# SEASONAL FOOD HABITS OF THE COYOTE (*CANIS LATRANS)* ON DIFFERING LANDSCAPES IN THE PIEDMONT REGION OF GEORGIA

by

JAMES DAVID KELLY

(Under the Direction of Karl V. Miller)

## ABSTRACT

I evaluated the seasonal food habits of coyotes via scat analysis from March 2010 through February 2011 on Cedar Creek (CC) and B.F. Grant (BFG) Wildlife Management Areas. These sites in the Piedmont Region of central Georgia differ in habitat composition and, therefore, the availability of food items. BFG had a greater proportion of early successional habitat (28%) than CC (7%), likely resulting in increased availability of small mammal prey items. I analyzed 353 scats, and commonly occurring food items included persimmon (*Diospyros virginiana*), muscadines (*Vitis rotundifolia*), white-tailed deer (*Odocoileus virginianus*), cotton rats (*Sigmodon hispidus*), rabbits (*Sylvilagus* spp.), and insects. Occurrence of these food items in coyote scats differed by season and study site. During the fawning season, 61.5% and 26.7% of scats contained fawn remains on BFG and CC, respectively, likely due to a greater fawn abundance on BFG. My data suggest that abundant alternative prey may not buffer fawn predation.

INDEX WORDS: *Canis latrans*, Coyote, Diet, Food habits, Foraging strategy, Georgia, *Odocoileus virginianus*, Piedmont, Scat analysis, White-tailed deer

# SEASONAL FOOD HABITS OF THE COYOTE (*CANIS LATRANS*) ON DIFFERING LANDSCAPES IN THE PIEDMONT REGION OF GEORGIA

by

JAMES D. KELLY

B.S. Biology, Mansfield University of Pennsylvania, 2008

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

2012

# SEASONAL FOOD HABITS OF THE COYOTE (*CANIS LATRANS*) ON DIFFERING LANDSCAPES IN THE PIEDMONT REGION OF GEORGIA

by

JAMES DAVID KELLY

| | |
|---|---|
| Major Professor: | Karl V. Miller |
| Committee: | Robert J. Warren<br>Steven B. Castleberry |

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
May 2012

# DEDICATION

In loving memory of my Grandad, John David Dunham (July 6, 1925 - September 6, 2011), the man who instilled in me a passion for the outdoors and the white-tailed deer.

# ACKNOWLEDGEMENTS

I would first like to acknowledge my Lord and Savior, Jesus Christ, for placing this call upon my life and for giving me the strength, courage, and discipline to see this thesis to completion. It is my prayer that wherever my career takes me it would bring glory and honor to Him.

I would also like to thank so many different people for their guidance, support, and friendship. First, I would like to acknowledge Dr. Karl V. Miller for giving me the opportunity to pursue graduate education in wildlife management. I also thank Dr. Bob Warren for mentoring me during my tenure as a graduate student. He always gave me his full and undivided attention even at his busiest. I would like to acknowledge Charlie Killmaster and John Bowers of the Georgia Department of Natural Resources (GA DNR), not only for funding this research and my assistantship, but also for staying engaged in the project and helping with fieldwork. In addition, I acknowledge GA DNR area managers Coley Paschal and Freddy Hayes for their help coordinating fieldwork efforts. I thank Dustin Thompson for help with spatial analysis of B.F. Grant Wildlife Management Area. I thank my research partner and PhD student on the project, Will Gulsby, for all of his help with my research project. I know he will go very far in his career as a deer biologist.

I would also like to acknowledge other fellow graduate students Will Ricks, Graham Marsh, Vanessa Lane, Mike Cherry, and Brad Cohen for their help with my graduate program and for their friendship. Coffee breaks will never be quite the same without the company of my fellow Yankee, Brad Cohen.

I thank all of my friends and family “back home” for their love and support during my graduate research. I especially thank my parents and parents in-law for their love, encouragement, and support. I thank my best friends and hunting buddies, Craig Sheeley and Tom Humbert, for their unwavering friendship. I am so grateful that there is always a deer stand with my name on it whenever I visit Braund Valley or Humbert Farms.

I thank all of my Athens Church community group members, but I especially want to thank the Gamblin Family for their friendship and for the countless ways they have helped my family and me. You treated us like family from day one; we celebrated holidays together, you were at the hospital for the birth of our son, you gave us a place to stay when we did not have one, you helped us move twice, and the list goes on! I will never know why you repeatedly chose to be so kind and gracious to us. You have truly blessed my family, and we will consider you a part of our family for the rest of our days.

Lastly and most importantly, I would like to thank my best friend, the mother of my son, and my beautiful bride, Jessica. This endeavor began rather unexpectedly one week into our marriage and one hour before signing a lease on an apartment in Pennsylvania. You have stood by my side for better or for worse through this whole process. You loved me even when I was not very lovable. You waited patiently for me when I was absent both physically and mentally. You believed in me when no one else, including myself, believed in me; I am so thankful for that. This process was a trying one, but I believe our marriage is stronger because of it. I love and cherish you more than I could ever express in writing, and I am so blessed to have you as my wife.

# TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS .......... v

LIST OF TABLES .......... ix

LIST OF FIGURES .......... x

CHAPTER

1 Introduction and Literature Review .......... 1

Introduction and Justification .......... 1

Literature Review .......... 2

Study Sites .......... 11

Thesis Format .......... 12

Literature Cited .......... 13

2 Coyote Food Habits on Two Sites of Differing Landscape Characteristics in the Piedmont Region of Georgia .......... 22

Abstract .......... 23

Introduction .......... 24

Study Sites .......... 26

Methods .......... 27

Results .......... 29

Discussion .......... 31

Literature Cited .......... 35

3 Summary ....................................................................................................45

Management Implications....................................................................45

Literature Cited ........................................................................................47

# LIST OF TABLES

Page

Table 2.1: Coyote food habits as percent of scats (a) and percent of occurrence (b) on B.F. Grant and Cedar Creek Wildlife Management Areas in the Georgia Piedmont by season from March 2010 and through February 2011 ............................................................................41

# LIST OF FIGURES

Page

Figure 1.1: Major land type categories for B.F. Grant Wildlife Management Area in Putnam County, Georgia (2011). ....................20

Figure 1.2: Major land type categories for the portion of Cedar Creek Wildlife Management Area north of GA Highway 212 in Putnam County, Georgia (2011)....................21

Figure 2.1: Seasonal percent occurrence of major food item categories (a), plant food items (b), and animal food items (c) by season from coyote scats (n=353) collected on B.F. Grant and Cedar Creek Wildlife Management Areas in the Georgia Piedmont from March 2010 through February 2011....................42

Figure 2.2: Percent of coyote scats containing major food item categories from scats collected (n=353) between March 2010 through February 2011 by season on B.F. Grant and Cedar Creek Wildlife Management Areas. ....................44

# CHAPTER 1

# INTRODUCTION AND LITERATURE REVIEW

## INTRODUCTION AND JUSTIFICATION

Historically, the range of the coyote (*Canis latrans*) was limited to western North America, but in the latter half of the 20th century its range expanded into the southeastern United States due to natural and anthropogenic factors (Bekoff 1977, Hill et al. 1987, Kilgo et al. 2010). For example, between 1925 and 1952, 15 instances were documented of multiple coyotes being intentionally released into various locations, primarily for sport hunting with hounds (Hill et al. 1987). Concurrent changes in the landscape due to forestry and agricultural activities and the extinction of the red wolf (*C. rufus)* have contributed to the success of coyotes in the Southeast, and they are now ubiquitous throughout the region (Bekoff 1978). Because coyotes are a relatively new addition to the fauna of the Southeast (Bekoff 1978, Hill et al. 1987), research assessing their ecological role is critical so that wildlife managers can adapt management plans to their presence.

Several recent studies have suggested that this novel predator can be a major mortality factor for white-tailed deer (*Odocoileus virginianus*) fawns in the Southeast (Saalfeld and Ditchkoff 2007, Howze 2009, VanGilder et al. 2009, Kilgo et al. 2010). Also, several coyote food habits studies have found that white-tailed deer are a commonly occurring prey item during the fawning season (Blanton and Hill 1989, Chamberlain and Leopold 1999, Schrecengost et al. 2008, Vangilder 2008, Howze 2009). However, the frequency of occurrence of fawns in the coyote’s diet and the overall diet composition of coyotes in these studies varied among studies across the southeastern U.S. landscape, and none has compared coyote food habits on landscapes composed of differing habitat types within the same physiographic region.

The purpose of this study was to examine coyote food habits on two study sites of different landscape compositions, management regimes, and prey densities within the Piedmont region of Georgia (B.F. Grant and Cedar Creek Wildlife Management Areas). This study is part of a large-scale research project funded by the Georgia Department of Natural Resources Wildlife Resources Division designed to assess the potential impact of coyotes on deer recruitment in Georgia. In particular, this study evaluated the importance of white-tailed deer fawns in the diet of coyotes during the fawning season (May-June) on sites of differing habitat composition and deer densities.

# LITERATURE REVIEW

## *Coyotes Range Expansion and Increasing Populations*

Coyote fossil records are documented in the southeastern U.S. from the mid-Pleistocene, but were not found in the region again until the mid-twentieth century (Bekoff 1978). During the twentieth century, their range expanded back into the southeastern United States from the western U.S. due to natural and anthropogenic factors (Bekoff 1977, Hill et al. 1987, Kilgo et al. 2010). There are several documented cases between 1925 and 1952 of western coyotes being released in the Southeast for sport hunting with hounds (Hill et al. 1987). Concurrent changes in the landscape due to forestry and agricultural activities and the extinction of the red wolf have contributed to the success of coyotes in the Southeast. Coyotes are now ubiquitous throughout the region with populations reportedly increasing (Bekoff 1978, Lovell et al. 1998). Because coyotes are a relatively new addition to the fauna of the Southeast (Bekoff 1978, Hill et al. 1987), research assessing their ecological role is limited.

### *Coyote Food Habits Studies*

Food habits analyses can assess the breadth of food items utilized by coyotes in a particular area and season, and help elucidate the ecological niche that they fill. Food habits can be analyzed directly by examining stomach contents of coyote carcasses, or indirectly via scat analysis. Stomach contents are a reliable measure of food habits, but it is often difficult to obtain a sufficient sample size because it requires euthanasia of the coyote. Scat analysis can also be a reliable measure of food habits. However differential digestibility of prey items may overestimate the importance of smaller prey items (e.g., *Peromyscus* spp.) compared to larger ones (e.g., white-tailed deer) in the coyote diet (Bekoff 1978, O'Gara 1986, Kelly 1991). Also, near complete digestibility of eggs and 1-2-day-old birds may under represent the importance of some upland game birds in the diet of coyotes (Wagner and Hill 1994).

There is often confusion about the definition of terms relating to the presence of food items in scat analyses (Kelly 1991). Thus, I define percent occurrence as the number of times a prey item occurs divided by all occurring prey items, and percent of scats or percent of stomachs as the number of times a prey item occurs divided by the number of scats or stomachs collected. Food habits expressed in percent occurrence best shows relative frequency of occurrence of a given food item, while percent of scats best shows how common a food item is in the coyote diet; this variable is used for comparison to other coyote food habits studies (Ackerman et al. 1984, van Dijk et al. 2007).

Coyote food habits have been studied extensively in their traditional range. Most studies show that coyotes primarily feed on lagomorphs, small mammals, and carrion (Johnson and Hansen 1979, Litvaitis and Shaw 1980, Bowyer et al. 1983). Unfortunately, application of these data to the Southeast is limited because of spatiotemporal variability in food item availability and utilization (Bekoff 1977, Cypher et al. 1994).

Studies in the southeastern United States have reported that coyotes primarily utilize soft mast, small mammals (e.g., rodents and lagomorphs), insects (primarily Orthopterans and Coleopterans), and white-tailed deer (i.e., carrion and fawns) in varying quantities. In Arkansas, Gipson (1974) recorded food items in stomachs from 168 coyotes collected during July 1969 through January 1974 and found the five most commonly occurring prey items were poultry, persimmons (*Diospyros virginiana*), insects, rodents, and songbirds. Wooding et al. (1984) found that across all seasons in Mississippi and Alabama the most frequently occurring items (percent of scats and stomachs collectively) were rodents (43.1%), fruit (38.6%), rabbits (*Sylvilagus* spp., 34.7%), insects (29.9%), white-tailed deer (28.0%), and birds (22.5%). On seven study sites in Mississippi, Alabama, Tennessee, and Kentucky, Blanton and Hill (1989) examined summer coyote food habits and reported that rabbits occurred in the highest percent of scats and stomachs (31.6%), followed by deer[1] (30.8%), grasshoppers (26.5%), and persimmon (19.5%). Conversely, Howze et al. (2009) reported that the most frequently occurring food items on a study site in southwestern Georgia were adult and fawn white-tailed deer (30.1%), cotton rats (*Sigmodon hispidus*, 28.2%), plums (*Prunus* spp., 27.6%), and various grasses (Poaceae, 19.2%). Additionally, Stratman and Pelton (1997) found that in northwestern Florida, Coleopterans occurred in the greatest percentage of scats (55%), followed by *Vaccinium* spp. (35%), saw palmetto (*Serenoa repens*, 30%), and *Rubus* spp. (28%). Schrecengost et al. (2008) reported that no single food item occurred in all 15 months of their study of coyote food habits in coastal South Carolina. Soft mast dominated the coyote diet from spring to late autumn, while during the winter, animal food items were most common (Schrecengost et al. 2008).

---

[1] Includes white-tailed deer and may include fallow deer (*Dama dama*)

Collectively, these studies suggest spatial and temporal variability in coyote food habits, which underscores the importance for region and even site-specific food habits studies to understand the underlying processes driving coyote foraging patterns.

Although there is overlap in the food items reported among prior studies, the importance of particular food items in the coyote diet differs geographically and temporally, likely stemming from differences in food-item availability and abundance. In the aforementioned studies, deer occurred in varying degrees during their respective fawning season. In Arkansas, deer occurred in only 5% of stomachs in April-June and did not occur during July-September (Gipson 1974). In northwestern Florida, white-tailed deer occurred in 29% of scats during early fall, which is the fawning season for this region, but there was no significant difference in occurrence of fawns between a high and a low deer density area (Stratman and Pelton 1997). In Mississippi and Alabama, deer occurred in 33.3% of scats during July and 71.4% in August, which is peak fawning period for these study sites (Wooding et al. 1984). On study sites in Mississippi, Alabama, Tennessee, and Kentucky, Blanton and Hill (1989) found that white-tailed deer was the most frequently occurring (74.2%) of four major food items in scats on areas of high deer density, but occurred less frequently (8.8%) in areas of low deer density. More recently, Schrecengost et al. (2008) found fawn remains in 15-38% of scats from May to July in the Upper Coastal Plain of South Carolina. Similarly, VanGilder et al. (2009) found that deer remains occurred in 37.5% of scats during the Alabama fawning season. Among these studies where fawns occurred in varying frequencies, it is likely that the respective coyote, fawn, and alternative prey densities on these study sites were a contributing factor (Blanton and Hill 1989, Prugh 2005).

### *Impacts of Coyotes on Fawn Recruitment*

The effects of coyotes on game populations such as white-tailed deer, Northern Bobwhite (*Colinus virginianus*), and Wild Turkey (*Meleagris gallopovo*) are of interest to hunters and wildlife managers throughout North America, but these effects are of particular concern in the Southeast where coyotes are a novel predator and are becoming increasingly abundant (Lovell et al. 1998, Houben 2004, Kilgo et al. 2010). Despite significant anecdotal evidence that coyotes are affecting deer populations in the Southeast, there has been relatively little research evaluating the impacts of coyotes on deer populations (Kilgo et al. 2010).

Throughout its range, several studies have shown that coyotes are a major mortality factor for deer fawns. In Pennsylvania, Vreeland et al. (2004) captured 218 fawns on two study sites and found that coyotes accounted for 62.4% of the observed fawn mortality on a predominately agricultural landscape and only 31.7% on a heavily forested landscape. In New Brunswick, Ballard et al. (1999) radio-collared 78 fawns and found that coyotes accounted for 54% of their annual mortality. Similarly, on an island off the coast of Maine, Long et al. (1998) captured and radio-collared between one and nine fawns for five consecutive years and found that coyotes accounted for at least 47% of all fawn mortalities. Nelson and Woolf (1987) caught and radio-collared 54 fawns across a 3-year period in southern Illinois and found that coyotes and domestic dogs (*C. lupus familiaris*) accounted for 69% of natural mortalities. In south-central Iowa, Huegel et al. (1985) captured 58 fawns over 3 years and equipped them with mortality sensors. They attributed 53.8% and 23.1% of fawn deaths to coyotes and dogs, respectively. In Colorado, Whitaker and Lindzey (1999) radiocollared sympatric white-tailed deer (n=37) and mule deer (*O. hemionus,* n=83) across 2 years and found that coyotes were responsible for 79% of fawn mortalities. They also concluded that mule deer had a higher probability of survival than white-tailed deer fawns, with parturition date being the best predictor of survival (Whittaker and Lindzey 1999). Another study found that coyotes accounted for 41.7% of fawn mortality in an exurban deer population in Alabama where the investigators radio-collared 36 neonates over a 2-year period (Saalfeld and Ditchkoff 2007). Coyotes obviously prey on fawns during the fawning season throughout their range, but it remains unclear if this predation is having an impact on deer populations in the Southeast.

Several studies have assessed the impacts of coyotes on fawn recruitment by measuring responses in recruitment in areas following coyote removal. In the Coastal Plain of South Texas, Beasom (1974) removed 129 coyotes and 66 bobcats (*Lynx rufus*) in 1971 and 59 coyotes and 54 bobcats in 1972 from a 2,023-ha treatment site. Fawn recruitment nearly doubled from 0.47 fawns per doe in 1971 to 0.82 fawns per doe in 1972, while a non-removal control site only recruited 0.12 fawns per doe in 1971 and 0.32 fawns per doe in 1972. Guthery and Beasom (1977) performed a similar experiment in South Texas on a removal and a control site, both approximately 4,047-ha. They removed 132 coyotes and 18 bobcats from 1975-1976 and noted fawn production on the removal area was 70% greater in 1975 and 43% greater in 1976 than on a non-removal control site. In Oklahoma, Stout (1982) removed coyotes from three sites and reported increases of 262%, 92%, and 167% the first fall after reduction on each study site. More recently, VanGilder et al. (2009) reported an average increase in fawn recruitment of 189% after an intensive bobcat and coyote removal in Alabama. In southwestern Georgia, Howze et al. (2009) reported a fawn-to-doe ratio of 0.68 in a 4,200-ha area where 23 coyotes and 3 bobcats were removed, and a fawn-to-doe ratio of 0.07 in an adjacent 2,800-ha non-removal zone. Collectively, these studies suggest that coyotes can influence fawn recruitment for the immediate recruitment period, but more research is needed to see if coyote predation on fawns affects deer densities over multiple years.

### *Habitat Driven Impacts on Coyote Food Habits*

It is not well understood if coyote food habits, particularly coyote-fawn predation, are a function of coyote density, prey availability, or habitat composition. Some studies suggest that coyote density is controlled by prey availability (Andelt et al. 1987, Chamberlain and Leopold 1999), which in turn is controlled by available habitat for the prey species. For example, coyotes prefer open areas such as early successional areas, edges, recently disturbed, or agricultural areas (Holzman and Conroy 1992, Chamberlain et al. 2000, Kays et al. 2008, Schrecengost et al. 2009). Coincidentally, these areas constitute the primary habitat for many small mammals (Atkeson and Johnson 1979), which are a staple in the coyote diet. These open, agricultural, regularly disturbed, or grassland habitats are also very productive habitats for white-tailed deer. Consequently, areas composed of more early successional habitats, compared to mature closed-canopied forests, may lose more fawns to coyote predation. In central Pennsylvania, Vreeland et al. (2004) found that compared to a heavily forested mountainous site, fawn survival was greater on an agricultural landscape. However, at least 62.5% (25% unidentified) of predation mortality on the agricultural site was attributed to coyotes. Therefore, coyote predation on fawns may not be as important in heavily forested sites where other mortality factors such as disease, malnutrition, and bear predation are more limiting (Vreeland et al. 2004). Similarly, Andelt et al. (1987) found significantly more deer occurring in scats during the fawning season in early successional habitats compared to all other stages of succession. Thus, on agricultural or early successional areas, coyote predation may be a major fawn mortality factor due to these sites being better coyote habitat during all seasons.  Examination of the coyote diet in landscapes composed of different habitat types within the same region is necessary.

### *Coyote Foraging Strategies*

Understanding coyote foraging strategies is critical to effective game management in the Southeast where the composition and abundance of available prey items can change temporally and with varying management practices.  Many studies on eastern coyotes describe this canid as a generalist predator that feeds opportunistically by preying upon food items as they are encountered, yielding a dietary composition of food items ranked in order of abundance (Andelt and Andelt 1984, Wooding et al. 1984, Stratman and Pelton 1997, Schrecengost et al. 2008, Vangilder 2008).  Other studies suggest that coyotes forage optimally (MacCracken and Hansen 1987, Hernández et al. 2002).  Optimal foraging theory suggests that an animal will always select the highest-ranking food item in terms of intrinsic profitability (i.e., size, handling time, inherent vulnerability, and nutritional content) regardless of its density, and lower-ranking food items will be included in the predators diet in decreasing order of profitability only when the highest ranking food item falls below a threshold abundance (Charnov 1976, Stephens and Krebs 1986). Other recent literature suggests that coyotes may employ a foraging strategy in which they prey on food items that are most profitable in terms of a net gain in energy, which represents a slight modification to the optimal foraging theory (Prugh 2005).

Patterson et al. (1998) found that the functional response of coyote foraging strategies were not proportional to the changes in relative densities of deer or snowshoe hare (*Lepus americanus*).  This was especially true when deer densities were low and coyotes continued to feed largely on deer, despite high hare densities.  They surmised this response was facilitated by increased deer vulnerability from deep snow during winter and of fawns during summer

(Patterson et al. 1998). Additionally, in relation to the relative abundance of deer and hare, coyotes fed on a disproportionate number of fawns in five of six territories suggesting that prey switching by coyotes may be influenced by changes in prey diversity, abundance, and vulnerability (Patterson et al. 1998).

MacCracken and Hansen (1987) ranked profitability of prey items based on body size for assessment of optimal foraging by coyotes in Idaho. Coyotes selected prey as predicted by optimal foraging theory because consumption of low-ranked foods was influenced by abundance of the most profitable prey (black-tailed jackrabbits, *Lepus californicus*). Additionally, Hernández et al. (2002) reported that coyotes met all assumptions of the optimal foraging model in the Chihuahuan Desert because there was no significant linear relationship between percent occurrence of lagomorphs and their availability. In addition, percent occurrence of rodents or arthropods (lower-ranking food items) was not related to their respective availabilities. They reported a negative relationship between number of lagomorphs consumed and the number available, but no relationship between rodent or arthropod consumption versus availability.

In the Alaskan range, Prugh (2005) calculated selection ratios based on relative occurrence in scats over available biomass of a particular prey item. Snowshoe hare density was the best predictor of the overall coyote diet composition, in which coyote selection ratios for hares increased as hare density decreased (Prugh 2005). However, coyotes added less profitable food items in decreasing order of profitability in a linear pattern and there was no evidence of a threshold at which only snowshoe hares (the most profitable item in this area) were in the coyote diet. She suggested that coyotes were feeding on prey items with the highest ‘net profitability’—an adaptation of the optimal foraging theory that includes search time, a variable that decreases with increasing prey density (Prugh 2005). Thus, it is pertinent to examine coyote food habits simultaneously on two sites of differing densities of an intrinsically profitable food item (i.e., white-tailed deer fawns) where the net profitability of that food item would also differ.

## STUDY SITES

I conducted my research on B.F. Grant (BFG) Wildlife Management Area (WMA) and Cedar Creek (CC) WMA, both of which are managed by Georgia Department of Natural Resources Wildlife Resources Division. These sites lie in the Piedmont physiographic region at an elevation of approximately 140-170 m. Both sites are located west of Eatonton in Putnam County, Georgia, and are separated by approximately 8 km of privately owned land between the southern-most point of BFG and the northern-most point of CC.

The 4,856-ha BFG WMA consists of intensively managed planted loblolly pine stands (*Pinus taeda*) interspersed with mature hardwood forests dominated by oaks (*Quercus* spp.) and hickories (*Carya* spp.) in the lower lying areas. Timber harvest occurs regularly on BFG and, as a result, the WMA contains many areas of early successional habitat (Fig 1.1). In addition, an agricultural research station maintained by the University of Georgia comprises a mosaic of agricultural fields distributed throughout the WMA. This area consists primarily of fields managed for hay and cattle grazing and is dominated by fescue (*Festuca* spp.) and Bermuda (*Cynodon dactylon*) grasses. Collectively, clearcuts and agricultural fields comprise 28% of the land on BFG. I assumed BFG had a relatively abundant small mammal population compared to CC, given the large percentage of suitable small mammal habitat (i.e., pre-canopy closure, early successional areas; Atkeson and Johnson 1979).

White-tailed deer are hunted on BFG through a quota hunt permit system that restricts hunter numbers during firearms season and, as a result, deer are abundant with an estimated density of 19 deer/km$^2$ (W.D. Gulsby, unpublished camera survey data). Hunters can only harvest quality-antlered deer as defined by 38.1-cm outside spread or 40.6-cm main beams, and they can harvest one antlerless deer. Seasons on BFG are limited to 8 days of archery, 6 days of firearms, and 3 days of primitive weapons.

Cedar Creek WMA, located within the Oconee National Forest, is 16,187-ha. My study area encompassed a 5,000-ha area north of Georgia Highway 212. This area is a mixture of mature, upland loblolly pines and hardwood bottomland forests similar to BFG (Fig. 1.2). In contrast to BFG, timber management is minimal, consisting primarily of late-winter burns; therefore, early successional areas and pastures comprise only 7% of the total land cover. Thus, I assumed that small mammal populations were low on CC relative to BFG due to the low amount of early successional habitat.

Deer populations on CC are managed for a maximum sustained yield. There are no antler restrictions and hunters may harvest two bucks and ten antlerless deer. The deer density on CC is approximately 9 deer/ $km^2$ (W.D. Gulsby, unpublished camera survey data). Deer hunting opportunity is greater on CC with an approximately 1-month archery season and 21 days of firearms season.

## THESIS FORMAT

This thesis is presented in manuscript form. Chapter 1 is an introduction and literature review of coyote food habits and the implications for white-tailed deer populations and a detailed description of my study sites. Chapter 2 is a manuscript prepared for submission to a peer-reviewed scientific journal that presents coyote food habits as determined by scat analysis on two sites of contrasting landcover, stand types, and prey densities. Chapter 3 presents a summary of results and management implications of this research.

## LITERATURE CITED

Ackerman, B. B., F. G. Lindzey, and T. P. Hemker. 1984. Cougar food habits in southern Utah. Journal of Wildlife Management 48:147-155.

Andelt, W. F., and S. H. Andelt. 1984. Diet bias in scat deposition-rate surveys of coyote density. Wildlife Society Bulletin 12:74-77.

Andelt, W. F., J. G. Kie, F. F. Knowlton, and K. Cardwell. 1987. Variation in coyote diets associated with season and successional changes in vegetation. Journal of Wildlife Management 51:273-277.

Atkeson, T. D., and A. S. Johnson. 1979. Succession of small mammals on pine plantations in the Georgia Piedmont. American Midland Naturalist 101:385-392.

Ballard, W. B., H. A. Whitlaw, S. J. Young, R. A. Jenkins, and G. J. Forbes. 1999. Predation and survival of white-tailed deer fawns in northcentral New Brunswick. Journal of Wildlife Management 63:574-579.

Beasom, S. L. 1974. Relationships between predator removal and white-tailed deer net productivity. Journal of Wildlife Management 38:854-859.

Bekoff, M. 1977. *Canis latrans*. Mammalian Species 79:1-9.

Bekoff, M. 1978. Coyotes: biology, behavior, and management. Academic Press, Inc., New York, NY.

Blanton, K. M., and E. P. Hill. 1989. Coyote use of white-tailed deer fawns in relation to deer density. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 43:470-478.

Bowyer, R. T., S. A. McKenna, and M. E. Shea. 1983. Seasonal changes in coyote food habits as determined by fecal analysis. American Midland Naturalist 109:266-273.

Chamberlain, M. J., and B. D. Leopold. 1999. Dietary patterns of sympatric bobcats and coyotes in central Mississippi. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 53:204-219.

Chamberlain, M. J., C. D. Lovell, and B. D. Leopold. 2000. Spatial-use patterns, movements, and interactions among adult coyotes in central Mississippi. Canadian Journal of Zoology 78:2087-2095.

Charnov, E. L. 1976. Optimal foraging: attack strategy of a mantid. American Midland Naturalist:127-154.

Cypher, B. L., K. A. Spencer, and J. H. Scrivner. 1994. Food-item use by coyotes at the Naval Petroleum Reserves in California. Southwestern Naturalist 39:91-95.

Gipson, P. S. 1974. Food habits of coyotes in Arkansas. Journal of Wildlife Management 38:848-853.

Guthery, F. S., and S. L. Beasom. 1977. Responses of game and nongame wildlife to predator control in South Texas. Journal of Range Management 30:404-409.

Hernández, L., R. R. Parmenter, J. W. Dewitt, D. C. Lightfoot, and J. W. Laundré. 2002. Coyote diets in the Chihuahuan Desert, more evidence for optimal foraging. Journal of Arid Environments 51:613-624.

Hill, E. P., P. W. Sumner, and J. B. Wooding. 1987. Human influences on range expansion of coyotes in the Southeast. Wildlife Society Bulletin 15:521-524.

Holzman, S., and M. J. Conroy. 1992. Home range, movements, and habitat use of coyotes in southcentral Georgia. Journal of Wildlife Management 56:139-146.

Houben, J. M. 2004. Status and management of coyote depredations in the eastern United States. Sheep and Goat Research Journal:16-22.

Howze, M. B. 2009. The effect of predation on white-tailed deer recruitment at the Joseph W. Jones Ecological Research Center. M.S. Thesis, University of Georgia, Athens.

Howze, M. B., L. M. Conner, R. J. Warren, and K. V. Miller. 2009. Predator removal and white-tailed deer recruitment in southwestern Georgia. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 63:17-20.

Huegel, C. N., R. B. Dahlgren, and H. L. Gladfelter. 1985. Mortality of white-tailed deer fawns in south-central Iowa. Journal of Wildlife Management 49:377-380.

Johnson, M. K., and R. M. Hansen. 1979. Coyote food habits on the Idaho National Engineering Laboratory. Journal of Wildlife Management 43:951-956.

Long, R. A., A. F. O'Connell, and D. J. Harrison. 1998. Mortality and survival of white-tailed deer *Odocoileus virginianus* fawns on a north Atlantic coastal island. Wildlife Biology 4:237-247.

Kays, R. W., M. E. Gompper, and J. C. Ray. 2008. Landscape ecology of eastern coyotes based on large-scale estimates of abundance. Ecological Applications 18:1014-1027.

Kelly, B. T. 1991. Carnivore scat analysis: an evaluation of existing techniques and the development of predictive models of prey consumed. M.S. Thesis, University of Idaho, Moscow.

Kilgo, J. C., H. S. Ray, C. Ruth, and K. V. Miller. 2010. Can coyotes affect deer populations in southeastern North America? Journal of Wildlife Management 74:929-933.

Litvaitis, J. A., and J. H. Shaw. 1980. Coyote movements, habitat use, and food habits in southwestern Oklahoma. Journal of Wildlife Management 44:62-68.

Lovell, C. D., B. D. Leopold, and C. C. Shropshire. 1998. Trends in Mississippi predator populations, 1980-1995. Wildlife Society Bulletin 26:552-556.

MacCracken, J. G., and R. M. Hansen. 1987. Coyote feeding strategies in southeastern Idaho: optimal foraging by an opportunistic predator? Journal of Wildlife Management 51:278-285.

Nelson, T. A., and A. Woolf. 1987. Mortality of white-tailed deer fawns in southern Illinois. Journal of Wildlife Management 51:326-329.

O'Gara, B. W. 1986. Reliability of scat analysis for determining coyote feeding on large mammals. Murrelet 67:79-81.

Patterson, B. R., L. K. Benjamin, and F. Messier. 1998. Prey switching and feeding habits of eastern coyotes in relation to snowshoe hare and white-tailed deer densities. Canadian Journal of Zoology 76:1885-1897.

Prugh, L. R. 2005. Coyote prey selection and community stability during a decline in food supply. Oikos 110:253-264.

Saalfeld, S. T., and S. S. Ditchkoff. 2007. Survival of neonatal white-tailed deer in an exurban population. Journal of Wildlife Management 71:940-944.

Schrecengost, J. D., J. C. Kilgo, D. Mallard, H. S. Ray, and K. V. Miller. 2008. Seasonal food habits of the coyote in the South Carolina Coastal Plain. Southeastern Naturalist 7:135-144.

Schrecengost, J. D., J. C. Kilgo, H. S. Ray, and K. V. Miller. 2009. Home range, habitat use and survival of coyotes in western South Carolina. American Midland Naturalist 162:346-355.

Stephens, D. W., and J. R. Krebs. 1986. Foraging theory. Princeton University Press, Princeton, NJ.

Stout, G. G. 1982. Effects of coyote reduction on white-tailed deer productivity on Fort Sill, Oklahoma. Wildlife Society Bulletin 10:329-332.

Stratman, M. R., and M. R. Pelton. 1997. Food habits of coyotes in northwestern Florida. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 51:269-275.

van Dijk, J., K. Hauge, A. Landa, R. Andersen, and R. May. 2007. Evaluating scat analysis methods to assess wolverine *Gulo gulo* diet. Wildlife Biology 13:62-67.

Vangilder, C. L. 2008. Coyote and bobcat food habits and the effects of an intensive predator removal on white-tailed deer recruitment in northeastern Alabama. M.S. Thesis, University of Georgia, Athens.

VanGilder, C. L., G. R. Woods, and K. V. Miller. 2009. Effects of an intensive predator removal on white-tailed deer recruitment in northeastern Alabama. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 63:11-16.

Vreeland, J. K., D. R. Diefenbach, and B. D. Wallingford. 2004. Survival rates, mortality causes, and habitats of Pennsylvania white-tailed deer fawns. Wildlife Society Bulletin 32:542-553.

Wagner, G. D., and E. P. Hill. 1994. Evaluation of southeastern coyote diets during the wild turkey reproductive season. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 48:173-181.

Whittaker, D. G., and F. G. Lindzey. 1999. Effect of coyote predation on early fawn survival in sympatric deer species. Wildlife Society Bulletin 27:256-262.

Wooding, J. B., E. P. Hill, and P. W. Sumner. 1984. Coyote food habits in Mississippi and Alabama. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 38:182-188.

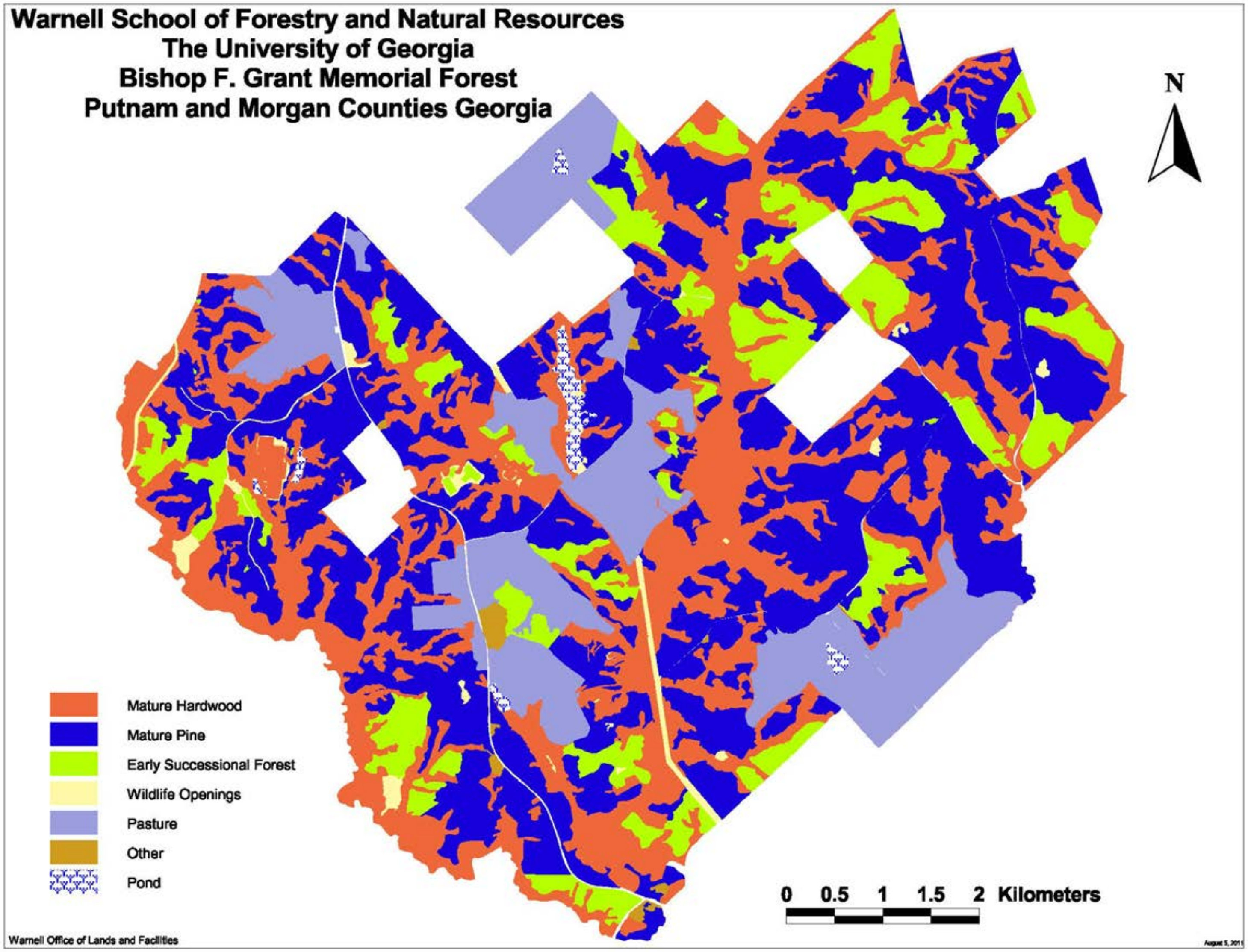


**Figure 1.1** Major land type categories for B.F. Grant Wildlife Management Area in Putnam County, Georgia (2011). Early successional forest was all forests that had been clearcut less than 7 years previous to 2011.

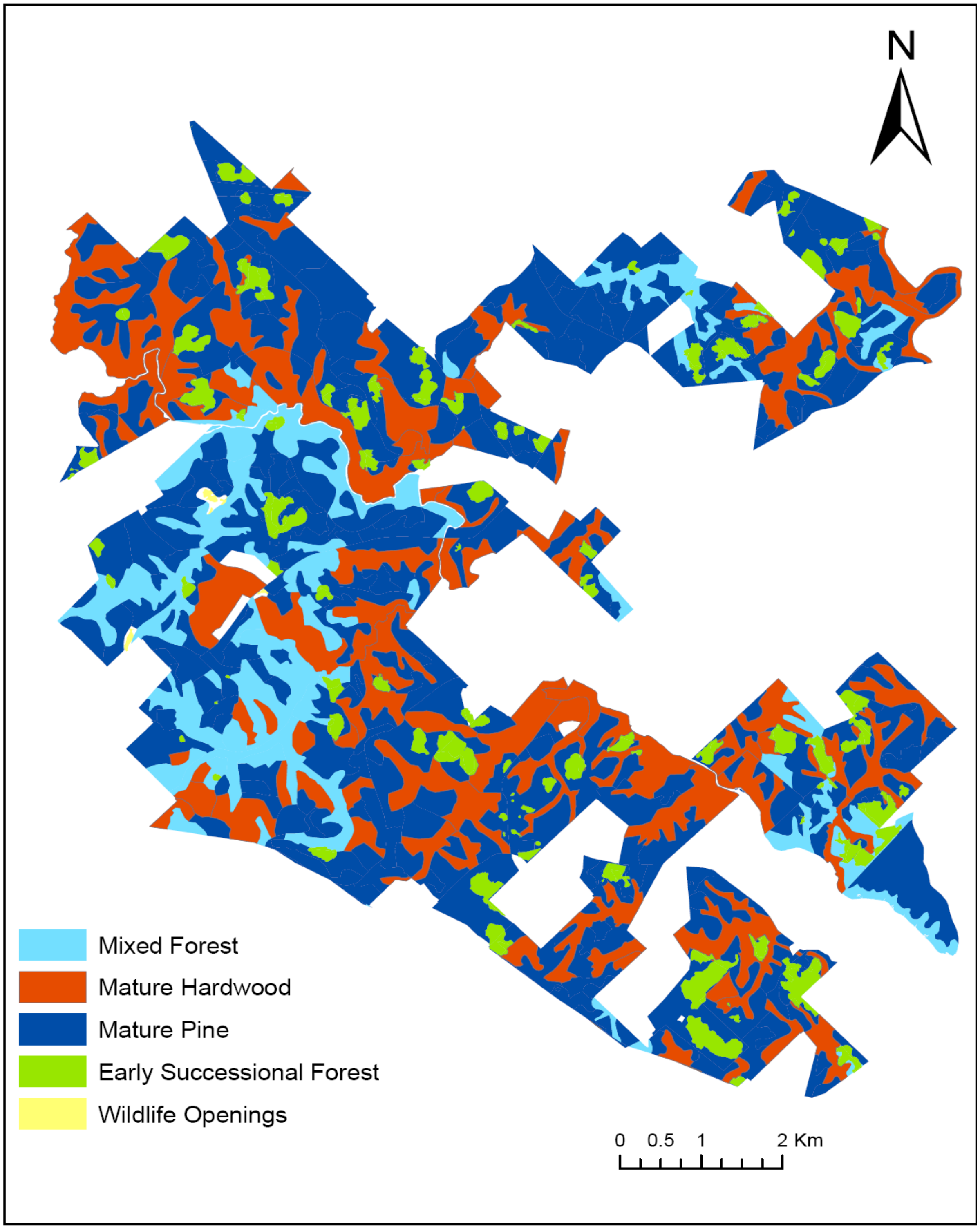


**Figure 1.2** Major land type categories for the portion of Cedar Creek Wildlife Management Area north of GA Highway 212 in Putnam County, Georgia (2011). Early successional forest was all forests that had been clearcut less than 7 years previous to 2011.

# CHAPTER 2

# COYOTE FOOD HABITS ON TWO SITES OF DIFFERING LANDSCAPE CHARACTERISTICS IN THE PIEDMONT REGION OF GEORGIA[1]

---

[1] Kelly, J.D., W.D. Gulsby, C.H. Killmaster, J.W. Bowers, and K.V. Miller. To be submitted to *Southeastern Naturalist*

## ABSTRACT

To investigate the foraging ecology of coyotes and potential impacts they may have on prey populations in the Southeast, we evaluated their seasonal food habits via scat analysis from March 2010 through February 2011 on Cedar Creek (CC) and B.F. Grant (BFG) Wildlife Management Areas in the Piedmont of central Georgia differed in habitat composition and therefore availability of coyote food items. Cedar Creek was primarily comprised of mature loblolly pines (*Pinus taeda*), with 7% early successional habitat (<7 year old stands). B.F. Grant was comprised of a variety of hardwood and pine forest types with 28% early successional habitat. Deer density was estimated at 9/km$^2$ and 19/km$^2$ on CC and BFG, respectively. We analyzed 146 coyote scats from CC and 207 from BFG. Commonly occurring food items included persimmon (*Diospyros virginianus*), muscadines (*Vitis rotundifolia*), white-tailed deer (*Odocoileus virginianus*), hispid cotton rats (*Sigmodon hispidus*), rabbits (*Sylvilagus* spp.), and insects. From July-October, soft mast was the most frequently occurring item on both sites but occurred in a higher percentage on CC. Small mammals occurred on both sites in each season except November-December. In each season that small mammals occurred, frequency of occurrence was greater on BFG except during the fawning season (May-June). During the fawning season, 61.5% and 26.7% of scats contained fawn remains on BFG and CC, respectively. Just prior to fawning (March-April), coyotes on BFG relied primarily on small mammals but switched almost exclusively to fawns during the fawning season. Fawn abundance on BFG was likely sufficient to make them the most profitable prey choice, while fawn abundance on CC may have been below this level. Furthermore, our data suggest that abundant alternative prey may not buffer fawn predation, especially when deer are abundant.

## INTRODUCTION

Historically, the range of coyotes (*Canis latrans*) was limited to western North America, but in the latter half of the 20th century their range expanded into the southeastern United States due to natural and anthropogenic factors (Bekoff 1977, Hill et al. 1987, Kilgo et al. 2010). Changes in the landscape, the intentional release of coyotes for sport hunting, and the extirpation of the red wolf (*C. rufus)* have all contributed to the success of coyotes in the Southeast.

The effects of coyotes on game populations such as deer, Northern Bobwhite (*Colinus virginianus*), and Wild Turkey (*Meleagris gallopavo*) are of interest to hunters and wildlife managers throughout North America, but these effects are of particular concern in the Southeast where coyotes are a novel predator and are becoming increasingly abundant (Lovell et al. 1998, Houben 2004, Kilgo et al. 2010). Despite their increasing abundance and significant anecdotal evidence that coyotes are affecting game populations in the Southeast, there has been relatively little research evaluating the impacts of coyotes on wildlife populations (Kilgo et al. 2010). Coyote food habits studies in the region indicate that white-tailed deer (*Odocoileus virginianus)* fawns can be a major food item during the fawning season (Wooding et al. 1984, Schrecengost et al. 2008, Vangilder 2008, Howze 2009), although others have reported that fawns were not an important part of the diet (Gipson 1974, Stratman and Pelton 1997).

Most prior studies in the region have reported that coyotes primarily utilize soft mast of many species, small mammals (e.g., rodents and lagomorphs), insects (primarily Orthopterans and Coleopterans), and white-tailed deer (primarily carrion and fawns) in varying quantities. For example, Schrecengost et al. (2008) found a higher frequency of occurrence of plums (*Prunus* spp.) than had previously been reported in any coyote food habits study. Additionally, in northwestern Florida, Stratman and Pelton (1997) reported soft mast occurred 30% more frequently and animal matter 70% less frequently than had been previously reported in the

Southeast.  Many researchers in the region have reported that persimmon (*Diospyros virginiana*) was the most frequently occurring food item during the fall on their study sites (Gipson 1974, Stratman and Pelton 1997, Chamberlain and Leopold 1999, Schrecengost et al. 2008, Vangilder 2008), but Hoearth and Causey (1991) found that rodents occurred more frequently than fruit during this season on their study site in western-central Alabama.  White-tailed deer fawns have been reported in the coyote diet during the fawning season in many studies (Andelt et al. 1987, Blanton and Hill 1989, Chamberlain and Leopold 1999, Schrecengost et al. 2008), but frequency of fawn occurrence in scats and stomachs has varied considerably.  For example, Blanton and Hill (1989) found that on seven study sites in Mississippi, Alabama, Tennessee, and Kentucky deer occurred in 30% of summer coyote scats and stomachs (76.9% of deer occurrences were confirmed as fawn) across all study sites collectively.  However, when they compared areas of high deer density to those of low deer density, deer occurred in 74.2% of scats and stomachs on the high deer density areas but only in 8.8% of scats and stomachs on the low deer density areas.

Although there is overlap in the food items reported in the aforementioned studies, the importance of particular food items in the coyote diet differs geographically and temporally.  It is not well understood if coyote foraging behavior, specifically coyote-fawn predation, is a function of relative prey abundance, coyote abundance, habitat composition, other landscape characteristics, or other ecological interactions.  Therefore, the twofold objectives of this study were  to document seasonal coyote food habits on two sites in the Piedmont region of Georgia and to examine the differences in coyote food habits as affected by different deer management regimes, habitat composition, and prey densities.

## STUDY SITES

We conducted our research on B.F. Grant (BFG) Wildlife Management Area (WMA) and Cedar Creek (CC) WMA, both managed by Georgia Department of Natural Resources Wildlife Resources Division. These WMAs lie in the Piedmont physiographic region at an elevation of approximately 140-170 m. Both sites are located west of Eatonton in Putnam County, Georgia, separated by approximately 8 km of privately owned land between the southern-most point of BFG and the northern-most point of CC.

The 4,856-ha BFG consists of intensively managed planted loblolly pines (*Pinus taeda*) interspersed with mature hardwood forests dominated by oaks (*Quercus* spp.) and hickories (*Carya* spp.) in the lower lying areas. Timber harvest occurs regularly on BFG and, as a result, contains many early successional areas. In addition, an agricultural research station maintained by the University of Georgia comprises a mosaic of agricultural fields distributed throughout the WMA. This area consists primarily of pastures managed for hay and cattle grazing and is dominated by fescue (*Festuca* spp.) and Bermuda (*Cynodon* spp.) grasses. Collectively, clearcuts and agriculture comprise 28% of the land on BFG. Because early successional habitats in the Georgia Piedmont provide habitat for abundant small mammal populations (Atkeson and Johnson 1979), we assumed BFG had a relatively high small mammal population given the large percentage of suitable small mammal habitat (i.e., pre-canopy closure, early successional areas). This WMA has a quota hunt system that restricts hunter numbers during firearms season and, as a result, deer are abundant with an estimated density of 19 deer/km$^2$ (W.D. Gulsby, unpublished camera survey data). Hunters can only harvest quality-antlered deer as defined by 38.1-cm outside spread or 40.6-cm main beams, and they can harvest one antlerless deer. Seasons on BFG are limited to 8 days of archery, 6 days of firearms, and 3 days of primitive weapons.

The 16,187-ha Cedar Creek WMA is located within the Oconee National Forest. Our study area included the portion of the WMA north of Georgia Highway 212 (approximately 5,000 ha). It is a mixture of mature, upland loblolly pines and hardwood bottoms similar to BFG. However, timber harvesting is limited and forest management consists primarily of late-winter prescribed fire. Therefore, early successional areas and pastures constitute only 7% of the total land cover. Based on Atkeson and Johnson (1979), we assumed relatively low small mammal populations on CC due to the small percentage of suitable small mammal habitat. Deer management guidelines allow for more liberal harvest than on BFG. There are no antler restrictions and hunters may harvest up to two bucks and ten antlerless deer. The deer density on CC is approximately 9 deer/ $km^2$ (W.D. Gulsby, unpublished camera survey data). Deer hunting opportunity is much greater on CC WMA with an approximately 1-month archery season and 21 days of firearms season.

## METHODS

We collected scats along designated routes totaling 25 km on BFG and 18 km on CC as well as opportunistically on each study area weekly from March 2010 to February 2011. We identified scats as coyote if they fit published criteria of size, shape, contents, and odor (Murie 1974). We collected scats that were ≤ 7 days old based on subjective field evaluation of moisture content or if found on a route cleared ≤ 7 days previously. On a subsample of fresh scats ≤ 3 days old we removed a small segment to be genotyped[*] using a modified protocol of Kohn et al. (1999). All scats verified to be non-coyote[†] from the genetic study were excluded from this analysis.

---

[*] Genetic analyses were performed by the Center for Veterinary Genetics at the University of California, Davis

[†] 6.7% of scats sent for testing were genetically verified to be non-coyote

For analysis, we placed scats in 10.16 x 15.24 cm mill cloth bags (Hubco Inc., Hutchinson, Kansas), labeled with a unique identifier, and stored them frozen to minimize decomposition. Scats were oven-dried at 65° C for 72-96 hr, then soaked, washed in an automatic clothes washer, and dried as outlined by Chamberlain and Leopold (1999). We identified plant and animal food items macroscopically and microscopically when necessary by comparing to reference materials at the University of Georgia Warnell School of Forestry and Natural Resources mammalian collection and seed reference collection as outlined by Schrecengost et al. (2008). Additionally, we used published dichotomous hair keys (Spiers 1973, Tumlison 1983).

We separated white-tailed deer fawn remains from adult deer remains by evaluating macroscopic characteristics (i.e., color and length of hair and hoof fragments) and by microscopically comparing cuticular scale imprints to adult and fawn cuticular scale references. To create scale impressions, we used a modified protocol of Williamson (1951) and Bowyer and Curry (1983). We placed guard hairs on a plastic cover slip, pressed them between two microscope slides, and heated them in an oven for 5 minutes on medium heat. The press was cooled for 5 minutes and the hair wiped off the slip leaving a negative impression of cuticular scales.

Previous coyote food habits studies have presented scat analysis data in several different formats and often terms are used interchangeably (Kelly 1991, Wagner and Hill 1994, Schrecengost et al. 2008). We expressed our data in percent of scats and percent of occurrence. As defined by Schrecengost et al. (2008), percent of scats (PS) is the percent of a sample of scats in which a food item occurs, and percent of occurrence (PO) is the number of times a prey item occurs as a percent of total number of occurrences for all food items. Data presented in PO are most appropriate for showing the relative frequency that a given food item was consumed because it accounts for more than one food item occurring in a single scat (Ackerman et al. 1984). PS data provides an indication of how common a food item is in the coyote diet and how the item compares to other food habits studies (Ackerman et al. 1984, van Dijk et al. 2007). We grouped infrequently occurring items into an ‘other’ category. We pooled data into 2-month seasons because these better represented temporal availability of food items.

## RESULTS

We analyzed 207 and 146 scats on BFG and CC, respectively, collected between March 2010 and February 2011 (Table 2.1). Grasses (Poaceae) occurred in all seasons sampled on both study sites but rarely occurred in large volumes. Adult white-tailed deer hairs occurred in five of six seasons sampled on both sites. Rabbits (*Sylvilagus* spp.) occurred in all six seasons on BFG and in four seasons on CC. Small mammals (primarily *Peromyscus* spp. and *Sigmodon hispidus*) occurred in five seasons on both study sites. Armadillo (*Dasypus novemcinctus)* occurred in three seasons on both study sites. Insects (i.e., Orthopterans and Coleopterans) occurred in five seasons on BFG and in three seasons on CC. Soft mast (primarily persimmon and *Vitis* spp.) was found in scats in only three and four seasons on BFG and CC, respectively, but it was the most frequently occurring food item on CC overall (Table 2.1).

Vegetative items comprised the majority of food item occurrences in July through October on CC and in September-October on BFG (Fig 2.1.a), but the PO of individual plant items varied by season and by study site (Fig. 2.1.b). Persimmon occurred in 50.9 PS and 69.2 PS in September-October on BFG and CC, respectively. Wild grapes and muscadines (*Vitis* spp.) occurred in a greater percentage of scats on CC (60.2%) than on BFG (38.2%) in September and October. During July and August, blackberries (*Rubus* spp.) were found in similar frequency on BFG (16.7 PS) and CC (13.3 PS). During the same period, wild pear

(*Pyrus communis*) occurred in 6.3 PS on BFG and 30.0 PS on CC. Poaceae occurred in 18.8 PS and 13.0 PS overall on BFG and CC, respectively (Table 2.l).

During November through June the coyote diet was dominated by animal food items on both study sites (Fig 2.1.a), but occurrence of individual animal items varied by season (Fig. 2.1.c). White-tailed deer occurred in 50 PS on BFG and 80 PS on CC during November-December. Conception dates of deer in central Georgia (C. Killmaster, unpublished data) and a 200-day gestation period (Verme 1965) place parturition primarily in the months of May and June. During this season, fawns were present in 61.5 PS on BFG but only 26.7 PS on CC. Furthermore, fawns comprised most of the food item occurrences during this season on BFG (43.6 PO) while on CC occurrences were equal to that of hispid cotton rat (*Sigmodon hispidus,* 18.2 PO). Rabbit occurred in low amounts during all seasons on BFG and occurred in 14.0 PS overall while on CC rabbit was found in only four seasons and in 4.8 PS overall. Cotton rat was the most frequently occurring small mammal on both sites but occurred more frequently on BFG than CC. Cotton rat was the most frequently occurring food item overall (26.1 PS) on BFG, but it only occurred in 8.9 PS on CC. Orthopterans were most important in July-August and occurred in 29.2 PS and 23.3 PS on BFG and CC, respectively, during this season (Table 2.1).

The most frequently occurring food items changed seasonally on each site (Table 2.1), but occurrence of major food item categories (i.e., soft mast, deer, small mammal, rabbit, and insect) also differed between the two sites within several seasons (Fig 2.2). During March-April, small mammals (45.75 PS) were the most commonly occurring food item on BFG followed by deer (21.7 PS) and rabbit (17.4 PS, Fig 2.2). During the same season on CC, deer and small mammal occurred equally (40 PS) followed by rabbit (20 PS). During fawning season (May-June), BFG coyotes switched from small mammals to deer (mostly fawns) almost exclusively

(64.1 PS); small mammals occurred in only 13.3 PS during the fawning season on BFG. On CC, fawns were not as common in the coyote diet during fawning season and small mammal and deer occurred in the same proportion (26.7 PS, Fig. 2.2). Soft mast was the most frequently occurring item in September-October on BFG (43 PS) and even more so on CC (76 PS). In November-December, the diet composition was mostly deer (50.0 PS) and rabbit (50.0 PS) on BFG and entirely deer (80 PS) and soft mast (40 PS) on CC (Fig. 2.2). During January-February, deer, followed by small mammal, was the most important food item on both sites (Fig 2.2).

## DISCUSSION

Coyote food habits on CC and BFG reflected the predicted relative availability and abundance of food items on these sites, given their respective management regimes and landscape characteristics. The most important food items for coyotes differed between the two sites within seasons. For example, in March-April small mammals were the single most important food item on BFG. This is probably due to the large amount of small mammal habitat on BFG (28% early succession). During the same season on CC, small mammals occurred in a smaller percentage of scats than on BFG and in an equal proportion as deer, likely due to the limited small mammal habitat on CC (7% early succession).

In May-June, when fawns were neonatal and most vulnerable, BFG coyotes switched almost exclusively to consuming fawns. On CC during the same season, fawns occurred less frequently and no apparent prey switch was observed. This is likely due to the different deer densities on each site.

During July-August and September-October soft mast was the most important food item on both sites, but occurrence was greater on CC where there was more canopy cover of *Vitis* spp. and persimmon and less alternative food sources. Similarly, a study examining coyote food habits through all stages of succession found that frequency of Texas persimmon (*Diospyros* *texana*) in scats significantly increased in the latter stages due to an absolute increase of Texas persimmon in canopy cover (Andelt et al. 1987).

During the majority of the deer hunting season (November-December) and the following season (January-February) white-tailed deer was the most frequently occurring food item and comprised most of the occurrences on CC. On BFG, white-tailed deer was equal to rabbit in frequency of occurrence during November-December and was the most important in January-February. However, in both seasons, white-tailed deer was less important on BFG than on CC. This is likely due to the differential availability of deer carrion between the two sites during these seasons. There was an abundance of deer carcasses on CC during these seasons due to the ample hunting opportunity in the season prior to and during November-December yielding abundant carrion from unrecovered deer and remains from harvested deer on site. Conversely, BFG had less hunting opportunity. Small mammals were not observed in BFG scats during November-December, however, inferences about this season are limited due to low sample size (n=6).

There is increasing concern among deer managers and enthusiasts that coyotes may be impacting deer populations in the Southeast (Kilgo et al. 2010). Several studies have documented that coyotes can be significant predators of fawns in the Southeast (Saalfeld and Ditchkoff 2007, Howze 2009, VanGilder et al. 2009), and many food habits studies, including this study, have indicated that fawns can be a significant part of the coyote diet. Several of these food habits studies have suggested that abundant alternative prey items (e.g., small mammals or soft mast) during the fawning season may buffer predation on fawns (Andelt and Andelt 1984, Schrecengost et al. 2008, Howze et al. 2009). If abundant small mammals could buffer fawn predation, we would have predicted that the occurrence of fawns in coyote scats on BFG might have been less than that of CC, a site with minimal small mammal habitat. In contrast, fawn remains occurred more frequently in the coyote diet on BFG than on CC, likely because BFG had a higher deer density. Blanton and Hill (1989) found that on several study sites throughout the Southeast, occurrence of fawn in the coyote diet was significantly higher on high deer density sites than on low deer density sites. Conversely, Stratman and Pelton (1997) found no significant difference in the occurrence of fawn in coyote scats between a high deer density area and a low deer density area on the same landscape in northwestern Florida. However, the measured density on this landscape's high deer density area (approx. 2.6/km$^2$) was less than half that of our lower deer density site. Therefore, our data suggest that abundant alternative prey items may not buffer fawn predation when deer densities are high.

Many have described coyotes as a generalist predator that feeds opportunistically (Andelt and Andelt 1984, Wooding et al. 1984, Stratman and Pelton 1997, Schrecengost et al. 2008, Vangilder 2008). However, recent literature suggests that coyotes may forage optimally. Prugh (2005) proposed an adaptation to optimal foraging theory (Charnov 1976, Stephens and Krebs 1986) that evaluates not only the food item's intrinsic profitability (i.e., size, handling time, inherent vulnerability, and nutritional content) but also extrinsic factors such as search time, which is affected by prey density. She suggested coyotes forage by selecting items with the highest 'net profitability.' She found that in the Alaskan range, food items were included in the coyote diet in order of net profitability. Several other studies have demonstrated optimal foraging by coyotes in northeastern, southwestern, and northwestern North America (MacCracken and Hansen 1987, Windberg and Mitchell 1990, Reichel 1991, Patterson et al. 1998, Hernández et al. 2002), but none has done so in the southeastern U.S.

Our data appear to support Prugh's (2005) theory of net profitability. This model may explain why an abundance of small mammals on BFG did not buffer coyote predation on fawns and why fawns were not as important in the diet of coyotes on CC. Fawns on BFG were likely at a sufficient density to make them a more profitable prey choice than small mammals while CC fawns may have been less important because fawn density was much lower, making search time higher, and thus, a less-profitable prey choice. Research quantifying both coyote food item use versus availability of all available food items in a given area and season is necessary to make better inferences about coyote foraging strategies in the southeastern U.S. This, in turn, will help assess which southeastern U.S. management regimes, habitat types, or other landscape characteristics yield the highest risk of significant coyote-fawn predation given the area’s inferred prey densities.

# LITERATURE CITED

Ackerman, B. B., F. G. Lindzey, and T. P. Hemker. 1984. Cougar food habits in southern Utah. Journal of Wildlife Management 48:147-155.

Andelt, W. F., and S. H. Andelt. 1984. Diet bias in scat deposition-rate surveys of coyote density. Wildlife Society Bulletin 12:74-77.

Andelt, W. F., J. G. Kie, F. F. Knowlton, and K. Cardwell. 1987. Variation in coyote diets associated with season and successional changes in vegetation. Journal of Wildlife Management 51:273-277.

Atkeson, T. D., and A. S. Johnson. 1979. Succession of small mammals on pine plantations in the Georgia Piedmont. American Midland Naturalist 101:385-392.

Bekoff, M. 1977. *Canis latrans*. Mammalian Species 79:1-9.

Blanton, K. M., and E. P. Hill. 1989. Coyote use of white-tailed deer fawns in relation to deer density. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 43:470-478.

Bowyer, R. T., and K. D. Curry. 1983. Use of a roller press to obtain cuticular impressions of guard hairs on acetate strips. Journal of Mammalogy 64:531-532.

Chamberlain, M. J., and B. D. Leopold. 1999. Dietary patterns of sympatric bobcats and coyotes in central Mississippi. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 53:204-219.

Charnov, E. L. 1976. Optimal foraging: attack strategy of a mantid. American Midland Naturalist:127-154.

Gipson, P. S. 1974. Food habits of coyotes in Arkansas. Journal of Wildlife Management 38:848-853.

Hernández, L., R. R. Parmenter, J. W. Dewitt, D. C. Lightfoot, and J. W. Laundré. 2002. Coyote diets in the Chihuahuan Desert, more evidence for optimal foraging. Journal of Arid Environments 51:613-624.

Hill, E. P., P. W. Sumner, and J. B. Wooding. 1987. Human influences on range expansion of coyotes in the Southeast. Wildlife Society Bulletin 15:521-524.

Hoerath, J. D., and M. K. Causey. 1991. Seasonal diets of coyotes in western Central Alabama. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 45:91-96.

Houben, J. M. 2004. Status and management of coyote depredations in the eastern United States. Sheep and Goat Research Journal:16-22.

Howze, M. B. 2009. The effect of predation on white-tailed deer recruitment at the Joseph W. Jones Ecological Research Center. M.S. Thesis, University of Georgia, Athens.

Howze, M. B., L. M. Conner, R. J. Warren, and K. V. Miller. 2009. Predator removal and white-tailed deer recruitment in southwestern Georgia. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 63:17-20.

Kelly, B. T. 1991. Carnivore scat analysis: an evaluation of existing techniques and the development of predictive models of prey consumed. M.S. Thesis, University of Idaho, Moscow.

Kilgo, J. C., H. S. Ray, C. Ruth, and K. V. Miller. 2010. Can coyotes affect deer populations in southeastern North America? Journal of Wildlife Management 74:929-933.

Kohn, M. H., E. C. York, D. A. Kamradt, G. Haught, R. M. Sauvajot, and R. K. Wayne. 1999. Estimating population size by genotyping faeces. Proceedings: Biological Sciences 266:657-663.

Lovell, C. D., B. D. Leopold, and C. C. Shropshire. 1998. Trends in Mississippi predator populations, 1980-1995. Wildlife Society Bulletin 26:552-556.

MacCracken, J. G., and R. M. Hansen. 1987. Coyote feeding strategies in southeastern Idaho: optimal foraging by an opportunistic predator? Journal of Wildlife Management 51:278-285.

Murie, O. J. 1974. A field guide to animal tracks. Second edition. Houghton Mifflin Company, Boston, MA.

Patterson, B. R., L. K. Benjamin, and F. Messier. 1998. Prey switching and feeding habits of eastern coyotes in relation to snowshoe hare and white-tailed deer densities. Canadian Journal of Zoology 76:1885-1897.

Prugh, L. R. 2005. Coyote prey selection and community stability during a decline in food supply. Oikos 110:253-264.

Reichel, J. D. 1991. Relationships among coyote food habits, prey populaitons, and habitat use. Northwest Science 65:133-137.

Saalfeld, S. T., and S. S. Ditchkoff. 2007. Survival of neonatal white-tailed deer in an exurban population. Journal of Wildlife Management 71:940-944.

Schrecengost, J. D., J. C. Kilgo, D. Mallard, H. S. Ray, and K. V. Miller. 2008. Seasonal food habits of the coyote in the South Carolina Coastal Plain. Southeastern Naturalist 7:135-144.

Spiers, J. K. 1973. A microscopic key to the hairs of Virginia land mammals. Virginia Tech, Blacksburg, VA.

Stephens, D. W., and J. R. Krebs. 1986. Foraging theory. Princeton University Press, Princeton, NJ.

Stratman, M. R., and M. R. Pelton. 1997. Food habits of coyotes in northwestern Florida. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 51:269-275.

Tumlison, R. 1983. An annotated key to the dorsal guard hairs of Arkansas game mammals and furbearers. Southwestern Naturalist 28:315-323.

van Dijk, J., K. Hauge, A. Landa, R. Andersen, and R. May. 2007. Evaluating scat analysis methods to assess wolverine *Gulo gulo* diet. Wildlife Biology 13:62-67.

Vangilder, C. L. 2008. Coyote and bobcat food habits and the effects of an intensive predator removal on white-tailed deer recruitment in northeastern Alabama. M.S. Thesis, University of Georgia, Athens.

VanGilder, C. L., G. R. Woods, and K. V. Miller. 2009. Effects of an intensive predator removal on white-tailed deer recruitment in northeastern Alabama. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 63:11-16.

Verme, L. J. 1965. Reproductive studies on penned white-tailed deer. Journal of Wildlife Management 29:74-79.

Wagner, G. D., and E. P. Hill. 1994. Evaluation of southeastern coyote diets during the wild turkey reproductive season. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 48:173-181.

Williamson, V. H. H. 1951. Determination of hairs by impressions. Journal of Mammalogy 32:80-84.

Windberg, L. A., and C. D. Mitchell. 1990. Winter diets of coyotes in relation to prey abundance in southern Texas. Journal of Mammalogy 71:439-447.

Wooding, J. B., E. P. Hill, and P. W. Sumner. 1984. Coyote food habits in Mississippi and Alabama. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 38:182-188.

**Table 2.1** Coyote food habits as percent of scats (a) and percent of occurrence (b) on B.F. Grant and Cedar Creek Wildlife Management Areas in the Georgia Piedmont by season from March 2010 and through February 2011.

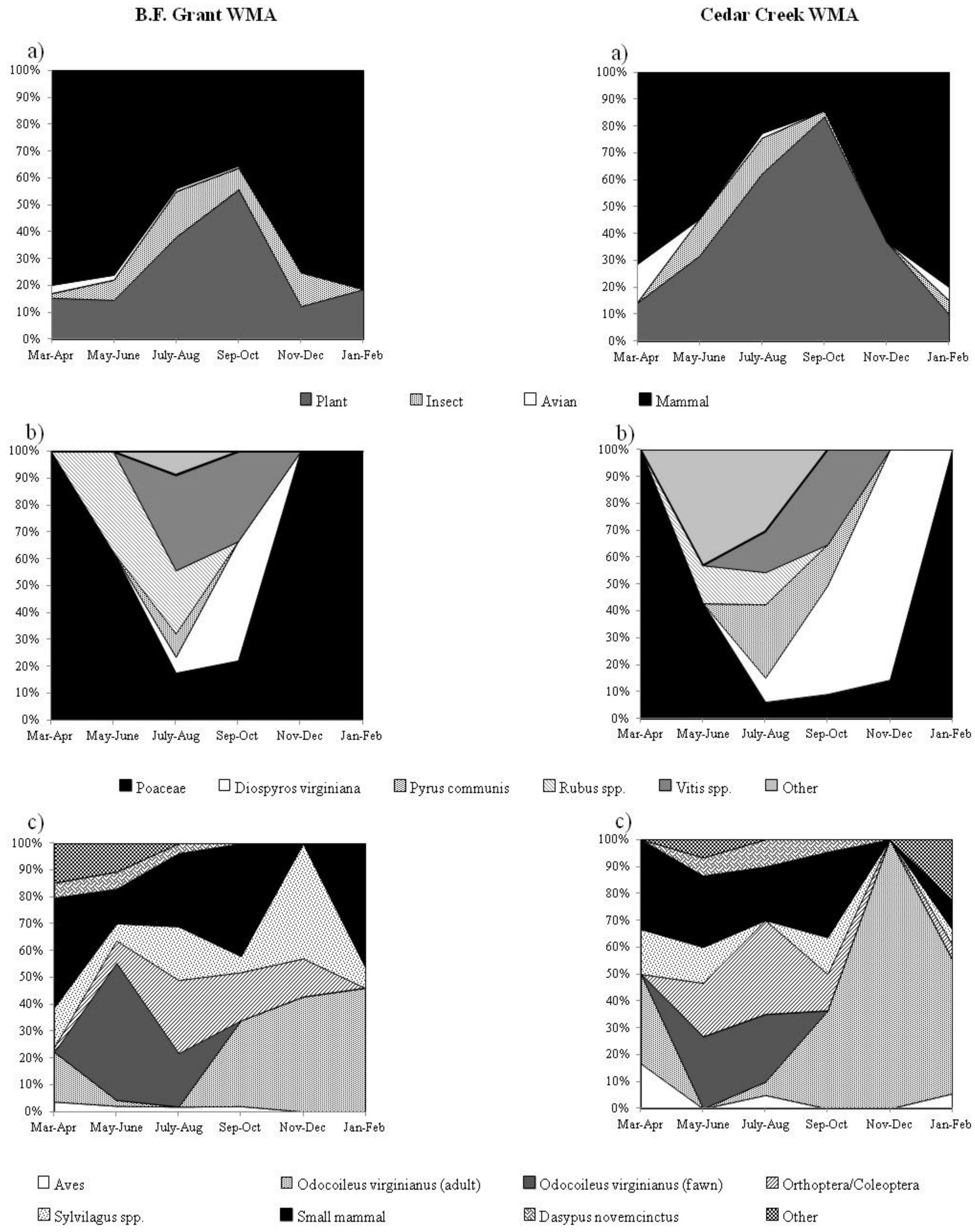
| a) | 2010 | | | | | | | | | | 2011 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mar-Apr | | May-June | | July-Aug | | Sep-Oct | | Nov-Dec | | Jan-Feb | | Overall | |
| | BFG | CC | BFG | CC | BFG | CC | BFG | CC | BFG | CC | BFG | CC | BFG | CC |
| Food Items | (46) | (5) | (39) | (15) | (48) | (30) | (55) | (65) | (6) | (15) | (13) | (16) | (207) | (146) |
| Plants | | | | | | | | | | | | | | |
| *Diospyros virginiana* | | | | | 4.2 | 10.0 | 50.9 | 69.2 | | 40.0 | | | 14.5 | 37.0 |
| Poaceae | 21.7 | 20.0 | 12.8 | 20.0 | 12.5 | 6.7 | 25.5 | 15.4 | 16.7 | 6.7 | 23.1 | 12.5 | 18.8 | 13.0 |
| *Prunus persica* | | | | 6.7 | | 6.7 | | | | | | | | 2.1 |
| *Prunus serotina* | | | | 6.7 | 4.2 | 16.7 | | | | | | | 1.0 | 4.1 |
| *Prunus* spp. (plum) | | | | 6.7 | 2.1 | 10.0 | | | | | | | 0.5 | 2.7 |
| *Pyrus communis* | | | | | 6.3 | 30.0 | | 26.2 | | | | | 1.4 | 17.8 |
| *Rubus* spp. | | | 7.7 | 6.7 | 16.7 | 13.3 | | | | | | | 5.3 | 3.4 |
| *Vitis* spp. | | | | | 25.0 | 16.7 | 38.2 | 60.0 | | | | | 15.9 | 30.1 |
| Animals | | | | | | | | | | | | | | |
| Aves | 4.3 | 20.0 | 2.6 | | 2.1 | 3.3 | 1.8 | | | | | 6.3 | 2.4 | 2.1 |
| *Castor canadensis* | | | | 6.7 | | | | | | | | 6.3 | | 1.4 |
| Coleoptera | | | 2.6 | | 2.1 | | | | 16.7 | | | 6.3 | 1.4 | 0.7 |
| *Dasypus novemcinctus* | 6.5 | | 7.7 | 6.7 | 4.2 | 6.7 | | 1.5 | | | | | 3.9 | 2.7 |
| *Diadelphus virginiana* | | | 2.6 | | | | | | | | | | 0.5 | |
| Insectivora | 2.2 | 40.0 | 2.6 | | 2.1 | | | 3.1 | | | 7.7 | | 1.9 | 2.7 |
| *Mephitis mephitis* | | | 2.6 | | | | | | | | | 6.3 | 0.5 | 0.7 |
| *Microtus pinetorum* | 2.2 | | | | | | | | | | | | 0.5 | |
| *Odocoileus virginianus* (adult) | 21.7 | 40.0 | 2.6 | | | 3.3 | 29.1 | 12.3 | 50.0 | 80.0 | 46.2 | 56.3 | 17.4 | 21.9 |
| *Odocoileus virginianus* (fawn) | | | 61.5 | 26.7 | 22.9 | 16.7 | | | | | | | 16.9 | 6.2 |
| Orthoptera | 2.2 | | 7.7 | 20.0 | 29.2 | 23.3 | 16.4 | 4.6 | | | | | 13.0 | 8.9 |
| *Oryzomys palustris* | 2.2 | | | | | | | 1.5 | | | | | 0.5 | 0.7 |
| *Peromyscus* spp. | 4.3 | | | | 4.2 | | 7.3 | 1.5 | | | 7.7 | | 4.3 | 0.7 |
| *Procyon lotor* | 2.2 | | 5.1 | | | | | | | | | | 1.4 | |
| *Sigmodon hispidus* | 37.0 | | 12.8 | 26.7 | 25.0 | 13.3 | 29.1 | 4.6 | | | 30.8 | 12.5 | 26.1 | 8.9 |
| Snake | 2.2 | | 2.6 | | | | | | | | | | 1.0 | |
| *Sus scrofa* | 13.0 | | | | | | | | | | | 12.5 | 2.9 | 1.4 |
| *Sylvilagus* spp. | 17.4 | 20.0 | 7.7 | 13.3 | 22.9 | | 5.5 | 4.6 | 50.0 | | 7.7 | 6.3 | 14.0 | 4.8 |
| *Tamias striatus* | | | | | | | 1.8 | | | | | | 0.5 | |
| Other* | 2.2 | | | | | 3.3 | | | | | 15.4 | | 1.4 | 0.7 |

| b) | 2010 | | | | | | | | | | 2011 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mar-Apr | | May-June | | July-Aug | | Sep-Oct | | Nov-Dec | | Jan-Feb | | Overall | |
| | BFG | CC | BFG | CC | BFG | CC | BFG | CC | BFG | CC | BFG | CC | BFG | CC |
| Food Items | (65) | (7) | (55) | (22) | (89) | (54) | (113) | (133) | (8) | (19) | (18) | (20) | (348) | (255) |
| Plants | | | | | | | | | | | | | | |
| *Diospyros virginiana* | | | | | 2.2 | 5.6 | 24.8 | 33.8 | | 31.6 | | | 8.6 | 21.2 |
| Poaceae | 15.4 | 14.3 | 9.1 | 13.6 | 6.7 | 3.7 | 12.4 | 7.5 | 12.5 | 5.3 | 16.7 | 10.0 | 11.2 | 7.5 |
| *Prunus persica* | | | | 4.5 | | 3.7 | | | | | | | | 1.2 |
| *Prunus serotina* | | | | 4.5 | 2.2 | 9.3 | | | | | | | 0.6 | 2.4 |
| *Prunus* spp. (plum) | | | | 4.5 | 1.1 | 5.6 | | | | | | | 0.3 | 1.6 |
| *Pyrus communis* | | | | | 3.4 | 16.7 | | 12.8 | | | | | 0.9 | 10.2 |
| *Rubus* spp. | | | 5.5 | 4.5 | 9.0 | 7.4 | | | | | | | 3.2 | 2.0 |
| *Vitis* spp. | | | | | 13.5 | 9.3 | 18.6 | 29.3 | | | | | 9.5 | 17.3 |
| Animals | | | | | | | | | | | | | | |
| Aves | 3.1 | 14.3 | 1.8 | | 1.1 | 1.9 | 0.9 | | | | | 5.0 | 1.4 | 1.2 |
| *Castor canadensis* | | | | 4.5 | | | | | | | | 5.0 | | 0.8 |
| Coleoptera | | | 1.8 | | 1.1 | | | | 12.5 | | | 5.0 | 0.9 | 0.4 |
| *Dasypus novemcinctus* | 4.6 | | 5.5 | 4.5 | 2.2 | 3.7 | | 0.8 | | | | | 2.3 | 1.6 |
| *Diadelphus virginiana* | | | 1.8 | | | | | | | | | | 0.3 | |
| Insectivora | 1.5 | 28.6 | 1.8 | | 1.1 | | | 1.5 | | | 5.6 | | 1.1 | 1.6 |
| *Mephitis mephitis* | | | 1.8 | | | | | | | | | 5.0 | 0.3 | 0.4 |
| *Microtus pinetorum* | 1.5 | | | | | | | | | | | | 0.3 | |
| *Odocoileus virginianus* (adult) | 15.4 | 28.6 | 1.8 | | | 1.9 | 14.2 | 6.0 | 37.5 | 63.2 | 33.3 | 45.0 | 10.3 | 12.5 |
| *Odocoileus virginianus* (fawn) | | | 43.6 | 18.2 | 12.4 | 9.3 | | | | | | | 10.1 | 3.5 |
| Orthoptera | 1.5 | | 5.5 | 13.6 | 15.7 | 13.0 | 8.0 | 2.3 | | | | | 7.8 | 5.1 |
| *Oryzomys palustris* | 1.5 | | | | | | | 0.8 | | | | | 0.3 | 0.4 |
| *Peromyscus* spp. | 3.1 | | | | 2.2 | | 3.5 | 0.8 | | | 5.6 | | 2.6 | 0.4 |
| *Procyon lotor* | 1.5 | | 3.6 | | | | | | | | | | 0.9 | |
| *Sigmodon hispidus* | 26.2 | | 9.1 | 18.2 | 13.5 | 7.4 | 14.2 | 2.3 | | | 22.2 | 10.0 | 15.5 | 5.1 |
| Snake | 1.5 | | 1.8 | | | | | | | | | | 0.6 | |
| *Sus scrofa* | 9.2 | | | | | | | | | | | 10.0 | 1.7 | 0.8 |
| *Sylvilagus* spp. | 12.3 | 14.3 | 5.5 | 9.1 | 12.4 | | 2.7 | 2.3 | 37.5 | | 5.6 | 5.0 | 8.3 | 2.7 |
| *Tamias striatus* | | | | | | | 0.9 | | | | | | 0.3 | |
| Other* | 1.5 | | | | | 1.9 | | | | | 11.1 | | 0.9 | 0.4 |

**Note:** Numbers in parentheses are sample sizes (a) and number of occurences (b)

* includes leaf fragments and unidentifiable debris

**Figure 2.1** Seasonal percent occurrence of major food item categories (a), plant food items (b), and animal food items (c) by season from coyote scats (n=353) collected on B.F. Grant and Cedar Creek Wildlife Management Areas in the Georgia Piedmont from March 2010 through February 2011.


B.F. Grant WMA
Cedar Creek WMA
a)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Mar-Apr
May-June
July-Aug
Sep-Oct
Nov-Dec
Jan-Feb
Plant
Insect
Avian
Mammal
b)
Poaceae
Diospyros virginiana
Pyrus communis
Rubus spp.
Vitis spp.
Other
c)
Aves
Odocoileus virginianus (adult)
Odocoileus virginianus (fawn)
Orthoptera/Coleoptera
Sylvilagus spp.
Small mammal
Dasypus novemcinctus
Other

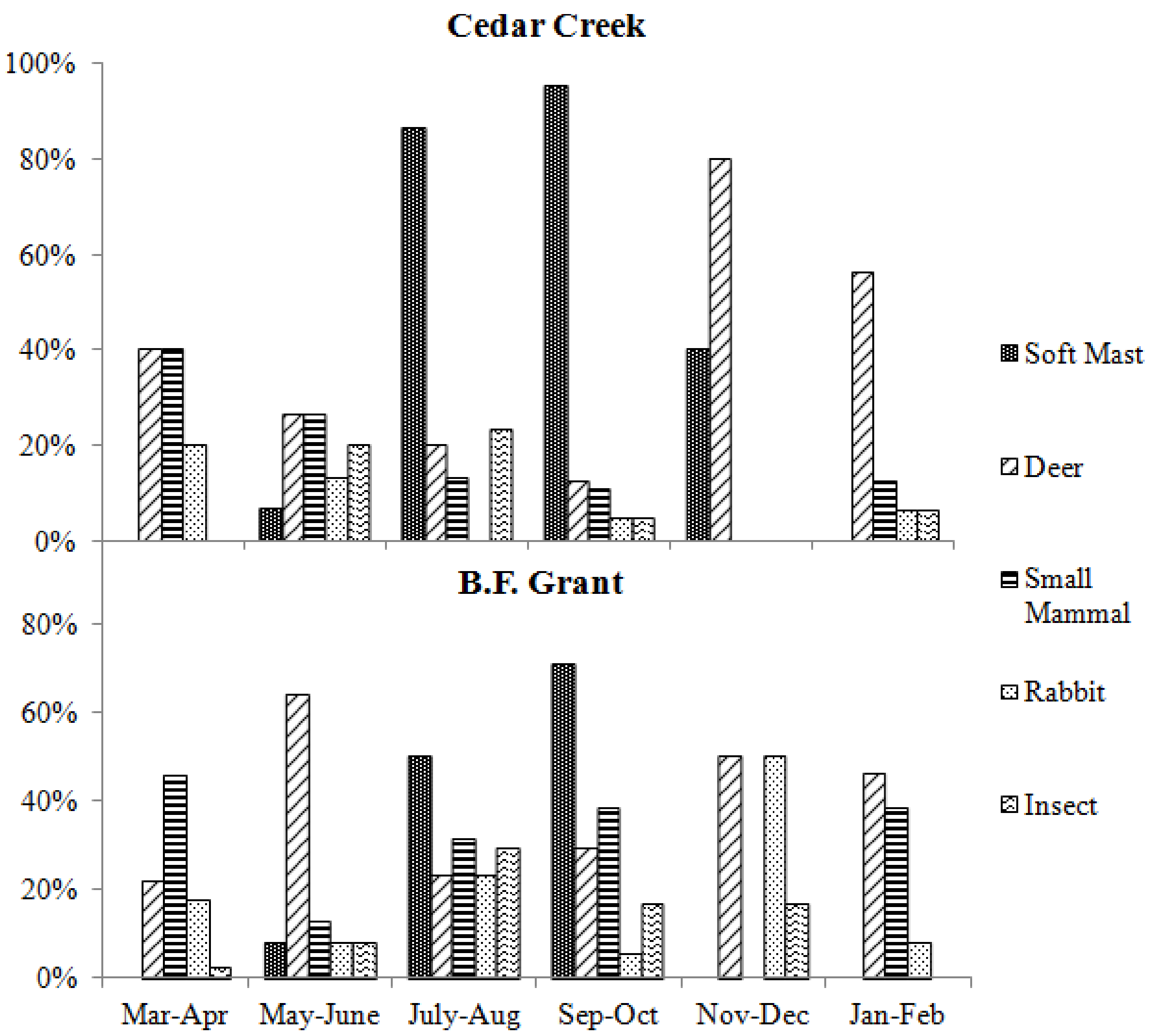


**Figure 2.2** Percent of scats containing major food item categories from coyote scats collected (n=353) between March 2010 through February 2011 by season on B.F. Grant and Cedar Creek Wildlife Management Areas.

# CHAPTER 3

## SUMMARY

The food habits of coyotes on BF Grant and Cedar Creek Wildlife Management Areas were similar to other recent coyote food habits studies in the Southeast (Schrecengost et al. 2008, Vangilder 2008, Howze 2009). Commonly occurring food items were persimmon, muscadines, white-tailed deer, small mammals, and insects. When available and most abundant, soft mast dominated the coyote diet. The importance of other food items, however, differed by study site. In particular, fawns were much more important in the diet of coyotes on BFG, a high deer density site, than of those on CC, a low deer density site, during the fawning season (May-June). During March-April, just prior to fawning season, small mammals were the primary prey of coyotes on BFG, but during the fawning season, coyotes on BFG switched to fawns almost exclusively. A similar switch in coyote food habits did not occur on CC across these two seasons. My data support an optimal foraging model as outlined by Prugh (2005). Fawns on BFG apparently were the most profitable prey choice during fawning season because of their inherent profitability and relatively high density level, while fawns on CC were likely not as profitable of a choice due to lower density levels.

### MANAGEMENT IMPLICATIONS

Coyotes are of great interest to researchers, managers, and hunters in the Southeast because their ecological role is not yet well understood in the region. Coyote populations are reportedly growing (Lovell et al. 1998) while several deer populations have simultaneously experienced a downward trend (Kilgo et al. 2010). Recent literature has suggested that providing an abundance of alternate food sources may buffer predation on fawns during the fawning season because of the high frequency of soft mast in the coyote diet during peak soft mast availability (Schrecengost et al. 2008, Howze 2009). However, my data suggest that alternate prey items may not buffer fawn predation, especially where deer densities are relatively high because the net profitability of the fawns would exceed that of any other available food item. This lends further support for annual coyote removal efforts during the fawning season to mitigate coyote-fawn predation.

# LITERATURE CITED

Howze, M. B. 2009. The effect of predation on white-tailed deer recruitment at the Joseph W. Jones Ecological Research Center. M.S. Thesis, University of Georgia, Athens.

Kilgo, J. C., H. S. Ray, C. Ruth, and K. V. Miller. 2010. Can coyotes affect deer populations in southeastern North America? Journal of Wildlife Management 74:929-933.

Lovell, C. D., B. D. Leopold, and C. C. Shropshire. 1998. Trends in Mississippi predator populations, 1980-1995. Wildlife Society Bulletin 26:552-556.

Prugh, L. R. 2005. Coyote prey selection and community stability during a decline in food supply. Oikos 110:253-264.

Schrecengost, J. D., J. C. Kilgo, D. Mallard, H. S. Ray, and K. V. Miller. 2008. Seasonal food habits of the coyote in the South Carolina Coastal Plain. Southeastern Naturalist 7:135-144.

Vangilder, C. L. 2008. Coyote and bobcat food habits and the effects of an intensive predator removal on white-tailed deer recruitment in northeastern Alabama. M.S. Thesis, University of Georgia, Athens.