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Hunting strategies used in protected areas in the atlantic rainforest of northeastern Brazil

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The significance of faunal resources and their utilization potentials for the benefit of mankind is well known, and constitute important natural resources in local communities in the Atlantic forests of region Northeastern Brazil, including in their protected areas. In order to gain access to these resources, hunters have developed a series of techniques and strategies that are described in the present work from interviews with 109 hunters in 4 official conservation units. Fifteen different techniques for the hunting and capture of wild animals have been registered, divided into 3 categories: Trapping (n=27,9%), active search (n=31%) and passive waiting (n=41,1%). All the techniques listed under the active search and passive waiting categories are complemented by the use of firearms. The environmental and administrative characteristics of the studied areas and the socioeconomic profile of the hunters interviewed, influenced the differences in the techniques and hunting strategies. Additional studies concerning these hunting activities will be useful to contribute to proposals for oversight and management plans for hunting in the region, with the objective of attaining sustainable use of faunal resources to the local human communities.

Keywords: Atlantic forest, Hunting techniques, Protection areas, Wildlife conservation
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The adoption of hunting strategies for the use of animals and their by-products is one of the oldest ways of interaction between humans and the biodiversity of the planet[1] and has been utilized since time immemorial, and has been disseminated among the most diverse human populations throughout history[2]. Nowadays, varied human cultures make use of wild animals and their by-products to serve many purposes, from food, trade, to magical-religious, medicinal and cultural purposes[3–8], which stimulate the continuity of hunting practices[9–12].

In Brazil, despite of its biodiversity and ample cultural variety, the factors that are associated with the preservation of the different forms of using the fauna by diverse human populations, there are few studies on hunting[13–16], a large part of them are restricted to the Amazon and Atlantic forests[17,18,19] and, most recently to the Caatinga[8,11,12,20].

Despite of some studies have been carried out on the atlantic forest of northeastern Brazil[21], there are no published papers about hunting practices and techniques in conservation units (CUs) from this biome in the state of Paraíba, even when the atlantic forest is considered a biodiversity hotspot[22], besides being the most anthropized and populated natural landscape of the country[23], owner of a significant number of endangered animal species[24,25].

Efficient strategies to the conservation of fauna in CUs from the atlantic forest need to take into consideration the human presence and its ways of interaction with animals[26]. To understand the multidimensional context of hunting is fundamental to indicate efficient strategies of conservation[27,28], especially in the atlantic forest.

This study describes the techniques utilized for the hunting of wild animals in CUs of the atlantic forest in the state of Paraíba, Northeast Brazil, as well as their relations with the socio-economic aspects of the hunters. It is expected that the results can be useful in the formulation of management strategies and law enforcement plans, aiming at the conservation of biodiversity in these areas.

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Materials and methods

Area of study

The present study was carried out in 4 atlantic forest CUs and their surroundings in the state of Paraíba (National Restinga Forest of Cabedelo, municipality of Cabedelo - A1; Benjamim Maranhão Botanical Garden, municipality of João Pessoa - A2; Engenho Gargaú Private Natural Heritage Reserve, municipality of Santa Rita- A3; and Guaribas Biological Reserve -, municipality of Mamanguape A4), Brazil. These CUs are distributed over remaining forest fragments of different sizes to the east of the state, in the Intermediate Geographic Region of João Pessoa, which is the most populated region of João Pessoa (Fig. 1).

The vegetation is predominantly sub evergreen forest, with parts of semi-deciduous forest and savannah forest. The native vegetation of the atlantic forest is currently scarce, it has been replaced mainly by the sugarcane monoculture[21,29].

Procedures and data analysis

The research was conducted in the period between May of 2015 to June of 2018. Information about the hunting techniques was collected through semi-structured questionnaires, supplemented by free interviews and casual conversations[30]. The questionnaires contained questions about the types of hunting and capture strategies used for the cynegetic fauna of the region. All the interviewees were informed about the research purpose and officially consented to participate in the research study. This research study was approved by the research ethics Committee from the Federal University of Campina Grande (Protocol 23096.013946/17-00).

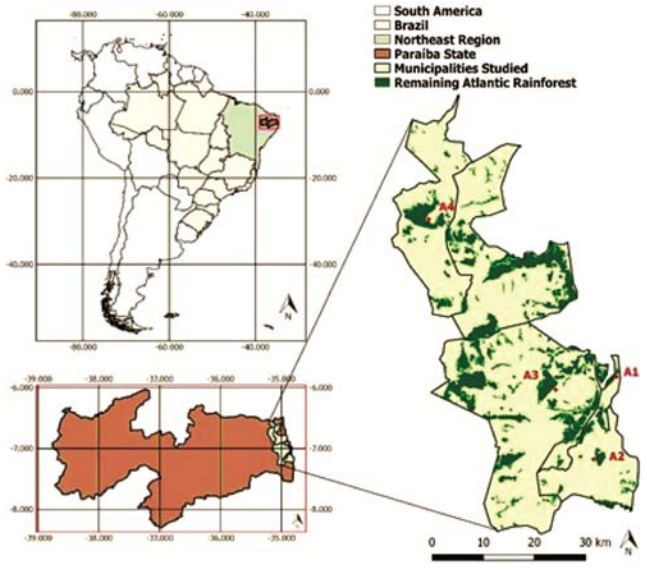

Fig. 1 — Area of study with points indicating the Conservation Units Caption: A1-National Restinga Forest of Cabedelo; A2-Benjamim Maranhão Botanical Garden; A3-Engenho Gargaú Private Natural Heritage Reserve; A4-Guaribas Biological Reserve.

One hundred and nine hunters were interviewed, all males aged between 18 and 82 (average age of 46, 7 years). Their socio-economic data is summarized on Table 1. Amongst the hunters, the most experienced hunters were chosen, based on the "native specialist" criteria, self-acknowledged or recognized by the community as culturally competent[31]. These informants, whenever possible, were monitored during simulated hunting activities.

The hunted species were identified by following: 1) analysis of the animals or body parts donated by the interviewees (with the approval of the Biodiversity Authorization and Information System – SISBio - Protocol 58.124); 2) analysis of pictures of the animals, which were taken during the interviews or while monitoring the interviewee´s activities and 3) by their common names, along with the help of taxonomists familiarized with the studied fauna.

To verify if there is a significant correlation between the number of hunting and capture techniques

Table 1 — Summary on the socioeconomic variables of the interviewees

	N	%
Gender		
Male	109	100
Ages		
18 – 25 years old	12	11
26 – 45 years old	37	33,9
46 – 60 years old	32	29,4
Over 60 years old	28	25,7
Civil Status		
Unmarried	14	12,8
Stable union	23	21,1
Married	66	60,6
Divorced	2	1,8
Widower	4	3,7
Scholarity		
Incomplete elementary school	52	47,7
Complete primary education	34	31,2
Incomplete high school	6	5,5
Complete high school	17	15,6
Monthly income		
Around US$ 130,00	7	6,4
Around US$ 260,00	59	54,1
Around US$ 380,00	36	33
Around US$ 510,00	5	4,6
Around US$ 760,00	2	1,8

mentioned by the hunters and I) the number of species directly pursued, II) the size of preserved forest fragments, III) the extent of anthropization of the surrounding matrix in UCs, IV) the socioeconomic variables of the hunters (average monthly income, age and education), the collected data was analyzed through a Generalized linear model – GLM[32], assuming the Poisson distribution or the exponential.

To quantify the preference and the frequency of hunting techniques use in the sampled areas, Turner´s Cultural Significance Index[33] has been used, with adapted scores:

$$ISC = \sum q.\ FC$$

Where: "q" is the frequency of use, which degrees are based on categories indicated by the interviewees, prevailing the most mentioned category (techniques used only in the past (q=0,5); techniques of "infrequent use" (q=1); techniques of "moderately infrequent use" (q=2); techniques of "frequent use" (q=3); techniques of "very frequent use" (q=4)); "CF" – Correction Factor – is given by the quotient between the number of interviewees that mentioned the technique and the number of interviewees that mentioned the most reported technique.

Results and discussion

The hunting and capture of wild animals in areas of the atlantic forest in Brazil is recorded since the colonial period[34], representing one of the most employed forms of traditional management of fauna. Although the present research has been conducted in CUs, a total of 156 hunted or captured species were registered in the region, especially the *Hydrochoerus hydrochaeris*, *Cuniculus paca*, *Dasypus novemcinctus*, *Euphractus sexcinctus* and *Dasyprocta iacki* (n=109 mentions), *Salvator merianae* and *Bothrops leucurus* (n=103), *Micrurus ibiboboca* (n=101), *Crotalus durissus* (n=97), *Penelope superciliaris* (n=94), *Iguana iguana* (n=91), *Crypturellus noctivagus* and *Nothura maculosa* (n=82).

Most part of the registered species had already been listed as hunted in the northeastern region of Brazil[8,11,12,20,35-45], a fact the highlights the dissemination of this practice and demonstrates the inefficiency of conservation policies aimed at the protection of local wild fauna, even in areas of total protection, as some of the CUs researched here.

It was observed that in the researched area, the hunting and capture of wild animals is associated with five main motivating factors: Food (n=31, 2% of mentions); Raising (n=25, 7%); Trade (n=20, 7%); Wildlife management (n=16, 4%); and Medicinal use (n=6%). The hunting strategies and their ways of management are passed down through generations by oral tradition.

All these motivations had already been registered in other research papers about hunting in Brazil[12,20,46], in other countries in America[47–51], and in other parts of the world[52–55] and the use of oral tradition as its main vehicle to socio-cultural dissemination in the Northeast region of Brazil was already known[26,56].

Fifteen different techniques for the hunting and capture of wild animals have been registered, divided into three categories: Trapping (n=27, 9%), Active Search (n=31%) and Passive Waiting (n=41, 1%), all the techniques listed under the Active search and Passive waiting categories are complemented by the use of firearms.

The use of firearms as a hunting strategy is widespread in the whole world[46,53,57–60], acting as a way of supplementing the employed techniques, as well as being a form of protection in the mindset of some hunters[20], who carry them in the forest, even when they look for the capture of live animals[12].

The regression (GLM – Fig. 2) has demonstrated that there is a significant correlation between the number of hunting and capture techniques mentioned by the hunters and the number of directly chased species ($E_{(log)}$=0,1169; Z=16,28; Pr(>|z|)=<2e-16). This fact was expected, since the greater the local exploited richness, the more complex the set of tools and exploitation strategies on the part of the users needs to be[61]. Besides that, the co-evolution of the technologies and hunting strategies is an important part of the process of adaptation of the hunters to the inherences and variations in the availability of the local faunistic resources[62], which in the Atlantic Forest are extremely diverse.

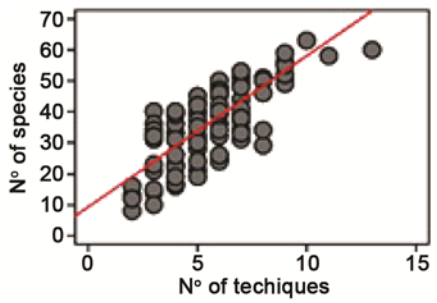

Fig. 2 — Relation between the number of mentioned hunting and capture techniques and the numbers of species chased by the hunters

Considering that the size of the preserved forest fragments, as well as the level of anthropization in the buffer zones (the surrounding matrix) exerts an influence that is directly linked to the composition of species present in a region[63], additional statistical analyses were done. The regression (GLM–Fig. 3A) showed a significant correlation between the number of techniques utilized and the size (in hectares) of the hunting areas, with a tendency to increase the number of techniques as the areas enlarge ($E_{(log)}$=0,00012; Z=52,52; Pr(>|z|)=0,0000001). The linear model of the relation between the number of mentioned techniques and the extent of anthropization in the buffer zones (GLM–Fig. 3B) demonstrated that there is an effect of this anthropization on the number of mentioned techniques (GLM: df= 3; F= 11.288; Pr<0,01), with an increase in the average number of mentions of techniques as the anthropization diminished.

Among the studied CUs, the ones with a wider area and the least anthropization of the surrounding matrix were the ones that presented a greater variety in the use of techniques and strategies in the exploration of wild fauna. This fact entirely contradicts what is expected from protected areas[64], which in this scenario should protect the biodiversity from the effects of anthropization[65]. Even more concerning is that these results could reflect, by inference, the facility for accessing the animals[66–68], revealing the flaws and limitations of law enforcement and determent of hunting practices, even in protected areas[69–71].

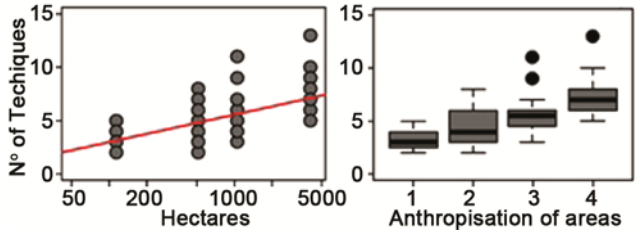

Fig. 3 Relation between the number of mentioned hunting and capture techniques to the size of fragments (A-left) and the level of anthropization around them (B–right). Caption: Anthropization of areas – 1-National Restinga Forest of Cabedelo; 2-Benjamim Maranhão Botanical Garden; 3–Engenho Gargaú Private Natural Heritage Reserve; 4-Guaribas Biological Reserve.

Our results suggest that there is a minimum effect of the interviewee´s income on the number of used hunting techniques (Fig. 4A), as the regression shows (GLM) ($E_{(log)}$=–0,1648; Z=–0,748; Pr(>|z|)=0,455). However, it was perceived that the interviewees with a lower average monthly income would rather use the Passive Waiting techniques, since they are less costly and take advantage of the resources readily available in the environment, while the ones with a higher average monthly income use hunting tools that are more expensive and prefer Active Search and the use of traps.

The average income of the hunters certainly exerts a direct influence over how they perform their activity[72]. Moreover, it is considered that, more and more, different hunting motivations that are not only of subsistence, push the increase of cynegetic technologies[60,73,74], sometimes elevating their costs, in exchange for a higher return, even financially for the hunters[46,75–80].

As to the relation between the interviewees' age and the number of mentioned hunting techniques, however, the results of the regression demonstrated that there is a significant dependency ($E_{(log)}$=0,013; Z=4,848; Pr(>|z|)=1.24e-06), with a strong tendency of older interviewees mentioning a larger number of cynegetic strategies (Fig. 4B).

The positive correlation between the interviewees' age and the number of mentioned hunting techniques results from the strong historical and oral tradition which the hunting strategies are passed on among its practitioners, which, naturally, have accumulated experiences throughout their lives, passing them on to the younger ones. Since historically the orality has been the great responsible for the sharing of traditional

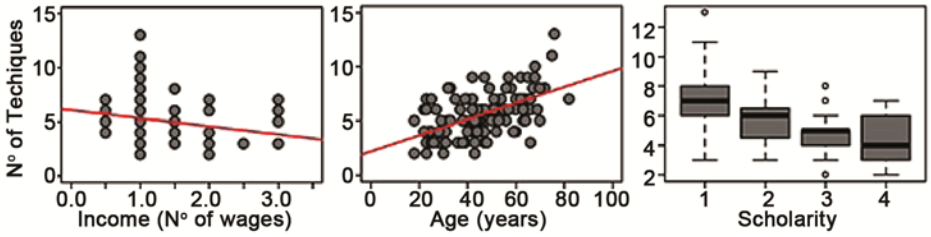

Fig. 4 — Relation between the number of hunting and capture techniques mentioned with the average income of the interviewees (A – left), their age (B – center) and their education level (C – right). Caption: Schooling – 1 - Incomplete graded school; 2 - Complete graded school; 3 - Incomplete high school; 4 - Complete high school.

knowledge about the environment, this knowledge has accumulated and, apparently, has shaped the practices of traditional management of the wild fauna in the region[56].

The linear model of the relation between the number of the hunting strategies that were mentioned and the education level of the interviewees (Fig. 4C) revealed that there is an effect of the level of education on the number of mentioned techniques (GLM: Df=3; F= 8,2163; Pr<0,01), with a reduction in the average number of mentions of hunting procedures as the education level increased.

Concerning the existing negative correlation between the increase in education level of the interviewees and the number of mentioned cynegetic techniques, suggests that there is an influence of an effect tied to the age, once that the interviewees with a higher education level are generally the younger ones. It must not be ignored, however, that good educational policies present a determinant potential in the awareness of the necessity of faunistic conservation, displaying an undeniable efficiency when implemented as a fulcrum of conservation actions[70,71,81].

The interviewees related to use different techniques (Fig. 5) depending on the targeted animal. The hunting and capture techniques named by the interviewees and the Cultural Significance Index (CSI) of each one of the strategies listed are included in Table 2.

The traps stood out when the objective was to capture the animals alive, mostly songbirds, raised or commercialized as pets in the region. The most utilized trapping technique was the "alçapão" (CSI=3,26) which consists of a small cage with an articulated top and with baits (Fig. 5B) and placed together or next to cages containing male birds that act luring with their singing other birds that the hunter wants to capture.

The wide use of traps had already been registered as a hunting strategy in northeastern Brazil[20] and in other regions of the country[57,82,83] and in the world[60,84]. In some cases, the employed techniques were very similar to the ones utilized by the hunters in the present study[11]. Bezerra[85] emphasizes that the use of selective capture techniques of male birds, as the alçapão, can seriously affect the reproductive dynamics of local bird populations, which many times adopt monogamous behavior[36,37]. Its recurrence inside the studied Conservation Units certainly contrasts with the conservation efforts of the CUs and contradicts their aims concerning the maintenance of the species richness.

To meet the demand for food, the techniques of Active Search, with the help of hunting dogs (CSI=2,52) and imitation whistles (CSI=2,95) stood out; and Passive Waiting, with the use of camouflage and ambush (CSI=4,00) were prominent.

The hunting aided by dogs is generally practiced at night, usual in trails through dense forest and targeting mammals of small and medium sizes, as *C. paca*, *D. iacki*, *D. novemcinctus* and *E. sexcinctus*. The

Fig. 5 — Hunting techniques used by the interviewees in the studied Conservation Units. Caption: A – Imitation whistles; B – Alçapão; C – Arapuca; D – Curral de Ceva; E – Fojo; F – Girau; G – Waiting ; H – Hunting dog; I – Loop.

Table 2 — categories of hunting and capture techniques named by the interviewees and Cultural Significance Index. Caption: "q" – Use frequency; CF – Correction Factor; CSI – Cultural Significance Index.

Categories and Techniques	Citations	%	"q"	CF	CSI
Traps	172	27,9			
Cages with pivoted tops (Alçapão)	84	13,6	4	0,82	3,26
Wooden cages with bait (Arapuca)	35	5,7	2	0,24	0,68
Ground traps with pivoted tops (Fojo)	15	2,4	1	0,15	0,15
Nooses	11	1,8	3	0,11	0,32
Fishing hooks	9	1,5	2	0,09	0,17
Armadillo cages (Jequi)	9	1,5	1	0,09	0,09
Cages for carnivorous	5	0,8	1	0,05	0,05
Glue-trap (Visgo)	4	0,6	1	0,04	0,04
Active Search	191	31,0			
Imitation (Arremedo)	76	12,3	4	0,74	2,95
Hunting with dogs	65	10,6	4	0,63	2,52
Bird obfuscate (Facheado)	43	7,0	3	0,42	1,25
Excavation	7	1,1	3	0,07	0,20
Passive wait	253	41,1			
Waiting/ Ambush (Espera)	103	16,7	4	1,00	4,00
Waiting/ Ambush with bait	92	14,9	4	0,89	3,57
Raised platform for ambush (Girau)	58	9,4	4	0,56	2,25

hunters follow the dogs that sniff seeking the preys until they trap them, usually in dens. In some cases these animals are captured after digging (CSI=0,20) their hiding places.

The cost of a hunting dog can be over US$ 300. Its training, care and transport also require a reasonable financial cost from the hunters. This lead us to believe that this technique is not viable when the motivation for hunting is subsistence, it is more logical to infer that, based on the accounts of the interviewees, that this motivation is actually the leisure derived from hunting and the preference for the taste of meats from wild animals.

In an ample study on hunting strategies and techniques employed in semi-arid areas of northeastern Brazil, Alves *et al*.[20] registered the local practice of hunting dog trade. The present study has also registered a similar fact, with a report on the existence of illegal kennels, dedicated to captive breeding, training and the commercialization of hunting dogs in the area covered by the research, which also configures as an environmental crime[86,87].

The technique of waiting and ambush (CSI=4,00) basically consists of constructing hidden shelters inside the forest, next to areas of foraging or nests of the species targeted by the hunter, who stays there sheltered and, with the help of firearms slaughter the animals. This technique can be supplemented with baits (CSI=3,57). The baits are locally called "cevas". The most used by the interviewed hunters harness the oil palm fruit (*Elaeis guineensis* Jacq.) or a salty, moistened and fermented preparation from the cassava root (*Manihot esculenta* Crantz) that releases a very strong and attractive odour, especially to mammals as *C. paca* and *D. iacki*. The use of baits, according to the interviewees, increases the quantity and the diversity of attracted species and susceptible to be hunted.

According to the hunters, when the targeted animal has a keen sense of smell or hearing, it is preferable to build the shelters on the top of the trees (CSI=2,25), in a technique known as "girau", so the animals do not notice the presence of the hunters in the forest.

The prevalence of use of passive waiting techniques, according to the majority of the interviewees, is explained by the sense of security and impunity from the hunters, once that these hiding places in the forest are difficult to be identified, even by federal and regional institutions responsible for the enforcement and determent of environmental crimes in the researched Conservation Units, that present a reduced number of employees and are, in line with a Brazilian tendency, structurally and logistically precarious[88,89].

Another justification for the use of passive hunting strategies was the attempt to minimize the conflicts with the management of the researched Conservation Units, due to the exploitation of their natural resources. It is recurring in Brazil that inhabitants from the countryside and the surroundings of environmental

preservation areas tend to mask their daily practices of local usufruct seeking to minimize barriers related to the environmental legislation[90,91].

According to the account of the interviewees, it can be noticed that the hunters show a precise knowledge about the ecology of the animals that are hunted, and that this knowledge orientates the choice of different strategies and places and time periods which will be utilized, increasing the chances of a successful hunt and causing the same animal to be killed or capture with the use of different techniques.

On the one hand, this local ecological knowledge, resulting from a strategic empiric adaptation of the hunter, represents a fundamental condition for the success of cynegetic practices[92–96], on the other hand, this knowledge could be a strategic and efficient conservation tool if taken into account in the establishment and wildlife management plans in Conservation Units[26,97].

Conclusion

The present study has demonstrated that the ample and disseminated use of different techniques and hunting strategies in the researched Conservation Units is still a recurring practice, as in many other regions of the country, which demonstrates that the currently adopted conservation strategies to the models of CUs here studied have not been effective in deterring hunting, requiring them to be reconsidered.

The local ecological knowledge of the interviewed hunters has demonstrated to be very broad, enabling multiple hunting strategies to be shaped according to the different nuances offered by the environment, occasion and the condition of the hunters. In this regard, this knowledge could be an excellent tool for wildlife management, if considered by the competent authorities.

The socioeconomic variables certainly shaped the use of hunting strategies in the researched CUs, being fostered by cultural traditions and, mainly, by the precarious law enforcement. By contrast, it is very difficult to impose conservation policies in areas where the wild fauna has historically been considered as an essential natural resource as it happens in the area of this study, which explains the apparent failure to comply with the conservation objectives set by the CUs.

Therefore, it is suggested that, to minimize the contrasting ethical conflicts between the conservation of wildlife and human necessities (use and wildlife management), that the establishment, the enforcement, the standardization and the modernization of these conservation policies considerer the social and cultural aspects of human populations, as well as being supported by the development of strategies of environmental education. It is believed that by achieving these goals, the anthropogenic impacts on overexploited species will be minimized.

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References

1 Holland K, Medicine from animals: from mysticism to science, *Pharmaceutical Historian*, 24 (3) (1994) 9-12.
2 Pontting, C, *Uma História Verde do Mundo*, (Civilização Brasileira, Rio de Janeiro), 1995.
3 Bennett EL & Robinson JG, Hunting for Sustainability: The start of a synthesis. In Hunting for sustainability in Tropical Forests, In: *Biology and Resource Series*, edited by Robinson JG & Bennett EL (Columbia University Press, New York), 1999, 499-519.
4 Naranjo EJ, Guerra MM, Bodmer RE & Bolanos JE, Subsistence hunting by three ethnic groups of the Lacondon Forest, Mexico, *Journal of Ethnobiology*, 24 (2004) 384-395.
5 Alves RRN & Rosa IL, From cnidarians to mammals: The use of animals as remedies in fishing communities in NE Brazil, *Journal of Ethnopharmacology*, 107 (2006) 259-276.
6 Barbosa JAA & Aguiar JO, Utilização místico-tradicional da fauna no semiárido paraibano. *Revista Polêm!ca*. 11 (4) (2012) 642-649.
7 Barbosa JAA, Nobrega VA & Alves RRN, Aspectos da caça e comércio ilegal da avifauna silvestre por populações tradicionais do semi-árido paraibano, *Revista de Biologia e Ciências da Terra*, 10 (2) (2010) 39-49.
8 Barbosa JAA, Aguiar JO & Alves RRN, Medicinal use of animals by hunters in North eastern Brazil, *Indian Journal of Traditional Knowledge*, 17 (3) (2018) 485-493.
9 Ayres JM & Ayres C, Aspectos da caça no alto Rio Aripuanã, *Acta Amazonica*, 9 (1979) 287-298.
10 10Leeuwenberg FJ & Robinson JG, Traditional Management of Hunting by a Xavante Community in Central Brazil: The Search for Sustainability. In: *Biology and Resource Series*, edited by Robinson JG & Bennett EL (Columbia University Press, New York), 1999, 375-394.
11 Barbosa JAA, Nobrega VA & Alves RRN, Hunting practices in the semiarid region of Brazil, *Indian Journal of Traditional Knowledge*, 10 (3) (2011) 486-490.
12 Barbosa JAA & Aguiar JO, Conhecimentos e usos da fauna por caçadores no semiárido brasileiro: um estudo de caso no estado da Paraíba, Nordeste do Brasil, *Biotemas*, 28 (2) (2015) 137-148.
13 Martins ES, *A caça de subsistência de extrativistas na Amazônia: sustentabilidade, biodiversidade e extinção de espécies* (M.Sc. Biology Dissertation/ Universidade de Brasília, Brasília), 1993.

14 Calouro AM, *Caça de subsistência: sustentabilidade e padrões de uso entre seringueiros ribeirinhos e não ribeirinhos do Estado do Acre* (M.Sc. Biology Dissertation/ Universidade de Brasília, Brasília), 1995.

15 Emídio-Silva C, *A caça de subsistência praticada pelos índios Parakanã (sudeste do Pará): características e sustentabilidade* (M.Sc. Biology Dissertation/ Museu Paraense Emílio Goeldi & Empresa Brasileira de Pesquisa Agropecuária, Belém), 1998.

16 Barbosa JAA, *A caça e o uso da fauna no agreste: um estudo etnobiológico a partir da memória dos caçadores do município de Queimadas (1940-2012)* (M.Sc. Natural resourcesDissertation/ Universidade Federal de Campina Grande, Campina Grande), 2013.

17 Medeiros MFST, *A Caça de Subsistência na Reserva Extrativista Alto Juruá/AC: Caracterização, consumo e estratégias de caça* (M.Sc. Zoology Dissertation/ Universidade Federal da Paraíba, João Pessoa), 2001.

18 Pianca CC, *A caça e seus efeitos sobre a ocorrência de mamíferos de médio e grande porte em áreas protegidas na Mata Atlântica na Serra de Paranapiacaba* (M.Sc. Biology Dissertation/ Universidade de São Paulo, São Paulo), 2004.

19 Trinca CT & Ferrari SF, Caça em assentamento rural na amazôniamatogrossense. In: *Diálogos em ambiente e sociedade no Brasil*, editedby: Jacobi P & Ferreira LC (ANPPAS/Annablume, Indaiatuba), 2006, 155-167.

20 Alves RRN, Mendonça LET, Confessor MVA, Vieira WLS & Lopez LCS, Hunting strategies used in the semi-arid region of northeastern Brazil, *Journal of Ethnobiology and Ethnomedicine*, 5 (12) (2009a) 1-16.

21 Souza JB & Alves RRN, Hunting and wildlife use in an Atlantic Forest remnant of northeastern Brazil, *Tropical Conservation Science*, 7 (1) (2014) 145-160.

22 SOS Mata Atlântica A Mata Atlântica, (*https://www.sosma.org.br/nossa-causa/a-mata-atlantica*), 2019.

23 23Ribeiro MC, The Brazilian Atlantic Forest: How much is left, and how is the remaining forest distributed? Implications for conservation, *Biologicalconservation*, 142 (6) (2009) 1141-1153.

24 Machado ABM, Drummond GM & Paglia AP, *Livro Vermelho da fauna brasileira ameaçada de extinção - Volume 2,* (Fundação Biodiversitas, Belo Horizonte) 2008.

25 IUCN Red List of Threatened Species, (*http://www.iucnredlist.org/#nogo1*), 2018.

26 Barbosa JAA & Aguiar JO, Etnoconservação e história ambiental para um novo modelo conservacionista do século XXI, *Novos Cadernos NAEA*, 21 (1) (2018) 243-255.

27 Alves RRN & Rosa IL, Zootherapeutic practices among fishing communities in North and Northeast Brazil: A comparison, *Journal of Ethnopharmacology*, 111 (2007) 82-103.

28 Rocha MSP, Mourão JS, Souto MSW, Barboza RRD & Alves RRN, O Uso dos Recursos Pesqueiros no Estuário do Rio Mamanguape, Estado da Paraíba, Brasil, *Interciencia*, 33 (2008) 903-909.

29 Andrade JR & Santos SC, Estudo sobre o desmatamento da mata atlântica na Paraíba, *REBES*, 4 (2) (2014) 24-33.

30 Huntington HP, Using Traditional ecological knowledge in science: Methods and applications, *Ecological Applications*, 10 (5) (2000) 1270-1274.

31 Hays TE, An Empirical Method for the Identification of Covert Categories in Ethnobiology, *American Ethnologist*, 3 (3) (1976) 489-507.

32 Nelder JA & Wedderburn RWM, Generalized Linear Models, *Journal of the Royal Statistical Society – A*, 135 (3) (1972) 370-384.

33 Turner N J, "The importance of a rose", evaluating the cultural significance of plants in Thompson and Liloet Interior Salish, *American anthropogist*, 90 (2) (1988) 272-290.

34 Dean W, *A ferro e fogo: história e devastação da Mata Atlântica brasileira*, (Companhia das Letras, São Paulo), 1996.

35 Bezerra DMM, Araújo HFP & Alves RRN, The use of wild birds by rural communities in the semi-arid region of Rio Grande do Norte State, Brazil. Bioremediation, *BiodoversityandBioavalability*, 5 (2011) 117-120.

36 Bezerra DMM, Araújo HFP & Alves RRN, Captura de aves silvestres no semiárido brasileiro: técnicas cinegéticas e implicações para a conservação, *Tropical Conservation Science*, 5 (2012) 50-66.

37 Bezerra DMM, Araújo HFP, Alves AGC & Alves RRN, Birds and people in semiarid northeartern Brazil: symbolic and medicinal relationships, *Journal of Ethnobiology and Ethnomedicine*, 9 (2013) 1-11.

38 Souto WMS, Mourão JS, Barboza RRD & Alves RRN, Parallels between zootherapeutic practices in Ethnoveterinary and Human Complementary Medicine in NE Brazil, *Journal of Ethnopharmacology*, 134 (2011) 753-767.

39 Pereira JPR & Schiavetti A. Conhecimentos e usos da fauna cinegética pelos caçadores indígenas "Tupinambá de Olivença" (Bahia), *Biota Neotropica*, 10 (1) (2010) 175-183.

40 Alves RRN, Oliveira MGG, Barboza RRD, Singh R &Lopez LCS, Medicinal Animals as therapeutic alternative in a semi-arid region of Northeastern Brazil, *Forsch Komplementmed / Research in Complementary Medicine*, 16 (2009b) 305-312.

41 Alves RRN, Nougueira EEG, Araújo HFP & Brooks SE, Birdkeeping in the Caatinga, NE Brasil, *Human Ecology*, 38 (2010a) 147-156.

42 Alves RRN, Oliveira MGG, Barboza RRD & Lopez LCS, An ethnozoological survey of medicinal animals commercialized in the markets of Campina Grande, NE Brazil, *Human Ecology Review*, 17 (1) (2010b) 11-17.

43 Alves RRN, Barbosa JAA, Santos SLDX, Souto WMS & Barboza RRD, Animal-Based Remedies as Complementary Medicines in the Semi-Arid Region of Northeastern Brazil, *Evidence-Based Complementary and Alternative Medicine*, (2011) 1-15.

44 Ferreira FS, Brito SV, Ribeiro SC, Almeida WO & Alves, R. R. N. Zootherapeutics utilized by residents of the community Poço Dantas, Crato-CE, Brazil, *Journal of Ethnobiology and Ethnomedicine*, 5 (2009a) 1-10.

45 Ferreira, FS, Brito SV, Ribeiro SC, Saraiva AAF, Almeida WO & Alves RRN, Animal-based folk remedies sold in public markets in Crato and Juazeiro do Norte, Ceará, *Brazil, Evidence-Based Complementary and Alternative Medicine*, 9 (2009b) 1-8.

46 Fernandes-Ferreira H, *A caça no Brasil – Panorama histórico e atual* (Ph.D. Zoology Thesis/ Universidade Federal da Paraíba, João Pessoa), 2014.

47 Espinosa S & Salvador J, Hunters' Landscape accessibility and daily activity of ungulates in the Yasuní Biosphere Reserve, Ecuador, *Therya*, 8 (1) (2017) 1-8.

48 Medina-Torres S, Cortés-Gregorio I, Lara-Ponce E & Sandoval-Forero EA, Use of wild mammals among Yoremes and Yoris from El Fuerte, Sinaloa, México, *Agricultura, Sociedad Y Desarrollo*, 13 (4) (2016) 529-545.

49 Parra-Colorado JW, Botero-Botero A & Saavedra-Rodríguez CA, Percepción y uso de mamíferos silvestres por comunidades campesinas andinas de Génova, Quindío, Colombia, *Bol. Cient. Mus. Hist. Nat. U. de Caldas*, 18 (1) (2014) 78-93.

50 Santos-Fita D, Naranjo EJ & Rangel-Salazar JL, Wildlife uses and hunting patterns in rural communities of the Yucatan Peninsula, Mexico, *Journal of Ethnobiology and Ethnomedicine*, 3 (38) (2012) 1-17.

51 León P & Montiel S, Wild Meat Use and Traditional Hunting Practices in a Rural Mayan Community of the Yucatan Peninsula, Mexico, *Hum Ecol*, 36 (2008) 249-257

52 Harrison RD, Sreekar R, Brodie JF, Brook S, Luskin M, O'Kelly H, Rao M, Scheffers B & Velho N, Impacts of hunting on tropical forests in Southeast Asia, *Conserv Biol*., 30 (5) (2016) 972-981.

53 Suwannarong K, Chapman RS, Lantican C, Michaelides T & Zimicki S, Hunting, Food Preparation, and Consumption of Rodents in Lao PDR, *PLoS ONE*, 10 (7) (2015) 1-14.

54 Gangaas KE, Kaltenborn BP & Andreassen HP, Geo-Spatial Aspects of Acceptance of Illegal Hunting of Large Carnivores in Scandinavia, *PLoS ONE*, 8 (7) (2013) 1-9.

55 Foerster S, Wilkie DS, Morelli GA, Demmer MS, Telfer P, Steil M & Lewbel A, Correlates of Bushmeat Hunting among Remote Rural Households in Gabon, Central Africa, *Conservation Biology*, 26 (2) (2011) 335–344.

56 Aguiar JO & Barbosa JAA, Ouvindo os caçadores do semiárido: natureza, cultura, memórias e percepções acerca da caça no agreste paraibano. In: *Representações do Sertão: poder, cultura e identidades*, edited by Dias RD & Araújo JX (Humanitas, São Paulo), 2013, 403-429.

57 Almeida MB, Lima EC, Aquino TV & Iglesias MP, Caçar. In: *Enciclopédia da floresta – o Alto Juruá: práticas e conhecimentos das populações*, edited by Cunha MC & Almeida MB (Companhia das Letras, São Paulo), 2002, 311-335.

58 Jerozolimski A & Peres CA, Bringing home the biggest bacon: a cross-site analysis of the structure of hunter-kill profiles in Neotropical forests, *Biological Conservation*, 111 (2003) 415-425.

59 Dai C & Hu W, Hunting strategies employed by bird hunters with economic pursuit in the city of Guiyang, Southwest China, *Journal for Nature Conservation*, 40 (2017) 33-41.

60 Duda R, Gallois S & Reyes-Garcia V, Hunting Techniques, Wildlife Offtake and Market Integration. A Perspective from Individual Variations among the Baka (Cameroon), *African Study Monographs*, 38 (2) (2017), 97-118.

61 Renoux F & Thoisy B, Hunting management: the need to adjust predictive models to feld observations, *Ethnobiology and Conservation*, 5 (1) (2016) 1-13.

62 Ross EB, Food Taboos, Diet and Hunting Strategy: the adaptation to animals in Amazon cultural ecology, *Current Anthropology*, 19 (1978) 1-36.

63 Alves BCF, Influência antrópica sobre a riqueza e abundância de anfíbios anuros em alagados de um remanescente de Mata Atlântica, Paraíba, Brasil (M.Sc. EcologyandConservationDissertation/ Universidade Estadual da Paraíba, Campina Grande), 2014.

64 Silva JIAO, Barbosa ESL, Silva AGF & Nunes GHF, Protected Areas in brazilian semiarid: study of management of these spaces preserved, *REUNIR*, 7 (2) (2017) 48-66.

65 Silva ML & Costa AP, Educação e Gestão em Perspectiva Sustentável: em busca de uma pedagogia para unidades de conservação, *Revista Amazônia, Organizações e Sustentabilidade*, 5 (2) (2016) 59-71.

66 Policarpo IS, Barboza RRD, Borges AKM & Alves RRN, Mammalian fauna used in folk medicine among hunters in a semiarid region of Brazil, *Environ Dev Sustain*, (2018) 1-10.

67 Barboza RRD, Lopes SF, Souto WMS, Fernandes-Ferreira H & Alves RRN. The role of game mammals as bushmeat In the Caatinga, northeast Brazil. *Ecology and Society*, 21 (2) (2016) 1-11.

68 van Vliet N, Cornelis D, Beck H, Lindsey P, Nasi R & LeBel S, Meat from the wild: extractive uses of wildlife and alternatives for sustainability, In: *Curr Trends Wildl Res*, edited by Mateo R, Arroyo B & Garcia JT (Springer, Berlin) 2016, 225-265.

69 Risso LC, Unidades de conservação e comunidades: espaços de participação e conflitos territoriais, *Anais do VI Congresso Iberoamericano de Estudios Territoriales y Ambientales*, (UNESP, São Paulo), 2014.

70 Quinteiro T, *Investigação sobre as concepções de infrações ambientais no contexto da educação ambiental* (M.Sc. Education Dissertation/ Universidade Estadual paulista, Bauru), 2017.

71 Fischer ML, Parolin LC, Vieira TB & Gabardi FRA, Bioética Ambiental e Educação Ambiental: levantando a reflexão a partir da percepção, *Revbea*, 12 (1) (2017) 58-84.

72 Alves RRN, Gonçalves MBR & Vieira WLS, Caça, uso e conservação de vertebrados no semiárido Brasileiro, *Tropical Conservation Science*, 5 (3) (2012) 394-416.

73 Castilho LC, Kristel, MV, Milner-Guland EJ & Schiavetti A, Hunting of mammal species in protected areas of the southern Bahian Atlantic Forest, Brazil, *Oryx - Fauna & Flora International*, (2017) 1-11.

74 El Bizri HR, Morcatty TQ, Lima JJS & Valsecchi J, The thrill of the chase: uncovering illegal sport hunting in Brazil through YouTube™ posts, *Ecology and Society*, 20 (3) (2015) 30-49.

75 Oldfield S, *The trade in wildlife: regulation for conservation* (Earthscan Publications Ltd, London), 2001.

76 Oliveira WSL, Luna MSO, Souto WMS, & Alves RRN, Interactions between people and game mammals in a Brazilian semi-arid area, *Indian Journal of Traditional Knowledge*, 16 (2) (2017) 221-228.

77 Lund JF & Jensen FS, Is recreational hunting important for landscape multi-functionality? Evidencefrom Denmark. *Land Use Policy*, 61 (2017) 389–397.

78 Lau R, A caça esportiva e os efeitos do chumbo nas aves do sul do Brasil, *Oecologia Australis*, 20 (4) (2016) 417-424.

79 van Vliet N, Quiceno MP, Cruz D, Aquino LJN & Yagüe B, Bushmeat networks link the forest to urban areas in the trifrontier region between Brazil, Colombia, and Peru, *Ecol Soc*, 20 (3) (2015) 1-21.

80 Fischer A, Sandström C, Delibes-Mateos M, Arroyo B, Tadie D, Randall D, Hailu F, Lowassa A, Msuha M, Kerezi V, Reljić S, Linnell J & Skrbinšek AM, On the multifunctionality of hunting – an institutional analysis of eight cases from Europe and Africa. *Journalof*

Environmental Planning and Management, 56 (2) (2012) 531-552.

81 Martins DG, Hanazaki N & Krelling AG, Navegando entre a Etnoecologia e a Educação Ambiental: narrativas de estudantes de uma escola de Governador Celso Ramos (SC), *Revbea*, 12 (1) (2017) 139-154.

82 Smith NJH, Utilization of game along Brazil's transamazon highway, *Acta Amazonica*, 6 (1976) 455-466.

83 Lisboa P, *Natureza, homem e manejo de recursos naturais na região de Caxiuanã, Melgaço, Pará* (MPEG, Belém) 2002.

84 Clausen KK, Christensen TK, Gundersen OM & Madsen J, Impact of hunting along the migration corridor of pink-footed geese Anserbrachyrhynchus –implications for sustainable harvest management. *Journal of Applied Ecology*, 54 (5) (2017) 1563-1570.

85 Bezerra DMMSQ, Uso de habitat e densidade de aves ameaçadas de extinção e sob pressão cinegética em uma área de caatinga prioritária para conservação (Ph.D. Zoology Thesis/ Universidade Federal da Paraíba, João Pessoa), 2015.

86 Brasil, *Lei nº 9.605/98* - Dispõe sobre as sanções penais e administrativas derivadas de condutas e atividades lesivas ao meio ambiente, e dá outras providências (Casa Civil, Brasília), 1998.

87 Brasil, *Decreto nº 6.514/08* - Dispõe sobre as infrações e sanções administrativas ao meio ambiente, estabelece o processo administrativo federal para apuração destas infrações, e dá outras providências (Casa Civil, Brasília), 2008.

88 Oliveira AGC, Unidades de Conservação: desafios e alternativas de gestão econômica dos parques nacionais (M.Sc. Economic Management of the Environment Dissertation/ Universidade de Brasília, Brasília), 2017.

89 Wands cheer CB, Conservation Areas and the breach of legal objectives of protection, *Revista Direito Ambiental e sociedade*, 6 (2) (2016) 201-224.

90 Beiroz H, Buffer Zones of Protected Areas in Urban Areas under the Territorial View: Reflections, Demands and Challenges, *Desenvolv. Meio Ambiente*, 35 (2015) 275-286.

91 Fontes CFL & Guerra AJT, Conflitos socioambientais na APA de Cairuçu (Paraty-RJ) à luz da sobreposição com unidades de conservação de diferentes categorias. *Geousp – Espaço e Tempo*, 20 (1) (2016) 178-193.

92 Alves RR & Nishida AK, A ecdise do caranguejo-uçá, Ucidescordatus (Crustacea, Decapoda, Brachyura) na visão dos caranguejeiros, *Interciencia*, 27(3) (2002)110-117.

93 Alves RR, Nishida AK & Hernandez MI, Environmental Perception of Gatherers of the Crab Caranguejo-uçá (Ucidescordatus, Decapoda, Brachyura) Affecting Their Collection Attitudes. *Journal of Ethnobiology and Ethnomedicine*, 1 (2005) 1-8.

94 Nishida AK, Nordi N & Alves RRN, Mollusk Gathers of Northeast Brazil: Gathering Techniques and Productivity, *Human Ecology*, 34 (1) (2006) 133-145.

95 Alves RRN & Rosa IML, Use of tucuxi dolphin Sotaliafluviatilis for medicinal and magic religious purposes in North of Brazil, *Human Ecology*, 36 (2008) 443-447.

96 Nordi N, Nishida AK & Alves RRN, Effectiveness of two gathering techniques for Ucidescordatus in Northeast Brazil: implications for the sustainability of mangrove ecosystems, *Human Ecology*, 37 (2009) 121-127.

97 Berkes F, *Sacred Ecology: Traditional ecological knowledge and resource management* (Taylor & Francis, Philadelphia) 1999.