0.53	0.69	1.00			
AvgWLOSize.500	0.70	0.03	0.01	-0.01	-0.02	1.00		
AvgWLOSize.1750	0.30	0.03	-0.09	0.11	0.08	0.55	1.00	
%WLO.500	0.48	-0.07	-0.40	0.60	0.38	0.68	0.50	1.00
%WLO.1750	0.25	-0.08	-0.41	0.49	0.67	0.39	0.70	0.65
RoadCover.500	-0.09	0.06	0.08	-0.12	-0.13	-0.08	-0.12	-0.11
RoadCover.1750	-0.15	0.18	0.03	-0.04	0.16	-0.18	-0.40	-0.18
%Developed.500	-0.11	-0.05	-0.27	0.36	0.43	-0.14	-0.08	0.10
%Developed.1750	-0.12	-0.11	-0.28	0.37	0.51	-0.11	-0.14	0.08
%HW.500	0.16	-0.20	-0.32	0.29	0.33	0.11	0.33	0.27
%HW.1750	0.27	-0.19	-0.35	0.34	0.29	0.23	0.46	0.38
%TotalHW.500	0.17	-0.19	-0.32	0.30	0.37	0.12	0.33	0.26
%TotalHW.1750	0.27	-0.21	-0.38	0.38	0.35	0.22	0.45	0.40
%Pine.500	-0.18	0.10	0.44	-0.47	-0.52	-0.15	-0.36	-0.38
%Pine.1750	-0.22	0.18	0.49	-0.49	-0.54	-0.19	-0.45	-0.44
%Mixed.500	-0.04	-0.06	0.36	-0.24	-0.34	0.08	-0.08	-0.14

[17] WLOsize – area of opening (m^2). Shape – WLOsize divided by area of circle with equal circumference. WLOdist – distance (m) to nearest opening. WLOnum – number of openings in buffer. AvgWLOSize – average area of openings in buffer. %WLO – percent buffer composed of opening. RoadCover – amount of road (m) in buffer. %Developed – percent area NLCD class "Developed". %HW - percent area NLCD class "Deciduous". %TotalHW - percent area NLCD class "Deciduous" or "Woody Wetlands". % Pine - percent area NLCD class "Evergreen". %Mixed – percent area NCLD class "Mixed".

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [18]

	WLOsize	*Shape*	*WLOdist*	*WLOnum.500*	*WLOnum.1750*	*AvgWLOSize.500*	*AvgWLOSize.1750*	*%WLO.500*
%Mixed.1750	-0.12	-0.08	0.41	-0.37	-0.45	-0.05	-0.22	-0.30
%Forest.500	-0.01	-0.21	0.26	-0.27	-0.33	0.04	0.02	-0.14
%Forest.1750	0.13	-0.18	0.31	-0.30	-0.52	0.13	0.08	-0.09
%HWandMixed.500	0.15	-0.24	-0.17	0.20	0.19	0.16	0.32	0.22
%HWandMixed.1750	0.25	-0.25	-0.22	0.22	0.13	0.23	0.42	0.30
%PineandMixed.500	-0.16	0.05	0.51	-0.48	-0.56	-0.08	-0.32	-0.37
%PineandMixed.1750	-0.21	0.10	0.54	-0.52	-0.59	-0.17	-0.43	-0.45
%TotHWdivbypFor.500	0.19	-0.15	-0.44	0.44	0.56	0.12	0.35	0.34
%TotHWdivbypFor.1750	0.23	-0.19	-0.47	0.49	0.56	0.19	0.44	0.44
%HWdivbypForest.500	0.18	-0.17	-0.45	0.45	0.52	0.10	0.34	0.35
%HWdivbypForest.1750	0.24	-0.18	-0.45	0.45	0.49	0.21	0.45	0.43
%PinedivbypForest.500	-0.20	0.19	0.36	-0.42	-0.46	-0.17	-0.37	-0.36
%PinedivbypForest.1750	-0.22	0.23	0.38	-0.40	-0.43	-0.21	-0.44	-0.39
%Shrub.500	-0.05	0.08	-0.28	0.25	0.27	-0.11	-0.02	0.10
%Shrub.1750	-0.13	0.13	-0.27	0.19	0.36	-0.17	-0.15	0.01
%Grass.500	0.02	0.24	0.04	-0.05	-0.07	0.03	-0.06	0.00
%Grass.1750	-0.08	0.30	0.06	-0.08	-0.04	-0.05	-0.13	-0.06
%ForagingHabitat.500	0.13	0.21	-0.09	0.13	0.07	0.16	0.08	0.23
%ForagingHabitat.1750	0.00	0.27	-0.10	0.09	0.18	0.08	0.18	0.16

[18] WLOsize – area of opening (m^2). Shape – WLOsize divided by area of circle with equal circumference. WLOdist – distance (m) to nearest opening. WLOnum – number of openings in buffer. AvgWLOSize – average area of openings in buffer. %WLO – percent buffer composed of opening. %Mixed – percent area NCLD class "Mixed". %Forest - percent area NLCD class of any forest type. %HWandMixed - percent area NCLD class "Deciduous" or "Mixed". %PineandMixed - percent area NCLD class "Evergreen" or "Mixed". %TotHWdivbypFor - %TotHW divided by %Forest. %HWdivbypForest - %HW divided by %Forest. %PinedivbypForest - %Pine divided by %Forest. % Shrub - percent area NCLD class "Shrub/Scrub". %Grass - percent area NCLD class "Grassland/Herbaceous". %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture".

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [19]

	%WLO.1750	*RoadCover.500*	*RoadCover.1750*	*%Developed.500*	*%Developed.1750*	*%HW.500*	*%HW.1750*
%WLO.1750	1.00						
RoadCover.500	-0.15	1.00					
RoadCover.1750	-0.16	0.17	1.00				
%Developed.500	0.16	0.08	0.12	1.00			
%Developed.1750	0.17	-0.06	0.09	0.74	1.00		
%HW.500	0.40	-0.23	-0.60	-0.06	-0.01	1.00	
%HW.1750	0.46	-0.21	-0.67	-0.05	-0.11	0.92	1.00
%TotalHW.500	0.42	-0.23	-0.57	-0.02	0.06	0.98	0.90
%TotalHW.1750	0.49	-0.20	-0.65	0.02	-0.03	0.91	0.99
%Pine.500	-0.52	0.28	0.42	-0.25	-0.22	-0.72	-0.73
%Pine.1750	-0.60	0.24	0.55	-0.22	-0.23	-0.84	-0.89
%Mixed.500	-0.25	0.11	-0.06	-0.07	0.04	-0.39	-0.35
%Mixed.1750	-0.41	0.22	-0.04	-0.11	-0.05	-0.45	-0.45
%Forest.500	-0.17	0.05	-0.41	-0.40	-0.23	0.36	0.25

[19] %WLO – percent buffer composed of opening. RoadCover – amount of road (m) in buffer. %Developed – percent area NLCD class “Developed”. %HW - percent area NLCD class “Deciduous”. %TotalHW - percent area NLCD class “Deciduous” or “Woody Wetlands”. % Pine - percent area NLCD class “Evergreen”. %Mixed – percent area NCLD class “Mixed”. %Forest - percent area NLCD class of any forest type.

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [20]

	%WLO.1750	*RoadCover.500*	*RoadCover.1750*	*%Developed.500*	*%Developed.1750*	*%HW.500*	*%HW.1750*
%Forest.1750	-0.25	0.09	-0.53	-0.48	-0.56	0.26	0.34
%HWandMixed.500	0.32	-0.19	-0.67	-0.10	0.01	0.90	0.82
%HWandMixed.1750	0.34	-0.14	-0.76	-0.11	-0.14	0.83	0.92
%PineandMixed.500	-0.52	0.27	0.31	-0.23	-0.16	-0.74	-0.74
%PineandMixed.1750	-0.62	0.27	0.40	-0.21	-0.20	-0.81	-0.85
%TotHWdivbypFor.500	0.53	-0.24	-0.50	0.22	0.25	0.86	0.84
%TotHWdivbypFor.1750	0.61	-0.22	-0.55	0.23	0.25	0.86	0.90
%HWdivbypForest.500	0.51	-0.25	-0.54	0.17	0.16	0.91	0.89
%HWdivbypForest.1750	0.57	-0.23	-0.59	0.14	0.14	0.90	0.95
%PinedivbypForest.500	-0.50	0.24	0.61	-0.20	-0.23	-0.81	-0.82
%PinedivbypForest.1750	-0.53	0.19	0.67	-0.16	-0.19	-0.84	-0.90
%Shrub.500	0.17	-0.06	0.30	0.29	0.13	-0.21	-0.10
%Shrub.1750	0.13	-0.06	0.55	0.24	0.23	-0.23	-0.27
%Grass.500	-0.11	-0.01	0.29	-0.07	-0.19	-0.33	-0.29
%Grass.1750	-0.12	-0.01	0.46	-0.05	-0.13	-0.41	-0.43
%ForagingHabitat.500	0.10	-0.05	0.20	0.04	-0.08	-0.25	-0.18
%ForagingHabitat.1750	0.25	-0.13	0.22	0.07	0.08	-0.13	-0.16

[20] %WLO – percent buffer composed of opening. RoadCover – amount of road (m) in buffer. %Developed – percent area NLCD class "Developed". %HW - percent area NLCD class "Deciduous". %TotalHW - percent area NLCD class "Deciduous" or "Woody Wetlands". % Pine - percent area NLCD class "Evergreen". %Mixed – percent area NCLD class "Mixed". %Forest - percent area NLCD class of any forest type. %HWandMixed - percent area NCLD class "Deciduous" or "Mixed". %PineandMixed - percent area NCLD class "Evergreen" or "Mixed". %TotHWdivbypFor - %TotHW divided by %Forest. %HWdivbypForest - %HW divided by %Forest. %PinedivbypForest - %Pine divided by %Forest. % Shrub - percent area NCLD class "Shrub/Scrub". %Grass - percent area NCLD class "Grassland/Herbaceous". %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture".

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [21]

	%TotalHW.500	*%TotalHW.1750*	*%Pine.500*	*%Pine.1750*	*%Mixed.500*	*%Mixed.1750*	*%Forest.500*
%TotalHW.500	1.00						
%TotalHW.1750	0.91	1.00					
%Pine.500	-0.74	-0.76	1.00				
%Pine.1750	-0.85	-0.92	0.87	1.00			
%Mixed.500	-0.35	-0.32	0.25	0.31	1.00		
%Mixed.1750	-0.41	-0.42	0.41	0.44	0.86	1.00	
%Forest.500	0.34	0.23	0.26	-0.02	0.36	0.37	1.00
%Forest.1750	0.23	0.31	0.10	0.01	0.38	0.49	0.71
%HWandMixed.500	0.89	0.83	-0.66	-0.76	0.06	-0.07	0.56
%HWandMixed.1750	0.82	0.93	-0.64	-0.81	-0.03	-0.07	0.43
%PineandMixed.500	-0.74	-0.74	0.90	0.82	0.64	0.71	0.36
%PineandMixed.1750	-0.80	-0.86	0.82	0.93	0.58	0.73	0.13

[21] %TotalHW - percent area NLCD class “Deciduous” or “Woody Wetlands”. %Pine - percent area NLCD class “Evergreen”. %Mixed – percent area NCLD class “Mixed”. %Forest - percent area NLCD class of any forest type. %HWandMixed - percent area NCLD class “Deciduous” or “Mixed”. %PineandMixed - percent area NCLD class “Evergreen” or “Mixed”.

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [22]

	%TotalHW.500	*%TotalHW.1750*	*%Pine.500*	*%Pine.1750*	*%Mixed.500*	*%Mixed.1750*	*%Forest.500*
%TotHWdivbypFor.500	0.90	0.87	-0.85	-0.91	-0.44	-0.50	-0.02
%TotHWdivbypFor.1750	0.87	0.94	-0.83	-0.98	-0.36	-0.49	0.05
%HWdivbypForest.500	0.90	0.90	-0.84	-0.92	-0.49	-0.55	0.03
%HWdivbypForest.1750	0.89	0.96	-0.82	-0.97	-0.41	-0.53	0.09
%PinedivbypForest.500	-0.83	-0.85	0.91	0.91	0.10	0.25	-0.07
%PinedivbypForest.1750	-0.85	-0.93	0.80	0.96	0.14	0.24	-0.20
%Shrub.500	-0.24	-0.11	-0.17	-0.05	-0.39	-0.41	-0.71
%Shrub.1750	-0.24	-0.28	0.01	0.09	-0.43	-0.50	-0.57
%Grass.500	-0.34	-0.31	-0.03	0.26	-0.14	-0.11	-0.57
%Grass.1750	-0.43	-0.46	0.21	0.36	-0.21	-0.22	-0.46
%ForagingHabitat.500	-0.26	-0.19	-0.16	0.09	-0.20	-0.20	-0.64
%ForagingHabitat.1750	-0.15	-0.18	-0.08	0.00	-0.35	-0.42	-0.49

[22] %TotalHW - percent area NLCD class “Deciduous” or “Woody Wetlands”. %Pine - percent area NLCD class “Evergreen”. %Mixed – percent area NCLD class “Mixed”. %Forest - percent area NLCD class of any forest type. %TotHWdivbypFor - %TotHW divided by %Forest. %HWdivbypForest - %HW divided by %Forest. %PinedivbypForest - %Pine divided by %Forest. % Shrub - percent area NCLD class “Shrub/Scrub”. %Grass - percent area NCLD class “Grassland/Herbaceous”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”.

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [23]

	%Forest.1750	*%HWandMixed.500*	*%HWandMixed.1750*	*%PineandMixed.500*	*%PineandMixed.1750*
%Forest.1750	1.00				
%HWandMixed.500	0.47	1.00			
%HWandMixed.1750	0.59	0.89	1.00		
%PineandMixed.500	0.25	-0.49	-0.52	1.00	
%PineandMixed.1750	0.20	-0.60	-0.64	0.91	1.00
%TotHWdivbypFor.500	-0.03	0.72	0.72	-0.87	-0.89
%TotHWdivbypFor.1750	0.01	0.75	0.80	-0.82	-0.94
%HWdivbypForest.500	0.02	0.74	0.76	-0.88	-0.91
%HWdivbypForest.1750	0.08	0.77	0.83	-0.83	-0.95
%PinedivbypForest.500	-0.12	-0.83	-0.81	0.76	0.79
%PinedivbypForest.1750	-0.22	-0.84	-0.90	0.70	0.82
%Shrub.500	-0.55	-0.41	-0.29	-0.31	-0.20
%Shrub.1750	-0.76	-0.45	-0.52	-0.18	-0.14
%Grass.500	-0.27	-0.42	-0.37	-0.08	0.15
%Grass.1750	-0.48	-0.54	-0.57	0.07	0.18
%ForagingHabitat.500	-0.35	-0.36	-0.28	-0.21	-0.01
%ForagingHabitat.1750	-0.61	-0.31	-0.36	-0.22	-0.17

[23] %Forest - percent area NLCD class of any forest type. %HWandMixed - percent area NCLD class “Deciduous” or “Mixed”. %PineandMixed - percent area NCLD class “Evergreen” or “Mixed”. %TotHWdivbypFor - %TotHW divided by %Forest. %HWdivbypForest - %HW divided by %Forest. %PinedivbypForest - %Pine divided by %Forest. % Shrub - percent area NCLD class “Shrub/Scrub”. %Grass - percent area NCLD class “Grassland/Herbaceous”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”.

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [24]

	%TotHWdivbypFor.500	*%TotHWdivbypFor.1750*	*%HWdivbypForest.500*	*%HWdivbypForest.1750*
%TotHWdivbypFor.500	1.00			
%TotHWdivbypFor.1750	0.94	1.00		
%HWdivbypForest.500	0.97	0.94	1.00	
%HWdivbypForest.1750	0.93	0.99	0.96	1.00
%PinedivbypForest.500	-0.90	-0.90	-0.90	-0.89
%PinedivbypForest.1750	-0.88	-0.95	-0.89	-0.95
%Shrub.500	0.03	0.02	0.07	0.02
%Shrub.1750	-0.06	-0.10	-0.05	-0.12
%Grass.500	-0.24	-0.29	-0.24	-0.28
%Grass.1750	-0.33	-0.39	-0.32	-0.37
%ForagingHabitat.500	-0.10	-0.12	-0.10	-0.12
%ForagingHabitat.1750	-0.01	-0.03	0.00	-0.02

[24] %TotHWdivbypFor - %TotHW divided by %Forest. %HWdivbypForest - %HW divided by %Forest. %PinedivbypForest - %Pine divided by %Forest. % Shrub - percent area NCLD class “Shrub/Scrub”. %Grass - percent area NCLD class “Grassland/Herbaceous”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”.

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [25]

	%PinedivbypForest.500	*%PinedivbypForest.1750*	*%Shrub.500*	*%Shrub.1750*	*%Grass.500*	*%Grass.1750*
%PinedivbypForest.500	1.00					
%PinedivbypForest.1750	0.93	1.00				
%Shrub.500	0.07	0.12	1.00			
%Shrub.1750	0.23	0.30	0.74	1.00		
%Grass.500	0.22	0.34	-0.03	0.03	1.00	
%Grass.1750	0.38	0.48	0.08	0.15	0.73	1.00
%ForagingHabitat.500	0.08	0.19	0.03	0.04	0.95	0.67
%ForagingHabitat.1750	0.08	0.15	0.11	0.14	0.61	0.84

[25] %PinedivbypForest - %Pine divided by %Forest. % Shrub - percent area NCLD class “Shrub/Scrub”. %Grass - percent area NCLD class “Grassland/Herbaceous”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”.

Table 3.9. Correlation coefficient matrix depicting the correlation (r) of habitat variables within a 500m and 1,750m radius of camera sites used to create models of wild turkey use and density in Alabama, summer 2015 and 2016. [26]

	%ForagingHabitat.500	*%ForagingHabitat.1750*
%ForagingHabitat.500	1.00	
%ForagingHabitat.1750	0.67	1.00

[26] %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture".

Table 3.10. Comparison of use (ψ) and detection (*p*) models for wild turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[27]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(R500 - %Pine) *p*(Study Area + Hour^2 + DayBait)	7161.65	0.00	0.923	3571.83	9
ψ(R500 - %Forest*(Pine/Forest)) *p*(Study Area + Hour^2 + DayBait)	7168.59	6.94	0.029	3573.30	11
ψ(R500 - %Forest*(HW/Forest)) *p*(Study Area + Hour^2 + DayBait)	7169.94	8.28	0.015	3573.97	11
ψ(R500 - %Forest^2*(Pine/Forest)) *p*(Study Area + Hour^2 + DayBait)	7170.97	9.31	0.009	3573.48	12
ψ(R500 - %Forest^2*(HW/Forest)) *p*(Study Area + Hour^2 + DayBait)	7171.10	9.45	0.008	3573.55	12
ψ(R500 - %(Pine and Mixed)) *p*(Study Area + Hour^2 + DayBait)	7171.84	10.18	0.006	3576.92	9
ψ(R1750 - %Pine) *p*(Study Area + Hour^2 + DayBait)	7172.28	10.63	0.005	3577.14	9
ψ(R500 - %Forest*(TotalHW/Forest)) *p*(Study Area + Hour^2 + DayBait)	7172.93	11.27	0.003	3575.46	11
ψ(R1750 - %(Pine and Mixed)) *p*(Study Area + Hour^2 + DayBait)	7175.81	14.16	0.001	3578.91	9
ψ(R500 - %Hardwood) *p*(Study Area + Hour^2 + DayBait)	7176.60	14.95	0.001	3579.30	9
ψ(R500 - %Total Hardwoods) *p*(Study Area + Hour^2 + DayBait)	7177.13	15.48	0.000	3579.56	9
ψ(R500 - %Forest^2*(TotalHW/Forest)) *p*(Study Area + Hour^2 + DayBait)	7177.45	15.80	0.000	3576.73	12
ψ(R1750 - %Forest*(HW/Forest)) *p*(Study Area + Hour^2 + DayBait)	7178.01	16.36	0.000	3578.01	11
ψ(R1750 - %Forest^2*(TotalHW/Forest)) *p*(Study Area + Hour^2 + DayBait)	7179.36	17.71	0.000	3577.68	12
ψ(R1750 - %Forest*(Pine/Forest)) *p*(Study Area + Hour^2 + DayBait)	7179.38	17.72	0.000	3578.69	11
ψ(R1750 - %Total Hardwoods) *p*(Study Area + Hour^2 + DayBait)	7180.12	18.47	0.000	3581.06	9

[27] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. % Pine - percent area NLCD class “Evergreen”. %Forest - percent area NLCD class of any forest type. Pine/Forest - %Pine divided by %Forest. HW/Forest - %HW divided by %Forest. %PineandMixed - percent area NCLD class “Evergreen” or “Mixed”. % Pine - percent area NLCD class “Evergreen”. %Hardwood - percent area NLCD class “Deciduous”. %Total Hardwoods - percent area NLCD class “Deciduous” or “Woody Wetlands”. %TotHW/Forest - %TotHW divided by %Forest. %Total Hardwoods - percent area NLCD class “Deciduous” or “Woody Wetlands”.

Table 3.10. Comparison of use (ψ) and detection (*p*) models for wild turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[28]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(R500 - WLONum) *p*(Study Area + Hour^2 + DayBait)	7187.77	26.12	0.000	3584.89	9
ψ(R1750 - %Forest*(TotalHW/Forest)) p(Study Area + Hour^2 + DayBait)	7181.14	19.49	0.000	3579.57	11
ψ(R1750 - %Forest^2*(HW/Forest)) p(Study Area + Hour^2 + DayBait)	7181.59	19.94	0.000	3578.80	12
ψ(R1750 - %Forest^2*(Pine/Forest)) p(Study Area + Hour^2 + DayBait)	7181.79	20.14	0.000	3578.90	12
ψ(R1750 - WLONum) p(Study Area + Hour^2 + DayBait)	7184.26	22.61	0.000	3583.13	9
ψ(R500 - %(Hardwood and Mixed)) p(Study Area + Hour^2 + DayBait)	7184.96	23.31	0.000	3583.48	9
ψ(R1750 - %Hardwood) p(Study Area + Hour^2 + DayBait)	7185.29	23.64	0.000	3583.64	9
ψ(R1750 - %(Hardwood and Mixed)) *p*(Study Area + Hour^2 + DayBait)	7189.29	27.64	0.000	3585.64	9
ψ(R1750 - % WLO) *p*(Study Area + Hour^2 + DayBait)	7189.77	28.12	0.000	3585.89	9
ψ(WLOdist) *p*(Study Area + Hour^2 + DayBait)	7191.32	29.67	0.000	3586.66	9
ψ(R500 - % WLO) *p*(Study Area + Hour^2 + DayBait)	7194.38	32.72	0.000	3588.19	9
ψ(R500 - %Foraging Habitat^2) *p*(Study Area + Hour^2 + DayBait)	7195.95	34.29	0.000	3587.97	10
ψ(R500 - %Forest) *p*(Study Area + Hour^2 + DayBait)	7196.16	34.51	0.000	3589.08	9
ψ(R1750 - %Forest) *p*(Study Area + Hour^2 + DayBait)	7196.53	34.87	0.000	3589.26	9
ψ(R1750 - %Foraging Habitat) *p*(Study Area + Hour^2 + DayBait)	7196.55	34.89	0.000	3589.27	9
ψ(.) *p*(Study Area + Hour^2 + DayBait)	7197.05	35.40	0.000	3590.53	8
ψ(R500 - %Shrub) *p*(Study Area + Hour^2 + DayBait)	7197.27	35.62	0.000	3589.64	9

[28] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. WLONum - number of openings in buffer. %Forest - percent area NLCD class of any forest type. TotHW/Forest - %TotHW divided by %Forest. HW/Forest - %HW divided by %Forest. Pine/Forest - %Pine divided by %Forest. Hardwood and Mixed - percent area NCLD class "Deciduous" or "Mixed". %Hardwood - percent area NLCD class "Deciduous". %WLO – percent buffer composed of opening. WLOdist – distance (m) to nearest opening. %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". % Shrub - percent area NCLD class "Shrub/Scrub".

Table 3.10. Comparison of use (ψ) and detection (*p*) models for wild turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[29]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(.) *p*(.)	7316.23	154.58	0.000	3656.12	2
ψ(R1750 - %Foraging Habitat^2) p(Study Area + Hour^2 + DayBait)	7197.54	35.89	0.000	3588.77	10
ψ(Shape) p(Study Area + Hour^2 + DayBait)	7197.63	35.97	0.000	3589.81	9
ψ(R500 - %Foraging Habitat) p(Study Area + Hour^2 + DayBait)	7198.05	36.39	0.000	3590.02	9
ψ(R1750 - %Shrub) p(Study Area + Hour^2 + DayBait)	7198.54	36.89	0.000	3590.27	9
ψ(R500 - %Shrub^2) p(Study Area + Hour^2 + DayBait)	7198.82	37.17	0.000	3589.41	10
ψ(R500 - %Forest^2) p(Study Area + Hour^2 + DayBait)	7199.12	37.46	0.000	3589.56	10
ψ(R1750 - %Forest^2) p(Study Area + Hour^2 + DayBait)	7199.51	37.86	0.000	3589.76	10
ψ(R1750 - %Shrub^2) p(Study Area + Hour^2 + DayBait)	7200.55	38.89	0.000	3590.27	10
ψ(R500 - Road Cover) p(Study Area + Hour^2 + DayBait)	7215.66	54.01	0.000	3598.83	9
ψ(R500 - Road + %Foraging Habitat) p(Study Area + Hour^2 + DayBait)	7216.22	54.57	0.000	3598.11	10
ψ(R1750 - Road Cover) p(Study Area + Hour^2 + DayBait)	7266.95	105.29	0.000	3624.47	9
ψ(WLOsize) *p*(Study Area + Hour^2 + DayBait)	7402.72	241.06	0.000	3692.36	9
ψ(R500 - AvgWLOSize) *p*(Study Area + Hour^2 + DayBait)	7458.04	296.39	0.000	3720.02	9
ψ(R1750 - WLOSize) *p*(Study Area + Hour^2 + DayBait)	7535.29	373.64	0.000	3758.65	9
ψ(R1750 - Roads + %Foraging Habitat) *p*(Study Area + Hour^2 + DayBait)	8464.30	1302.65	0.000	4222.15	10

[29] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Shape – WLOsize divided by area of circle with equal circumference. %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". %Shrub - percent area NCLD class "Shrub/Scrub". %Forest - percent area NLCD class of any forest type. RoadCover – amount of road (m) in buffer. WLOsize – average area of openings in buffer (m^2).

Table 3.11. Comparison of use (ψ) and detection (*p*) models for turkey poults using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[30]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(R500 - % WLO) *p*(StudyArea + Hour^2 + DayBait)	1427.23	0.00	0.154	704.61	9
ψ(R500 - %Foraging Habitat^2) *p*(StudyArea + Hour^2 + DayBait)	1428.96	1.73	0.065	704.48	10
ψ(R500 - %Pine) *p*(StudyArea + Hour^2 + DayBait)	1429.21	1.98	0.057	705.61	9
ψ(.) *p*(StudyArea + Hour^2 + DayBait)	1429.55	2.32	0.048	706.77	8
ψ(R500 - %Hardwood) *p*(StudyArea + Hour^2 + DayBait)	1429.71	2.48	0.044	705.86	9
ψ(R500 - %(Hardwood and Mixed)) *p*(StudyArea + Hour^2 + DayBait)	1430.01	2.78	0.038	706.01	9
ψ(R500 - %(Pine and Mixed)) *p*(StudyArea + Hour^2 + DayBait)	1430.04	2.81	0.038	706.02	9
ψ(Shape) *p*(StudyArea + Hour^2 + DayBait)	1430.34	3.11	0.032	706.17	9
ψ(R500 - %Foraging Habitat) *p*(StudyArea + Hour^2 + DayBait)	1430.53	3.30	0.030	706.26	9
ψ(R1750 - %Pine) *p*(StudyArea + Hour^2 + DayBait)	1430.57	3.34	0.029	706.28	9
ψ(R500 - %Total Hardwoods) *p*(StudyArea + Hour^2 + DayBait)	1430.63	3.40	0.028	706.32	9
ψ(R1750 - %Forest) *p*(StudyArea + Hour^2 + DayBait)	1430.71	3.49	0.027	706.36	9
ψ(R1750 - %(Hardwood and Mixed)) *p*(StudyArea + Hour^2 + DayBait)	1430.75	3.52	0.026	706.37	9
ψ(R500 - %Shrub) *p*(StudyArea + Hour^2 + DayBait)	1430.80	3.57	0.026	706.40	9
ψ(R500 - %WLO + %Hardwood) *p*(StudyArea + Hour^2 + DayBait)	1430.84	3.61	0.025	705.42	10
ψ(R500 - WLONum) *p*(StudyArea + Hour^2 + DayBait)	1430.88	3.66	0.025	706.44	9

[30] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. %WLO – percent buffer composed of opening. %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". %Pine - percent area NLCD class "Evergreen". %Hardwood - percent area NLCD class "Deciduous". HardwoodandMixed - percent area NCLD class "Deciduous" or "Mixed". PineandMixed - percent area NCLD class "Evergreen" or "Mixed". Shape – WLOsize divided by area of circle with equal circumference. %TotalHardwoods - percent area NLCD class "Deciduous" or "Woody Wetlands". %Forest - percent area NLCD class of any forest type. %Shrub - percent area NCLD class "Shrub/Scrub". WLOnum – number of openings in buffer.

Table 3.11. Comparison of use (ψ) and detection (*p*) models for turkey poults using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[31]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(R1750 - %Shrub) *p*(StudyArea + Hour^2 + DayBait)	1431.24	4.01	0.021	706.62	9
ψ(R1750 - %Foraging Habitat^2) p(StudyArea + Hour^2 + DayBait)	1430.88	3.66	0.025	705.44	10
ψ(WLOdist) p(StudyArea + Hour^2 + DayBait)	1430.91	3.68	0.024	706.45	9
ψ(R500 - %Forest) p(StudyArea + Hour^2 + DayBait)	1431.04	3.81	0.023	706.52	9
ψ(R1750 - WLONum) p(StudyArea + Hour^2 + DayBait)	1431.05	3.82	0.023	706.53	9
ψ(R1750 - %Foraging Habitat) p(StudyArea + Hour^2 + DayBait)	1431.12	3.89	0.022	706.56	9
ψ(R1750 - %Hardwood) p(StudyArea + Hour^2 + DayBait)	1431.19	3.97	0.021	706.60	9
ψ(R1750 - %Total Hardwoods) *p*(StudyArea + Hour^2 + DayBait)	1431.38	4.16	0.019	706.69	9
ψ(R1750 - %(Pine and Mixed)) *p*(StudyArea + Hour^2 + DayBait)	1431.43	4.21	0.019	706.72	9
ψ(R1750 - % WLO) *p*(StudyArea + Hour^2 + DayBait)	1431.53	4.31	0.018	706.77	9
ψ(R500 - %Forest*(HW/Forest)) *p*(StudyArea + Hour^2 + DayBait)	1432.66	5.43	0.010	705.33	11
ψ(R500 - %Shrub^2) *p*(StudyArea + Hour^2 + DayBait)	1432.80	5.57	0.010	706.40	10
ψ(R500 - %Forest^2*(HW/Forest)) *p*(StudyArea + Hour^2 + DayBait)	1433.02	5.79	0.008	704.51	12
ψ(R1750 - %Forest^2) *p*(StudyArea + Hour^2 + DayBait)	1433.15	5.92	0.008	706.58	10
ψ(R1750 - %Shrub^2) *p*(StudyArea + Hour^2 + DayBait)	1433.17	5.94	0.008	706.59	10
ψ(R500 - %Forest*(Pine/Forest)) *p*(StudyArea + Hour^2 + DayBait)	1433.23	6.00	0.008	705.61	11
ψ(R1750 - %Forest*(Pine/Forest)) *p*(StudyArea + Hour^2 + DayBait)	1433.25	6.02	0.008	705.63	11

[31] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. %Shrub - percent area NCLD class “Shrub/Scrub”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”. WLOdist – distance (m) to nearest opening. %Forest - percent area NLCD class of any forest type. WLOnum – number of openings in buffer. %Hardwood - percent area NLCD class “Deciduous”. %TotalHardwoods - percent area NLCD class “Deciduous” or “Woody Wetlands”. PineandMixed - percent area NCLD class “Evergreen” or “Mixed”. %WLO – percent buffer composed of opening. HW/Forest - %HW divided by %Forest. Pine/Forest - %Pine divided by %Forest.

Table 3.11. Comparison of use (ψ) and detection (*p*) models for turkey poults using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[32]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(.)*p*(.)	1475.37	48.15	0.000	735.69	2
ψ(R1750 - %Forest*(HW/Forest)) p(StudyArea + Hour^2 + DayBait)	1433.29	6.06	0.007	705.65	11
ψ(R500 - %Forest^2) p(StudyArea + Hour^2 + DayBait)	1433.44	6.21	0.007	706.72	10
ψ(R500 - %Forest*(TotalHW/Forest)) p(StudyArea + Hour^2 + DayBait)	1434.17	6.94	0.005	706.09	11
ψ(R1750 - %Forest*(TotalHW/Forest)) p(StudyArea + Hour^2 + DayBait)	1434.52	7.29	0.004	706.26	11
ψ(R1750 - %Forest^2*(Pine/Forest)) p(StudyArea + Hour^2 + DayBait)	1435.28	8.05	0.003	705.64	12
ψ(R500 - %Forest^2*(Pine/Forest)) p(StudyArea + Hour^2 + DayBait)	1435.41	8.18	0.003	705.70	12
ψ(R500 - %Forest^2*(TotalHW/Forest)) p(StudyArea + Hour^2 + DayBait)	1435.65	8.42	0.002	705.82	12
ψ(R1750 - %Forest^2*(HW/Forest)) p(StudyArea + Hour^2 + DayBait)	1435.99	8.76	0.002	705.99	12
ψ(R1750 - %Forest^2*(TotalHW/Forest)) p(StudyArea + Hour^2 + DayBait)	1436.42	9.19	0.002	706.21	12
ψ(R500 - Road) p(StudyArea + Hour^2 + DayBait)	1449.96	22.73	0.000	715.98	9
ψ(R500 - Road + %Foraging Habitat) p(StudyArea + Hour^2 + DayBait)	1452.90	25.68	0.000	716.45	10
ψ(R1750 - AvgWLOSize) *p*(StudyArea + Hour^2 + DayBait)	1520.41	93.18	0.000	751.20	9
ψ(WLOsize) *p*(StudyArea + Hour^2 + DayBait)	1535.91	108.68	0.000	758.95	9
ψ(R500 - AvgWLOSize) *p*(StudyArea + Hour^2 + DayBait)	1545.65	118.42	0.000	763.82	9
ψ(R1750 - Road) *p*(StudyArea + Hour^2 + DayBait)	1566.80	139.57	0.000	774.40	9
ψ(R1750 - Road + %Foraging Habitat) *p*(StudyArea + Hour^2 + DayBait)	1568.91	141.68	0.000	774.45	10

[32] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. %Forest - percent area NLCD class of any forest type. TotalHW/Forest - %TotHW divided by %Forest. HW/Forest - %HW divided by %Forest. Pine/Forest - %Pine divided by %Forest. AvgWLOSize – average area of openings in buffer(m^2). WLOsize – area of opening (m^2). Road – amount of road (m) in buffer.

Table 3.12. Comparison of use (ψ) and detection (*p*) models for male turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[33]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(R1750 - %Forest*(Pine/Forest)) *p*(Study Area + DayBait)	2694.79	0.00	0.167	1338.40	9
ψ(R1750 - %Forest^2*(Pine/Forest)) *p*(Study Area + DayBait)	2695.20	0.41	0.136	1337.60	10
ψ(R1750 - %Forest^2*(HW/Forest)) *p*(Study Area + DayBait)	2696.04	1.25	0.089	1338.02	10
ψ(R1750 - %Forest*(TotalHW/Forest)) *p*(Study Area + DayBait)	2696.14	1.35	0.085	1339.07	9
ψ(R1750 - %Forest^2*(TotalHW/Forest)) *p*(Study Area + DayBait)	2696.17	1.38	0.083	1338.09	10
ψ(R1750 - %Forest*(HW/Forest)) *p*(Study Area + DayBait)	2696.25	1.46	0.080	1339.13	9
ψ(R500 - %(Pine and Mixed)) *p*(Study Area + DayBait)	2696.83	2.04	0.060	1341.41	7
ψ(R1750 - %(Pine and Mixed)) *p*(Study Area + DayBait)	2697.23	2.43	0.049	1341.61	7
ψ(R500 - %Pine) *p*(Study Area + DayBait)	2697.57	2.78	0.042	1341.78	7
ψ(R1750 - WLONum) *p*(Study Area + DayBait)	2698.06	3.27	0.033	1342.03	7
ψ(R500 - %Forest*(Pine/Forest)) *p*(Study Area + DayBait)	2699.12	4.33	0.019	1340.56	9
ψ(R500 - %Forest^2*(HW/Forest)) *p*(Study Area + DayBait)	2699.28	4.49	0.018	1339.64	10
ψ(R1750 - %Pine) *p*(Study Area + DayBait)	2699.29	4.50	0.018	1342.65	7
ψ(R500 - %Forest^2*(Pine/Forest)) *p*(Study Area + DayBait)	2699.36	4.57	0.017	1339.68	10
ψ(R500 - %Forest*(HW/Forest)) *p*(Study Area + DayBait)	2699.51	4.72	0.016	1340.76	9
ψ(R1750 - %Shrub) *p*(Study Area + DayBait)	2699.66	4.87	0.015	1342.83	7
ψ(R500 - %Forest^2*(TotalHW/Forest)) *p*(Study Area + DayBait)	2699.90	5.11	0.013	1339.95	10
ψ(R500 - %Forest*(TotalHW/Forest)) *p*(Study Area + DayBait)	2700.10	5.31	0.012	1341.05	9

[33] Study Area – study area survey was performed on. DayBait – days since bait was last replenished. %Forest - percent area NLCD class of any forest type. TotalHW/Forest - %TotHW divided by %Forest. HW/Forest - %HW divided by %Forest. Pine/Forest - %Pine divided by %Forest. PineandMixed - percent area NCLD class "Evergreen" or "Mixed". %Pine - percent area NLCD class "Evergreen". WLOnum – number of openings in buffer. %Shrub - percent area NCLD class "Shrub/Scrub".

Table 3.12. Comparison of use (ψ) and detection (*p*) models for male turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[34]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(R1750 - % WLO) *p*(Study Area + DayBait)	2702.08	7.29	0.004	1344.04	7
ψ(R1750 - %Forest) p(Study Area + DayBait)	2700.25	5.46	0.011	1343.12	7
ψ(R1750 - %Forest^2) p(Study Area + DayBait)	2701.22	6.43	0.007	1342.61	8
ψ(R1750 - %Shrub^2) p(Study Area + DayBait)	2701.53	6.74	0.006	1342.76	8
ψ(R500 - %Shrub) p(Study Area + DayBait)	2701.62	6.83	0.005	1343.81	7
ψ(R500 - %Shrub^2) *p*(Study Area + DayBait)	2702.26	7.47	0.004	1343.13	8
ψ(R500 - %Forest) *p*(Study Area + DayBait)	2703.24	8.45	0.002	1344.62	7
ψ(R500 - %Forest^2) *p*(Study Area + DayBait)	2704.41	9.62	0.001	1344.21	8
ψ(R500 - %Hardwood) *p*(Study Area + DayBait)	2704.52	9.73	0.001	1345.26	7
ψ(R1750 - %Total Hardwoods) *p*(Study Area + DayBait)	2704.61	9.82	0.001	1345.31	7
ψ(R500 - %Total Hardwoods) *p*(Study Area + DayBait)	2704.96	10.16	0.001	1345.48	7
ψ(R1750 - %Hardwood) *p*(Study Area + DayBait)	2705.00	10.21	0.001	1345.50	7
ψ(WLOdist) *p*(Study Area + DayBait)	2705.03	10.24	0.001	1345.51	7
ψ(R1750 - %Foraging Habitat) *p*(Study Area + DayBait)	2705.57	10.78	0.001	1345.78	7
ψ(R1750 - %Foraging Habitat^2) *p*(Study Area + DayBait)	2706.00	11.21	0.001	1345.00	8
ψ(R500 - WLONum) *p*(Study Area + DayBait)	2706.05	11.25	0.001	1346.02	7
ψ(.) *p*(Study Area + DayBait)	2706.85	12.06	0.000	1347.43	6
ψ(R500 - %(Hardwood and Mixed)) *p*(Study Area + DayBait)	2707.31	12.51	0.000	1346.65	7

[34] Study Area – study area survey was performed on. DayBait – days since bait was last replenished. %WLO – percent buffer composed of opening. %Forest - percent area NLCD class of any forest type. %Shrub - percent area NCLD class “Shrub/Scrub”. %Hardwood - percent area NLCD class “Deciduous”. %TotalHardwoods - percent area NLCD class “Deciduous” or “Woody Wetlands”. WLOdist – distance (m) to nearest opening. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”. HardwoodandMixed - percent area NCLD class “Deciduous” or “Mixed”.

Table 3.12. Comparison of use (ψ) and detection (*p*) models for male turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[35]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(WLOsize) *p*(Study Area + DayBait)	2954.42	259.63	0.000	1470.21	7
ψ(R500 - %Foraging Habitat) p(Study Area + DayBait)	2707.47	12.68	0.000	1346.74	7
ψ(R1750 - %(Hardwood and Mixed)) p(Study Area + DayBait)	2708.05	13.26	0.000	1347.02	7
ψ(R500 - % WLO) p(Study Area + DayBait)	2708.05	13.26	0.000	1347.03	7
ψ(Shape) p(Study Area + DayBait)	2708.66	13.87	0.000	1347.33	7
ψ(R500 - %Foraging Habitat^2) p(Study Area + DayBait)	2709.47	14.68	0.000	1346.74	8
ψ(R500 - Road) p(Study Area + DayBait)	2734.14	39.35	0.000	1360.07	7
ψ(R500 - Road + %Foraging Habitat) p(Study Area + DayBait)	2734.65	39.85	0.000	1359.32	8
ψ(.) p(.)	2747.89	53.09	0.000	1371.94	2
ψ(R500 - AvgWLOSize) *p*(Study Area + DayBait)	2962.12	267.33	0.000	1474.06	7
ψ(R1750 - AvgWLOSize) *p*(Study Area + DayBait)	2980.19	285.40	0.000	1483.09	7
ψ(R1750 - Road) *p*(Study Area + DayBait)	3222.33	527.54	0.000	1604.17	7
ψ(R1750 - Road + %Foraging Habitat) *p*(Study Area + DayBait)	3224.79	530.00	0.000	1604.40	8

[35] Study Area – study area survey was performed on. DayBait – days since bait was last replenished. WLOsize – area of opening (m^2). %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". HardwoodandMixed - percent area NCLD class "Deciduous" or "Mixed". %WLO – percent buffer composed of opening. Shape – WLOsize divided by area of circle with equal circumference. AvgWLOSize – average area of openings in buffer(m^2). Road – amount of road (m) in buffer.

Figure 3.1. Relationships of male wild turkey probability of use to percentage of forested area within a 1,750m buffer and percentage of that forested area that is composed of pine trees in Alabama, summer 2015 and 2016. The effect of percent of forested area is shown at varying percentages of percent pine and hardwood as labeled.

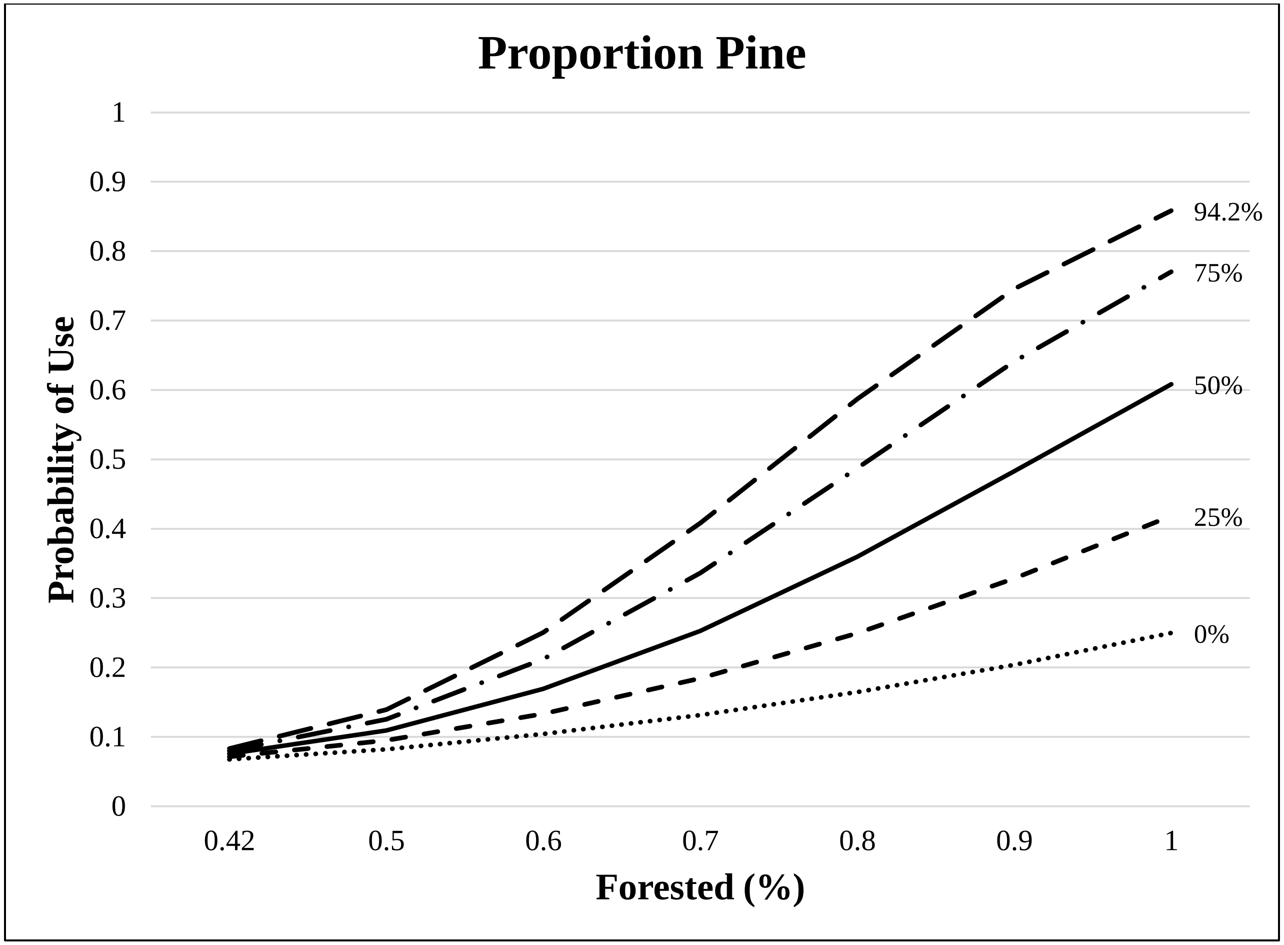

Figure 3.2. Relationships of male wild turkey probability of use to percentage of forested area within a 1,750m buffer and percentage of that forested area that is composed of hardwood trees in Alabama, summer 2015 and 2016. The effect of percent of forested area is shown at varying percentages of percent pine and hardwood as labeled.

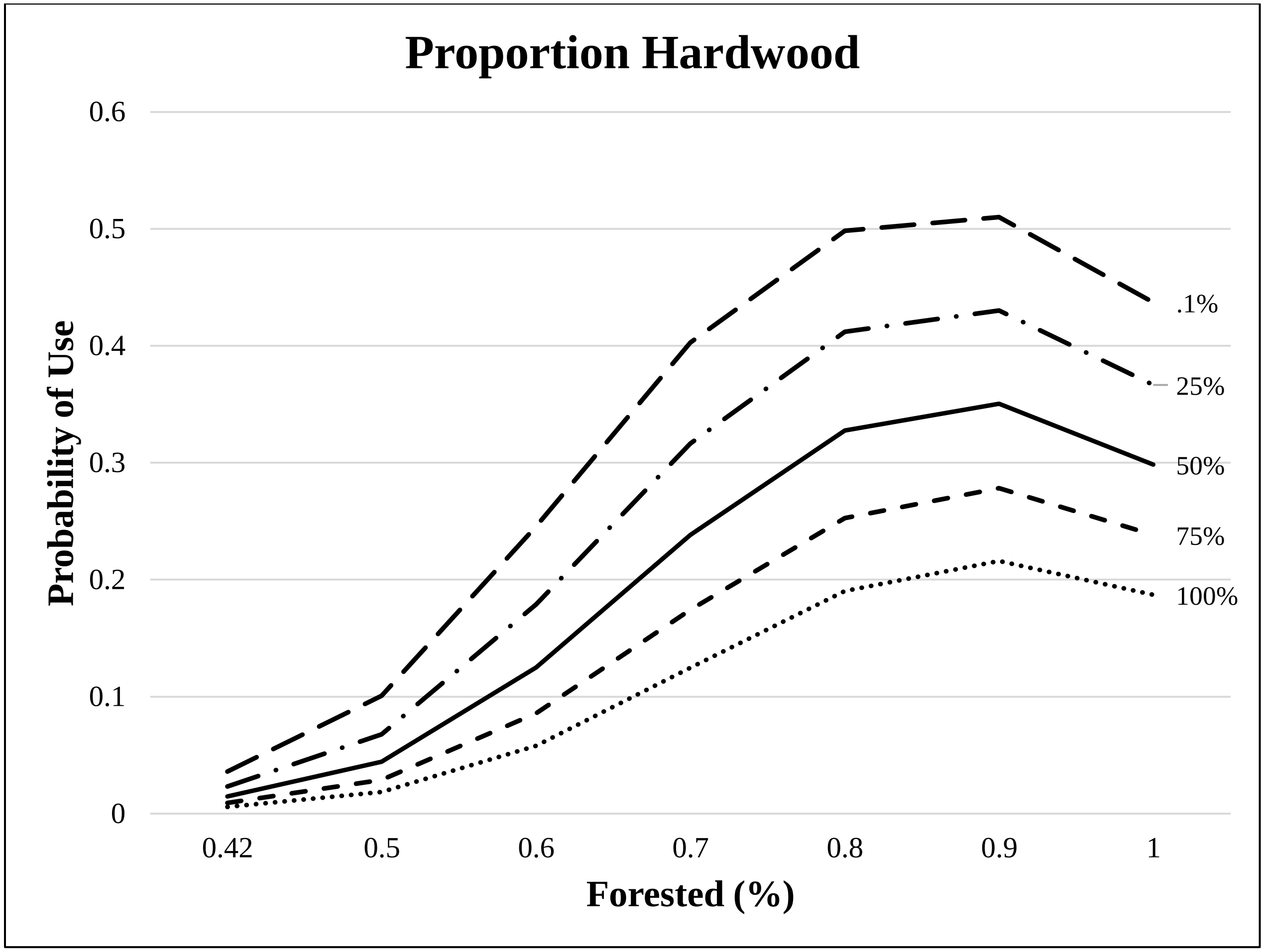

Table 3.13. Comparison of use (ψ) and detection (*p*) models for female turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[36]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(R500 - %Pine) *p*(StudyArea + Hour^2 + DayBait)	4989.23	0.00	0.149	2485.62	9
ψ(R500 - %Forest*(HW/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4990.01	0.78	0.101	2484.01	11
ψ(R500 - %(Pine and Mixed)) *p*(StudyArea + Hour^2 + DayBait)	4990.54	1.31	0.078	2486.27	9
ψ(R500 - %Hardwood) *p*(StudyArea + Hour^2 + DayBait)	4990.74	1.50	0.070	2486.37	9
ψ(R500 - %Forest*(Pine/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4990.75	1.51	0.070	2484.37	11
ψ(R500 - %Total Hardwoods) *p*(StudyArea + Hour^2 + DayBait)	4990.95	1.71	0.063	2486.47	9
ψ(R1750 - %Forest*(HW/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4991.21	1.98	0.055	2484.61	11
ψ(R500 - %Forest^2*(HW/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4991.48	2.25	0.048	2483.74	12
ψ(R1750 - %Forest*(Pine/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4991.49	2.26	0.048	2484.74	11
ψ(R500 - %Forest^2*(Pine/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4991.78	2.55	0.042	2483.89	12
ψ(R500 - %(Hardwood and Mixed)) *p*(StudyArea + Hour^2 + DayBait)	4992.09	2.85	0.036	2487.04	9
ψ(R1750 - %Pine) *p*(StudyArea + Hour^2 + DayBait)	4992.66	3.42	0.027	2487.33	9
ψ(R500 - %Forest*(TotalHW/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4992.67	3.44	0.027	2485.33	11
ψ(R1750 - %Total Hardwoods) *p*(StudyArea + Hour^2 + DayBait)	4993.03	3.80	0.022	2487.52	9
ψ(R1750 - %Forest^2*(Pine/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4993.10	3.87	0.022	2484.55	12
ψ(R1750 - %(Hardwood and Mixed)) *p*(StudyArea + Hour^2 + DayBait)	4993.12	3.88	0.021	2487.56	9
ψ(R1750 - %Forest^2*(HW/Forest)) *p*(StudyArea + Hour^2 + DayBait)	4993.20	3.97	0.020	2484.60	12

[36] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. %Pine - percent area NLCD class "Evergreen". %Forest - percent area NLCD class of any forest type. HW/Forest - %HW divided by %Forest. PineandMixed - percent area NCLD class "Evergreen" or "Mixed". %Hardwood - percent area NLCD class "Deciduous". %TotalHardwoods - percent area NLCD class "Deciduous" or "Woody Wetlands". Pine/Forest - %Pine divided by %Forest. HardwoodandMixed - percent area NCLD class "Deciduous" or "Mixed". TotalHW/Forest - %TotHW divided by %Forest.

Table 3.13. Comparison of use (ψ) and detection (*p*) models for female turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[37]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(.) *p*(StudyArea + Hour^2 + DayBait)	4996.50	7.26	0.004	2490.25	8
ψ(R500 - %Forest^2*(TotalHW/Forest)) p(StudyArea + Hour^2 + DayBait)	4993.42	4.18	0.018	2484.71	12
ψ(R1750 - %Hardwood) p(StudyArea + Hour^2 + DayBait)	4993.51	4.28	0.018	2487.76	9
ψ(R1750 - %Forest*(TotalHW/Forest)) p(StudyArea + Hour^2 + DayBait)	4994.59	5.36	0.010	2486.29	11
ψ(R1750 - %(Pine and Mixed)) p(StudyArea + Hour^2 + DayBait)	4994.83	5.60	0.009	2488.41	9
ψ(R1750 - %Forest^2*(TotalHW/Forest)) p(StudyArea + Hour^2 + DayBait)	4995.16	5.93	0.008	2485.58	12
ψ(R1750 - % WLO) *p*(StudyArea + Hour^2 + DayBait)	4996.51	7.27	0.004	2489.25	9
ψ(Shape) *p*(StudyArea + Hour^2 + DayBait)	4996.87	7.64	0.003	2489.44	9
ψ(R1750 - WLONum) *p*(StudyArea + Hour^2 + DayBait)	4997.06	7.83	0.003	2489.53	9
ψ(R500 - WLONum) *p*(StudyArea + Hour^2 + DayBait)	4997.35	8.12	0.003	2489.67	9
ψ(R1750 - %Shrub) *p*(StudyArea + Hour^2 + DayBait)	4997.80	8.57	0.002	2489.90	9
ψ(R500 - % WLO) *p*(StudyArea + Hour^2 + DayBait)	4997.82	8.59	0.002	2489.91	9
ψ(R1750 - %Forest) *p*(StudyArea + Hour^2 + DayBait)	4998.04	8.80	0.002	2490.02	9
ψ(R1750 - %Foraging Habitat) *p*(StudyArea + Hour^2 + DayBait)	4998.39	9.16	0.002	2490.19	9
ψ(WLOdist) *p*(StudyArea + Hour^2 + DayBait)	4998.40	9.17	0.002	2490.20	9
ψ(R500 - %Forest) *p*(StudyArea + Hour^2 + DayBait)	4998.47	9.24	0.001	2490.23	9
ψ(R500 - %Shrub) *p*(StudyArea + Hour^2 + DayBait)	4998.47	9.24	0.001	2490.24	9

[37] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. %Forest - percent area NLCD class of any forest type. TotalHW/Forest - %TotHW divided by %Forest. %Hardwood - percent area NLCD class "Deciduous". PineandMixed - percent area NCLD class "Evergreen" or "Mixed". %WLO – percent buffer composed of opening. Shape – WLOsize divided by area of circle with equal circumference. WLOnum – number of openings in buffer. %Shrub - percent area NCLD class "Shrub/Scrub". %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture".

Table 3.13. Comparison of use (ψ) and detection (*p*) models for female turkey using camera trap surveys in Alabama, summer 2015 and 2016. For each model, values for bias corrected AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[38]

Model	AIC	ΔAIC	*w*	Lik	K
ψ(R500 - Road + %Foraging Habitat) *p*(StudyArea + Hour^2 + DayBait)	5028.25	39.02	0.000	2504.12	10
ψ(R500 - %Foraging Habitat) p(StudyArea + Hour^2 + DayBait)	4998.49	9.26	0.001	2490.25	9
ψ(R1750 - %Shrub^2) p(StudyArea + Hour^2 + DayBait)	4998.56	9.33	0.001	2489.28	10
ψ(R500 - %Foraging Habitat^2) p(StudyArea + Hour^2 + DayBait)	4999.07	9.83	0.001	2489.53	10
ψ(R1750 - %Forest^2) p(StudyArea + Hour^2 + DayBait)	4999.54	10.31	0.001	2489.77	10
ψ(R500 - %Forest^2) p(StudyArea + Hour^2 + DayBait)	4999.79	10.56	0.001	2489.90	10
ψ(R500 - %Shrub^2) p(StudyArea + Hour^2 + DayBait)	4999.87	10.64	0.001	2489.94	10
ψ(R1750 - %Foraging Habitat^2) p(StudyArea + Hour^2 + DayBait)	5000.39	11.16	0.001	2490.20	10
ψ(R1750 - AvgWLOSize) p(StudyArea + Hour^2 + DayBait)	5006.83	17.59	0.000	2494.41	9
ψ(R500 - AvgWLOSize) p(StudyArea + Hour^2 + DayBait)	5016.27	27.04	0.000	2499.14	9
ψ(R500 - Road) p(StudyArea + Hour^2 + DayBait)	5026.08	36.85	0.000	2504.04	9
ψ(WLOsize) *p*(StudyArea + Hour^2 + DayBait)	5034.29	45.06	0.000	2508.15	9
ψ(.) *p*(.)	5034.70	45.47	0.000	2515.35	2
ψ(R1750 - Road + %Foraging Habitat) *p*(StudyArea + Hour^2 + DayBait)	5655.22	665.98	0.000	2817.61	10
ψ(R1750 - Road) *p*(StudyArea + Hour^2 + DayBait)	5657.82	668.58	0.000	2819.91	9

[38] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Road – amount of road (m) in buffer. %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". %Shrub - percent area NCLD class "Shrub/Scrub". %Forest - percent area NLCD class of any forest type. AvgWLOSize – average area of openings in buffer(m^2). WLOsize – area of opening (m^2).

Table 3.14. Estimates (ψ) and standard deviations (SD) for probability of wild turkey use on managed wildlife openings across study areas.

	Total		Male		Female		Poult	
	ψ	SD	ψ	SD	ψ	SD	ψ	SD
Barbour	0.499	0.140	0.157	0.065	0.413	0.051	0.140	0.009
Oakmulgee	0.755	0.109	0.390	0.053	0.488	0.033	0.139	0.005
Scotch	0.815	0.161	0.292	0.093	0.593	0.031	0.149	0.010
Skyline	0.421	0.053	0.181	0.029	0.365	0.015	0.136	0.012
Average	0.612	0.201	0.258	0.115	0.456	0.088	0.140	0.010

Table 3.15. Comparison of density (λ) and detection (*p*) models for wild turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[39]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R500 - %Forest^2*(HW/Forest)) *p*(Study Area + Hour^2 + DayBait)	16799.31	0.00	0.758	8387.65	12
λ(R500 - %Forest*(HW/Forest)) *p*(Study Area + Hour^2 + DayBait)	16801.67	2.36	0.233	8389.84	11
λ(R500 - %Forest*(Pine/Forest)) *p*(Study Area + Hour^2 + DayBait)	16808.89	9.58	0.006	8393.44	11
λ(R500 - %Forest^2*(Pine/Forest)) *p*(Study Area + Hour^2 + DayBait)	16810.59	11.28	0.003	8393.29	12
λ(R1750 - %Forest^2*(HW/Forest)) *p*(Study Area + Hour^2 + DayBait)	16816.99	17.68	0.000	8396.49	12
λ(R1750 - %Forest^2*(Pine/Forest)) *p*(Study Area + Hour^2 + DayBait)	16828.19	28.88	0.000	8402.10	12
λ(R500 - %Pine) *p*(Study Area + Hour^2 + DayBait)	16830.40	31.09	0.000	8406.20	9
λ(R1750 - %Forest*(HW/Forest)) *p*(Study Area + Hour^2 + DayBait)	16839.93	40.62	0.000	8408.96	11
λ(R1750 - %Forest*(Pine/Forest)) *p*(Study Area + Hour^2 + DayBait)	16847.33	48.03	0.000	8412.67	11
λ(R500 - %(Pine and Mixed)) *p*(Study Area + Hour^2 + DayBait)	16855.57	56.26	0.000	8418.78	9
λ(R500 - %Forest*(TotalHW/Forest)) *p*(Study Area + Hour^2 + DayBait)	16882.79	83.48	0.000	8430.39	11
λ(R1750 - %Forest^2*(TotalHW/Forest)) *p*(Study Area + Hour^2 + DayBait)	16883.35	84.04	0.000	8429.68	12
λ(R500 - %Forest^2*(TotalHW/Forest)) *p*(Study Area + Hour^2 + DayBait)	16885.81	86.50	0.000	8430.90	12
λ(R1750 - %Forest*(TotalHW/Forest)) *p*(Study Area + Hour^2 + DayBait)	16894.50	95.19	0.000	8436.25	11
λ(R1750 - %Pine) *p*(Study Area + Hour^2 + DayBait)	16927.04	127.73	0.000	8454.52	9
λ(R500 - %Hardwood) *p*(Study Area + Hour^2 + DayBait)	16930.98	131.67	0.000	8456.49	9
λ(R500 - WLONum) *p*(Study Area + Hour^2 + DayBait)	16946.34	147.03	0.000	8464.17	9
λ(R1750 - %Forest^2) *p*(Study Area + Hour^2 + DayBait)	16948.81	149.50	0.000	8464.40	10

[39] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. %Forest - percent area NLCD class of any forest type. TotalHW/Forest - %TotHW divided by %Forest. HW/Forest - %HW divided by %Forest. Pine/Forest - %Pine divided by %Forest. %Pine - percent area NLCD class “Evergreen”. PineandMixed - percent area NCLD class “Evergreen” or “Mixed”. %Hardwood - percent area NLCD class “Deciduous”. WLOnum – number of openings in buffer.

Table 3.15. Comparison of density (λ) and detection (*p*) models for wild turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[40]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R500 - %Total Hardwoods) *p*(Study Area + Hour^2 + DayBait)	16957.25	157.94	0.000	8469.63	9
λ(R1750 - % WLO) p(Study Area + Hour^2 + DayBait)	16949.89	150.58	0.000	8465.94	9
λ(R1750 - %(Pine and Mixed)) p(Study Area + Hour^2 + DayBait)	16950.55	151.24	0.000	8466.27	9
λ(R1750 - WLONum) p(Study Area + Hour^2 + DayBait)	16952.74	153.43	0.000	8467.37	9
λ(R500 - %(Hardwood and Mixed)) p(Study Area + Hour^2 + DayBait)	16955.06	155.75	0.000	8468.53	9
λ(R500 - %Foraging Habitat^2) *p*(Study Area + Hour^2 + DayBait)	16958.24	158.94	0.000	8469.12	10
λ(R500 - %Foraging Habitat) *p*(Study Area + Hour^2 + DayBait)	16958.74	159.43	0.000	8470.37	9
λ(R1750 - %Hardwood) *p*(Study Area + Hour^2 + DayBait)	16966.79	167.48	0.000	8474.39	9
λ(R1750 - %Total Hardwoods) *p*(Study Area + Hour^2 + DayBait)	16967.67	168.36	0.000	8474.84	9
λ(R1750 - %(Hardwood and Mixed)) *p*(Study Area + Hour^2 + DayBait)	16969.96	170.66	0.000	8475.98	9
λ(R1750 - %Foraging Habitat^2) *p*(Study Area + Hour^2 + DayBait)	16974.92	175.61	0.000	8477.46	10
λ(R500 - %Forest^2) *p*(Study Area + Hour^2 + DayBait)	16978.01	178.71	0.000	8479.01	10
λ(R1750 - %Foraging Habitat) *p*(Study Area + Hour^2 + DayBait)	16980.13	180.82	0.000	8481.07	9
λ(R1750 - %Shrub^2) *p*(Study Area + Hour^2 + DayBait)	16980.72	181.41	0.000	8480.36	10
λ(R500 - %Shrub^2) *p*(Study Area + Hour^2 + DayBait)	16984.40	185.09	0.000	8482.20	10
λ(R500 - %Shrub) *p*(Study Area + Hour^2 + DayBait)	16988.94	189.63	0.000	8485.47	9
λ(WLOdist) *p*(Study Area + Hour^2 + DayBait)	17003.75	204.44	0.000	8492.87	9

[40] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. %Forest - percent area NLCD class of any forest type. %Hardwood - percent area NLCD class "Deciduous". %TotalHardwoods - percent area NLCD class "Deciduous" or "Woody Wetlands". %WLO – percent buffer composed of opening. PineandMixed - percent area NCLD class "Evergreen" or "Mixed". WLOnum – number of openings in buffer. HardwoodandMixed - percent area NCLD class "Deciduous" or "Mixed". %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". %Shrub - percent area NCLD class "Shrub/Scrub". WLOdist – distance (m) to nearest opening.

Table 3.15. Comparison of density (λ) and detection (*p*) models for wild turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[41]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R1750 - AvgWLOSize) *p*(Study Area + Hour^2 + DayBait)	41993.93	25194.63	0.000	20987.97	9
λ(R500 - % WLO) p(Study Area + Hour^2 + DayBait)	17004.38	205.07	0.000	8493.19	9
λ(R1750 - %Forest) p(Study Area + Hour^2 + DayBait)	17008.89	209.58	0.000	8495.44	9
λ(.) p(Study Area + Hour^2 + DayBait)	17010.36	211.05	0.000	8497.18	8
λ(Shape) p(Study Area + Hour^2 + DayBait)	17014.25	214.94	0.000	8498.13	9
λ(R1750 - %Shrub) p(Study Area + Hour^2 + DayBait)	17014.40	215.10	0.000	8498.20	9
λ(R500 - %Forest) p(Study Area + Hour^2 + DayBait)	17048.08	248.77	0.000	8515.04	9
λ(.) p(.)	17319.82	520.52	0.000	8657.91	2
λ(R500 - Road) p(Study Area + Hour^2 + DayBait)	17544.87	745.56	0.000	8763.44	9
λ(R500 - Road + %Foraging Habitat) p(Study Area + Hour^2 + DayBait)	27039.72	10240.42	0.000	13509.86	10
λ(R500 - AvgWLOSize) *p*(Study Area + Hour^2 + DayBait)	41993.93	25194.63	0.000	20987.97	9
λ(WLOsize) *p*(Study Area + Hour^2 + DayBait)	41993.93	25194.63	0.000	20987.97	9
λ(R1750 - Road) *p*(Study Area + Hour^2 + DayBait)	41993.93	25194.63	0.000	20987.97	9
λ(R1750 - Road + %Foraging Habitat) *p*(Study Area + Hour^2 + DayBait)	41995.93	25196.63	0.000	20987.97	10

[41] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. AvgWLOSize – average area of openings in buffer(m^2). %WLO – percent buffer composed of opening. %Forest - percent area NLCD class of any forest type. Shape – WLOsize divided by area of circle with equal circumference. . %Shrub - percent area NCLD class “Shrub/Scrub”. Road – amount of road (m) in buffer. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”. WLOsize – area of opening (m^2).

Table 3.16. Comparison of density (λ) and detection (*p*) models for turkey poults using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[42]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R1750 - %Forest^2*(HW/Forest)) *p*(Hour^2 + DayBait + Study Area)	6595.60	0.00	0.998	3285.80	12
λ(R1750 - %Forest*(HW/Forest)) *p*(Hour^2 + DayBait + Study Area)	6607.95	12.35	0.002	3292.98	11
λ(R1750 - %Forest^2*(Pine/Forest)) *p*(Hour^2 + DayBait + Study Area)	6613.11	17.51	0.000	3294.56	12
λ(R1750 - %Forest*(Pine/Forest)) *p*(Hour^2 + DayBait + Study Area)	6620.39	24.79	0.000	3299.20	11
λ(R1750 - %Forest^2*(TotalHW/Forest)) *p*(Hour^2 + DayBait + Study Area)	6628.99	33.39	0.000	3302.49	12
λ(R500 - %Forest^2*(HW/Forest)) *p*(Hour^2 + DayBait + Study Area)	6645.86	50.26	0.000	3310.93	12
λ(R1750 - %Forest*(TotalHW/Forest)) *p*(Hour^2 + DayBait + Study Area)	6653.33	57.73	0.000	3315.66	11
λ(R500 - %Forest*(HW/Forest)) *p*(Hour^2 + DayBait + Study Area)	6668.67	73.06	0.000	3323.33	11
λ(R500 - %Forest^2*(Pine/Forest)) *p*(Hour^2 + DayBait + Study Area)	6671.12	75.52	0.000	3323.56	12
λ(R500 - %Forest*(Pine/Forest)) *p*(Hour^2 + DayBait + Study Area)	6674.50	78.89	0.000	3326.25	11
λ(R1750 - %Foraging Habitat^2) *p*(Hour^2 + DayBait + Study Area)	6685.16	89.56	0.000	3332.58	10
λ(R500 - %Pine) *p*(Hour^2 + DayBait + Study Area)	6698.66	103.06	0.000	3340.33	9
λ(R1750 - %Forest^2) *p*(Hour^2 + DayBait + Study Area)	6700.37	104.77	0.000	3340.18	10
λ(R500 - %Foraging Habitat^2) *p*(Hour^2 + DayBait + Study Area)	6711.67	116.06	0.000	3345.83	10
λ(R500 - %(Hardwood and Mixed)) *p*(Hour^2 + DayBait + Study Area)	6712.69	117.09	0.000	3347.34	9
λ(R500 - %Hardwood) *p*(Hour^2 + DayBait + Study Area)	6725.60	130.00	0.000	3353.80	9
λ(R1750 - %Shrub^2) *p*(Hour^2 + DayBait + Study Area)	6725.87	130.27	0.000	3352.93	10

[42] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. TotalHW/Forest - %TotHW divided by %Forest. HW/Forest - %HW divided by %Forest. Pine/Forest - %Pine divided by %Forest. %Forest - percent area NLCD class of any forest type. %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". %Pine - percent area NLCD class "Evergreen". HardwoodandMixed - percent area NCLD class "Deciduous" or "Mixed". %Hardwood - percent area NLCD class "Deciduous". %Shrub - percent area NCLD class "Shrub/Scrub".

Table 3.16. Comparison of density (λ) and detection (*p*) models for turkey poults using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[43]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R500 - %Forest^2*(TotalHW/Forest)) *p*(Hour^2 + DayBait + Study Area)	6735.88	140.28	0.000	3355.94	12
λ(R500 - %(Pine and Mixed)) *p*(Hour^2 + DayBait + Study Area)	6726.12	130.51	0.000	3354.06	9
λ(R1750 - %(Hardwood and Mixed)) *p*(Hour^2 + DayBait + Study Area)	6729.11	133.51	0.000	3355.56	9
λ(R500 - %Foraging Habitat)*p*(Hour^2 + DayBait + Study Area)	6732.88	137.28	0.000	3357.44	9
λ(R1750 - %Shrub) *p*(Hour^2 + DayBait + Study Area)	6733.47	137.87	0.000	3357.74	9
λ(R500 - WLONum) *p*(Hour^2 + DayBait + Study Area)	6734.26	138.66	0.000	3358.13	9
λ(R1750 - WLONum) *p*(Hour^2 + DayBait + Study Area)	6746.18	150.58	0.000	3364.09	9
λ(R1750 - %Total Hardwoods) *p*(Hour^2 + DayBait + Study Area)	6747.88	152.28	0.000	3364.94	9
λ(R1750 - % WLO) *p*(Hour^2 + DayBait + Study Area)	6748.62	153.02	0.000	3365.31	9
λ(Shape) *p*(Hour^2 + DayBait + Study Area)	6750.29	154.69	0.000	3366.15	9
λ(R1750 - %Foraging Habitat) *p*(Hour^2 + DayBait + Study Area)	6750.90	155.30	0.000	3366.45	9
λ(.) *p*(Hour^2 + DayBait + Study Area)	6751.07	155.47	0.000	3367.53	8
λ(R1750 - %(Pine and Mixed)) *p*(Hour^2 + DayBait + Study Area)	6751.57	155.97	0.000	3366.78	9
λ(R500 - %Shrub) *p*(Hour^2 + DayBait + Study Area)	6752.19	156.59	0.000	3367.09	9
λ(R500 - %Forest) *p*(Hour^2 + DayBait + Study Area)	6752.48	156.87	0.000	3367.24	9
λ(R500 - % WLO) *p*(Hour^2 + DayBait + Study Area)	6752.96	157.36	0.000	3367.48	9

[43] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. TotalHW/Forest - %TotHW divided by %Forest. %Forest - percent area NLCD class of any forest type. PineandMixed - percent area NCLD class “Evergreen” or “Mixed”. HardwoodandMixed - percent area NCLD class “Deciduous” or “Mixed”. %Shrub - percent area NCLD class “Shrub/Scrub”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”. WLOnum – number of openings in buffer. %TotalHardwoods - percent area NLCD class “Deciduous” or “Woody Wetlands”. %WLO – percent buffer composed of opening. Shape – WLOsize divided by area of circle with equal circumference.

Table 3.16. Comparison of density (λ) and detection (*p*) models for turkey poults using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[44]

Model	AIC	ΔAIC	*w*	Lik	K
λ(WLOsize) *p*(Hour^2 + DayBait + Study Area)	13659.86	7064.26	0.000	6820.93	9
λ(WLOdist) p(Hour^2 + DayBait + Study Area)	6753.69	158.09	0.000	3367.84	9
λ(R500 - %Shrub^2) p(Hour^2 + DayBait + Study Area)	6754.43	158.83	0.000	3367.22	10
λ(R500 - %Forest^2) p(Hour^2 + DayBait + Study Area)	6754.59	158.99	0.000	3367.30	10
λ(.) p(.)	7000.44	404.84	0.000	3498.22	2
λ(R500 - AvgWLOSize) p(Hour^2 + DayBait + Study Area)	13350.01	6754.41	0.000	6666.01	9
λ(R1750 - AvgWLOSize) p(Hour^2 + DayBait + Study Area)	13525.64	6930.04	0.000	6753.82	9
λ(R500 - Road) *p*(Hour^2 + DayBait + Study Area)	14292.49	7696.89	0.000	7137.25	9
λ(R500 - Road + %Foraging Habitat) *p*(Hour^2 + DayBait + Study Area)	14293.93	7698.33	0.000	7136.97	10
λ(R1750 - Road) *p*(Hour^2 + DayBait + Study Area)	15920.65	9325.05	0.000	7951.33	9
λ(R1750 - Road + %Foraging Habitat) *p*(Hour^2 + DayBait + Study Area)	15922.65	9327.05	0.000	7951.33	10

[44] Study Area – study area survey was performed on. Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. WLOsize – area of opening (m^2). WLOdist – distance (m) to nearest opening. %Shrub - percent area NCLD class “Shrub/Scrub”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”. %Forest - percent area NLCD class of any forest type. AvgWLOSize – average area of openings in buffer(m^2). Road – amount of road (m) in buffer.

Figure 3.3. Relationship of total wild turkey density to percentage of forested area within a 500m buffer and percentage of that forested area that is composed of hardwood trees in Alabama, summer 2015 and 2016. The effect of percent of forested area is shown at varying percentages of percent hardwood as labeled.

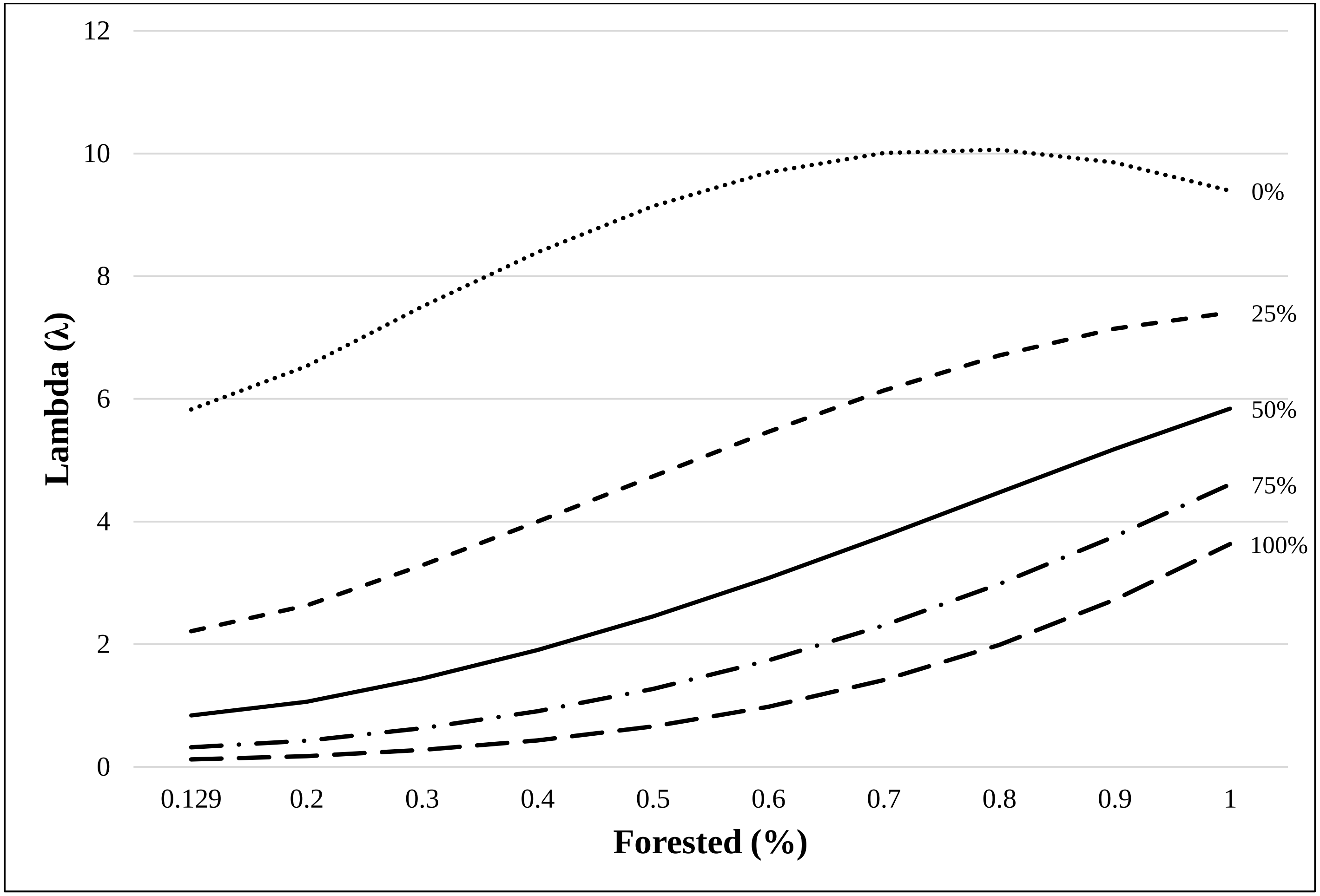

Figure 3.4. Relationship of wild turkey poult density to percentage of forested area within a 1,750m buffer and percentage of that forested area that is composed of hardwood trees in Alabama, summer 2015 and 2016. The effect of percent of forested area is shown at varying percentages of percent hardwood as labeled.

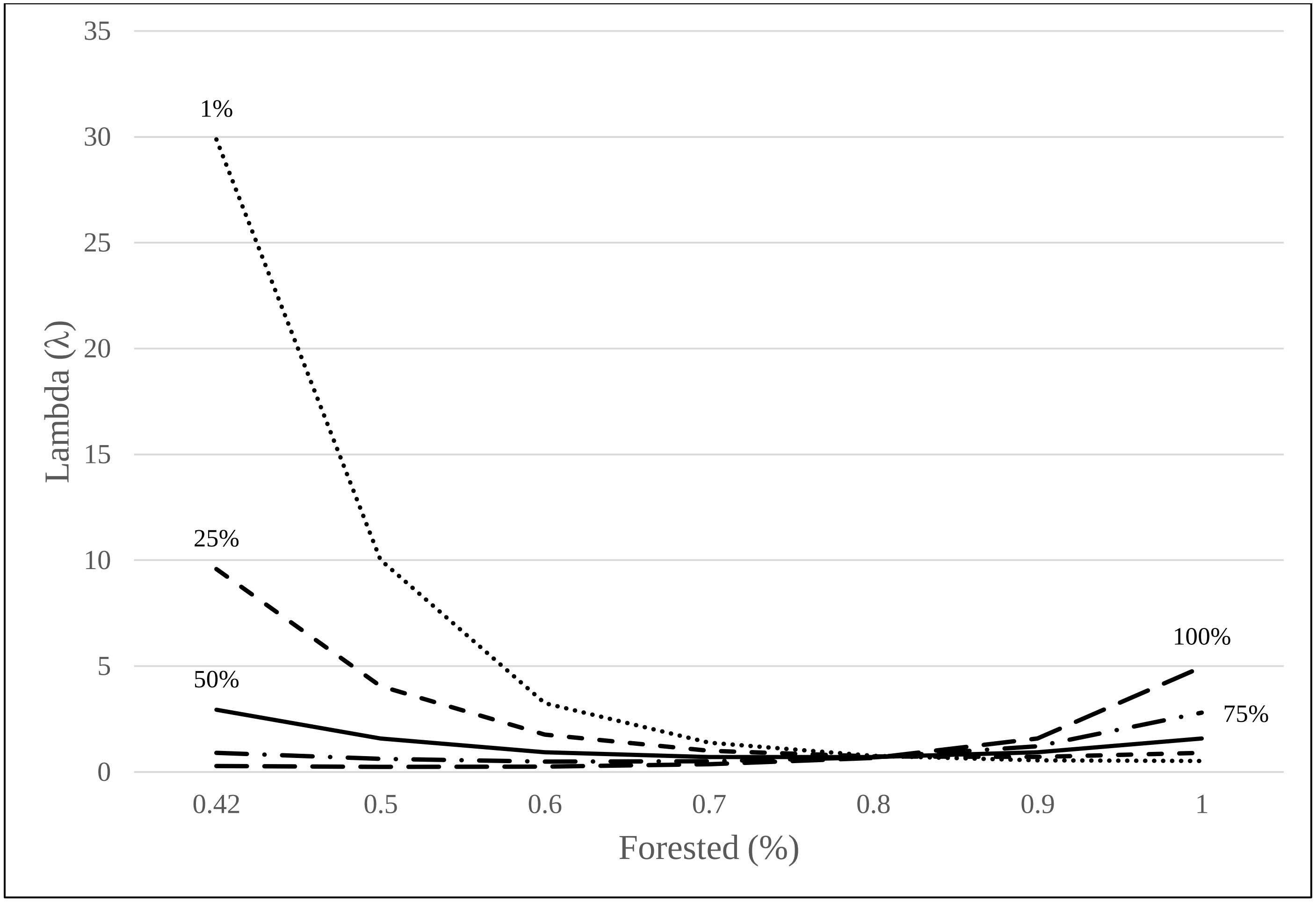

Table 3.17. Comparison of density (λ) and detection (*p*) models for male turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[45]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R500 - %Forest*(Pine/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4217.62	0.00	0.596	2097.81	11
λ(R500 - %Forest^2*(Pine/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4219.21	1.60	0.268	2097.61	12
λ(R1750 - %Forest*(Pine/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4222.14	4.53	0.062	2100.07	11
λ(R1750 - %Forest^2*(Pine/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4223.29	5.67	0.035	2099.65	12
λ(R500 - %Forest*(TotalHW/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4225.43	7.81	0.012	2101.71	11
λ(R500 - %Forest^2*(TotalHW/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4225.73	8.12	0.010	2100.87	12
λ(R1750 - %Forest^2*(TotalHW/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4227.37	9.76	0.005	2101.69	12
λ(R500 - %Forest*(HW/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4227.65	10.04	0.004	2102.83	11
λ(R1750 - %Forest^2*(HW/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4228.13	10.52	0.003	2102.07	12
λ(R500 - %Forest^2*(HW/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4228.62	11.01	0.002	2102.31	12
λ(R1750 - %Forest*(TotalHW/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4229.72	12.11	0.001	2103.86	11
λ(R1750 - %Forest*(HW/Forest)) *p*(DayBait+ Study Area + Year + DayYear)	4230.91	13.30	0.001	2104.46	11
λ(R1750 - WLONum) *p*(DayBait+ Study Area + Year + DayYear)	4237.55	19.94	0.000	2109.78	9
λ(R500 - %Forest) *p*(DayBait+ Study Area + Year + DayYear)	4242.70	25.09	0.000	2112.35	9
λ(R1750 - %Forest^2) *p*(DayBait+ Study Area + Year + DayYear)	4243.00	25.38	0.000	2111.50	10
λ(R1750 - %Forest) *p*(DayBait+ Study Area + Year + DayYear)	4243.45	25.83	0.000	2112.72	9
λ(R500 - %(Pine and Mixed)) *p*(DayBait+ Study Area + Year + DayYear)	4243.72	26.10	0.000	2112.86	9
λ(R500 - %Forest^2) *p*(DayBait+ Study Area + Year + DayYear)	4244.43	26.82	0.000	2112.22	10
λ(R500 - %Pine) *p*(DayBait+ Study Area + Year + DayYear)	4244.65	27.04	0.000	2113.33	9

[45] Study Area – study area survey was performed on. DayYear – Julian date of the survey. DayBait – days since bait was last replenished. %Forest - percent area NLCD class of any forest type. TotalHW/Forest - %TotHW divided by %Forest. HW/Forest - %HW divided by %Forest. Pine/Forest - %Pine divided by %Forest. WLOnum – number of openings in buffer. PineandMixed - percent area NCLD class “Evergreen” or “Mixed”. %Pine - percent area NLCD class “Evergreen”.

Table 3.17. Comparison of density (λ) and detection (*p*) models for male turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[46]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R500 - %Shrub^2) *p*(DayBait+ Study Area + Year + DayYear)	4253.25	35.63	0.000	2116.62	10
λ(R500 - %Shrub) p(DayBait+ Study Area + Year + DayYear)	4251.47	33.85	0.000	2116.73	9
λ(R1750 - % WLO) p(DayBait+ Study Area + Year + DayYear)	4252.52	34.90	0.000	2117.26	9
λ(R1750 - %Shrub) p(DayBait+ Study Area + Year + DayYear)	4252.72	35.10	0.000	2117.36	9
λ(R1750 - %(Pine and Mixed)) *p*(DayBait+ Study Area + Year + DayYear)	4254.15	36.54	0.000	2118.08	9
λ(R1750 - %Shrub^2) *p*(DayBait+ Study Area + Year + DayYear)	4254.72	37.10	0.000	2117.36	10
λ(R1750 - %Foraging Habitat) *p*(DayBait+ Study Area + Year + DayYear)	4258.35	40.74	0.000	2120.18	9
λ(R1750 - %Foraging Habitat^2)*p*(DayBait+ Study Area + Year + DayYear)	4258.68	41.06	0.000	2119.34	10
λ(R500 - %Foraging Habitat^2) *p*(DayBait+ Study Area + Year + DayYear)	4258.91	41.29	0.000	2119.45	10
λ(R500 - WLONum) *p*(DayBait+ Study Area + Year + DayYear)	4259.39	41.77	0.000	2120.69	9
λ(R1750 - %Pine) *p*(DayBait+ Study Area + Year + DayYear)	4259.63	42.02	0.000	2120.82	9
λ(R500 - %Foraging Habitat) *p*(DayBait+ Study Area + Year + DayYear)	4260.02	42.41	0.000	2121.01	9
λ(WLOdist) *p*(DayBait+ Study Area + Year + DayYear)	4265.84	48.23	0.000	2123.92	9
λ(R500 - % WLO) *p*(DayBait+ Study Area + Year + DayYear)	4276.01	58.40	0.000	2129.01	9
λ(R1750 - %Total Hardwoods) *p*(DayBait+ Study Area + Year + DayYear)	4276.45	58.83	0.000	2129.22	9
λ(R500 - %Hardwood) *p*(DayBait+ Study Area + Year + DayYear)	4276.64	59.03	0.000	2129.32	9
λ(R500 - %Total Hardwoods) *p*(DayBait+ Study Area + Year + DayYear)	4276.82	59.21	0.000	2129.41	9

[46] Study Area – study area survey was performed on. DayYear – Julian date of the survey. DayBait – days since bait was last replenished. %Shrub - percent area NCLD class “Shrub/Scrub”. %WLO – percent buffer composed of opening. PineandMixed - percent area NCLD class “Evergreen” or “Mixed”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”. WLOnum – number of openings in buffer. %Pine - percent area NLCD class “Evergreen”. %ForagingHabitat – combined %Grass, %WLO, and NLCD class “Cultivated Crop” or “Hay/Pasture”. WLOdist – distance (m) to nearest opening. %Hardwood - percent area NLCD class “Deciduous”. %TotalHardwoods - percent area NLCD class “Deciduous” or “Woody Wetlands”.

Table 3.17. Comparison of density (λ) and detection (*p*) models for male turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[47]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R500 - Road + %Foraging Habitat) *p*(DayBait+ Study Area + Year + DayYear)	4373.94	156.32	0.000	2176.97	10
λ(R1750 - %Hardwood) p(DayBait+ Study Area + Year + DayYear)	4277.46	59.84	0.000	2129.73	9
λ(Shape) p(DayBait+ Study Area + Year + DayYear)	4279.88	62.26	0.000	2130.94	9
λ(.) p(DayBait+ Study Area + Year + DayYear)	4280.83	63.22	0.000	2132.42	8
λ(R500 - %(Hardwood and Mixed)) p(DayBait+ Study Area + Year + DayYear)	4281.63	64.02	0.000	2131.82	9
λ(R1750 - %(Hardwood and Mixed)) p(DayBait+ Study Area + Year + DayYear)	4282.18	64.57	0.000	2132.09	9
λ(.) p(.)	4311.29	93.67	0.000	2153.64	2
λ(WLOsize) p(DayBait+ Study Area + Year + DayYear)	4369.06	151.44	0.000	2175.53	9
λ(R500 - Road) p(DayBait+ Study Area + Year + DayYear)	4371.91	154.29	0.000	2176.95	9
λ(R1750 - AvgWLOSize) *p*(DayBait+ Study Area + Year + DayYear)	4375.20	157.59	0.000	2178.60	9
λ(R500 - AvgWLOSize) *p*(DayBait+ Study Area + Year + DayYear)	4379.86	162.24	0.000	2180.93	9
λ(R1750 - Road) *p*(DayBait+ Study Area + Year + DayYear)	4482.56	264.94	0.000	2232.28	9
λ(R1750 - Road + %Foraging Habitat) *p*(DayBait+ Study Area + Year + DayYear)	4484.56	266.94	0.000	2232.28	10

[47] Study Area – study area survey was performed on. DayYear – Julian date of the survey. DayBait – days since bait was last replenished. Road – amount of road (m) in buffer. %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". %Hardwood - percent area NLCD class "Deciduous". Shape – WLOsize divided by area of circle with equal circumference. HardwoodandMixed - percent area NCLD class "Deciduous" or "Mixed". WLOsize – area of opening (m^2). AvgWLOSize – average area of openings in buffer(m^2).

Figure 3.5. Relationship of male turkey density to percentage of forested area within a 500m buffer and percentage of that forested area that is composed of pine trees in Alabama, summer 2015 and 2016. The effect of percent of forested area is shown at varying percentages of percent pine as labeled.

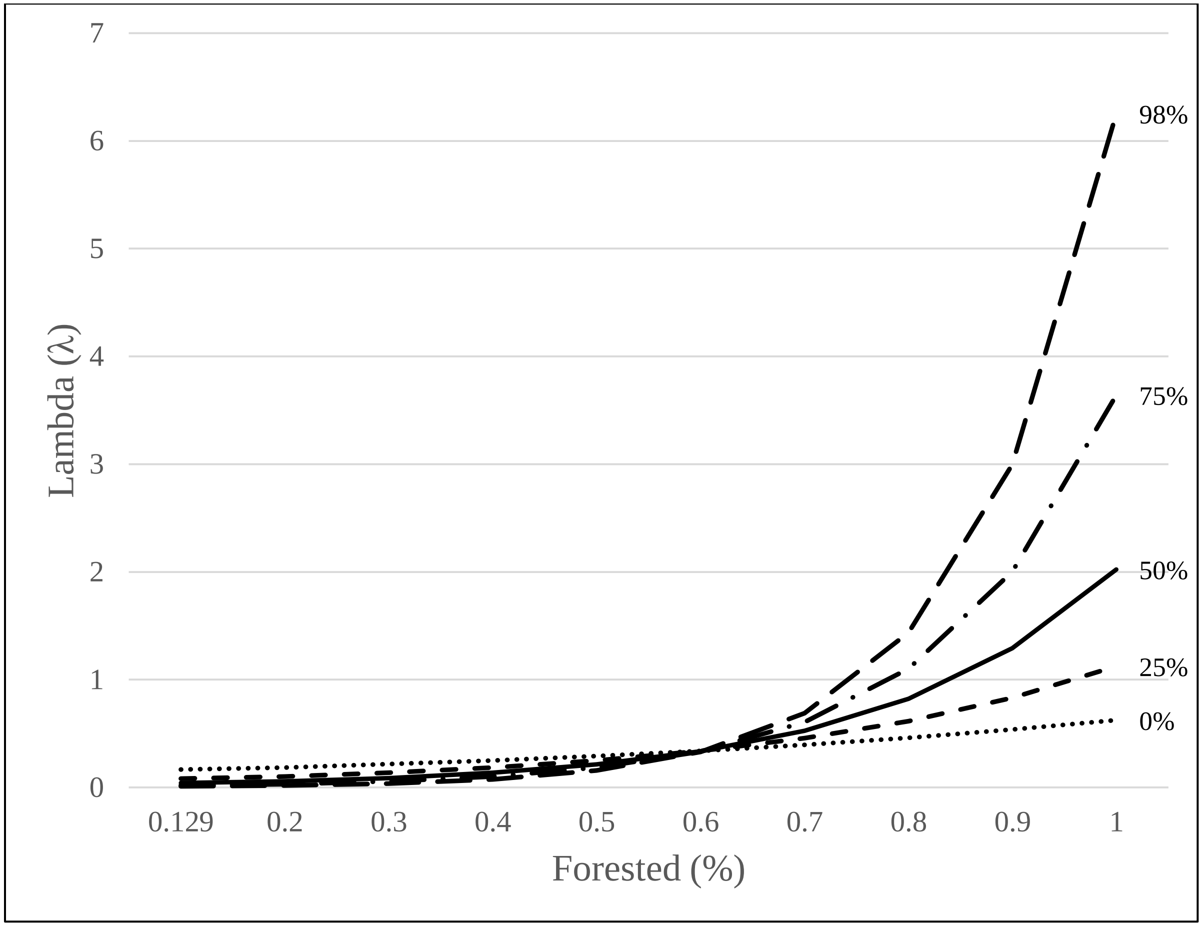

Figure 3.6. Relationship of female turkey density to percentage of forested area within a 1,750m buffer and percentage of that forested area that is composed of hardwood trees in Alabama, summer 2015 and 2016. The effect of percent of forested area is shown at varying percentages of percent hardwood as labeled.

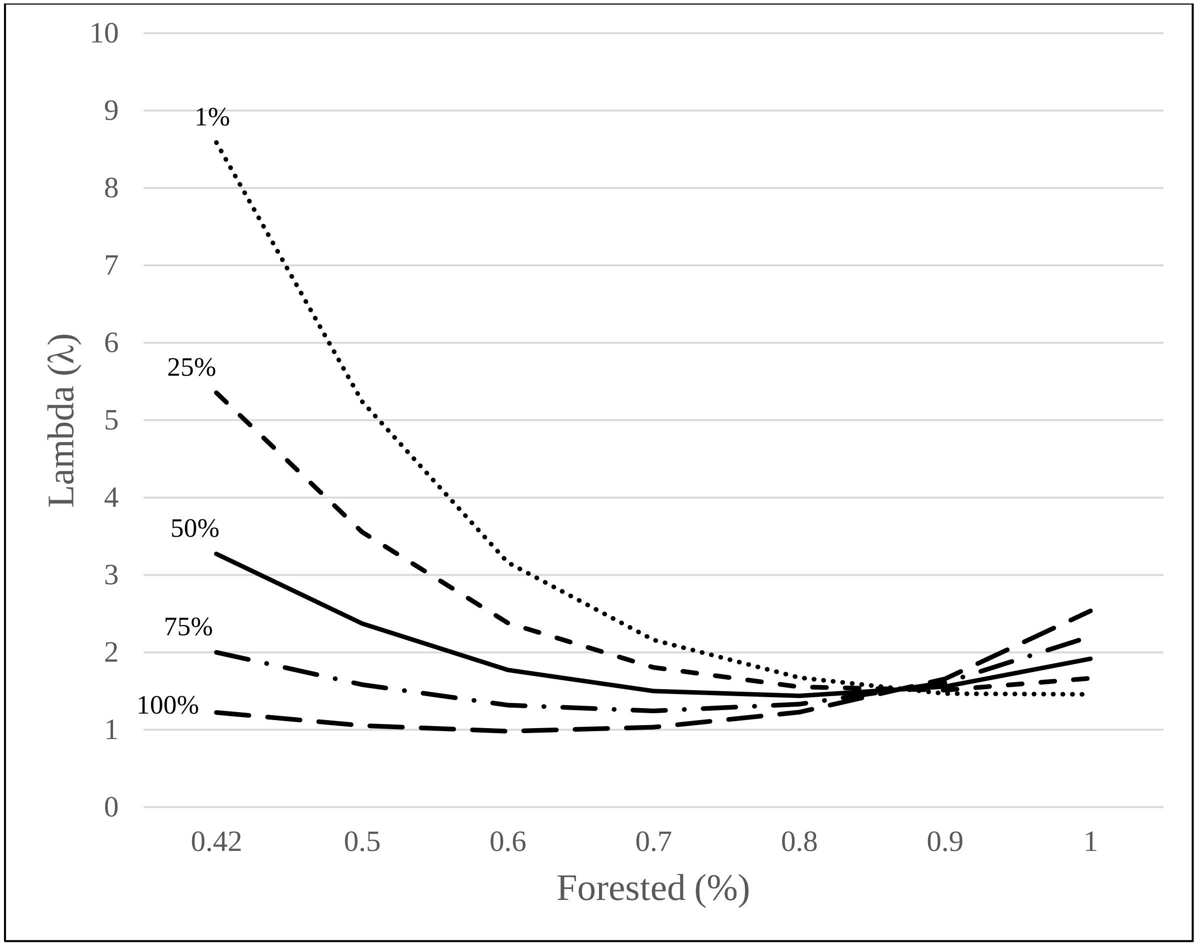

Table 3.18. Comparison of density (λ) and detection (*p*) models for female turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[48]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R1750 - %Forest^2*(HW/Forest)) *p*(Hour^2 + DayBait)	7356.30	0.00	0.413	3669.15	9
λ(R500 - %Forest^2*(HW/Forest)) *p*(Hour^2 + DayBait)	7356.37	0.07	0.398	3669.19	9
λ(R1750 - %Forest*(HW/Forest)) *p*(Hour^2 + DayBait)	7358.98	2.68	0.108	3671.49	8
λ(R500 - %Forest^2*(Pine/Forest)) *p*(Hour^2 + DayBait)	7361.55	5.25	0.030	3671.77	9
λ(R1750 - %Forest^2*(Pine/Forest)) *p*(Hour^2 + DayBait)	7362.64	6.34	0.017	3672.32	9
λ(R1750 - %Forest*(Pine/Forest)) *p*(Hour^2 + DayBait)	7363.29	6.99	0.013	3673.64	8
λ(R500 - %Forest*(HW/Forest)) *p*(Hour^2 + DayBait)	7363.50	7.20	0.011	3673.75	8
λ(R500 - %Forest*(Pine/Forest)) *p*(Hour^2 + DayBait)	7365.35	9.05	0.004	3674.68	8
λ(R1750 - %Forest^2*(TotalHW/Forest)) *p*(Hour^2 + DayBait)	7365.80	9.50	0.004	3673.90	9
λ(R500 - %Pine) *p*(Hour^2 + DayBait)	7367.61	11.31	0.001	3677.80	6
λ(R1750 - %Forest*(TotalHW/Forest)) *p*(Hour^2 + DayBait)	7369.90	13.60	0.000	3676.95	8
λ(R500 - %Forest^2*(TotalHW/Forest)) *p*(Hour^2 + DayBait)	7373.75	17.45	0.000	3677.88	9
λ(R1750 - %(Hardwood and Mixed)) *p*(Hour^2 + DayBait)	7374.10	17.80	0.000	3681.05	6
λ(R500 - %(Pine and Mixed)) *p*(Hour^2 + DayBait)	7374.34	18.04	0.000	3681.17	6
λ(R500 - %Forest*(TotalHW/Forest)) *p*(Hour^2 + DayBait)	7377.42	21.12	0.000	3680.71	8
λ(R1750 - %Forest^2) *p*(Hour^2 + DayBait)	7378.07	21.77	0.000	3682.03	7
λ(R500 - %(Hardwood and Mixed)) *p*(Hour^2 + DayBait)	7379.03	22.73	0.000	3683.51	6
λ(R500 - %Hardwood) *p*(Hour^2 + DayBait)	7379.22	22.92	0.000	3683.61	6

[48] Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. TotalHW/Forest - %TotHW divided by %Forest. HW/Forest - %HW divided by %Forest. Pine/Forest - %Pine divided by %Forest. %Forest - percent area NLCD class of any forest type. %Pine - percent area NLCD class “Evergreen”. HardwoodandMixed - percent area NCLD class “Deciduous” or “Mixed”. PineandMixed - percent area NCLD class “Evergreen” or “Mixed”. %Hardwood - percent area NLCD class “Deciduous”.

Table 3.18. Comparison of density (λ) and detection (*p*) models for female turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[49]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R1750 - %Forest) *p*(Hour^2 + DayBait)	7383.67	27.37	0.000	3685.84	6
λ(R1750 - %Pine) p(Hour^2 + DayBait)	7379.47	23.17	0.000	3683.74	6
λ(R1750 - %Hardwood) p(Hour^2 + DayBait)	7379.76	23.46	0.000	3683.88	6
λ(R1750 - %Total Hardwoods) p(Hour^2 + DayBait)	7380.11	23.81	0.000	3684.05	6
λ(R500 - %Total Hardwoods) p(Hour^2 + DayBait)	7382.26	25.96	0.000	3685.13	6
λ(R1750 - % WLO) *p*(Hour^2 + DayBait)	7383.88	27.58	0.000	3685.94	6
λ(R1750 - %Foraging Habitat^2) *p*(Hour^2 + DayBait)	7384.19	27.89	0.000	3685.10	7
λ(R1750 - %(Pine and Mixed)) *p*(Hour^2 + DayBait)	7384.36	28.06	0.000	3686.18	6
λ(R1750 - %Shrub) *p*(Hour^2 + DayBait)	7384.71	28.41	0.000	3686.35	6
λ(R500 - %Shrub) *p*(Hour^2 + DayBait)	7385.28	28.98	0.000	3686.64	6
λ(R1750 - %Shrub^2) *p*(Hour^2 + DayBait)	7385.54	29.24	0.000	3685.77	7
λ(R500 - %Forest) *p*(Hour^2 + DayBait)	7385.91	29.61	0.000	3686.95	6
λ(R500 - %Foraging Habitat) *p*(Hour^2 + DayBait)	7385.92	29.62	0.000	3686.96	6
λ(R500 - %Forest^2) *p*(Hour^2 + DayBait)	7385.94	29.64	0.000	3685.97	7
λ(.) *p*(Hour^2 + DayBait)	7386.13	29.83	0.000	3688.06	5
λ(R500 - %Shrub^2) *p*(Hour^2 + DayBait)	7386.26	29.96	0.000	3686.13	7
λ(Shape) *p*(Hour^2 + DayBait)	7387.72	31.42	0.000	3687.86	6

[49] Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. %Forest - percent area NLCD class of any forest type. %Pine - percent area NLCD class "Evergreen". %Hardwood - percent area NLCD class "Deciduous". %TotalHardwoods - percent area NLCD class "Deciduous" or "Woody Wetlands". %WLO – percent buffer composed of opening. %Shrub - percent area NCLD class "Shrub/Scrub". %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". PineandMixed - percent area NCLD class "Evergreen" or "Mixed". Shape – WLOsize divided by area of circle with equal circumference.

Table 3.18. Comparison of density (λ) and detection (*p*) models for female turkey using camera trap surveys in Alabama, spring 2015 and 2016. For each model, values AIC, relative difference in AIC (ΔAIC), model probability (*w*), model likelihood (Lik), and number of parameters (K) are shown.[50]

Model	AIC	ΔAIC	*w*	Lik	K
λ(R500 - Road + %Foraging Habitat) *p*(Hour^2 + DayBait)	7764.85	408.55	0.000	3875.42	7
λ(R500 - %Foraging Habitat^2) p(Hour^2 + DayBait)	7387.94	31.64	0.000	3686.97	7
λ(R1750 - %Foraging Habitat) p(Hour^2 + DayBait)	7388.06	31.76	0.000	3688.03	6
λ(R1750 - WLONum) p(Hour^2 + DayBait)	7388.08	31.78	0.000	3688.04	6
λ(R500 - % WLO) p(Hour^2 + DayBait)	7388.09	31.79	0.000	3688.05	6
λ(R500 - WLONum) p(Hour^2 + DayBait)	7388.14	31.84	0.000	3688.07	6
λ(WLOdist) p(Hour^2 + DayBait)	7390.99	34.69	0.000	3689.50	6
λ(.) p(.)	7440.00	83.70	0.000	3718.00	2
λ(R1750 - AvgWLOSize) p(Hour^2 + DayBait)	7453.94	97.64	0.000	3720.97	6
λ(WLOsize) p(Hour^2 + DayBait)	7524.16	167.86	0.000	3756.08	6
λ(R500 - Road) *p*(Hour^2 + DayBait)	7826.92	470.62	0.000	3907.46	6
λ(R500 - AvgWLOSize) *p*(Hour^2 + DayBait)	19999.35	12643.05	0.000	9993.67	6
λ(R1750 - Road) *p*(Hour^2 + DayBait)	19999.35	12643.05	0.000	9993.67	6
λ(R1750 - Road + %Foraging Habitat) *p*(Hour^2 + DayBait)	20001.35	12645.05	0.000	9993.67	7

[50] Hour – hour of the day photo was taken in. DayBait – days since bait was last replenished. Road – amount of road (m) in buffer. %ForagingHabitat – combined %Grass, %WLO, and NLCD class "Cultivated Crop" or "Hay/Pasture". WLOnum – number of openings in buffer. %WLO – percent buffer composed of opening. WLOdist – distance (m) to nearest opening. AvgWLOSize – average area of openings in buffer(m^2).

Table 3.19. Estimates of density of turkeys on study areas in Alabama, summer 2015 and 2016. For each study area, the mean turkey density (Mean), mode of densities (Mode), and standard deviations (SD) for each were reported.

	Total				Male				Female				Poult			
	Mean	SD	Mode	SD	Mean	SD	Mode	SD	Mean	SD	Mode	SD	Mean	SD	Mode	SD
Barbour	2.74	0.28	1.38	1.13	0.52	0.12	0.01	0.10	1.43	0.21	0.96	0.61	0.72	0.15	0.10	0.30
Oakmulgee	6.53	0.39	6.20	1.47	1.34	0.18	0.74	0.59	1.67	0.20	1.25	0.59	0.79	0.14	0.23	0.42
Scotch	7.94	0.55	7.62	1.94	0.95	0.19	0.01	0.09	2.77	0.33	2.22	0.94	3.24	0.35	1.31	0.87
Skyline	2.44	0.25	1.74	0.86	0.54	0.12	0.03	0.18	1.36	0.19	0.91	0.59	1.10	0.17	0.14	0.35
Average	4.75	0.18	2.52	1.31	0.85	0.08	0.00	0.04	1.73	0.11	1.12	0.41	1.31	0.10	0.07	0.25

Table 3.20. Estimates (P:H), lower confidence limits (LCL) and upper confidence limits (UCL) for wild turkey productivity in the form of a poult to hen ratio.

	P:H	LCL	UCL
Barbour	0.489	0.229	0.750
Oakmulgee	0.509	0.282	0.737
Scotch	1.348	0.797	1.899
Skyline	0.763	0.417	1.110
Average	0.748	0.570	0.925

CHAPTER IV: CONCLUSION

There is a need to validate or replace current estimates with surveys that provide information about current populations which will better equip managers to make decisions about turkey populations. I demonstrated the importance of using empirical data when making estimates of population size and structure through the use of gobble count surveys. I found that current estimates of male turkey density that are based on expert opinion do not account for all important habitat characteristics which could cause them to be biased. Current estimates of turkey populations produced by the ADCNR are based on expected density of turkeys and the amount of forested habitat. While this relationship was identified as being important in my analysis of density, there was significant variation depending on the type of forest. When an area was completely forested, I estimated a density of 0.136 male turkeys per $4km^2$ grid cell when all of the forest was hardwood and a density of 11.071 male turkeys per $4km^2$ grid cell when it was 93% pine. An opposite relationship between male turkey density and forest composition was observed at low forest cover (22% forested), with a density of 11.388 males per $4km^2$ grid cell when pine constitutes 0% of the forested area and a density 0.025 per $4km^2$ grid cell when pine constitutes 93%. The variation among these densities in different forest types would yield different assessments of turkey populations depending on the level of forest cover. Estimates based on expert opinion overestimated the number of turkeys within an area compared to my estimates produced from gobble count surveys. If estimates are to be made from expected densities in given habitat types, validation through gobble count surveys is an option for increasing accuracy and precision.

I also successfully implemented a camera survey to estimate wild turkey use, density, and productivity on wildlife life openings on 4 wildlife management areas in Alabama. When compared to estimates produced from expert opinion and opportunistic roadside surveys, I believe estimates produced using camera surveys to be more accurate and precise because they are able to account for variation in detection of individuals and density across landcover types. Similar to my gobble count survey analysis, I observed variation of densities due to the types of forested landcover available as well as differences according to the sex of turkeys. For a completely forested area, I would expect 9.393 turkeys per wildlife opening if the forest was 100% pine and 3.632 turkeys per wildlife opening if the area was 100% hardwoods. On a wildlife opening surrounded by pine forest, I would expect a density of 1.456 female turkeys per wildlife opening and 6.25 male turkeys per wildlife opening. On a wildlife opening surrounded by hardwood, I would expect a density of 2.535 female turkeys per wildlife opening and 0.625 male turkeys per wildlife opening. I was able to incorporate such variation of density due to habitat covariates and sex classification into my estimates of wild turkey densities on managed wildlife openings on our study areas.

Gobble count surveys and camera surveys are viable options for validating expert opinion and estimating wild turkey use and density. Gobble count surveys are a relatively cheap survey method that provide information about male wild turkey use and density prior to and during the hunting season. This information may be useful for state agencies to inform hunters and stakeholders about the status of male wild turkey populations. These surveys can also identify the best conditions and times of the year for hearing turkey gobbling activity, which could help inform hunters about how to best increase their chances of an enjoyable hunting experience. For a slightly higher cost, camera surveys are able to provide information about the whole turkey population. These surveys can be used to estimate the densities of different classifications of turkeys in variable landcover which provide a more accurate estimate of wild turkey population size on which to base management. Monitoring productivity, which can also be obtained from camera surveys, may allow managers to predict shifts in future populations and shift management practices accordingly. Both gobble count and camera surveys are tools that can be utilized by wildlife managers to assist in maintaining stable wild turkey populations.

Appendix A. Summarization of selected survey cells for each study area based on classifications of National Land Cover Data (Homer et al. 2015). Each classification (Class) had a sum total of grid cells that met a criteria (Total) and a number of sites that were surveys (Selected). Classification was based on percent developed land (Dev), percent area composed of hardwood trees (HW), percent area composed of pine trees (Pine), and percent area composed of agricultural land (Ag).

Study Site	Class	Total	Selected	Dev	HW	Pine	Ag
Oakmulgee	46	4	2	<5%	5-25%	>75-100%	<5%
"	61	3	1	<5%	>25-50%	>25-50%	<5%
"	66	42	17	<5%	>25-50%	>50-75%	<5%
"	86	3	0	<5%	>50-75%	>25-50%	<5%
Scotch	81	1	0	<5%	>50-75%	5-25%	<5%
"	86	3	2	<5%	>50-75%	>25-50%	<5%
"	101	8	7	<5%	>75-100%	<5%	<5%
"	106	9	9	<5%	>75-100%	5-25%	<5%
Skyline	21	47	3	<5%	>75-100%	<5%	<5%
"	41	2	1	<5%	>50-75%	5-25%	<5%
"	46	16	2	<5%	>75-100%	5-25%	<5%
"	66	5	1	<5%	>50-75%	>25-50%	<5%
"	141	10	2	<5%	>50-75%	<5%	5-25%
"	146	16	2	<5%	>75-100%	<5%	5-25%
"	166	7	1	<5%	>50-75%	5-25%	5-25%

Appendix A. Summarization of selected survey cells for each study area based on classifications of National Land Cover Data (Homer et al. 2015). Each classification (Class) had a sum total of grid cells that met a criteria (Total) and a number of sites that were surveys (Selected). Classification was based on percent developed land (Dev), percent area composed of hardwood trees (HW), percent area composed of pine trees (Pine), and percent area composed of agricultural land (Ag).

Study Site	Class	Total	Selected	Dev	HW	Pine	Ag
Skyline	191	1	1	<5%	>50-75%	>25-50%	5-25%
"	261	3	1	<5%	>25-50%	<5%	>25-50%
"	266	6	1	<5%	>50-75%	<5%	>25-50%
"	286	3	1	<5%	>25-50%	5-25%	>25-50%
"	291	3	1	<5%	>50-75%	5-25%	>25-50%
"	381	1	1	<5%	5-25%	<5%	>50-75%
"	386	1	1	<5%	>25-50%	<5%	>50-75%
"	406	1	1	<5%	5-25%	5-25%	>50-75%
Barbour	41	3	3	<5%	5-25%	>50-75%	<5%
"	46	2	2	<5%	5-25%	>75-100%	<5%
"	61	2	2	<5%	>25-50%	>25-50%	<5%
"	66	11	6	<5%	>25-50%	>50-75%	<5%
"	86	5	3	<5%	>50-75%	>25-50%	<5%
"	106	5	3	<5%	>75-100%	5-25%	<5%
"	166	1	1	5-25%	5-25%	>50-75%	<5%

Appendix B. Average values within a grid cell for covariates used in analysis of gobble count data (Chapter II) for all study areas.

	Barbour	Oakmulgee	Scotch	Skyline	Average
Road (m)	6282.55	5691.27	7562.11	2026.45	4350.80
%WLO	0.63%	0.17%	0.20%	0.65%	0.49%
#WLO	6.33	1.81	2.57	2.81	3.23
%Developed	3.47%	1.25%	1.37%	1.28%	1.69%
%Pine	25.53%	33.18%	48.33%	1.58%	19.04%
%HW	31.06%	31.51%	5.42%	74.51%	47.95%
%TotHW	34.77%	34.74%	6.85%	75.07%	49.76%
%Forest	70.25%	95.34%	65.95%	80.32%	79.28%
%Pine/%Forest	36.06%	34.69%	74.33%	2.31%	25.52%
%TotHW/%Forest	49.95%	36.59%	9.88%	92.10%	61.40%
%Shrub	18.46%	3.05%	16.39%	4.90%	8.69%
%Food	7.76%	0.39%	16.46%	13.92%	10.42%

Appendix C. Average landcover covariate values used in analysis of camera survey data (Chapter III) on each study area.

	Barbour	Oakmulgee	Scotch	Skyline	Average
WLOsize (m^2)	3851.62	4087.96	3104.22	7605.73	4795.95
CircRatio	48.50%	52.58%	70.57%	56.16%	55.85%
WLOdist (m)	184.37	608.73	550.96	275.53	402.94
WLOnum.500	4.97	1.40	1.77	3.58	2.94
WLOnum.1750	30.77	5.52	10.65	18.16	16.14
AvgWLOArea.500 (m^2)	3331.84	4081.15	3417.88	5992.18	4287.88
AvgWLOArea.1750 (m^2)	4127.28	4080.20	3317.54	8334.76	5097.87
%WLO.500	1.97%	0.66%	0.72%	2.89%	1.60%
%WLO.1750	1.30%	0.23%	0.34%	1.64%	0.90%
DenRoad.500 (m)	1682.35	3539.79	2739.81	1281.98	2322.72
DenRoad.1750 (m)	17888.94	15335.22	29037.18	9910.74	17033.81
%Developed.500	5.06%	1.26%	1.45%	1.03%	2.17%
%Developed.1750	4.00%	1.40%	1.02%	0.95%	1.86%
%HW.500	45.11%	30.33%	3.41%	75.82%	41.29%
%HW.1750	38.77%	29.58%	2.92%	77.72%	39.92%
%TotalHW.500	50.78%	33.39%	3.95%	75.82%	43.72%
%TotalHW.1750	45.17%	32.55%	3.26%	77.83%	42.49%
%Pine.500	9.72%	34.25%	48.02%	2.40%	22.12%
%Pine.1750	13.34%	33.77%	51.97%	1.36%	23.32%
%Forest.500	66.10%	91.16%	59.83%	80.90%	76.40%
%Forest.1750	61.26%	89.71%	63.47%	81.17%	75.51%
%(HW+Mixed).500	56.38%	56.91%	11.81%	78.51%	54.28%
%(HW+Mixed).1750	47.92%	55.94%	11.50%	79.81%	52.19%
%(Pine+Mixed).500	20.99%	60.84%	56.42%	5.08%	35.11%
%(Pine+Mixed).1750	22.49%	60.13%	60.55%	3.45%	35.59%
%TotHW/%Forest.500	79.49%	36.96%	7.64%	93.65%	57.39%
%TotHW/%Forest.1750	75.07%	36.39%	5.12%	95.69%	56.21%
%HW/%Forest.500	70.15%	33.48%	6.34%	93.65%	53.80%
%HW/%Forest.1750	64.17%	33.05%	4.58%	95.54%	52.37%
%Pine/%Forest.500	13.34%	37.30%	77.50%	3.01%	29.52%
%Pine/%Forest.1750	21.20%	37.63%	82.22%	1.77%	32.11%
%Shrub.500	17.45%	4.17%	18.88%	12.83%	12.51%
%Shrub.1750	17.03%	3.93%	18.62%	9.19%	11.31%
%Food.500	7.56%	0.86%	20.01%	8.06%	8.00%
%Food.1750	7.96%	0.49%	15.84%	9.20%	7.52%