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Understanding the diet of an unmanaged population of coyotes (*Canis latrans*) in southern Texas

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Abstract

Coyotes (*Canis latrans* Say, 1823) have great dietary plasticity, which can variably impact population dynamics and food availability of other wildlife. Understanding coyote diet in a system with a lack of human intervention can provide insight into their natural ecological role, a perspective muddled in the context of extrinsic influences. Our study evaluated the diet of a coyote population in southern Texas where no native wildlife is managed by harvesting, trapping, or supplemental feeding, and compared our results with previous studies. We collected coyote scat from transects on the roads of the East Foundation's San Antonio Viejo Ranch every month of 2022. From morphological analysis of fecal remains, we identified 23 unique species with white-tailed deer (*Odocoileus virginianus* (Zimmermann, 1780)) and invasive wild pig (*Sus scrofa* Linnaeus, 1758) being the most common prey items over the year, detected 38.4% and 14.4% among all prey items, respectively. The distinctly high proportion of ungulates consumed as opposed to small mammals is possibly due to high ungulate prey density as well as intraspecific niche differentiation by the unmanaged coyote population, where older, more experienced coyotes select for large mammals and younger coyotes select for small mammals. Future research exploring anthropogenic effects on predator and prey population demographics as well as predator behavior could provide more insight into how human presence may alter predator diet.

Key words: coyote (*Canis latrans* Say, 1823), diet, feeding ecology, prey selection, Texas

Introduction

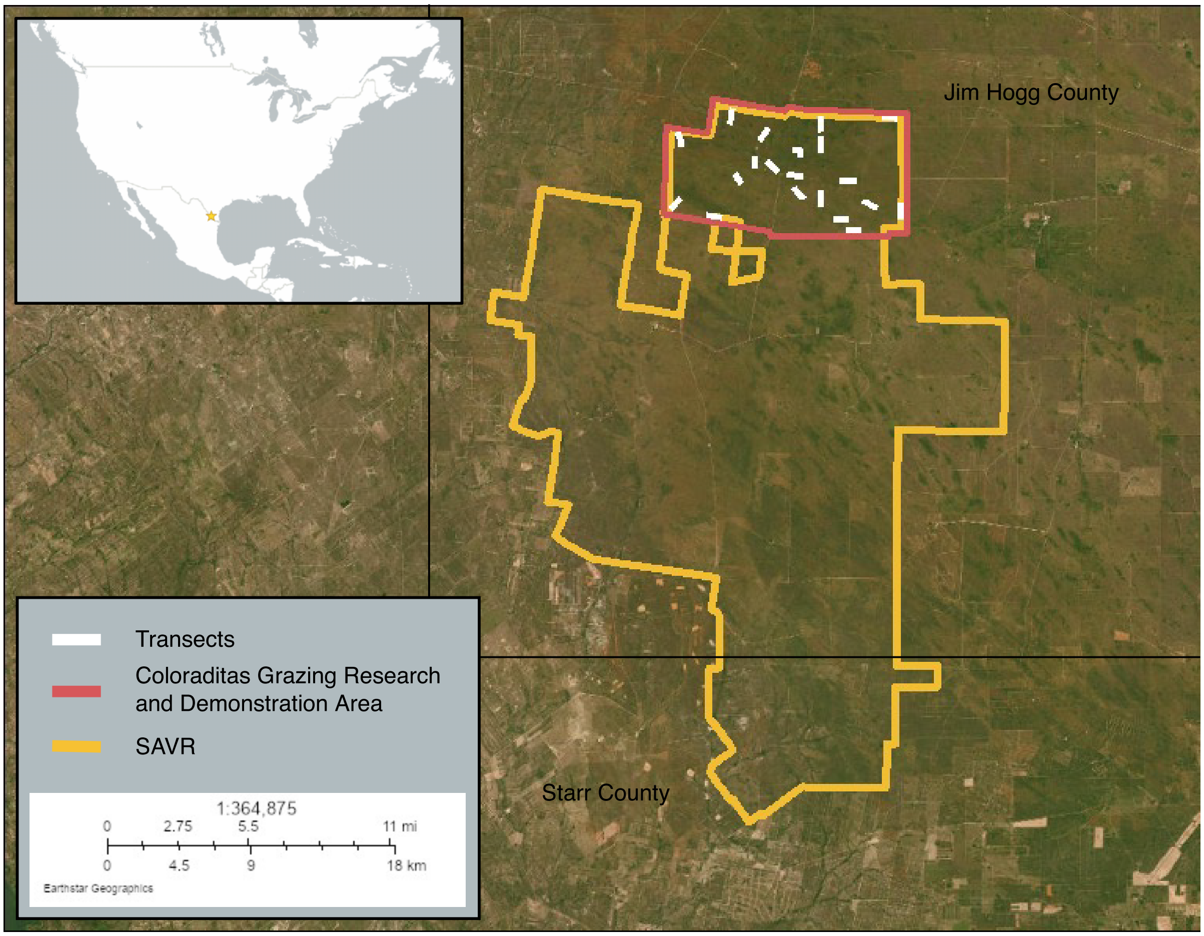
In conservation, the diet of species in a system is foundational knowledge necessary for management. Conservationists and managers must consider the interactions of multiple species in a system, linked by their roles as both predator and prey, and balance the abundance of all species to achieve a sustainable ecosystem. For predators, selection of prey and other diet items can strongly influence the population dynamics of other wildlife, as well as food availability for those species, as observed in the top-down trophic cascade on Isle Royale (McLaren and Peterson 1999). One such species whose diet is of management concern is the coyote (*Canis latrans* Say, 1823), which has been a source of interest among wildlife and livestock managers.

Coyote diet may vary across seasons, successional changes, weather conditions, fluctuating prey abundance (Andelt 1995), and changes in their behavior and movements (Steenweg et al. 2015). They also exhibit great dietary plasticity, which may lead to variability in their impacts on other species as a predator (Menge and Olson 1990). Coyotes are mesocarnivores, characterized by their medium size (Vilella et al. 2020) and the preeminence of animal matter in their diet, as well as omnivores (Windberg and Mitchell 1990), and opportunistic eaters, who select prey depending on food availability while still exhibiting diet preference (Andelt 1995). They are also scavengers; their consumption of carrion is of increasing interest to society, given its ecosystem service to remove carrion that can potentially vector diseases (Leivers et al. 2023).

Management interest in coyotes is historically attributed to predation on livestock and economically valuable game animals, such as white-tailed deer (*Odocoileus virginianus* (Zimmermann, 1780)) and northern bobwhite (*Colinus virginianus* (Linnaeus, 1758)) (Knowlton et al. 1999). The degree to which lethal removal of coyotes economically benefits these enterprises has been debated (Mitchell et al. 2004). For example, coyotes have been shown to be a significant cause of mortality for deer fawns (<3 months old; Kilgo et al. 2012). Even so, some studies have promoted a decrease in the take of antlerless deer instead of using predator management to maintain and grow deer populations (Robinson et al. 2014). Thus, it is integral to understand how management methods, such as predator control as well as the harvest and supplemental feeding of native wildlife, influence predator–prey dynamics to optimize the production of livestock and game to meet their property goals (Bradley and Fragre 1988).

Understanding coyote diet in natural ecosystems at a landscape scale can provide insight into management on

Fig. 1. Map of the approximate location of the East Foundation's San Antonio Viejo Ranch (SAVR) in Texas, USA. Within SAVR is the Coloraditas Grazing Research and Demonstration Area with twenty 1 km long transects. Transects were surveyed monthly throughout 2022 for coyote (*Canis latrans*) scat. Figure was created in ArcGIS online using East Foundation (2024) and Esri (2024) shapefiles.



similar properties. Although predator removal has been a standard management technique for generations, questions have been raised in recent years regarding cost-effectiveness and the impact on the ecosystem by allowing for mesopredator release and an increase in rodent populations (Mitchell et al. 2004). Without an understanding of the diet of coyotes in a natural system, conservationists and livestock ranchers alike cannot anticipate the changes in predator–prey dynamics and ecosystem function that may result from shifts in natural resource management methods.

We therefore sought to understand the diet of a coyote population in a South Texas Plains rangelands system where no native wildlife is managed by harvesting, trapping, or supplemental feeding, with economically valuable livestock and wildlife present. Further, the locality of southern Texas, a core area of the historic range of the coyote, allows for a diverse array of coyote food resources, of both animal and plant matter, that exhibit seasonal changes in availability. Results from this region will be representative across the coyote's expansive range.

Materials and methods

Study area

We conducted our research on the 60 298 ha San Antonio Viejo Ranch (SAVR), owned and operated by the East Foundation, located in Jim Hogg and Starr counties (Fig. 1). SAVR focuses on cattle (*Bos taurus* Linnaeus, 1758) ranching and land stewardship research, managing their ranches as living laboratories for ranching, science, and education. The area is composed of shrub savannas, with honey mesquite (*Prosopis glandulosa* Torr.), prickly pear (*Opuntia* spp. Mill.), cat-claw acacia (*Senegalia greggii* (A. Gray) Britton and Rose), blackbrush acacia (*Vachellia rigidula* (Benth.) Seigler and Ebinger), whitebrush (*Aloysia gratissima* (Gillies and Hook.) Tronc.), and granjeño (*Celtis pallida* Torr.), as well as early to mid-successional grasses, including three-awns (*Aristida* spp. L.), little bluestem (*Schizachyrium scoparium* (Michx.) Nash), and windmill grasses (*Chloris* spp. Sw.). SAVR is fully fenced along the perimeter with fenced pastures throughout which have either a gate or a cattleguard. Interior fences are wildlife friendly with the bottom raised 30 cm above the ground. Cattle do not have free range of the entirety of SAVR—they are intentionally stocked into certain pastures—but wildlife are able to transgress fences and move throughout SAVR freely. Lethal harvest and harassment of native animals, including coyotes, has not occurred on SAVR since the East Foundation's inception in 2010. There are non-native species present, the wild pig (*Sus scrofa* Linnaeus, 1758) and nilgai (*Boselaphus tragocamelus* (Pallas, 1766)), who are removed in low numbers but not managed through a concerted effort. This region persistently supports high coyote densities, noted throughout the literature (Knowlton 1972; Windberg 1995), and long-term GPS telemetry studies have shown that the SAVR coyote population is spatially stable with very minimal emigration from the property (Tomeček JM, unpublished data).

During our study, there was no consumptive use or supplementation of native wildlife species on the ranch, with human involvement in the environment limited to range management for grazing and maintenance of ranch infrastructure, such as water wells, fences, and roads. This presented a unique opportunity to observe predator–prey dynamics in a system with a lack of human influence. Specifically, we focused our study in the Coloraditas Grazing Research and Demonstration Area (CGA). The CGA is the northernmost part of the ranch with a total area of 7684 ha (Montalvo et al. 2020). Road systems transect pastures and follow most fence lines, and there are 23 man-made water sources throughout the area.

Field collection

Following common scat survey practices for canids, we collected samples along ranch roads due to preferential coyote use for travelling and territorial marking behaviors using scat (Steenweg et al. 2015). We surveyed twenty, 1 km transects along the roads of the CGA. We randomly generated the transects using ArcGIS. We traversed the transects in December 2021 and identified 20 suitable transects that were accessible without overgrowth of brush obstructing the pathway (Fig. 1). At that time, we cleared them of present scat. We surveyed the transects at a monthly interval from January to December 2022.

To survey the selected transects, two observers drove 4 km/h in a utility terrain vehicle (UTV) to simulate the average walking speed of a person (Steenweg et al. 2015). We identified coyote scat based on a swirled composition and tapered base with the presence of components such as hair, bones, or plant matter. We collected scat in sterile Whirlpak polyethylene bags. Both observers independently identified scat and gave a confidence estimate that the scat originated from coyote (on a scale of 1–5), and any below full confidence were marked to be re-examined later in the laboratory. In the field, observers additionally used tracks and hair to assist with identification. In the field at the time of collection, we measured scat length (cm) and width (mm) and recorded a GPS location (WGS 84, UTM-14) for each. We photographed samples and labeled the sterile bag with a unique identification code.

We worked to avoid sampling errors such as biased sampling methods and misidentification of scat (Morin et al. 2019). We considered the sampling intensity necessary to achieve an adequate sample size of 94 samples to distinguish seasonal and local differences recommended by Trites and Joy (2005). Although bias can result from misidentification of the predator scat, the distinguishing features of coyote scat allowed all observers to differentiate it from sympatric carnivores in the area, the bobcat (*Lynx rufus* (Schreber, 1777)) and gray fox (*Urocyon cinereoargenteus* (Schreber, 1775)).

Lab processing

We processed scat to morphologically identify items such as bones, hair, plant matter, or feathers. We used morphological identification because of reduced cost compared to molecular approaches. Additionally, molecular analysis requires species-specific primers for prey items and scat samples with minimal degradation, and it introduces more opportunities for sampling error during the DNA amplification process (Morin et al. 2019). Morphological analysis has also been shown to not suffer from imperfect detection of prey items as a major source of bias (Morin et al. 2019). Even so, we took multiple subsamples within each scat to further minimize this bias and account for the possibility of white-tailed deer remains obscuring other mammal hair.

We processed samples at Texas A&M University using facilities within the Department of Rangeland, Wildlife, and Fisheries Management. To prepare scats for identification, we used a process modified from Ciucci et al. (1996). We froze samples at −20 °C, thawed, and oven-dried at 90 °C for 24 h, and then recorded the dry weight. Subsequently, we soaked samples in water for 48 h, and then washed them in a premade sleeve of hosiery under running water to separate the macro- and micro-components (Bowyer et al. 1983). We discarded micro-components with the assumption that all prey items coyotes consumed were represented in the macro-components. We hand-separated macro-components on an aluminum sheet pan, dried them at 90 °C for 1.5 h, and weighed components. Finally, we evenly distributed macro-components on a premade sheet with a grid marked with four points. After collecting each of the four components on the grid point, we identified remnants using references and specimens.

We mounted mammal hair onto glass slides and examined them with a compound microscope at x300 and identified them based on medullar and cuticle patterns using the *Atlas and Key to the Hair of Terrestrial Texas Mammals* (Debelica and Thies 2009). We identified mammal hair down to species and classified mammalian bone fragments as either the class Mammalia or as their identified order. We identified all avian feathers to species based on visual observation. We grouped all insects into the class "insecta". Vegetation in the form of seeds and fruit was identified by visual observation down to species, but grasses were broadly classified as "unidentified plant". By grouping prey items unable to be identified to species into taxa groups, we accounted for the sampling bias of unequal identifiability of items in scats (Morin et al. 2019).

Data analysis

We calculated the percent occurrence and relative percent occurrence of each food item to evaluate diet composition. The percent occurrence was calculated with the frequency of occurrence per food item divided by the total number of scats within a timeframe, representing the consistency of food items. Relative percent occurrence was calculated with frequency of occurrence per food item divided by the total number of occurrences of all food items within a timeframe, representing the importance of each item in the overall diet. We grouped months into seasons reflective of coyote life history, corresponding with the biological seasons of breeding (December–February), gestation (March–May), pup-rearing (June–August), and dispersal (September–November) (Gese et al. 1988).

Results

We collected 177 scat samples in the breeding season, 32 in the gestation season, 7 in the pup-rearing season, and 30 in the dispersal season for a total of 246 samples throughout the sampling period and identified 23 prey species with an average of 1.5 unique items per scat.

Among the taxonomical groups identified in the scat, ungulates had the highest percent occurrence and relative percent occurrence over the year (Tables 1 and 2), showing that their consumption was consistent across the year and an important element of coyote diet. White-tailed deer were found in every season and were the most consumed species among all species identified, with 57.3% occurrence and 38.4% relative occurrence over the year (Tables 1 and 2). Wild pig, the second most consumed diet item, and collared peccary (*Dicotyles tajacu* (Linnaeus, 1758)) were consumed inconsistently across seasons and were both absent during the pup-rearing season (Tables 1 and 2).

Vegetation was inconsistently used across the year with high consumption during the dispersal season with 73.3% occurrence and 76.5% relative occurrence (Tables 1 and 2). The most consumed vegetation was honey mesquite and prickly pear, both only found during the dispersal season. Minimally consumed vegetation included unidentified plant, which comprised of grass fibers, a species of nightshade (*Solanum* sp. L.) and Hibera del soldado (*Waltheria indica* L.) (Tables 1 and 2).

We found rodents across all seasons, and it was the most consumed taxonomical group during the pup-rearing season (Tables 1 and 2). We identified nine species, most notably the fulvous harvest mouse (*Reithrodontomys fulvescens* J. A. Allen, 1894), the hispid pocket mouse (*Chaetodipus hispidus* (Baird, 1858)), and the hispid cotton rat (*Sigmodon hispidus* Say and Ord, 1825) (Tables 1 and 2). Other species included the northern grasshopper mouse (*Onychomys leuogaster* (Wied-Neuwied, 1841)), white-footed mouse (*Peromyscus leucopus* (Rafinesque, 1818)), the Texas pocket gopher (*Geomys personatus* True, 1889), Merriam's pocket mouse (*Perognathus merriami* J. A. Allen, 1892), southern plains woodrat (*Neotoma micropus* Baird, 1855), and northern pygmy mouse (*Baiomys taylori* (Thomas, 1887)), in descending order.

Of the order Carnivora, we identified Northern raccoon (*Procyon lotor* (Linnaeus, 1758)) in every season except for dispersal and striped skunk (*Mephitis mephitis* (Schreber, 1776)) in only the breeding season (Tables 1 and 2). Cottontail species (*Sylvilagus* Gray, 1867) were the only lagomorphs identified and were present in every season but were not a substantial element of diet over the entire year (Tables 1 and 2). Cingulates included the nine-banded armadillo (*Dasypus novemcinctus* Linnaeus, 1758), which was found in the breeding and gestation seasons (Tables 1 and 2).

Avian species were poorly represented in coyote diets (Tables 1 and 2); we found northern bobwhite and pyrrhuloxia (*Cardinalis sinuatus* Bonaparte, 1838), both in the breeding season (Tables 1 and 2). Finally, insects made up the smallest percentage of diet and were only detected in the breeding season.

Among the seasons, breeding had the most diversity in diet (Fig. 2*a*), gestation had the smallest proportion of white-tailed deer relative to all ungulates (Fig. 2*b*), pup-rearing had the lowest amount of diversity (Fig. 2*a*) with the highest proportion of rodents (Fig. 2*c*), and dispersal had a significant majority of vegetation (Fig. 2*a*).

Discussion

We examined coyote diet in a system lacking human influence through harvesting, trapping, and supplemental feeding and found a consistently observed shift in diet toward vegetation in the growing season and a notable large consumption of ungulates, particularly white-tailed deer and wild pigs, through the rest of the year. This contrasts previous studies showing coyote diet consisting largely of rodents and lagomorphs (Windberg and Mitchell 1990). Interestingly, when considering prey availability, coyotes have been shown to significantly prefer white-tailed deer where available (Hayward et al. 2023). Additionally, a review of coyote diet in North America posited several characteristics correlated with high ungulate consumption, such as larger coyote mass as well as living sympatric with wolves (*Canis lupus* Linnaeus, 1758), in temperate forests, places with snow cover, and with a reduced human footprint (Jensen et al. 2022).

While studies have shown consumption of livestock by coyotes living on active ranchlands (Young et al. 2006), no cattle remains were found in our study despite having cattle present in our study location throughout its duration. The comparatively larger size of cattle compared to other prey species may have deterred coyotes from pursuing them (Janeiro-Otero et al. 2020). Although coyotes would have more ability to prey on calves, lactating mothers have been shown to display increased vigilance, helping to protect their offspring from predation (Kluever et al. 2008). Additionally, Janeiro-Otero et al. (2020) proposed that a high abundance of wild prey could reduce livestock depredation, allowing for coexistence between coyotes, livestock, and landowners.

Among wild prey species in SAVR, the high presence of wild pigs in the diet composition is noteworthy, as Young et al. (2006) found that a population of unmanaged coyotes was increasingly consuming wild pigs as wild pig abundance increased in the area. They proposed the increase in consumption of wild pigs may alleviate predation pressures on other prey items, such as smaller mammals. This could explain the comparatively low proportion of non-ungulate mammals and cattle remains in the SAVR coyote diet as well.

Table 1. Percent occurrence of major taxa identified in coyote (*Canis latrans*) scat by biological seasons as well as over the entire year.

Taxa	Breeding ($n = 177$)	Gestation ($n = 32$)	Pup-rearing ($n = 7$)	Dispersal ($n = 30$)	Year ($n = 246$)
Ungulates	86.4	65.6	23.3	23.3	74.4
Vegetation	9.0	3.1		73.3	15.9
Rodents	16.9	28.1	57.1	3.3	17.9
Carnivores	7.9	12.5	14.3		7.7
Lagomorphs	5.6	12.5	14.3	6.7	6.9
Cingulates	4.5	3.1			3.7
Birds	2.8			3.3	2.4
Insects	1.7				1.2
White-tailed deer	69.5	37.5	28.6	13.3	57.3
Wild pig	23.7	25.0		10.0	21.5
Northern raccoon	7.3	12.5	14.3		7.3
Honey mesquite				60.0	7.3
Prickly pear				56.7	6.9
Cottontail	5.6	12.5	14.3	6.7	6.9
Hispid pocket mouse	5.6	6.3		3.3	5.3
Fulvous harvest mouse	5.1	3.1	42.9		5.3
Unidentified plant	6.2	3.1			4.9
Nine-banded armadillo	4.5	3.1			3.7
Collared peccary	3.4	6.2			3.2
Hispid cotton rat	2.8	6.3			2.8
Nightshades	2.8			3.3	2.4
Northern grasshopper mouse	0.6	6.3	14.3	3.3	2.0
White-footed mouse	1.1	6.3			1.6
Pyrrhuloxia	2.3				1.6
Merriam’s pocket mouse	1.7				1.2
Southern plains woodrat	1.7				1.2
Insect	1.7				1.2
Hibera del soldado				10.0	1.2
Texas pocket gopher		9.4			1.2
Northern pygmy mouse	1.1				0.8
Northern bobwhite	0.6			3.3	0.8
Unidentified mammal		3.1			0.4
Unidentified rodent	0.6				0.4
Striped skunk	0.6				0.4

Note: Scat was collected from the East Foundation’s San Antonio Viejo Ranch, Texas, monthly throughout 2022. Biological seasons are breeding (December–February), gestation (March–May), pup-rearing (June–August), and dispersal (September–November) with n representing the number of scats within each timeframe. The sum of percentages total over 100% because multiple unique food items can be found in a single scat.

Such high consumption of ungulates by coyotes has been reported previously in the literature (Gifford et al. 2019; Balluffi-Fry et al. 2020). These studies propose causes such as limited alternative prey availability, changes in coyote foraging behavior due to lack of persecution, and high ungulate abundance and density, with Balluffi-Fry et al. (2020) reporting a density of 2.5 deer/km^2 within their study area. In the Gulf Coast Prairies and Marshes of Texas, Young et al. (2006), comparing the diet of a population of unmanaged coyotes from 1978 (Andelt et al. 1987) to 2003, showed high consumption of white-tailed deer as well. Pertaining to the original study, Andelt et al. (1987) note an exceptionally high density of deer in the area, roughly 30–49 deer/km^2. The white-tailed deer density on SAVR has been reported as ranging from 8.48 to 13.49 deer/km^2 (Peterson et al. 2020), and unpublished data from a 2022 survey show the density from the CGA specifically to be 14.4 deer/km^2 (Cherry MJ and Foley AR (Texas A&M University-Kingsville, Kingsville,

Table 2. Relative percent occurrence of major taxa identified in coyote (*Canis latrans*) scat by biological seasons as well as over the entire year.

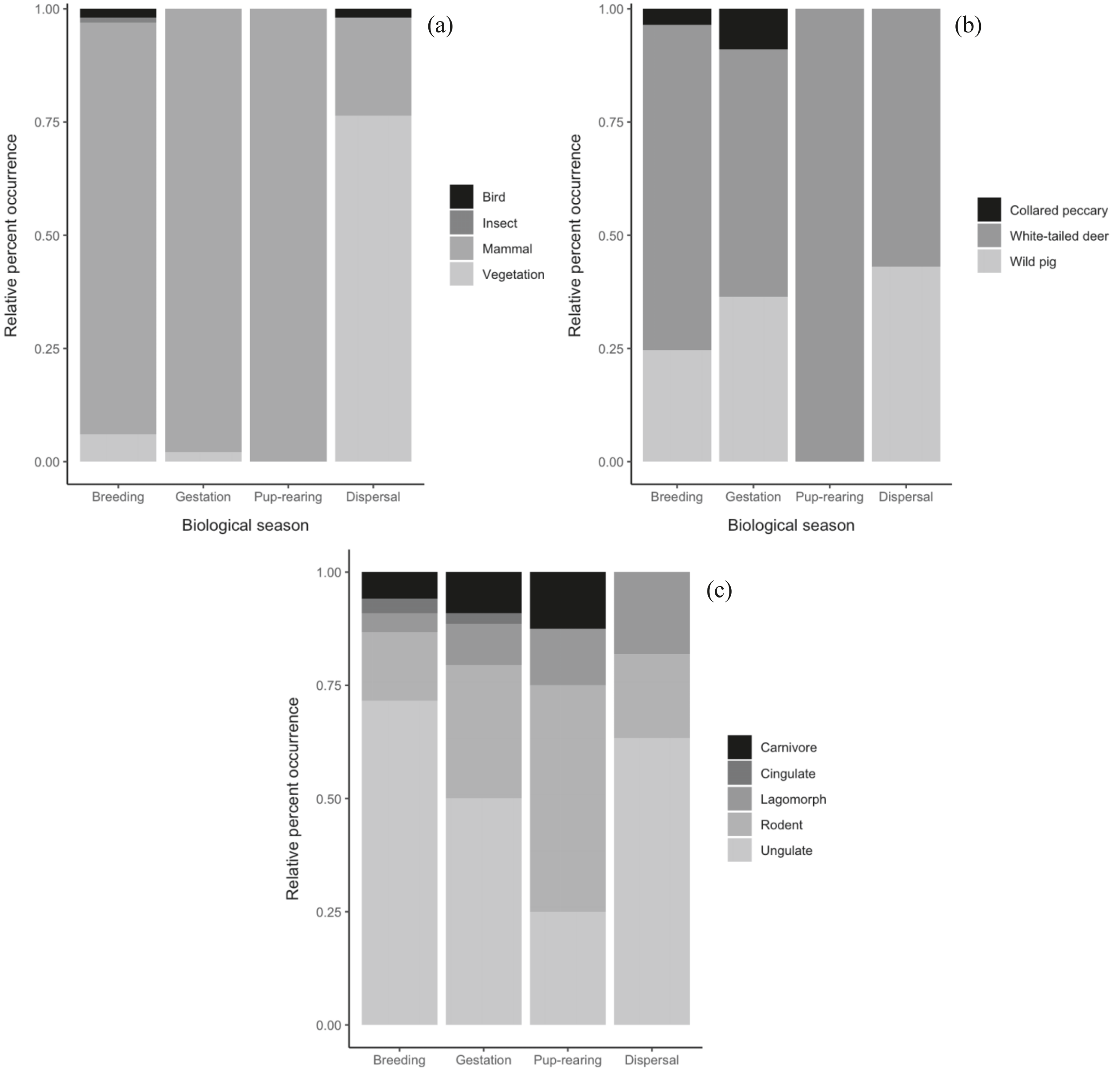
Taxa	Breeding (*n* = 263)	Gestation (*n* = 45)	Pup-rearing (*n* = 8)	Dispersal (*n* = 51)	Year (*n* = 367)
Ungulates	65.0	48.9	25.0	13.7	55.1
Vegetation	6.1	2.2		76.5	15.3
Rodents	13.3	26.7	50.0	3.9	14.4
Carnivores	5.3	8.9	12.5		5.2
Lagomorphs	3.8	8.9	12.5	3.9	4.6
Cingulates	3.0	2.2			2.5
Birds	1.9			2.0	1.6
Insects	1.1				0.8
White-tailed deer	46.8	26.7	25.0	7.8	38.4
Wild pig	16.0	17.8		5.9	14.4
Northern raccoon	4.9	8.9	12.5		4.9
Honey mesquite				35.3	4.9
Prickly pear				33.3	4.6
Cottontail	3.8	8.9	12.5	3.9	4.6
Hispid pocket mouse	3.8	4.4		2.0	3.5
Fulvous harvest mouse	3.4	2.2	37.5		3.5
Unidentified plant	4.2	2.2			3.3
Nine-banded armadillo	3.0	2.2			2.5
Collared peccary	2.3	4.4			2.2
Hispid cotton rat	1.9	4.4			1.9
Nightshades	1.9			2.0	1.6
Northern grasshopper mouse	0.4	4.4	12.5	2.0	1.4
White-footed mouse	0.8	4.4			1.1
Pyrrhuloxia	1.5				1.1
Merriam's pocket mouse	1.1				0.8
Southern plains woodrat	1.1				0.8
Insect	1.1				0.8
Hibera del soldado				5.9	0.8
Texas pocket gopher		6.7			0.8
Northern pygmy mouse	0.8				0.5
Northern bobwhite	0.4			2.0	0.5
Unidentified mammal		2.2			0.3
Unidentified rodent	0.4				0.3
Striped skunk	0.4				0.3

Note: Scat was collected from the East Foundation's San Antonio Viejo Ranch, Texas, monthly throughout 2022. Biological seasons are breeding (December–February), gestation (March–May), pup-rearing (June–August), and dispersal (September–November) with *n* representing the total frequency of occurrences of all food items within each timeframe. The sum of percentages total at 100% because we calculated relative percent occurrence using food item frequency over total frequency of all food items.

Texas) (personal communication, 5 March 2024)). The density of white-tailed deer on SAVR could simply mean more prey availability to coyotes, but it could also lead to pressures from density-dependent mechanisms acting on the white-tailed deer population, which could cause poor nutrition, increased mortality, and low recruitment, especially during and after winter. This may reflect our observation of deer consumption being concentrated in the breeding and gestation seasons (December–May).

In addition to the commonality of high ungulate densities in these studies (Young et al. 2006; Gifford et al. 2019), SAVR similarly does not persecute coyotes. As found in Dumond et al. (2001), coyote diet can vary significantly in response to the type and degree of human disturbance. Patterns of coyote activity can change based on human-related activities as well as prey abundance (Kitchen et al. 2000) as coyote activity relates to searching for prey (Young et al. 2006). Although previous literature has speculated coyotes in the absence of

Fig. 2. Each panel shows the relative percent occurrence of a particular group of taxa identified in coyote (*Canis latrans*) scat across coyote biological seasons. The panels show (*a*) the major taxa identified, (*b*) each ungulate to all ungulate food items identified, and (*c*) each mammalian taxa to all mammalian food items identified. Scat was collected from the East Foundation's San Antonio Viejo Ranch, Texas, monthly throughout 2022. Relative percent occurrence was calculated with frequency of occurrence per food item divided by total number of unique occurrences of all food items within a timeframe.



human disturbance shift to diurnal use patterns (Kitchen et al. 2000), as in Gifford et al. (2019), we have not observed this with the SAVR population.

French et al. (2022) found that activity cycles of coyotes on SAVR varied by individual and cyclically varied temporally. Across individuals, crepuscular behavior was the most variable, especially in the summer. The variability in coyote activity could enhance the opportunity for successful hunting of white-tailed deer for nocturnal individuals during this season, particularly in targeting fawns. In the absence of external human-caused pressures to limit activity patterns, coyotes have more freedom to optimize their window of hunting activity to maximize foraging efficiency. This makes a variety of prey items available and ultimately allows for the selection of preferred species. This presents the opportunity for their diet to have distinct differences compared to coyotes forced to limit activity to times and areas that will not subject them to human persecution, potentially leading to the selection of suboptimal feeding times. Further, Lehner (1976) noted that the adaptive shift out of coyotes' natural activity patterns can make livestock more vulnerable to predation. The ability of SAVR coyotes to feed during optimal times in an area of abundant native prey items may alleviate the hunting pressure on calves, thus reducing wildlife–livestock conflict.

Unexploited coyote populations are known to exhibit older age structures (Wells and Lehner 1978), which we also see in the population at SAVR (Tomeček JM, unpublished data). There is evidence of coyotes selecting different prey depending on age and experience (Gese et al. 1996). Hayward et al. (2023) speculate that older, dominant coyotes in groups may selectively hunt larger prey species, such as white-tailed deer, while younger coyotes may select for smaller species. Following this logic, the large proportion of white-tailed deer consumed throughout the year might lead one to consider the effects of different age-structured coyote populations on their diet.

Given the high degree of individual variation in activity patterns of SAVR coyotes (French et al. 2022), as well as potential age-dependent prey preference, one may posit that the SAVR population may be engaging in intraspecific niche differentiation. As a population saturated across the landscape (French et al. 2022), competition may lead individuals to specialize in specific hunting behaviors. Logically, this could reduce intraspecific competition and enhance foraging success to allow for the high density of coyotes characteristic of this region, and of our study population. This dynamic has been studied in other group-living carnivorans (Sheppard et al. 2018).

The coyotes at SAVR may play an important ecological role by regulating prey abundance, specifically white-tailed deer. The concurrent high densities of both white-tailed deer and coyotes observed at SAVR, combined with frequent deer consumption noted in our results, suggest that healthy white-tailed deer populations can persist without persecution of coyotes in systems such as SAVR, which support high deer density with an absence of extrinsic influences, such as human harvest. Predator culling has been shown to not affect ungulate population size if it is already at or near carrying capacity (Ballard et al. 2001). Ultimately, aspects of the habitat such as food, water, and weather would ultimately limit the growth in herd size, while predator take of deer is theorized to be largely a source of compensatory mortality (Clark and Hebblewhite 2021), further displaying the coyotes' role as population regulators.

A limitation of our study is the paucity of samples from May to September. The low sample size during this time is likely due to concentrated activity around den sites (Andelt et al. 1979) and increased insect activity and consumption of feces during this time (Norris and Michalski 2010). Future research with scat sampling should consider whether their efforts will be affected by environmental or behavioral shifts throughout the year and consider methods to account for low sample sizes.

We recommend future research evaluating the diet of unmanaged coyotes in a system with harvested white-tailed deer to refine insights from our study, specifically to help evaluate the role of coyotes as population regulators when outside pressures (e.g., hunting) also act on the same prey populations. We also encourage future studies to address coyote age structure specific hunting behaviors and diet, as well as the relationship of these factors to coyote density and abundance. This is especially true of the high consumption of invasive wild pigs; any take of wild pigs by coyotes contributes to conservation (Villeneuve et al. 2020) and may also help delay or restrict the spread of foreign animal diseases, such as African Swine Fever. Although our work contributed to an understanding of the dynamic nature coyote diet, insight from such expanded research could help managers better understand the ecological role coyotes play in their ecosystem, better equipping managers to make decisions about both coyotes and their prey species.

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Data availability

Data analyzed during this study are available from the corresponding author upon reasonable request.

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The authors declare there are no competing interests.

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