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## **Coyote Food Habits at DeSoto National Wildlife Refuge, Nebraska**

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**ABSTRACT** – Coyote (*Canis latrans*) food habits were determined from 490 scats collected from October 1994 to October 1995 at DeSoto National Wildlife Refuge (DNWR), along the Nebraska/Iowa border. Mammals occurred most frequently, as measured by percent-of-scats (POS), followed by vegetation, birds, and invertebrates. Mammals also constituted the largest portion of coyote diet, as determined by fresh weight correction factors. Within the mammalian category, white-tailed deer (*Odocoileus virginianus*) occurred most frequently and constituted the largest portion of diet by fresh weight correction factors. White-tailed deer occurrence and importance in diet peaked in June, which corresponds to the fawning period of white-tailed deer at DNWR. Mammals occurred in greater than 75 POS in all months except July and August, when mammals occurred in 38 and 30 POS, respectively. In July and August, vegetation in coyote scats, primarily mulberries (*Morus* spp.), was highest at 88 and 83 POS, respectively. Invertebrate occurrence peaked in May and in September. Bird occurrence peaked in December, which corresponded with the snow goose (*Chen caerulescens*) migration, and May, which corresponded with the nesting period for several species of ground nesting birds.

**Key words:** correction factors, diet, food habits, prey, coyote, *Canis latrans*.

In the prairie region of the central United States, the coyote (*Canis latrans*) is one of the most important mammalian predators (Brillhart and Kaufman 1994). As a predator, the role of the coyote in the biological community holds great interest, particularly with respect to management issues of conservation, control, and harvest (Caughley and Sinclair 1994).

Food habit studies are fundamental for determining the roles of organisms in their communities. Many studies of coyote food habits have been conducted (e.g. Meinzer et al. 1975, Bowyer et al. 1983, Harrison and Harrison 1984, MacCracken and Uresk 1984, Toweill and Anthony 1988, Brillhart and Kaufman 1994). These studies range in purpose from ascertaining the effects of coyote predation on human resources, such as livestock, to investigating the behavioral ecology of coyotes in response to seasonal changes in food availability. Studies have been conducted in various regions throughout the United States and consequently, in many different types of habitat. However, specific information is lacking on the food habits of coyotes in the Missouri River Valley of the Great Plains. The purpose of our study was to gain an understanding of coyote food habits at DeSoto National Wildlife Refuge (DNWR). Our study was conducted in conjunction with a study on the DNWR white-tailed deer (*Odocoileus virginianus*) population in which there was an interest in determining the effects of coyotes on deer, particularly during the fawning season.

### STUDY AREA

DeSoto National Wildlife Refuge is located on the floodplain of the Missouri River between Blair, Nebraska and Missouri Valley, Iowa. The 3166-ha refuge is composed primarily of floodplain forest, reestablished native grasslands, and agricultural fields. Floodplain forest constitutes 1100 ha of the refuge and is characterized by aging cottonwoods (*Populus deltoides*) being replaced by more shade-tolerant species, including rough-leaved dogwood (*Cornus drummondii*), hackberry (*Celtis occidentalis*), mulberry (*Morus* spp.), and green ash (*Fraxinus pennsylvanica*). The ground layer in the floodplain forest is dominated by poison ivy (*Toxicodendron radicans*) and horsetail (*Equisetum* spp.). The approximately 150 ha of reestablished native grassland include big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), little bluestem (*Schizachyrium scoparium*), and sideoats grama (*Bouteloua curtipendula*). Under cooperative farming agreements, approximately 1000 ha of the refuge are managed for crops, including nearly equal amounts of corn, soybeans, and a forage-legume mixture. About 100 ha of wildlife food plots, consisting of a legume mixture as well as milo and wheat, are planted each year.

DeSoto National Wildlife Refuge also contains a 300 ha lake that serves as the primary attraction for hundreds of thousands of waterfowl, such as snow geese (*Chen caerulescens*), mallards (*Anas platyrhynchos*), and blue-winged teal (*A. discors*), which pass through the refuge every year. Other wildlife that are abundant on the refuge include white-tailed deer, raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), opossum (*Didelphis virginiana*), eastern

cottontail (*Sylvilagus floridanus*), mice (*Peromyscus* spp.), and voles (*Microtus* spp). Densities of mammals found on the refuge are unknown with the exception of white-tailed deer, which varies in density from 15 to 25 deer/km<sup>2</sup> (VerCauteren 1993). Since the establishment of DNWR in 1958, no hunting or trapping of coyotes has been allowed or documented (G. Gage pers. comm.). Although no census of coyotes has ever been conducted at DNWR, we feel densities are relatively high, based on visual and auditory observation.

## METHODS

We determined coyote food habits from analysis of 490 scats collected from October 1994 to October 1995. Scats were collected weekly, with few exceptions (47/52 weeks). During our study, a refuge service road, on the Nebraska side of the refuge, served as a scat collection transect. No public access was allowed on the service road, and it received only limited use by refuge personnel, cooperative farmers, and another research team. The road traversed a level area composed of floodplain forest interspersed with crop fields and reestablished native grassland. We cleared the road of all scats prior to the beginning of the study.

Initially, we collected scats from a portion of road approximately 5 km in length. After 12 May 1995, we chose not to collect from a 0.8 km section of road because the number of scats present did not merit the time and effort of collecting. During the winter and early spring months when snow and ice covered the service road, we collected scats from portions of a 13 km refuge road (kept largely snow free), which circumscribed our study area.

We placed scats in plastic bags labeled with the collection date and stored them at -10°C until preparation and analysis. We removed water-soluble materials from scats by enclosing them in nylon stockings and washing them in a commercial clothes washer (Johnson and Hansen 1979). Using reference collections and medulla patterns, we identified remaining scat contents (Moore et al. 1974).

We separated food items into categories based on characteristics related to prey size and type. The mammal category was divided into four sub-categories: 1) small-sized mammals--10-100 g rodent-sized prey, 2) lagomorphs--predominately eastern cottontail, 3) medium-sized mammals--e.g. raccoon, striped skunk, and opossum, and 4) white-tailed deer. Other categories included birds, vegetation, and invertebrates. We quantified coyote food habits by percent-of-scats (POS), which is the number of scats containing a food item/total number of scats x 100.

Correction factors should be used to associate relative frequencies of prey remains in scats to the actual amount of prey consumed in studies of carnivore food habits (Floyd et al. 1978, Ackerman et al. 1984, Weaver 1993). Each of

these authors used a kg-per-scat type correction factor, based on a regression equation developed from feeding trials. In addition to quantifying coyote food habits by POS, we quantified food habits by percent-fresh-weight-of-prey (PFWP). We used Program Scat 1.5 (Kelly and Garton 1993), which incorporates correction factors from coyote feeding trials (Kelly 1991), to determine PFWP. We used visual estimates to apportion scat contents and the kg-per-scat estimators when we modified our data with Program Scat 1.5.

## RESULTS

Mammalian prey remains occurred most frequently (73 POS) in annual coyote diets, followed by vegetation (39 POS), birds (10 POS), and invertebrates (9 POS) (Table 1). White-tailed deer occurred most frequently in the mammalian category (31 POS), followed by small and medium-sized mammals (25 and 18 POS, respectively), and lagomorphs (14 POS).

**Table 1.** Annual percent-of scats (POS) and percent-fresh-weight-of-prey (PFWP) of food items found in coyote scats collected from October 1994 to October 1995 at DeSoto National Wildlife Refuge, Nebraska.

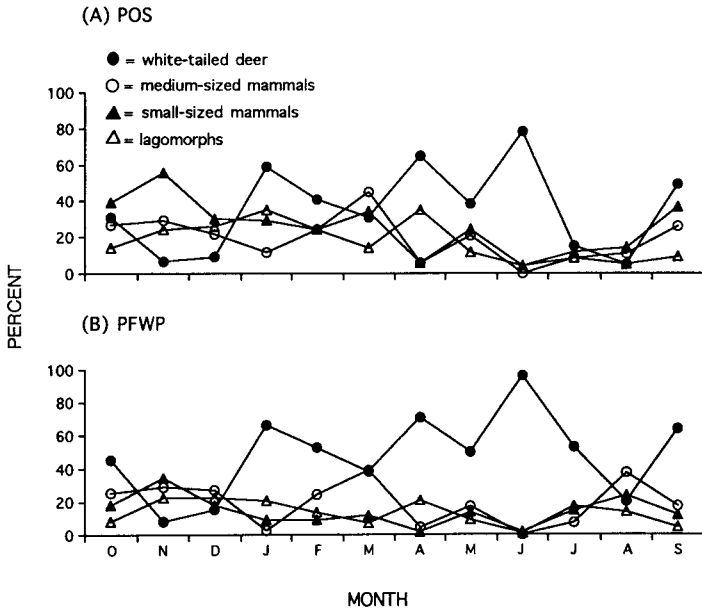
Food Item	POS	PFWP
Mammals	73	95
Small-sized mammals	25	13
Lagomorphs	14	12
Medium-sized mammals	18	19
White-tailed deer	31	52
Birds	10	4
Vegetation	39	--- <sup>a</sup>
Invertebrates	9	1

<sup>a</sup>No PFWP correction factors are available for vegetation.

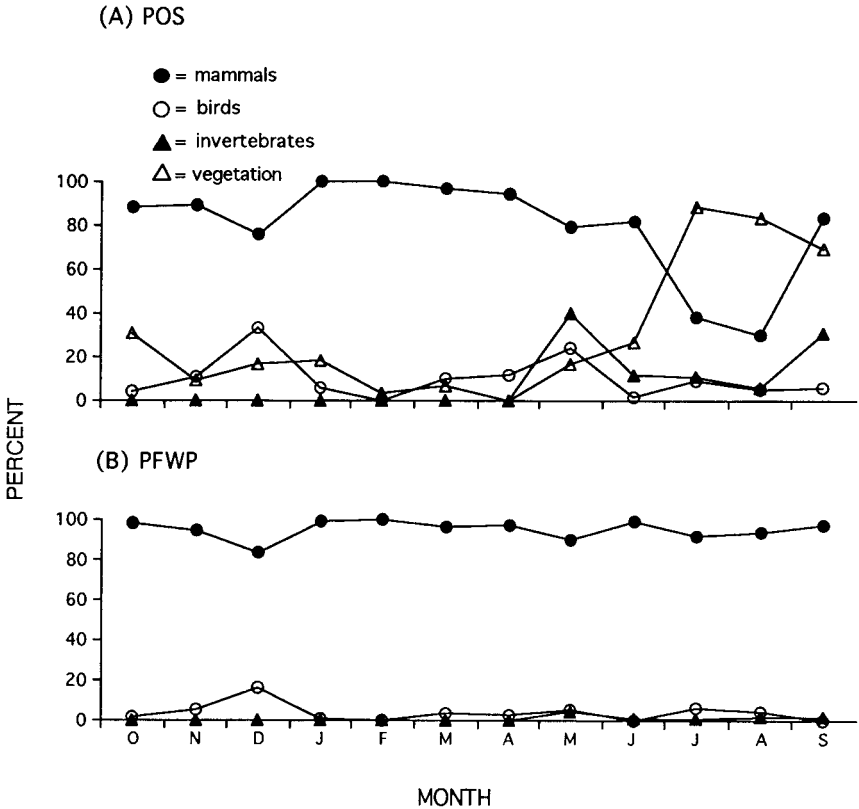
Occurrence within and among the mammal sub-categories varied widely throughout the study year (Fig. 1a). Occurrence of white-tailed deer was highly variable by month, with peak occurrence in June at 78 POS. During the fall, small mammals occurred most frequently in scats. Lagomorphs and medium-sized mammals occurred at relatively low levels throughout the year.

Seasonal trends were apparent in coyote diets. Mammals occurred in greater than 75 POS in all months except July and August, when they occurred in 38 and 30 POS, respectively (Fig. 2a). In July and August, vegetation (primarily mulberries) in coyote scats was highest at 88 and 83 POS, respectively. Invertebrate occurrence peaked in May at 40 POS, and in September at 31 POS. Birds occurred most frequently in December at 33 POS, and in May at 24 POS.

Values based on PFWP correction factors are additive, not overlapping as POS values are. Furthermore, no correction factors are currently available for food items composed of vegetation. Annual PFWP of major categories in order of importance is as follows: mammals (95 PFWP), birds (4 PFWP), and invertebrates (<1 PFWP). White-tailed deer composed the greatest part of annual coyote diet within the mammalian category (52 PFWP), followed by medium and small-sized mammalian prey (19 and 13 PFWP, respectively), and lagomorphs (12 PFWP). Seasonal shifts in major food categories based on PFWP were not as apparent with vegetation absent from the data (Fig. 2b). However, seasonal shifts of mammalian categories alone (Fig. 1b) closely parallel those based on POS data.



**Figure 1.** (A) Percent-of-scats (POS) and (B) percent-fresh-weight-of-prey (PFWP) of mammals found in coyote scats collected from October 1994 to October 1995 at DeSoto National Wildlife Refuge, Nebraska.



**Figure 2.** (A) Percent-of-scats (POS) and (B) percent-fresh-weight-of-prey (PFWP) of major food items found in coyote scats collected from October 1994 to October 1995 at DeSoto National Wildlife Refuge, Nebraska.

**DISCUSSION**

Although results obtained by using the POS method may be the simplest to compute and comprehend, they are often misinterpreted. Two sources of bias associated with this method may lead to misinterpretation. These are: 1) the number of scats produced varies according to the size and type of the prey consumed, and 2) different proportions of prey within a given scat are equated (Kelly 1991). Because of these biases, it is imperative that results obtained by using frequency data be interpreted so as to not equate

occurrence with actual amounts of prey consumed (Kelly 1991). Shifts in occurrence of a food item in scats do not always indicate shifts in consumption of that food item. Despite the biases of frequency data, this method provides an important source of information relative to food habits by measuring how pervasive a food item is in a diet (Kelly 1991).

While POS results give information on how common a food item is in a diet, PFWP based on kg-per-scat correction factors provides an empirically-based estimate of actual biomass of prey consumed (Kelly 1991). Biomass estimates can provide a better understanding of the relative importance of food items in animal diets. Since there are no correction factors available for food items composed of vegetation and PFWP values are additive, our results may overestimate the importance of all remaining food categories.

Mammals were the most frequently occurring food item of coyotes at DNWR. Other studies have reported similar results (Bowyer et al. 1983, Andelt et al. 1987, Brillhart and Kaufman 1994). Mammals also were shown to comprise the majority of coyote diet at DNWR by PFWP correction factors. The occurrence of lagomorphs and small and medium-sized mammals varied during the year. Taken together, however, these foods may offer the coyote a predictable source of readily available prey throughout the year. Small prey, in particular voles, are a common food item of coyotes (MacCracken and Uresk 1984, Brillhart and Kaufman 1994). In addition, lagomorphs are a staple of coyote diets throughout the year (Toweill and Anthony 1988). Andelt et al. (1987) stated that lagomorphs appear in coyote diets from fall to spring. In their study, the decline in lagomorph occurrence during summer coincided with the availability of deer fawns and fruit. Similarly, coyotes at DNWR appeared to depend on readily available small and medium-sized mammals, but at certain times of the year, they used foods that were either very abundant, readily accessible, or energetically cost efficient.

White-tailed deer occurred most frequently in coyote scats at DNWR and composed the greatest part of coyote diet based on PFWP correction factors. High annual occurrence of white-tailed deer has also been reported in other studies (Harrison and Harrison 1984, MacCracken and Uresk 1984, Andelt et al. 1987). The occurrence of deer in coyote scats and the estimated proportion of diet were highest during the month of June (Fig. 1). White-tailed deer fawns at DNWR are usually born in late May and early June. Some scats collected during May and June contained hooves and teeth of deer fawns, which suggested that coyotes were preying or scavenging on fawns. Toweill and Anthony (1988) also reported hooves and teeth of deer fawns in coyote scats collected during spring and summer. Another study showed that coyote pups fed primarily on white-tailed deer from the time of weaning until they foraged on their own (Harrison and Harrison 1984). Harrison and Harrison (1984)



speculated that it is either energetically or nutritionally more efficient to catch and transport deer fawns than to catch and transport a comparable amount of small prey.

The occurrence of white-tailed deer in coyote scats and the estimated importance in diet also peaked during January and April (Fig. 1). Vulnerability of white-tailed deer to predation may be higher at these times because of the effects of winter weather and declining forage resources (Ullrey et al. 1970). Malnourished white-tailed deer may be more susceptible to predation (Menzel 1975). In addition, coyotes may be scavenging on the carcasses of white-tailed deer that have died during winter. Also, during January the high occurrence of white-tailed deer in coyote scats may be the result of coyotes scavenging on hunter-killed white-tailed deer; the annual muzzleloader white-tailed deer hunt at DNWR occurs during December. Another explanation for high occurrence values during January and April is based on the quantitative technique. Only 17 scats each were collected during both January and April, the lowest monthly totals for the entire study. Since the sample size was small, occurrence values may be inflated.

During the months of July and August, occurrence of mammals in coyote scats declined, while occurrence of vegetation (primarily mulberries) was highest (Fig. 2a). We assumed a shift in diet that corresponded to shifts in food item occurrence. The actual shift, however, was most likely not as dramatic as Fig. 2a indicates. A lack of correction factors for vegetation and the biases of occurrence data prohibited us from being more specific.

A shift in coyote diet to vegetation, primarily fruit, has been reported in other studies (Harrison and Harrison 1984, Towell and Anthony 1988). Towell and Anthony (1988) concluded that fruits were an important part of the summer diet of coyotes in their study area, although using frequency data overestimates the importance of fruit when quantified because high ingestion of fruits leads to a higher than normal scat deposition rate. During the summer months, they reported 83% occurrence for fruits. During July and August, occurrence of vegetation in coyote scats at DNWR was 88 and 83 POS, respectively. These also were the months when the highest number of scats were collected, 66 and 63, respectively. The low digestibility of these fruits probably contributed to a higher number of scats produced. This did, as already mentioned, inflate POS values. However, other factors also should be considered to account for the high POS values at this time. For example, vegetation in the form of berries, provided an easily accessible food source for newly independent pups, that are still inexperienced hunters.

Invertebrate occurrence in coyote scats peaked in May and September (Fig. 2a). In May, invertebrates consisted primarily of Coleoptera, and in September primarily of Orthoptera. Brillhart and Kaufman (1994) reported similar results, including prevalence of Coleoptera in early summer, and

Orthoptera in late summer. As expected, during the winter months, there was a complete absence of invertebrates from coyote scats when this food source was unavailable. Invertebrates composed less than 1% of coyote diets at DNWR, as determined by PFWP correction factors. While the occurrence of invertebrates in the diet of coyotes at DNWR was not random, this food source likely provided little sustenance in the quantities that were consumed.

Bird occurrence in scats was highest during the months of December and May (Fig. 2a). Estimated importance of birds in coyote diets was highest during December, followed by July and May (Fig. 2b). In December, birds were estimated to compose nearly 17% of coyote diets. Peak fall migration of snow geese at DNWR typically occurs in late November, with over 500,000 observed in 1994 and 1995 (G. Gage, pers. comm.). Coyotes likely were taking advantage of this tremendous infusion of potential food by preying on or scavenging geese that either were impaired by, or had succumbed to physical injury or health problems. Occurrence of birds in coyote scats during May corresponded with nesting and brood rearing of ground nesting birds, such as ring-necked pheasant (*Phasianus colchicus*), wild turkey (*Meleagris gallopavo*), and northern bobwhite (*Colinus virginianus*). During this time, egg shells occurred in some scats.

Our study suggested that coyotes at DNWR altered their diet possibly to capitalize on food sources that were very abundant, readily accessible, or energetically cost efficient. Many of these shifts in diet could be described as seasonal. Coyotes of DNWR were not unique in this respect. Andelt et al. (1987) cited several studies in which coyotes altered their diet seasonally. Although coyotes in different areas may have similar feeding responses, actual diets often differ. Local variations in prey base and seasonal events, such as insect emergence, fruiting periods, and seasonal fluctuations in potential prey, may result in dietary variation. Although much is known of coyote food items and feeding response, our knowledge of coyote diets is far from complete (Kelly 1991).

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