Evaluating Potential Factors Affecting Puma Puma concolor Abundance in the Mexican Chihuahuan Desert

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Short communication

Evaluating potential factors affecting puma *Puma concolor* abundance in the Mexican Chihuahuan Desert

John W. Laundré, Joel Loredo Salazar, Lucina Hernández & Daniel Nuñez López

The distribution and abundance of pumas *Puma concolor* within mountain ranges of similar size in the Mexican Chihuahuan desert is known to vary. In 2001-2002, we tested 11 variables pertaining to habitat composition, prey abundance and anthropogenic factors to identify which ones might explain the difference in puma abundance between two mountain ranges (El Cuervo and Sierra Rica) of similar size. We found that shrub density (32.2 ± 1.9 (SE) vs 30.0 ± 1.7 shrubs/km^2) and diversity (2.1 ± 0.1 vs 1.9 ± 0.1) did not differ between the two ranges. However, El Cuervo had significantly lower density of mule deer *Odocoileus hemionus* (158.3 ± 62.6/km^2 vs 703.3 ± 296.1/km^2) and collared peccary *Tayassu tajacu* (5.0 ± 2.8/km^2 vs 146.7 ± 70.1/km^2) faecal groups than Sierra Rica. Conversely, anthropogenic factors such as road density (52.4 km/100 km^2 vs 43.9 km/100km^2), town density (25 towns/100 km^2 vs 6 towns/100 km^2) and human density (6 individuals/100 km^2 vs 0.08 individuals/100 km^2), were higher for El Cuervo than for Sierra Rica. We hypothesized that anthropogenic factors were the most important in explaining the difference in abundance of pumas between the two ranges. We propose that the higher number of people and accessibility to El Cuervo results in a high incidence of illegal hunting which suppresses prey and puma populations. We discuss the consequences of our results to the conservation of pumas in the Mexican Chihuahuan desert.

Key words: abundance, anthropogenic factors, Chihuahuan desert, Mexico, mountain range, puma, Puma concolor

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The puma was once the most widely distributed large mammalian carnivore in North America (Currier 1983). Although its range in the United States of America declined dramatically over the last two centuries, current populations, including the U.S. portion of the Chihuahuan desert, are considered viable (Harveson et al. 1999, Pittman et al. 1999, Logan & et al. 2001). However, in the Mexican portion of the Chihuahuan Desert little is known of its current status and abundance.

The puma is the only remaining large mammalian carnivore in the Mexican Chihuahuan desert (Anderson 1972). Large carnivores are often of conservation concern because they are recognized as important components in some ecosystem functions (Boyce & Anderson 1999). Consequently, identifying factors that affect the abundance of pumas in the Chihuahuan Desert can help in conserving pumas in this ecosystem.

To identify factors influencing puma abundance, we compared abiotic and biotic factors between two mountain ranges of similar physiognomy but known to have different relative abundances of pumas (Hernández & Laundré 2003). We assumed that factors that did not differ between the two areas could be eliminated as possible impacts on puma abundance. Factors that did differ between the areas were considered possible influences on puma abundance.

Study sites

Our two study areas were located in the northern part of the Mexican Chihuahuan Desert (Loredo-Salazar 2003; Fig. 1). The mountain range 'El Cuervo' (28°57'N-29°22'N latitude and 105°44'W-106°18'W longitude) is located 80 km northeast of the city of Chihuahua and covers approximately 619 km^2. The other mountain range studied was 'Sierra Rica' (28°38'N-29°29'N and 103°16'W-104°32'W; 717 km^2) located within the Area de Protección de Flora y Fauna Cañon de Santa Elena near the Mexican-United States border.

Figure 1. Location of the study areas El Cuervo and Sierra Rica in the state of Chihuahua in northern Mexico.

Predominant shrub species in both study areas were creosote bush *Larrea tridentata*, mesquite *Prosopis glandulosa* and ocotillo *Fouqueria splendens* (Loredo-Salazar 2003). The climate in both areas is typical of the hot desert with average maximum daily temperatures of 38-44°C and average rainfall of approximately 300 mm.

Methods

The assessment of puma abundance in El Cuervo was based on five preliminary visits which we made in the fall-winter of 1999-2000 to parts of the mountain range most likely to contain puma sign (i.e. dry river beds, rocky ledges and small reservoirs), and on interviews with local ranchers concerning possible sightings of pumas. During these visits we found no puma sign and local ranchers commented that pumas were known to occur in the area but were extremely rare. Based on these findings, and on the assumption that puma abundance is related to the amount of sign found in an area (Smallwood 1997), we classified this mountain range as an area of low puma abundance (Hernández & Laundré 2003). During six visits in the fall-winter of 1999-2000 to likely locations in Sierra Rica we found fresh puma tracks on every occasion. Local ranchers reported that pumas were relatively common; they often saw their tracks and occasionally saw individuals, and they reported that pumas were a problem regarding predation on their livestock (Bueno-Cabrera et al. 2005). Thus, we classified this mountain range as an area of high puma abundance (Hernández & Laundré 2003).

In each area we measured the abundance of two native prey species, the mule deer *Odocoileus hemionus* and collared peccary *Tayassu tajacu*, and two domestic prey, cattle *Bos taurus* and equines (horses *Equus feris* and donkeys *E. africanus*). We estimated relative prey abundance by counting the number of faecal groups found in 500 × 20 m belt transects (Gallina et al. 1991, Alvarez-Cardenas et al. 1999). As the mountain ranges were relatively large and many areas inaccessible, we randomly placed the transect lines perpendicular to and starting 20 m from existing roads that lead into the ranges. We determined the minimum number of transects needed (Krebs 1999) to be 30 in each area.

We divided the number of faecal groups found per species in each transect by the area of the transect (500 m × 20 m) to estimate the density (# faecal groups/km^2).

The structure of the desert plant community can affect the distribution of mule deer (Alvarez-Cardenas et al. 1999, Sánchez-Rojas & Gallina 2000), which could then affect puma abundance. Therefore, we estimated shrub density, cover, height and species diversity using the point quarter method and formulae from Brower et al. (1990), at 50-m intervals along the 30 transects used for studying faecal groups in both areas.

Human activity can influence the behaviour and distribution of pumas (Van Dyke et al. 1986, Murphy et al. 1999), thus we measured the density (#/100 km^2) of towns, humans and roads in and around the study areas. To calculate these densities we first circumscribed a 20-km buffer around each mountain range. We chose a 20-km buffer as a reasonable distance that local people might travel to visit the mountain ranges. We estimated the number of towns, the human population and kilometres of roads within the buffers from Geographic Information System (GIS) layers available from the local office of the Instituto Nacional de Estatistica Geografía e Informática (INEGI). Based on the areas of the 20-km buffers, we then calculated the various densities.

The statistical design for all comparisons was the parametric group t or the nonparametric equivalent, Mann-Whitney Test (Zar 1999). All statistical tests were conducted using the Statistica (Statsoft 1999) program, and all GIS analyses were conducted using ARC/info© software. All means are ± standard error.

Results

During our field work in 2001-2002, we found evidence of two native prey species, mule deer and the collared peccary, in our two study areas. For mule deer, the density of faecal groups was significantly higher in Sierra Rica (703.3 ± 296.1/km^2) than in El Cuervo (158.3 ± 62.6/km^2; Z = 2.86, P < 0.01; Fig. 2A). For collared peccary, the density of faecal droppings in Sierra Rica (146.7 ± 70.1/km^2) was significantly higher than in El Cuervo (5 ± 2.8/km^2; Z = 2.43, P < 0.05; see Fig. 2A). For domestic animals, we found no difference in the density of cattle faecal droppings between the two areas (Sierra Rica: 3,716.7 ± 615.8/km^2 vs El Cuervo: 2,586.7 ± 634.6/km^2). However, we did find significantly more faecal droppings of equines (horses and donkeys) in Sierra Rica (661.7 ± 156/km^2) than in El Cuervo (3.3 ± 2.3/km^2; Z = 5.95, P < 0.001; see Fig. 2A).

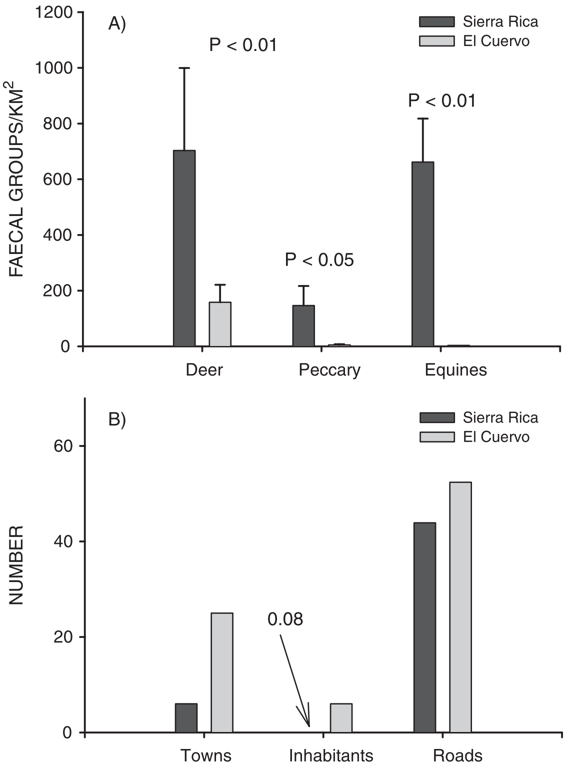

Figure 2. Density of faecal groups for deer, peccary and equines (A) and of towns (#/100 km^2), inhabitants (#/100 km^2) and roads (km/100 km^2) within a 20 km radius (B) of the study areas Sierra Rica (■) and El Cuervo (□). The data for cattle are not presented in (A) because there was no difference in faecal density between the two areas.

We found no difference in shrub density (32.2 ± 1.9/km^2 vs 30.0 ± 1.7/km^2), cover (7.2 ± 0.3 m^2 vs 6.6 ± 0.2 m^2) or species diversity (2.1 ± 0.1 vs 1.9 ± 0.1) between Sierra Rica and El Cuervo, respectively. However, shrub height in Sierra Rica (1.3 ± 0.02 m) was significantly higher than in El Cuervo (1.2 ± 0.02 m; t = 2.96, P < 0.01). This difference (0.1 m), however, was likely not biologically significant.

The density of towns within the 20-km buffer of El Cuervo was > 4 times higher than in Sierra Rica (25/100 km^2 vs 6/100 km^2; Fig. 2B). Human density around El Cuervo was 75 times higher than around Sierra Rica (6 individuals/100 km^2 vs 0.08 individuals/100 km^2; see Fig. 2B). El Cuervo had a higher road density than Sierra Rica (52.4 km/100 km^2 vs 43.9 km/100 km^2; see Fig. 2B).

Discussion

In this study we attempted to determine some of the factors that might contribute to the difference in puma abundance between two mountain ranges in the Chihuahuan desert of Northern Mexico. Differences in shrub density or cover could affect relative puma abundance, either indirectly by impacting prey abundance or directly by reducing the amount of successful hunting habitat that pumas need (Laundré & Hernández 2003). However, we found no difference in the composition and structure of the vegetal communities in the two areas. Thus, at least for our two study sites, habitat differences were unlikely to be a contributing factor.

The abundance of prey will influence the abundance of the predator (Laundré et al. 2007), and we did find differences in the abundance of mule deer, collared peccary and equines between the two areas, with higher relative abundance of each in Sierra Rica. Because the higher abundance of these species coincided with higher relative abundance of pumas, we considered the differences in prey abundance to be a possible factor contributing to the differences between the two areas. Of these, the number of native prey was probably more important because predation by pumas on equines in the Chihuahuan Desert of Mexico is relatively low (Bueno-Cabrera et al. 2005). The higher abundance of equines in Santa Elena is perhaps a result of more communal ejido lands than are found in El Cuervo; residents of ejidos commonly maintain more equines than private ranchers (Bueno-Cabrera et al. 2005, J.W. Laundré, pers. obs.).

The differences in deer and peccary abundance but not in habitat composition and structure between the two areas may seem contradictory. However, this contradiction can be resolved if we consider that the level of human presence is higher in El Cuervo than in Sierra Rica. In the United States and Canada, puma abundance can be relatively high close to major metropolitan areas (Beier 1995). In these countries, the hunting of pumas and their prey (deer and elk *Cervus elaphus*) is strictly regulated, and there is a high adherence to these regulations by the general public. In contrast, in Latin America, illegal and subsistence hunting of wildlife by humans is a major problem for most wildlife species (Robinson & Redford 1991, Alvard et al. 1997, Merriam 1997, Chiarello 1999, Escamilla et al. 2000). This is also the case in Mexico (Leopold 1959, Ezcurra & Gallina 1981 Galindo-Leal & Weber 1998).

Because much of the prey taken by illegal and subsistence hunters overlaps with prey species taken by pumas (Redford, 1992 Carrillo et al. 2000, Escamilla et al. 2000), human hunters may reduce the prey populations needed to support viable populations of pumas. We propose that the higher number of people near the El Cuervo mountain range contributes to a higher level of illegal hunting of both pumas and their principle prey, mule deer and the peccary. Consequently, we further hypothesize that this higher level of illegal harvest may be a factor in the differences in relative abundance of pumas and their prey between the two areas.

This hypothesis has consequences for puma conservation in the Mexican Chihuahuan Desert. Firstly, isolated mountain ranges would be more important to puma conservation than ranges close to large metropolitan areas. Secondly, conservation efforts aimed at pumas, even in high human impact areas, should concentrate on intensive environmental education efforts. If this effort succeeds in raising the environmental consciousness and respect for wildlife in general, and for deer and pumas specifically, we predict that deer and, subsequently, puma numbers in these areas would rebound.

In summary, habitat factors are not the likely reason for differences in puma abundance in mountain ranges of the Mexican Chihuahuan Desert. The reason for these differences is most likely the intensity of use by humans which, we propose, has a negative impact on prey and puma abundance, primarily as a result of illegal hunting. Although our study was limited to a comparison of two mountain ranges, it is the first of its kind in the Chihuahuan Desert of Mexico, where even the most basic information on puma ecology and abundance is lacking. As such, our findings provide a valuable first step in the evaluation of possible factors influencing puma abundance in the greater portion of the largest North American desert.

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