Wild Animals Used as Food Source in the Region of the Serra do Conduru State Park – PESC, Bahia, Brazil

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Abstract

Background: The consumption of wild animals through hunting performs an essential role in human eating habits in different tropical areas. However, the frequent and consistent use of hunting is indicated as one of the main causes of extinction and/or population decline in various species. Thus, the present study aimed to identify the wild animals used as food source in five locations in the region of the Serra do Conduru State Park, Bahia, Brazil.

Methods: The field survey was carried out from June 2016 to July 2017 by conducting semi-structured interviews, complemented by informal conversations with 45 hunters (44 men and one women), who provided information on hunted species, the purpose of hunting, capture techniques, and other aspects of hunting. We characterized the composition of the species used for feeding in the five locations through permutation multivariate analyses of variance. Generalized linear models were built to assess whether the socio-demographic variables of the hunters affect the number of captured species.

Results: A total of 67 species (34 families and 22 orders) of hunting importance were registered in the region, 41 of which are captured for eating. The taxa most represented were: mammals (32), birds (21), reptiles (13) and amphibia (1). *Pecari tajacu*, *Dasypus novemcinctus*, and *Cuniculus paca* are the most hunted species for food. Hunters who still reside within the conservation unit capture a greater number of wild animals. Older hunters and hunters with a smaller family size hunt more species. The rifle and domestic dogs are the most used techniques in the region.

Conclusion: The results demonstrate that illegal hunting is a practice that still occurs in the region of the Serra do Conduru State Park. This reinforces the need for measures aimed at the conservation of hunted species, especially those found to be under some degree of threat in nature. Future research is necessary to estimate the pressure hunting exerts on the region and to assess its impact on local fauna.

Introduction

Researchers have confirmed the importance of hunting, in various regions around the world, especially in tropical forests [1–7]. Hunted species make up part of the diet of rural populations and urban areas in various tropical regions [8–11] and are among the main sources of animal protein for traditional communities at different locations [12–15]. However, although hunting is responsible for supplementing the diet of various traditional populations [16, 17], the demand for game meat in the tropical region has been putting pressure on wild species, making it difficult to recover their numbers [18–23].

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 [24–27]. However, although hunting is responsible for supplementing the diet of various traditional populations [12, 16], the demand

for game meat in the tropical region has been putting pressure on wild species, making it difficult to recover their numbers [12, 18–20, 22, 23].

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 [22, 28–32]. 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 [33, 34].

Knowing the hunted species, form of capture, eating preferences, reason for capture, and the effectiveness of monitoring by the environmental bodies, are necessary aspects to the understanding of hunting, the form of use, and the degree of threat to wild animal species [12, 18, 30, 35]. Thus, the present study aims to identify the wild animal species used as food source in the region of the Serra do Conduru State Park (PESC), Bahia, Brazil. Furthermore, it also aims to quantify the main techniques used in capture of the species and the possible factors and/or motivations associated with the continuity of hunting in the region.

Methods

Study Area

The Serra do Conduru State Park (14°26'53" S; 39°05'36" O) (Fig. 1) is a Conservation Unit (UC) preserving an area of 9,275 hectares, which covers the municipalities of Ilhéus, Uruçuca, and Itacaré. It was created by State Decree no. 6,227 of 21st February 1997 to counterbalance the building of a highway (BA 001) [36]. It is located within the Costa de Itacaré/Serra Grande Environmental Protection Area (APA) [36, 37]. Both APAs include among their objectives the conservation of the remnants of Atlantic Forest and of the biodiversity of South Bahia [36, 37]. The illegal access to the PESC was indicated by the administration as a serious problem [38].

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) (situated within the Costa de Itacaré/Serra Grande APA and in the region of the PESC) and Community of Tesouras (CT) (on the borders of the PESC) (Fig. 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).

The SG (14°27'53"S 39°02'24"W) 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 [39]. The DT (14°21'24"S 39°10'30"W) is located 28 km from the Itacaré municipality. 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 [39, 40]. The AC (14°21'35"S 39°02'12"W), located between the districts of Serra Grande and Itacaré, is made up of small rural producers dedicated to agriculture and local handicrafts (Ynamata Institute, 2008, Sema 2005) [40]. The NV (14°29'45"S 39°12'14"W) it is composed of 44 families of small farmers who were expropriated during the implementation of the PESC [41]. The CT (14°23'41"S 39°05'21"W) is composed of 8 families who, due to slow landholding regularization, still reside within the PESC [39, 41].

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 [42], and through the snowball technique [43]. These two techniques made it possible to interview all the hunters identified in the region. Sampling was intentional and not random, whereby the interviewees were pre-defined [44].

The information was obtained through open, semi-structured interviews, complemented by informal conversations [43]. The free-listing technique was used to register the names of the species hunted for food, from which comes the principle that the more culturally important elements appear on many of the lists in order of cultural importance [45]. To overcome the limitations of free listing, nonspecific prompting and reading back were used [45]. 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) (Caae 61683516.2.0000.5526).

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 [46]. 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 [47].

Using a permutation multivariate analyses of variance (PERMANOVA) [48], we characterize the composition of the species used for food cited at the five locations. We used Jaccard distance measures,

and 5000 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 [49]. 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.

Generalized linear models (GLMs) were built to assess whether the socio-demographic variables of the hunters affect the number of captured species. The number of captured 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 [50]. 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 [50]. 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 [51].

Results

Socio-Demographic Parameters of the Hunters

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, followed by 38 to 47, and 68 to 77. Most of the hunters are native to the region or have resided at their locations for approximately 15 years. Regarding education, most of the interviewees have only completed the first period of basic education (1st to 4th grade), followed by those that admitted to never having studied. In terms of occupational activity, most are farmers and extractivists, and considering number of children most have three children or more than seven children. In relation to family size, most live alone or with another person (Table 1).

Table 1
Socio-demographic parameters of the forty-five hunters interviewed
in the region of the Serra do Conduru State Park, Bahia, Brazil.

Socio-demographic parameters		(n°)	(%)
Gender	Male	44	97.8
	Female	1	2.2
Origin	Born in the locality	19	42.2
	Born in another locality	26	57.8
Age	18–27	3	6.7
	28–37	6	13.3
	38–47	9	20
	48–57	5	11.1
	58–67	11	24.4
	68–77	8	17.8
	78–87	2	4.5
	88–97	1	2.2
Number of children	0	5	11.1
	1	5	11.1
	2	5	11.1
	3	12	26.7
	4	5	11.1
	5	1	2.2
	6	4	8.9
	7 or more	8	17.8
Education level	Illiterate	17	37.8
	Elementary school I	19	42.2
	Elementary school II	7	15.6
	Incomplete high school	1	2.2
	Complete high school	1	2.2

Data recorded between June 2016 and July 2017.

Socio-demographic parameters		(n°)	(%)
Family size	1	10	22.2
	2	9	20
	3	7	15.6
	4	5	11.1
	5	5	11.1
	6	8	17.8
	7 or more	1	2.2
Time living in the region	Up to 15 years	15	33.3
	16–30 years	11	24.4
	31–45 years	8	17.8
	46–60 years	4	8.9
	61–75 years	5	11.1
	76–90 years	2	4.5
Profession	Farmer	27	60
	Extractivist	10	22.2
	Bricklayer	1	2.2
	Gardener	1	2.2
	Farm manager	2	4.5
	Teacher	1	2.2
	Hotel receptionist	1	2.2
	Public agente	1	2.2
	Merchant	1	2.2
Data recorded between June 2016 and July 2017.			

A total of 67 species (34 families and 22 orders) of hunting importance were registered in the region of the PESCA, 41 of which were captured for consumption. The species accumulation curves demonstrate complete stabilization (Fig. 2), reaching the asymptote in approximately five interviews, indicating sampling efficiency in data collection. Besides the use of hunting for food (subsistence), there were reports of hunting for medicinal, religious-magical purposes, control hunting (or retaliation) and evidence of animal trade.

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.

Mammalia were the most representative taxon in relation to the number of species, followed by Birds, Reptilia and Amphibia. Eight orders of mammals were cited; Carnivora, Rodentia and Xenarthra had the highest numbers of species. Ten orders were identified for Birds; Psittacines were the most cited, followed by Craciforms and Tinamiformes. Reptiles were represented by three orders, Squamata being the taxon with most species. Only one species (*Leptodactylus* [Anura order]) was identified for the amphibians (Table 2).

Among the mammals, the lowland paca, *Cuniculus paca*, is the most captured species for food, followed by the collared peccary, *Pecari tajacu*, and the long-nosed armadillo, *Dasypus novemcinctus*. Among the birds, the little tinamou, *Crypturellus soui*, the solitary tinamou, *Tinamus solitarius*, and the rusty-margined guan, *Penelope supercilialis*, had the highest number of citations (Table 2). The tegus, *Salvator merianae*, and the pit viper, *Lachesis muta*, were the only species of reptile used for food. Among the amphibians, the frog, *Leptodactylus sp.*, was the only species used for food.

The five locations were dissimilar (Permanova $r^2 = 0.18$, $p = 0.04$) in relation to species composition captured for food (Fig. 3). Ten species were cited exclusively at one location; 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 lowland paca and the long-nosed armadillo were of common use in the diet at five locations.

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.

Some socio-demographic parameters are related to the number of species captured for food (Table 2). The age of hunters has a positive effect on the number of species hunted ($p = 0.02$, Table 2, Fig. 4), hunters of higher age range captured a greater number of species. However, the size of the family has a negative effect ($p = 0.01$, Table 3, Fig. 5), larger families capture fewer species. The average number of species hunted did not differ between locations (Deviance $_{4,40} = 71.53$, $p > 0.05$), but was significantly higher in CT (Deviance $_{1,43} = 56.433$, $p = 0.01$, Fig. 6). All 41 species used as a food resource were cited by CT hunters, while 29, 23, 21 and 20 species are, respectively, food sources for SG, NV, DT and AC hunters. The other socio-demographic parameters analyzed did not affect the number of species used for food ($p > 0.05$, Table 3).

Table 3

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*

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.

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.

The average of species hunted for food observed for the five localities (CS - Camboinha Settlement, NV - Nova Vida Settlement, CT - Comunidade 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 ($\pm$ se). Different letters above the columns represent statistically different means ($p < 0.05$).

The hunters mentioned four hunting strategies: hunting with a rifle; hunting with a dog; hunting with a trap; and hunting with bait. CT was the only location where 100% of the hunters used the four hunting strategies. Hunting with a rifle, the most common technique in the region, is used by 78% of the hunters; followed by hunting with a dog, traps, and bait, used by 60%, 47%, and 25% of the interviewees respectively. Mostly, the hunters use a combination of two or more hunting techniques such as hunting with a rifle accompanied by dogs.

According to the International Union for Conservation of Nature (IUCN), six species (four mammals and two species of bird) cited in this study are threatened of extinction. The otter, *Lontra longicaudis*, the maned sloth, *Bradypus torquatus*, and the coastal black-handed titi, *Callicebus melanochir*, are listed as vulnerable species; the solitary tinamou, *Tinamus solitarius*, and the capuchin monkey, *Sapajus*

xanthosternos, are categorized as endangered and the red-billed curassow, *Crax blumenbachii*, is listed as critically endangered. The red bracket deer, *Mazama Americana*, is a species listed as data deficient (DD).

Discussion

The fact that only one woman identifies as a hunter demonstrates that although the activity is not restricted to males in the region, it is traditionally practiced by men in the studied locations. Ribeiro and Schiavetti also recorded the presence of female hunters when researching the knowledge, beliefs, and use of mastofauna by residents of the PESC region [41]. Pereira and Schiavetti identified indigenous women practicing hunting to feed their families in the district of Olivença, Ilhéus, Bahia, Brazil (70 kilometers south of the studied area) [52]. Santos and other researchers also recorded female hunters in the municipality of Taperoá, in the state of Paraíba, Northeast Brazil [53].

The age range of the interviewees indicates that hunting is practiced by people of advanced age, which may be associated with local culture, where older people are hunters. The fact that the interviewed public conduct an activity aimed at the rural environment, such as farmers and extractivists, majority of the study participants, indicates that the practice of hunting is more common among people that are directly connected to the countryside. A similar pattern related to the low levels of education and profession was identified by Ribeiro and Schiavetti upon describing knowledge, beliefs, and use of mastofauna resources by residents of the PESC [41]. Castilho and collaborators found that rural residents in protected areas in the south of Bahia with low-level education present attitudes and motivations related to hunting for human consumption, besides identifying a relationship between primary-level education and hunting prevalence [8].

Hunted species play an important role in the supply of protein to local families. Other researchers in Brazil have also indicated this importance [16, 55, 54, 55]. The preference for mammals follows a similar pattern to diverse studies carried out in various neo-tropical biomes [4, 6, 9, 18, 56], in the state of Bahia [57, 58] and South Bahia [8, 41, 52].

Care should be taken regarding other purposes that the wild species perform in the region. These include the use of fauna in traditional medicine; control hunting and commercial hunting. Such purposes are characterized as other anthropogenic disturbances that act synergistically with the use of fauna for food. In the Atlantic Forest region of South Bahia, Pereira and Schiavetti described the use of 14 species as medicinal resources by indigenous hunters of Tupinambá in the district of Olivença (Ilhéus, Bahia, Brazil) [52]. In the PESC, Teixeira and collaborators reported the use of 23 species of wild animals in traditional medicine [15]. Regarding control hunting, Santos and others identified 45 species of wild animal involved in conflicting relationships with farmers in the Costa de Itacaré/Serra Grande Environmental Protection Area (Bahia, Brazil) [59]. No studies have been found in the region addressing commercial hunting, making such studies on the theme a necessity for the region. The multiple uses of wild animals, including medicinal and dietary, should be appropriately evaluated to understand the pressure the target species are placed under [60].

The higher consumption of mammals by hunters in the PESC region may be related to the greater supply of meat that these species provide. Mammals are historically the animals most affected by hunting, due to their medium size and abundant population [35, 61]. Mammals have greater body size and supply more meat for food [52]. However, despite the dietary significance of hunting for the rural population, the overexploitation of these species leads to serious consequences for the ecosystem [19, 20]. In tropical forests, the abundance of wildlife is directly correlated with hunting patterns more than with other factors such as type of forest, habitat size, or protected area status [21, 62]. Cassano and other researchers did not find any traces of lowland pacas, white-lipped peccaries or deer (*Mazama sp.*) in photographic traps in a study carried out in the cocoa region of South Bahia and suggested that hunting may have made these species uncommon in the region [63].

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 [64]. The structure and dynamic of tropical forests are compromised due to the scarcity or extinction of herbivores, carnivores, and frugivores [65, 66]. 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 [6, 63, 67–69].

The consumption of wild animals can also transmit infectious diseases to humans [70, 71]. It is estimated that 75% of infectious diseases are connected to animals [62, 71, 72]. Various wild animal organs and tissues are infected by *Salmonella*, which can cause chronic diarrhea and endotoxic shock [60]. Armadillo species of the *Dasypus* genre are a natural reservoir of zoonoses, such as trichinosis, coccidioidomycosis, Chagas disease, and typhoid fever, which can also affect human beings who consume these species [73]. The bacteria, *Mycobacterium leprae*, which causes leprosy (Hansen's disease), can be transmitted from armadillos to humans through the consumption of their meat [74]. Costa and collaborators detailed a fatal case of an armadillo hunter infected with the pulmonary disease, coccidioidomycosis, in the state of Ceará, North-East Brazil [75]. Eulálio and others discovered that three in every 26 armadillos (*D. novemcinctus*) captured in the state of Piauí, Brazil, were infected with *Coccidioides immitis* [76].

Regarding food preference, the lowland paca, the long-nosed armadillo, and the collared peccary are the most used species in local consumption. Other studies carried out in Bahia [77], in South Bahia [8, 52], and in Brazil also indicate the lowland paca and armadillo species as the most consumed species and the most appreciated meats [19, 20]. Historical studies indicate that the lowland paca has suffered from hunting since the olden days [78, 79–81], hunted in various regions of Brazil [5, 82, 83] and indicated as the vertebrate species the most preferred mammal for hunting within the national territory [19, 84].

The long-nosed armadillo, *Dasypus novemcinctus*, is valued in the region for its flavor and its ease of capture in comparison to other prey. Slaughter of the *Dasypus* genre has been recorded in various places in Brazil [52, 85, 86]. According to the hunters, the collared peccary, *Pecari tajacu*, is found throughout the region, making it easy to capture. The collared peccary has a gregarious habitat, also making it easier to

capture and even kill more than one at a time [87]. For Freitas and others, *Pecari 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 [82]. In the same study region, Santos and collaborators 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 [59].

The tegu, *Salvator merianae*, identified as the lizard of greatest dietary importance in the region of the PESCS, was also considered by Alves and others as the reptile of greatest hunting importance in a study carried out in two municipalities in Paraíba, Brazil [57]. Teixeira and other researchers indicated the tegus as the reptile most used for zootherapy in the region of the PESCS [15]. Fitzgerald states that lizards of this genus are also commonly hunted in Argentina, Paraguay, and parts of Bolivia [88].

The number of species captured at the five locations may be related to the frequency of occurrence and the abundance of species in each location. The hunting pattern of vertebrates for food can be influenced by availability and abundance of species in the region [18, 89]. Comunidade Tesouras is within an integral protection CU, 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 PESCS (SNUC - LAW 9.985/2000)[90].

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 [91, 92]. The traditional customs and the hunter's experience with capture methods affects the choice of hunting technique [91]. The variety of hunting strategies reflects the necessity to access the abundance of hunted animals living in different habitats [18, 30, 93]. 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 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 [56, 57, 94]. The fact that endangered species are used as food source by hunters in the PESCS 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 [12]. However, contest that this reduction is not viable in many areas due to the socio-economic problems and the strong influence of cultural factors [28, 30].

Conclusions

Our results demonstrate that illegal hunting is a practice that still occurs in the region of the Serra do Conduru State Park. A significant proportion of wild species from the Atlantic Forest, especially mammals, is exploited as a protein source, which, according to the hunters, is the main reason for hunting in the region. However, it should be highlighted that the slaughter of wild animals is not limited exclusively to the need for subsistence, since records confirm the use of fauna for medicinal purposes, religious-magical purposes, control hunting, and illegal commerce.

The need for measures aimed at conservation of hunted species is reinforced, especially for those found under some degree of threat. 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. Moreover, studies aimed at the illegal trade of wild animals are also recommended, since local species are targets of buying and selling in the region. 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.

Abbreviations

ANOVA: Understanding Analysis of Variance; APA:Environmental Protection Area; CEP:Ethics Committee for Research with Human Beings; CR:Critically Endangered; CS:Camboinha Settlement; CT:Community of Tesouras; DD:Data Deficient; DT:District of Taboquinhas;EN:Endangered; GLM:Generalized Linear Models; MMA:Ministry for the Environment;IUCN:International Union for Conservation of Nature;LC:Least Concern; NE:Not Evaluated; NMDS:Non-Metric Multidimensional Scaling; NT:Near Threatened; NV:Nova Vida Settlement; PERMANOVA:Permutation Multivariate Analyses of Variance; PESC:Serra do Conduru State Park; UC:Conservation Unit; SEMA:Environment Secretary; SG:District of Serra Grande; TCLE:Consent Form; UESC:State University of Santa Cruz; VU:Vulnerable.

Declarations

Ethics approval and consent to participate

This work follow the 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) (Caae 61683516.2.0000.5526).

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

Please contact author for data requests.

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Authors' contributions

JVST – Data collect and writing of the manuscript. JSS and DHAG – Data collect. Joanna Sosnowska and Henrik. WDR – Data analysis. AS - Final revision of the manuscript. The authors read and approved the final.

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Figures

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).

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.

Figure 4

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.

Figure 5

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 6

The average of species hunted for food observed for the five localities (CS - Camboinha Settlement, NV - Nova Vida Settlement, CT - Comunidade 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 ($\pm$ se). Different letters above the columns represent statistically different means ($p < 0.05$).

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