

Abundance and Food Habits of Cougars and Bobcats in the Sierra San Luis, Sonora, México

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Abstract—Cougars (*Puma concolor*) and bobcats (*Lynx rufus*) are present throughout the Sky Islands of the Sonoran desert. We determined the abundance and food habits in northeastern Sonora, Mexico. Abundance indicated that cougars were common (4.19 ± 5.57 cougars/100 km² and 0.05 ± 0.05 scats/km). According to the scat index, bobcats were more abundant than cougars but no significant differences were found between the two ranches in the study area for both species. Cougars fed primarily on white-tailed deer (*Odocoileus virginianus*) and bobcats fed primarily on eastern cotton-tailed rabbit (*Sylvilagus floridanus*), where a small dietary overlap was estimated (0.34, Morisita index and 0.22, Pianka index). Our data help the management and conservation of this region.

Introduction

Many carnivores have been extirpated and forced to modify their distribution as human presence increases throughout Mexico (Leopold 1977, Primack et al. 2001). Nevertheless, these carnivores are found in the most rugged, remote, and isolated areas. These species are directly linked to their herbivorous prey, directly impacting their population, and thereby altering plant production and seed dispersion (Logan and Sweaner 2001, Ripple and Beschta 2003). This web of interaction becomes rather complex as prey species are shared by multiple carnivore species (Neale and Sacks 2001). That is the case for cougars (*Puma concolor*) and bobcats (*Lynx rufus*), where they are sympatric with other species (e.g., black bears, coyotes, and eagles) at the upper levels in the food chain (Sunquist and Sunquist 1989, 2001).

Recently, anthropogenic activities (e.g., overgrazing, human population growth, and timber extraction) have modified the distribution and availability of resources to top predators, potentially reducing populations due to energy restrictions and altered spatial patterns (Primack et al. 2001, Sunquist and Sunquist 2001). In the Sierra San Luis, northeastern Sonora, livestock ranching has a long history of modifying natural conditions but in the past seven years there has been a change in the land use due to improved conservation practices. As a result, cattle were removed and consequently human impact reduced in some areas, allowing the vegetation to recover from overgrazing and soil loss.

Estimation of abundance is a useful tool for monitoring and determining management strategies of wildlife populations (Carbone et al. 2001, Wilson and Delehay 2001). Therefore we studied the populations of both bobcats and pumas on two ranches in the Sierra San Luis, El Pinito and Los Ojos, in the center of the Madrean Archipelago, with a hypothesis that the population of these predators will have different abundances according to the area, because of the diverse biotic communities at hand. Also, in places where cougars, bobcats, black bears, and

coyotes coexist, there can be competition for prey affecting their abundance and distributions (Currier 1983, Maehr 1997).

Study Area

The study area encompasses the El Pinito and Los Ojos ranches, which are located in northeastern Sonora, adjacent to northwestern Chihuahua, southeastern Arizona, and southwestern New Mexico (figure 1). As part of the Sierra San Luis, they represent a combination of alpine woodlands of the Sierra Madre Occidental and some elements of the Chihuahuan and Sonoran desert of lower altitudes, as well as riparian vegetation (Brown 1994).

The El Pinito ranch is mainly covered by pine-oak forests in the highest portions of the mountains, canyons, and slopes, where we found *Abies*, *Pinus*, *Juniperus*, and *Quercus*. Chaparral and thorn scrub vegetation occur on the lower parts and plateaus with vegetation represented by *Quercus*, *Arctostaphylos*, *Juniperus*, *Opuntia*, and *Yucca*. Along the west edge of the ranch, riparian vegetation is predominant. In contrast, Los Ojos is mainly covered by chaparral and thorn scrub vegetation and with riparian vegetation in canyons where perennial rivers flow (Brown 1984).

Methods

Tracks, scrapes, and scats were recorded and collected along transects placed in the two ranches, covering 21 linear kilometers at each ranch. Scats were identified by their shape, size, and color. In the case of tracks, we used field guides (Ceballos and Miranda 1986), and for the scrapes we assumed that male cougars usually made them whereas bobcats rarely do (Shaw et al. 1988). In addition, we placed six camera traps (CamTraker®) per ranch, covering as much area as possible. Both cameras and transects were surveyed approximately every three weeks between April 2003 and January 2004 with a total of nine surveys conducted.

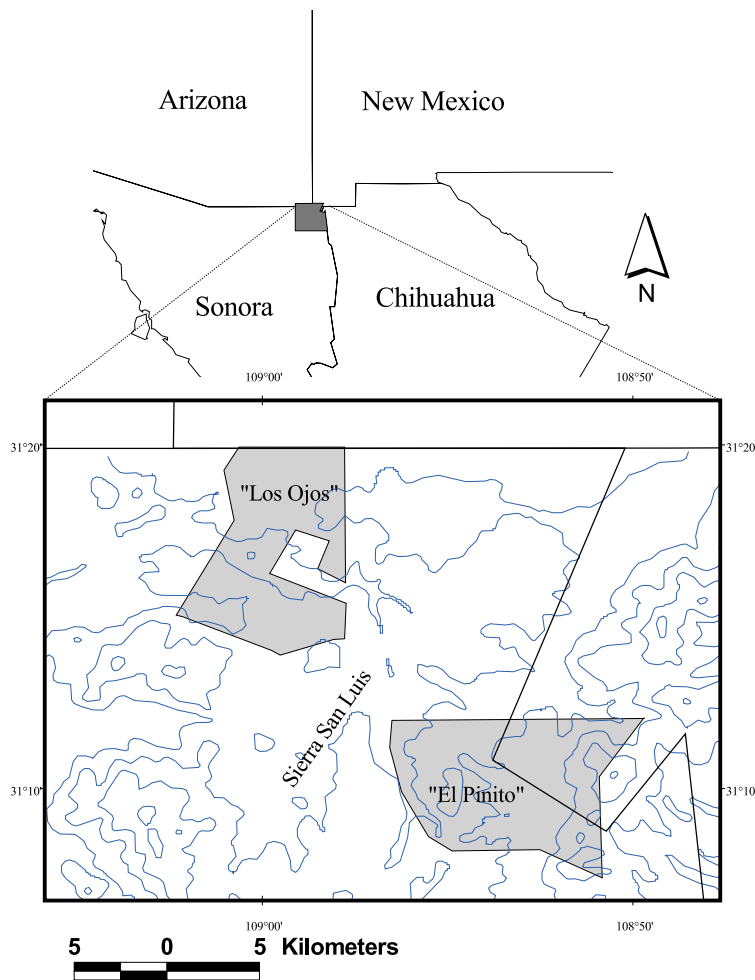


Figure 1—The “El Pinito” and “Los Ojos” ranches in the Sierra San Luis study area.

Scats were examined after being washed in nylon stockings with running water. Prey items found were identified from hair and bone fragments through identification keys (Monroy and Rubio 2003, Moore et al. 1974) and were compared with samples of hair and bones housed at the Escuela de Biología, Universidad Autónoma de Querétaro (following Ackerman et al. 1984, Fernández 2002).

Frequency of occurrence, relative frequency, and biomass consumed were calculated for each prey item (Ackerman et al. 1984, Núñez et al. 2000). Biomass calculations for cougars implied the use of a correction factor, $Y = 1.98 + 0.035 X$, where Y is the weight of prey consumed per scat and X is the estimated prey body weight (Ackerman et al. 1984). For bobcats, we used a different correction factor, $y = 16.63 + 4.09 x$, where y is the fresh weight of prey consumed (g) per g of scat produced (dry weight) and x is the estimated prey body weight (Baker et al. 2001, De Villa et al. 2002). Also the degree of dietary overlap was calculated using the indexes of Morisita (Bower 1977) and Pianka (1974).

Relative abundance was estimated as an index of scats/km and tracks/km (Shaw 1988, Wilson and Delehay 2001). Also, density was calculated with the formula $y = 140.33 x^{-1.116}$, where y is the number of camera days until the first picture was taken

and x is the estimated density in 100 km². This statistic was used because it does not rely on individual identity (Carbone et al. 2001). Statistical analysis between ranches and species were performed in the program Sigmasat 3.0 (Jandel Corporation®).

Results

We collected 71 scats (20 of cougars and 51 of bobcats), and registered 43 track sets (31 cougars and 12 of bobcats) and 52 cougar scrapes. We recorded 10 cougar pictures in contrast to only one bobcat picture.

Abundance

Cougar relative abundance estimation was of 0.05 ± 0.05 scats/km and 0.08 ± 0.08 tracks/km with a tendency to decrease at the end of the year. We found no significant differences between ranches for the scat index ($t = -0.809$, D.F.=16, $P=0.431$) or for the tracks index ($t = 0.365$, D.F.=16, $P=0.72$). Our density estimate was of 4.19 ± 5.57 cougars/km². Bobcat abundance was 0.13 ± 0.11 scats/km and 0.03 ± 0.05 tracks/km, with no difference between ranches for the scat index ($T=104.5$, $P=0.102$) and tracks index ($T=82$, $P=0.79$). The estimated density was 0.7 ± 2.1 . In addition to the photographs of individual animals obtained we were able to register two different female cougars with their cubs, one of them feeding on a white-tailed deer (*Odocoileus virginianus*) (table 1).

Food Habits

Cougars fed on eight different prey species, all of them mammals (table 2). The 20 cougar scats contained 30 components, an average of 1.5 components per scat. Small mammals (<1 kg) comprised 6.67% of relative frequency and 0.74% of biomass consumed, medium-sized mammals (1-10 kg) comprised 26.66% of relative frequency and 18.2% of biomass consumed, and large mammals (>10 kg) comprised 66.67% of the relative frequency and 81% of the biomass consumed. The main prey items for cougars were four mammals with 91.76% of the consumed biomass and 80% of relative frequency: white-tailed deer, collared peccary (*Tayasu tajacu*), cattle (*Bos taurus*), and coati (*Nasua narica*), in order of importance. White-tailed deer accounted for 43.81% of biomass consumed and 36.67% of relative frequency (table 2).

Bobcats fed on 10 different prey species (table 3). The 51 bobcat scats analyzed contained 68 components of prey, with an average of 1.33 components per scat. Mammals accounted for 91.2% of the relative frequency and 93.1% of the biomass consumed. Small mammals comprised 22% of relative frequency and 16.26% of the biomass consumed, medium-sized mammals comprised 63.23% of the relative frequency and 57.43% of biomass consumed, and one large mammal, white-tailed deer, comprised 5.88% of relative frequency and 19.41% of biomass consumed. Three mammals accounted for 77.94% of the relative frequency and 82.03% of the biomass consumed: eastern cotton-tailed rabbit (*Sylvilagus floridanus*), white-tailed deer, and

Table 1—Relative abundance and density (per 100 km²) of cougars and bobcats in the “El Pinito” and “Los Ojos” ranches of Sonora, Mexico, from July 2003 to December 2003.

	<i>Puma concolor</i>			<i>Lynx rufus</i>		
	“El Pinito”	“Los Ojos”	Total	“El Pinito”	“Los Ojos”	Total scats
Scats/km	0.04±0.04	0.06±0.06	0.05±0.05	0.15±0.07	0.12±0.18	0.13±0.11
Tracks/km	0.09±0.1	0.07±0.08	0.08±0.08	0.04±0.08	0.03±0.03	0.03±0.05
Density			4.19±5.57			0.7±2.1

Table 2—Relative biomass consumed by the cougars based on 20 scats collected in the “El Pinito” and “Los Ojos” ranches of Sonora, Mexico, from July 2003 to December 2003.

Prey	Frequency of occurrence	Prey weight (kg)	Correction factor	Relative biomass	Relative frequency
<i>Sylvilagus floridanus</i>	10	1.14	1.14	2.87	6.67
<i>Lepus californicus</i>	5	2.4	2.064	2.60	3.33
<i>Mephitis</i> sp	5	1.6	1.6	2.02	3.33
<i>Nasua narica</i>	20	4	2.12	10.68	13.33
<i>Thomomys umbrinus</i>	10	0.295	0.295	0.74	6.67
<i>Odocoileus virginianus</i>	55	33.79	3.16265	43.81	36.67
<i>Bos taurus</i>	10	100	5.48	13.80	6.67
<i>Tayasu tajacu</i>	35	19.5	2.6625	23.47	23.33

white-throated wood rat (*Neotoma albigula*). The cotton-tailed rabbit alone accounted for 57.35% of the relative frequency and 51.66% of the biomass consumed (table 3). A bird and a snake consumed by bobcats could not be identified and comprised 5.8% and 2.94% of the consumed biomass, respectively.

Interspecific Interactions

In both cougars and bobcats, mammals were the principal prey items, with four prey shared between them. We compared the biomass consumed using the Morisita index and the percentage of relative frequency using the Pianka index (Nuñez et al. 2000), to measure dietary overlap. The two methods indicated a low dietary overlap. The Morisita index was 0.34 (1 is complete overlap, 0 is complete separation), and the Pianka index was 0.22 (1 is complete overlap, 0 is complete separation). The skunk (*Mephitis* sp.) and the southern pocket gopher

(*Thomomys umbrinus*) were consumed in low proportions by cougars and bobcats. In contrast, eastern cotton-tailed rabbit provided over half of the dietary biomass for bobcats, and white-tailed deer provided approximately half of the biomass consumed by cougars.

Discussion

Our methods used to estimate abundances of cougars and bobcats in our study sites were not consistent; whereas tracks and densities from camera traps worked for cougars, they did not for bobcats because it was more difficult for us to record bobcats indirectly through tracks and photographs. Cougar tracks are easier to spot than those of bobcats, suggesting that bobcats had a very low density compared to other regions (table 1, Lariviere and Walton 1997). Scats seem a more reliable index

Table 3—Relative biomass consumed by bobcats based on 51 scats collected in the “El Pinito” and “Los Ojos” ranches of Sonora, Mexico, from July 2003 to December 2003.

Prey	Frequency of occurrence	Prey weight (g)	Correction factor	Relative biomass	Relative frequency
<i>Sylvilagus floridanus</i>	76.47	1140	21.29	51.66	57.35
<i>Mephitis</i> sp.	7.84	1600	23.17	5.77	5.88
<i>Thomomys umbrinus</i>	1.96	295	17.84	1.11	1.47
<i>Neotoma albigula</i>	19.61	240	17.61	10.96	14.71
<i>Chaetodipus</i> sp.	3.92	37.5	18.16	2.09	2.94
<i>Peromyscus</i> sp.	1.96	34	18.02	1.04	1.47
<i>Sigmodon</i>	1.96	115	17.10	1.06	1.47
<i>Odocoileus virginianus</i>	7.84	15000	77.98	19.41	5.88
Unidentified bird	7.84	380	18.18	4.53	5.88
Unidentified snake	3.92	600	19.08	2.37	2.9

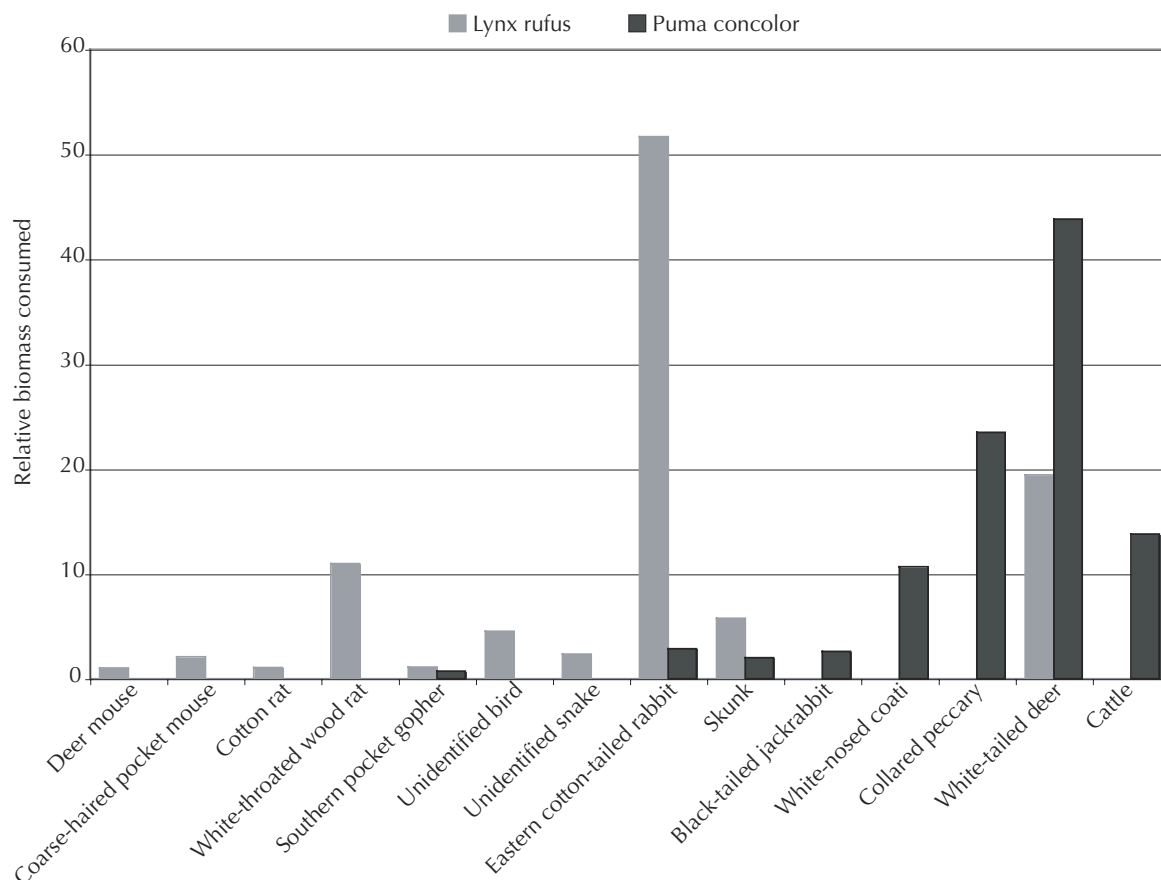


Figure 2—Relative biomass (percent of diet) consumed by cougars and bobcats in order of prey weight.

of abundance for both species (table 1). Based on scat data, there were no significance differences between the abundance of both species in the two ranches, regardless of the predominant vegetation communities. This suggested that these cats were in all vegetation types and did not prefer one over another. However, scat index of abundance (table 1) showed that cougar abundance was higher on the Los Ojos ranch whereas bobcats were more abundant on the El Pinito ranch.

Bobcats were more abundant than cougars, despite data suggesting that bobcats had relatively low abundances at the study sites. These low abundances were probably due to the effect of El Niño, which reduced populations of lagomorphs (data on file with Carlos A. Lopez Gonzalez, Universidad Autónoma de Querétaro). Estimated densities for cougars were similar to those registered for similar localities (Currier 1983, Logan and Sweanor 2001, table 1). As mentioned before, the particular year of study was very difficult for both prey and predators. Water was very scarce and some plant species did not produce fruit, resulting in a low abundance of black bears that may have allowed cougars and bobcats to occupy additional spatial resources.

The food habits showed only a small dietary overlap because cougar feed primarily on larger prey. The mean weight of cougar prey was 20.3 kg in contrast to that of bobcat prey, which was a mean weight of 1.9 kg consisting mainly of medium-sized mammals (figure 2). This difference resulted in a very low competition for prey but influenced the population

dynamics of these prey for both species. White-tailed deer dominated the diet of cougars as they do in other southern regions of Mexico (Nuñez et al. 2000), but farther north the main prey seems to be the mule deer (*Odocoileus hemionus*, Currier 1983, Logan and Sweanor 2001), which is not part of the mammalian community of the study site. Bobcats fed primarily on lagomorphs as they do in most parts of North America, especially eastern cotton-tailed rabbit. Although black-tailed jackrabbits (*Lepus californicus*) are present in the area, they live in very low numbers on the ranches. Against the common belief of ranchers, neither cougars nor bobcats heavily affect cattle. The biomass consumed for both species was low, and previous studies indicate that bobcats usually consumed it as carrion (Lariviere and Walton 1997, Maehr 1997). As in other places with cattle, the best management option is to hold calves out of the cougar's range, until they are larger (136-182 kg) so they can defend themselves (Shaw et al. 1988). In neighbouring ranches, livestock killings were few, because they breed cattle so that females effectively can defend their calves, reducing predation from cougars (Personal communication, Manuel Gomez Manteca, ranch owner).

Cougars and bobcats are sensitive to anthropogenic and natural changes. Monitoring their abundance and food habits for an extended time period can give us the opportunity to evaluate the health status of populations and develop management strategies of predator populations that will find common ground between ranching activities and conservation efforts.

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