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Wildlife Consumption Dynamics: Unveiling Conduru Park in Southern Bahia, Brazil

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ABSTRACT

The current investigation aimed to identify the wild animals utilized as a food source in five locations within the Serra do Conduru State Park region, Bahia, Brazil. The field survey was conducted from June 2016 to July 2017, involving semi-structured interviews and informal conversations with 45 hunters. The composition of species used for sustenance in the five locations was characterized through permutation multivariate analyses of variance. Generalized linear models were constructed to evaluate whether socio-demographic variables among hunters influenced the number of captured species. A total of 40 species was indicated like used for consumption in the region of the PESC. The species are classified to: one genus of Amphibia (one families and 1 order); 10 species and one genus of Birds (five families and five orders); 27 species and 2 genus of Mammals (19 families and 7 orders); and 2 species of Reptilia (two families and one order). *Dicotyles tajacu*, *Dasypus novemcinctus*, and *Cuniculus paca* emerged as the most targeted species for food. Hunters who still reside within the conservation unit capture a greater number of wild animals. Older hunters and those with smaller family sizes hunt a broader range of species. The rifle and domestic dogs are the predominant techniques employed in the region. The findings underscore the persistence of illegal hunting practices in the Serra do Conduru State Park region. This emphasizes the necessity for measures directed at the conservation of hunted species, particularly those identified as being under some degree of threat in nature.

Keywords: Atlantic Forest; Hunted species; Ethnozoology.

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SIGNIFICANCE STATEMENT

This study identifies the wild animal species most hunted and used as a food resource in the Serra do Conduru State Park (PESC) region, Bahia, Brazil and how this illegal activity can contribute to impact the reduction of wild animal species populations, including endangered species. Our results show the possible factors and/or motivations associated with the continuity of hunting in the region and discuss the need for actions aimed at the conservation of hunted species, such as the creation of extensive education programs for the dissemination of information on fauna conservation.

INTRODUCTION

The hunting of wild animals represents one of the oldest relationships between humans and biodiversity that is known (Alves and Souto 2010) and researchers have confirmed the importance of hunting, in various regions around the world, especially in tropical forests (Bodmer et al. 1996; Cullen Jr et al. 2001; Ojasti 1997, 2000; Peres and Nascimento 2006; Robinson and Redford 1991; Silva et al. 2022; Van Vliet et al. 2023). In many places, organized hunting of wild animals can bring considerable benefits to biodiversity conservation (Leader-Williams et al. 1996; Lewis and Alpert 1997; Lewis and Jackson 2005). In others, as hunted species are part of the diet of rural and urban populations or traditional communities (Castilho et al. 2018; Mesquita and Barreto 2015; Van Vliet et al. 2011, 2015, 2017) and are among the main sources of animal protein for traditional communities (e.g., indigenous, riverside communities; Alves et al. 2016; Faria and Malvasio 2018; Teixeira et al. 2020) being fundamental for the subsistence of the human population, especially those isolated (Fernandes-Ferreira and Alves 2014; Figueira et al. 2003).

The reasons for the growth in hunting activity in tropical forests are diverse, including increased human population, expansion of the highway network, the use of modern hunting instruments, occupation history, the preference for game meat, availability of game substitutes, socioeconomic conditions, the degree of dependence on hunting as a food source, and cultural conditions (Bennet and Robinson 2000; Bodmer et al. 1996; Constantino 2016; Constantino et al. 2008; Jerozolimski and Peres 2003; Schenck et al. 2006; Van Vliet and Mbazza 2011; Wright et al. 2007). However, although hunting is responsible for supplementing the diet of various traditional populations (Fernandes-Ferreira and Alves 2014; Silva-Neto 2016), the demand for game meat in the tropical region by traditional, urban and rural populations has been putting pressure on wild species, making it difficult to recover their numbers (Alves et al. 2009a; Alves et al. 2016; Pérez 2009; Ramos et al. 2016; Sousa and SrbekAraújo 2017) and provoked several local extinctions (Canale et al. 2012).

Human consumption of hunted animals can lead to the extinction and/or population decline of various species, as well as a reduction in the mean body mass of animal populations as a result of selecting larger animals, diminishing future productivity of hunted populations (Alves and Rosa 2007a; Fernandes-Ferreira and Alves 2014, 2017; Ramos et al. 2016; Thiollay 2005; Thoisy et al. 2005). It should be highlighted that the effects of hunting are intensified by the loss and fragmentation of habitat, which increases the possibility of hunters accessing previously inaccessible areas, besides diminishing the occupation area of the species (Ramos et al. 2016). In contrast, some authors argue that hunting wild animals can be even more impactful than habitat loss (Cullen-Jr. et al. 2000).

Some communities have a great desire to hunt for consume meat, and this is a serious problem to Protected Areas (PA) (Castilho et al. 2018). A lot of factors can contribute for hunt around Protected Areas, as the household poverty and food security, and it is necessary to invest in environmental enforcement and assistance programs to communities (van Velden et al. 2020). To some organisms, like mammals, the PAs in tropical regions can be their diversity affected at 20% due to hunting, and aspects as poverty and inaccessibility to domestic meat increase this impacts (Benítez-López et al. 2019). In Brazil, hunt is strongly associated with absence of protein resources of domestic animals, and have a great importance to poor families, furthermore the cultural questions and socioeconomic factors have influence too (Alves et al. 2009a). This strengthens the necessity to study and understand the relations of social, cultural and economic aspects of hunting for food around of protected areas.

In the south of Bahia some Protected Areas are affected by illegal hunting, with people hunting a lot of species within and around these areas to consumption, and this situation include endangered species, which is very dangerous to these areas (Castilho et al, 2019). Some conflicts with the local fauna in the region are a problem to the species living in the Protected Areas of south Bahia, as hunt to consumption and the damage caused to some mammalian's species in the crops (Santos et al. 2020). The indiscriminate hunt of mammals in the region can provoke pressure in the local populations, and new politics need be established (Ribeiro, Schiavetti 2009).

In view of the negative impacts that hunting of wild animals bring, so that it is possible to preserve them, it is first necessary to know which species are most targeted by humans, how the catches are made and for what reasons the consumption of wild animals in the region of interest is an activity carried out by the locals (Alves and Rosa 2007b; Alves et al. 2009a; Alves et al. 2016). Furthermore, understanding the repercussions of hunting on species diversity, as highlighted by Oliveira and Calouro (2019), is crucial for developing targeted management alternatives. These alternatives should take into account both the local population and conservation efforts, particularly for species at risk of extinction. Therefore, the present study has as main objective to identify the species of wild animals most hunted for consumption in the region of the Serra do Conduru State Park (PESC), Bahia, Brazil. With this, it also seeks to quantify

the main techniques used to capture the species, the socioeconomic aspects associated with the continuity of hunting in the region. Finally, the study discusses the impacts of hunting on species conservation in the region. Another uses derived from the hunt were not considered in this work, because the focus is the hunt for food.

MATERIAL AND METHODS

Study area

The Serra do Conduru State Park (39° 05'32" W / 14°26'17" S) (Figure 1) is a Protected Area (PA) preserving an area of 92.75 Km2, which covers the municipalities of Ilhéus, Uruçuca, and Itacaré. This PA was created by State Decree no. 6,227 of 21st February 1997 to counterbalance the building of a highway (BA 001) (Bahia 2005). It is located within the Environmental Protection Area Itacaré-Serra Grande Coast (Bahia 2005). Both PAs include among their objectives the conservation of the remnants of Atlantic Forest and of the biodiversity of South Bahia (Bahia 2005). The PESC is categorized like an Integral Protection Area, with possibility to scientific research, environmental education, leisure and environmental tourism, wherein to practice this activities depends to management authorization, and it is not allowed to live in the area (Brasil 2000). According to Schiavetti et al. (2012), illegal access to the PESC was indicated by the administration as a serious problem. The present study was carried out in five communities surrounding the PESC: District of Serra Grande (SG), District of Taboquinhas (DT), Nova Vida Settlement (NV), Camboinha Settlement (CS) and Community of Tesouras (CT) (Figure 1).

The SG (39°02'24" W / 14°27'56" S) is a district of the municipality of Uruçuca, located in the south of Bahia. It has an estimated population of 3,585 inhabitants, 74% living in the urban area and 26% in the rural area (Instituto Ynamata 2008). The DT (39°10'21" W / 14°21'31" S) is located 28 km from the Itacaré city hall (Instituto Ynamata 2008). Prior to tourism, its economy was based on the cultivation of cocoa, but with the decline of the crop and the advance of tourism the district began placing more value on its natural resources (Bahia 2005; Instituto Ynamata 2008). The AC (39° 2'45.06" W / 14°20'45" S), located between the districts of Serra Grande and Itacaré, is made up of small rural producers dedicated

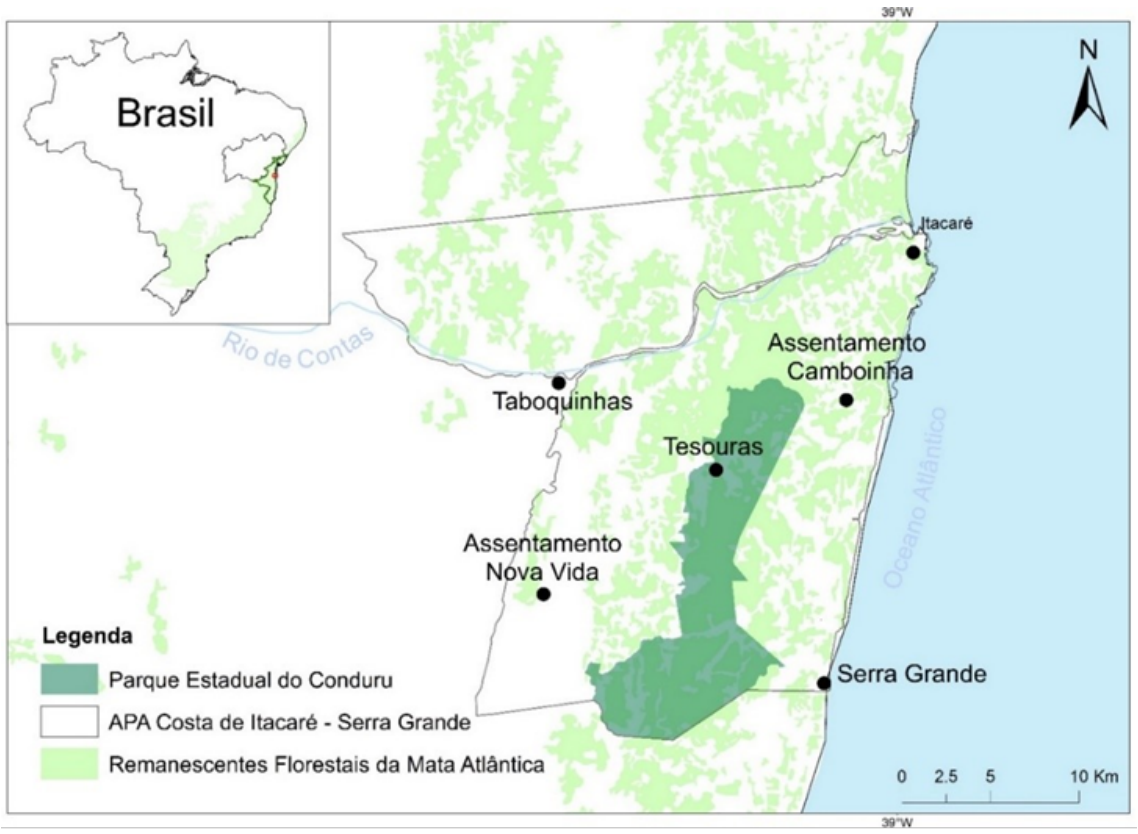

Figure 1. Location of the study area and the communities in which the fieldwork study was carried out with the hunters: Camboinha Settlement (CS), Community of Tesouras (CT), Nova Vida Settlement (NV), District of Serra Grande (SG) and District of Taboquinhas (DT).

to agriculture and local handicrafts (Bahia 2005; Instituto Ynamata 2008). The NV (39°09'04" W / 14°27'38" S) it is composed of 44 families of small farmers who were expropriated during the implementation of the PESC (Ribeiro and Schiavetti 2009). The CT (39° 5'24.21" W / 14°25'59" S) is composed of eight families who, due to slow landholding regularization, still reside within the PESC (Ribeiro and Schiavetti 2009; Sema 2005). In general, all families living around and into the PESC are not traditional population, but they are land squatters, farmers or farm workers (Bahia 2005).

Data collection

Data collection was carried out between June 2016 and July 2017. Only farmers that had also performed hunting activities in the region for at least two years, or that had already hunted for a minimum period of two years during their lives, participated in the study. The participants were interviewed only once. The hunters were selected using the criteria of "native specialists", who are those who recognize themselves as, and are recognized by the community as, culturally competent (Hays 1976), and through the snowball technique (Huntington 2000). These two techniques made it possible to interview a great number of the hunters identified in the region. Sampling was intentional and not random, whereby the interviewees were pre-defined (Albuquerque and Paiva 2004). All people were questioned about de hunting in the region of the PESC.

The information was obtained through open and semi-structured interviews, complemented by informal conversations (Huntington 2000) with questions related to the socio-demographic parameters of the interviewees (gender, origin, age, number of children, level of education, number of people in family, time living in the region and profession), the hunting strategies used (the people was free to cite the strategies) and the main common names of animals hunted and recognized by them. The "freelist" technique was used to record the names of species hunted for food (Albuquerque et al. 2008). This methodology considers that the more times the species appears on the list, the greater the cultural importance given to that species (Albuquerque et al. 2008; Quinlan 2005). To overcome the limitations of free listing were used: "nonspecific prompting", when the participants were questioned about other individuals or nonspecific groups, in order to remember more species; and "reading back", when the list cited by participants is read again slowly (Brewer 2002; Albuquerque et al. 2008).

To respect the rights of intellectual property, the following protocol were adopted in the field: we introduced ourselves before the interview, explaining the nature and objectives of the study; and we then asked for permission to record the information. Before being interviewed, each participant received a Consent Form (TCLE) and a form authorizing the use of images, according to the rules established by Resolution no. 196 of the National Health Council of 10/1996 and approved by the Ethics Committee for Research with Human Beings (CEP) of the State University of Santa Cruz (UESC) (Certificate of Presentation of Ethical Appreciation: 61683516.2.0000.5526; Approval number of the project: 2.227.546).

Data analysis

The results were qualitatively analyzed according to the union model of diverse individual competencies, according to which, all the information referring to the researched subject is considered (Freitas et al. 1996). We considered the number of species cited by hunters like species richness, so we know the richness of each community. Species accumulation curves were constructed to verify whether the number of interviews was significant in relation to species of hunting importance that can be found in the study area. The number of species hunted was plotted as a function of the number of respondents, with 10,000 randomizations performed to generate a confidence interval (Colwell and Coddington 1994). We used the IUCN Red List of Threatened Species (IUCN 2022), Brazilian National List of Endangered Species (Brasil 2022) and Bahia List of Endangered Species (Bahia 2017) do analyze three scale of the conservation status of species hunted in the PESC region: global, national and regional.

Using a permutation multivariate analyses of variance (PERMANOVA, Anderson 2001), we evaluated differences between species cited at the five locations. We used Jaccard distance measures, and 5,000 permutations were generated. PERMANOVA is a permutation Understanding Analysis of Variance (ANOVA), which was developed to test the simultaneous response of one or more variables to one or more factors. PERMANOVA uses the "Adonis" procedure in the vegan package for R (Oksanen et al. 2013). We also used non-metric multidimensional scaling (NMDS) to represent the results of the PERMANOVA analyses. In the NMDS, we also used the Jaccard for the ordination of wild animal species composition used as a food source at the five locations. We realized a rarefaction curve with the iNEXT package (Chao et al. 2014; Hsieh et al 2016), using the number of species and the communities to observe the difference between the diversity of communities. To observe the differences into species richness in the five communities studied, we use the Venn Diagram to indicate the number of species in each community, using the packages "ggVen-

nDiagram" (Gao et al. 2021).

Generalized linear models (GLMs) were built to assess whether the socio-demographic variables of the hunters affect the number of species cited to the hunters. The number of mentioned species were used as the response variable, and age of the hunters and socio-demographic were used as the explanatory variables. The models were subjected to an analysis of residuals to test the adequacy of the error distribution (Crawley 2012). The minimum adequate model (MAM) was obtained by extracting non-significant terms ($p < 0.05$) from the full model; when significant differences were observed between habitats, the data were submitted to contrast analysis by aggregating levels (Crawley 2012). If the level of aggregation was not significant and did not alter the deviance explained by the null model, the levels were pooled together (contrast analyses). All statistical analyses were conducted with R software (R Development Core Team 2022). We considered in all tests only the species cited to used like food by hunters, because this was the objective of the work.

RESULTS

A total of 45 hunters (44 men and one woman) from the five locations in the study area were interviewed. The number of interviewees in each location was: NV – 14; AC – 10; CT – 8; SG – 8; and DT – 5. Most of the interviewees were aged between 58 and 67 (n = 11 people; mean = 62.82; sd = 2.82), followed by 38 to 47 (n = 9 people; mean = 43.33; sd = 3.60), 68 to 77 (n = 8 people; mean = 70.75; sd = 2.37), 28 to 37 (n = 6 people; mean = 33.33; sd = 3.14), 48 to 57 (n = 5 people; mean = 53.40; sd = 2.30), 18 to 27 (n = 3 people; mean = 23.00; sd = 4.58), 78 to 87 (n = 2 people; mean = 82.00; sd = 5.65), and 88 to 97 (only one person with 90 years old). Most hunters are local residents born in the region (42.2%) or born in another location (57.8%), but who have lived there for several years. Regarding education, most of the interviewees completed only the first period of elementary school (1st to 4th grade; 42.2%), followed by those who admitted never having studied (37.8%). In terms of occupational activity, the majority are farmers (60%) and extractivists (22.2%) and, considering the number of children, most have three children (26,7%) or more than seven children (17.8%). Regarding the size of the family, most live alone (22.2%) or with another person (complementary material).

A total of 40 species was indicated like used for consumption in the region of the PESC. The species are classified to: one genus of Amphibia (one families and 1 order); 10 species and one genus of Birds (five families and five orders); 27 species and 2 genus of Mammals (19 families and 7 orders); and 2 species of Reptilia (two families and one order). The species accumulation curves demonstrates complete stabilization (Figure 2), reaching the asymptote in approximately five interviews, indicating sampling efficiency in data collection.

The people indicated only one amphibian hunted for food, the frog (*Leptodactylus* sp.). Among the birds, the little tinamou (*Crypturellus soui*), the solitary tinamou (*Tinamus solitarius*) and the rusty-margined guan (*Penelope superciliaris*), had the highest number of citations. Among the mammals, the lowland paca (*Cuniculus paca*) is the species most indicated for hunting for food, followed by the collared peccary (*Dicotyles tajacu*) and the long-nosed armadillo (*Dasypus novemcinctus*). The tegus (*Salvator merianae*) and the Boa (*Boa constrictor*) were the only species of reptile used for food (Table 1).

People indicated five species hunted for food and present in the three red lists, indicated here respectively with IUCN, Brazilian (BR) and Bahia (BA) status of conservation in parentheses: one bird, the *Crax blumenbachii* (IUCN = Endangered; BR = Endangered; BA = Critically Endangered); four mammals, the *Bradypus torquatus* (IUCN = Vulnerable; BR = Vulnerable; BA = Vulnerable), the *Sapajus xanthosternos* (IUCN = Critically Endangered; BR = Endangered; BA = Endangered), the *Callicebus melanochir* (IUCN = Vulnerable; BR = Vulnerable; BA = Vulnerable), and the *Chaetomys subspinosus* (IUCN = Vulnerable; BR = Vulnerable; BA = Vulnerable). So, was indicated *Penelope superciliaris* (Birds: Cracidae), present like "Near Threatened" in IUCN red list, *Tinamus solitarius* (Birds: Tinamidae) in "Near Threatened" and "Endangered" categories at IUCN and Bahia red list respectively, *Sylvilagus brasiliensis* (Mammalia: Leporidae) in the "Endangered" category of IUCN red list.

Hunters mentioned four hunting strategies: rifle hunting; hunt with a dog; trapping; and hunting with bait. CT was the only place where all 45 hunters used the four hunting strategies. Rifle hunting, the most common technique in the region, is used by 35 hunters; followed by hunting with dogs, traps and bait, used by 27, 21 and 11 interviewees, respectively. Most of the time, hunters use a combination of two or more hunting techniques, such as rifle hunting accompanied by dogs.

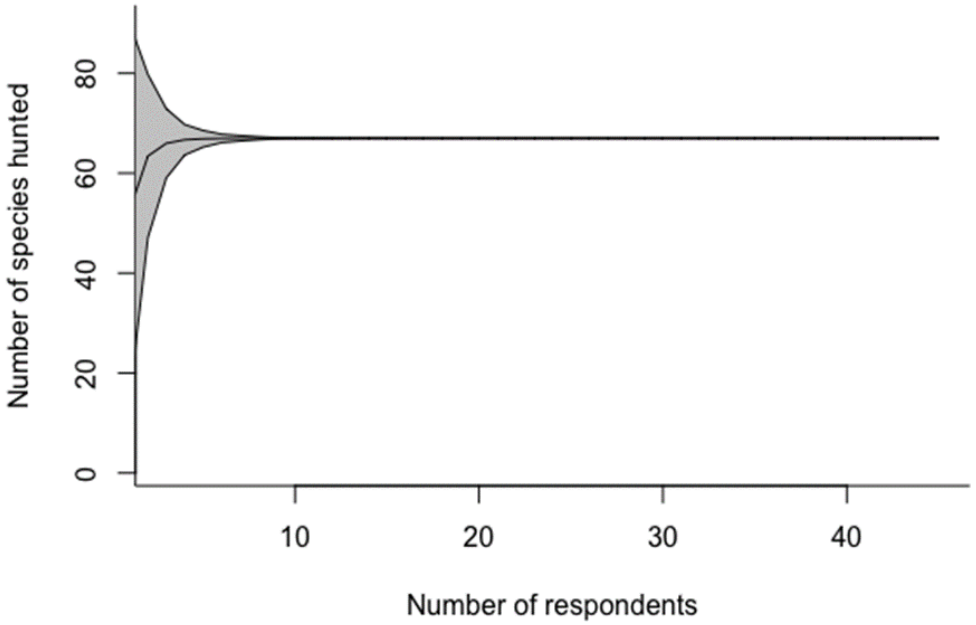

Figure 2. Species accumulation curve for the number of species hunted based on the number of respondents in the region of the Serra do Conduru State Park, Bahia, Brazil. The shaded area represents the confidence intervals of 95% based on 10,000 randomizations.

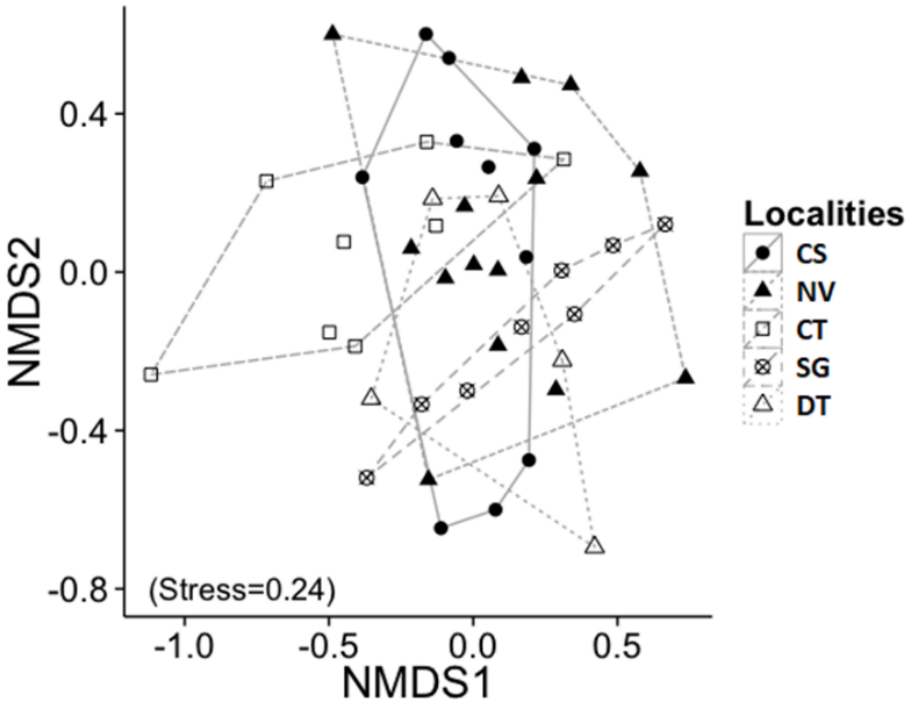

Figure 3. Non-metric multidimensional scaling (NMDS) analyses showing the dissimilar of the composition of wild animal species used as a food source at the five locations studied in the region of the Serra do Conduru State Park, Bahia, Brasil. Each symbol represents a different location. Camboinha Settlement (CS), Communitie Tesouras (CT), Nova Vida Settlement (NV), District of Serra Grande (SG), and District of Taboquinhas (DT). A significant difference in species composition captured for food ($p<0.05$) among the five locations was observed in the PERMANOVA analyse. Data recorded between June/16 and June/17.

Table 1. List of wild animal species captured by the hunters in the region of the Serra do Conduru State Park, Bahia, Brazil. Nº: number of citations to hunt for food; IUCN: category in IUCN Red List; BR: category in Brazilian list of threatened species; SEMA: category in list of threatened species of Bahia.

CLASS	Order	Family	Scientific name	Vernacular name	Nº	IUCN	BR	BA
AMPHIBIA	Anura	Leptodactylidae	*Leptodactylus sp.*	Caçote	1	-	-	-
BIRDS	Columbiformes	Columbidae	*Patagioenas cayennensis*	Pale-vented Pigeon	3	LC	-	-
	Galliformes	Cracidae	*Penelope superciliaris*	Rusty-margined Guan	7	**NT**	-	-
		Cracidae	*Ortalis araucuan*	East brasilian chachalaca	6	LC	-	-
		Cracidae	*Crax blumenbachii*	Red-billed Curassow	4	**EN**	**EN**	**CR**
	Passeriformes	Icteridae	*Psarocolius decumanus*	Crested Oropendola	1	LC	-	-
	Piciformes	Ramphastidae	*Ramphastos sp.*	Toucan	1	-	-	-
	Tinamiformes	Tinamidae	*Crypturellus soui*	Little Tinamou	8	LC	-	-
		Tinamidae	*Tinamus solitarius*	Solitary tinamou	8	**NT**	-	**EN**
		Tinamidae	*Rhynchotus rufescens*	Red-winged Tinamou	6	LC	-	-
		Tinamidae	*Crypturellus parvirostris*	Small-billed Tinamou	6	LC	-	-
MAMMALIA	Carnivora	Canidae	*Cerdocyon thous*	Crab-eating fox	21	LC	-	-
		Felidae	*Leopardus sp.*	Leopard	2	-	-	-
		Mustelidae	*Lontra longicaudis*	Neotrpical otter	4	**NT**	-	**VU**
		Mustelidae	*Eira barbara*	Tayra irara	5	LC	-	-
		Procyonidae	*Nasua nasua*	South american coati	6	LC	-	-
		Procyonidae	*Procyon cancrivorus*	Crab-eating raccoon	3	LC	-	-
		Procyonidae	*Potos flavus*	Kinkajou	17	LC	-	-
	Cetartiodactyla	Cervidae	*Mazama americana*	Red brocket deer	5	DD	-	-
		Cervidae	*Subulo gouazoubira*	Gray brocket deer	8	LC	-	-
		Tayassuidae	*Dicotyles tajacu*	Collared peccary	38	LC	-	-

CLASS	Order	Family	Scientific name	Vernacular name	Nº	IUCN	BR	BA
MAMMALIA	Cingulata	Dasypodidae	*Dasypus novemcinctus*	Nine-banded armadillo	26	LC	-	-
		Chlamyphoridae	*Euphractus sexcinctus*	Six-banded armadillo	22	LC	-	-
		Chlamyphoridae	*Cabassous tatouay*	Greater naked tailed armadillo	9	LC	-	-
	Didelphimorphia	Didelphidae	*Didelphis aurita*	Black-eared opossum	12	LC	-	-
	Lagomorpha	Leporidae	*Sylvilagus brasiliensis*	Tapiti	1	**EN**	-	-
	Pilosa	Bradypodidae	*Bradypus variegatus*	Brown-throated three-toed	1	LC	-	-
		Bradypodidae	*Bradypus torquatus*	Maned three-toed sloth	1	**VU**	**VU**	**VU**
		Myrmecophagidae	*Tamandua tetradactyla*	Southrn tamandua	14	LC	-	-
		Cebidae	*Sapajus xanthosternos*	Buff-headed Capuchin	1	**CR**	**EN**	**EN**
		Pitheciidae	*Callicebus melanochir*	Coastal Black-handed Titi	2	**VU**	**VU**	**VU**
	Rodentia	Caviidae	*Hydrochoerus hydrochaeris*	Capybara	12	LC	-	-
		Cricetidae	*Oligoryzomys sp.*	Rodents	2	-	-	-
		Cricetidae	*Nectomys squamipes*	Water-rat	3	LC	-	-
		Cuniculidae	*Cuniculus paca*	Spotted paca	40	LC	-	-
		Dasyproctidae	*Dasyprocta leporina*	Agouti	4	LC	-	-
		Erethizontidae	*Coendou (Sphiggurus) insidiosus*	Bahia hairy dwarf porcupine	8	LC	-	-
		Erethizontidae	*Chaetomys subspinosus*	Bristle-spined Rat	5	**VU**	**VU**	**VU**
REPTILIA	Squamata	Boidae	*Boa constrictor*	Boa constrictor	12	LC	-	-
		Teiidae	*Salvator merianae*	Tegu	29	LC	-	-

The five locations were dissimilar (Permanova r^2 = 0.18; p = 0.04) in relation to species composition captured for food (Figure 3), and the rarefaction demonstrated that non stabilization curve for each community, with more divert to SG, NV, CS, CT and DT respectively (Figure 4). Ten species were cited exclusively at one location (Figure 5), three species were cited at two of the five locations, 11 were shared by three of the communities, five used for food were common to four of the communities and 12 species, such as the *C. paca* and the *D. novemcinctus* were of common use in the diet at five locations.

Some sociodemographic parameters are associated with the number of species used for food. The age of the hunters is positively related to the number of species hunted (p = 0.02; Table 2; Figure 6), hunters of a larger age group pointed a greater number of species. However, the families size is related to the number of species (p = 0.01; Table 2; Figure 7), that is, larger families capture fewer species. The average number of species hunted did not differ between sites (Deviance 4.40 = 71.53; p> 0.05), but was significantly higher in the CT (Deviance 1.43 = 56.433; p = 0.01; Figure 8). All 41 species used for food resource were cited by hunters CT, while 29, 23, 21 and 20 species are, respectively, food sources for hunters SG, NV, DT and AC. The other sociodemographic parameters analyzed were not related to the number of species used for feeding (p> 0.05; Table 2).

DISCUSSION

Our results demonstrate that hunting is a practice that still occurs in the region of the Serra do Conduru State Park. A great part of the wild species of the Atlantic Forest, mainly mammals, is exploited as a source of protein, which, according to hunters, is the main reason for hunting in the region. However, it should be noted that the slaughter of wild animals is not limited solely to the need for subsistence, but it is not our focus in this work. Through our results, it is evident the need for measures aimed at the conservation of hunted species, especially those that are under some degree of threat.

Although in different cultures women play an important role in hunting activities as support or hunting trips (Pereira and Schiavetti 2010; Ribeiro and Schiavetti 2009; Santos et al. 2018), we already expected the absence or low number of women identified as hunters. In the locations studied, only one woman identified herself as a hunter, demonstrating that this activity is predominantly performed by men. In other regions of Brazil occur the prevalence of men hunting too, like in Catimbau National Park, in Pernambuco state (Marques et al. 2022), National Forest Restinga of Cabedelo, Benjamim Maranhão Botanical Garden, Engenho Gargaú Private Natural Heritage Reserve, Guaribas Biological Reserve (Barbosa et al. 2022) and in the north region of Brazil (Ramos et al. 2020).

The age group of the interviewees indicates that hunting is practiced by people of advanced age, which may be associated with the local culture, where the elderly are hunters. This is possibly due to the greater experience of these people with regard to hunting equipment and strategies for capturing these animals due to empirical knowledge about the behavioral characteristics of animals (Ayres and Ayres 1979). In other regions of northeastern Brazil the same happens, with older men involving with the hunting. Dantas-Aguiar et al. (2011) found more hunter with 30 to 40 year old and 52 to 62 year old in the community of Campos Formoso, Bahia. In the Catimbau National Park, Pernambuco, was found the same result, with hunters older, into 41 and 62 years old (Marques et al. 2022). A study carried out in four protected areas of Paraíba, the hunters were between 26 and 45 years old (Barbosa et al. 2022). Possibly the new generations are more access to education and information, and this result in the less interesting of younger in the hunt. So, this needs to evaluate in the news works. In some cases, the age influence on education level, and younger have the most education level (Barbosa et al. 2022). Usually hunters have less education level (Ramos et al. 2020; Marques et al. 2022), and the same result was found in our work. The relationship between the low level of education of hunters in the PESC region and hunting seems to be a common pattern observed in several other studies (Ribeiro and Schiavetti 2009; Castilho et al. 2018).

The hunted species play an important role in providing proteins to local families following a traditionally known pattern (Alves et al. 2009b, 2012; Barboza et al. 2016; Melo et al. 2014; Pereira and Schiavetti, 2010). Furthermore, the preference for mammals follows a pattern similar to several studies carried out in several neotropical biomes (Alves et al. 2009b; Mesquita and Barreto 2015; van Vliet et al. 2017), in the state of Bahia (Alves 2012; Dantas-Aguiar et al. 2011) and Southern Bahia (Castilho et al. 2018; Pereira and Schiavetti, 2010; Ribeiro and Schiavetti, 2009; Teixeira et al., 2020). This preference is mainly due to the degree of difficulty of capture and the cost of hunting, flavor and yield of meat supplied by the animal (Cullen et al. 2001; Damaceno et al. 2019; Pereira and Schiavetti 2010).

Mammals are historically the animals most affected by hunting, due to their medium size and abundant population (Martínez and Garcia 2015; Trinca and Ferrari 2006; Ramos et al. 2020). Despite the dietary importance of hunting for the rural population, overexploitation of these species has serious consequences for the ecosystem (Alves and Souto 2010).

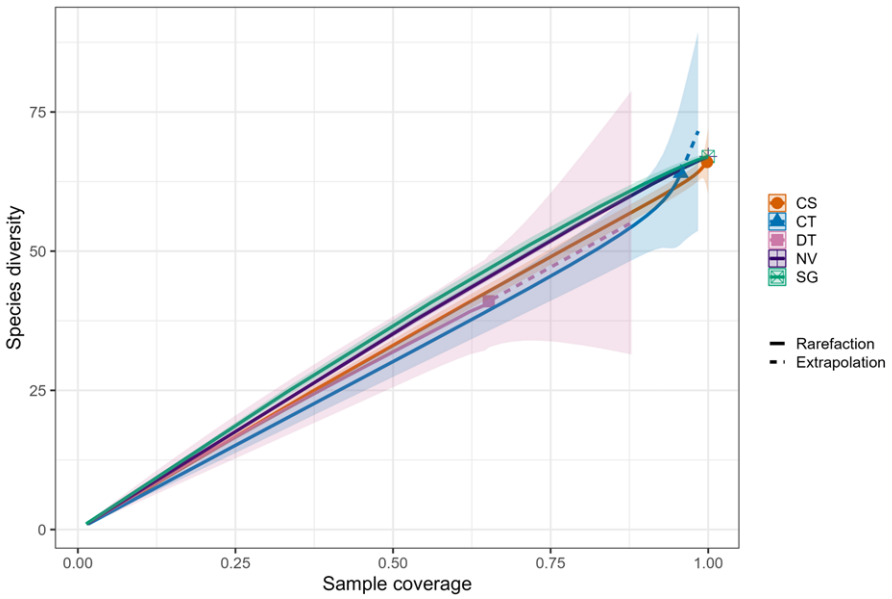

Figure 4. Rarefaction with the species diversity and sample coverage based on the hunter's answers of five communities around the Serra do Conduru State Park, Bahia, Brazil. CS: Camboinha Settlement; CT: Community of Tesouras; DT: Districti of Taboquinhas; NV: Nova Vista Settlement; SG: Districti of Serra Grande.

In tropical forests, the abundance of wildlife is directly correlated with hunting patterns more than with other factors such as forest type, habitat size or protected area status (Pérez 2009). In the south of Bahia, Cassano et al. (2012) found no traces of *Cuniculus paca*, *Mazama americana* or *Subulo gouazoubira* for example, this suggesting that hunting may have made these species disappear in some regions of the Bahia.

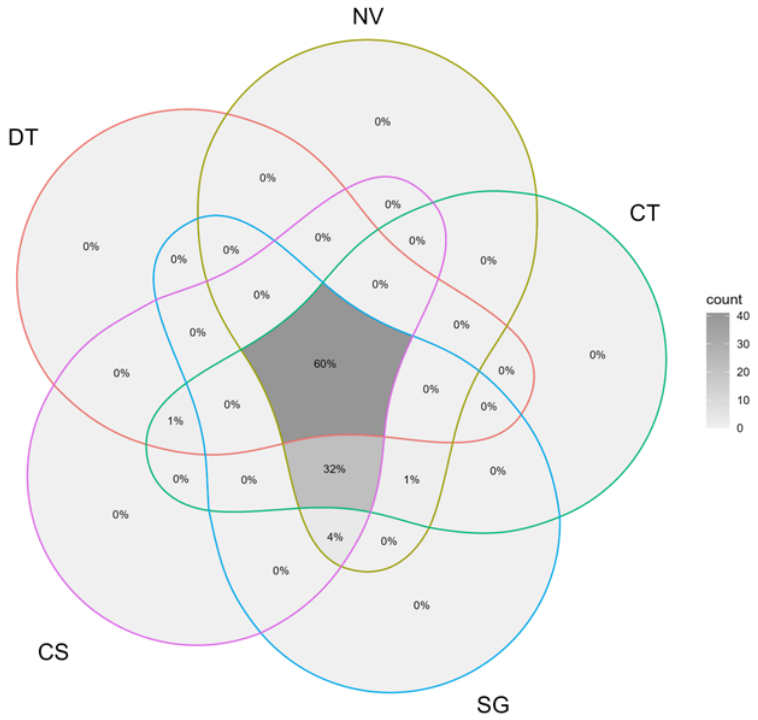

Figure 5. Venn diagram demonstrating the number of species in the communities around the Serra do Conduru State Park, Bahia, Brazil. CS: Camboinha Settlement; CT: Community of Tesouras; DT: Districti of Taboquinhas; NV: Nova Vista Settlement; SG: Districti of Serra Grande.

Table 2. Results of deviance of the minimal adequate model showing the effects of explanatory variables (socio-demographic parameters) on the number of species hunted (response variable). The error distribution used in the model was Quasi-Poisson. * represents statistical difference ($p < 0.05$).

Response variable	Explanatory variables	df	Deviance / *F*	*P*
Number of species hunted	Locality	4	71.530	**0.03***
	Age	1	41.239	**0.02***
	Gender	1	15.335	**0.10**
	Education level	4	36.585	**0.20**
	Profession	7	63.327	**0.17**
	Number of children	1	3.185	**0.45**
	Origin	1	4.220	**0.38**
	Time living in the region	1	2.461	**0.50**
	Family size	1	46.480	**0.01***

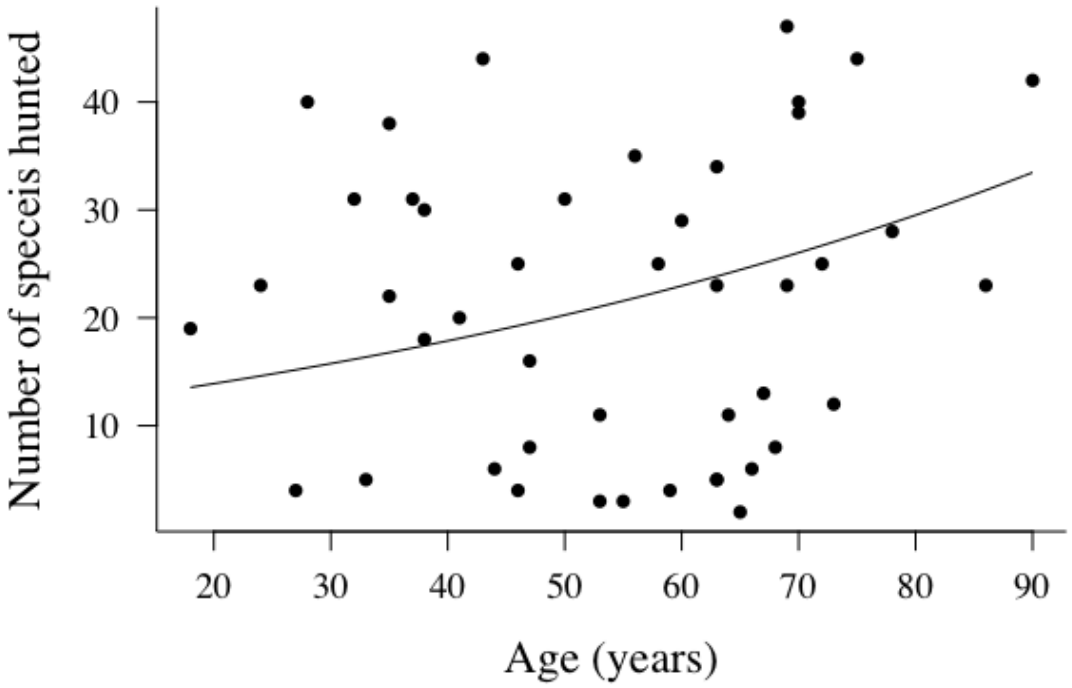

Figure 6. Effect of hunters' ages on the number of species hunted for food in the region of the Serra do Conduru State Park, Bahia, Brazil. The error distribution used in the model was Quasi-Poisson.

As well as the concern regarding species directly affected by hunting, studies on the consequences of defaunation indicate that the ecology of forests used for hunting is severely disturbed (Harrisson 2011). The structure and dynamic of tropical forests are compromised due to the scarcity or extinction of herbivores, carnivores, and frugivores (Dirzo and Miranda 1991). The effects are related to the predation and dispersion of seeds, herbivory, and increased seedling density and imbalances in the food chain of the ecosystems, such as increased density of small mammals due to a lack of predators and competitors (Alves and Souto 2010; Terborgh et al. 2001).

The number of citations indicated the food preference, and the *C. paca*, *D. novemcinctus* and *D. tajacu* were the most used species in local consump-

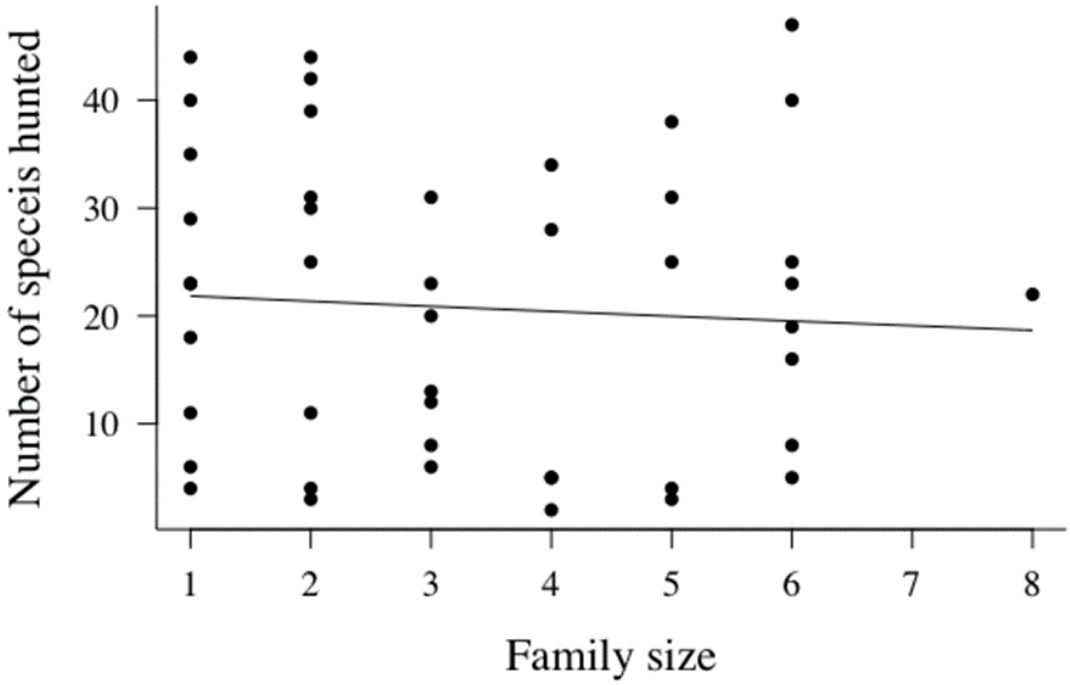

Figure 7. Effect of family size on the number of species hunted for food in the region of the Serra do Conduru State Park, Bahia, Brazil. The error distribution used in the model was Quasi-Poisson.

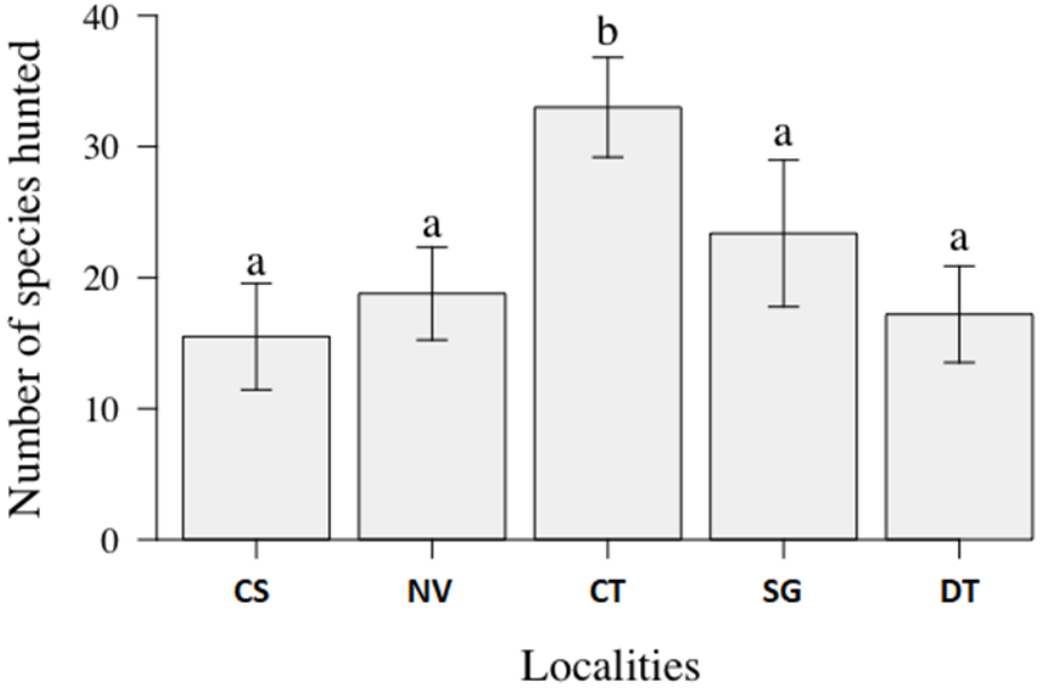

Figure 8. The average of species hunted for food observed for the five localities (CS - Camboinha Settlement, NV - Nova Vida Settlement, CT - Communitie Tesouras, SG - District of Serra Grande and DT - District of Taboquinhas) in the region of the Serra do Conduru State Park, Bahia, Brazil. The vertical bars correspond to the standard error (± se). Different letters above the columns represent statistically different means ($p < 0.05$)

tion. Other studies carried out in Bahia (Flesher and Laufer 2013), in South Bahia (Castilho et al. 2018; Pereira and Schiavetti 2010), and in Brazil (Cullen Jr. et al. 2001; Fernandes-Ferreira and Alves 2014) also

indicate the lowland paca and armadillo species as the most consumed species and the most appreciated meats. Historical studies indicate that the lowland paca has suffered from hunting since the olden days (Cardim 1925; Varnhagen 1860; Silva 1898), hunted in various regions of Brazil (Canale et al. 2012; Freitas et al. 2005; Peres and Nascimento 2006) and indicated as the vertebrate species the most preferred mammal for hunting within the national territory (Fernandes-Ferreira and Alves 2014).

The *D. novemcinctus*, is valued in the region for its flavor and its ease of capture in comparison to other prey. The valorization of this species was also registered in several regions of Brazil (Hanazaki et al. 2009; Pereira and Schiavetti 2010; Rocha-Mendes 2005). According to the hunters in our study, the collared peccary, *D. tajacu*, is found throughout the region, making it easy to capture. According to Desbiez et al. (2011), the species has a gregarious habitat, also making it easier to capture and even kill more than one at a time. For Freitas et al. (2005), *D. tajacu* is widely pursued for eating as it has a high biomass, guaranteeing greater food resources, besides having a large percentage of body fat, a characteristic appreciated by the hunters. In the same region, Santos et al. (2020) identified the collared peccary as the most killed species as a result of the invasion, consumption, and/or destruction of agricultural crops, which is characterized by further motivation to slaughter the collared peccary.

The tegu, *Salvator merianae*, identified as the lizard of greatest dietary importance in the region of the PESC, was also considered by Alves et al. (2012) as the reptile of greatest hunting importance in a study carried out in two municipalities in Paraíba. Teixeira et al. (2020) indicated the tegus as the reptile most used for zootherapy in the region of the PESC. Fitzgerald (1994) states that lizards of this genus are also commonly hunted in Argentina, Paraguay, and parts of Bolivia.

The inclusion of hunted species on lists of endangered species represents a challenge to find forms of exploitation that minimize the impact on hunted species, and for this it is necessary to understand the context involving hunting practices (Alves 2012). The fact that endangered species are used as food source by hunters in the PESC region alerts us to the necessity for research that seeks to understand the degree of threat that these species are subjected to and the need for conservation strategies to minimize and revert such threats. Thus, it is necessary to understand the multidimensional context of hunting in the region, considering cultural and socioeconomic aspects, so that there is a reduction in pressure from hunting (Alves et al. 2016). To reduce the pression of poaching is necessary considering cultural factors to guarantee the sustainability regional hunting, actions as educational programs, news components in environmental legislation, combating sport hunting and limitations on the use of hunting technologies, as firearms (Alves et al. 2009a).

Understand the hunting strategies is important to reduce de risk of many species, because some strategies are less selective and can increase the chance to kill endangered species, as strategies to trap with firearms and use of dogs (Oliveira and Calouro 2019; Santos et al. 2022; Yudha et al. 2022; Pattiselanno et al. 2023,). Hunting strategies are fundamental to obtaining greater success in the search and killing of prey, and, consequently, reduce the expenditure of energy in the performance of hunts (Blasco et al. 2010; Costamagno et al. 2006). For Alves et al. (2009a), the variety of hunting strategies reflects the necessity to access the abundance of hunted animals living in different habitats. This diversity and choice of hunting strategy was also observed in the studied area. The hunters argue as to the greatest success in diversity and abundance of captured species when using different hunting techniques; for example, the use of a rifle with a dog, or the use of traps in areas when carrying out an active hunt with the support of a rifle and a domestic dog. The strategy is dependence of the pray, and hunters use the more efficient to kill more animals, generally they use firearms and dogs (Souza et al. 2022a), so the actively strategies offer more risk to the animals (Souza et al. 2022b).

The number of species indicated at the five locations may be related to the frequency of occurrence and the abundance of species in each location. According to Alves et al. (2009a), the hunting pattern of vertebrates for food can be influenced by availability and abundance of species in the region. Communitie Tesouras is within the PESC, an environmental protected area of integral protection, where the forest fragments are preserved to a greater degree and there is possibly a greater abundance and occurrence of species within its limits, which makes it possible for the hunters to have more hunting options. All the hunters from CT are extractivists who depend on natural resources to guarantee their survival and, possibly, invest more time in hunting activities as a way of acquiring a source of protein. It is worth highlighting that as an integral CU, hunting or any direct use of the natural resources is prohibited in the PESC (Brasil 2000).

The low species diversity in DT occur probably because this community is located far from the PESC. It is possible see the communities more proximity to the PESC present more species hunted. The PAs are more efficient to protected biodiversity and commonly are more richness and abundance of species (Gray et al 2016). Non-protected areas are more exposed to

humans use for many reasons as economy, culture or recreation (Avigliano et al 2019), and this may have influenced in our result, demonstrating more species cited by hunters in areas more close to PESC. So, the future works need evaluated this effect, and analyze the relationship between distance and biodiversity in this areas with methods to study the occurrence of fauna around this communities.

The positive relation between age and number of species cited by hunters was expected. Other works founded the same, with older hunter indicating more species (Barbosa et al. 2022; Oliveira and Calouro 2019). In some cases, the older hunter needs learning younger how the species behaving, and ecological aspects (Oliveira and Calouro 2019). With this, the tradition and knowledge are transferred for youngers, and de community maintains the tradition (Barbosa et al. 2022).

Larger families may prioritize the quality of the prey over quantity, resulting in a lower number of indicated species by hunters. Consequently, hunters with larger family sizes tend to prefer pursuing larger animals such as *Cuniculus paca*, *Dasypus novemcinctus*, *Dicotyles tajacu*, and *Euphractus sexcinctus*, as these species provide a greater quantity of meat. However, this preference poses a potential risk to endangered mammal species in the PESC region.

Several actions can be implemented aiming at the conservation of species involving the local population, in particular hunters, as the creation of extensive education programs for the dissemination of information on the conservation of endangered species, on the rules and legislation that regulate game activity. It is important to create channels of communication between academic institutions and government agencies with the population (Alves 2012), strengthening relations and allowing the greater involvement of populations in important decisions regarding the conservation of fauna in their communities. In this sense, it is important to argue about the need to include community participation in decisions involving the PESC management plan. In addition, research aimed at estimating the pressure of hunting and wild animal trafficking in the region should be encouraged.

CONCLUSION

Our study demonstrate that is necessary measures aimed at conservation of hunted species, especially for those found under some degree of threat. Its necessary understanding more reasons to hunting at the area of PESC and work mainly with families more dependent to the hunt. This will guide new proposals in the PESC. Families with older people and less scholar instructions need attention, because this may be a factor to increase the hunt. Work with news generations would be fundamental to better results about hunt, and this younger generation could contribute to reduce the hunt in the PESC.

As a strategic management plan involving the local population, particularly the hunters, creation of broad education programs for the dissemination of information on conservation of endangered species and the rules and legislation regulating hunting activity is recommended. Within conservation measures, it is necessary to consider the dietary importance of hunting for local families. The effects of hunting on the wild fauna are not easy to measure; further research is needed to estimate the pressure of hunting on the region and assess the impact of the activity on the local fauna. Furthermore, the environmental organs responsible for the conservation of protected areas should guarantee efficient monitoring, since hunting has been shown to be present in the studied areas.

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DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

CONTRIBUTION STATEMENT

Conceived the idea presented: J.V.S.T.; A.S. Carried out the study: J.V.S.T. Carried out the data analysis: J.V.D.T.; W.D.R.; J.E.S.M. Wrote the first draft of the manuscript: J.V.S.T. Review and final writing of the manuscript: J.V.S.T.; A.S.; W.D.R.; J.E.S.M.

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