Food Habits of Coyotes in Northwestern Florida

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Abstract: Recent declines in deer densities in some areas of Eglin Air Force Base (AFB), Florida, have prompted concerns regarding the impact of coyote *(Canis latrans)* predation. We determined the food habits of coyotes from analysis of 166 scats collected on Eglin AFB from November 1994 to October 1996. We compared the frequency of white-tailed deer *(Odocoileus virginianus)* remains found in scats collected in high- and low-deer density areas during the deer fawning season to evaluate impacts of coyotes on white-tailed deer. Important coyote foods (by frequency of occurrence) were shrub/vine fruit (80%), beetles (55%), persimmon (27%), and deer (15%). Deer occurred most often (29%) during the fawning season. There was no difference in the frequency of deer remains found in scats collected in high- and low-deer density areas. The dominance of soft mast in the diet illustrates the important role that soft mast can play in the diet of coyotes.

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Coyotes are generally considered animals of the western plains (Webster et al. 1985). As eastern forests were cleared and converted to farm land, the resulting patchwork of field and brushy edges created suitable habitat for this opportunistic mammal. Coyotes have increased dramatically in the southeastern United States since 1972, and now occur in every southeastern state (Gipson 1978, Hill et al. 1987).

The distribution of coyotes in the eastern United States was likely facilitated by releases by humans (Gipson 1978). Twenty incidents were identified in the southeastern U.S. where coyotes were released or escaped (Hill et al. 1987); 5 of these occurred in Florida. Today, coyotes are found throughout northwestern Florida and scattered locations in the central and northern portions of the state (Hill et al. 1987).

Coyotes are omnivorous, opportunistic predators and scavengers taking a variety of animal prey, including lagomorphs, rodents, birds, ungulates, and domestic livestock (Sperry 1941, Wooding et al. 1984, Blanton and Hill 1989). They also may

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consume significant amounts of carrion. Some studies reported that coyotes are significant predators on white-tailed deer 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 and some herds suffer no apparent detrimental effects (Ozoga and Harger 1996, Nixon et al. 1991).

Eglin AFB is a 185,600-ha military installation located in northwestern Florida. Eglin AFB lies east of Pensacola and occupies parts of Santa Rosa, Okaloosa, and Walton counties. Over one-third of the base is open to public recreation, including hunting. Annual surveys of deer track counts indicate that in recent years, the density of white-tailed deer in some areas of the base has declined (J. Johnson, Eglin AFB, pers. commun.). Hunters have expressed concern that coyotes are responsible for the low deer density in these areas. This study was initiated to determine the food habits of coyotes and assess potential impacts of this species on white-tailed deer on Eglin AFB.

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Methods

We collected coyote scats on roads throughout Eglin AFB from November 1994 to October 1996. Roads were not cleared prior to collection because many of the roads were traveled on a daily and weekly basis. Therefore, we were confident that scats were deposited within a 1-week period. Also vehicle traffic, frequent rains, and rapid decomposition made scats >1 week old too difficult to identify and incomplete for collection. Although some areas were visited every 2–3 weeks for scat collection, we are confident that the scats collected were also <1 week old.

We identified scats based on a combination of: tracks, which distinguished coyotes from foxes, bobcats, and domestic dogs; odor, which was identifiable to coyote scats; and size, which eliminated most large and small mammals. Scats that could not be identified as coyote were not collected.

Scats were placed in plastic bags, labeled by date and location, and frozen. Scats were thawed and washed through a series of wire mesh sieves to separate food items of various sizes. We determined frequency of occurrence (%) and visually estimated percent volume for each food item in each scat. We identified food items to species whenever possible. Hair and fruit were identified using known reference collections and insects were identified by the Florida State Collection of Arthropods, University of Florida. A reference collection of white-tailed deer hair was used to distinguish between adults and fawns. We grouped food items into 7 food types: tree fruit, shrub/vine fruit, invertebrate, mammal, avian, vegetation (grasses, forbs, and other live plant material), and debris (sand, bark, twigs, pine needles, rocks, and dead leaves).

We determined seasons by plant phenology and changes in coyote food habits. Season dates were: spring, 1 February–30 April; summer, 1 May–30 July; early fall,

1 August–15 October; and late fall, 16 October–30 January. Because fawning occurs in late August and September (Petrick et al. 1994), we divided fall into an early and late season to separate the deer fawning season and the deer hunting season.

During the early fall season, we collected scats primarily in 2 areas. One area (85 km^2) had a high deer density (1/24 ha) and the other (202 km^2) (1/40 ha) (McWhite et al. 1993, J. Johnson, Eglin AFB, pers. commun.). The 2 areas were similar in habitat composition and separated by a 4-lane highway. Because movement rates by coyotes were highest near sunrise and sunset (Summer et al. 1984), which coincided with peak traffic times, we assumed movements by coyotes between the areas was minimal. In Alabama and Mississippi, coyote home ranges varied from 12 to 41 km^2 depending on the sex and age of the animal (Summer et al. 1984), and in Georgia, home ranges varied from 7 to 28 km^2 (Holzman et al. 1992). Therefore, we felt the study areas were of sufficient size that the scats collected represented multiple animals.

The densities for both study sites were determined from surveys of deer track counts (McWhite et al. 1993). Because track counts are typically used as indices of abundance (Davis and Winstead 1980), we do not consider the estimates to be the actual deer densities of either study site. Because track count surveys can show changes in population size (Davis and Winstead 1980), we feel the 2:1 ratio in track counts between the 2 areas closely approximates the actual difference in densities between the 2 study areas. The difference in densities between the 2 areas also is reflected in the harvest data. Nearly twice as many deer are harvested annually from the high-density area (J. Johnson, Eglin AFB, pers. commun.). We used χ^2 analysis to determine if there was a difference in the relative proportion of deer occurring in coyote scats between the high-density and low-density areas during the early fall season. Although we assumed coyote movements between the 2 areas was minimal, we removed the scats collected within 3.2 km of the 4-lane highway from the data set and calculated a new χ^2 value.

Results

We collected 166 scats on Eglin AFB during the study period and identified 22 food items. Data were pooled across years. Annually, 81% of the coyote scats was of plant origin, with 63% composed of shrub/vine fruit. Spring scats were dominated by smilax berries (*Smilax* spp.; Table 1). Smilax berries occurred in 75% of the spring scats and accounted for 68% of the scats by volume. Animal matter [beetles (Coleoptera) (25%), white-tailed deer (13%), and wild hog *(Sus scrofa)* (13%)] occurred in half of the spring scats and accounted for 30% of the volume.

The summer scats were dominated by shrub/vine fruit. Blackberry (*Rubus* spp.) and blueberry (*Vaccinium* spp.) comprised 83% of the summer scats by volume and occurred in 81% and 71% of the scats, respectively. Invertebrates, primarily beetles (76%), occurred most often in summer scats. White-tailed deer remains were not found in the summer scats examined.

The early fall scats also were dominated by shrub/vine fruit. Saw palmetto berries *(Serenoa repens)* and blueberry occurred in 60% of the early fall scats and ac-

Table 1. Frequency of occurrence (F; %) and volume percent (V; %) of items identified in 166 coyote scats collected on Eglin Air Force Base, Florida, November 1994 to October 1996. Data were pooled across years.

	Spring ($N = 8$)		Summer ($N = 58$)		Early fall ($N = 77$)		Late fall ($N = 23$)		Total ($N = 166$)	
Food item	F	V	F	V	F	V	F	V	F	V
Tree fruit	0	0	0	0	49	31	17	16	27	17
Diospyros virginiana					53	30	17	16	27	16
Prunus serotina					4	1			2	T[a]
Shrub/vine fruit	75	70	96	83	68	45	78	73	80	63
Gaylussacia spp.					3	T			1	T
Ilex coriacea					4	3			1	1
Licania michauxii					9	1			4	T
Rubus spp.			81	63					28	22
Serenoa repens	50	3			39	25	65	64	30	21
Smilax spp.	75	68					13	9	5	4
Vaccinium spp.			71	20	21	15			35	14
Vitis rotundifolia			2	T	5	1			3	T
Invertebrate	25	5	76	11	51	10	35	2	56	9
Coleoptera	25	5	72	10	50	10	35	2	55	9
Orthoptera			10	1	13	T			10	T
Mammal	25	25	9	2	39	10	13	4	22	7
Didelphis virginianus					1	1			1	1
Odocoileus virginianus	13	13			29	5	13	4	15	4
Sigmodon hispidus			5	1					2	T
Sus scrofa	13	13							1	1
Sylvilagus floridanus			3	1	4	3			3	1
Mammal—Unknown					5	1			2	1
Avian	0	0			4	T	4	T	5	1
Meleagris gallapavo			2	T			4	T	1	T
Avian—unknown			7	3	4	T			4	1
Vegetation	0	0	2	T	5	T	13	4	5	1
Debris	0	0	14	1	24	4	9	1	17	2

a. Trace amount (<1.0%).

counted for 40% of the scats by volume. Persimmon *(Diospyros virginiana)* occurred in 53% of the scats examined and accounted for 30% of the early fall scats by volume. Animal matter was dominated by beetles, which occurred in 50% of the early fall scats and accounted for 10% of the volume. Deer hair occurred in 29% ($N = 22$) of early fall scats. One adult deer and 21 fawns were identified from deer remains found in early fall scats. There was no difference in the frequency of deer found in scats between the high-density and low-density areas ($\chi^2 = 1.17$, 1 *df*, $P = 0.28$). After removing the scats collected within 3.2 km of the 4-lane highway, χ^2 analysis also showed no difference in the frequency of deer found in scats between the high-density and low-density areas ($\chi^2 = 1.99$, 1 *df*, $P = 0.15$).

The late fall scats of coyotes on Eglin AFB were dominated by saw palmetto

fruit. Saw palmetto fruit accounted for 64% of the late scats by volume and occurred in 65% of the scats examined. Persimmon accounted for 16% of the late fall scats by volume. Deer hair occurred in 13% ($N = 3$) of the late fall scats. All of the deer hair found in late fall scats were identified as adult deer.

The presence of saw palmetto fruit in the early fall and late fall scats occurred in 1996 and 1994, respectively. In 1995, a mast failure occurred and no palmetto berries were found in scats. The early fall scats in 1995 were dominated by blueberry and persimmon, which occurred in 86% of the scats and accounted for 46% of the volume. The late fall scats in 1995 were dominated by persimmon and smilax berries, which accounted for 71% of the volume.

Discussion

The high volume of soft mast consumed by coyotes on Eglin AFB illustrates the important role that soft mast can play in the diet of this species in Florida. Soft mast in the diet of coyotes is 30% higher than reported from any other study on the species in the Southeast (Arkansas: Gipson 1974; Louisiana: Hall 1979; Alabama and Mississippi: Wooding et al. 1984, Blanton and Hill 1989; Kentucky: Blanton and Hill 1989; Tennessee: Lee 1986, Blanton and Hill 1989, Gabor 1993). However, results are similar to that reported for gray foxes *(Urocyon cinereoargenteus)* and red foxes *(Vulpes vulpes)* in Tennessee (Greenberg and Pelton 1991). The seasonal importance of persimmon in our study is similar to that found in Arkansas (Gipson 1974), Tennessee (Gabor 1993), and Alabama and Mississippi (Wooding et al. 1984), but 26%–33% higher than reported by Hall (1979) for Louisiana and by Blanton and Hill (1989) for Alabama, Mississippi, Kentucky, and Tennessee. The seasonal availability of persimmons was believed to reduce fall activity and movement rates of coyotes in Alabama and Mississippi (Summer et al. 1984).

This study is the first to report significant amounts of saw palmetto berries and blueberries in the diets of coyotes. The importance of blackberries in the summer diet of coyotes at Eglin AFB is higher than reported for summer diets in Alabama, Mississippi, Kentucky, and Tennessee (8%; Blanton and Hill 1989) and Louisiana (12%; Hall 1979). The high consumption of blackberry, blueberry, and saw palmetto berries illustrates the ability of coyotes to exploit a variety of vegetative resources in the region.

The occurrence of animal matter in the scats of coyotes on Eglin AFB is nearly 70% less than reported from other coyote food habits studies in the Southeast (Wooding et al. 1984). Rabbits and rodents have been shown to be important components of coyote diets in other regions of the Southeast (Wooding et al. 1984, Blanton and Hill 1989). The higher volume of soft mast consumed may indicate a lack of abundant small mammalian prey. Although differences in digestibility between meat (highly digestible) and soft mast (less digestible) probably led to an underestimate of animal matter and an overrepresentation of fruit in the diet, it is unlikely that the differences are large enough to change the overall results of the study. Other studies cited above contended with differential digestibility of food items, yet reported much higher occurrence of animal matter in scat samples.

Beetles occurred more often than all other animal matter combined. In Tennessee, food habits of gray foxes and red foxes also showed a 2-fold difference in occurrence rates between invertebrates and mammals (Greenberg and Pelton 1991). Because of the low occurrence of mammals, coyotes may be using invertebrates as an alternative source of protein during most of the year.

Deer occurrence (15%) was similar to that found in Louisiana (Hall 1979) and Tennessee (Gabor 1993), but less than that reported for Arkansas (22%; Gipson 1974), Alabama and Mississippi (29%; Wooding et al. 1984, Blanton and Hill 1989), Kentucky (29%; Blanton and Hill 1989), and Tennessee (29%; Lee 1986, Blanton and Hill 1989). Deer occurred most often in early fall (29%); this coincided with the fawning period and was consistent with coyotes seeking vulnerable fawns and exploiting the increase in available food. The deer and hogs consumed in late fall and spring were probably carrion because the deer hunting season started at the beginning of the late fall season and ended in February. In addition, the frequent occurrence of deer in early fall scats may over-represent mortality of deer caused by coyotes. Coyotes may feed on a deer kill for several days or scavenge on other kills (e.g. roadkill, natural mortality, predation by other coyotes).

The effects of a fruit-based diet on population dynamics of coyotes in the region is unknown. However, coyotes have inhabited the region for many years and the population appears to be stable to slightly increasing (J. Johnson, Eglin AFB, pers. commun.). Coyotes may be able to obtain adequate nutrients from other food sources in the absence of abundant prey species. These alternative foods may reduce coyote predation on deer and small mammals. Increasing soft mast production would benefit other wildlife species while providing managers a potential alternative method for managing coyote populations. Managers should be aware of potential increases in coyote predation during years of significant soft mast failures, particularly on deer fawns during the early fall season. Fawn recruitment rates and cause-specific mortality should be determined to have a better understanding of the role of coyote predation.

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