



Research, part of a Special Feature on [Why does hunting in tropical regions matter?](#)

## The role of game mammals as bushmeat In the Caatinga, northeast Brazil

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**ABSTRACT.** Although the use of wild mammals as a source of food has been better studied in tropical forest environments, their importance as a source of protein for human communities in semiarid environments is little known. In the latter, the availability of wild animal meat is limited in comparison to other environments. In the semiarid regions of northeastern Brazil, hunting wild mammals for their meat is traditional, playing a crucial role in the livelihoods and food security of various rural and urban communities, especially during the annual drought seasons. In this study, we investigated the role of wild mammals as bushmeat in 10 communities within the Caatinga biome in northeast Brazil. We used key-informant interviews, household surveys, and questionnaires to determine the species hunted and consumed. We found that about 30 species were used for bushmeat, with communities clustering into two main groups. We showed that in almost all municipalities visited, all mammals hunted were reported after interview days. A total of 46.9% of hunters consumed bushmeat at least once a week. However, preference for bushmeat over livestock was perceived to be more a matter of taste (61.50% of respondents) than a real need for protein supplementation from the wild. The ease of entering environmental areas where wild mammals can be found has disadvantages for wildlife in terms of pressure and overexploitation, especially where it concerns endangered species. The key to understanding the socioeconomic, cultural, and ecological contexts in which there are traditional uses is to develop conservationist strategies suitable for the socioeconomic reality of human populations.

**Key Words:** *conservation; ethnozoology; hunting practices; local ecological knowledge; mammals; semiarid region*

### INTRODUCTION

In tropical regions worldwide, the meat of wild animals (bushmeat) is part of the diets of rural communities and is also eaten in urban areas. In many cases, hunted animals can be an important income source for many rural people, and can form the basis of a highly lucrative trade (Elliott et al. 2002, Milner-Gulland and Bennett 2003, Wilkie et al. 2005, van Vliet et al. 2014, 2015). Although invertebrates can be locally important dietary items, it is the larger terrestrial vertebrates that make up most of the wild animals eaten by humans (Alves 2012). In particular, mammals contribute most of the biomass of the bushmeat consumed in terrestrial environments (Silvius et al. 2004, van Vliet et al. 2014, Mesquita and Barreto 2015).

In semiarid regions, such as the Brazilian Caatinga, wild mammal meat can be a vital source of animal protein for human communities there because the availability of fish or other sources is limited. In this ecoregion, wild meat can be especially critical during the early drought periods typical in this environment, when crops are scarce and domestic animals may die because of starvation and dehydration (Miranda and Alencar 2007, Alves et al. 2009, Pereira and Schiavetti 2010, Fernandes-Ferreira et al. 2012).

Although mammalian diversity in semiarid environments is lower than in tropical rainforests, the hunting of mammals is still important in supplying meat and other products (Albuquerque et al. 2012). Hunting in the Caatinga region has long been traditionally practiced for subsistence purposes (Alves et al. 2009, 2012, Albuquerque et al. 2012). However, some authors suggest that currently, wildlife hunting is less of a subsistence activity, but one linked to recreation and entertainment (Alves et al. 2009, 2012). Whatever the reasons for hunting may be, overexploitation of wildlife in the Caatinga is a real threat to the ecoregion's biodiversity (Leal et al. 2005a, Alves et al. 2009, Fernandes-

Ferreira et al. 2012); numerous species, particularly mammals, are threatened with extinction (Alves et al. 2009, 2012). In this scenario, the importance of ethnozoological studies is clearly evident (Alves and Souto 2015).

In this study, we investigated the importance of mammals as bushmeat in a number of localities within the Caatinga biome, northeast Brazil. We interviewed active hunters within a total of 10 municipalities in 4 different states in northeast Brazil, aiming to estimate the number of species of mammals that are used as a food resource in the region and to investigate if there is a change in the taxonomic richness of mammalian game species according to geographic location.

### METHODS

#### Study area

All study localities were situated within the Brazilian semiarid region in the northeast of the country. This region (around 750,000 km<sup>2</sup>) is mostly occupied by the Caatinga biome, an ecoregion predominantly comprising xerophytic, woody, thorny, and deciduous vegetation (Sampaio 1995, Costa et al. 2007). The region is characterized by a warm, dry climate (Veloso et al. 1991), experiencing drought periods that can last up to 11 months in a year (Ab'Saber 1977). These unique climatic conditions have led to the emergence of specific morphological and physiological adaptations in the fauna and flora of the biome (Rodrigues 1996, Vieira et al. 2009, Albuquerque et al. 2012).

The Caatinga contains a relatively low animal species diversity and only a small number of endemics (Andrade-Lima 1982, Prance 1987, Vanzolini 1996). However, the region is considered to harbor a unique component of Brazil's biodiversity (Leal et al. 2005a). A total of 153 mammal species are found in the Caatinga, more than those found in the Pantanal swamps (n = 113) or the Grande Chaco (n = 102; Meserve 2007), though less than in the

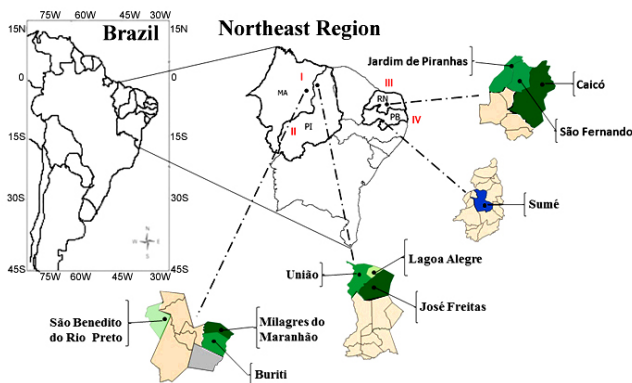
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Amazon Rainforest (n = 350; Meserve 2007), Atlantic Forest (n = 261; Myers et al. 2000), and Cerrado (n = 199; Klink and Machado 2005). Despite advances in our knowledge of the mammals of the Caatinga, many areas of the Caatinga have not yet been studied, so undescribed species are likely to be present (Albuquerque et al. 2012).

### Study localities

Data were collected from 10 municipalities within 4 different states in the northeast region of Brazil: Caicó (CC), Jardim de Piranhas (JP), and São Fernando (SF) in Rio Grande do Norte (RN); Buriti (B), Milagres do Maranhão (MM), and São Benedito do Rio Preto (SBP) in Maranhão (MA); José Freitas (JF), União (U), and Lagoa Alegre (LA) in Piauí (PI); and the municipality of Sumé (S) in Paraíba (PB; Fig. 1)

**Fig. 1.** Map showing the studied area. MA = State of Maranhão (I); PI = State of Piauí (II); RN = State of Rio Grande do Norte (III); and PB = State of Paraíba (IV), and their respective municipalities.



Before starting data collection, we introduced ourselves, explained the nature and objectives of our research, and asked the respondents for permission to record their answers to our questions. Approval for the study was obtained from the Ethics Committee of Universidade Federal da Paraíba (UFPB).

We selected study sites on the basis of the following criteria: (1) evidence of intense hunting activities; (2) accessibility; (3) lack of studies on ethnoecology and ethnozoology in those regions; and (4) cultural diversity. We selected the informants in this sample utilizing the “snowball” technique (Posey 1986). In all cases, species mentioned as hunted by the respondents were identified directly from observation of animals killed and donated to the project, photographs taken during the interviews of animals hunted, and on the basis of their vernacular names (with the aid of taxonomists familiar with the fauna of the study area).

### Procedures

Field research was conducted by the first author of the manuscript between April 2010 and October 2012. We interviewed a total of 413 hunters in rural and urban areas (399 men and 14 women), 40 individuals in each city visited except Jardim de Piranhas, RN (n = 42) and Sumé, PB (n = 51).

Semistructured interviews, complemented by free interviews, were conducted with respondents in each of the localities surveyed

(Huntington 2000). The aim of these interviews was to collect quantitative estimates of hunting practices and mammal bushmeat sources used by the different communities. Among the interviewees, we selected key informants (more experienced hunters) or “native specialists,” i.e., people who considered themselves and were considered by the community as very knowledgeable about the culture in this area (Hays 1983, Marques 2002). The interview contained questions on the hunters’ demographics (Table 1), main livelihood activities, and income, as well as information on protein sources consumed, mammals hunted, access to mammalian bushmeat, and preferences.

**Table 1.** Information on educational attainment, age, income, and gender of interviewees.

Demographic and social aspects	Total
Gender	
Male	399 (96.6%)
Female	14 (3.38%)
Age	
29 or younger	141 (34.1)
30-39	129 (31.23)
40-49	77 (18.64)
50-59	35 (8.47)
60-69	24 (5.81)
70 or older	7 (1.69)
Occupation	
Agricultural and correlated	188 (45.52)
Commerce and general servicing	93 (22.5)
Others	76 (18.40)
Monthly income <sup>†</sup>	
Less than minimum wage	85 (20.58)
One to two times minimum wage	197 (47.69)
Three to four times minimum wage	39 (9.44)
Undeclared	92 (22.27)
Educational attainment	
Illiterate	33 (7.9)
Semiliterate	67 (16.22)
Attended school for 9 years	85 (20.58)
Attended school for less than 9 years	56 (13.55)
Finished high school	14 (3.38)
Housing	
Private	235 (56.9)
Rented	101 (24.45)
Other	90 (21.79)

<sup>†</sup>Brazilian minimum wage approximately equivalent to US\$180 at the time surveys took place.

To analyze whether the species richness cited by informants was the same estimated richness for the 10 surveyed areas, we utilized the rarefaction technique with the standardization of sampling effort by the number of citations recorded (Gotelli and Colwell 2001, Magurran 2011). For this, we compared, using 1000 randomizations, the species richness observed using the Sobs Mao Tau with the species richness estimated using Jackknife 1, which was the estimator that correlated most closely with observed richness (Walther and Moore 2005). The accumulation curves were calculated using the software EstimateS<sup>©</sup> version 8.2 (Colwell 2009). Species mentioned at each city surveyed were compared using the Jaccard similarity coefficient (presence/absence data). Cluster analyses were performed using the software PRIMER-E (Clarke and Gorley 2006) with the unweighted pair

group method using arithmetic averages (UPGMA). Graphs were prepared using the program STATISTICA (Statsoft 2001).

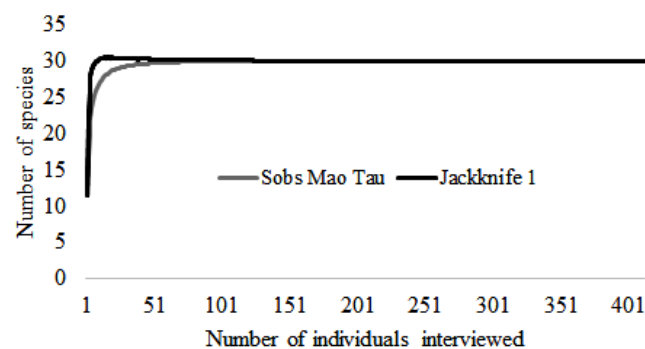
## RESULTS

A total of 38 species of wild mammals were reported as hunted by the interviewees. Of these, 30 species were bushmeat by hunters and other people in the areas surveyed. The order with the highest number of recorded species was Carnivora (15 species), followed by Rodentia (9), Primates (3), Artiodactyla (2), Pilosa (2), Cingulata (2), Didelphimorphia (2), Lagomorpha (1), and Chiroptera (1; Table 2). Among the mammals used as bushmeat, the most cited (more than 160 times) were: red brocket deer *Mazama americana* (n = 167); grey brocket deer *M. gouazoubira* (n = 173); tree ocelot *Leopardus wiedii* (n = 183); Spix's yellow-toothed cavy *Galea spixii* (n = 192); Southern tamandua *Tamandua tetradactyla* (n = 246); Brazilian guinea pig *Cavia aperea* (n = 324); rock cavy *Kerodon rupestris* (n = 335); six-banded armadillo *Euphractus sexcinctus* (n = 369); and nine-banded armadillo *Dasybus novemcinctus* (n = 395).

Although a number of species were reported as being used as bushmeat in all locations, there were variations in richness by location. In the municipalities of Rio Grande do Norte State, hunters indicated the use of at least 19 species, and in the states of Piauí and Maranhão, 30 species were mentioned. The place where there was a smaller number of species used as bushmeat was Sumé, PB, with 15 species reported by hunters.

The richness estimator indicated that in almost all municipalities visited, 100% of mammal species of hunting value were sampled for each location, except the municipality of Jardim de Piranhas, where the sampling effort was 87%. However, in all cases, a clear stabilization of the asymptote was demonstrated in the species accumulation curve (Fig. 2). Observed species richness (n = 30) was similar (n = 30) to the estimated number, which reflected the universe of mammal species used as bushmeat consumed by cited interviews.

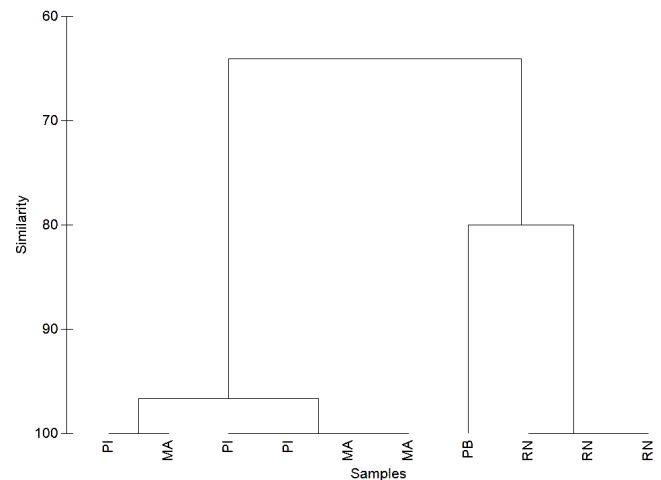
**Fig. 2.** Rarefaction curves showing the number of observed mammal species cited by interviewees of the municipalities surveyed in Brazil's semiarid region, with 95% confidence interval for the observations (calculated with 1000 randomizations), and the number of species estimated by Jackknife 1.



Considering the game mammals' richness of each location visited, the similarity dendrogram showed the formation of two well-defined major groups with 65% similarity to each other and

subsequently the formation of similar subgroups (Fig. 3). The first group comprised the species cited in three municipalities in RN plus the city located in Paraíba, which are geographically close. The second group formed the species mentioned in MA and PI, showing 95% similarity.

**Fig. 3.** Dendrogram of similarity (Jaccard index) produced by cluster analysis (UPGMA connection method) among the 10 municipalities surveyed of Caatinga biome.



Hunting pressure was constant throughout the year and hunters employed various techniques adapted to specific habitats and mammalian species. The most common included weapons, hunting dogs, and different kinds of traps. At least 68% of respondents described that open forest of Caatinga was preferred for hunting because visibility was higher than in habitats that had very dense vegetation, where walking off the trails was challenging. Because the Caatinga biome represents a mosaic of phytophysiognomic formations, hunters stated that degraded areas supplied approximately 30% of the animals killed and little diversity of small mammal species at short distances from their municipalities (< 4 km), whereas undisturbed or slightly disturbed areas supplied the greatest diversity of mammalian species including those of major commercial interest, e.g., grey brocket deer, red brocket deer, and armadillos, which were preferable sources of meat for local traditional festivities. To reach undisturbed areas of the semiarid region, the majority of hunters (74%) described the benefits of using motorized vehicles to cover distances > 50 km from their homes. This practice decreased the time and effort to cover long distances and increased the chances of having good catches in those areas. According to 66% of respondents, over the past 15 years, the continued use of motorcycles, dogs, and sophisticated shotguns has led to at least 35% decrease in the abundance of game animals in surveyed area.

Regarding the frequency that hunters consumed the meat of wild mammals, a total of 194 (46.97%) respondents answered at least once a week, 27.84% (n = 115) stated every 15 days, 15.98% (n = 66) stated at least every 1 - 2 weeks and 9.20% (n = 38) consumed wild meat every three months or more during the year. According to the hunters, when they killed more than one specimen and the product of the hunt was intended for personal consumption, the meat was usually shared with relatives or even friends. In the

**Table 2.** Mammal species cited by respondents in each municipality surveyed and their risk categories.

Taxon	Municipalities										Number of Citations	Risk categories		
	RN		PI			MA			PB	IUCN		CITES	Brazilian Red List	
	JP	CC	SF	JF	LA	U	B	MM	SBP					S
<b>ARTIODACTYLA</b>														
Cervidae														
<i>Mazama gouazoubira</i> (Fischer, 1814) - brocket deer	X	X	X	X	X	X	X	X	X	X	173	LC	-	-
<i>Mazama americana</i> (Erxleben, 1777) - red brocket deer	X	X	X	X	X	X	X	X	X	X	167	DD	-	-
<b>CARNIVORA</b>														
Canidae														
<i>Cerdocyon thous</i> Smith, 1839 - crab-eating fox	X	X	X	X	X	X	X	X	X	X	155	LC	II	-
<i>Speothos venaticus</i> Lund, 1839 - bush dog				X	X	X	X	X	X		35	NT	I	VU
Felidae														
<i>Leopardus pardalis</i> (Linnaeus, 1758) ocelot	X	X	X	X	X	X	X	X	X	X	257	LC	I	-
<i>Leopardus tigrinus</i> (Schreber, 1775) - oncilla	X	X	X	X	X	X	X	X	X	X	134	VU	I	EN
<i>Leopardus wiedii</i> (Schinz, 1821) - tree ocelot	X	X	X	X	X	X	X	X	X	X	262	NT	I	VU
<i>Panthera onca</i> (Linnaeus, 1758) - jaguar				X	X	X	X	X	X		75	NT	I	VU
<i>Puma concolor</i> (Linnaeus, 1771) - puma				X	X	X	X	X	X		105	LC	I	VU
<i>Herpailurus yagouaroundi</i> (É. Geoffroy Saint-Hilaire, 1803) - jaguarundi	X	X	X	X	X	X	X	X	X	X	248	LC	I	-
Mephitidae														
<i>Conepatus semistriatus</i> (Boddaert, 1785) - striped hog-nosed skunk	X	X	X	X	X	X	X	X	X	X	127	LC	-	-
Mustelidae														
<i>Eira barbara</i> (Linnaeus, 1758) - tayra				X	X	X	X	X	X		42	LC	III	-
<i>Galictis vittata</i> (Schreber, 1776) - greater grison	X	X	X	X	X	X	X	X	X	X	80	LC	III	-
<i>Lontra longicaudis</i> (Olfers, 1818) - neotropical otter				X	X		X	X			12	DD	I	-
Procyonidae														
<i>Nasua nasua</i> (Linnaeus, 1766) - South American coati				X	X	X	X	X	X		73	LC	III	-
<i>Procyon cancrivorus</i> Storr, 1780 - crab-eating raccoon	X	X	X	X	X	X	X	X	X		157	LC	-	-
<b>DIDELPHIMORPHA</b>														
Didelphidae														
<i>Didelphis albiventris</i> Lund, 1840 - white-eared opossum	X	X	X	X	X	X	X	X	X	X	157	LC	-	-
<i>Didelphis marsupialis</i> Linnaeus, 1758 - black-eared opossum				X	X	X	X	X	X		64	LC	-	-
<b>LAGOMORPHA</b>														
Leporidae														
<i>Sylvilagus brasiliensis</i> (Linnaeus, 1758) - tapeti				X	X	X	X	X	X		25	LC	-	-
<b>RODENTIA</b>														
Caviidae														
<i>Cavia aperea</i> Erxleben, 1777 - Brazilian guinea pig	X	X	X	X	X	X	X	X	X	X	324	LC	-	-
<i>Galea spixii</i> (Wagler, 1831) - Spix's yellow-toothed cavy	X	X	X	X	X	X	X	X	X	X	192	LC	-	-
<i>Hydrochoerus hydrochaeris</i> Brisson, 1762 - capybara				X	X	X	X	X	X		61	LC	-	-
<i>Kerodon rupestris</i> (Wied, 1820) - rock cavy	X	X	X	X	X	X	X	X	X	X	335	LC	-	VU
Cuniculidae														
<i>Cuniculus paca</i> (Linnaeus, 1758) - spotted paca				X	X	X	X	X	X		64	LC	III	-
Dasypodidae														
<i>Dasyprocta prymmolopha</i> Wagler, 1831 - black-rumped agouti	X	X	X	X	X	X	X	X	X		159	LC	-	-
Echimyidae														
<i>Thrichomys apereoides</i> (Lund, 1941) - punare	X	X	X	X	X	X	X	X	X	X	131	LC	-	-
Erethizontidae														
<i>Coendou prehensilis</i> (Linnaeus, 1758) - Brazilian porcupine				X	X	X	X	X	X		185	LC	-	-
<b>PILOSA</b>														
Myrmecophagidae														
<i>Tamandua tetradactyla</i> (Linnaeus, 1758) - southern tamandua	X	X	X	X	X	X	X	X	X	X	246	LC	-	-
<b>CINGULATA</b>														
Dasypodidae														
<i>Dasypus novemcinctus</i> Linnaeus, 1758 - nine-banded armadillo	X	X	X	X	X	X	X	X	X	X	395	LC	-	-
<i>Euphractus sexcinctus</i> (Linnaeus, 1758) - six-banded armadillo	X	X	X	X	X	X	X	X	X	X	369	LC	-	-

opinion of 62.7% (n = 259) of the respondents, the more sociable and supportive the hunter was, the more consideration and respect he got within the family and among other beneficiaries of the hunt.

When asked about the reasons for preference of wild meat over meat of domestic animals, the majority of respondents (n = 254, 61.50%) said that the preference for bushmeat today was a matter of taste than for a real need for protein supplementation. Even with some reservations due to cultural issues of food taboos for some wild species, such as armadillos, it was noticed that the majority of respondents (n = 388, 94%) considered all wild meat as noble, clean, and healthy. Although appreciated as local delicacies, six-banded armadillo meat is considered an allergenic food, and it is not advised to be eaten by individuals with health problems such as infections, wounds, venereal diseases, and hepatitis, or during menstruation or pregnancy. This taboo may be linked to the omnivorous and scavenger dietary habits of this species. According to 188 (45.52%) respondents who were farmers and ranchers, the meat of wild mammals is better when compared to farm animals such as cattle, goats, and pigs.

According to the majority of respondents (n = 262, 63.4%), high preference for meat of wild mammal species also extended to individuals who did not hunt, but purchased the meat of these animals. Of the species cited, the majority of respondents (n = 304, 73.6%) highlighted the distinctive flavor of their meat, especially when prepared with the addition of alcoholic beverages, herbs, fruits, and other spices. The meat could be eaten either grilled, in a soup, fried, baked, or smoked in a handcrafted way.

For all wild mammal species used as food, there is some level of concern regarding conservation. Of these, in addition to being included in the International Union Red List species for Conservation of Nature (IUCN Red List), seven were listed in the Appendices of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 2015) and six species were listed on the Brazilian Red List of threatened fauna (MMA 2014). The species found on the IUCN Red List were in different categories: 24 in “low concern” (LC), 1 in “data deficient” (DD), 1 in “vulnerable” (VU; *Leopardus tigrinus*), and 3 in “nearly threatened” (NT; *Speothos venaticus*, *Leopardus wiedii*, and *Panthera onca*). As for the species in the Brazilian Red List, five were classified as vulnerable, especially the group of carnivores, and one species was considered endangered (EN; *Leopardus tigrinus*).

## DISCUSSION

Our results showed that the consumption of wild mammal meat was the main reason for hunting these animals in the Brazilian semiarid region, because of the 38 species of mammals hunted in the region, 29 (76%) were consumed as a source of protein. This trend has been observed in other studies conducted in the Brazilian semiarid land (Alves et al. 2009, 2012, Pereira and Schiavetti 2010, Barbosa et al. 2011, Melo et al. 2014), but also in other biomes (Bodmer et al. 1997, Lopes and Ferrari 2000, Hanazaki et al. 2009, Dantas-Aguiar et al. 2011, Souza and Alves 2014, Mesquita and Barreto 2015), in which mammals represented the preferred group used as a source of game meat. Still, as shown by other authors, there are other uses of vertebrates in the Caatinga, related to hunting for bushmeat, because by-products of animals slaughtered for bushmeat such as horns,

hides, skulls, and others, are used for other purposes, maximizing the use of local resources (Alves et al. 2012). Other uses of game mammals in the northeastern semiarid region include the breeding of pets, and even the use of their products in folk medicine handicrafts and mystical/religious practices (Alves 2009, Alves et al. 2009, Souto et al. 2011).

Our results confirmed that in the Brazilian semiarid region, wild mammals represented a major source of bushmeat, reflecting a situation that occurs in all Brazilian biomes (Becker 1981, Hanazaki et al. 2009, van Vliet et al. 2014, Mesquita and Barreto 2015). The exploitation of a high proportion (24%) of mammalian species that occur in the Caatinga reinforces the hunting importance of this taxon. Our data suggest that, despite having a lower species richness than in other Brazilian biomes, in the Caatinga, game richness is equal to or greater proportionally. This may be because in this region hunted species are of different sizes, because the larger species are scarce. In other Brazilian biomes, hunting for consumption usually targets large species, particularly in areas of the Atlantic Forest (Cullen et al. 2000, Hanazaki et al. 2009, Souza and Alves 2014) and the Amazon Rainforest (Pezzuti and Chaves 2009, Rosas-Ribeiro et al. 2012).

It was also evident that there were a number of mammalian species (n = 15) that were exploited in all localities surveyed, indicating the spread of the same uses as protein resource for local communities and geographical continuity in the selection of exploited resources of mammalian fauna in the Brazilian semiarid region. Nevertheless, there was the case of species mentioned in only some states, which resulted in the formation of different groups and subgroups according to the locality studied, as revealed by the similarity analysis. This suggests that variations in the composition of species of mammals in the ecoregions of the Caatinga influences the choice of species hunted. The municipalities studied in the states of Maranhão and Piauí, for example, showed areas of environmental transition between Caatinga and Cerrado, enabling ecological communities of these two biomes to be in contact, increasing the diversity of species in the region, and thus increasing their availability to hunters. This was reflected in the richness of species cited by respondents in these areas and contributed to the greater similarity between them.

Some of the game mammals cited by the respondents, such as *Speothos venaticus*, *Panthera onca*, *Puma concolor*, *Eira barbara*, *Lontra longicaudis*, *Nasua nasua*, *Didelphis marsupialis*, *Hydrochoerus hydrochaeris*, *Cuniculus paca*, and *Coendou prehensilis*, exhibit very different distributions in Brazil (Chiarello et al. 2008, Canale et al. 2012, Carvalho and Gonçalves 2013, Rodrigues et al. 2013). However, in some areas of the Caatinga displaying drier shrubland, such as in the states of Rio Grande do Norte and Paraíba, the records of these species are scarce or very old or these species are considered extinct (Keuroghlian et al. 2012), whereas in more dense, humid areas of the Caatinga, such as in Maranhão and Piauí, these species find refuge areas with different vegetation types of the Caatinga (Bucher 1982, Veloso et al. 1991, Castelletti et al. 2003). Our results reflected this situation because these species were most cited in the locations of Maranhão and Piauí.

These results demonstrated the close relationship that local hunters have with the natural environment in which they live,

exploiting the resources available in the region. The use of local and easily accessible resources is certainly related to historical and cultural aspects, that is, hunting tradition focusing on local species, reflecting the transfer of knowledge from generation to generation. Our results are in agreement with other ethnobotanical and ethnozoological studies that demonstrate that the diversity of animals and plants known and used by human populations can be influenced by the diversity found in the environment (Bennett 1992, Phillips and Gentry 1993, Robinson and Bennett 2004, Alves and Rosa 2006, 2007, 2010). These studies suggest that more easily found animals and plants are more likely to be used by local people, thus increasing the likelihood of these resources to be incorporated into the local culture.

Differences in hunting activities in different habitat types of Caatinga are explained by hunters' cultural preferences. Our results suggest that there is potential to increase hunting in open areas and during dry seasons, although dense vegetation with little anthropogenic disturbance is preferable for hunting specific mammals. Studies have demonstrated that peri-urban hunters commonly recognize different types of habitats for several purposes, and despite hunters' preferences for mature forest, disturbed forest has higher hunting pressure due to proximity of communities and villages, whereas mature and dense forest are more distant (Fa et al. 2002, van Vliet and Nasi 2008, Mesquita and Barreto 2015). Moreover, in the Brazilian semiarid region as well as in several regions of the world, the use of motorized vehicles has been practiced not only by hunters but also by specialized middlemen in the illegal trade of bushmeat, so this contributes to overexploitation of many game species besides deforestation of the remaining vegetation of biomes (Juste et al. 1995, Fa et al. 2006, Di Bitetti et al. 2008, Read et al. 2010, Mockrin et al. 2011). The hunting impacts on wildlife are a complex phenomenon that varies in space and over time, and little is known on the subject (Grignolio et al. 2011). For decades, many target species of hunters have been frugivorous or granivorous, which are important in seed dispersion (Wright et al. 2007). We emphasize that a higher level of accessibility to preserved areas and the use of new technologies has led to a change in the current hunting scenario in the Brazilian Northeast.

It was noticed that the frequency of meat consumption of wild mammals by hunters did not follow a specific pattern, but most ate game meat on a regular basis, every week or every fortnight. Although there is little information about the frequency of the consumption of game meat in northeast Brazil, it is believed that until a few decades ago, many local residents consumed bushmeat almost daily during dry periods, when livestock herds died of thirst and hunger (Leal et al. 2005b, Alves et al. 2009). Today, despite the fact that droughts are frequent and continue to decimate herds, improvements in social conditions in the Brazilian semiarid region enables the purchase of domestic animal meat, also at lower prices compared to game meat.

In the areas surveyed, consumption of game mammals is associated with social interactions among hunters, including the sharing of game meat. Similar situations have been reported in other regions of Brazil and the world. Fa et al. (2003) documented the exploitation of wild meat in the world's tropical forests, noting that the sharing of meat between urban hunters was quite

common as a means of socializing. Cullen et al. (2004) observed the effects of hunting in tropical forest fragments in Brazil and found regular social interactions among local hunters. In a study of hunting in a rural settlement in the Mato Grosso Amazon, Brazil, Trinca and Ferrari (2006) found that it is quite common among local hunters to slaughter killed game animals and share the meat, especially for mammals.

Our results show that the preference of wild mammal meat was highlighted as an important incentive for the demand of this product in the areas visited, where it was regarded by hunters as a resource that has flavor, aroma, and distinct nutritional value in relation to other sources of animal protein. Previous studies corroborate this finding. Mbete et al. (2011), for example, pointed out that the taste category and cultural aspects are the most important things that rouse consumption of the main species of cloven-hoof animals, rodents, and primates in the homes of Brazzaville (Congo). Lindsey et al. (2012) reported that in certain urban areas, the preference depending on the taste of meat can be as high as 100% among consumers, encouraging hunters to provide increasing amounts of bushmeat.

Essentially none of the respondents showed any concern for the conservation of mammals hunted in the places visited. This situation is worrisome, because the potential impact that hunting for meat has on wildlife is known (Milner-Gulland and Bennett 2003, Albrechtsen et al. 2007, Care for the Wild International 2007, Esser et al. 2012). According to the IUCN (2008), almost a quarter (22%) of mammalian species in the world are endangered species and 836 (15%) are classified as data deficient (Schipper et al. 2008, Vié et al. 2009), where hunting exerts substantial pressure on mammals.

Although most of the species mentioned in this research are categorized in the Red List as "least concern," it should be considered that at the local level these populations may suffer overexploitation and extinction. In the Caatinga, there are historical accounts of extinctions and eliminations of fauna by excessive hunting. For example, hunting activities for subsistence purposes has almost eradicated the three-banded armadillo *Tolypeutes tricinctus* (Linnaeus, 1758) in the Brazilian semiarid region (IBAMA 2004, Miranda et al. 2014) and the Brazilian tapir *Tapirus terrestris* (Linnaeus, 1758), which is currently considered regionally extinct and possibly nonexistent in this biome since the 1980s (Medici et al. 2012). In addition, the rapid deforestation of the Caatinga biome, increasing urbanization, incorporation of new technologies in hunting activities, and, above all, the continued intensification of illegal exploitation of bushmeat has led to instabilities in the population structure of game animals. This scenario is in concordance with other studies (Milner-Gulland and Bennett 2003, Parliamentary Office of Science and Technology 2005, Bennett et al. 2007, Endo et al. 2010).

Some studies suggest that important game mammals recorded in Caatinga areas, including the brocket deer and red deer, the armadillos such as the nine-banded armadillo (the game species most appreciated by local hunters) and six-banded armadillo, are found in relictual populations in the Brazilian semiarid lands because of hunting pressure that they suffered over the last centuries (Oliveira et al. 2003, Medri et al. 2011, Desbiez et al. 2012). Similarly, *Tamandua tetradactyla* is considered by the hunters of the locations surveyed as a species that is increasingly

hard to find, even on hunting trips with the help of dogs. This was corroborated by Smith (2007), who states that their slow speed and ease of being spotted because of their color and size make for easy capture. Therefore, we can infer that the hunting pressure on these animals is increasing greatly in the Brazilian semiarid area because of the demand for the meat of such animals as well as the use of multiple hunting strategies, with emphasis on the use of firearms and hunting dogs along with motorized transport to the hunting grounds.

Our results indicate that a significant proportion of the mammals that occur in the Caatinga have been exploited as a protein source in the areas surveyed, which is the main reason for hunting in the area. However, it is noteworthy that the killing of wild game during hunting activities is not fully associated with a need for subsistence because hunting is also motivated by recreation, entertainment, trade, or trafficking. In addition, our data indicated that the number of game mammals recorded in this study corresponded to almost all mammals exploited as meat sources in the Brazilian semiarid region and that exploitation was directly associated with species richness in each area, suggesting a greater prevalence of consumption of species endemic to the specified region.

This scenario, associated with several factors that have had an impact on the Caatinga, has caused a population decline of many local species of mammals, and even their extinction, in most of this biome. This situation shows that subsistence hunting in the Brazilian semiarid region, as elsewhere, is influenced by a complex set of biological, socioeconomic, political, and institutional factors that are essential to understand this multidimensional framework for the design of effective conservation solutions. Therefore, the combination of more rigorous supervision by conservation agencies through medium- and long-term campaigns in environmental education and population awareness are immediate strategies to reduce the demand for wildlife.

Responses to this article can be read online at:  
<http://www.ecologyandsociety.org/issues/responses.php/8358>

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