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Coyote (*Canis latrans*) Food Habits in Three Urban Habitat Types of Western Washington

Abstract

The coyote (*Canis latrans*) is a common resident in urban areas throughout the United States, yet little is known about coyote diets in these environments. I characterized the annual diet of coyotes in an urban environment of western Washington by analyzing their scat from three areas representing typical patterns of human occupation and density: residential (1413 humans/km^2), mixed agricultural-residential (348 humans/km^2), and mixed forest-residential (126 humans/km^2). Coyote scats were collected twice a month for 1 year (Nov. 1989-Oct. 1990) in each habitat type. Fruits and mammals were the largest classes of food items in all habitat types and their seasonal use was similar among habitats. Apple (*Malus* spp.) and cherry (*Prunus* spp.) were the most abundant fruits in the scats, and ranged from 22-41% and 9-13% of the annual diet, respectively. Vole (*Microtus* spp.) was the most abundant mammalian food item (41.7%) of coyotes in mixed agricultural-residential habitat while house cat (*Felis catus*) and squirrel (*Sciurus* spp. and *Tamiasciurus* spp.) were the two most abundant mammalian food items (13.1 and 7.8%, respectively) of coyotes in residential habitat. No single mammalian species made up >6.0% of the coyote diet in mixed forest-residential habitat. Coyotes in my western Washington study area rely on foods that result from human activity but those foods, particularly mammals, may change as land use patterns change.

Introduction

Coyotes (*Canis latrans*) are becoming increasingly common in human modified habitats throughout North America (Atkinson and Shackleton 1991, MacCracken 1982). One possible explanation for this trend is that human-dominated areas produce abundant food sources for coyotes. Coyotes living in urban habitats have relatively small home ranges (Atkinson and Shackleton 1991, Shargo 1988), which may indicate abundant food resources. However, little is known about the diet of coyotes in these areas. MacCracken's (1982) description of the annual diet of coyotes in residential habitat was based on a small number of scats (n = 97) collected during a single month. Atkinson and Shackleton (1991) described the diet of coyotes in an area that was mostly agricultural (>50% of the study area) and Shargo's (1988) description of urban coyote diet was based on 22 scats. Additionally, none of these studies looked at diet as a function of human density.

Coyotes may play an important role in human modified landscapes. Soulé et al. (1988) suggested that coyotes may reduce the abundance of house cats (*Felis catus*) and other small mammalian carnivores that prey on song birds and thus indirectly contribute to the maintenance of native avifauna. My objectives were to document the annual diet of coyotes in three types of urban habitat of western Washington and to qualitatively assess how coyote diets changed as a function of land use patterns and human density.

Study Area

The study area, located in the low elevation (<200 m) region of King and Snohomish counties, was bordered on the west by Puget Sound and on the east by foothills of the Cascade Mountains. This portion of Washington lies in the wetter region of the Western Hemlock Zone (Franklin and Dyrness 1984). The study area was logged at the turn of the 19th century. Much of the land has been developed for urban and agricultural uses but there are numerous patches of 40-80 year-old naturally regenerated forest dominated by Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western red cedar (*Thuja plicata*), red alder (*Alnus rubra*), and maple (*Acer* spp; Franklin and Dyrness 1984).

Urban areas are mosaics of habitat patches differing in size and intensity of human use. I chose

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three habitat types in which to establish permanent scat collection routes (hereafter routes): residential habitat, mixed agricultural-residential (hereafter mixed agricultural) habitat, and mixed forest-residential (hereafter mixed forest) habitat. I described coyote diets in these habitats, which represented the typical range of different land uses in urban western Washington. I characterized habitat types on the basis of human density (Census Population and Housing 1990, Seattle, Wash., unpubl. data). I calculated the density of humans within census tracts in which the route was located and census tracts which were within 1 km of a route. I included density figures from census tracks within 1 km of routes to help characterize the area from which coyotes likely would have foraged. Despite efforts to characterize collection areas, coyotes may have deposited scats in habitats very different from where they foraged. Census tracts are areas of similar land use and human density patterns for which human demographic statistics are calculated (Census Population and Housing 1990, Seattle, Wash., unpubl. data).

Residential habitat, which was predominantly single family housing development, represented the most urbanized edge of the coyote's range in King County (Quinn 1991) with a mean density of 1412.72 (SE = 260.12) humans/km^2. Coyotes in this habitat type were closely associated with remnant patches of second growth forest found in parks and riparian areas (Quinn 1995). Mixed agricultural habitat had a density of 347.97 (SE = 51.52) humans/km^2 and was predominantly pasture land supporting dairy farms. Mixed forest habitat had a density of 125.66 (SE = 17.74) humans/km^2 and was predominantly second growth forest with interspersed single family housing developments.

To minimize the chance of encountering scats from midsized carnivores other than coyotes, I located routes in regions of relatively high coyote density (Quinn 1992, 1995), outside the range of the indigenous red fox (*Vulpes vulpes cascadensis,* Aubry 1984), and in areas where bobcats (*Felis rufus*) and introduced red fox (*Vulpes vulpes*) were extremely rare (D. A. Ware, Wash. Dept. Wildl. unpubl. data; J. R. Consolini, Wash. State Trappers Assoc., pers. comm.). There was no evidence of feral dogs (*Canis familiaris*) near any of the routes based on personal records of an animal damage control trapper who has worked in these areas for the past three years (J. R. Consolini, Wash. State Trappers Assoc., pers. comm.). My field observations were consistent with these assumptions.

Methods and Materials

I cleared all scats from routes, which consisted of unpaved trails, in October 1989. From November 1989 through October 1990, I collected all scats at 2-week intervals from each route. Routes were 5-9 km in total length but were discontinuous because of the patchy nature of coyote habitat and suitable scat collection areas. The residential route was composed of 6 segments, totaling 9 km in length, and located near the northern border of Seattle. All segments were within 0.5-8.0 km of each other and were in patches of second growth forest surrounded by residential housing developments. The mixed agricultural route, totaling 5 km in length, was composed of 3 segments separated from each other by 0.3-0.5 km. This route was located 5 km north of Redmond in the Sammamish River flood plain. The flood plain was predominantly pasture land surrounding small farms. The adjacent uplands consisted of housing developments and patches of second growth forest. The mixed forest route was 5 km in length and located on Novelty Hill 12 km northeast of Redmond. This route was composed of 2 segments separated by approximately 0.5 km along a power line right-of-way off Novelty Hill road. Except for blackberry (*Rubus* spp.) and grasses directly below the power lines, the area was predominantly second growth forest with interspersed housing developments.

I identified scats by their physical appearance, including size (Danner and Dodd 1982) and shape (Murie 1954). As an added safeguard against including dog scats in the samples I assumed that scats composed of >50% commercial dog food (estimated visually) originated from dog. Commercial dog food was easily identified under low magnification by the abundance of grain particles.

Collected scats were individually bagged and dried at 50°C for 48 hours. Food items in dried feces were separated manually and identified by comparison with reference collections of mammal skeletons and guard hairs, and with hair medulla (Moore et al. 1974) and plant seed keys (Martin 1961).

I used Knowlton's (1964) method for estimating coyote diet because it produces an easily understood qualitative measure of food importance. I visually estimated the volume of each individual food item to the nearest 5% of each scat. I counted only the major food item (>40% by volume) of each fecal specimen (Andelt 1985, Knowlton 1964). When two items each composed >40% of fecal volume, I assigned a 0.5 count to each.

Because I did not sample from replicate habitat types, I made only qualitative comparisons among habitat types. I defined seasons as: spring (1 Apr.-30 Jun.), summer (1 Jul.-30 Sep.), fall (1 Oct.-31 Dec.), and winter (1 Jan.-31 Mar.).

Results

I collected a total of 1435 coyote scats from all habitat types (735 from residential, 449 from mixed agricultural, and 251 from mixed forest). From 88 to 91% of scats from each habitat consisted of a single food item as defined in the methods. Fruits and mammals were the two most abundant classes of food items in scats from all habitats (Table 1). Apple (*Malus* spp.), cherry and plum (*Prunus* spp.), vole (predominantly *Microtus*), and house cat each comprised >10% of the diet in one or more habitat types. Bird, reptile, insect, livestock, and vegetation other than fruit were minor components (<3%) of the diet in each habitat type (Table 1).

Coyotes in mixed agricultural habitat had the highest proportion of mammals in the diet followed by the residential habitat (Table 1). Vole was the most abundant mammalian food item in the diet of coyotes in mixed agricultural habitat. Cat was the most abundant mammalian food item (13.1%) in residential habitat followed by squirrel (*Sciurus* spp. and *Tamiasciurus* spp.) at 7.9% of the annual diet. With the exception of muskrat (*Ondatra zibethica*), which was not found in scats from residential habitat, and dog, coyote, and raccoon (*Procyon lotor*), which were found only in scats from residential diets, diets in all habitat types contained the same mammal species. Muskrat, dog, coyote and raccoon each made up <3.0% of the diet in each habitat. Mammals made up the majority of the spring diet (>58.0%) in all habitat types. For the remainder of the year, mammals were a fairly consistent proportion of the diet (approx. 30.0%) except in the mixed agricultural habitat. During winter, coyote diets in mixed agricultural habitat contained twice as much mammal as in other habitat types (Figure 1).

TABLE 1. Food items, by percent, in the annual diet (1989-90) of western Washington coyotes (*Canis latrans*) from residential habitat, mixed agricultural - residential habitat (mixed agric), mixed forest - residential habitat (mixed forest), and all habitats combined (pooled).

	Habitat Type			
Food Item	Residential	Mixed Agric	Mixed Forest	Pooled
Fruit				
Apple (*Malus* spp.)	29.4	21.7	40.6	29.1
Cherry (*Prunus* spp.)	9.7	12.8	9.4	10.6
Other/unknown	3.5	2.7	7.0	3.9
Total fruit	42.6	37.2	57.0	43.6
Mammal				
Vole (*Microtus* spp.)	3.3	41.7	5.7	15.9
Squirrel (*Sciurus/ Tamiasciurus* spp.)	7.9	1.4	1.1	4.6
Cat (*Felis catus*)	13.1	2.3	3.3	7.8
Mountain beaver (*Aplodontia rufa*)	3.9	0.5	5.4	3.1
Other	7.8	8.3	12.8	8.9
Unknown	2.3	0.8	3.6	2.1
Total mammal	38.3	55.0	31.9	42.4
Miscellaneous				
Bird/reptile	2.7	1.6	2.8	2.4
Grass/other vegetation	4.0	2.3	3.4	3.4
Garbage	1.4	1.1	1.4	1.3
Dogfood	4.5	1.8	1.5	3.1
Unknown	6.4	1.1	2.0	3.9

Coyotes in mixed forest habitat had the highest proportion of fruits in the diet followed by coyotes in residential habitat (Table 1). Cherry and plum were the first dietary fruits to appear in the summer followed by berry (*Rubus* spp.). Apple, the most abundant dietary fruit in all habitat types (Table 1), generally did not appear in the diet until the fall but remained an important food item into the winter. The greatest proportion of dietary fruits occurred in the summer or fall in all habitat types (Figure 1). The higher annual proportion of fruits in mixed forest habitat was primarily the result of high winter consumption of fruits in that habitat type (Figure 1).

Discussion

The diets of coyotes in all three habitat types were similar in composition for the major food classes (mammals and fruits). Coyotes in all habitat types took advantage of the seasonal availability of mammals and fruits. The winter/spring peak of mammals

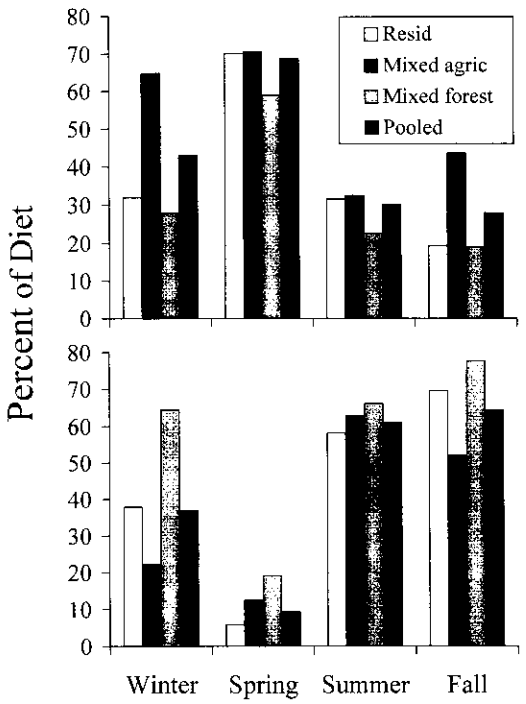

Figure 1. Percentages of mammals (top panel) and fruits (lower panel) in the seasonal diet of coyotes from three habitat types in western Washington, 1989-90: residential habitat (resid), mixed agricultural-residential habitat (mixed agric), mixed forest-residential habitat (mixed forest), and all habitats combined (pooled). I defined seasons as winter (1 Jan.-31 Mar.), spring (1 Apr.-30 Jun.), summer (1 Jul.-30 Sep.), and fall (1 Oct.-31 Dec.).

in the diet corresponded to the time when the availability of fruits was probably at its annual low. Fruits became an important class of coyote food in June and remained important until January. This study was consistent with other studies that have shown fruits to be important dietary components in many coyote populations throughout North America (Dibello et al. 1990, MacCracken 1982, Toweill and Anthony 1988). Apple was the most important fruit in the diet of coyotes in my study area because it was available at times of the year when mammals and other fruits were relatively scarce. Apple ripens later in the year than other fruits and cooler fall and winter temperatures slow the decomposition of apples and make them available for relatively longer periods. Although fruit was a major component of the coyote diets in this study, its importance may be overestimated. Diets containing large quantities of fruit may increase the rate of scat deposition (Andelt and Andelt 1984). In addition, conclusions about dietary preference or the importance of particular food items to coyote fitness should be made cautiously because coyote diet was not assessed in terms of food item availability.

While mammals were important components of the diet in all habitat types, there was considerable variation in proportions of individual mammal species. Coyotes in mixed forest habitat had the lowest proportion of mammals in the diet and no single species of mammal made up >6% of the annual diet. Voles dominated the mammalian portion of coyote diets in the mixed agricultural habitat. This is consistent with Atkinson and Shackleton's (1991) study of coyote food habits in a predominantly agricultural habitat in Canada where voles made up nearly 70% (by volume) of the coyote diet. Cat was the most abundant mammalian food item for coyotes in the residential habitats. In 1991, the Humane Society of the United States (R. Lamb, Humane Soc. of the U.S., pers. comm.) estimated that there were approximately one cat per three households in the U.S. Clearly, cats represent an abundant resource for predators such as the coyote, particularly in areas with high human density. Shargo (1988) found 13.6% occurrence of cat in 22 scats collected in his urban study area, which was most similar to my residential habitat type. However, cat was absent and only a minor food item (<3% frequency of occurrence) of urban/rural coyotes in British Columbia (Atkinson and Shackleton 1991) and urban coyotes in California (MacCracken 1982), respectively.

One major consequence of human activity is the creation of food sources that are readily exploited by coyotes (Gier 1975). Human alteration, particularly logging and the clearing of land for agriculture, may have facilitated the colonization of Oregon, Washington, and British Columbia by coyotes (Dalquest 1948). In western Oregon, many important food items of coyotes were associated with clear-cut areas rather than the surrounding forest (Toweill and Anthony 1988). In British Columbia, coyotes fed primarily (>70% by volume) on meadow voles (*Microtus* spp.) living in agricultural lands that were previously forested (Atkinson and Shackleton 1991). My study suggested that coyotes in western Washington eat large

quantities of food that result from human activity and that coyote diet may change as a function of human density and land-use.

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