Diets of Free-Ranging Mexican Gray Wolves in Arizona and New Mexico

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Abstract

*Systematic diet studies of Mexican gray wolves (*Canis lupus baileyi*) were not conducted before wolves were extirpated by the late 1960s from the southwestern United States. We collected carnivore scats (*n *= 1,682) from the Apache and Gila national forests in Arizona and New Mexico, USA, from April 1998 through October 2001 and identified scats to species using traditional field methods, of which 251 were identified as Mexican wolf scats. We found the diet consisted of large-sized food items (92.8% percent frequency of occurrence [PFO]), primarily elk (*Cervus elaphus*) adults (36.6% PFO) and calves (36.2% PFO). Biomass calculations indicated that Mexican wolves consumed 414 kg of prey as represented by the scats, with elk representing 76.7% of the biomass. When comparing PFO with percent biomass, PFO calculations may have underrepresented larger food items and percent biomass may have overrepresented smaller food items. We compared the diet composition of Mexican wolf scats (*n *= 251) to the diets reported in previous North American gray wolf (*C. lupus*) studies (*n *= 7). The high proportion of elk in Mexican wolf diets in our study area may reflect the low-density, early colonizing stage of the wolf population and elk probably being the most numerous ungulate in our study area. Our results suggested that free-ranging Mexican wolves consumed a higher proportion of large-sized prey than other North American gray wolves. Our results provide baseline diet information for a newly reestablished wolf population.*
(WILDLIFE SOCIETY BULLETIN 34(4):1127–1133; 2006)

Key words

Arizona, Canis latrans*,* Canis lupus baileyi*,* Cervus elaphus*, coyote, diet, elk, Mexican gray wolf, New Mexico.*

Life-history characteristics of the Mexican gray wolf (*Canis lupus baileyi*; hereafter Mexican wolf) are largely unknown because systematic studies were not conducted on the subspecies before it was extirpated from the wild (Brown 1983). Biologists have established that the Mexican wolf is the smallest and southernmost occurring subspecies of gray wolf (*C. lupus*) in North America (Young and Goldman 1944, Hall and Kelson 1959, Bogan and Mehlhop 1983, Nowak 1995), the most genetically distinct (Wayne et al. 1992, Garcia-Moreno et al. 1996), and the most endangered (McBride 1980, Brown 1983, Bednarz 1988, Ginsberg and Macdonald 1990). The United States Fish and Wildlife Service (USFWS) began releasing captive-reared Mexican wolves into the Blue Range Wolf Recovery Area (BRWRA) in Arizona and New Mexico, USA, during April 1998.

The purpose of our study was to determine the diets of free-ranging Mexican gray wolves in Arizona and New Mexico and to determine if there were differences among years, between seasons, or among packs. We also compared diet composition of Mexican wolves to that reported in 7 previous diet studies of northern gray wolves. Lastly, we compared ranking of prey importance between biomass consumption and percent frequency of occurrence (PFO) data. This information is beneficial for managing Mexican wolf and prey populations and investigating depredation incidents in areas where Mexican wolves are recovering in the southwestern United States.

Study Area

We conducted our research within the BRWRA, which encompassed 17,700 km^2 and included all of the Apache and Gila national forests in east-central Arizona and west-central New Mexico (Parsons 1998). The White Mountain (Fort Apache) and San Carlos Indian reservations bordered the BRWRA on the west, and private lands bordered the area to the east, north, and south, and were scattered within public lands. Domestic cattle grazed almost all areas (United States Forest Service [USFS], unpublished data) and there were an estimated 10,599 cattle and calves in Greenlee County (United States Department of Agriculture [USDA] 1999).

Elevations ranged from 1,200 m along the San Francisco River to 3,350 m on Mount Baldy, Escudilla, and Mogollon mountains (USFWS 1996). Lower elevations were characterized by rolling hills with moderately steep-walled canyons and sandy washes, while higher elevations were typified by rugged slopes, deep canyons, elevated mesas, and rock cliffs (USFWS 1996). Dominant vegetation included ponderosa pine (*Pinus ponderosa*), aspen (*Populus tremuloides*), fir (*Pseudotsuga menziesii* and *Abies* spp.), juniper (*Juniperus*

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spp.), piñon (*Pinus cembroides*), mesquite (*Prosopis* spp.), evergreen oaks (*Quercus* spp.), and a variety of grasses and forbs (USFWS 1996). Annual temperatures averaged 16.4°C maximum and −3.1°C minimum, and most precipitation fell during thunderstorms (annual average 52.1 cm) from July through September and snow (annual average 139.3 cm) from December through March (Desert Research Institute, Western Region Climate Center, unpublished data).

From April 1998 through October 2001, ≥87 Mexican wolves either were released from captivity or born in the wild within the BRWRA. Approximately 37 Mexican wolves were free-ranging as of October 2001 and 31 of those individuals were fitted with radiocollars. Other predators within the study area included humans, mountain lion (*Puma concolor*), black bear (*Ursus americanus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), and red fox (*Vulpes vulpes*; USFWS 1993, Arizona Game and Fish Department [AGFD] 1994, unpublished report). Density estimates were unavailable for these species.

Potential large-sized prey within the BRWRA included Rocky Mountain elk (*Cervus elaphus nelsoni*), Coues white-tailed (*Odocoileus virginianus couesi*) and desert mule (*O. hemionus eremicus*) deer, pronghorn (*Antilocapra americana*), and Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*; USFWS 1996). The USFWS (1996) estimated there were 15,800 elk (3.7/km^2) and that they were increasing, while deer of both species were estimated at 57,170 (13.4/km^2) and were thought to be declining. No other estimates of prey abundance were available. Potential medium- and small-sized prey included collared peccary (*Pecari tajacu*; USFWS 1996), beaver (*Castor canadensis*), porcupine (*Erethizon dorsatum*), jackrabbits (*Lepus* spp.), cottontail rabbits (*Sylvilagus* spp.), skunks (*Mephitis* spp.), various tree (*Sciurus* and *Tamiasciurus* spp.) and ground (*Spermophilus* spp.) squirrels, chipmunks (*Tamias* spp.), wood rats (*Neotoma* spp.), mice (*Peromyscus* spp.), voles (*Microtus* spp.), other small mammals and birds (Hoffmeister 1986), and Merriam's turkey (*Meleagris gallopavo*; Groebner et al. 1995).

Elk calving occurred during May and June, mule deer fawning occurred June through August, and white-tailed deer fawning occurred during August (AGFD, unpublished data, New Mexico Department of Game and Fish [NMDGF] 1998–2001). Hunting of cervids occurred intermittently from late August through January for white-tailed and mule deer and from September through mid-December for elk (AGFD 1998–2001, NMDGF 1998–2001), which likely provided entrails, wounding losses, and unretrieved carcasses for Mexican wolves.

Methods

We selected scat analysis to study the diets of free-ranging Mexican wolves because it was noninvasive and did not interfere with species recovery efforts. Scat analysis is widely used in determining carnivore diets, and scats are readily available and easily collected (Scott 1941, Putman 1984). We used percent frequency of occurrence (PFO) of food items per scat in order to determine the diet composition and relative amounts of food items consumed by Mexican wolves and to compare with previous North American gray wolf diet studies.

We collected carnivore scats ($n = 1{,}682$) from April 1998 through October 2001 from areas where captive-released, translocated, and wild-born Mexican wolves were known to frequent within the BRWRA. We concentrated our searches in these areas to maximize scat collection. Personnel of the Mexican Wolf Interagency Field Team (i.e., USFWS, AGFD, NMDGF, USDA Animal and Plant Health Inspection Service Wildlife Services, and USFS) also collected scats opportunistically. We used an opportunistic sampling strategy (Frenzel 1974) because the sampling areas followed radiocollared Mexican wolves as they moved within the study area. We collected scats along forest roads, trails, ridgelines, and riparian areas, and from opened release pens, campsites, den sites, and kill and carcass sites.

Scat collectors wore rubber gloves and placed the scats in brown paper bags, which were labeled with date, location, and scat identification number. We identified scats to carnivore species using traditional field methods (i.e., diameter, location, and tracks near the scats [Scott 1943, Weaver and Fritts 1979, Green and Flinders 1981, Danner and Dodd 1982]) reported in the literature. We air-dried the bagged scats and stored them at room temperature in large plastic containers until analysis.

We measured the maximum diameter of each dried scat (Scott 1943, Weaver and Fritts 1979, Green and Flinders 1981, Danner and Dodd 1982) using 152-mm dial calipers (General Tools Manufacturing Co., New York, New York). The diameter criterion for identifying gray wolf scats was ≥24-mm diameter established by Thompson (1952) and has been accepted for several studies (Mech 1970, Stephenson and Johnson 1972, Peterson 1974, Van Ballenberghe et al. 1975). However, Weaver and Fritts (1979) suggested scat diameters ≥30 mm be used to identify gray wolf scats. Halfpenny (1986) indicated that scats >25-mm diameter would correctly identify wolf 63% of the time compared to other wild canids. For identifying Mexican wolf scats, we established ≥28 mm based on results from DNA analysis (Reed et al. 2004).

We estimated the diets of Mexican wolves from 251 of the 1,682 scats. We excluded the remaining scats from this diet study because they were <28-mm diameter and most of those were identified as coyote scats ($n = 677$). The remainder were ≤15-mm diameter and were probably fox scats (Carrera 2004), or they could not be positively identified to carnivore species (Carrera 2004).

We broke scats apart by hand and separated undigested food items (i.e., hair, bone, teeth, claws, and hooves). We identified the undigested food items macroscopically by comparing to a reference collection.

We calculated percent frequency of occurrence (PFO) of prey items (i.e., no. of occurrences of a prey item divided by the total no. of occurrences of all prey items). To facilitate

Table 1. Food items found in scats from free-ranging Mexican gray wolves. Scats were collected from Apr 1998 to Oct 2001 in Arizona and New Mexico, USA, and were identified using traditional methods. Comparison values are expressed as percent frequency of occurrence.

	1998		1999		2000		2001		Total	
Food items	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Large-sized food items										
Elk										
Adult	55	36.9	5	25.0	21	38.2	16	39.0	97	36.6
Calf	54	36.2	7	35.0	23	41.8	12	29.3	96	36.2
Deer (white-tailed and mule)										
Adult	5	3.4	1	5.0	1	1.8			7	2.6
Fawn			2	10.0	2	3.6	2	4.9	6	2.3
Unknown native ungulate	21	14.1			4	7.3	4	9.8	29	10.9
Domestic cattle			4	20.0	2	3.6	5	12.2	11	4.2
Medium- and small-sized food items										
Porcupine	1	0.7							1	0.4
Nuttall's cottontail							1	2.4	1	0.4
Red squirrel	2	1.3	1	5.0					3	1.1
Golden-mantled ground squirrel	3	2.0			1	1.8			4	1.5
Mouse	3	2.0							3	1.1
Unknown rodent	1	0.7			1	1.8			2	0.8
Birds	1	0.7							1	0.4
Insects	1	0.7					1	2.4	2	0.8
Vegetation	2	1.3							2	0.8
No. of food items	149		20		55		41		265	
No. of scats	139		19		52		41		251	
No. of food items/scat	1.07		1.05		1.06		1.00		1.06	

statistical comparisons, we pooled ungulate prey (i.e., adult and neonate elk and deer and domestic bovine) and considered them large-sized food items. We then pooled smaller food items (i.e., medium- and small-sized mammals, birds, reptiles, insects, and vegetation) and considered them medium- and small-sized food items. We did not include nonfood items (e.g., rocks, sticks, pine needles). Although we used PFO, we addressed potential reported biases in the method by determining the biomass represented by each scat according to methods described by Floyd et al. (1978) and Weaver (1993). We used likelihood-ratio contingency table analysis (G-test; Ott 1988) corrected for continuity (Williams 1976) to determine differences in diet composition among years (1998–2001), between 2 seasons (spring–summer: Mar–Aug; autumn–winter: Sep–Feb), among packs (n = 4), and between Mexican wolves and other northern gray wolves. We considered all tests significant at the probability level of $P \leq 0.05$.

Results

Food remains in Mexican wolf scats (n = 251) consisted mainly of elk (72.8% PFO) and other native ungulates (15.8% PFO; Table 1). Smaller mammalian prey (5.3% PFO), birds (0.4% PFO), insects (0.8% PFO), and vegetation (0.8% PFO) were less common (Table 1). Cattle composed 4.2% PFO. We found no differences in diet among years ($n = 4$, $G_{adj} = 2.588$, $P = 0.460$) or between seasons (210 large-sized food items vs. 36 medium- and small-sized food items during autumn–winter and 15 large-sized vs. 4 medium- and small-sized food items during spring–summer [$n = 2$, $G_{adj} = 0.490$, $P = 0.484$]). Diets among all packs were not different ($n = 4$, $G_{adj} = 7.719$, $P = 0.052$) although 2 packs included medium- and small-sized food items in their diet.

We found a difference (G_{adj} = 462.492, P = <0.0001; Table 2) between the diets of Mexican wolves and other North American gray wolves. Mexican wolves consumed a higher percentage of large-sized food items (92.8% PFO) than reported for other North American gray wolves (range 58.5–82.9% PFO).

Based on calculations of biomass, elk adults (57.2%) were the most important food component of the Mexican wolf's diet. Small mammals were of less importance (range = 0.10% for cottontails to 0.40% for ground squirrel; Table 3).

Discussion

The historic diets of Mexican wolves were not well-documented, but some observers suggested that the subspecies preyed primarily on white-tailed (Brown 1983) and mule deer, and alternatively on elk, pronghorn, peccary, beaver, rabbits, hares, and other small mammals (Parsons 1996). Early assessments of the diet of the Mexican wolf were based on field observations and stomach analysis (Young and Goldman 1944). Leopold (1959) hypothesized that the Mexican wolf's diet consisted mainly of deer but included bighorn sheep, pronghorn, collared peccary, rabbits, rodents, and some plant foods. The principal native prey of Mexican wolves was found to be deer (McBride 1980), but they also consumed pronghorn, rabbits, and mice.

Domestic livestock increased in Arizona and New Mexico from 1880 to 1890, and native prey populations decreased due to unregulated subsistence and market hunting

Table 2. Comparison of food remains found in scats ($n = 251$) from free-ranging Mexican gray wolves with diet composition reported in other North American gray wolf diet studies ($n = 7$). Scats were collected from Apr 1998 to Oct 2001 in Arizona and New Mexico, USA. Food items were combined as large-sized (i.e., adult and young ungulates) food items and medium- and small-sized food items (e.g., rabbits and rodents). Comparison values are expressed as percent frequency of occurrence.

Source	Large-sized food items	Medium- and small-sized food items	Large-sized food items PFO[a]
Ballard et al. (1987)	3,263	2,316[b]	58.5 a
Thompson (1952)	421	292[c]	59.0 a
Spaulding et al. (1997)	2,402	1,082	68.9 b
Murie (1944)	935	406	69.7 b
Mech (1966)	392	124	76.0 c
Cowan (1947)	353	94	79.0 cd
Arjo et al. (2002)	753	155	82.9 d
This study	246	19	92.8 e

[a] PFO = percent frequency of occurrence. Percentages followed by the same lowercase letter are not significantly different ($P > 0.05$, G-test, adjusted for continuity).
[b] Data included unidentified ungulates and undefined "unidentified" food items.
[c] Data included unidentified nonfood items.

Table 3. Estimated percent biomass of food items consumed by free-ranging Mexican gray wolves in Arizona and New Mexico, USA, from Apr 1998 to Oct 2001.

Prey	Mass of prey (kg)	kg/scat[a]	No. scats	Biomass consumed (kg)	% of items
Elk adult	250.0[b]	2.44	97	236.7	57.2
Cattle	318.0[c]	2.98	11	32.8	8.0
Unknown adult ungulate	150.3[d]	1.64	29	47.6	11.5
Adult deer	50.5[e]	0.84	7	5.9	1.4
Elk calf	50.0[f]	0.84	96	80.6	19.5
Deer fawn	18.0[g]	0.58	6	3.5	0.8
Porcupine	10.8[h]	0.53	1	0.53	0.1
Cottontail	0.9[h]	0.45	1	0.45	0.1
Birds	0.6[i]	0.44	1	0.44	0.1
Squirrel	0.2[h]	0.44	3	1.32	0.3
Ground squirrel	0.2[h]	0.44	4	1.76	0.4
Unknown rodent	0.2[h]	0.44	2	0.88	0.2
Mice	0.02[h]	0.44	3	1.32	0.3
Total			261[i]	413.8	99.9

[a] From Weaver (1993): calculated by equation $\hat{Y} = 0.439 + 0.008X$.
[b] Assumed mass from Hudson et al. (2002).
[c] Assumed mass from Ensminger (1976).
[d] Assumed mass averaged from Anderson (1981) and Hudson et al. (2002).
[e] Assumed mass averaged from Anderson (1981) and Geist (1998).
[f] Assumed mass from Cook (2002).
[g] Assumed mass from Audubon Society Field Guide to North American Mammals (1980).
[h] Assumed mass from Traves (1983).
[i] Excludes 2 insects and 2 vegetation.

(USFWS 1996). Historically, the BRWRA had a plentiful supply of elk, deer, and other wild game. By 1890 the native elk (*Cervus elaphus merriami*) were extinct (Nelson 1902) and Rocky Mountain elk were translocated to the area around 1925. With the reduction of the large native ungulate prey base, Mexican wolves reportedly turned to the more abundant and more easily caught livestock (Bailey 1931, Young and Goldman 1944, Brown 1983, Parsons 1996). Not all wolves were livestock killers and such behavior was only displayed by particular packs or individuals (Leopold 1959). Because of the conflict between livestock and predators, an extirpation campaign began. Historic records of the Mexican wolf's diets during the extirpation campaign primarily focused on wolves that depredated domestic cattle, but the reports likely were exaggerated and biased (Gipson and Ballard 1998).

Two factors could have biased our results: 1) lack of independence when scats are collected at the same time from pack mates, and 2) exclusion of smaller wolf scats favoring larger prey. Because we collected few scats from kill sites and scats were collected throughout the study area, we doubt that the first factor resulted in significant bias. However, the conservative minimum-diameter criterion ($\geq$28 mm) we used to identify most Mexican wolf scats could have biased our results by eliminating small wolf scats that contained medium- or small-sized prey, while larger-diameter scats contained a disproportionate amount of elk and inflated our estimates of the consumption of elk. Larger scats tend to have remains of larger ungulate prey (Danner and Dodd 1982).

Although wolves tend to prey on sick, weak, and unfit prey (Mech 1970), there is no evidence in southwestern United States historic records that indicated such hunting behavior by Mexican wolves (Brown 1983). However, during the first year of Mexican wolf recovery efforts, all confirmed Mexican wolf prey carcasses were elk and most remains were young of the year and old or injured individuals (Parsons 1998). From May 1998 through October 2001, Defenders of Wildlife–Bailey Wildlife Foundation Wolf Compensation Trust (unpublished data) paid US$16,612 for Mexican wolf–related injuries. Wolves killed 4 adult cattle, 11 calves, and 1 herding dog as well as injured 2 horses, 1 calf, and 1 guard dog. Our results, combined with USFWS kill reports and Defenders of Wildlife–Bailey Wildlife Foundation Wolf Compensation Trust reports, document that Mexican wolves consumed more large-sized native ungulates than domestic livestock.

Frequency of prey occurring in a sample of scats continues to be a common quantifying technique used to evaluate wolf-feeding ecology (Ciucci et al. 1996, Forbes and Theberge 1996, Spaulding et al. 1998, Arjo et al. 2002). Frequency data are calculated by counting each prey occurrence in a sample of scats, which are typically expressed as PFO. However, it is unknown how frequency data relate to the actual amount of each prey consumed (Floyd et al. 1978). Attempts to determine frequency-data accuracy have produced conflicting results (Kelly 1991), with technical and interpretational difficulties (Reynolds and Aebischer 1991).

Various researchers have contemplated frequency-data biases since the 1950s. Some researchers reported that frequency data fairly quantified prey remains in carnivore scats (Scott 1941, Erlinge 1968, Corbett 1989, Ciucci et al. 1996, Spaulding et al. 1997), while others determined that

Table 4. Comparison of ranks of percent frequency of occurrence (PFO) to estimated biomass consumed of various prey items identified in Mexican gray wolf scats in Arizona and New Mexico, USA, from Apr 1998 to Oct 2001.

Prey	PFO	Rank	Biomass (%)	Rank
Elk adult	36.6	1	57.2	1
Cattle	4.2	4	8.0	4
Unknown ungulate	10.9	3	11.5	3
Adult deer	2.6	5	1.4	5
Elk calf	36.2	2	19.5	2
Deer fawn	2.3	6	0.8	6
Porcupine	0.4	10	0.1	10
Cottontail	0.4	10	0.1	10
Birds	0.4	10	0.1	10
Squirrel	1.1	8	0.3	8
Ground squirrel	1.5	7	0.4	7
Unknown rodent	0.8	9	0.2	9
Mice	1.1	8	0.3	8
Total	98.1[a]		99.9	

[a] Excludes insects and vegetation.

PFO was not reliable (Lockie 1959, Weaver and Hoffman 1979, Zielinski 1986, Kelly 1991).

Lockie (1959) asserted that frequency-data accuracy of prey consumed was affected by volume variation of undigested prey material found in a scat, compounded by the prey-part variation consumed by the carnivore, and occurrence variation of $\geq$1 prey species in a single scat. Mech (1970) suggested that frequency of occurrence data might overrepresent the mass of relatively smaller animals consumed compared with larger animals because smaller animals (e.g., cottontail and rodents) have a higher surface:volume ratio. Therefore, smaller prey may be overrepresented in terms of actual prey mass consumed because hair is the primary identifiable undigested remain found in scats (Mech 1966, 1970). Floyd et al. (1978) and Traves (1983) reported overrepresentation of smaller prey in terms of mass and underrepresentation in terms of numbers. Weaver (1993) also reported that larger prey consisted of proportionately more digestible matter than smaller prey, which could result in frequency data inaccurately representing prey consumed. Corbett (1989) indicated that the biomass-consumed method allowed only an evaluation of the numbers of specific prey species consumed. When applying biomass models, determining the average live mass of a prey item is a critical step (Ciucci et al. 1996), as the researcher must account for the size differences for age classes (Floyd et al. 1978). This information comes from kill figures and is applicable only for ages from birth to 4–5 months (Pimlott et al. 1969) because differentiation between either yearlings and adults or females and males cannot easily be determined (Ciucci et al. 1996).

Kelly (1991) suggested that the relationship between the amount of prey consumed by a carnivore and the frequency that prey occurs in a sample of the carnivore's scats was unknown. According to Kelly (1991), these 2 biases may cause frequency data to misrepresent the amount of prey consumed by as much as 900%, and he recommended that these biases be corrected during scat content analyses if results were to represent carnivore diets accurately (Kelly 1991). We compared PFO to biomass estimates and found that PFO underestimated the relative importance of elk adults, the largest food item mass, and overestimated elk calves, a smaller food item (Table 4). With both elk adults (large) and elk calves composing a large portion of the wolf diet, there may be cause for concern for a potential bias from the PFO results. However, there did not appear to be a bias when we ranked the importance of ungulates versus medium- to small-sized non-ungulate mammalian prey because the difference in rankings did not significantly affect the relative importance of the main food categories.

Frequency and biomass methods differ substantially because frequency data are measures of undigested food remains found in a scat sample, and biomass is an estimate of the relative importance of food remains in terms of actual biomass ingested; therefore, it would not be correct to interpret the different rankings the same way (Ciucci et al. 1996). To assess a carnivore's diet accurately, scat-analysis data interpretation is enhanced by comparing results with $\geq$2 methods, even though different quantitative methods are not designed to be interpreted in the same manner (Ciucci et al. 1996).

Wolves tend to concentrate on the smallest or easiest to catch large prey species in areas where $\geq$2 large prey species inhabit the same area (Mech 1970, Messier and Crete 1985). Our results indicate that Mexican wolves primarily consumed adult elk and calves, the largest of the 5 large native ungulate species available within the BRWRA, and not the smaller deer. Comparison of these results with diets of other North American gray wolves suggests that Mexican wolves consumed a higher proportion of large-sized native ungulates than their northern counterparts. However, recently reintroduced wolves in Yellowstone National Park also have shown a high propensity to kill large prey items; about 90% elk during winter and large numbers of elk during summer with mule deer composing about 25–35% of the kills (D. Smith, United States National Park Service, personal communication). Previous gray wolf diet studies included scats collected from den and rendezvous sites and kill or carcass sites, while we collected our Mexican wolf scats from locations throughout the wolves' territories.

Gray wolves in different areas rely on different prey, and usually the wolf's diet is composed of 1 or 2 species (Mech 1970). Although early accounts of ungulate densities within the BRWRA suggested that deer were 3–4 times more abundant than elk (USFWS 1996), elk may now be as or more abundant than deer (AGFD, unpublished data, USFS, unpublished data). We propose that the large proportion of elk remains in Mexican wolf scats was because, during the low-density, early colonizing stage of wolf recovery, elk were naïve to predation by wolves, and elk were the most numerous ungulate species. Wolves in more northern landscapes primarily preyed upon the most vulnerable ungulates: juvenile, old, or postrut males (Carbyn 1974, 1983, Fritts and Mech 1981, Huggard 1992, Boyd et al. 1994). The proportion of naïve elk was probably relatively high in our study area because wolves had been absent for ≥40 years. This long absence of wolves may have increased the vulnerability of resident elk. Naïve prey confronted with new or reintroduced predators have been less wary than prey previously exposed to such danger (Byers 1998, Berger 1999, Berger et al. 2001, Mech et al. 2001). Mexican wolves we studied may have preyed upon vulnerable elk at a higher rate than would be possible for wolves in established northern populations where elk and wolves have a longer history of coexistence. However, unless deer numbers greatly increase, we predict that elk will continue to dominate Mexican wolf diet.

Mexican wolves are one of the 4 top nonhuman predator species in Arizona and New Mexico, and little research has been conducted on the other predators (i.e., mountain lion, black bear, and coyote) that now share the same prey base. A multi-carnivore prey-selection study could be used to determine why Mexican wolves consumed primarily elk.

Acknowledgments

The Mexican Wolf Interagency Field Team assisted with the collection of scats and provided Mexican wolf location data. The USFS Alpine and Clifton Ranger District personnel assisted with logistics. This is Texas Tech University, College of Agricultural Sciences and Natural Resources technical publication T-9-1048. This study was funded by the USFWS and Texas Tech University.

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