

# CARNIVORA AND THEIR LARGER MAMMALIAN PREY: SPECIES INVENTORY AND ABUNDANCE IN THE JANOS-NUEVO CASAS GRANDES PRAIRE DOG COMPLEX, CHIHUAHUA

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**Abstract.** This study examined the carnivore species composition and abundance in the Janos-Nuevo Casas Grandes prairie dog complex of north-western Chihuahua, Mexico. Thirteen species of carnivores were recorded in habitats including prairie dog towns, grassland, mesquite scrub and riparian vegetation. From artificial scent-stations and spotlight transects the most abundant carnivore species appeared to be the kit fox *Vulpes macrotis* and the coyote *Canis latrans*. Striped/hooded skunks (*Mephitis* spp) and American badgers (*Taxidea taxus*) were also common. No significant differences were found between the abundance of kit foxes or coyotes on prairie dog towns or grassland; but skunks were more abundant on grasslands. The abundance of hares (*Lepus californicus*), rabbit (*Sylvilagus audubonii*), and kangaroo rat (*Dipodomys* spp) was also estimated; hares and kangaroo rats were more abundant in the grassland, whilst rabbits were more abundant in prairie dog towns.

**Resumen.** Se estudió la composición de especies de carnívoros en el complejo de perros llaneros Janos-Nuevo Casas Grandes, en el noroeste de Chihuahua, México. Se registraron 13 especies de carnívoros en los siguientes hábitats; colonias de perros llaneros, pastizal, matorral de mezquite y vegetación riparia. Por medio de estaciones olfativas y transectos de lampareo se determinó que la zorra norteña *Vulpes macrotis* y el coyote *Canis latrans* fueron los más abundantes. Los zorrillos (*Mephitis* spp) y tejones (*Taxidea taxus*) también fueron comunes. No se encontraron diferencias significativas en la abundancia de zorras norteñas o coyotes entre colonias de perros llaneros o pastizal. Los zorrillos fueron más abundantes en el pastizal. También se estimó la abundancia de liebres (*Lepus californicus*), conejos (*Sylvilagus audubonii*), y ratas canguro (*Dipodomys* spp); las liebres y ratas canguro son más abundantes en el pastizal, mientras los conejos son más abundantes en las colonias de perros llaneros.

**Key words:** Carnivore abundance, Chihuahua, Mexico, prairie dog, scent-station, spotlighting.

## INTRODUCTION

Prairie dogs are a declining keystone species of the North American grasslands that sustain important numbers of predators (Ceballos et al., 1993; Miller et al., 1994; Wuerthner, 1995). The prairie dog towns of north-western Chihuahua have only recently been studied (Ceballos et al., 1993) with most investigations oriented towards determining the importance of prairie dogs and their activities for regional biodiversity. The present work examines species composition of carnivores within the prairie dog complex and surrounding habitats.

The role of top predators in the prairie dog ecosystem remains largely unknown even for such thoroughly studied species as the coyote. The same can be said of the generally less well-known kit fox, a species considered at risk of extinction in Mexico (SEDESOL, 1994). Information on the biology of these species is needed, and one of the fundamental questions relates to their abundance; such information is essential for their management and conservation (Berry, 1994; Gilpin and Soulé, 1986). While density is a preferred parameter, it is frequently difficult to obtain and therefore of limited value when it can not be obtained for large areas or many localities. In these situations, indices of abundance, which are easier to obtain can provide necessary information for the management of a species. We therefore attempted to produce estimates of abundance for the carnivores that can be easily compared to other areas.

## STUDY AREA

The study was conducted in the north-west of the State of Chihuahua, Mexico, within the Chihuahuan Desert ecoregion (Rzedowski, 1981). The area is a plain, limited to the north and west by the mountains of the Sierra Madre Occidental, and to the south and east by the desert scrub of the Chihuahuan Desert (30°57.8'N, 108°12.5'W and 30°37.5'N, 108°40.3'W). Altitude ranges from 1400 to 1600 m, and the main habitats are native short-grass prairie dominated by grasses and forbs. Areas within the short-grass prairie are occupied by prairie dog (*Cynomys ludovicianus*) towns and were therefore considered a different habitat than the short-grass prairie without prairie dogs that we refer to as grasslands. Other habitats found in the area are mesquite scrub and riparian vegetation that grows along seasonal streams (Brockman, 1986; Gay and Dwyer, 1980; Rzedowski, 1981).

The climate was characterised by García (1973) as (Bsokw(e')); that is arid, temperate with hot summers, winter rains and a thermal oscillation >14°C. Mean annual temperature is 15.7°C, with a mean of 6.0°C in January and a mean of 26.1°C in June. Temperature during the study ranged from -12°C to 49.8°C. The mean annual rainfall is 381 mm, with 77% of the rain falling between April and August, although

during this study rainfall was below to the annual mean (1994 = 252 mm, 1995 = 193.3 mm, and by June 1996 = 0 mm) due to a drought that started in 1993 and affected the entire region.

## METHODS

The species inventory of carnivores was conducted in the four habitat types described above. The transects undertaken to estimate carnivore and prey abundance through scent-stations and spotlighting were confined to the grassland and prairie dog towns within the same area.

Presence of species of carnivores in the area was determined by the following methods: 1) identification of tracks found in mud or at scent-stations; 2) spotlighting sessions; 3) direct opportunistic daytime observations, and 4) from carcasses and skulls found in the area or owned by local people.

In order to estimate the abundance of carnivore populations, we established twenty six transects in an stratified design, each with 10 scent-stations. Effort conducted in spring ( $n = 259$  usable stations; 100 in prairie dog towns, 82 in grassland and 77 in mesquite scrub), and again in autumn 1994 ( $n = 258$  usable stations; 130 in prairie dog towns, 98 in grassland and 30 in mesquite scrub). In the autumn, the number of stations in the scrub was reduced to increment the sample size in the prairie dog towns and grassland, the habitats of principal interest to this study.

Transects were set up along roads; each transect was 5 km long, with stations separated by 500 m. Distance between transects was  $> 2$  km (Roughton and Sweeny, 1982). Due to the limited number of prairie dog towns of large enough size to accommodate transects, there was inevitably some pseudo-replication on the largest towns to increase sample size in order to obtain usable numbers of observations.

The footprints of all carnivores that visited each station were identified to species with the aid of field guides, except for the hooded and striped skunks whose tracks were very similar (Aranda, 1987). The abundance of black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*) and kangaroo rats (*Dipodomys* spp) which are major prey species of both kit fox and coyote (List, 1997), was also estimated.

Relative abundance indices were obtained using frequency of scent-station visits according to Linhart and Knowlton (1975):

$$\text{Index} = (\text{Total stations visited} / \text{Total operative station nights}) \times 1\ 000$$

Independence between habitats and seasons was tested with two-way, 2 by 3 contingency tables using Chi-square test (Sokal and Rohlf, 1995).

We drove 1,234.2 km conducting spotlighting transects on a stratified design

where, 787.4 km of the transects were in prairie dog towns and 446.8 km were on grassland. Transects covered a total area of 740 km<sup>2</sup> (472.4 km<sup>2</sup> in prairie dog towns and 268.1 km<sup>2</sup> in grassland). Transects were performed from a vehicle travelling at 15 km/h searching for animals with a 1,000,000 candle power spotlight, along the full length of every usable road in the study area, between dusk and dawn. The search area encompassed a 300 m wide belt on each side of the road. Transect length fluctuated from 1.6 to 24 km. Because it was assumed that the vehicle travelled faster than the animals so the possibilities of recording the same individual twice were minimal, the distance separating the transects was not important (Buckland et al., 1993; Smith and Nydegger, 1985).

There were 13 sampling periods; one in both the spring of 1994, and 1995; from June 1995 to May 1996 there were monthly sessions, except for December 1995. Some of the roads utilised for transects became unavailable for use due to bad conditions, closure, and construction of new fences. Hence, the distribution and length of transects changed slightly over time.

Spotlighting was carried out around the new moon, starting one hour after sunset and ending one hour before sunrise. Along transects the number of jackrabbits and rabbits was also recorded. Kangaroo rats were not taken into account because their small size made them quite inconspicuous during spotlighting.

While the area covered by transects was known, no attempts were made to obtain an estimate of density for the species counted, since the low number of individuals seen would have given such inaccurate estimates that it would lack any biological value.

Throughout the 2.5 years of study, we recorded every species of carnivore that we saw outside the scent-stations or the spotlighting transects, either alive or dead, and through signs, tracks and markings. Also, we interviewed local inhabitants about the animals present in the area and recorded the species when we were shown pelts or other animal parts to confirm the report.

## RESULTS

Thirteen carnivore species belonging to 12 genera and 5 families were found in the area (Table 1). Prairie dog towns and grassland had the same number of species ( $n = 10$ ). In the mesquite scrub and riparian areas the number of recorded species was 7 (Table 1). The methods by which the different species were recorded are given in Table 1.

Two species were not recorded on prairie dog towns or grassland; grey fox, which was recorded on mesquite scrub and riparian vegetation, and black bear, detected only in riparian vegetation (and in corn fields).

Table 1. Species of carnivores present in the Janos - Nuevo Casas Grandes region, Chihuahua. Habitat where present, and detection method. SS = scent-stations, SL = spotlighting, OS = opportunistic sight or sign, IW = interviews. \*The track of these two species are indistinguishable from each other.

Species	Common name	Habitat on which presence was detected							Detection method				
		Dog town	Grassland	Scrub	Riparian	SS	SL	OS	IW				
Canidae													
<i>Canis latrans</i>	coyote	x	x	x	x	x	x	x	x	x	x	x	x
<i>Urocyon cinereoargenteus</i>	grey fox			x	x	x	x	x	x	x	x	x	x
<i>Vulpes macrotis</i>	kit fox	x	x	x	x	x	x	x	x	x	x	x	x
Ursidae													
<i>Ursus americanus</i>	black bear				x								x
Procyonidae													
<i>Bassariscus astutus</i>	ringtail	x	x					x					
<i>Procyon lotor</i>	raccoon	x	x		x				x				x
Mustelidae													
<i>Mustela frenata</i>	long-tailed weasel	x	x		x			x					x
<i>Taxidea taxus</i>	badger	x	x	x				x	x				x
<i>Conepatus mesoleucus</i>	hog-nosed skunk	x	x		x			x					
<i>Mephitis macroura</i>	hooded skunk	x	x		x			x*	x				x
<i>Mephitis mephitis</i>	striped skunk	x	x		x			x*	x				x
<i>Spilogale putorius</i>	western spotted skunk	x	x		x			x	x				x
Felidae													
<i>Lynx rufus</i>	bobcat				x								x
<b>Total of records</b>		<b>10</b>	<b>10</b>	<b>7</b>	<b>9</b>	<b>10</b>	<b>8</b>	<b>9</b>	<b>9</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>7</b>

### Scent-stations

Seven species of carnivores were detected on the scent-stations in the spring transects, and 8 species in the autumn transects (Table 2). One grey fox was registered in the spring transects, but none in the autumn transects. Conversely, the hog-nosed skunk and the long-tailed weasel were recorded in the autumn transects only. The combined sampling effort failed to register 4 other species known to exist in the area. From the 259 stations of the three habitats, 53 (20.5%) had carnivore tracks in spring, and 61 (23.6%) of 258 had carnivore tracks in the autumn. The coyote was the most abundant carnivore on the scent-stations; indices of abundance in both seasons were 60.1 in prairie dog towns and 46.0 in grassland. The next most abundant carnivores were the kit fox with indices of 15.5 in prairie dog towns and 9.7 in grassland, and the striped-hooded skunks with indices of 5.8 in prairie dog towns and 19.3 in grassland. The indices of abundance for the badger were 9.7 in prairie dog towns and 3.9 in grassland. The remaining species were only represented in a particular habitat and season (Table 2), often by only one individual.

No statistically significant differences were found between habitat or season for any carnivore species in the scent-stations, except that the number of coyotes detected in grassland was greater in spring than autumn ( $X^2 = 4.976$ ,  $P = <0.05$ ). The badger showed a slightly higher percentage of visits (3.8) in prairie dog towns than in grassland (1.0), although the difference was not significant.

The tracks of the black-tailed jackrabbit, desert cottontail and kangaroo rats were readily identified. The kangaroo rats visited the scent-stations at a higher frequency (33.8% and 63.3%) than any of the other two prey species. Rabbits were the least numerous of all, but were represented in all habitats and seasons (Table 2). The visits to scent-stations by kangaroo rats and jackrabbits were significantly lower ( $X^2 = 21.318$ ,  $P < 0.001$ , and  $X^2 = 7.072$ ,  $P = 0.05$ ) in the prairie dog towns than in the other habitats during both seasons (Table 2).

Except for kangaroo rats which showed an increase in visitation rate in the autumn ( $X^2 = 7.74$ ,  $P = 0.01$ ), the spring and autumn differences in visitation rates were small for the lagomorphs, and there was no detectable change among seasons (Table 2).

### Spotlighting

Ten species of carnivores were detected on the spotlighting transects. Spotlighting failed to detect 3 species known to be present in the area (black bear, bobcat and ringtail). Since no studies on the striped and hooded skunks have been undertaken in this area, it was not possible to determine with certainty which species was observed

Table 2. Visitation indices to scent-stations by carnivores, rodents and lagomorphs in prairie dog towns (PD), grassland (G) and mesquite scrub (S).

Species	Habitat	Spring	Autumn	Both seasons
Coyote	PD	46.3	56.6	60.1
	G	61.8	31.0	46.0
	S	30.9	23.3	27.0
Grey fox	PD	0	0	0
	G	0	0	0
	S	3.9	0	1.9
Kit fox	PD	7.7	23.3	15.5
	G	3.9	15.5	9.7
	S	7.7	0	3.9
Ringtail	PD	0	0	0
	G	3.9	3.9	3.9
	S	0	0	0
Hog-nosed skunk	PD	0	3.9	1.9
	G	0	3.9	1.9
	S	0	0	0
Hooded-striped skunk	PD	0	11.6	5.8
	G	19.3	19.4	19.3
	S	0	0	0
Spotted skunk	PD	7.7	0	3.9
	G	0	3.9	1.9
	S	3.9	0	1.9
Badger	PD	0	19.4	9.7
	G	3.9	3.9	3.9
	S	3.9	0	1.9
Long-tailed weasel	PD	0	3.9	1.9
	G	0	11.6	5.8
	S	0	0	0
Kangaroo rat	PD	54.1	120.0	87.0
	G	77.2	73.6	75.4
	S	100.4	73.6	87.0
Jackrabbit	PD	19.3	7.7	13.5
	G	44.8	54.3	52.2
	S	65.6	19.4	42.5
Rabbit	PD	11.6	38.7	25.1
	G	19.3	31.0	25.1
	S	23.2	11.6	13.5

or if hybrids are present. Thus *Mephitis* skunks observations were analysed by genus, rather than by species. Three species, grey fox, racoon and long-tailed weasel, were observed only 1-3 times during spotlighting. Kit foxes were the most frequently seen carnivores ( $n = 146$ ) followed by coyotes ( $n = 128$ ) and *Mephitis* skunks ( $n = 58$ ), whilst only 15 badgers were seen during spotlighting sessions. The only species for which abundance could reliably be obtained were coyotes, kit foxes and *Mephitis* skunks.

Coyotes were more abundant in the spring of 1994, when 2.74 individuals per 10 km of transect (/10 kmT) were observed in all habitats, but declined to 0.19/10 kmT in July 1995. After that, it increased to 1.8/10 kmT in September 1995, and then steadily declined, reaching a low of 0.41/10 kmT by the end of the study (Fig. 1). The mean number of coyotes seen was 1.0/10 kmT ( $range = 0.0 - 3.5$ ,  $SD = 0.75$ ). There was no significant difference in the number of coyotes on prairie dog towns and in grassland ( $t = 2.01$ ,  $P = 0.068$ ).

The average number of kit foxes was 1.18/10 kmT ( $range = 0.2-4.0$ ,  $SD = 0.78$ ), and no statistical difference was observed between the number of foxes in prairie dog towns or grassland ( $t = 1.44$ ,  $P > 0.05$ ; Fig. 2). The spotlighting transects from March 1994 to October 1995 showed a negative correlation between the number

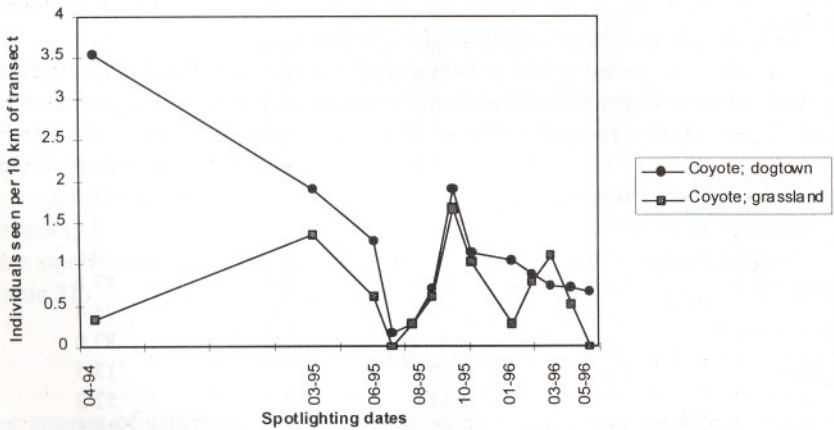


Figure 1. Abundance of coyotes in grassland and prairie dog towns, estimated from spotlighting transects.



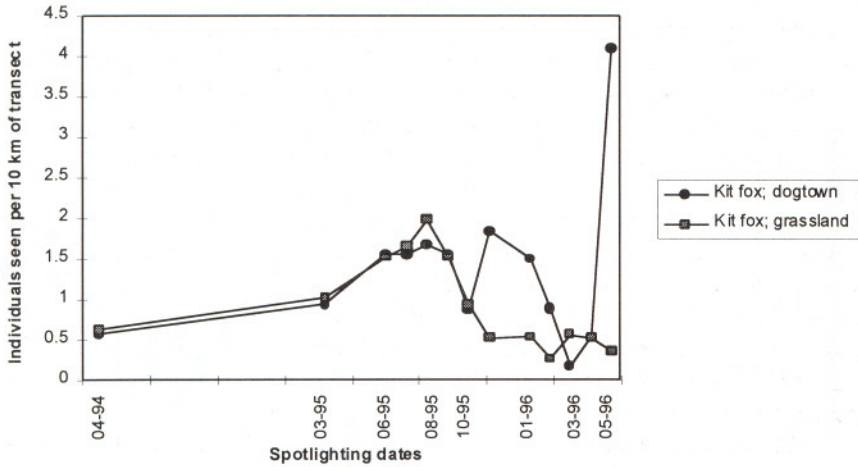


Figure 2. Abundance of kit foxes in grassland and prairie dog towns, estimated from spotlighting transects.

of foxes with respect to the numbers of coyotes ( $P = -0.986$ ), but from November 1995, both species declined in numbers (Fig. 3).

Skunks were the only carnivores for which a statistically significant difference was observed when compared in prairie dog towns ( $0.15/10 \text{ kmT}$ ) and grassland ( $0.9/10 \text{ kmT}$ ), and were more abundant in grasslands ( $t = 6.04$ ,  $P < 0.005$ ). The average number of skunks was  $0.46/10 \text{ kmT}$  ( $\text{range} = 0 - 1.7$ ,  $SD = 0.55$ ). A sharp decline in skunks was observed between July 1995 and October 1995, followed by a steady recovery (Fig. 4).

Black-tailed jackrabbits were the most abundant of the two prey species ( $X = 4.92/10 \text{ kmT}$ ,  $\text{range} = 0.4 - 16$ ,  $SD = 3.99$ ) and were significantly more numerous in grassland than in prairie dog towns ( $t = 3.78$ ,  $P < 0.005$ ; Fig. 5). Contrary to hares, rabbits were more abundant on prairie dog towns than in grassland ( $t = 4.43$ ,  $P < 0.005$ ), but were not as abundant ( $X = 1.36/10 \text{ kmT}$ ,  $\text{range} = 0.0 - 5$ ,  $SD = 1.2$ ; Fig. 6). The number of both hares and rabbits seen fluctuated greatly between transect sessions.

### Opportunistic sightings and interviews

From the interviews and opportunistic sightings we obtained additional infor-

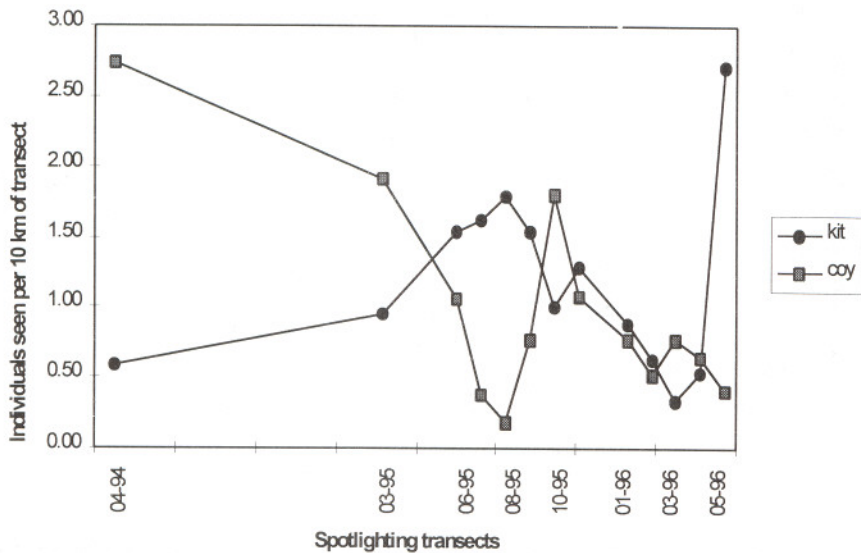


Figure 3. Abundance of coyotes and kit foxes in the area estimated from spotlighting transects. Data from prairie dog towns and grassland combined.

mation about the carnivores and other large mammals in the area. Five black bears (*Ursus americanus*) were reported by local people during the period of study, and 3 of them were killed. Pumas (*Puma concolor*) were reported by local people to be a rare vagrant from the neighbouring mountains, but no evidence of its presence was observed during this study. Similarly a jaguar (*Panthera onca*) was shot in 1982 in one of the ranches of the area (A. Lafón, pers. comm.); that was the only report of jaguars for the study area. Mexican wolves (*Canis lupus*) used to be present in the area (Leopold 1959; Brown 1983), but they have not been recorded there for over 20 years (McBride, 1980). No wild ungulates were detected during spotlighting or scent-stations, but collared peccaries (*Tayassu tajacu*) were observed once in a prairie dog town, and frequently in riparian areas of private ranches. Pronghorn antelope (*Antilocapra americana*), mule deer (*Odocoileus virginianus*) and bison (*Bison bison*), have been locally extirpated: however, all three species are still present in adjacent regions.

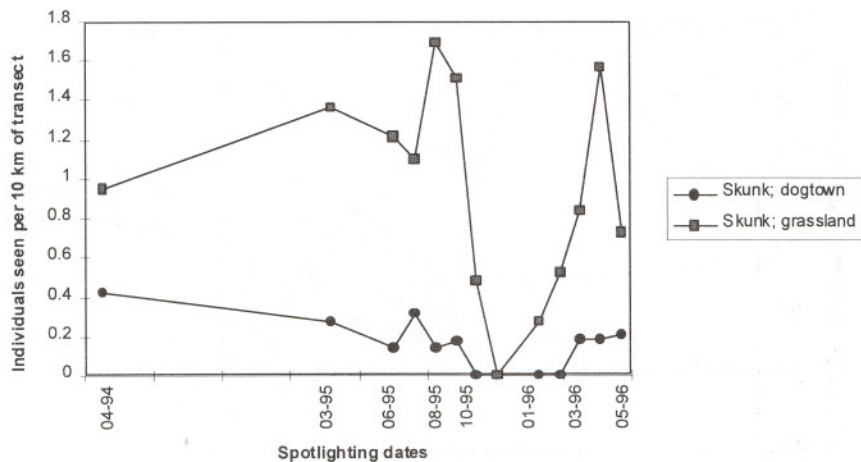


Figure 4. Abundance of skunks in grassland and prairie dog towns, estimated from spotlighting transects.

## DISCUSSION

While the methodologies used for determining the abundance of carnivores are diverse (Andelt and Andelt, 1984; Clark, 1972; Nellis and Keith, 1976; O'Farrell, 1998), all have advantages and disadvantages that have to be evaluated according to the conditions of the site and objectives of the study. We selected spotlighting and scent-stations (or scent traps), because these methods are easy and cheap to implement, require little training, can be conducted by a team of two people, give straight forward indices of abundance, and can be carried out in a wide variety of habitats. Therefore, such methods have good potential to be implemented in other areas for comparative purposes (Babb and Kennedy, 1989; Buckland et al., 1993; Clark 1989; Conner et al., 1983; Linhart and Knowlton, 1975; Pyrah, 1984; Voigt and Berg, 1987; Roughton and Sweeny, 1982).

While in many parts of Mexico large carnivores have been extirpated, the Janos - Nuevo Casas Grandes region still holds populations of most of the species present in historic times. At least 13 species of carnivores are found in the study site.

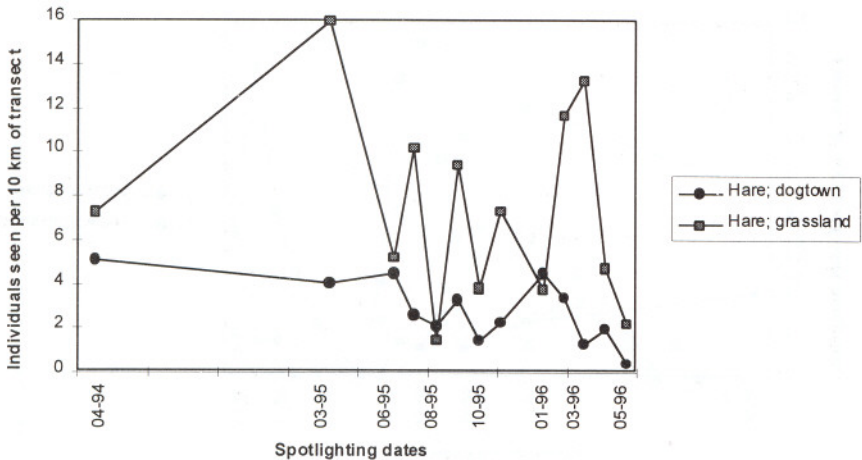


Figure 5. Abundance of jackrabbits in grassland and prairie dog towns, estimated from spotlighting transects.

The two apparent absentees from the former carnivore assembly are the puma, whose infrequent visits may be easily overlooked, and the Mexican wolf, considered as endangered in Mexico (SEDESOL, 1994). Since there have been no confirmed reports of the wolves' presence across their entire former range for the last ten years, we conclude it is the only carnivore species which has been extirpated from the area.

The combination of both spotlighting and scent-stations was useful for determining the species of carnivores present in the area; however, diurnal searches for signs or sightings were also required to complement the information.

Carnivore species composition did not strongly differ in grasslands and prairie dog towns such result should be expected for medium size and large mammals with high vagility, because individuals of these species use large areas that can include adjacent prairie dogs towns grasslands and other habitats. That is indeed the case in our study site for coyotes and kit foxes, where average home range size was 90 and 11.5 km<sup>2</sup>, respectively, and included grasslands, prairie dog towns, and mesquite scrubs (List, 1997).

The absence of records of grey fox and bobcat from the prairie dog towns and grassland suggests that the prairie is not the primary habitat for these two species (Thompson et al., 1992). It also should be considered that hunting can contribute to

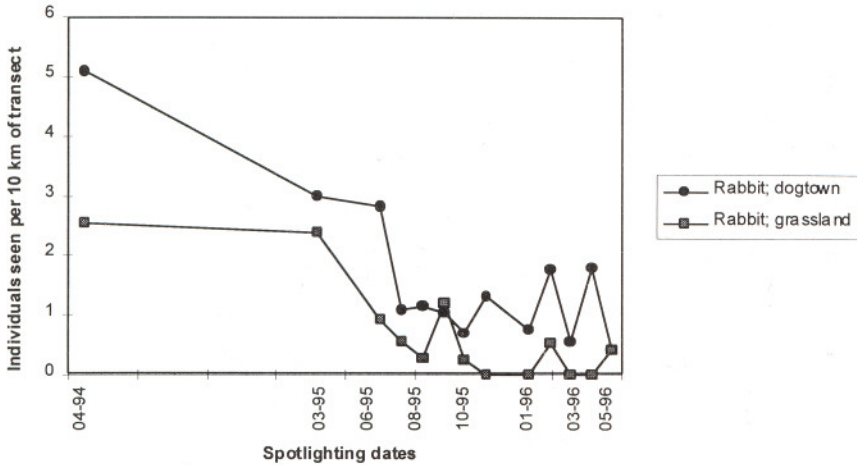


Figure 6. Abundance of rabbits in grassland and prairie dog towns, estimated from spotlighting transects.

the marginal use of the grassland, since this habitat provides little cover for these species. From our observations, their movements into the open prairie appear to be unusual events.

Bears and pumas occasionally descend from the mountains to the plains, and the chance of detecting them by monthly spotlighting line transects or by scent-stations is small. In cases when detection of carnivores not normally present in a particular area is required, other methods such as repeated spotlighting transects or systematic search of signs around a reported sighting may be more suitable, because they increase the possibility of detecting a rare species (Clark et al., 1984; Van Dyke and Brocke, 1987a, 1987b). The jaguar killed within the study area was probably a dispersing individual, because the closest breeding population is over 150 km away, in the other side of the Sierra Madre Occidental Range (C. López, pers. comm.).

The scent-stations provide an useful tool to compare relative abundance of coyotes between different habitats. The visitation indices obtained in this study in the autumn in the three habitats when are low compared to indices observed in New Mexico, Texas, and Arizona (Linhart and Knowlton, 1975). However, this variation is not surprising because many factors such as habitat, prey, and hunting, can influence their abundance.

Harris (1983) reported that coyotes were more likely to visit scent-stations when they were away from their territories than when they were within their territories. If this pattern is true for the study area, it could have influenced the results, because there was seasonal coyote control in part of the grassland, making it more likely that more non-resident coyotes would have entered that area. The above, together with the high vagility of this species, that makes them more capable of visiting more stations on a given transect or even more than one transect than the kit foxes, can explain why coyotes were more abundant on the scent-stations than the kit foxes, contrary to the pattern observed through spotlighting.

Scent-stations and spotlighting produced similar trends of abundance for the same species at the same habitats, but compared to scent-stations, spotlighting produced more abundant and reliable data, with less effort, at a reduced cost. Also, since with spotlighting the sampling for a large area was performed in 3-4 days, the bias due to seasonality was reduced. We therefore recommend the use of spotlighting for the estimation of carnivore abundance, at least in open habitats.

The negative relationship observed during part of the study between kit foxes and coyote could be due to the fact that the coyote may predate upon kit fox (Moehrensclager and List, 1996; Ralls and White, 1995). Alternatively, kit foxes may be reacting to the presence of the coyotes by reducing their activity when coyotes are present in the area. If this is the case, an increase of the coyote density in the area sustained over a long period is likely to result in a decrease on the kit fox population. The negative relationship was not evident when numbers of both species declined.

Skunks were the only carnivores that showed a marked preference for grassland habitat over prairie dog towns. Skunks feed primarily on birds eggs, insects and other invertebrates (Bowen and Simon, 1990; Fenske-Crawford and Niemi, 1997; Leopold, 1959; Vickery et al., 1992). Grasslands, where the plant cover was greater, provided a better habitat for such small prey than the more over-grazed prairie dog towns (M. Royo, pers. comm.), and the abundance of ground nesting birds was higher in the grassland (Manzano-Fischer, 1996). Because the decline on skunks from September 1995 to January 1996, was so dramatic and prolonged, a big die off is a probable cause. Whether if this was product of a epizootic outbreak or food scarcity is not know, since no direct evidence was found.

Badgers showed a higher abundance in prairie dog towns than elsewhere, though the trend failed to reach significance with the small sample sizes available for this species. The trend was expected because the badger is a truly fossorial species and its local distribution and activity depends on fossorial prey, such as prairie dogs (Clark et al., 1982; Messick, 1987). The overall density in the area must be low, and therefore the number of observations not enough to show a significant difference between habitats.

Except for coyotes, kit foxes, striped-hooded skunks and badgers, the rest of the carnivores recorded by spotlighting or scent-station transects had very low abundance within the grassland and prairie dog towns. A study on the distribution and abundance of furbearers in New Mexico (including the south-western part of the State, distant only 60 km from our study site), showed that the grassland was one of the habitats where coyotes, striped and hooded skunks and badgers were more abundant, while the hog-nosed skunks were more abundant in forested areas and rocky terrain, and less common in grassland. The abundance of bobcats and grey foxes, is generally greater in habitats with high vegetation cover (Thompson et al., 1992); so it was expected to find them at low abundances as in grasslands.

The lower abundance of kangaroo rats in prairie dog towns was expected, since their burrows were seen in different soil types. The low number of hares within prairie dog towns is probably due to the lack of vegetation cover to hide from coyotes, and the reduced plant biomass in the prairie dog towns product of a prolonged drought and grazing of cattle, ants, and prairie dogs (Manzano-Fischer, 1996; on the scent-stations M. Royo, pers. comm.). The grassland had more vegetal cover for food and shelter, whereas the mesquite had a high plant coverage because of the bushes, whilst their leaves and plantules also provided food. Both of these factors could explain the higher abundance of hares in grassland and scrub, while also providing the food for coyotes and kit foxes outside the prairie dog towns. Rabbits were more abundant on prairie dog towns, because they utilise burrows dug by other species, and the burrow density is higher in the prairie dog towns than in the grassland (Dano, 1952; Hansen and Gold, 1977; Moehrensclager and List, 1996 ).

The lack of wild ungulates was surprising because pronghorn antelopes (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), and bison (*Bison bison*) are found in private ranches around the study area. The hunting pressure by local inhabitants seems to be the main reason for the absence of wild ungulates from the area, but competition for grass due to cattle overgrazing must be a limiting factor for the wild ungulates to recolonise the study area (Brown, 1997; Fleischner, 1994; Leopold, 1937). The absence of the ungulates can explain the lack of records of mountain lions from our study, and also is a limiting factor for the recovery of other carnivore species such as the jaguar and wolf.

### ACKNOWLEDGMENTS

We thank M. Doughty, M. Eaton, E. Jiménez, G. Johnson and C. Philcox, dedicated volunteers. The assistance throughout the development of this study of G. Ceballos, P. Manzano-Fischer, B. Miller, J. Pacheco and M. Royo was invaluable. J. Fa, K. Hambler, P. Johnson and P. Stewart helped improve the manuscript. J. Servín and D. Valenzuela made useful comments on the manuscript. The British Council and Consejo Nacional de Ciencia y Tecnología gave scholarships to R.L. The study was

conducted with funds from Consejo Nacional para el Conocimiento y Uso de la Biodiversidad, Dirección General de Apoyo al Personal Académico de la Universidad Nacional Autónoma de México, The People's Trust for Endangered Species, United States Agency for International Development.

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