Coyote Use of White-tailed Deer Fawns in Relation to Deer Density

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Abstract: We determined summer diets of coyotes (*Canis latrans*) from analysis of 523 scats and 9 stomachs collected on 7 study areas in Mississippi, Alabama, Kentucky, and Tennessee from May 1985 to September 1986. We compared coyote diets among 4 areas where white-tailed deer (*Odocoileus virginianus*) occurred in high densities (HDA's) and 3 areas with low deer densities (LDA's) during pre-fawning, fawning, and post-fawning periods on each study area. Important coyote foods (by frequency of occurrence) were fruit (45.7%), insects (36.5%), rabbit (*Sylvilagus ssp.*, 31.6%), deer (30.8%), and rodents (23.5%). During fawning, deer were the most frequent ($\bar{x}$ = 74.2%) major food item on the HDA's, and the least frequent ($\bar{x}$ 8.8%) major food item on the LDA's. Summer use of deer was largely fawns (76.9%) and occurred in peaks corresponding to the local fawn drop. Significantly greater use of fawns occurred during fawning and post-fawning than in pre-fawning on the HDA's. The patterns of food use exemplified the opportunistic feeding behavior of coyotes.

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The diet of coyotes has been of interest to wildlife biologists, farmers, and ranchers, and many studies in the western United States have assessed the impact of coyotes on wildlife and livestock (Sperry 1941, Korschgen 1957, Litvaitis and Shaw 1980). Since the early 1960s, the coyote has become established in the southern United States and now occurs in every southeastern state (Paradiso 1966, Gipson 1978, Hill et al. 1987). Regional coyote populations are increasing rapidly in both range and density (Hill et al. 1987; P. W. Sumner, N.C. Wildl. Resour. Comm., pers. commun. 1989). For example, the estimated harvest of coyotes by trappers

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and hunters in Mississippi increased from <500 in 1975 to 41,847 in 1986–87 (Steffen 1987).

The coyote is an omnivorous, opportunistic predator and scavenger and is able to respond to changing food availability or prey vulnerability (Bekoff 1977, Van Vuren and Thompson 1982). Major foods include lagomorphs, rodents, ungulates, and domestic livestock (Sperry 1941, Hawthorne 1972, Hamilton 1974). Some studies have reported that coyotes are significant predators on white-tailed deer and mule deer (*O.hemionus*) and are the major factor regulating some herds (Cook et al. 1971, Stout 1982, Hamlin et al. 1984). However, coyote-deer relations are area-specific; some herds suffer no apparent detrimental effects (Ozoga and Harger 1966, Westmoreland and Woolf 1981). Although coyotes may kill adult deer, most predation occurs on fawns (Steigers and Flinders 1980, Bartush and Lewis 1981).

Regional studies of coyote food habits (Wilson 1967, Gipson 1974, Michaelson 1975, Hall 1979, Smith and Kennedy 1983, Wooding 1984, Lee 1986) have not been directed specifically at coyote-deer relationships, and sampling in some studies was inadequate to address summer foods. Therefore, our objectives were to determine the summer diet of coyotes on areas representative of the southeastern United States in months preceding, during, and following the peak of deer fawning, and to compare the coyote diet among areas of relatively high and low deer density.

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Study Areas

Study areas were selected on the basis of location, relative population densities of white-tailed deer, the presence of an established coyote population, and geographic features (roads, levees, etc.) that would facilitate the collection of coyote scats. Recent deer harvest records, conservation agency population estimates, and opinions of resident or district wildlife biologists (Table 1) were considered in classifying areas as HDA's or LDA's. Observations of deer and deer sign on each area during the course of the study were consistent with area classifications.

Four HDA's were selected, 1 each at Land Between the Lakes, Kentucky-Tennessee (LBL); Noxubee National Wildlife Refuge, Mississippi (NNWR); Thomas Wildlife Management Area, Alabama (TWMA); and Sumter Farms, Alabama (SF). Three LDA's were selected: the Divide Section Wildlife Management

Table 1. Characteristics of areas with high and low population densities of white-tailed deer where summer foods of coyotes were studied in 1985 and 1986.

Area[a]	Size (ha)	Deer harvests[b]		Source[c]
		Annual	Deer/ha	
		High density areas		
LBL	68,000	1,799	1/38	D. Sharp, TVA
NNWR	19,021	433	1/44	J. Burnett, USFWS
SF	2,904	119	1/24	D. Everett, SF
TWMA	12,270	252	1/48	K. McKutchen, ADCNR
		Low density areas		
DSWMA	4,007	0	—	R. Wilson, MDWC
RHOB	10,117	56	1/180	R. Wilson, MDWC
PC	4,251	<10	<1/425	R. Wilson, MDWC

[a]LBL, Land Between The Lakes; NNWR, Noxubee National Wildlife Refuge; SF, Sumter Farms; TWMA, Thomas Wildlife Management Area; DSWMA, Divide Section Wildlife Management Area; RHOB, Red Hill/Ole Blue Hunting Clubs; PC, Prentiss County Study Area.

[b]5-year means.

[c]Area Wildlife Biologists; TVA, Tennessee Valley Authority; USFWS, US Fish and Wildlife Service; ADCNR, Alabama Department of Conservation and Natural Resources; MDWC, Mississippi Department of Wildlife Conservation.

Area (DSWMA), Red Hill/Ole Blue Hunting Club (RHOB), and Prentiss County Study Area (PC) in northeastern Mississippi. Detailed descriptions of the study areas were given by Blanton (1988).

Methods

Scat/Stomach Collection and Analysis

Scats were collected in months before, during, and after the fawn drop in 1985 and 1986. Peak fawn drop on the Mississippi areas was in late July or early August (Jacobson et al. 1979). On the 2 Alabama areas, the peak fawning period was the first or second week in August (Lueth 1967). Unpublished data suggested that the peak fawning period was mid-June at the LBL (D. Sharp, pers. commun.). Data collection began approximately 1.5 months before the estimated peak fawn drop and continued for 1.5 months after the peak. All samples collected more than 15 days prior to the estimated peak fawning date were placed in the pre-fawning category, samples collected in the 1-month period surrounding the peak fawning date were placed in the fawning category, and the post-fawning samples were those collected >15 days after peak fawning.

Freshly deposited coyote scats were collected at 1- to 2-week intervals along roads, trails, levees, and field borders. Scats were identified by size and general appearance (Murie 1954), odor, and using nearby tracks. Initially, the routes were searched before the first collection period to remove all old scats, but that was unnecessary once we gained experience determining relative ages of scats.

Scats were hand-washed in 0.35-mm mesh nylon bags to remove fecal material, dried, and the undigested food items identified. Hair was identified using reference hair slides of possible prey species and keys by Spiers (1973) and Moore et al. (1974). Fawns were distinguished from adult deer by using body parts and the length, diameter, and color of the hair. Seeds were identified using reference materials collected in the field.

Coyote stomachs were collected by trapping coyotes using scent-post sets, shooting at night with the aid of a spotlight, and soliciting carcasses from farmers and landowners. Stomach contents were analyzed using procedures described by Korschgen (1980). Scat samples (98.3% of all samples) and stomach samples (1.7%) were pooled because comparable results were obtainable from both approaches (Fichter et al. 1955, Korschgen 1957), particularly with respect to deer occurrence (Wooding 1984).

Data Analysis

The percent occurrence of all food items was tabulated for all study areas combined for both summers. The percent occurrence of 5 major food categories also was tabulated by period of collection for each study area.

A split-plot analysis of variance (ANOVA) was used to compare HDA's to LDA's for each of 5 major food categories using the GLM program of SAS (SAS 1986). In this design, each level of the first factor (levels of deer density) was assigned to a whole plot, and each whole plot received every level of the second factor (collection periods). The individual study areas were the experimental units, and the analysis was performed using the percent occurrence of the particular food item on each area. Because the data are binomial, an arcsin transformation was conducted, and the analysis was performed on both the raw and transformed data (Steel and Torrie 1980:236). When the ANOVA indicated differences ($P < 0.05$) between collection periods, Tukey's W (Steel and Torrie 1980:185) was used at ($P < 0.05$) to separate means and determine which periods differed. When the ANOVA indicated a significant interaction between level of deer density and collection period for a particular food item, multiple t-tests were used at ($P < 0.05$) to compare collection period differences within each deer density, and deer density differences within each collection period.

Results

Coyote scats ($N = 523$) and stomachs ($N = 9$) were collected from May–September 1985 and June–September 1986 and analyzed. The sample size from individual study areas included: LBL (82), NNWR (40), SF (64), TWMA (117), DSWMA (127), RHOB (52), and PC (50).

Rabbit was the most frequently occurring summer food item, followed by deer, grasshoppers, and persimmon (Table 2). Rodents occurred in 23.5% of the samples. Fruit was an important part of the diet (45.7%), although no single species occurred in >20% of the samples. Blackberries, pokeberries, persimmon, and corn made up

Table 2. Summer diet of coyotes determined from 523 scats and 9 stomachs collected from 7 study areas in Mississippi, Alabama, Tennessee, and Kentucky from May–September 1985 and June–September 1986.[a]

Food item	% occurrence
Mammals	
Rabbits	31.6
Deer[b]	30.8
Rodents	
Cotton rat (*Sigmodon hispidus*)	5.5
Muskrat (*Ondatra zibethicus*)	2.3
Squirrels (*Sciurus spp.*)	2.1
Other and unknown rodents	13.5
Other and unknown mammals	11.3
Fruit	
Persimmon (*Diospyros virginianus*)	19.5
Pokeberry (*Phytolacca americana*)	7.9
Blackberry (*Rubus spp.*)	7.5
Corn (*Zea* spp.)	5.1
Other and unknown fruit	14.5
Insects	
Grasshoppers (*Orthoptera*)	26.5
Other and unknown insects	14.7
Birds	10.3
Miscellaneous	7.5

[a]For a complete list of foods identified, see Blanton (1988).
[b]May include fallow deer (*Dama dama*) from the LBL study area.

a large percentage of the diet on some areas. Insects ranked high in percent occurrence (36.5%), but usually occurred in small volumes (except for grasshoppers). Except for chickens, birds were not identified beyond class (Table 2). The most common miscellaneous items were eggshells (including reptile), grass, and garbage.

Of the 5 major food items tested in the ANOVA, the only significant interaction between levels of deer density and collection period was for deer ($P < 0.001$), indicating that differences in deer occurrence between the HDA's and LDA's varied with collection period. There was no change ($P < 0.05$) in deer occurrence across collection periods on LDA's, while on the HDA's deer occurred more frequently ($P < 0.05$) in the diet during fawning and post-fawning periods than pre-fawning (Table 3). Occurrence of deer remains was greater on HDA's than LDA's during the fawning and post-fawning periods, while there was no difference during the pre-fawning period ($P < 0.05$). No other food items differed ($P < 0.05$) in occurrence between HDA's and LDA's (Table 3). Rodent occurrence was higher in the pre-fawning period than either the fawning or post-fawning periods for both HDA's and LDA's (Table 3).

Most (76.9%) of the deer occurrences were fawns, whereas 1.2% were adults and 21.9% were of unknown age. Occurrence of deer during the fawning period

Table 3. Mean occurrence (%) of 5 major coyote food categories as determined from 523 scats and 9 stomachs collected on 4 high deer density areas (HDA's) and 3 low density areas (LDA's) in the southeastern United States from May–September 1985 and June–September 1986.[a]

Food item	Deer density	Collection period: Pre-fawning $\bar{x}$	Pre-fawning (*N*)	Fawning $\bar{x}$	Fawning (*N*)	Post-fawning $\bar{x}$	Post-fawning *N*	Total
Deer[b]	HDA'S	7.1A	(70)	74.2B	(132)	58.5B	(101)	46.6
	LDA'S	2.4A	(52)	8.8A	(91)	12.9A	(86)	8.0
	Total	5.1		46.1		39.0		30.1
Rabbit[c]	HDA'S	33.9		14.5		18.8		22.4
	LDA'S	41.0		43.2		37.5		40.5
	Total	36.9A		26.8A		26.8A		30.2
Rodent[c]	HDA'S	37.3		11.6		21.4		23.5
	LDA'S	32.2		21.6		7.8		20.5
	Total	35.1A		15.9B		15.6B		22.2
Insect[c]	HDA'S	20.8		26.4		14.7		20.6
	LDA'S	38.1		52.6		60.6		50.4
	Total	28.2A		37.6A		34.4A		33.4
Fruit[c]	HDA'S	39.9		23.6		39.3		34.3
	LDA'S	51.3		41.5		65.3		52.7
	Total	44.8A		31.3A		50.4A		42.2

[a]Sample size for each cell is shown in parentheses.

[b]For deer; Excluding totals, means within a row followed by different letters are significantly different, and means within a column followed by different letters are significantly different ($P < 0.05$).

[c]Within each food group, means (total) followed by different letters are significantly different ($P < 0.05$).

was highest on NNWR (88.2%) followed by SF (75.0%), and LBL (70.9%). On the TWMA, deer occurrence peaked during the post-fawning period (70.8%).

Discussion

Our results suggest that the coyote can immediately exploit seasonal foods as they become available. Deer fawns were a more important component of the summer diet of coyotes on HDA's than on LDA's. The occurrence of deer (30.8%) in the summer diet was similar to rates reported elsewhere in the southeastern United States (Hall 1979, Wooding 1984). However, the seasonal rate of deer occurrence on most HDA's was characterized by peak usage during fawning and post-fawning, with little or no use during the pre-fawning period.

A decrease in the occurrence of other foods, particularly rabbits and rodents, as deer fawns became available also was observed on HDA's. MacCracken and Hansen (1987) noted that diet selection is influenced not only by food availability, but also by handling costs (time and effort needed to capture and ingest prey), and by the profitability of the prey (energy and nutrients obtained). This relationship may partly account, in our study, for the decrease in occurrence of rabbits and

rodents on the HDA's when deer fawns became available (Table 3). Harrison and Harrison (1984) hypothesized that low rodent populations on a heavily forested area in Maine made it more efficient for coyotes to catch and transport deer fawns to their pups than to catch sufficient quantities of small rodents, suggesting that demands of pup rearing may also influence coyote diet selection.

The occurrence and perhaps importance of rodents and lagomorphs in coyote diets in this study was slightly less than in most studies in the original range of the coyote (Pederson and Tuckfield 1983, Lee 1986). Results are not directly comparable because most of these studies report annual rather than summer diets. Although rabbits were similar in importance, rodents were less important overall (23.5%) in this study than in the summer samples collected by Wooding (1984) in Mississippi and Alabama (approximately 38%) and Hall (1979) in Louisiana (30.2%). The occurrence of fruit, especially persimmon, was consistent with levels reported by Wooding (1984) and Hall (1979).

Management Implications

Although this and similar studies have not quantified the level of coyote predation on deer, we measured the extent of fawns in the coyote's diet, an important indicator of predation. The magnitude of fawn occurrence in the coyote's diet should alert managers to the coyote's potential to influence deer herd dynamics in the southeastern United States.

In response to restocking and management programs, the white-tailed deer has increased dramatically over the last 3 decades in the southeast. Most of this increase occurred before coyote populations were established and expanded. As coyote numbers increase regionally, managers must assess impacts on native wildlife and agricultural commodities.

Because densities of many deer herds are near or exceed habitat carrying capacity, coyote predation on fawns may be locally beneficial. However, if high, sustained deer harvests are a management goal, the role of the coyote as an opportunistic predator must be considered. In areas where deer populations are low, biologists should consider habitat factors and illegal hunting as possible causes. However, because coyote predation has the potential to influence deer populations, managers of LDA's should closely monitor occurrence rates of fawns in summer diets of coyotes. We believe that regional deer management will become increasingly challenging as coyote populations develop to maximum densities.

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