HABITAT AND ROOST SITE SELECTION BY MALE EASTERN WILD TURKEYS IN SOUTHWESTERN GEORGIA

by

JAMES ANDREW RUTTINGER

(Under the Direction of Robert J. Warren and Michael J. Chamberlain)

ABSTRACT

Habitat and roost site selection of male eastern wild turkeys (*Meleagris gallopavo sylvestris*) were investigated on 2 southwestern Georgia sites of predominantly longleaf pine (*Pinus palustris*) and pine-hardwood forests—the Joseph W. Jones Ecological Research Center and Silver Lake Wildlife Management Area. Males selected for mature forest habitat types, specifically mature pine habitats. Males also selected hardwood habitats within the study areas and mixed pine-hardwood habitats within their home ranges. They selected roosts in or near mature pine or hardwood habitats with a dense herbaceous understory, and avoided roosting near pine plantations, shrub/scrub habitat, and roads—though they occasionally roosted in plantation pines. Maintaining mature pine, hardwood, and/or mixed stands will promote male turkey habitat and ensure the availability of roosts in the longleaf pine ecosystem, and though they are not selected for the most, pine plantations can also be used as roost sites.

INDEX WORDS: eastern wild turkey, *Meleagris gallopavo sylvestris*, compositional analysis, habitat selection, roost site selection, mature pine, mixed pine-hardwood
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JAMES ANDREW RUTTINGER

BSFR, University of Georgia, 2010

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

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DEDICATION

I would like to dedicate this thesis to my parents, Jennie and Frank, and my sister, Courtney. Thank you all for your love and support throughout my pursuit of attaining my M.S. degree. Without you this would not have been possible.
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CHAPTER 1
INTRODUCTION, LITERATURE REVIEW AND THESIS FORMAT

The wild turkey (*Meleagris gallopavo*) is a species that attracts the interest of many landowners and wildlife managers because of its popularity as a game species and importance as a recreational resource (Vangilder and Kurzejeski 1995, Tapley et al. 2001). According to the National Wild Turkey Federation (National Wild Turkey Federation [NWTF] 2003), there has been a 450% increase in the number of turkey hunters since 1973 in the U.S. An estimated $2 billion of economic impact has been added to America’s economy from spring turkey hunting seasons alone via habitat improvement, tourism, and management agency fees. This popularity has led to numerous research studies; however, many knowledge gaps still exist. One topic in need of research is wild turkey resource selection throughout its range. Habitat and roost site selection are critical aspects to our understanding of male wild turkey spatial ecology, and are of paramount importance to the development and implementation of efficient management practices to maximize wild turkey abundance.

The eastern wild turkey (*M. g. sylvestris*) is the subspecies with the largest distribution (Kennamer 2013), and research is needed to determine any possible difference in management for birds across different ecosystems. Little is known about male turkey habitat selection in the endangered longleaf pine (*Pinus palustris*)—wiregrass (*Aristida stricta*) ecosystem native to the southeastern U.S., and even less is known about roosting ecology of male wild turkeys. Recent declines have been observed in wild turkey populations in several southeastern U.S. states such as Georgia (D. K. Lowrey, Georgia Department of Natural Resources, unpublished data), South
Carolina (C. Ruth, South Carolina Department of Natural Resources, unpublished data), and Alabama (S. W. Barnett, Alabama Department of Conservation and Natural Resources, unpublished data). Factors that account for the recent decline of some turkey populations may include an abundance of predators, environmental factors (e.g., drought or flooding), or limited habitat requirements such as food or roost site availability (Georgia Department of Natural Resources [GADNR] 2011). Therefore, distinguishing selected habitat is important to the development of management programs designed to sustain wild turkey populations.

**Eastern Wild Turkey Life History**

The wild turkey is a native, large non-migratory game bird that ranges throughout the eastern United States. Portions of the southwestern United States, northern Mexico, and southeastern Canada (Mock et al. 2002). Five subspecies occur across North America: Rio Grande (\textit{M. g. intermedia}), Merriam’s (\textit{M. g. merriami}), Gould’s (\textit{M. g. mexicana}), Osceola (\textit{M. g. osceola}), and eastern wild turkey (\textit{M. g. sylvestris}). My research focused on the eastern wild turkey, which is found throughout most of the eastern United States including the Cumberland Plateau, Appalachian Plateau, Ozarks, and Gulf States (NWTF 2013). Eastern wild turkeys use a wide variety of habitats within their native range including: old forests (Porter 1992), forest openings, farms, plantations (Shaffer and Gwynn 1967), large timberlands with little human disturbance (Shaw 1959), mixed forest and agriculture (Vangilder and Kurzejeski 1995), and managed pine habitats (Kennamer et al. 1980, Holbrook et al. 1985, Exum et al. 1987).

Wild turkeys were mostly extirpated throughout their range in the United States by the early 1900s. In 1973, turkey populations were as low as 1.3 million nationally with only 17,000 birds in Georgia (NWTF 2003, GADNR 2011). Restocking programs have increased population sizes to an estimated 6 million birds nationally and >300,000 birds in Georgia (NWTF 2003,
Currently, some estimates indicate that turkey numbers in Georgia have stabilized (GADNR 2011); however, some populations in the Southeast appear to be declining (D. K. Lowrey, C. Ruth, S. W. Barnett, unpublished data). These perceived declines have led to questions about the factors that may currently be affecting wild turkey populations in southeastern U.S. ecosystems.

**Male Habitat Use**

Eastern wild turkeys use a variety of habitats including: old-growth forests (Porter 1992), forest openings, farms, plantations (Shaffer and Gwynn 1967), large timberlands with little human disturbance (Shaw 1959), mixed pine hardwood forests and agriculture (Vangilder and Kurzejeski 1995), and managed pine habitats (Kennamer et al. 1980, Holbrook et al. 1985, Exum et al. 1987). In the southeastern U.S., male wild turkeys select for upland pine (*Pinus spp.*) habitat during the fall, winter, and summer months; however, hardwood habitats are selected during the spring to increase probability of encounter with females (Godwin et al. 1992, Miller et al. 1999). Seasonal habitat use and other behavioral aspects (e.g., movement patterns) of male wild turkeys are affected by availability of food, water, and roosting habitat throughout the year (Holdstock et al. 2006, Stoddard 1963), with increased movement behaviors observed during the spring breeding season and less selection for specific habitat types as their behaviors change to include searching for females (McMahon and Johnson 1980, Clark 1985, Kelly et al. 1988, Godwin et al. 1994, Miller et al. 1999).

The endangered native longleaf pine—wiregrass community was once the dominant ecosystem in the southeastern coastal plain (Noss 1989, Frost 1993). Longleaf pine communities require prescribed burning (Stoddard 1963, Provencher et al. 1998). Burn intervals recommendations for wild turkey management range from 3-5 years (Stoddard 1963, McGliny
1985, Hurst and Dickson 1992, Palmer et al. 1996, Miller et al. 2000) in mature pine forests and 3-7 years in commercial pine forests (Miller and Conner 2007). However, fire frequencies < 3 years are typically needed to maintain the desired herbaceous ground cover associated with pine savannas (Glitzenstein et al. 2008). The effects of the 1-2-year burn rotations often used in longleaf pine forest have been studied little. Frequent fires may influence male wild turkey movement patterns by increasing availability or quality of forage in frequently burned areas as documented for other wildlife species (Stransky and Harlow 1981, Landers et al. 1986, Robbins and Myers 1992, Main et al. 2000). The objective of this study was to determine resource selection of male eastern wild turkeys at multiple scales on 2 longleaf pine-dominated forests in southwestern Georgia.

**Male Roost Site Selection**

Roost site selection is important for wild turkeys because roosting in trees is a predator avoidance mechanism and provides protection from adverse weather (Bailey and Rinell 1967, Austin and Degraaf 1975, Porter 1978, Kilpatrick et al. 1988). Land management practices that limit roost site availability (e.g. hardwood removal) may restrict the distribution of wild turkeys and expose them to greater risk of predation. This concern is applicable to all life stages of eastern wild turkeys because poults begin roosting in trees as soon as they are able to fly—within 2 weeks post-hatch (Speak et al. 1985, Vangilder et al. 1987, Peoples et al. 1995, Hubbard et al. 1999).

Previous studies have examined roosting habitat of the Merriam’s wild turkey (Hoffman 1968, Boeker and Scott 1969, Mackey 1984), the Rio Grande wild turkey (Crockett 1973, Haucke 1975), and the eastern wild turkey (Tzilkowski 1971, Kilpatrick et al. 1988) however, such studies have typically focused on winter roost characteristics in northern parts of their range.
as the prevailing harsh conditions create higher mortality rates (Austin and DeGraaf 1975, Wunz and Hayden 1975, Porter 1978). Chamberlain et al. (2000) determined that eastern wild turkey females selected mature trees in mixed pine-hardwood or pure pine stands. Moreover, wild turkeys have been shown to select roost sites near water or feeding areas (Dickson 1992).

Previous studies on roosts in the southeastern U.S. did not assess microhabitat characteristics associated with the roosts. Studies that successfully found specific roost trees focused on female winter roost characteristics in northern parts of the turkey’s range where large groups of birds roosted together, which made roost trees easily detectable because of scat deposits on the tree and footprints in the snow surrounding roost sites (Austin and DeGraaf 1975, Wunz and Hayden 1975, Porter 1978). No studies have evaluated roost site selection by males in the longleaf pine ecosystem, nor have studies of roost sites involved actual observations of roosting birds.

Accurate determination of roost trees is difficult using traditional methodology (e.g., remote location via radio telemetry). Thermal imaging offers a potential tool for observing roosting turkeys. Locke et al. (2006) tested the use of aerial and ground-based forward-looking infrared technology to detect wild turkeys, concluding that aerial detection was unsuccessful because the thermal imaging camera could not view roosting turkeys through the tree canopy. However, ground-based thermal detection efforts were more successful. Because there has been little research on roost site selection, it is unclear whether turkeys use certain habitat types because of roost selection or if roost sites are simply chosen because the birds are in that area when night falls (Chamberlain et al. 2000). I used radio telemetry coupled with thermal imagery to determine if the combination of these technologies can better facilitate location of roost sites.
My research objectives were to (1) determine seasonal habitat selection of male wild turkeys in the longleaf pine ecosystem in southwestern Georgia, (2) test the efficacy of a new approach to detect roosting wild turkeys, and (3) determine roost site selection of male eastern wild turkeys in a longleaf pine-dominated forest. My research was conducted at the Joseph W. Jones Ecological Research Center (henceforth Ichauway) and the Georgia Department of Natural Resources’ Silver Lake Wildlife Management Area (hereafter, Silver Lake WMA) located in southwestern Georgia. Chapter 2 describes seasonal habitat selection of male wild turkeys in southwestern Georgia. Chapter 3 describes the effectiveness of combining ground-based thermal imagery with radio telemetry to detect roosting wild turkeys and evaluates evidence of the effects of multiple microhabitat and landscape scale variables on roost site selection of male wild turkeys. The final chapter provides guidelines for habitat management that increases selected habitat for male wild turkeys.

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CHAPTER 2

HABITAT SELECTION OF MALE EASTERN WILD TURKEYS IN THE LONGLEAF PINE ECOSYSTEM IN SOUTHWESTERN GEORGIA

Ruttinger, J. A. To be submitted to the Journal of Wildlife Management.
Abstract

Habitat selection of eastern wild turkeys (*Meleagris gallopavo sylvestris*) has been extensively studied, but little research has occurred in the longleaf pine (*Pinus palustris*) ecosystem. Likewise, most habitat selection studies focus on female turkeys or on only one spatial scale. Therefore, we evaluated habitat selection of male eastern wild turkeys on longleaf pine-dominated sites at the Joseph W. Jones Ecological Research Center at Ichauway (henceforth Ichauway) and Silver Lake Wildlife Management Area (WMA) in southwestern Georgia and we used compositional analysis to assess habitat selection within the study areas (2nd order) and within the home ranges (3rd order) of male turkeys between 2 seasons (x and y). Mature pine habitats were consistently selected across spatial scales, whereas hardwood habitats were important to the establishment of home ranges and mixed pine-hardwood habitats were used within home ranges. Managers should recognize the importance of mature pine, mixed pine-hardwood, and mature hardwood stands to increase the suitability of their lands for wild turkeys in southwestern Georgia.
Introduction

The eastern wild turkey (*Meleagris gallopavo sylvestris*) attracts the interest of many landowners and wildlife managers because of its popularity as a game species (Vangilder and Kurzejeski 1995, Tapley et al. 2001). This popularity has led to numerous studies; however, habitat selection of male eastern wild turkeys within longleaf pine (*Pinus palustris*) dominated systems remains understudied. Eastern wild turkeys use a variety of habitats including old-growth forests (Porter 1992), forest openings, farms, plantations (Shaffer and Gwynn 1967), large timberlands with little human disturbance (Shaw 1959), mixed pine hardwood forests and agriculture (Vangilder and Kurzejeski 1995), and managed pine landscapes (Kennamer et al. 1980, Holbrook et al. 1985, Exum et al. 1987). Seasonal habitat use and other behaviors (e.g., movement patterns) of male wild turkeys are affected by availability of food, water, and roosting habitat (Holdstock et al. 2006, Stoddard 1963). Male wild turkeys in other pine-dominated habitats select for upland pine forest (*Pinus spp.*) during summer, fall, and winter; however, they select hardwoods during spring to increase probability of encounter with females (McMahon and Johnson 1980, Clark 1985, Kelly et al. 1988, Godwin et al. 1992, Miller et al. 1999).

The endangered native longleaf pine—wiregrass community was once the dominant ecosystem in the southeastern coastal plain (Noss 1989, Frost 1993). Longleaf pine communities require prescribed burning (Stoddard 1963, Provencher et al. 1998). Burn intervals recommendations for wild turkey management range from 3-5 years (Stoddard 1963, McGlinchey 1985, Hurst and Dickson 1992, Palmer et al. 1996, Miller et al. 2000) in mature pine forests and 3-7 years in commercial pine forests (Miller and Conner 2007). However, fire frequencies < 3 years are typically needed to maintain the desired herbaceous ground cover associated with pine savannas (Glitzenstein et al. 2008). The effects of the land management practices used to maintain longleaf pine forest on wild turkeys are poorly understood. Frequent fires may
influence male turkey movement patterns by increasing availability or quality of forage in frequently burned areas as documented for other wildlife species (Stransky and Harlow 1981, Landers et al. 1986, Robbins and Myers 1992, Main et al. 2000). The objective of this study was to determine resource selection of male eastern wild turkeys at two scales on two longleaf pine-dominated forests in southwestern Georgia.

**Methods**

**Study Sites**

_The Joseph W. Jones Ecological Research Center at Ichauway_—The Joseph W. Jones Ecological Research Center at Ichauway (henceforth Ichauway) was a 12,000-ha former hunting plantation. Formerly owned by Robert W. Woodruff, it was used as a research site by the Jones Center. It is located approximately 51 km north of Bainbridge, Georgia in Baker County. The landscape was flat, karst topography with elevations ranging from 30-100m (Beck and Arden 1983). The study area was characterized by short, mild winters and hot, humid summers with rainfall averaging 131 cm/year and average daily temperature of 11°C in the winter and 27°C in the summer (Lynch et al. 1986, Goebel et al. 1997, Boring 2001).

Prescribed fire has been the primary land management tool at Ichauway for decades (Atkinson et al. 1996). It was located approximately 51 km north of Bainbridge, Georgia in Baker County. Approximately 50% of the site was burned annually to reduce hardwood encroachment and conserve native ground cover. Approximately 25% of the understory was wiregrass (_Aristida stricta_)—a native fire-dependent grass that only flowers after growing-season burns. While prescribed burning can occur year round, most burns were initiated from March-August. Ichauway was divided into 144 burn units, averaging 70 ha in size, resulting in a matrix of burned and unburned habitats.
The primary goals for this burn regime were to conserve the native longleaf pine (*Pinus palustris*)-dominated overstory and herbaceous understory, and to promote northern bobwhite (*Colinus virginianus*) populations. During the past 6-7 years, significant hardwood removal efforts have also been implemented. Scattered individual hardwood trees and hardwood patches that remained provided hard mast for wildlife and potential roosting habitat for turkeys. Current and historic quail management practices have resulted in a mosaic of food plots and openings within the forested ecosystem.

Wild turkey reestablishment began at Ichauway in the late 1970s via translocation in a cooperative effort between the Georgia Department of Natural Resources and Tall Timbers Research Station (Smith et al. 2006). Twenty-eight turkeys were released on site during 1988-1990 (Sanders and Mueller 1988, DeVos and Sisson 1989, Sisson 1990). The population of turkeys on the site remained similar to the number of translocated birds until about 2000, when it began to increase (L.M. Conner, pers. Commun.). Since their reestablishment, no hunting of wild turkeys has occurred on this study site.

*Silver Lake Wildlife Management Area* (WMA)—Silver Lake WMA was a 3,900-ha tract of land recently acquired by the Georgia Department of Natural Resources (Silver Lake WMA 50-Year Plan [SLWMAP] 2009). It was located approximately 19 km southwest of Bainbridge, Georgia in Decatur County. The WMA was bordered by the Flint River to the east, Lake Seminole to the south, and Spring Creek to the west. Silver Lake WMA was purchased during 2008-2009. It was formerly owned and managed by International Paper Company as part of their Southland Experimental Forest and now consists of 3,412 ha of state-owned land and 491 ha of land leased from the U.S. Army Corps of Engineers. Silver Lake WMA was predominately longleaf and loblolly pine (*P. taeda*), followed by mixed pine/hardwood, hardwoods, bottomland
hardwoods, nonforested openings, and open water. Prescribed fire was the primary vegetation management tool at Silver Lake WMA, with a goal of implementing a 2-year burn rotation to manage native groundcover and establish fire-tolerant upland hardwoods. Historically burns were > 40-acres. Prescribed burning in recent years was implemented on a varied scale to promote habitat diversity. Large-scale helicopter burns were occasionally implemented. Historically, burning occurred during the dormant season; however, recent prescribed burning occurred during both growing and dormant seasons. Other management included mechanical and chemical control of undesirable vegetation, site preparation, and planting food plots.

Silver Lake WMA supported several threatened and endangered species including the red-cockaded woodpecker (*Picoides borealis*), gopher tortoise (*Gopherus polyphemus*), and bald eagle (*Haliaeetus leucocephalus*). The WMA provided recreational activities such as hunting, fishing, birding, and horseback riding. Turkey hunting was permitted, but restricted to 2, 1-week-long quota hunts and 1, 2-week-long open hunt during Georgia’s spring male-turkey-only hunting season. Potential predators of wild turkeys at the Jones Center and Silver Lake WMA were similar and include bobcats (*Lynx rufus*), coyotes (*Canis latrans*), and great horned owls (*Bubo virginianus*).

**Capture and Radio Telemetry**

We captured male wild turkeys using rocket nets (Wunz 1987) over bait sites consisting of corn or a corn-milo mix during the winter (December - March) of 2010 – 2011, summer and fall (June-September) of 2011, and winter (December 2011 – March 2012) and summer (June-August 2012. After capture, we removed turkeys from the net, classified them as adults or juveniles (Williams and Austin 1988), and placed them into appropriately sized cardboard boxes. We fitted each male with serially numbered, rivet (right leg) and butt-end (left leg) aluminum leg
bands (National Band and Tag Co., Newport, KY). We fitted all males with a mortality-sensing VHF radio transmitter weighing approximately 60g (Telenax, Playa del Carmen, Mexico; or Sirtrack, Havelock North, New Zealand) that were attached via a backpack harness. Capture and handling of birds followed standard protocols approved by the University of Georgia’s Institutional Animal Care and Use Committee (Animal Use Proposal Number A2013 05-034-Y1-A0).

We triangulated radio-tagged males from roads (Cochran and Lord 1963) using a handheld 3-element Yagi antenna and Wildlife Materials TRX 2000S receiver (Wildlife Materials, Murphysboro, Illinois), and recorded locations in the field with a mobile phone equipped with a Bluetooth GPS unit and Location of a Signal-SD (LOAS-SD) software (Ecological Software Solutions, LLC). To reduce error caused by movements, we determined each location using azimuths that were recorded within a 15-minute interval. We located all males at least once daily from 1 March – 31 May and ≥ once per week the remainder of the year.

**Data Analyses**

We eliminated locations taken ≥ 800m from the location of the turkeys and locations with error ellipses greater than 2.2 ha to reduce telemetry error. We also used ArcGIS 9.3 (ESRI 2008) to delete erroneous locations (e.g., locations in open water). We then estimated home ranges using the 95% minimum convex polygon (MCP) method (≥30 observations/season; Miller et al. 1997). We defined seasons based on breeding ecology of male eastern wild turkeys (Godwin et al. 1992, Miller et al. 1999). Breeding season was defined as 1 March - 31 May, whereas the non-breeding season extended from 1 June - 28 February.

delineated 7 habitat types: mature pine, mature pine-hardwood, forested/herbaceous wetlands, mature hardwood, evergreen pine plantation, forest opening, and open water (Table 2-1). We included open water habitat in home range size estimates but removed it from further analysis because each telemetry location was used in the analysis and turkeys are not found in open water habitats. To reduce the possibility of erroneous conclusions drawn from the study by eliminating the arbitrary definition of habitat availability, we combined all 95% MCP polygons across years to create one large habitat availability polygon for each study area (Aebischer et al. 1993) and determined seasonal use: availability ratios at two spatial scales described by Johnson (1980).

Sample units were individual turkeys within a season. We For Johnson’s 2nd order habitat selection (henceforth 2nd order), available habitat was based on the availability polygon developed by combining all 95% MCP polygons, and proportions of habitats within individual home ranges were defined as “used” habitat. At Johnson’s 3rd order habitat selection (henceforth 3rd order), we considered available habitat to be that located in each home range, and used habitat as the proportion of telemetry locations of each habitat type within a home range.

We used compositional analysis to rank habitat selection (Aebischer et al. 1993). When a habitat was not used we replaced it with a small positive number (0.9%) because log of 0 is undefined and Bingham et al. (2007) illustrated that 0.9% was the most accurate replacement when compared to habitat data with no unused habitat types by study animals. When a habitat was unavailable to an individual animal we inserted the mean size of that habitat available to all turkeys within the appropriate scale for that particular study site. This procedure assumes that the turkey responded to the habitat approximately the same as other turkeys in that study site (Aebischer et al. 1993). This process was only necessary at the 3rd order selection. We performed a two sample t-test on mean distance from turkey locations and an equivalent number
of randomly generated points within the home ranges of the each turkey to hardwood habitat and forest openings to further analyze the potential importance of these stands to male habitat selection.

Results

We collected 2,122 usable telemetry locations for male wild turkeys during 2011 and 2012. A total of 17 individual males were successfully monitored for inclusion in habitat analysis resulting in the creation of 36 seasonal home ranges. Habitat selection was generally consistent among spatial scales between seasons.

Male turkeys selected habitats when establishing their home ranges (2nd order, $P < 0.001$) and used habitats differentially within those home ranges (3rd order, $P < 0.001$; Table 2-2). Mature pine habitats were most selected by males when establishing home ranges, whereas hardwood habitats were selected over plantation pines. Males used mature pine and mixed pine-hardwood habitats more than all other habitat types. There was no significant difference ($P < 0.10$) between seasons at the 2nd order ($F_{5,30} = 0.345, P = 0.882$) or 3rd order ($F_{5,30} = 0.819, P = 0.546$) of habitat selection. Male locations were significantly further from hardwood habitat than random locations ($P < 0.001$) and significantly closer to forest openings ($P < 0.001$) than randoms.

Discussion

Mature pine habitats were important to males when selecting home ranges and were most used within home ranges. These results coincide with those of other studies on wild turkey habitat selection in pine-dominated forests (e.g., Holbrook 1973, Hurst and Dickson 1992, Godwin et al. 1992, Miller et al. 1999) that cited the abundant mast production, forb and grass production, insect attractiveness, and habitat structure (i.e. no midstory and adequate roost
branches) provided by these stand types. A roost site study we conducted concurrently identified mature pine habitat as most used by roosting males (Chapter 3). These study sites contained a high proportion of mature pine forests that are heavily managed via 1-2 year prescribed fire intervals—much more frequent than previously recommended rotations for wild turkeys (e.g. Stoddard 1963, Hurst and Dickson 1992, Miller and Conner 2007)—however, the turkeys still selected for this habitat in their home range selection and use within their home ranges. Similar habitat selection occurred for females on these sites (Perez 2013). This suggests that management practices recommended for the longleaf pine-wiregrass ecosystem (i.e., frequent prescribed fires) are also good for turkeys.

Hardwood habitats were important to males when establishing home ranges (2nd order), however they were not significantly used within the home ranges (3rd order). Hardwood habitats on the study sites were sparse and typically consisted of mature overstory trees capable of producing hard mast. Male turkeys in previous studies similarly incorporated mature hardwood habitats in their home ranges due to the availability of suitable food sources (Barwick and Speak 1973, Healy 1981, Hurst and Dickson 1992) and adequate roosting habitat (Haucke 1975, Kilpatrick et al. 1988, Chamberlain et al. 2000). A roost study we conducted concurrently (Chapter 3) found a negative correlation between roost site selection and distance to hardwood habitats, meaning that turkeys selected roost sites closer to hardwood habitats. Further, proximity to water has been previously shown as important in resource selection of wild turkeys (Wheeler 1948, Boeker and Scott 1969, Miller et al. 1999), and most hardwood habitats on the study sites are located between open water areas and mature pine stands. Hardwood habitat may be ranked high in 2nd order selection but not used within the home ranges at least partially because of its adjacency to one or more selected habitats, whether it was actually selected for or
not. Speak et al. (1975) and Smith and Teitelbaum (1986) have presented this relationship of
turkey habitat use to habitat associations previously. The patch size of mature hardwood habitat
for sites used in this study was very small (mean patch size > 2ha). Given the small size of
hardwood habitats, it is reasonable to assume that turkeys selected home ranges to include
hardwood habitat and used them within the home ranges; yet our methods underrepresented their
use due to a combination of error associated with telemetry and small sample sizes. However,
the significant increase in distance from random points to male locations suggests that hardwood
habitats are not very important to male turkeys on these study sites. This may be due to the birds
adapting to the small patch size and scarcity of hardwood habitat on the sites.

Males in other studies shifted their home ranges to include hardwoods during breeding
season, increasing chances of encounters with females (McMahon and Johnson 1980, Clark
1985, Kelly et al. 1988, Godwin et al. 1992). This did not occur in our study, as no seasonal
selection was shown by males on either scale. The hardwood habitats in the aforementioned
previous studies typically consisted of large, contiguous patches of hardwood bottoms. The
scarcity of hardwood habitat on the sites used is likely the cause for seasonal selection
differences between this and previous studies. Further, the study sites in this study were
surrounded by unsuitable habitat for turkeys (i.e. large open water and agricultural areas). This
limits the birds to only the habitat within the study areas. Therefore, there is little or no area for
them to shift to seasonally without leaving the properties entirely. Thus, the limited adequate
habitat availability restricts movement patterns that may be demonstrated by turkeys with larger
areas of contiguous forested habitat.

Within their home ranges, males used mature mixed stands similarly to mature pine
stands. This is likely due to the similarities between the 2 habitat types related to food
availability and stand structure. These habitat types were consistently juxtaposed on both study sites, and both habitat types were maintained with short rotation prescribed fire to promote native ground cover, which includes a rich herbaceous understory and soft mast producing midstory conducive to use by turkeys (Holbrook 1973, Palmer 1990, Hurst and Dickson 1992, Miller et al. 1999). Martin et al. (2012) similarly found male selection for mature pine and mixed forest savannahs maintained by short-rotation prescribed fire.

Forest openings were generally ranked among the least selected habitat types by males at either spatial scale. Previous studies have indicated a selection for forest openings in turkey habitat selection for feeding and courtship (Speak et al. 1975, Bailey et al. 1981, Hurst 1981, Hurst and Dickson 1992). This difference may be an effect of the difference in definition of habitat types. The selected openings in these studies were primarily large agricultural fields or pastures. On our study sites, most forest openings consisted of small agriculture fields or food plots, areas of high human traffic, abandoned agriculture fields, or shrub/scrub habitat with a dense midstory. Miller et al. (1999) reported results comparable to ours under similar conditions where the forest openings did not contain the appropriate structure to be selected by turkeys. Furthermore, turkeys on these study sites may have had their need for open areas met in the abundance of mature pine habitat with frequent fire that promotes an open understory. Zwank et al. (1988) reported that turkeys in Louisiana used forest openings less following a large basal area reduction largely due to increases in herbaceous understory growth and diversity. Swanson et al. (1995) discussed the advantage of understory conditions in lower density forests. In Florida, some cypress stands were thought to provide similar enough understory vegetation to fields to circumvent the need for providing forest openings to improve wild turkey habitat (Willams and Austin 1988). According to these studies, turkeys could have found adequate
cover and desirable food in the frequently-burned low-density mature pine and mixed stands, mitigating the need for forest openings seen in other habitat types.

Male turkeys showed low selection for pine plantations. These habitats consisted mainly of pole stands of loblolly pine without a history of thinning or fire. In most of these stands, the canopy had reached full closure and the lack of sunlight prevented the growth of potential herbaceous understory vegetation or a soft-mast producing midstory. Miller et al. (1999) reported similar results of low selection towards pole timber stands in heavily managed pine plantations in Mississippi.

**Management Implications**

Habitat use patterns determined from this study and previous studies indicate the importance of maintaining mature forests when managing for wild turkey habitat (Lambert et al. 1990, Hurst and Dickson 1992, Miller et al. 1999). Mature pine and mixed pine-hardwood stands were selected across both seasons and both scales measured. Mature pine stands were important in male turkey roost selection on these study sites as well (Chapter 3). Management regimes used to promote these habitats on both study sites consist predominantly of application of small-scale prescribed fires (Joseph W. Jones Ecological Research Center 2010, SLWMAP 2009). Other researchers also advocate prescribed fire for wild turkey habitat improvement (McGlincy 1985, Landers and Mueller 1986, Exum 1988, Provencher et al. 1998). In areas with an abundance of heavily-managed mature pine forests such as these, less emphasis is needed on the creation of forest openings as the low-density mature stands with open understories provide adequate food and cover for male turkeys. As in other studies, our data have shown an importance for maintaining at least a small component of mature hardwood habitat in pine-
dominated areas. Thus, we recommend against the removal of all hardwood stems, an increasing trend among some longleaf pine ecosystems.

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Table 2-1. Habitat types delineated from previous landcover data and aerial photography for Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2012.

<table>
<thead>
<tr>
<th>Habitat Type</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine Plantation</td>
<td>Pine habitat planted and managed in short rotation for commercial timber</td>
</tr>
<tr>
<td>Forest Opening</td>
<td>Any open habitat type with no forested overstory</td>
</tr>
<tr>
<td>Forested and Herbaceous Wetlands</td>
<td>Habitat suited to hold water for significant portions of the year</td>
</tr>
<tr>
<td>Hardwood</td>
<td>Overstory comprised primarily of hardwood species</td>
</tr>
<tr>
<td>Mature Pine</td>
<td>Overstory comprised primarily of mature pine managed primarily for conservation</td>
</tr>
<tr>
<td>Mature Pine-Hardwood</td>
<td>Overstory comprised of mixed pine and hardwood species managed primarily for conservation</td>
</tr>
</tbody>
</table>
Table 2-2. Ranks (5 = most selected, 0 = least selected) of Johnson’s 2nd order and 3rd order habitat selection using compositional analysis of male eastern wild turkeys at Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2012. Rankings with different letters within an order were significantly different.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>2nd Order $(P &lt; 0.001)$</th>
<th>3rd Order $(P &lt; 0.001)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature Pine</td>
<td>5$^a$</td>
<td>5$^a$</td>
</tr>
<tr>
<td>Mature Pine-HW</td>
<td>3$^{bc}$</td>
<td>4$^a$</td>
</tr>
<tr>
<td>Forest Opening</td>
<td>2$^{bc}$</td>
<td>2$^b$</td>
</tr>
<tr>
<td>Wetland</td>
<td>1$^{bc}$</td>
<td>0$^b$</td>
</tr>
<tr>
<td>Hardwood</td>
<td>4$^b$</td>
<td>1$^b$</td>
</tr>
<tr>
<td>Pine Plantation</td>
<td>0$^c$</td>
<td>3$^b$</td>
</tr>
</tbody>
</table>
CHAPTER 3
ROOST SITE SELECTION OF MALE EASTERN WILD TURKEYS IN SOUTHWESTERN GEORGIA

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Ruttinger, J. A. To be submitted to the Journal of Wildlife Management.
Abstract

Little research has been conducted on roost site selection of eastern wild turkeys (*Meleagris gallopavo silvestris*), and no studies have quantified microhabitat characteristics of roost sites in southern portions of the bird’s range. We evaluated the efficacy of ground-based thermal imaging combined with radio telemetry to identify roosting male turkeys. Furthermore, we created a model predicting roost site selection, and used this model to determine the effects of study site and season on roost site selection. Using radio telemetry and thermal imaging, we successfully collected data on 74 of 79 attempts (93.7%) to locate roosting male turkeys. The most parsimonious model of roost site selection consisted of 18 understory and landscape-level variables. However, only 6 of these variables were informative (i.e., 95% confidence intervals of variable estimates did not overlap zero): distance to 4 habitat types (mature pine, mature hardwood, shrub/scrub, and pine plantation), distance to road, and average height of understory vegetation within the understory. Male wild turkeys likely select to roost near mature pine or hardwood habitats with dense understory vegetation because the larger trees provide more adequate roost sites and produce hard mast, whereas the understory contains herbaceous forage species. They probably avoid roosting near roads as a human avoidance mechanism, and avoid shrub/scrub habitat and pine plantations because both habitats lack suitable roost trees and forage species. Seasonal differences did not improve model predictive ability, suggesting that it had little effect on roost selection. However, site differences showed promise in predicting roost sites, suggesting that males were showing selection towards differing roost sites on similar habitat types. Forest management to promote mature forests with dense herbaceous ground cover should provide adequate roosting habitat for male eastern wild turkeys.
Introduction

Roost sites are an important habitat requirement for wild turkeys, protecting them from predators and adverse weather (Bailey and Rinell 1967, Austin and DeGraaf 1975, Porter 1978, Kilpatrick et al. 1988). Management that limits roost site availability may also limit turkey populations. Previous studies have examined roosting habitat of the Merriam’s wild turkey (Hoffman 1968, Boeker and Scott 1969, Mackey 1984), the Rio Grande wild turkey (Crockett 1973, Haucke 1975), and the eastern wild turkey (Tzilkowski 1971, Kilpatrick et al. 1988, Chamberlain et al. 2000). Chamberlain et al. (2000) determined that eastern wild turkey hens selected mature trees in pine or mixed pine-hardwood stands. Previous studies on roosts in the southeastern U.S. did not assess microhabitat characteristics associated with the roosts. Studies that successfully found specific roost trees focused on female winter roost characteristics in northern parts of the turkey’s range where large groups of birds roosted together, which made roost trees easily detectable because of scat deposits on the tree and footprints in the snow surrounding roost sites (Austin and DeGraaf 1975, Wunz and Hayden 1975, Porter 1978). No studies have evaluated male wild turkey roost site selection in the longleaf pine ecosystem, nor have studies of roost sites involved actual observations of roosting birds.

Accurate determination of roost trees is difficult using traditional methodology (e.g., remote location via radio telemetry). Thermal imaging offers a potential tool for observing roosting turkeys. Locke et al. (2006) tested the use of aerial and ground-based forward-looking infrared technology to detect wild turkeys, concluding that aerial detection was unsuccessful because the thermal imaging camera could not view roosting turkeys through the tree canopy. However, ground-based thermal detection efforts were more successful. Because there has been little research on roost site selection, it is unclear whether turkeys use certain habitat types
because of roost selection or if roost sites are simply chosen because the birds are in that area when night falls (Chamberlain et al. 2000).

Ground-based thermal imagery, in combination with radio-telemetry, may provide an effective way to identify roost sites of wild turkeys. Our objectives were to (1) use radio telemetry coupled with thermal imagery to determine if the combination of these technologies can better facilitate location of roost sites, (2) use this new method to collect roost site data and form a predictive model for male eastern wild turkey roost site selection, and (3) test for possible effects of breeding season and hunting on the predictability of the best approximating model designed from the roost site selection variables.

Methods

Study Sites

The Joseph W. Jones Ecological Research Center at Ichauway—The Joseph W. Jones Ecological Research Center at Ichauway (henceforth Ichauway) was a 12,000-ha former hunting plantation formerly owned by Robert W. Woodruff. The landscape was flat, karst topography with elevation ranging from 30-100m (Beck and Arden 1983). The study area was characterized by short, mild winters and hot, humid summers with rainfall averaging 131 cm/year and average daily temperatures of 11°C during the winter and 27°C during the summer (Lynch et al. 1986, Goebel et al. 1997, Boring 2001).

Prescribed fire was the primary land management tool at Ichauway for decades (Atkinson et al. 1996). Approximately 50% of the site was burned annually to reduce hardwood encroachment and conserve native ground cover. Approximately 25% of the understory was wiregrass (*Aristida stricta*), a native fire-dependent grass that only flowers after growing-season burns. While prescribed burning can occur year round, most burns were initiated from March-
August. Ichauway was divided into 144 burn units, averaging 70 ha in size, resulting in a matrix of burned and unburned habitats.

The primary goals associated with application of prescribed fire were to conserve the native longleaf pine (*Pinus palustris*)-dominated overstory and herbaceous understory and to enhance northern bobwhite (*Colinus virginianus*) habitat. During the past 6-7 years, significant hardwood removal efforts were implemented on Ichauway with the goal of reducing hardwood prevalence within the longleaf pine matrix. Scattered individual hardwood trees and hardwood patches that remained provided hard mast for wildlife and potential roosting habitat for turkeys. Current and historic quail management practices resulted in a mosaic of food plots and openings within the forested ecosystem.

Wild turkey translocation began at Ichauway during the late 1970s in a cooperative effort between the Georgia Department of Natural Resources and Tall Timbers Research Station (Smith et al. 2006). Twenty-eight turkeys were released on site during 1988-1990 (Sanders and Mueller 1988, DeVos and Sisson 1989, Sisson 1990). The population of turkeys on the site remained similar to the number of translocated birds until about 2000, when it began to increase. Since their reestablishment, no hunting of wild turkeys has occurred on this study site.

*Silver Lake Wildlife Management Area (WMA)—*Silver Lake was a 3,900-ha tract of land managed by the Georgia Department of Natural Resources (Silver Lake WMA 50-Year Plan 2009) located approximately 19 km southwest of Bainbridge, Georgia in Decatur County. The WMA was bordered by the Flint River to the east, Lake Seminole to the south, and Spring Creek to the west. Silver Lake WMA consisted of land purchased during 2008-2009. It was formerly owned and managed by International Paper Company as part of their Southland Experimental Forest and consisted of 3,411 ha of state-owned land and 490 ha of land leased from the U.S.
Army Corps of Engineers. Silver Lake was predominately longleaf and loblolly pine (*Pinus taeda*), but also had mixed pine/hardwood, hardwoods, bottomland hardwoods, nonforested openings, and open water. Prescribed fire was the primary vegetation management tool at Silver Lake, with a goal of implementing a 2-year burn rotation to manage native groundcover and establish fire-tolerant longleaf pine trees. Historic burns were done on scales > 40 ha and occurred during the dormant season. Prescribed burning in recent years was implemented on varied spatial scales to promote habitat diversity, with large-scale helicopter burns occasionally implemented. Since the property’s purchase in 2009, prescribed burning has been implemented during both growing and dormant seasons. Other management activities included mechanical and chemical control of undesirable vegetation, site preparation, and planting food plots.

Silver Lake supported several threatened and endangered species, including the red-cockaded woodpecker (*Picoides borealis*), gopher tortoise (*Gopherus polyphemus*), and bald eagle (*Haliaeetus leucocephalus*). The WMA provided recreational activities such as hunting, fishing, birding, and horseback riding. Turkey hunting was permitted, but restricted to 2, 1-week-long quota hunts and 1, 2-week-long open hunt during Georgia’s spring hunting season. Potential predators of wild turkeys at the Jones Center and Silver Lake WMA were similar and include bobcats (*Lynx rufus*), coyotes (*Canis latrans*), and great horned owls (*Bubo virginianus*).

**Capture and Radio Telemetry**

We captured male wild turkeys using rocket nets (Wunz 1987) over bait sites consisting of corn or a corn-milo mix during the winter (December - March) of 2010 – 2011, summer and fall (June-September) of 2011, and during the winter (December – March) and summer (June-August) of 2012. We checked bait sites twice daily, and capture attempts were made after consistent use of sites by turkeys. After capture, we removed turkeys from the net, classified
them as adults or juveniles (Williams and Austin 1988), and placed them into cardboard boxes designed to accommodate wild turkeys. We fitted each male with serially numbered, rivet (right leg) and butt-end (left leg) aluminum leg bands (National Band and Tag Co., Newport, KY). We fitted all captured males with a mortality-sensing VHF radio transmitter weighing approximately 60g (Telenax, Playa del Carmen, Mexico; or Sirtrack, Havelock North, New Zealand) that was attached via a backpack harness. Capture and handling of birds followed standard protocols approved by the University of Georgia Institutional Animal Care and Use Committee (Permit Number A2010 7-120).

We triangulated radio-tagged turkeys from roads (Cochran and Lord 1963) using a hand-held 3-element Yagi antenna and Wildlife Materials TRX 2000S receiver (Wildlife Materials, Murphysboro, Illinois), and recorded locations in the field with a mobile phone equipped with a Bluetooth GPS unit and Location of a Signal-SD (LOAS-SD) software (Ecological Software Solutions, LLC). To reduce error caused by movements, we determined each location using azimuths that were recorded within a 15-minute interval.

We tracked male birds to their roosts at night and approached close enough (approximately 50m) to view through a Raytheon Infrared-Palm IR 250 Digital thermal camera (Raytheon Commercial Infrared, Dallas, Texas). Upon finding the bird, we flagged the nearest tree to our position and recorded the distance and azimuth to the roost tree, and whether the turkey flushed before data could be collected or during data collection. To reduce observer bias due to potentially flushing birds, thus altering their movement or roosting patterns, we located roosts for each bird ≤ 1 time per week. For each roost site, a random site was selected using a random point generator in ArcMAP 9.3 (Environmental Systems Resource Institute [ESRI] 2008) to compare roosting habitat with available habitat. We considered the tree nearest plot
center with DBH ≥ 20cm at each random site as a random roost tree and recorded data for this tree in the same manner as observed roost trees.

**Habitat Analyses**

We measured microhabitat characteristics associated with roost and random sites to determine if microhabitat influenced roost site selection. Variables measured included roost tree type (pine or hardwood), height, and diameter at breast height (DBH), as well as percent canopy cover, percent ground cover, understory vegetation height, and basal area. We considered the roost tree (or associated random point) as the center of the plot and took all surrounding vegetative measurements within a 15m radius of the center point. We measured canopy cover using a spherical densiometer (Lemmon 1956). We used a Robel pole to evaluate vertical obstruction around the roost tree (Robel et al. 1970) by placing the pole in the center of the plot and taking measurements in 4 cardinal directions at a distance of 15 m. We used a Daubenmire frame (Daubenmire 1959) to measure ground cover associated with the roost or random site and at 4 sites in each cardinal direction 15 m from the roost. For each tree ≥ 20 cm DBH within 15 m of the roost tree, we recorded type (pine or hardwood), DBH, and height.

We examined roost site selection at the landscape scale using ArcGIS 9.3 (Environmental Systems Resource Institute [ESRI] 2008). We manually digitized landcover polygons using 2010 digital orthophoto quarter quadrangles (National Agriculture Imagery Program 2010) to identify 9 habitat types, including mature pine, mature pine-hardwood, shrub/scrub, forested/herbaceous wetlands, mature hardwood, agriculture field/food plot, pine plantation, barren land/urban, and open water to be used in analysis. We also calculated distances between roost and random sites to the nearest open water, road, and other habitat types.

**Data Analyses**
We pooled roost site data from 2011-2013 for both study sites and all 3 years. We calculated ratios for rates of successful data collection versus instances where roosted birds were flushed to illustrate the success of the ground-based thermal imagery in combination with telemetry to identify roosting males (Table 3-1). The number of variables included in model construction was reduced by eliminating highly correlated ($|r| > 0.6$) variables (Brennan et al. 1986). All remaining variables except site and season were put into one of 4 categories (Table 3-2). Tree variables described the roost tree, whereas stand variables described forest structure surrounding the roost tree. Understory variables described understory vegetation surrounding the roost tree, and landscape variables described broader habitat characteristics associated with the roost site. Site and season were used in later analysis. We considered each roost sample independent because there was significant time allowed between sampling ($\geq 1$ week), and calculated percentage of habitat type used by each individual turkey when selecting roost sites (Table 3-3).

We used an information theoretic approach to model roost site selection as a function of the habitat variables measured in the field and assessed within ArcGIS (Anderson et al. 2000; Burnham and Anderson 2000). The analysis began with 38 a priori models representing each variable individually and all possible additive combinations of the 4 variable categories, a null model, and a global model (Table 3-4). Models predicting the probability of a tree being used as a roost site by male eastern wild turkeys were developed using logistic regression (Hosmer and Lemeshow 2000).

The most parsimonious model and variable importance were predicted using second order Akaike’s Information Criteria ($AIC_c$) (Anderson et al. 2000; Burnham and Anderson 2000). Akaike weights ($w_i$) were calculated for each model and were interpreted as the
probability of the \(i\)th model being the best approximating model of the \(a\) \(priori\) set; therefore, the model with the highest \(w_i\) was considered the best approximating model given our data.

To explore potential effects of study site on roost site selection, we added a variable for site to the best approximating model. Likewise, we added a season variable to the best approximating model to determine if the breeding ecology of male birds altered their roost selection. Breeding season was defined as 1 March - 31 May, with non-breeding season from 1 June - 28 February. Finally, we added a combination of study site and season to the best approximating model to determine whether a combination of the effects of hunting and breeding ecology (which occur at the same time of year) affected roost site selection. We compared all 3 aforementioned models to the best approximating habitat model to discern whether they increased its predictability (Table 3-5).

For each variable, \(\sum w_i\) was calculated to determine variable importance, then averaging of models whose \(w_i\) sums were \(\geq 0.90\) (meaning there was \(\geq 90\%\) chance that one of these models was the best approximating model) was used to estimate variables and unconditional standard errors for important variables (i.e., variables with \(\sum w_i \geq 0.20\)) (Burnham and Anderson 2000). Only variables with confidence intervals not encompassing zero were considered informative (Table 3-6).

**Results**

We made 79 attempts to view roosting male turkeys from March 2011 to March 2013. Of these attempts, 74 resulted in location of a roost (Table 3-1). We located the roost and exited the area without flushing the turkey 70\% of the time. We were successful enough to identify the roost tree for later data collection on 94\% of our attempts.
We used data from 72 roost sites collected from 18 individual male turkeys and 72 random sites in modeling efforts (Table 3-3). Two sites were excluded because they could not be relocated for sampling due to an inaccurate GPS location. Maximum, average, and minimum vegetation height variables were highly correlated ($|r| > 0.6$), as were distances to nearest agriculture/food plot, barren/urban land, and wetland habitat. To reduce bias in modeling, minimum understory vegetation height, maximum understory vegetation height, and distance to barren/urban land were removed from further analysis.

The model with the lowest AICc was the Understory + Landcover model (Table 3-3). The $w_i$ for this model was approximately 8.5 times greater than the next closest approximating model. Effects of site, season, and their combination did not improve predictive ability of the model (Table 3-4), but inclusion of site did decrease the predictability ($\Delta$AICc = 0.62) suggesting that there were differences between study sites. The adjusted $w_i$ for models containing site variables were $\leq 0.38$ (there was $\leq 38\%$ chance of one of these models being the best approximating model). The adjusted $w_i$ for models containing season variables were $\leq 0.05$.

The $w_i$ of the top 3 approximating models indicated there was a $\geq 99\%$ chance that one was the best approximating model of the 38 a priori models. The sums of the $w_i$ for landscape and understory variables were $> 0.99$ (Table 3-5), whereas weights for tree and stand variables were $\leq 0.10$. Only 6 variables were informative (Table 3-5). Males selected roosts closer to mature pine and hardwood habitats, but farther away from pine plantations, scrub, and roads. Likewise, roost sites were characterized by denser understory vegetation than random sites.

**Discussion**

Coupling ground-based thermal imagery with radio telemetry provided a viable research tool to study roosting ecology of wild turkeys. The success rate of this approach was contingent
on the ability to track specific males with radio-telemetry and narrow search efforts to specific areas. Then, birds could be viewed by looking up from the ground where tree canopy caused little loss of visibility, in contrast to Locke et al. (2006) who could not locate birds looking down through the canopy from above. While this approach worked well in the longleaf-pine forests of southwestern Georgia, further testing in different regions and environments is needed to evaluate the efficacy in other forest systems.

Male turkeys in southwestern Georgia avoided roads when selecting roost sites, potentially as a way to reduce predation risk and avoid disturbance. Roads obviously provide a source of disturbance through vehicle traffic and noise, therefore turkeys likely avoid this disturbance when choosing roosts.

Male turkeys roosted closer to mature pine habitat than other available habitat types. We expected the inclusion of this habitat type in the best approximating model because it was roosted in the most. Turkeys roosted in mature pine stands on approximately 66% (43 of 72) of the roost locations, making this the most used habitat type in this study. Godwin et al. (1992) and Miller et al. (1999) noted that male eastern wild turkeys selected upland pine and mixed pine-hardwood habitat types, suggesting that the larger body size of male turkeys equipped them to deal with the denser understory vegetation associated with these habitats. The lower tree density within mature pine habitat types may also permit easier flight into the tree canopy, and larger branches of mature trees may be required to support the larger body size of adult male turkeys.

Roosts were closer to mature hardwood stands than were random locations. There was little bottomland hardwood habitat available on our study sites compared to other habitat types, and bottomland hardwoods were typically associated with a water source. Given that proximity
to water was not a predictor of roost site selection, it appears that the selection of roosts closer to hardwood habitats stems from other reasons. Likely, the birds foraged in mature hardwood and pine forests due to abundance of food in these habitats (Holbrook 1973, Phalen et al. 1986, Palmer 1990, Hurst and Dickson 1992, Miller et al. 1999). In Chapter 2 of my thesis, male turkeys selected hardwood habitats within their study areas during the non-breeding season.

The positive relationship between understory vegetation height (measured through average visual obstruction) and roost site selection may have been an artifact of birds choosing to frequently roost in mature pine stands. Mature pine forests on our study sites consisted of open canopy habitat with a rich herbaceous understory. This habitat type is selected by male turkeys for foraging (Lambert et al. 1990, Godwin et al. 1992, Miller et al. 1999).

Selection of roost sites further from shrub/scrub habitat was likely an effect of the lack of suitable roost trees in this habitat. Shrub/scrub habitat at both study sites consisted primarily of abandoned agricultural fields or food plots with dense pole stands of hardwoods. Openings, particularly in primarily forested landscapes, are important to wild turkeys (Speak et al. 1975, Bailey et al. 1981, Hurst 1981, Everett et al. 1985, Hurst and Dickson 1992), but as successional patterns create pole stands with high stem density, turkeys often avoid them (Miller et al. 1999).

Male turkeys avoided roosting near pine plantations; these habitats consisted mainly of pole stands of loblolly pine without a history of thinning or fire. The lack of thinning typically results in dense stands of small diameter trees that are unsuitable for male turkeys to use as roosts (Bailey and Rinell 1968, Hoffman 1968, Flake et al. 1995, Chamberlain et al. 2000). Likewise, turkeys were also not selecting for this habitat type at a study area scale or within their home ranges (Chapter 2) as the canopy had reached full closure and the lack of sunlight
prevented the growth of potential herbaceous understory vegetation or a soft-mast producing midstory (Miller et al. 1999).

Habitat use by male eastern wild turkeys in other ecosystems often changes from breeding season to non-breeding season (Godwin et al. 1992, Miller et al. 1999), where the males alter their use patterns to increase chances of encounters with females. Given this, it stands to reason that roosting ecology may be equally affected. The spring hunting season for turkeys in Georgia overlaps the breeding season (late March-mid May; Georgia Department of Natural Resources 2013). Our findings suggest that males do not appreciably alter their selection of roosts during the breeding season. This lack of change agrees with habitat selection of turkeys on these study sites (Chapter 2). The roosting habitat for males and females may be similar enough that no change in roosting behavior was needed during the breeding season. Previous studies support this interpretation with findings of female turkey roost selection of large trees in mature pine and mixed pine-hardwood stands (Bailey and Rinnell 1968, Hoffman 1968, Chamberlain et al. 2000). Another potential reason for lack of seasonal selection change is roost tree fidelity, which has been shown to be high in Rio Grande turkeys with little available roost habitat (Crockett 1973, Haucke 1975); however, during the course of this study turkeys showed little conformity to specific areas and no roost tree fidelity. Because breeding season also coincides with hunting season at Silver Lake WMA, the lack of breeding season effect on model predictability may also imply that hunting pressure does not affect male turkey roost site selection.

Though the addition of a study site variable to the best approximating model did not increase its predictability, the model it created was a strong contender with the top model. This suggests that roost selection was influenced to some degree by differences present on the study
sites. Hunting pressure is an obvious difference between the 2 study sites; however the addition of the season and site/season combination variables reduced predictability of the top approximating model—implying that hunting is not the central reason that study site influenced predictability of the model. Though the longleaf pine ecosystem is dominant, other habitat types differ between study sites. The previously described habitat selection study (Chapter 2) did not include enough data to draw meaningful inferences from differences in selection between study sites, though it did suggest differences may occur. These potential differences may account for the different roost site selection among sites. Further research is needed to better distinguish male turkey roost site selection on each site. The noticeable difference in roost selection between 2 similar sites illustrates the importance of roost site studies on multiple habitat types to determine roosting habitat selected by male turkeys throughout the wild turkey’s range.

**Management Implications**

Mature pine and hardwood stands with dense understory vegetation were selected by male turkeys when roosting, whereas they avoided roads, shrub/scrub habitat, and young pine plantations. Management of roosting habitat should include maintaining mature pine and hardwood habitats and managing understory vegetation (e.g., prescribed burning) to promote an herbaceous understory by preventing development of a hardwood midstory. Also, limiting road building and usage (i.e., use minimal necessary roads for logging operations) can increase the suitability of roosting habitat. All but one of the important roost predictors were landscape level variables and none of them required discerning a specific roost tree. Thus, less labor intensive methods may be used to collect important location data. GPS transmitters can collect fine-scale data at a much higher quantity than the methods used in this study. However, replication of these methods is needed to ensure that the selection documented is consistent.
Literature Cited


Atkinson, J., J. Brock, and R. Smith. 1996. Operational longleaf pine management at Ichauway. The longleaf alliance annual meeting, Mobile, Alabama, USA.


Sanders, J. S., and B. S. Mueller. 1988. First year report on turkey restocking efforts on Ichauway Plantation by Tall Timbers Research Station. Source??

Silver Lake Wildlife Management Area 50-Year Plan (2009-2059) 2009. Georgia Department of Natural Resources. Source??


Table 3-1. Success rates using ground-based thermal imagery to determine roost sites of male eastern wild turkeys at Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2013.

<table>
<thead>
<tr>
<th>Attempts (N=79)</th>
<th>Success Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Success(^a)</td>
<td>55</td>
</tr>
<tr>
<td>Data Collected(^b)</td>
<td>74</td>
</tr>
<tr>
<td>Flush(^c)</td>
<td>5</td>
</tr>
</tbody>
</table>

\(^a\) Turkey was successfully roosted without being flushed.
\(^b\) Turkey was flushed but data were still successfully collected.
\(^c\) Turkey was flushed from the roost without being spotted, therefore no data could be collected.
Table 3-2. Variable categories and definitions of variables measured at male eastern wild turkey roost and random sites at Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2013.

<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Study site</td>
<td>Study site where roost was collected: Ichauway (unhunted) or Silver Lake WMA (hunted)</td>
</tr>
<tr>
<td>Season&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Season</td>
<td>Biological season: breeding (Mar. 1-May 31) or non-breeding (June 1-Feb. 28)</td>
</tr>
<tr>
<td>Tree</td>
<td>Type</td>
<td>Tree type (pine or hardwood)</td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>Roost tree height (m)</td>
</tr>
<tr>
<td></td>
<td>DBH</td>
<td>Roost tree diameter (cm)</td>
</tr>
<tr>
<td>Stand</td>
<td>BA</td>
<td>Total basal area (m&lt;sup&gt;2&lt;/sup&gt;/ha) of trees surrounding roost tree</td>
</tr>
<tr>
<td>Understory</td>
<td>Canopy closure</td>
<td>Canopy closure (%)</td>
</tr>
<tr>
<td></td>
<td>Min. understory vegetation height&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Minimum visual obstruction height (dm) of understory vegetation</td>
</tr>
<tr>
<td></td>
<td>Ave. understory vegetation height</td>
<td>Average visual obstruction height (dm) of understory vegetation</td>
</tr>
<tr>
<td></td>
<td>Max. understory vegetation height&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Maximum visual obstruction height (dm) of understory vegetation</td>
</tr>
<tr>
<td></td>
<td>% bare ground</td>
<td>Bare ground (%)</td>
</tr>
<tr>
<td></td>
<td>% debris</td>
<td>Debris groundcover (%)</td>
</tr>
<tr>
<td></td>
<td>% fern</td>
<td>Fern groundcover (%)</td>
</tr>
<tr>
<td></td>
<td>% forb</td>
<td>Forb groundcover (%)</td>
</tr>
<tr>
<td></td>
<td>% grass</td>
<td>Grass groundcover (%)</td>
</tr>
<tr>
<td></td>
<td>% vine</td>
<td>Vine groundcover (%)</td>
</tr>
<tr>
<td></td>
<td>% woody</td>
<td>Woody groundcover (%)</td>
</tr>
<tr>
<td>Landscape</td>
<td>Dist open water</td>
<td>Distance to nearest open water (m)</td>
</tr>
<tr>
<td></td>
<td>Dist road</td>
<td>Distance to nearest road (m)</td>
</tr>
<tr>
<td></td>
<td>Dist mature pine</td>
<td>Distance to nearest mature pine (m)</td>
</tr>
<tr>
<td></td>
<td>Dist mature pine/hardwood</td>
<td>Distance to nearest mature pine/hardwood (m)</td>
</tr>
<tr>
<td></td>
<td>Dist shrub/scrub</td>
<td>Distance to nearest shrub/scrub (m)</td>
</tr>
<tr>
<td></td>
<td>Dist wetland</td>
<td>Distance to nearest wetland (m)</td>
</tr>
<tr>
<td></td>
<td>Dist mature hardwood</td>
<td>Distance to nearest mature hardwood (m)</td>
</tr>
<tr>
<td></td>
<td>Dist. Agriculture</td>
<td>Distance to nearest agriculture or food plot (m)</td>
</tr>
<tr>
<td></td>
<td>Dist pine plantation</td>
<td>Distance to nearest pine plantation (m)</td>
</tr>
<tr>
<td></td>
<td>Dist barren land/urban&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Distance to nearest barren land/urban (m)</td>
</tr>
</tbody>
</table>
Table 3-3. Identification, percentage of habitat selection, and number of times observed on the roost for male eastern wild turkeys at Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2013.

<table>
<thead>
<tr>
<th>Turkey ID&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Pine plantation&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Mature hardwood&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Mature pine&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Mature pine/hardwood&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Total Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>0.0%</td>
<td>14.3%</td>
<td>71.4%</td>
<td>14.3%</td>
<td>7</td>
</tr>
<tr>
<td>65</td>
<td>0.1%</td>
<td>14.3%</td>
<td>42.9%</td>
<td>42.9%</td>
<td>7</td>
</tr>
<tr>
<td>67</td>
<td>0.0%</td>
<td>33.3%</td>
<td>50.0%</td>
<td>16.7%</td>
<td>6</td>
</tr>
<tr>
<td>280</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>4</td>
</tr>
<tr>
<td>295</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>1</td>
</tr>
<tr>
<td>296</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>3</td>
</tr>
<tr>
<td>327</td>
<td>0.0%</td>
<td>0.0%</td>
<td>50.0%</td>
<td>50.0%</td>
<td>2</td>
</tr>
<tr>
<td>401</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>2</td>
</tr>
<tr>
<td>405</td>
<td>33.3%</td>
<td>0.0%</td>
<td>66.7%</td>
<td>0.0%</td>
<td>3</td>
</tr>
<tr>
<td>408</td>
<td>18.2%</td>
<td>0.0%</td>
<td>63.6%</td>
<td>18.2%</td>
<td>11</td>
</tr>
<tr>
<td>426</td>
<td>100.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1</td>
</tr>
<tr>
<td>429</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>1</td>
</tr>
<tr>
<td>452</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>2</td>
</tr>
<tr>
<td>460</td>
<td>22.2%</td>
<td>11.1%</td>
<td>55.6%</td>
<td>11.1%</td>
<td>9</td>
</tr>
<tr>
<td>463</td>
<td>11.1%</td>
<td>11.1%</td>
<td>44.4%</td>
<td>33.3%</td>
<td>9</td>
</tr>
<tr>
<td>466</td>
<td>100.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>1</td>
</tr>
<tr>
<td>476</td>
<td>50.0%</td>
<td>0.0%</td>
<td>50.0%</td>
<td>0.0%</td>
<td>2</td>
</tr>
<tr>
<td>478</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>1</td>
</tr>
</tbody>
</table>

* Male turkey identification numbers were derived from the band attached to their left leg upon capture.

* Habitat types used at least once by a turkey during the study.
Table 3-4. Models, number of variables (K), distance from second-order Akaike’s Information Criteria (ΔAICc), and model weights (wi) explaining the effects of roost tree, understory, stand, and landscape level variables on predicting male eastern wild turkey roost sites at Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2013.

<table>
<thead>
<tr>
<th>Modela</th>
<th>K</th>
<th>AICc</th>
<th>Δi</th>
<th>wi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understory+Landscape</td>
<td>18</td>
<td>124.07</td>
<td>0</td>
<td>0.85</td>
</tr>
<tr>
<td>Stand+Understory+Landscape</td>
<td>19</td>
<td>128.93</td>
<td>3.32</td>
<td>0.10</td>
</tr>
<tr>
<td>Tree+Understory+Landscape</td>
<td>19</td>
<td>133.15</td>
<td>5.32</td>
<td>0.04</td>
</tr>
</tbody>
</table>

a Only models with wi ≥ 0.01 are included in the table.
Table 3-5. The top performing model (Understory+Landscape), combinations of it including study site and biological season as variables, number of variables (K), distance from second-order Akaike’s Information Criteria (ΔAICc), and adjusted model weights (wi) explaining the effects of hunting pressure and breeding season on predicting male eastern wild turkey roost sites at Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2013.

<table>
<thead>
<tr>
<th>Model</th>
<th>K</th>
<th>AIC$_c$</th>
<th>Δ$_i$</th>
<th>Adjusted $w_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understory+Landscape</td>
<td>18</td>
<td>124.07</td>
<td>0</td>
<td>0.52</td>
</tr>
<tr>
<td>Site+Understory+Landscape</td>
<td>19</td>
<td>124.70</td>
<td>0.62</td>
<td>0.38</td>
</tr>
<tr>
<td>Season+Understory+Landscape</td>
<td>19</td>
<td>128.66</td>
<td>4.58</td>
<td>0.05</td>
</tr>
<tr>
<td>Season+Site+Understory+Landscape</td>
<td>20</td>
<td>129.29</td>
<td>5.22</td>
<td>0.04</td>
</tr>
</tbody>
</table>
Table 3-6. Average variable estimates, unconditional standard errors, sum of Akaike weights, and 95% confidence intervals of predictor variables found in the top approximating models for male eastern wild turkey roost habitat at Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2013.

<table>
<thead>
<tr>
<th>Variable^a</th>
<th>Model-Averaged Estimate</th>
<th>SE</th>
<th>∑w_i^b</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dist. open water</td>
<td>-0.0004</td>
<td>0.0014</td>
<td>1.0</td>
<td>-0.0024</td>
<td>0.0032</td>
</tr>
<tr>
<td>Dist. road^c</td>
<td>0.0167</td>
<td>0.0061</td>
<td>1.0</td>
<td>0.0047</td>
<td>0.0286</td>
</tr>
<tr>
<td>Dist. mature pine^c</td>
<td>-0.0126</td>
<td>0.0056</td>
<td>1.0</td>
<td>-0.0236</td>
<td>-0.0018</td>
</tr>
<tr>
<td>Dist. mature pine/hardwood</td>
<td>-0.0012</td>
<td>0.0012</td>
<td>1.0</td>
<td>-0.0035</td>
<td>0.0010</td>
</tr>
<tr>
<td>Dist. shrub/scrub^c</td>
<td>0.0023</td>
<td>0.0014</td>
<td>1.0</td>
<td>0.0005</td>
<td>0.0051</td>
</tr>
<tr>
<td>Dist. wetland</td>
<td>0.0003</td>
<td>0.0002</td>
<td>1.0</td>
<td>-7.65e^-5</td>
<td>0.0006</td>
</tr>
<tr>
<td>Dist. mature hardwood^c</td>
<td>-0.0036</td>
<td>0.0012</td>
<td>1.0</td>
<td>-0.0059</td>
<td>-0.0013</td>
</tr>
<tr>
<td>Dist. pine plantation^c</td>
<td>0.0036</td>
<td>0.0016</td>
<td>1.0</td>
<td>0.0004</td>
<td>0.0068</td>
</tr>
<tr>
<td>Dist. agriculture</td>
<td>0.0035</td>
<td>0.0004</td>
<td>1.0</td>
<td>-0.0005</td>
<td>0.0012</td>
</tr>
<tr>
<td>Average understory vegetation height^c</td>
<td>0.2590</td>
<td>0.0952</td>
<td>1.0</td>
<td>0.0724</td>
<td>0.4455</td>
</tr>
<tr>
<td>% bare ground</td>
<td>19.0198</td>
<td>1305.883</td>
<td>1.0</td>
<td>-2540.464</td>
<td>2578.504</td>
</tr>
<tr>
<td>% debris</td>
<td>18.9740</td>
<td>1305.883</td>
<td>1.0</td>
<td>-2540.510</td>
<td>2578.458</td>
</tr>
<tr>
<td>% fern</td>
<td>19.1190</td>
<td>1305.883</td>
<td>1.0</td>
<td>-2540.365</td>
<td>2578.603</td>
</tr>
<tr>
<td>% forb</td>
<td>18.9186</td>
<td>1305.883</td>
<td>1.0</td>
<td>-2540.565</td>
<td>2578.403</td>
</tr>
<tr>
<td>% grass</td>
<td>18.9064</td>
<td>1305.883</td>
<td>1.0</td>
<td>-2540.577</td>
<td>2578.390</td>
</tr>
<tr>
<td>% vine</td>
<td>18.9776</td>
<td>1305.883</td>
<td>1.0</td>
<td>-2540.506</td>
<td>2578.462</td>
</tr>
<tr>
<td>% woody</td>
<td>18.9668</td>
<td>1305.883</td>
<td>1.0</td>
<td>-2540.517</td>
<td>2578.451</td>
</tr>
</tbody>
</table>

^a Only variables with ∑ wi ≥ 1.0 are included because remaining variables provide minimal information (∑ w_i ≤ 0.10).

^b Sum of Akaike weights indicating variable importance with higher values having more support.

^c Indicates 95% CI does not contain zero.
Table 3-7. Mean and standard error of informative variables (variables in the top approximating models with 95% confidence intervals excluding zero) used to predict roost site selection of male eastern wild turkeys at Ichauway and Silver Lake WMA in southwestern Georgia, 2011-2013.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Roost Mean (N=72)</th>
<th>SE</th>
<th>Random Mean (N=72)</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dist. road&lt;sup&gt;a&lt;/sup&gt;</td>
<td>162.80</td>
<td>16.03</td>
<td>58.07</td>
<td>57.17</td>
</tr>
<tr>
<td>Dist. mature pine&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.70</td>
<td>9.81</td>
<td>57.17</td>
<td>13.78</td>
</tr>
<tr>
<td>Dist. shrub/scrub&lt;sup&gt;a&lt;/sup&gt;</td>
<td>462.4</td>
<td>33.14</td>
<td>236.1</td>
<td>22.29</td>
</tr>
<tr>
<td>Dist. pine plantation&lt;sup&gt;a&lt;/sup&gt;</td>
<td>318.96</td>
<td>39.23</td>
<td>157.35</td>
<td>21.93</td>
</tr>
<tr>
<td>Dist. mature hardwood&lt;sup&gt;a&lt;/sup&gt;</td>
<td>493.76</td>
<td>51.73</td>
<td>535.80</td>
<td>45.733</td>
</tr>
<tr>
<td>Average understory vegetation height&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.71</td>
<td>0.55</td>
<td>7.72</td>
<td>0.54</td>
</tr>
</tbody>
</table>

<sup>a</sup> Variable measured in meters.

<sup>b</sup> Variable measured in decimeters.
CHAPTER 4
SYNTHESIS AND RECOMMENDATIONS

This study presents information on multiple facets of the resource selection of male eastern wild turkeys in the longleaf pine (*Pinus palustris*) ecosystem of southwestern Georgia. We provide information on habitat selection and report findings provided by a new method of collecting roost site selection data for male eastern wild turkeys.

We assessed male wild turkey habitat selection using compositional analysis to rank the selection of 6 habitat types (mature pine, mature pine-hardwood, forest openings, forested/herbaceous wetlands, mature hardwood, and evergreen pine plantation) on 2 habitat selection scales: Johnson’s 2<sup>nd</sup> and 3<sup>rd</sup> order habitat selection criteria (Johnson 1980) within 2 seasons (breeding season from 1 March - 31 May and non-breeding season from 1 June 1- 28 February). Habitat selection did not vary seasonally, which does not agree with other studies that report a shift in habitat selection during breeding season to increase chance of encounters with females (McMahon and Johnson 1980, Clark 1985, Kelly et al. 1988, Godwin et al. 1992). This difference may be accounted for by a general lack of hardwood habitat, which is typically the more selected female wild turkey habitat (Miller et al. 1999). Thus, female wild turkeys may be using habitat similar to that of males in this ecosystem so that the males do not shift their habitat use patterns to encounter females in the breeding season.

Mature pine and mixed pine-hardwood (which were typically associated with longleaf pine-dominated overstory) were consistently among the 3 highest ranked habitat types between scales. This selection agrees with findings of other studies (Holbrook 1973, Hurst and Dixon
1992, Miller et al. 1999) that cite the potential roost site availability, abundant herbaceous vegetation production, hard and soft mast production, and habitat structure with little midstory as factors of these habitat types that are conducive to wild turkey use.

Within their home ranges, males used mature mixed stands similarly to mature pine stands. This is likely due to the similarities between the 2 habitat types related to food availability and stand structure. These habitat types were consistently juxtaposed on both study sites, and both habitat types were maintained with short rotation prescribed fire to promote native ground cover, which includes a rich herbaceous understory and soft mast producing midstory conducive to use by turkeys (Holbrook 1973, Palmer 1990, Hurst and Dickson 1992, Miller et al. 1999). Martin et al. (2012) similarly found male selection for mature pine and mixed forest savannas maintained by short-rotation prescribed fire.

Our study on the use of ground-based thermal imagery in combination with radio telemetry proved to be successful. Of the 79 attempts at viewing roosting birds, 74 (94%) were successful enough for the collection of roost site selection data. While only anecdotal, I recorded no mortalities of wild turkeys on mornings following attempts that ended in flushing the bird from its original roost. Successful roosts allowed me to view the specific roost tree for a turkey and collect microhabitat data. With data successfully collected, I then used it to create predictor models for roost site selection of male eastern wild turkeys based on the microhabitat variables I collected and landscape-level variables based on the location of the roost, and then subsequently compared the effects of hunting and breeding ecology on the most parsimonious model.

The most-important predictor variables in the best-approximating models showed that wild turkey males selected roost sites with more abundant understory vegetation than the average found on both study sites near mature pine or mature hardwood habitats. This selection has been
shown in previous habitat studies as the larger trees provide adequate roosting habitat (Bailey and Rinell 1968, Kilpatrick et al. 1988) and the understories contain hard mast, soft mast, and herbaceous vegetation, which are preferred foods for eastern wild turkeys (Holbrook 1973, Phalen et al. 1986, Lambert et al. 1990, Godwin 1992, Miller et al. 1999).

Male turkeys avoided roosting near shrub/scrub habitat and pine plantations, likely due to the lack of suitable roost trees in combination with a lack of food production (Miller et al. 1999). The shrub/scrub habitat had no large trees within it and was typically overgrown with a dense midstory that produced little food for wild turkeys, while the pine plantations consisted of typically small densely planted trees with no suitable limbs for roosting and little understory vegetation. The turkeys also avoided roads when selecting roost sites. This is likely due to avoidance of human disturbance associated with roads.

Similarly to the findings of my habitat selection study, breeding ecology did not affect the roost site selection of male eastern wild turkeys. This may be an effect similar to that of their habitat selection, whereas the males do not need to alter their roosting patterns to encounter females. Previous studies illustrate the selection of female wild turkeys to roosting in the mature pine habitat, which the males in this study selected (Bailey and Rinnell 1968, Hoffman 1968, Chamberlain et al. 2000).

The effect of study site did not increase the predictability of the most-parsimonious model, however it decreased its predictability very little ($\Delta AIC_c = 0.62$). This result suggests that there may be some predictability value to the difference between study sites. However, these effects may be the result of the differing habitat types as well as or instead of hunting. Furthermore, because season and the combination of site and season drastically decreased the predictability of the best model ($\Delta AIC_c = 4.58$ and 5.22, respectively) and the breeding season of
eastern wild turkeys coincides with spring male-only turkey hunting season in Georgia (Georgia Department of Natural Resources 2013), it is reasonable to assume that hunting on Silver Lake WMA did not alter the habitat or roost site selection of the turkeys.

Management on longleaf pine-dominated properties should focus on promoting a mature pine stand with a well-managed understory to promote selected habitat for use and roosting of male eastern wild turkeys. Habitat heterogeneity should also be considered, as previous studies illustrate the benefit of a diverse ecosystem in promoting habitat availability to wild turkeys in pine-dominated properties (Lambert et al. 1990, Hurst and Dickson 1992, Miller et al. 1999). Prescribed burning has been shown benefit to wild turkey habitat (McGlincy 1985, Landers and Mueller 1986, Exum 1988, Provencher et al. 1998). The herbaceous understory growth associated with the highly selected roost and daily habitats are promoted through a rotating application of small-scale prescribed fires throughout the year (Joseph W. Jones Ecological Research Center 2010, Silver Lake Wildlife Management Area 50 Year Plan [SLWMAP] 2009). Continued research should yield a better understanding of the importance of different habitats in relation to eastern wild turkey roost site and habitat selection in longleaf pine-dominated ecosystems of the southeastern U.S.

**Literature Cited**


Silver Lake Wildlife Management Area 50-Year Plan [SLWMAP] (2009-2059) 2009. Georgia Department of Natural Resources. Source???

