Seasonal and Spatial Variation in Diets of Coyotes in Central Georgia

James D. Kelly, *New York State Department of Environmental Conservation, Division of Fish, Wildlife, and Marine Resources, 625 Broadway, 5th floor, Albany, NY 12233*

William D. Gulsby, *D. B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602*

Charlie H. Killmaster, *Georgia Department of Natural Resources, Wildlife Resources Division, 2070 U.S. Highway 278, S.E. Social Circle, GA 30025*

John W. Bowers, *Georgia Department of Natural Resources, Wildlife Resources Division, 2070 U.S. Highway 278, S.E. Social Circle, GA 30025*

Karl V. Miller, *D. B. Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30602*

Abstract: We used scat analysis to evaluate the food habits and potential impacts of coyotes (*Canis latrans*) on white-tailed deer (*Odocoileus virginianus)* populations in Georgia's Piedmont physiographic region. From March 2010 – February 2011, we analyzed 146 and 207 coyote scats on Cedar Creek (CC) and B. F. Grant (BFG) Wildlife Management Areas, respectively. Although separated by only 8 km, habitat composition and therefore prey availability was dissimilar between sites. We assumed small mammal density was greater on BFG than CC because early successional habitat was more common on BFG (28% of area vs 7% on CC). Similarly, estimated deer densities on BFG (29 deer/km^2) were approximately twice that of CC (12 deer/km^2). Commonly occurring food items in scats on both areas included persimmon (*Diospyros virginiana*), muscadine (*Vitis rotundifolia)*, deer, hispid cotton rats (*Sigmodon hispidus*), cottontails (*Sylvilagus* spp.), and insects. From July–October, soft mast occurred in 61% and 93% of scats on BFG and CC, respectively. From January–October, small mammals occurred in a greater percentage of scats on BFG (38%) than on CC (9%), 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. Increased availability of fawns on BFG likely made them a more energetically profitable prey choice than on CC, where deer were less abundant, despite greater density of alternative prey on BFG. Habitat management to increase the availability of small mammals as alternative prey for coyotes may have minimal impact on coyote depredation of white-tailed deer fawns.

Key words: coyote, *Canis latrans*, deer, diet, Georgia, *Odocoileus virginianus*

Journal of the Southeastern Association of Fish and Wildlife Agencies 2:296–302

Historically, the range of the coyote (*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 species including white-tailed deer (*Odocoileus virginianus*), Northern bobwhite (*Colinus virginianus*), and wild turkey (*Meleagris gallopavo*) are of interest to hunters and wildlife managers, especially in the Southeast where coyotes are a relatively recent addition to the predator community and are becoming increasingly abundant (Lovell et al. 1998, Houben 2004, Kilgo et al. 2010). While fawns can be a major food item for coyotes during the fawning season in the Southeast (Wooding et al. 1984, Schrecengost et al. 2008, VanGilder 2008, Howze 2009), fawns are not always a primary prey item (Gipson 1974, Stratman and Pelton 1997). Several factors including climatic conditions (Andelt et al. 1987), prey abundance (VanGilder et al. 2009), predator abundance (Grovenburg et al. 2011, Kilgo et al. 2010), or the presence of alternative prey (Harrison and Harrison 1984, Andelt et al. 1987) can influence coyote predation on fawns. Therefore, identification of important factors affecting predation rates in different systems is critical to understanding the effects of coyotes on deer populations.

Coyotes have a broad diet in the Southeast which primarily consists of several species of soft mast, small mammals (e.g., rodents and lagomorphs), insects (primarily Orthopterans and Coleopterans), and deer (primarily carrion and fawns), although the relative occurrence of individual items varies among studies. Thus, some have proposed that high availability of non-deer food items may buffer fawn predation (Andelt et al. 1987, Pusateri Burroughs et al. 2006). However, findings from multiple coyote food habits studies suggest that coyotes consume fawns when available, despite the presence of abundant alternative prey (Harrison and Harrison 1984, Schrecengost et al. 2008). In addition, some hypothesize that increased availability of alternative prey supports greater coyote densities, leading to increased fawn predation rates (Patterson et al. 1998, VanGilder et al. 2009). With so many factors potentially affecting fawn predation rates, it is not surprising that coyote use of fawns varies widely across the Southeast. For example, occurrence of deer in coyote scats and stomachs ranged from 9%–74% across seven study sites in Mississippi, Alabama, Tennessee, and Kentucky (Blanton and Hill 1989).

Whether coyote foraging behavior, specifically coyote-fawn predation, is a function of relative or absolute prey (deer) abundance, coyote abundance, habitat or landscape characteristics, or other unspecified ecological interactions is relatively unknown in the Southeast. Therefore, we conducted a descriptive study of seasonal coyote food habits on two sites in central Georgia that were dissimilar in deer density, habitat composition, and alternate prey availability. We predicted that coyote use of fawns would be positively related to deer density, regardless of alternate prey availability, and that occurrence of fawns in coyote scats would be greatest during the fawning season (May–June).

Study Areas

We conducted our research on B. F. Grant (BFG) and Cedar Creek (CC) Wildlife Management Areas (WMA), both managed by the Georgia Department of Natural Resources Wildlife Resources Division. These areas lie in the Piedmont physiographic region of Georgia at an elevation of approximately 140–170 m. Both sites are west of Eatonton in Putnam County, Georgia, and are separated by approximately 8 km.

Forest types on the 4,856-ha BFG WMA consisted of intensively managed plantations of loblolly pine (*Pinus taeda*) in the uplands, while lower-lying areas were comprised of mature hardwood forests dominated by oaks (*Quercus* spp.) and hickories (*Carya* spp.). Due to frequent timber harvest, approximately 800 ha (16%) of the area was early successional habitat. An agricultural research station within the site contained 52 ha (1%) of hay fields and 528 ha (11%) of cattle pasture. Fescue (*Schedonorus arundinaceus*) and Bermuda grass (*Cynodon dactylon*) dominated these areas. Pastures were lightly grazed due to implementation of rotational grazing practices. Collectively, early successional areas consisting of young (<7 years) pine plantations and pastures/fields comprised approximately 28% of the land area on BFG. Because early successional habitats provide preferred habitat for a variety of small mammals (Atkeson and Johnson 1979, Mengak and Guynn 2003), and BFG contained more early successional habitat, we assumed small mammals were more abundant on BFG than CC. Due to restrictions on hunting dates, hunter numbers, and the size of male deer legal for harvest, deer were abundant with an estimated density of 29 deer/km^2 based on Downing's (1980) population reconstruction model (C. Killmaster, Georgia Department of Natural Resources, Wildlife Resources Division, unpublished data).

The 16,187-ha CC WMA lies within the Oconee National Forest. Our study area was limited to a 5,000-ha portion of the WMA lying north of Georgia Highway 212. Forest types consisted of a mixture of mature loblolly pines in the uplands and oak-hickory hardwoods in low-lying areas similar to BFG. However, timber harvest was minimal and forest management was primarily limited to periodic (~3 years) prescribed fire in late winter and early spring, intended to reduce fuel loads for potential wildfires. Although prescribed fire often promotes an herbaceous understory, the canopy cover throughout much of the study area was too great to allow for regeneration of shade intolerant understory plant species. Therefore, only 350 ha (7%) of the site was comprised of early successional areas and <1% of the site was comprised of pastures and/or fields, with the remainder of the area consisting of closed-canopy forest. Because small mammal population densities are extremely low following canopy closure (Langley and Shure 1980), we assumed small mammal abundance on CC was low relative to BFG. Due to no restriction on hunter numbers and greater season lengths, the deer density on CC was approximately 12 deer/km^2 based on Downing's (1980) population reconstruction model (C. Killmaster, Georgia Department of Natural Resources, Wildlife Resources Division, unpublished data). Coyote abundance, estimated using fecal genotyping to noninvasively mark and recapture individual coyotes, was similar between sites during 2010, and no coyote was encountered on both sites (Gulsby et al. 2015). On average, fawn parturition in central Georgia occurred during the months of May and June (C. Killmaster, Georgia Department of Natural Resources, Wildlife Resources Division, unpublished data).

Methods

We collected scats along designated routes on unpaved roads and trails dispersed throughout each study area, totaling 25 km on BFG and 18 km on CC. Scat collection took place weekly from March 2010 to February 2011. Therefore, all scats were ≤7 days old. We identified scats as coyote if they fit published criteria of size, shape, and odor (Murie 1974).

Upon collection, we placed scats in 10.16- × 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 hours, soaked in water, then 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 comparison to reference materials at the University of Georgia Warnell School of Forestry and Natural Resources mammal and seed reference collections as outlined by Schrecengost et al. (2008). We also used dichotomous hair keys (Spiers 1973, Tumlison 1983) as needed.

We separated 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. We used a protocol modified from Williamson (1951) and Bowyer and Curry (1983) to create scale impressions. We placed guard hairs on a plastic cover slip, pressed them between two microscope slides, and heated them in an oven for five minutes on medium heat. After heating, we allowed the press to cool for five minutes and wiped the hair from the slip, leaving a negative impression of cuticular scales.

We estimated the percent of scats (PS) and the percent occurrence (PO) of each food item. 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. Percent of scats data provides an indication of how common a food item is in the diet and how presence of the item compares to other food habits studies (van Dijk et al. 2007), whereas PO can be interpreted as an approximation of the volumetric importance of items in the diet (but see Kauhala et al. 1998). We grouped infrequently occurring items into an 'other' category. Because sample sizes were insufficient to provide precise estimates of diet composition during some months, we pooled data into six two-month seasons. In addition, lack of replication of study areas precluded statistical comparisons of the occurrence of food items. Thus, we present descriptive statistics only.

Results

We analyzed 207 and 146 scats on BFG and CC, respectively, collected between March 2010 and February 2011 (Table 1). Veg-

Table 1. Coyote food habits as percent of scats (a) and percent 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
Didelphis 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

(Table continues)

Table 1. *(cont.)*

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
Didelphis 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 occurrences (b)
* includes leaf fragments and unidentifiable debris

etation comprised the majority of food item occurrences during July–October on CC and during September–October on BFG (Figure 1a), but individual plant species varied by season and study site (Figure 1b). Persimmon occurred in 50.9 PS and 69.2 PS during September–October on BFG and CC, respectively. Muscadines (*Vitis* spp.) occurred in 60.0 PS on CC and 38.2 PS on BFG during September–October. During July–August, blackberries (*Rubus* spp.) were found in 16.7 PS on BFG and 13.3 PS on CC. During the same period, pears (*Pyrus communis*) occurred in 6.3 PS on BFG and 30.0 PS on CC. Grasses (*Poa* spp.) occurred during all seasons, although rarely in large volumes (18.8 PS on BFG and 13.0 PS on CC; Table la).

During November – June on CC and November – August on BFG the coyote diet was dominated by animal prey (Figure 1a), but occurrence of individual taxa varied by season (Figure 1c). During fawning season (May–June), fawns were present in 61.5 PS on BFG and only 26.7 PS on CC (Table 1a). Cottontails (*Sylvilagus* spp.) occurred in minimal amounts (14.0 PS) during all seasons on BFG, whereas cottontail remains were found in only four seasons and 4.8 PS overall on CC. Hispid cotton rat (*Sigmodon hispidus*) was the most frequently occurring small mammal in scats on both sites, but occurred more frequently on BFG (26.1 PS) than CC (8.9 PS). Orthopterans were prevalent during July–August and occurred in 29.2 PS and 23.3 PS on BFG and CC, respectively, during these months (Table 1a).

The most frequently occurring food items changed temporally on each site (Table 1). During March–April, small mammals (45.8 PS) were the most common food item on BFG, followed by deer (21.7 PS) and cottontails (17.4 PS, Figure 2). During the same season on CC, deer and small mammals occurred equally (40.0 PS), followed by rabbit (20.0 PS). During fawning season (May–June), coyote scats on BFG primarily contained deer (64.1 PS), most of

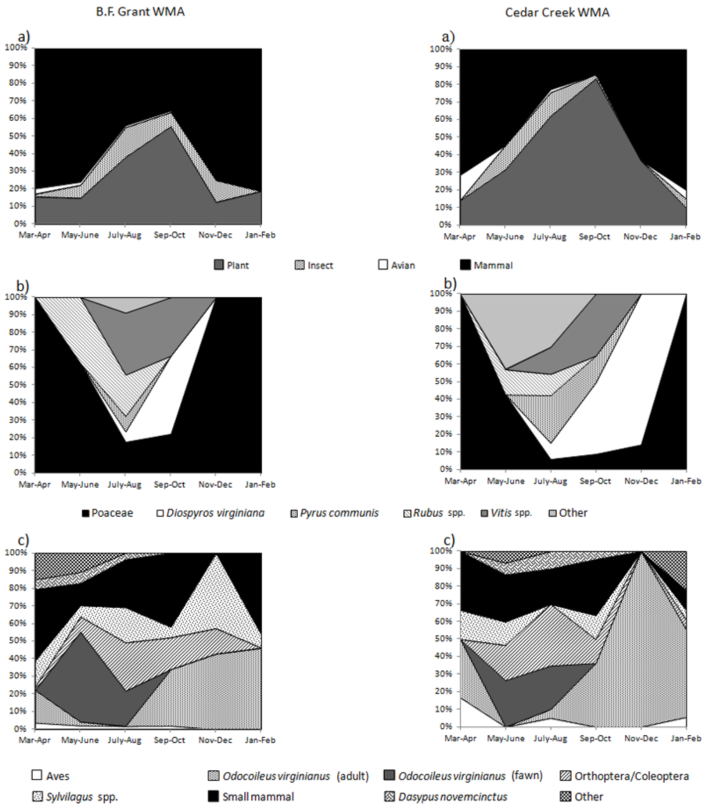

Figure 1. Seasonal percent occurrence of major food item categories (a), plant food items (b), and animal food items (c) by season from coyote scats (n = 353) collected on B.F. Grant and Cedar Creek Wildlife Management Areas in the Georgia Piedmont from March 2010 through February 2011.

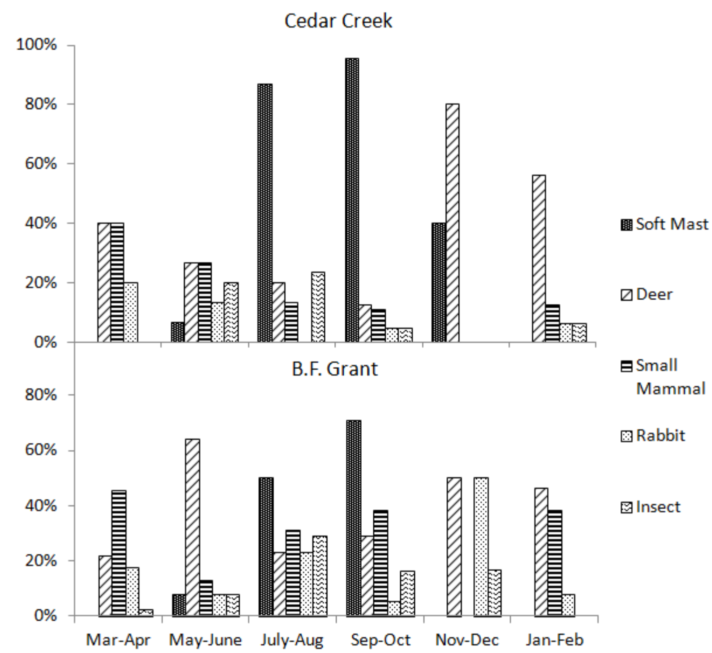

Figure 2. Percent of scats containing major food item categories from coyote scats collected (n = 353) between March 2010 through February 2011 by season on B.F. Grant and Cedar Creek Wildlife Management Areas.

which was fawns. Small mammals occurred in only 13.3 PS during the fawning season on this site. In contrast, fawns were not as common in the coyote diet during fawning season on CC, with small mammals and deer occurring in the same proportion of scats (26.7 PS, Figure 2). Soft mast was the most common item from September–October on BFG (43.0 PS) and CC (76.0 PS). From November–December, the diet composition was mostly deer (50.0 PS) and cottontails (50.0 PS) on BFG and predominantly deer (80.0 PS) and soft mast (40.0 PS) on CC (Figure 2). During January–February, deer, followed by small mammals, was the most important food item on both sites.

Discussion

Our results support those of others (Saalfeld and Ditchkoff 2007, Howze et al. 2009, VanGilder et al. 2009) that coyotes are significant fawn predators in the Southeast. However, our data did not support the hypothesis that alternative prey items (e.g., small mammals or soft mast) serve to buffer coyote predation on fawns. Small mammals were present in a greater PS on BFG than CC during all bimonthly periods (except May–June), which supported our assumption that small mammal abundance was greater there. However, when fawns were most vulnerable (May–June), BFG coyotes switched almost exclusively to fawns. During this same period, small mammals occurred more than twice as frequently in scats on CC, where we assumed fawns were less available due to lower deer density.

During the July–August and September–October periods when most fawns are ≥1 month old and less susceptible to coyote predation (Cook et al. 1971, Porath 1980), soft mast was an important food item on both sites. However, soft mast occurred more frequently in scats on CC, where later successional habitat was more prevalent. Because canopy coverage of muscadine and persimmon is greater in these areas (Andelt et al. 1987), coyote use of soft mast also appeared related to availability.

In our study, occurrence of fawns in coyote scats was better predicted by deer density than availability of alternative prey. This conclusion is substantiated by the findings of Blanton and Hill (1989) who observed that coyote use of fawns was greater in areas with greater deer density, across several Southeastern study sites. Conversely, Stratman and Pelton (1997) found no difference in the occurrence of fawn in coyote scats between high and low deer density areas in northwestern Florida. However, the estimated density (approximately 2.6/km^2) on this landscape's high deer density area was less than half that of our lower deer density site (CC). Therefore, it appears possible that abundance must reach some threshold to observe a proportional relationship between deer density and fawn predation.

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 forage optimally. Prugh (2005) proposed an adaptation to optimal foraging theory 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. In that study, food items were included in the coyote diet in order of net profitability. Several other studies have demonstrated optimal foraging by coyotes in other regions of North America (MacCracken and Hansen 1987, Windberg and Mitchell 1990, Reichel 1991, Patterson et al. 1998, Hernández et al. 2002, Petroelje et al. 2014), but none has demonstrated this in the Southeast. Our data appear to support Prugh's (2005) theory of net profitability. Assuming equal fawning rates between sites, fawns on BFG were likely at a sufficient density to make them a more profitable prey choice than small mammals. In contrast, lower fawn density on CC increased search time and decreased profitability of fawns. Future research quantifying both coyote food item use versus availability of known coyote food items within an area and season is necessary to improve inferences about coyote foraging strategies in the Southeast. Our results suggest that habitat management to increase the availability of small mammals as alternative prey for coyotes may have minimal impact on coyote depredation of white-tailed deer fawns.

Acknowledgments

Funding and support for this project were provided by the Georgia Department of Natural Resources Wildlife Resources Division through the Wildlife Restoration Program, which derives monies through an excise tax on sporting arms and ammunition paid by hunters and recreational shooters.

Literature Cited

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

______, 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.

Cook, R. S., M. White, D. O. Trainer, and W. C. Glazener. 1971. Mortality of young white-tailed deer fawns in south Texas. Journal of Wildlife Management 35:47–56.

Downing, R. L. 1980. Vital statistics of animal populations. Pages 247–267 *in* S. D. Schemnitz, editor. Wildlife management techniques manual. 4th edition. The Wildlife Society, Washington, D.C.

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

Grovenburg, T. W., C. C. Swanson, C. N. Jacques, R. W. Klaver, T. J. Brinkman, B. M. Burris, C. S. Deperno, and J. A. Jenks. 2011. Survival of white-tailed deer neonates in Minnesota and South Dakota. Journal of Wildlife Management 75:213–220.

Gulsby, W. D., C. H. Killmaster, J. W. Bowers, J. D. Kelly, B. N. Sacks, M. J. Statham, and K. V. Miller. 2015. White-tailed deer fawn recruitment before and after experimental coyote removals in central Georgia. Wildlife Society Bulletin in press.

Harrison, D. J. and J. A. Harrison. 1984. Foods of adult Maine coyotes and their known aged pups. Journal of Wildlife Management 48:622–626.

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.

Houben, J. M. 2004. Status and management of coyote depredations in the eastern United States. Sheep and Goat Research Journal 9:16–22.

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.

______, 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.

Kauhala, K., P. Laukkanen, and I. von Rege. 1998. Summer food composition and food niche overlap of the raccoon dog, red fox and badger in Finland. Ecography 21:457–463.

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.

Langley, A. K., Jr. and D. J. Shure. 1980. The effects of loblolly pine plantations on small mammal populations. American Midland Naturalist 103:59–65.

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.

Mengak, M. T. and D. C. Guynn, Jr. 2003. Small mammal microhabitat use on young loblolly pine regeneration areas. Forest Ecology and Management 173:309–317.

Murie, O. J. 1974. A Field Guide to Animal Tracks. Second edition. Houghton Mifflin Company, Boston, Massachusetts.

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.

Petroelje, T. R., J. L. Belant, D. E. Beyer, Jr., G. Wang, and B. D. Leopold. 2014. Population-level response of coyotes to a pulsed event. Population Ecology 56:349–358.

Porath, W. R. 1980. Fawn mortality estimates in farmland deer range. Pages 55–63 *in* R. L. Hine and S. Nehls, editors. White-tailed Deer Population Management in the Northcentral States. Proceedings of the 1979 Symposium of the North Central Section of The Wildlife Society, Urbana, Illinois.

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

Pusateri Burroughs, J., III, H. Campa, S. R. Winterstein, B. A. Rudolph, and W. E. Moritz. 2006. Cause-specific mortality and survival of white-tailed deer fawns in southwestern lower Michigan. Journal of Wildlife Management 70:743–751.

Reichel, J. D. 1991. Relationships among coyote food habits, prey populations, 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. M.S. thesis, Virginia Polytechnic Institute, Blacksburg.

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.

_____, 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.

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.