Density of ocelots in a semiarid environment in northeastern Brazil

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Abstract: Ocelots play a key role in ecological communities as mesopredators affecting the lower trophic level and other mesopredators. They show great variability in ecological traits across their distribution, but knowledge of this species is missing in several regions where it occurs. Here, we present the first study of ocelot in the Brazilian semiarid of Caatinga. Arid habitats might keep carnivore population density low and therefore vulnerable to environmental shocks and to human-induced changes, at risk of local extinction. To assess their population status, we used camera traps between September 2009 and January 2010. We estimated the density of ocelots using a spatially explicit capture-recapture method (SECR) to be 3.16 ± 0.46 individuals per 100 km². This is a low-density estimate for ocelots, which might reflect the harsh conditions of the arid habitat. A longer population study of the ocelot can answer if this low population density is enough for a long-term persistence of this species in this and other arid environments.

Keywords: Arid environments, Brazil, Density, Ocelot, SECR.
Introduction


Ocelot densities vary across its distribution, ranging from 2.3 to 75.2 individuals per 100 km² (Table 1) and are thought to decrease with lower precipitation and increasing distance from the equator (Di Bitetti et al. 2008). This is because a lower precipitation may decrease productivity (Chesson et al. 2004) which in turn, might decrease carnivore prey densities (Herfindal et al. 2005, Pettorelli et al. 2009, Sandom et al. 2013), and higher latitudes often correlates with a lower precipitation (Prince & Goward 1995, Di Bitetti et al. 2008). However, arid environments might present different challenges to species in those regions.

The semi-arid of the Caatinga, in northeastern Brazil (Figure 1), for instance, is a harsh environment where ocelots occurs (Oliveira & Cassaro 2005). This region has a high annual mean temperature (26 °C to 30 °C) and the lowest precipitation (300-1,000 mm/year) of Brazil (Prado 2008). Furthermore, this habitat is under heavily negative human induced changes like deforestation for ranches and plantations (Castelletti et al. 2004). However, there is almost no knowledge of ocelots’ population status in the Caatinga.

Ocelots are ecologically important as mesopredators, not only affecting prey species, but potentially other carnivore species as well (de Oliveira & Pereira 2013), it is essential to conduct studies in this region where not only the ocelot, but also others species, faces a harsh environment that is being severely modified by human activities (Leal et al. 2008). Therefore, this study aims to contribute to the knowledge of ocelot populations in arid habitats by estimating its abundance and density in one of the few conservation units in the Caatinga (Leal et al. 2008).

Material and Methods

The study was conducted at the Serra da Capivara National Park (SCNP), in southern Piauí state (Figure 1), covering an area of 1,291 km² (FUMDHAM 1994). Local mean annual rainfall is approximately 644 mm with temperatures ranging from 12-45°C and annual mean of 26°C (Pellerin 1991). To make up for the lack of permanent natural water sources, the park’s administration conducts artificial water hole management in which a water truck fills, periodically, artificial ponds distributed in the park.

We deployed 70 camera trap stations between September 1st 2009 and January 19th 2010 in roads and trails inside the park (Figure 1). We chose to install the stations in this way because several studies have demonstrated that big cats (Emmons 1988, Carbome & Christie 2001, Maffei et al. 2005) and ocelots (Trolle & Kéry 2005) have higher capture rates on roads and

![Figure 01. Map of Serra da Capivara National Park with camera locations.](http://www.scielo.br/bn)
trails than on forested habitats. Additionally, the dense thorny vegetation and dramatic relief present in the park made it very difficult to install trap stations in other areas. Each station had two cameras (LeafRiver – Leaf River Outdoor Products, Taylorsville, MS, US) facing each other in order to photograph both sides of the animal, which facilitates posterior individual identification. Cameras were set to operate continuously, with a 5-minute delay between consecutive photos. Each trap was spaced from the others by a mean distance of 2.9 ± 0.4 km (SD). Like other ocelot studies (Maffei et al. 2005, Di Bitetti et al. 2006, Maffei & Noss 2008), the present study was originally designed for jaguars (Silveira et al. 2009) and we opportunistically gathered important data on ocelots.

To estimate density we applied spatially explicit capture-recapture (SECR) Maximum-likelihood methods (Borchers & Efford 2008) implemented in software R 3.0.1 through the package “secr” (Efford 2011). These models estimate the density (D), assuming the existence of a relation of the animal detection probability to the distance (d) from each animal home range center. This follows a two-parameters function, \( g(d) \), with \( g \) being the detection probability when \( d = 0 \), and a spatial scale \( \sigma \), related to home range diameter (O’Brien & Kinnaird 2011). We considered six models with different effects on detection: (1) No variation in detection \([g(0),\sigma(0)]\), (2) variation after the first capture \([g(0),\sigma(J)]\), (3) variation with time \([g(T),\sigma(0)]\), (4) differences between sexes \([g(sex),\sigma(J)]\) (5) The conjoint effect of sex and time \([g(sex+T),\sigma(0)]\) and (6) behavior and time \([g(b+T),\sigma(0)]\). We selected between models by using the Akaake Information Criterion adjusted for small samples (AICc).

Results

We registered 316 pictures of ocelots comprising 51 individuals. (Two researchers identified each picture independently). It is possible to identify sex easily in ocelot’s pictures due the conspicuousness of the male’s scrotum, and we found a sex ratio of 1.5:1 males to females (31 males and 20 females). We found 38 individuals (74.5%) at more than one station, 27 at more than two (52.9%) and 11 individuals (21.5%) had no recaptures (i.e. registered at only one photograph). There were also several pictures of juveniles and cubs; however, we did not include them in the analysis because we could not identify them individually. Model selection highlighted the difference between sexes on detection probability (Table 2), consistent with other studies that find ocelots are a territorial species with variation in home range and activity between sexes (Dillon & Kelly 2008). The highest-ranked model estimated 3.16 ± 0.46 ocelots/100 km².

Discussion

Ocelot density in our study area was at the lower end for this species in relation to other regions (Table 1), which could make this population especially prone to environmental changes – man made or not – and local extinction (Purvis et al. 2000). Several characteristics of this arid region could be affecting ocelot populations. The first environmental factor that might play a role keeping this ocelot population at lower levels is the low productivity. In some regions, low productivity can limit prey species. The second environmental factor that could be affecting ocelot densities is the low density of prey. In small rodent is an important part of ocelot’s diet in this site, we do not believe low productivity with other carnivore species can affect a species population (Palomares & Caro 1999, Caro & Stoner 2003, Dayan & Simberloff 2005, Donadio & Buskirk 2006). Ocelots co-occur with Jaguars and Pumas in the SCNP. These apex carnivores have a relatively high density in this park (Silveira et al. 2009) and they might negatively affect ocelot densities through intraguild killing (Ritchie & Johnson 2009).

Continuous monitoring of this species would help elucidate whether this low density is the natural state of ocelots in the Caatinga or whether the population is declining. Even if the density remains constant during different years, it is still a very low estimative and likely to be subject to local extinction with environmental changes or increase in human activities in the region. This study provides background for future research concerning ocelots in these and other arid habitats.

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http://www.scielo.br/bn

Table 2. Model selection results for different density models.

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<th>Model</th>
<th>AICc</th>
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<td>([g(b),\sigma(J)])</td>
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<tr>
<td>([g(b + T),\sigma(J)])</td>
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<td>0</td>
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<tr>
<td>([g(0),\sigma(J)])</td>
<td>2012.1</td>
<td>13.64</td>
<td>0</td>
</tr>
</tbody>
</table>


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