MOVEMENT AND HABITAT ASSOCIATIONS OF COMMON GROUND DOVES, *COLUMBINA PASSERINA*, IN THE RED HILLS REGION

by

DESTINEE BRADEN

(Under the Direction of Clark Rushing)

ABSTRACT

The common ground dove, *Columbina passerina*, is the smallest species of dove in North America and inhabits open pine woodlands and shrub-scrub habitats (Johnston 1964, Jones and Mirarchi 1990). The subspecies residing in the southeastern United States, *C. p. passerina*, were once prevalent across their range, but have seen population declines over the last 20-40 years (Bowman and Woolfenden 1997, Cely and Glover 2000). The exact causes of these declines have not been identified (Cox 1987, Cely and Glover 2000). In contrast to the range-wide population declines, common ground doves are commonly seen on Red Hills properties that have been managed for northern bobwhite, *Colinus virginianus*. (Morris et al. 2010, Smith et al. 1982). Although anecdotal, this evidence suggests that management practices for bobwhite may have a positive effect on common ground doves and may be responsible for locally increasing dove populations.

INDEX WORDS: Common ground dove, *Columbina passerina*, Telemetry, Home range, Habitat selection, Habitat association, Call point surveys, Northern bobwhite quail, *Colinus virginianus*, Red Hills Region

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DESTINEE BRADEN

B.S., Abraham Baldwin Agricultural College, 2019

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

MASTER OF SCIENCE

ATHENS, GEORGIA

2023

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DESTINEE BRADEN

Major Professor:	Clark Rushing
Committee:	James Martin
	Richard Chandler

Electronic Version Approved:

Ron Walcott
Vice Provost for Graduate Education and Dean of the Graduate School
The University of Georgia
August 2023

ACKNOWLEDGEMENTS

I would like to thank Tall Timbers Research Station for their support before and throughout my master's project. Specifically, the Game Bird and Stoddard Bird Labs. Thank you to Jim Cox and Alex Jackson for being mentors throughout this process and all the biologists, technicians, and interns who were essential for completing my field work. Thank you to my advisor, Dr. Clark Rushing, for helping to guide me through this degree as well as Dr. James Martin and Dr. Richard Chandler. Thank you all for expanding my education and fascination with the natural world.

To all my friends I've met along this journey, thank you for helping to keep me sane during long days in the field and in the office. Last but not least, thank you to my family for the love and support needed throughout the completion of this degree. Specifically, my dad, Brandon Story, and husband, Shannon Braden, thank you both for always pushing me to do my best and follow my passion.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

Common ground doves occur throughout the southern United States, across Mexico and the West Indies, and into northern South America (Johnston 1964). This species has the largest distributional range in the Columbidae family, and most individuals reside as residents wherever found (Johnston 1964). The subspecies residing in the southeastern United States, C. p. passerina, were once prevalent across their range but have seen population declines over the last 20-40 years (Cely and Glover 2000). These declines have been recorded by the Breeding Bird Survey, especially in Florida, where the average detection rate decreased from 8 in 1969 to only 3 in 1983 (Cox 1987) The exact causes of these declines have not been identified. This is concerning because Florida and Texas hold the highest populations of ground doves in the United States (Cox 1987, Bowman and Woolfenden 1997, Cely and Glover 2000). Common ground doves are listed in Florida's State Wildlife Action Plan (FWC 2019) as a "species of greatest conservation need" (i.e., SGCN). Common ground doves are also a species of concern in North Carolina, South Carolina, and Alabama (Jones and Mirarchi 1990, Bowman and Woolfenden 1997, Cely and Glover 2000).

There are few major studies that have focused on this species, especially in the United States. M. Passmore (1981) focused on the breeding biology, growth and molt patterns, and food habits of ground doves in Texas. Swank (1952), Mitchell et al. (1996), Bowman and Woolfenden (1997) discussed nest density, nest site selection, and nesting success in the United States, while (Rivera-Milán 1996) studied nesting ecology in Puerto Rico. Molt patterns, behavior, and

reproduction, sometimes in juveniles, have been studied as well (Johnston 1962, Passmore 1984, Bosque et al. 2018, Rohwer and Rohwer 2018). Studies also reported on group sizes at watering areas and water requirements of the ground dove (Willoughby 1966, Burger 1992). Jones and Mirarchi (1990) studied habitats used by the common ground dove in southern Alabama, and Landers and Buckner (1979) studied the species use of young pine plantations in Georgia. These two articles are the only research conducted on habitat use. Few demographic data exist, and there are no long-term studies on marked individuals. The published historical remarks and sightings of the common ground dove date back to 1937 from D. Nicholson (1937), who wrote about breeding ground doves in Florida. Other remarks and historical notes include topics such as winter association of pairs (Frye 1941), precocious sexual competence (Johnston 1962), behavior (Johnston 1964), state records of the species (Mizanin 1999), and nesting observations (Cimprich 2011).

Common ground doves are frequently seen on properties throughout the Red Hills Region that conduct land management (e.g., prescribed fire) and cultural practices (e.g., supplemental feeding) recommended for northern bobwhite. In Puerto Rico, studies suggest nest densities may increase through an increase in food abundance and decrease of predators (Rivera-Milán 1996). Morris et al. (2010) recorded ground doves consuming supplemental feed provided for quail. Supplemental feeding and trapping and removal of meso-mammals are common practices on quail-managed properties. Vega and Rappole (1994) researched the effects of leaving strips of undisturbed mature thorn scrub interspersed between strips of mechanically cleared vegetation to improve habitat for white-tailed deer (*Odocoileus virginianus*) and bobwhite quail in Texas. This

management practice was found to increase the density of common ground doves relative to cleared vegetation and relative to undisturbed vegetation.

The research mentioned above is a compilation of all the studies that have been completed on the common ground dove. The combination of declining populations and gaps in natural history knowledge can lead to consequences for the species. By examining the ground dove's movement and abundance in the Red Hills Region, we aim to begin to be able to determine some of the key management strategies that benefit these populations. Specifically, how bobwhite management may play a role in increasing ground dove local abundance in the region.

CHAPTER 2

COMMON GROUND DOVE, *COLUMBINA PASSERINA*, HOME RANGE AND LANDSCAPE SCALE HABITAT SELECTION ON A QUAIL MANAGED PROPERTY[1]

[1] Braden, D. R. S. To be submitted to *The Wilson Bulletin*.

Abstract

Understanding the placement of home ranges and habitat use and selection within those ranges can provide direct insight into the habitat needs, and subsequently, the conservation actions required to conserve species of concern. The common ground dove (*Columbina passerina*) is the smallest species of dove in North America and inhabits open pine woodlands and shrub-scrub habitats. The subspecies native to the southeastern United States, *C. p. passerina*, was once prevalent across its range, but has seen population declines over the last 20-40 years. In contrast to the range-wide population declines, common ground doves are common on properties that conduct land management recommended for bobwhite quail (*Colinus virginianus,* hereafter "bobwhite" or "quail"). Anecdotal evidence suggests that management practices for bobwhite may have a positive effect on common ground doves and may be responsible for seemingly higher local dove abundance in the Red Hills Region. Ground doves were captured and tagged on Livingston Place, a quail managed property in the Red Hills Region, and tracked using radio telemetry. We calculated home ranges and completed a resource selection function in the summer and winter. Home range size in the summer was on average larger than home range size in the winter. Ground doves selected upland habitat, agricultural fields, wetlands and residential areas during both summer and winter. Recently burned areas were selected for in summer but were avoided in the winter. Selection for hardwood bottoms was also notably different between seasons, being selected for in the summer and avoided in winter. Identifying the different vegetation types needed seasonally is critical for implementing effective conservation actions,

especially for species of concern. This research, combined with future studies, may hold the answers we need to prevent further decline of the common ground dove.

Introduction

The location and extent of home ranges provide insights into the habitat requirements of species across both time and space (Lee et al. 2022). Habitat use and selection are fundamental to the study of wildlife ecology and are essential for the management and conservation of wildlife populations (Johnson 1980, Manly et al. 2002, Jia et al. 2019). *Home range* is defined as the area within which an individual animal acquires food, shelter, nesting areas, and mates, excluding areas that are only occasionally visited (Burt 1943). *Habitat use* is defined as the resources that are encountered and selected within a fixed period of time, while *habitat selection* occurs when a resource is used proportionally more than its availability on the landscape (Johnson 1980, Manly et al. 2002). In combination, understanding the placement of home ranges and habitat use and selection within those ranges can provide direct insight into the habitat needs, and subsequently, the conservation actions required to conserve species of concern.

The common ground dove (*Columbina passerina*) is the smallest species of dove in North America and inhabits open pine woodlands and shrub-scrub habitats (Johnston 1964, Jones and Mirarchi 1990). Common ground doves occur throughout the southern United States, across Mexico and the West Indies, and into northern South America (Johnston 1964). The subspecies native to the southeastern United States, *C. p. passerina*, was once prevalent across its range, but has seen population declines over the last 20-40 years (Bowman and Woolfenden 1997, Cely and Glover 2000). Steady population declines have been recorded by the Breeding Bird Survey,

especially in Florida, where the average encounter rate per route decreased 62.5% from 1969 to 1983 and have remained low since (Cox 1987, Cely and Glover 2000, Sauer et al. 2014). The exact causes of these declines have not been identified.

In contrast to the range-wide population declines, common ground doves are commonly seen on properties in the Red Hills Region, an area of south Georgia and north Florida encompassing approximately 121,405 hectares of mostly continuous upland pine savanna interspersed with hardwood drains and wetlands (Engstrom and Palmer 2005). The area is primarily managed for bobwhite quail (Colinus virginianus, hereafter "bobwhite" or "quail") and utilized for the sport hunting of the species (Moser et al. 2002, Engstrom and Palmer 2005). Properties in the region commonly conduct land management (e.g., prescribed fire) and cultural practices (e.g., supplemental feeding) to sustain quail (Morris et al. 2010, Smith et al. 1982).

In addition to supporting a thriving bobwhite population, these properties provide habitat for other declining species, including Bachman's and Henslow's sparrows (*Peucaea aestivalis* and *Ammodramus henslowii*, respectively), gopher tortoises (*Gopherus polyphemus*), striped newts (*Notophthalmus perstriatus*), and support the largest population of red-cockaded woodpeckers (*Leuconotopicus borealis*) on private lands (James 1995, Hermann et al. 2002, Cox and Jones 2009, Farmer et al. 2017). In the western portion of their range, Crosby et al. (2015) proposed bobwhite can act as an umbrella species for grassland/shrubland birds because areas occupied by bobwhite had an increased probability of occupancy of the grassland/shrubland birds and higher species richness. However, whether bobwhite act as an umbrella species in the pine savanna ecosystems of the Red Hills Region has not been well studied.

Several previous studies have suggested that ground doves may benefit from management practices used to support quail populations, including trapping/removal of meso-mammals and supplemental feeding. In Puerto Rico, studies suggest ground dove nest densities may increase through an increase in food abundance and decrease of predators (Rivera-Milán 1996). Ground doves have also been recorded consuming supplemental feed provided for bobwhite (Morris et al. 2010). However, whether implementation of these practices on properties in the Red Hills Region benefits the ground doves has not been directly demonstrated.

The objective of this study was to determine if ground doves select for feed trails and burned areas on a quail managed property, and to quantify use of different vegetation communities commonly found in the Red Hills Region. In addition, the basic ecology and natural history of ground doves remains understudied, and few demographic data exist. There are no long-term studies of marked individuals, and there have been no radio telemetry studies of this species. While some research has been conducted on ground dove habitat use, home range and habitat selection has not been studied for this species. To fill these knowledge gaps, a secondary objective of this project was to estimate seasonal variation in ground dove home range size and resource selection.

Methods

Study Area

Common ground doves were captured and tagged on Livingston Place (Figure 2.1, hereafter "Livingston"). Livingston is a 3,683-ha property located 18 kilometers east of Monticello, Florida and is primarily managed for bobwhite by Tall Timbers. Tall Timbers is a science-based non-profit

organization, which encompasses a plethora of different conservation objectives and transferring that knowledge to the surrounding region. Livingston conducts research that is centered around hunted populations of bobwhite and how management benefited other species in the ecosystem.

The focal study area on Livingston consisted of pine-dominated, old field vegetation maintained by fire on approximately a 2-year rotation. These uplands were interspersed with wetlands, hardwood bottoms, areas of planted pine, and hay/agricultural fields. Following the bobwhite breeding season (Apr. 15 – Sept. 15), tractors using roller choppers or mowers were used to make shooting/running lanes for hunters and bird dogs. These lanes created in the upland areas of the property were cut in a grid like pattern to create 9x9 meter blocks of vegetative cover. Following the bobwhite hunting season (early Nov. – early Mar.), the prescribed fire season began, and the property was burned in a mosaic pattern to intersperse burned and unburned areas (Figure 2.1). The average monthly rainfall during the wet season (Jun. – Aug.), was just over 19 centimeters while average monthly rainfall in the dry season (Sept. – May), was just over 9 centimeters. This area experiences extreme seasonal variation in humidity. During the wet season, humidity usually ranges from 90% - 98% and during the middle of the dry season (Dec. – Mar.), ranges from 2% - 10% (NOAA – Tallahassee, FL Area).

Trapping and Radio Tagging Ground Doves

Ground doves were banded and radioed on Livingston (Figure 2.1, IACUC 2023-001) and were caught as bycatch during bobwhite trapping using baited funnel traps (Stoddard 1931) during the spring (Mar.) and fall (Nov.) of 2022 (FWC Special Purpose Permit # SPGS-20-03A). All captured ground doves were banded on the right leg with an USGS-issued aluminum leg band, sexed, aged, and weighed, then a subset were fitted with radio transmitters (Federal Bird Banding Permit

#22446). Ten 1.5g necklace-styled radios (American Wildlife Enterprises - Monticello, FL, USA) were distributed in March and 16 backpack attached radios were distributed in November throughout the Lake Course (Figure 2.1) with a relatively even sex ratio (11 females & 15 males). The expected battery life of the radios was approximately 100 days.

Necklace-styled radios were fitted around the neck and closed with a small metal clamp. Backpack-styled radios were positioned in the middle of the back and looped around each wing using Stretch Magic Clear Cord (Pepperell SMF-1-5 0.7 mm) which was secured with super glue. Ground doves were tracked approximately 3 times per day (Mon. – Fri.), between 8am and 5pm with at least 1 hour between each individual location. The radios activated in March 2022 were tracked until early July 2022 and radios activated in November 2022 were tracked until early March of 2023 using a VHF Receiver (Lotek Wireless Inc Biotracker) and 3-element Yagi. Each position was used to triangulate each ground dove's location at each observation. No individuals were used in both study periods.

Data Analyses

Landcover data was obtained from Florida Wildlife Commission (FWC, Florida Cooperative Land Cover layer 2022). This raster layer had a grid size of 10 meters and was clipped to the Livingston property boundary using ArcGIS Pro. A polygon layer of the 2022 burned blocks was provided by Livingston and transformed into a raster layer with the same resolution as the FWC landcover raster using ArcGIS Pro. Euclidian distance to feed trails was created using the feed trail line vector provided by Livingston and transformed into a rater layer with the same resolution in ArcGIS Pro. The FWC landcover data was reclassified into 5 vegetation classes (upland, residential, agricultural

fields, hardwood bottoms, and wetlands) and Euclidian distance to each class was calculated in R.

Home range polygons for each individual were calculated using a 95% kernel density estimator in R (Fieberg and Kochanny 2005) using the adehabitatHR package (Calenge 2006). Only individuals with >30 locations were used for home range analyses (Seaman et al. 1999). We used a logistic regression with a logit link and random effect of individual to estimate the resource selection function (RSF). The RSF tested for ground dove selection between vegetation classes, burned areas, and feed trails. The RSF was calculated using used and available points; used points being locations obtained from the radioed ground doves and available points being systematic random points generated in R. The number of available points varied by individual depending on home range size because the systematic points were generated every 10 meters within home range polygons. This resulted in larger home ranges having more space available within the polygon for the systematic points to be generated. Systematic random points were generated with a cell size of 10 meters to match the cell size of the raster layers. All covariates were standardized by subtracting the mean then dividing by the standard deviation prior to analysis. Identical models were run for summer and winter.

Results

Radio Telemetry and Home Range

We radio tracked 16 doves in March of 2022 with necklace radios. Six radios were redistributed to new individuals after radios were slipped off by the original individuals. We obtained enough points to estimate home ranges for 8 individuals (3 females & 5 males, Figure 2.2), which had an

average of 60 locations for the each (min: 36, max: 92). The average home range size in the summer was 46.91 ha (SE = ± 14.56). Sixteen backpack radios were deployed starting in November of 2022 and we were able to estimate home ranges for 11 individuals (4 females & 7 males, Figure 2.3). We recorded an average of 127 locations per individual (min: 58, max: 155) and the average winter home range size was 34.20 ha (SE = ± 9.63).

Habitat Selection

Common ground doves selected locations closer to agricultural fields, residential areas, wetlands, and feed trails in both the summer and winter (Table 2.1 & 2.2, Figure 2.4, 2.6, & 2.8 - 2.10). Doves selected for upland in both seasons, but the confidence intervals overlap zero for summer (Table 2.1, Figure 2.4 & 2.7). Recently burned areas (<1 year rough) were selected for in summer but were avoided in the winter (Figure 2.4). Selection for hardwood bottoms was also notably different between seasons, being selected for in the summer and avoided in winter (Figure 2.4). Specifically, relative probability of use decreased by 11% for every 100-meter distance from hardwood bottoms in the summer and increased by 28% for every 100-meter distance in the winter (Figure 2.5).

Discussion

To our knowledge, this study is the first to calculate home range size and quantify habitat selection in common ground doves. Home range size in the summer was on average larger than home range size in the winter. Several habitat features appear to be important to common ground doves throughout the year. At Livingstone Place, ground doves selected upland habitat, agricultural fields, wetlands and residential areas during both summer and winter. The positive associations

with wetlands and residential areas have not previously been documented for this species. Ground doves have been observed utilizing supplemental feed provided for bobwhite (Morris et al. 2010), and our study suggests that they selected areas closer to feed trails during both seasons. These trails are common on bobwhite managed properties and our results indicate they may provide food for common grounds doves throughout the year.

Differences in seasonal home range size could be attributed to the differences in habitat selection observed between seasons. Burned areas were selected for in the summer but avoided in the winter. Blocks were burned in April and as a result were open at ground level before green up occurred later in the summer. In the winter, these same areas were denser at ground level. We hypothesize that, during winter, doves select for unburned areas due to the presence of more woody shrubs that would shade out anything growing beneath them therefore providing greater openness at ground level. We hypothesize hardwood bottoms could have been selected for in the summer as thermal refuges (Carroll et al. 2015). Once the temperature cooled down, these bottoms were no longer needed and therefore avoided in the winter. It is also possible that, during the breeding season, resource needs are higher, or the landscape features needed to raise young are more diverse than during winter, which could also result in larger home ranges. Further research on the links between vegetation features, survival, and reproductive success will be required to understand why home ranges differ among seasons in this species.

Our telemetry results are consistent with previous studies of habitat associations of common ground doves based on abundance data, supporting that ground doves select upland vegetation (Johnston 1964, Jones and Mirarchi 1990). In Georgia, Landers and Buckner (1979) recorded ground doves use of seedling pine stands, noting that doves favored areas with patchy

herbaceous cover interspersed with thickets which contained little ground level vegetation. Ground doves in Alabama occurred most often in early successional stages such as old fields and young pine forests (Jones and Mirarchi 1990). That study also noted that sites with ground doves had less dense canopies and smaller trees with lower diameter at breast height (DBH) measurements. Ground doves in Texas occupied habitats with an increased number of shrubs and decreased herbaceous ground cover (Roth 1971). Collectively, our results add to evidence that ground doves may prefer greater openness at ground level, which is provided by different stages of burned vegetation throughout the upland areas of this region.

More research is needed to specifically whether and how landscapes managed for bobwhite are beneficial to ground doves. Future telemetry studies would be useful, especially with a larger sample size, that link habitat use to microclimate conditions. Vegetation surveys or temperature readings conducted in areas frequently used by ground doves would also be helpful for determining specific characteristics that could further explain the seasonal differences in vegetation types. Linking habitat use within quail managed landscapes to variation in abundance, survival, and reproductive success will also be necessary for determining the specific features that benefit ground dove populations. Understanding how species use different areas within their home range is crucial for determining how to properly manage that species. Identifying the different vegetation types needed seasonally is critical for implementing effective conservation

actions, especially for species of concern. This research, combined with future studies, may hold the answers we need to prevent further decline of the common ground dove.

Tables

Table 2.1. Parameter estimates for summer habitat selection of common ground doves based on distance to uplands, feed trails, residential, agricultural fields, hardwood bottoms, wetlands respectively, and recently burned areas.

Summer:	**β**	**SE**	**2.50%**	**97.50%**
(Intercept)	-2.50058	0.17019	-2.87103	-2.13288
Distance to Upland	-0.07500	0.07701	-0.23139	0.07170
Distance to Feed Trail	-0.15182	0.06142	-0.27561	-0.03418
Distance to Residential	-0.26518	0.09515	-0.45454	-0.08051
Distance to Agriculture	-0.31778	0.06894	-0.45522	-0.18419
Distance to Hardwood	-0.34100	0.09600	-0.53259	-0.15488
Distance to Wetland	-0.43726	0.09225	-0.62164	-0.25860
Burned	0.10602	0.10416	-0.09871	0.31072

Table 2.2. Parameter estimates for winter habitat selection of common ground doves based on distance to uplands, feed trails, residential, agricultural fields, hardwood bottoms, and wetlands respectively, and recently burned areas.

Winter:	**β**	**SE**	**2.50%**	**97.50%**
(Intercept)	-0.75817	0.18473	-1.14950	-0.36218
Distance to Upland	-0.50804	0.07569	-0.65967	-0.36265
Distance to Feed Trail	-0.32286	0.07627	-0.47333	-0.17417
Distance to Residential	-0.44859	0.09030	-0.62733	-0.27145
Distance to Agriculture	-0.49518	0.06813	-0.62980	-0.36258
Distance to Hardwood	0.71965	0.09733	0.53236	0.91462
Distance to Wetland	-0.29881	0.08773	-0.47106	-0.12667
Burned	-0.58460	0.08605	-0.75407	-0.41665

Figures

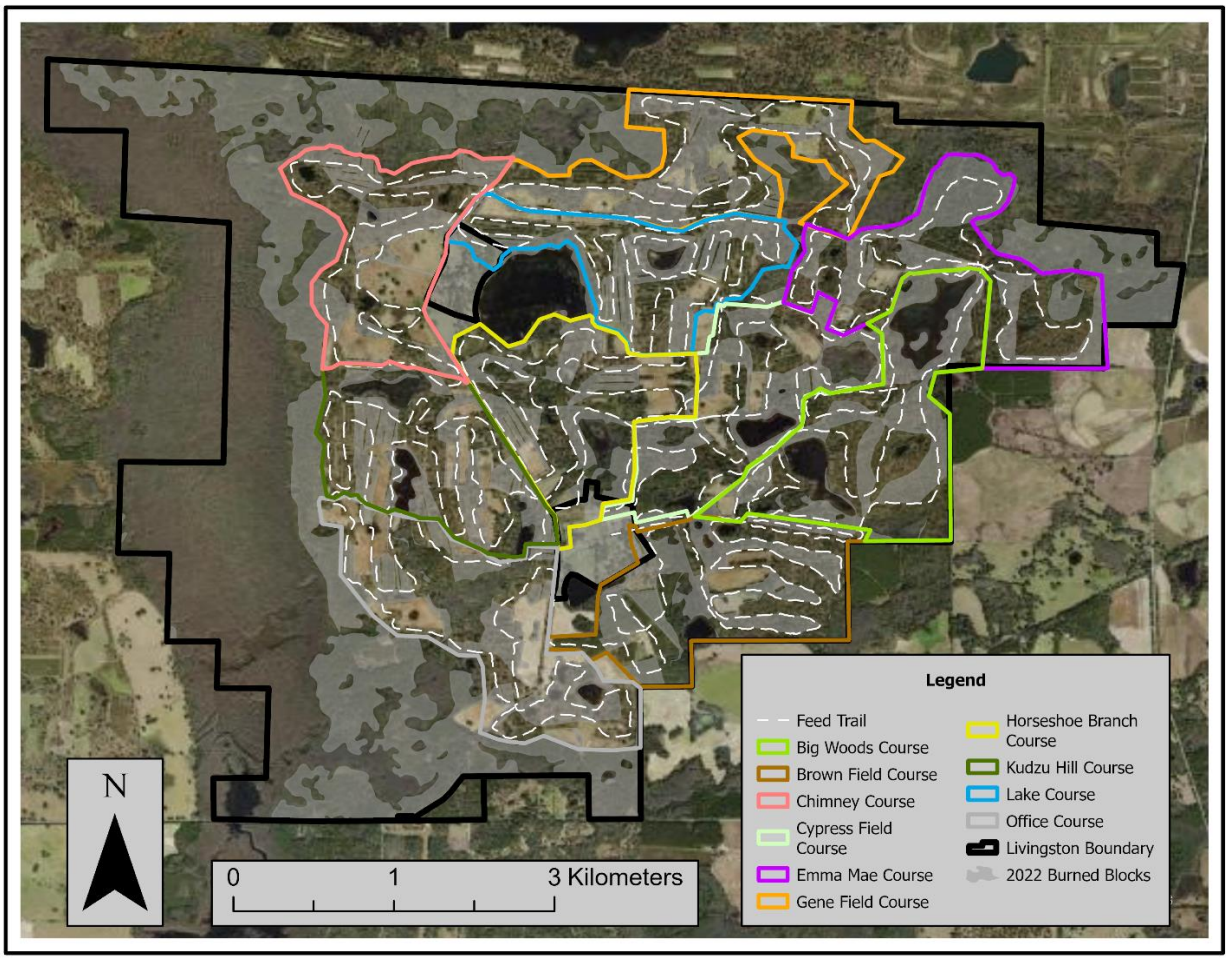

Figure 2.1. Map of Livingston Place located in Monticello, Florida, USA. Feed Trails and controlled burn blocks shown for 2022 (burned areas highlighted) with hunting courses outlined in different colors.

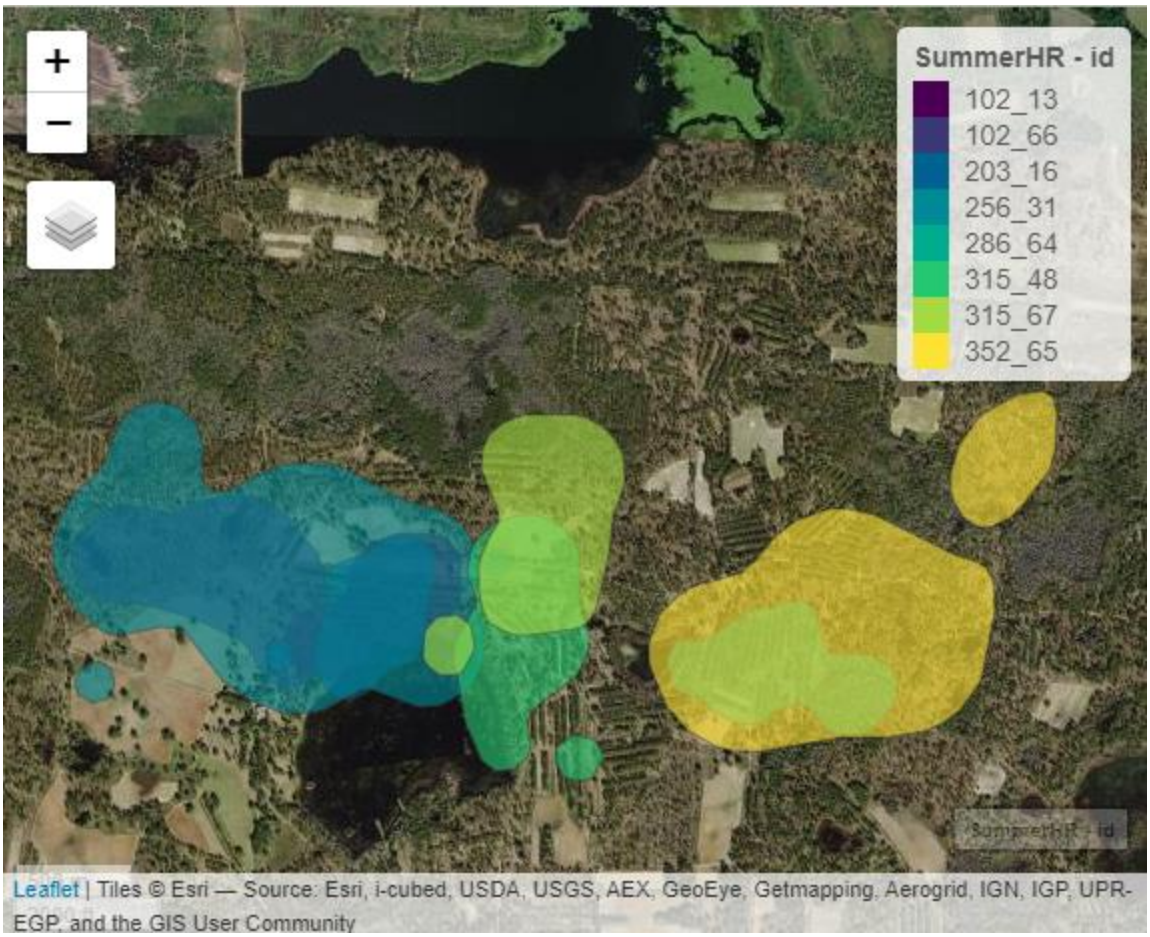

Figure 2.2. Summer 95% KDE home ranges for common ground doves tracked in 2022 on a quail managed property in Monticello, FL, USA. Individuals and their respective home ranges are represented by different colors.

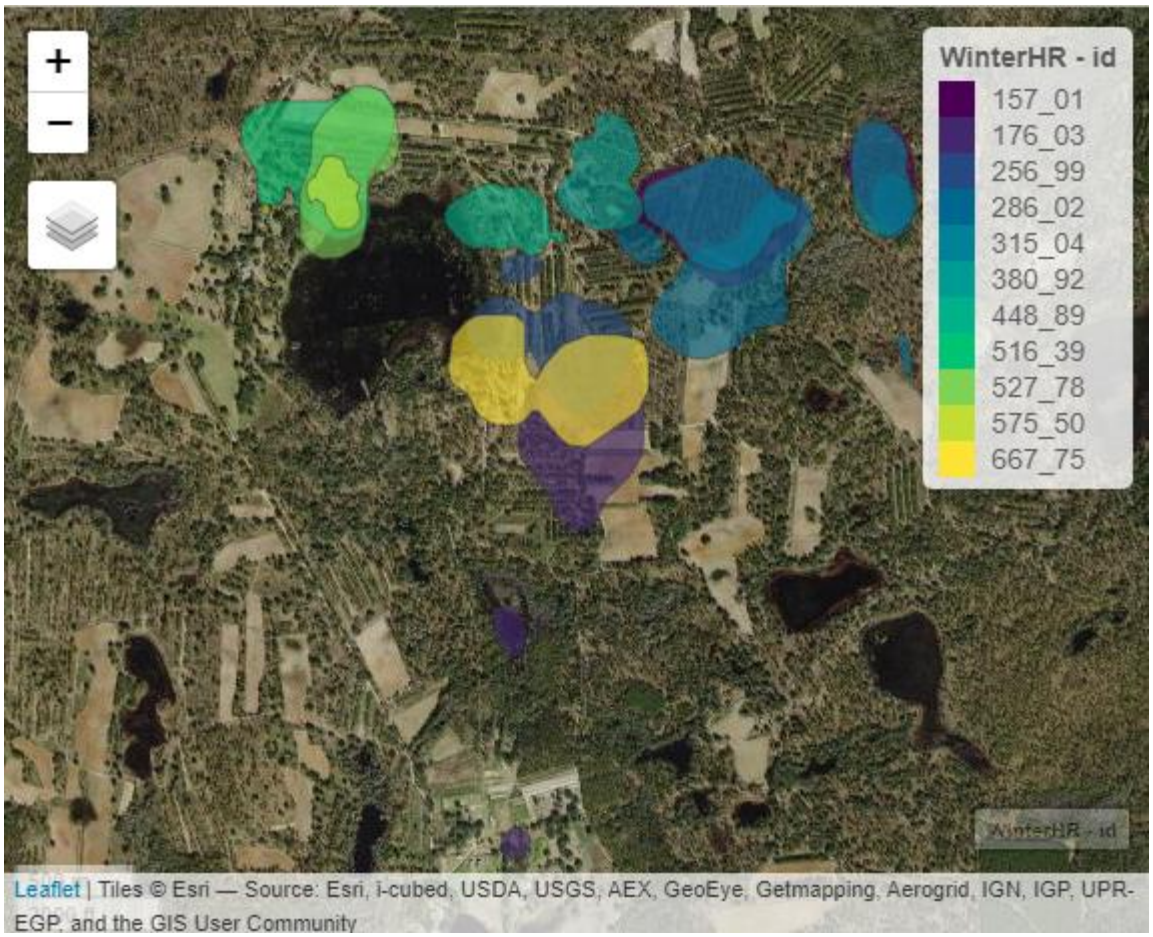

Figure 2.3. Winter 95% KDE home ranges for common ground doves tracked in 2022 on a quail managed property in Monticello, FL, USA. Individuals and their respective home ranges are represented by different colors.

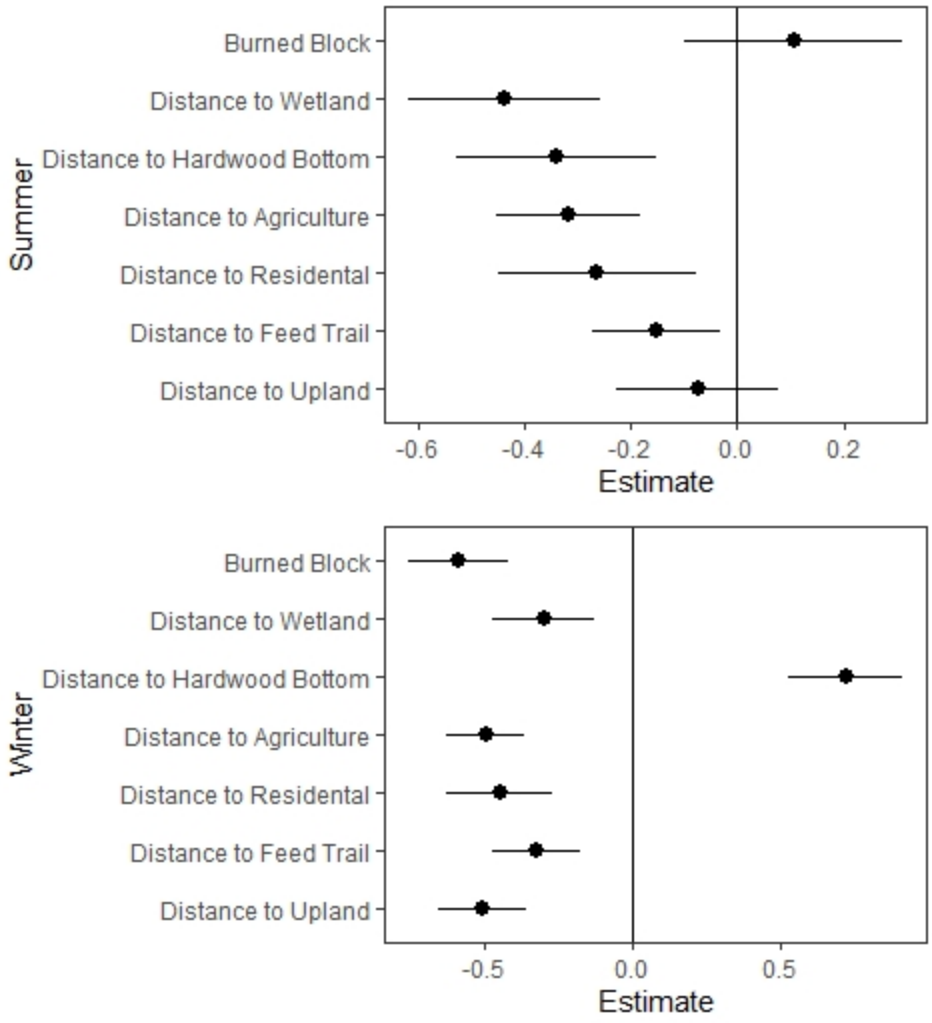

Figure 2.4. Coefficient estimates and 95% confidence intervals from the top model used to estimate common ground dove habitat selection on a quail managed property in Monticello, FL, USA in the summer and winter of 2022 respectively.

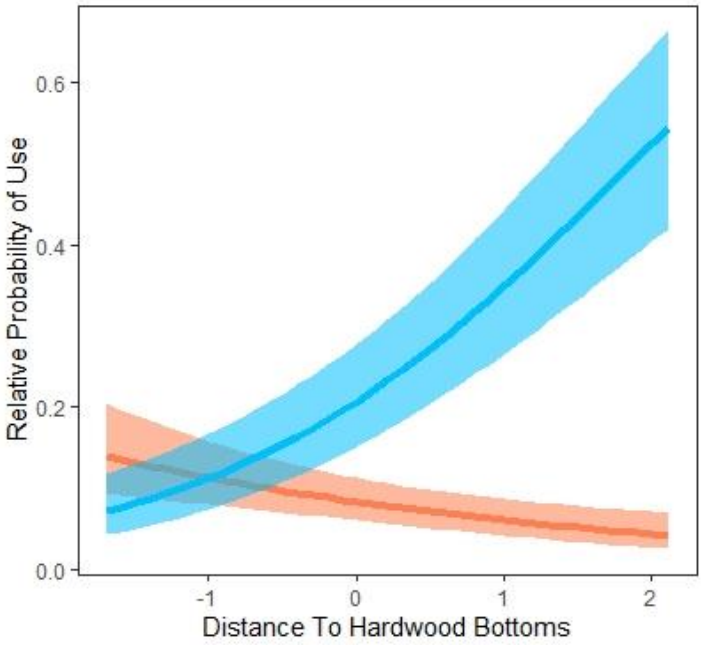

Figure 2.5. Relative probability of common ground dove use as a function of distance to hardwood bottoms on a quail managed property in Monticello, FL, USA. Summer use shown in red and winter use shown in blue. Distance reported in standard deviations with 1 standard deviation equal to 291 meters.

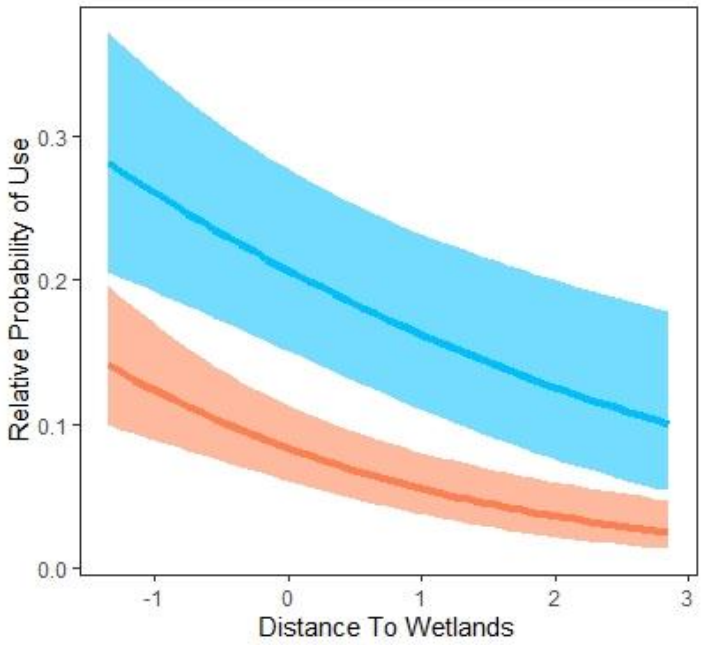

Figure 2.6. Relative probability of common ground dove use as a function of distance wetlands on a quail managed property in Monticello, FL, USA. Summer use shown in red and winter use shown in blue. Distance reported in standard deviations with 1 standard deviation equal to 206 meters.

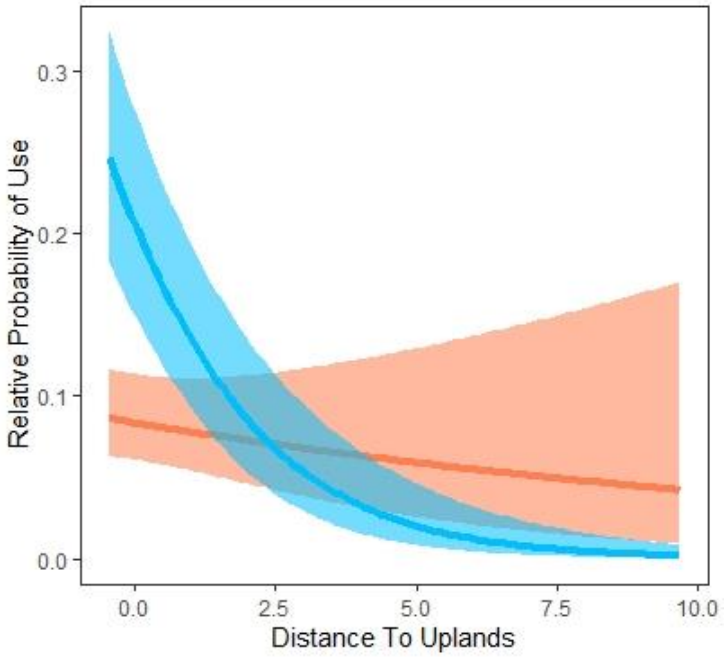

Figure 2.7. Relative probability of common ground dove use as a function of distance to uplands on a quail managed property in Monticello, FL, USA. Summer use shown in red and winter use shown in blue. Distance reported in standard deviations with 1 standard deviation equal to 25 meters.

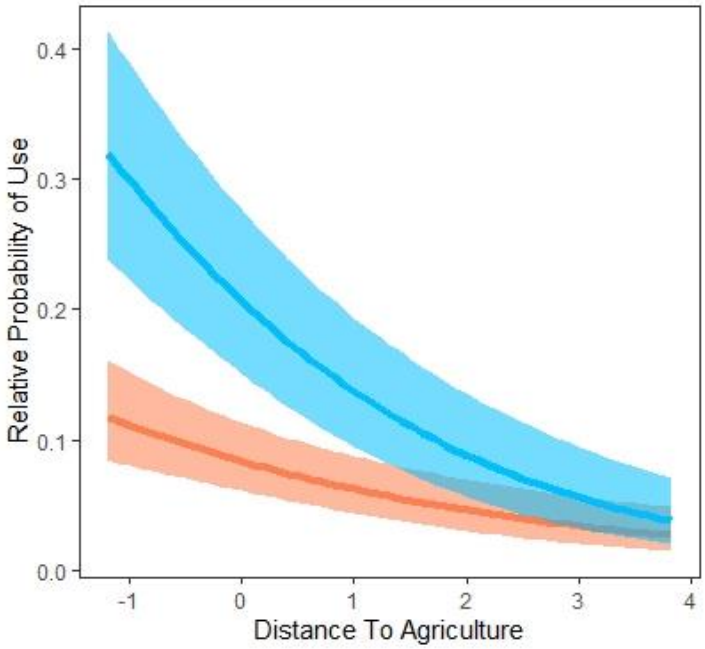

Figure 2.8. Relative probability of common ground dove use as a function of distance to agriculture on a quail managed property in Monticello, FL, USA. Summer use shown in red and winter use shown in blue. Distance reported in standard deviations with 1 standard deviation equal to 141 meters.

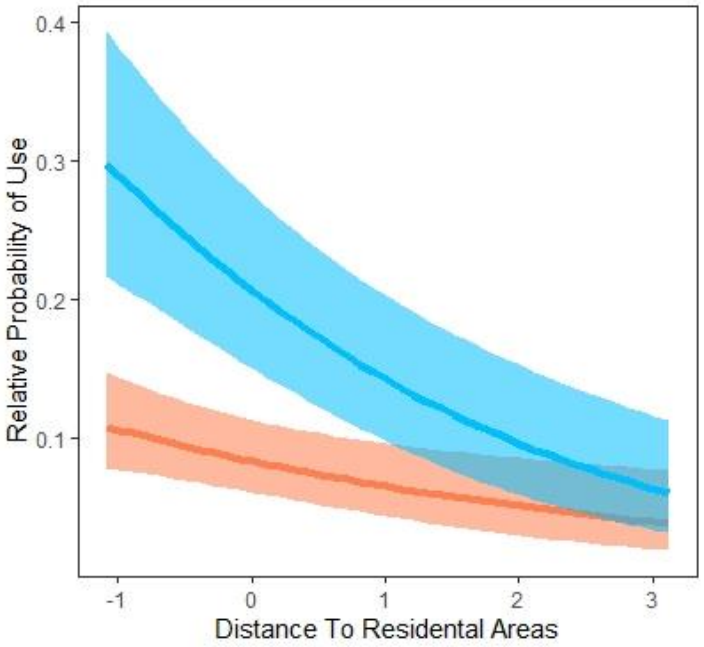

Figure 2.9. Relative probability of common ground dove use as a function of distance residential areas on a quail managed property in Monticello, FL, USA. Summer use shown in red and winter use shown in blue. Distance reported in standard deviations with 1 standard deviation equal to 198 meters.

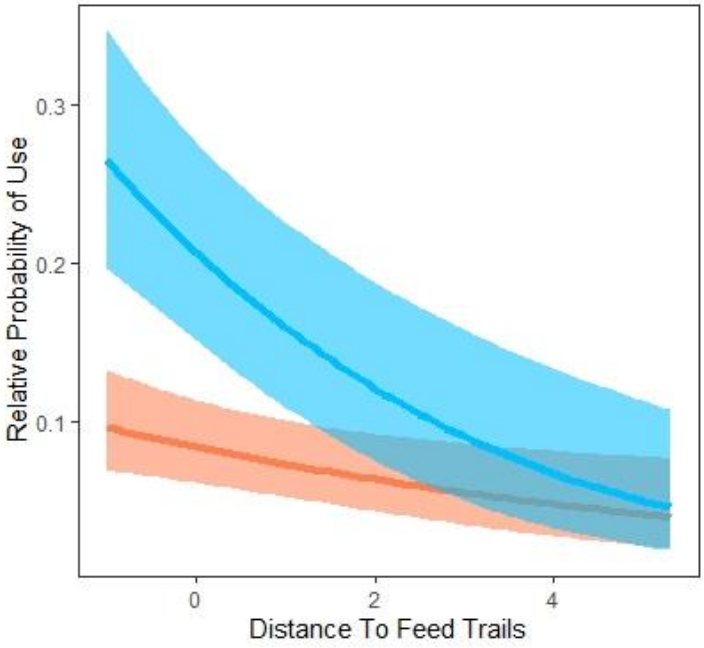

Figure 2.10. Relative probability of common ground dove use as a function of distance to hardwood bottoms on a quail managed property in Monticello, FL, USA. Summer use shown in red and winter use shown in blue. Distance reported in standard deviations with 1 standard deviation equal to 57 meters.

CHAPTER 3

HABITAT ASSOCIATIONS OF COMMON GROUND DOVES, *COLUMBINA PASSERINA*, IN THE RED HILLS REGION[2]

[2] Braden, D. R. S. To be submitted to *The Wilson Bulletin*.

Abstract

Across North America, early successional habitat has been subject to substantial degradation due to changes in land use and fire suppression and many grassland and shrubland bird populations that rely on these habitats have shown corresponding declines. One approach to thwart the decline of pine savannah habitats in the southeast has been to focus land management on creating habitat for bobwhite quail (*Colinus virgianus*, hereafter bobwhite), which has been proposed as an umbrella species in the western portion of its range. One species that could benefit from habitat management for bobwhite in the southeast is the common ground dove, *Columbina passerina*. Common ground doves (hereafter "ground doves") are native to the southeastern United States and inhabit open pine and scrub/shrub habitats. While the cause has not been identified, ground dove populations have been in a steady decline for the last 20-40 years. Ground doves are frequently seen throughout properties in the Red Hills Region, suggesting that management practices for bobwhite may positively affect the local population of ground doves. Call point surveys were conducted on 18 properties across the Red Hills Region in the summer of 2022. Density estimates within different habitat types were estimated using the gdistsamp function from the unmarked R package. Wetland was the only landcover type to have a significant effect on ground dove density, with ground dove density increasing in areas with a higher percentage of wetlands. Density was positively related to the remaining landcover types, though none were significant. Common ground doves are present and seen frequently on the bobwhite managed properties in the Red Hills Region year-round. Further research is needed to

quantify the preferred vegetation structures of ground doves and determine how specific bobwhite management practices benefit the species.

Introduction

In the southeastern United States, grassland ecosystems have been subject to substantial degradation due to changes in land use and fire suppression (Beckage et al. 2006, Outcalt 2000). Many grasslands and shrubland bird populations that rely on these ecosystems have shown corresponding declines. Across the southeast, 90-95% of the 30 million ha of pine savanna that once dominated the landscape has been lost (Outcalt 2000, Beckage et al. 2006). One approach to thwart the decline of pine savannas in the southeast has been to focus land management on creating habitat for Northern bobwhite quail (Colinus virginianus, hereafter "bobwhite" or "quail"). The Northern bobwhite is a species of game bird native to the southeastern U.S. that relies on grassland ecosystems (Stoddard 1931). While bobwhite have also seen population declines like many of the other grassland species, there is a great deal of social and financial support for large scale habitat restoration across its range (Dimmick et al. 2002, Williams et al. 2004, Sauer et al. 2014), largely to restore the vast areas of viable habitat needed to support sustainable hunting of bobwhite.

One such area is the Red Hills Region, which contains about 121,400 ha of primarily private land located in south Georgia and north Florida (Engstrom and Palmer 2005). This region is comprised of mostly continuous pine savanna that is primarily managed for bobwhite and utilized for sport hunting of bobwhite (Moser et al. 2002, Engstrom and Palmer 2005). This pine savanna is also intersected with agricultural fields, wetlands, and hardwood bottoms. Combined, this

landscape provides habitat to multiple threatened, endangered, or declining species, including Bachman's sparrow (Peucaea aestivalis), gopher tortoises (Gopherus polyphemus), and red-cockaded woodpeckers (Leuconotopicus borealis) (James 1995, Hermann et al. 2002, Cox and Jones 2009).

One other species that might benefit from habitat restoration for bobwhite is the common ground dove, Columbina passerina. Common ground doves (hereafter "ground doves") are native to the southeastern United States and inhabit open pine and scrub/shrub habitats (Johnston 1964, Jones and Mirarchi 1990). While the cause has not been identified, ground dove populations have been in a steady decline for the last 20-40 years (Bowman and Woolfenden 1997, Cely and Glover 2000). The subspecies occurring in the Red Hills Region, C. p. passerina, has seen declines especially in Florida according to Breeding Bird Survey data, where average encounter rates per route were down 62.5% from 1969 to 1983 and have remained low since (Cox 1987, Sauer et al. 2014). In contrast to regional population trends, ground doves are frequently seen throughout properties in the Red Hills Region, suggesting that the landscape provided by bobwhite management may positively affect the local population of ground doves. The objectives of this study were to determine if common ground doves were abundant on quail

managed properties in the Red Hills Region, calculate density of ground doves across multiple quail managed landscape types, and to understand the effects of landcover on abundance.

Methods

Study Area

Eighteen properties were surveyed across the Red Hills Region, located in northwest Florida and southwest Georgia, U.S.A. (Figure 3.1). The Red Hills Region is located between the Ochlockonee and Aucilla Rivers and stretches from Thomasville, GA to Tallahassee, FL. Some properties in the immediate surrounding area were also included because of similarities in management practices (Figure 3.1). Most properties in this region are privately owned and managed for sport hunting of bobwhite. The properties included in this study consist mostly of pine savanna with frequent controlled burn application, usually on a 2-year rotation, with scattered drains and wetland areas (Engstrom and Palmer 2005).

The hot season in the region falls between May and September, with an average high daily temperature above 29°C. The wet season falls between June and August, with an average monthly rainfall just over 19 centimeters. Humidity during this season ranges between 65% and 98% (NOAA – Tallahassee, FL Area).

Point Counts

Point count locations were generated randomly within each property and moved to the nearest road for ease of access and time management. Most roads on these properties are grass or dirt roads which are used to access the different areas of the properties. The minimum distance between points was 500 meters, resulting in 165 total points. Point counts took place between

May 15th and June 30th of 2022. The selected points covered approximately 6-14% of each property's total area. Counts began a half hour before sunrise and were completed by 3 hours after sunrise. Approximately 8 points were completed per day, weather permitting. Counts were not completed during precipitation events. During each count, observers recorded the date, start and stop times, temperature, wind (Beaufort scale), and noise level (on a similar scale). Once at a point location, observers waited one minute to allow birds to settle before the 10-minute listening period. All species seen and heard were recorded and their relative distance from the point centroid with a maximum distance at 250 meters. Only the common ground dove detections were included in the data analysis.

Data Analyses

Density was estimated using a hierarchical distance sampling model that estimates the probability of the target species being available for detection and uses a negative binomial distribution to model abundance, implemented using the gdistsamp function from the unmarked R package (Kellner et al. 2023). Common ground dove detections at each point were grouped into 25-meter distance bins prior to analysis (Figure 3.3). Detection probability was modeled as a function of temperature, noise, wind, and day of year, while density was modeled as a function of percent landcover for different vegetation types. Landcover data for each point location were obtained using a 30x30 meter raster landcover file created by the Tall Timbers Geospatial Laboratory. The raster layer was clipped to the point buffers and landcover data were extracted in meters squared within each buffer.

Six landcover types were included in the analysis: wetland, forested wetland, planted pine, upland hardwood, upland pine, and agriculture. Prior to including these covariates in the model, we tested for pairwise correlations, and none of the six variables were strongly correlated (> 0.7). To avoid the sum to one constraint we eliminated landcover types either occurred at a low percentage on the landscape or through screening methods, were not found to have any influence on abundance. These included pine flatwoods which comprised 0.08% of the buffer areas, urban 3.46%, and open water 0.67%.

We used a stepwise approach to determine the best-fitting model for the common ground dove detections. First, we fit models with alternative key functions (hazard rate and exponential) without any covariates included for detection probability, availability, or density. The key function models were ranked by AIC and the key function from the top ranked model was used in all subsequent models. To determine which observation covariates influenced detection probability, we fit a model that included temperature, noise, wind, and day of year. Covariates with $P < 0.05$ were included in the subsequent model. Finally, to determine how landcover influences density of common ground doves, we fit a model that included each landcover type. Covariates with $P < 0.05$ were considered to be significant predictors of common ground dove density.

Results

In total, 86 common ground doves were detected during the 165 point counts. Wetland comprised 0.16% of the buffer areas, forested wetland 7.55%, planted pine 12.27%, upland hardwood 27.07%, upland pine 35.75%, and agriculture comprised 12.87%. Day of year (DOY) was the only covariate that had a significant effect on detection probability (Table 3.1 & Figure

3.3). Wetland was the only landcover type to have a significant effect on ground dove density (Table 3.2), with ground dove density increasing in areas with a higher percentage of wetlands (Figure 3.2). We found no relationship between density and the remaining landcover types (Table 3.2).

Discussion

We tested whether various types of landcover influence the density of common ground doves and found that ground doves responded most strongly to the availability of wetlands. Ground dove density was positively correlated with percentage wetland cover, though we failed to detect relationships with other land cover types. These results are consistent with resource selection results based on telemetry data (chapter 2) which indicated that no specific landcover types were avoided in the summer, which is when our call counts were conducted.

Point count data indicated ground doves occurred at higher densities near wetlands, a result that is also consistent with telemetry-based estimates of resource selection. Collectively, these results indicate that wetlands are an important landcover type for ground doves throughout the year. Ground doves are known to regularly visit water holes to drink as water intake is especially important for this species because of the heat and dryness in the areas they inhabit (Jehl and Parkes 1982, Passmore 1981, Willoughby 1966). Ground doves deprived of water lost up to 8% of their body mass and water consumption tripled as temperatures increased from 30 to 40°C (Willoughby 1966). Other studies have proposed common ground doves' production of crop milk may exhaust water reserves in adults. Passmore (1981) captured ground doves via mist netting near watering sites and reported snails were consumed in small quantities during spring

and summer, but not in the winter. They hypothesized this food source may replenish calcium lost caused by egg and crop-milk production during the peak of nesting season.

There is also evidence of social congregations of common ground doves at watering holes as well. Ground doves drink with a bowed head and can swallow water without raising their heads, which could increase their vulnerability to predators (Burger 1992, Willoughby 1966). While observing courtship behavior in ground doves, Passmore (1981) recorded ground doves being usually seen singly or in pairs throughout the year. This changed at watering sites, where up to 60 ground doves flocked to drink and loaf in nearby trees. It has been proposed these large gatherings of ground doves at watering holes may increase alertness to predators. In Costa Rica, length of initial drinking bouts increased with group size and ground doves were never recorded drinking in groups with < 4 individuals (Burger 1992). Flocks as large as 40 individuals were also recorded commonly at water holes in southern California (Jehl and Parkes 1982). We hypothesize ground doves in the Red Hills utilize wetlands for similar purposes and possibly because of the abundance of seed produced by moist soil vegetation in the region.

Historically and presently, pine savanna ecosystems in the southeast have been interspersed with wetlands and our research supports the idea that these areas are one of the most important features within the pine savanna ecosystem, specifically for common ground doves. In the Red Hills Region, wetlands are abundant throughout its quail managed lands, but further research is needed to quantify the preferred vegetation structures of ground doves and determine how specific bobwhite management practices benefit the species. We know ground doves are present on these properties and reside in the region year-round, but little is known about their basic ecology such as annual/seasonal survival or reproductive success in different

landcover types. The use of telemetry to record ground dove movements coupled with vegetation surveys could provide a better understanding of specific needs for the species. This would be especially beneficial if analysis was compared between properties managed specifically for bobwhite and properties with varying management goals which would help to determine if these bobwhite managed properties provide a high-quality habitat stronghold for the declining common ground dove.

Tables

Table 3.1. Estimated effects of site covariates on detection probability on common ground doves during call point surveys completed in the summer of 2022 in the Red Hills Region of south Georgia and north Florida, U.S.A.

	β	**SE**	**z**	**P(>|z|)**
(Intercept)	-10.416	6.5891	-1.581	0.113921
Noise	-0.837	0.5432	-1.541	0.123326
Temperature	-0.013	0.0723	-0.179	0.858184
Wind	0.020	0.2055	0.099	0.921559
Day of year (DOY)	0.116	0.0316	3.681	0.000232

Table 3.2. Estimated effects of landcover covariates on common ground dove density during call point surveys completed in the summer of 2022 in the Red Hills Region of south Georgia and north Florida, U.S.A.

	β	**SE**	**z**	**P(>|z|)**
(Intercept)	-5.36256	2.1088	-2.543	0.0110
Wetland	0.34396	0.1529	2.250	0.0245
Planted Pine	0.02806	0.0226	1.242	0.2142
Forested Wetland	0.00921	0.0236	0.391	0.6960
Upland Hardwood	0.02518	0.0228	1.106	0.2686
Upland Pine	0.01939	0.0222	0.875	0.3814
Agriculture	0.02643	0.0226	1.169	0.2424

Figures

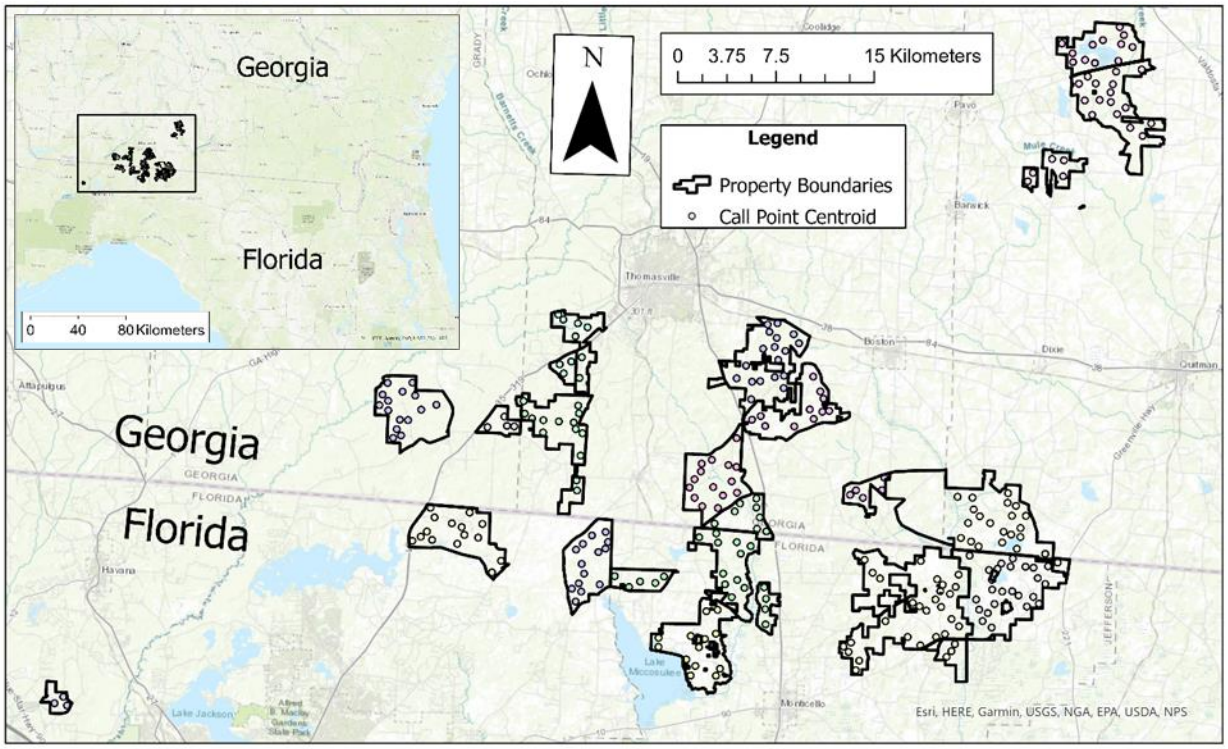

Figure 3.1. Properties in the Red Hills Region of north Florida and south Georgia, U.S.A. on which point counts were conducted for common ground doves in the summer of 2022. Property boundaries outlined in black and survey locations shown within each property boundary.

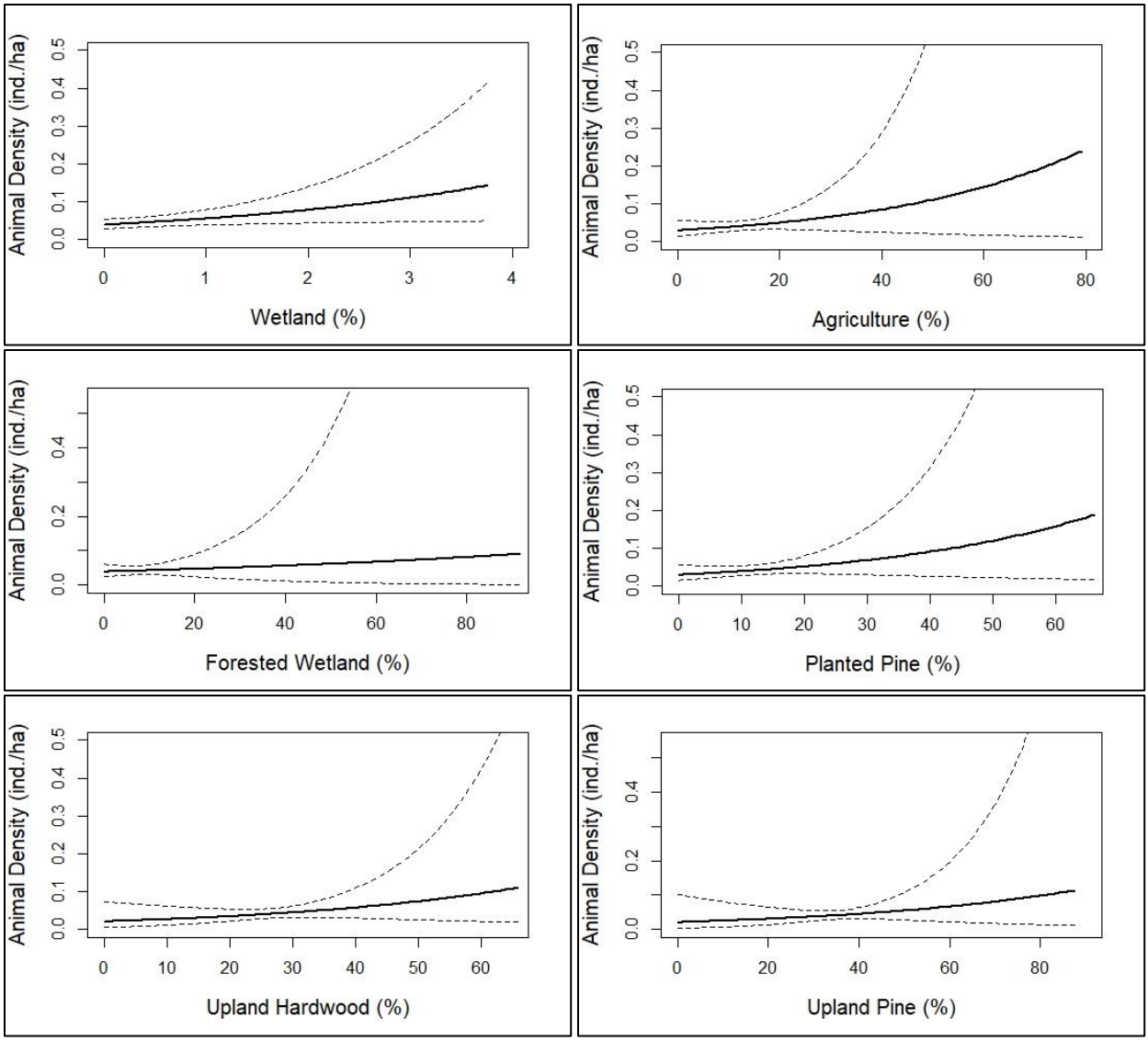

Figure 3.2. Predicted common ground dove density in hectares with 95% confidence intervals for each vegetation type present within 250 meters of all call point surveys conducted in the summer of 2022 in the Red Hills Region, U.S.A.

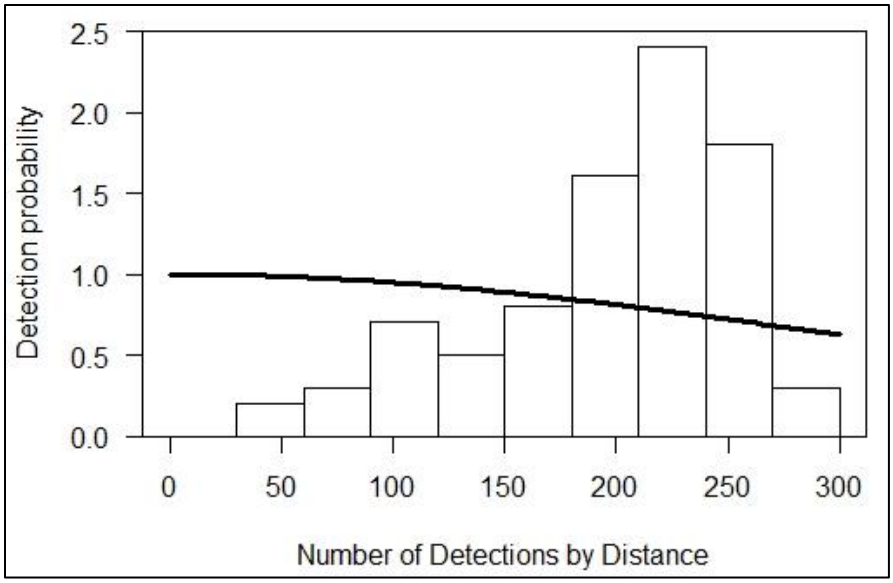

Figure 3.3. Detection probability and number of common ground dove detections at increasing distances from call point centroids. Call points completed throughout the summer of 2022 in the Red Hill Region located in south Georgia and north Florida, U.S.A.

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APPENDIX A

COLOR BANDING AND RESIGHTING OF COMMON GROUND DOVES

Color banding began in the Fall of 2021 on the northwest quadrant of Tall Timbers. Common ground doves captured were sexed, aged, and weighed before being fit with a USGS issued aluminum band on the right leg. In addition to the aluminum band, ground doves were given a unique combination of color bands. One color band was placed above the aluminum band on the right leg and 2 color bands were placed on the left leg. To date, 24 individuals have been color banded. Between May 20th and July 29th of 2022, 548 encounters of common ground doves were recorded during resighting surveys. Seven color banded doves have been resighted with 2 being seen multiple times. Fifteen encounters recorded doves with a single aluminum band and 524 encounters recorded doves that had no bands. Encounters of doves with a single aluminum band or no bands cannot be identified down to an individual basis. Due to the low resighting numbers, it was not feasible to incorporate color band resighting analysis in this thesis.

APPENDIX B

RADIO TELEMETRY ATTACHMENT PREFERENCES FOR COMMON GROUND DOVES

We used 2 different transmitter attachment styles between the summer and winter. We determined the necklace-style transmitters used for summer tracking were less favorable compared to the backpack-style used for winter tracking. Radioed ground doves were monitored closely in both seasons during the first couple of days after release. Doves with necklace-styled radios initially released well and usually flushed into shrubs or low hanging branches of trees. After release, these doves would pick and preen the necklace for 2 or 3 days before settling. Doves with backpack-styled radios also released well and in the same manor, but without any noticeable irritation from the radios. In the summer, 4 necklaces had to be censored from either loss of signal or end of radio life, 4 were identified as mortality events, and the remaining 8 were slipped off by the doves. In the winter, 4 of the 16 were determined to be mortality events and the remaining 12 were censored from either loss of signal or end of radio life.

The backpack transmitters were retained on the doves for a longer amount of time than the necklace radios. Only 3 out of the 16 individuals in the summer retained their radios until end of battery life while 11 out of 16 individuals in the winter retained their radios until loss of battery life. We believe the necklace radios were able to be pulled off by the ground doves and 8 out of the 16 individuals radioed in the summer managed to slip their radios. We were able to distinguish between mortalities and slipped radios by assessing the site where the radios were found. Mortalities consisted of either a pile of ground dove's feathers, likely from an avian

predator, or partial remains from ground doves, which was determined to be a mammal caused mortality. Radios that were determined to be slipped were found lying on the open ground with no evidence of depredation. None of the backpack radios used for winter tracking were slipped and the 4 radios recovered during the tracking period were all determined to be mortality events.

We initially decided to use the necklace attachment because of the success with previous ground-dwelling species research and to mimic the radios used for bobwhite on Livingston Place. We avoided glue on transmitters since they are usually only retained for approximately 20 days, and we wanted to be able to follow one individual for the entire length of radio life. Surgically attached radios were also avoided due to increased handling time and invasive nature associated with this attachment type. Once we determined the ground doves were slipping the necklace-styled radios, we attempted to fit a leg loop harnessed radio, but this style would not stay on the doves securely. The backpack attachment was the best fit and is our recommended style of radio attachment for future common ground dove studies.