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HUNTING AGREEMENTS AS A STRATEGY FOR THE CONSERVATION OF SPECIES: THE CASE OF THE CAZUMBÁ-IRACEMA EXTRACTIVE RESERVE, STATE OF ACRE, BRAZIL

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Abstract: One of the greatest challenges for the conservation of hunting species is not to prevent exploitation in a definitive way, but to avoid that overhunting leads to depletion of the species. As a wildlife management tool for hunting, we can highlight the Hunting Agreement, which consists of prohibiting or restricting the hunting of certain species most vulnerable. Thus, the goal of this study was to determine if the adoption of the Hunting Agreement caused a change in the habits of hunters at the Cazumbá-Iracema Extractive Reserve, located in the State of Acre, North Brazil. The Hunting Agreement imposes a ban on the slaughter of species and the use of certain hunting strategies. This study used the methodology of interview to verify the hunting preference and hunting calendar for quantification. We recorded the slaughter of 15 banned individuals namely *Ara* spp., *Amazona* spp, *Psittacara leucophthalmus* and *Tapirus terrestris*. The comparison of the absolute abundance of species with a prohibition of hunting or not presented a significant difference, showing that there is a greater slaughter of species without prohibition on hunting. The comparison of prohibited and non-prohibited hunting strategies had a significant difference, demonstrating the greater predominance of the use of permitted strategies. There is a greater slaughter of species without prohibition on hunting. Prohibited hunting strategies represent a punctual behavior within the community. The implementation of the Hunting Agreement pervades not only the population awareness of the population lag of the target species, but mainly cultural, behavioral, economic and legislative changes.

Keywords: conservation units; hunting calendar; selectivity; subsistence hunting; hunting strategy.

INTRODUCTION

Hunting is one of the oldest human activities to obtain animal protein and fat, prior to agriculture (Peres 2000, Robinson & Bennett 2000), essential part of its diet (Almeida *et al.* 2002). Archaeological and paleontological evidence indicates that hominids have begun to increase meat consumption at least 2.6 million years ago (Domínguez-Rodrigo *et al.* 2005). Until the invention of agriculture, meat was an indispensable component of human diets (Larsen 2003). The sedentary population in the Amazon region may be a factor that is influencing the reduction of the abundance of hunting species (Ferreira *et al.* 2012, Terra & Rebêlo 2005), once there is a tendency in the decrease of sources of

natural resources near dwelling. The exploitation of large species near the habitations would direct the hunting effort to the small and medium groups.

Subsistence hunting is known as the form of exploitation of natural resources most commonly spread throughout generations in the tropics (Fa *et al.* 2001). Traditional communities have as their main source of protein and fat products from wild fauna through hunting and fishing practices (Redford & Robinson 1987, Pezzuti *et al.* 2004). The greater the distance of these communities from the urban centers, the greater the reliance on subsistence hunting (Robinson & Bennett 2000, Jerozolimski & Peres 2003). On the other hand, the availability of this resource and its spatial distribution are factors that influence the distribution and densification of human populations (Ojasti 1996). One of the main consequences of hunting is the local extinction of the species (Peres 2001). This event is a non-random process ruled by morphological, metabolic and reproductive characteristics, which are usually correlated with the body mass of the most preferentially hunted species (Peters 1983).

One of the major challenges for the conservation of hunting species is not to prevent exploitation in a definitive way, but to avoid that overhunting leads to depletion of these species, as well as the cascade effects of this defaunation (Galetti & Dirzo 2013). These repercussions would directly affect the forest dwellers, since their meat supply would be compromised (Levi *et al.* 2011). It is necessary to create reliable governance mechanisms that can prevent exploitation at unsustainable levels, commonly associated with a robust knowledge of the amount of extraction that can be sustained by a particular target species (Levi *et al.* 2011). Only in this way it is possible to trace actions that aim at the sustainability and conservation of target species, even within a hunting practice maintenance scenario (Constantino 2015, Fragoso *et al.* 2016).

There is also a need to understand hunting to adopt effective conservation measures, as well as to seek measures to ensure the prudent and sustainable management of resources, especially in Conservation Units (Pezzuti *et al.* 2004). Currently, the mandatory imposition of protection for certain species does not have the proper effect, mainly due to the difficulty of inspection, both due to the lack of effective mechanisms and the low human resources. In a scenario like this, Silva-Neto (2009) argues that the best measure would be the implementation of ban periods for the target species, similar to that used with commercial species of fishery resources. In this sense, Hunting Agreements consist of establishing prohibitions or restrictions on hunting activities, which may include a particular species or set of species that present some degree of threat or sign of population decline and/or hunting practices considered to be harmful. These Hunting Agreements may arise from the perception of locus or based on scientific data, being adopted by a group that shares a common space. This model was adopted by the residents of the Alto Juruá Extractive Reserve in order to guarantee the moderate impact on the fauna and the guarantee of the availability of protein of wild origin. Among the measures established was the ban on trade of hunting and hunting with dogs, where there was a notable drop in subsistence hunting, where domestic dogs were introduced, as these move away the target animal (Almeida *et al.* 2012). This is a common problem in Neotropical rural communities (Koster 2009).

The goal of this study was to determine if the adoption of the Hunting Agreement caused a change in the habits of the hunters, reflecting in a smaller slaughter of species with prohibition on hunting, reduction of the use of the strategy of hunting with dogs and reduction in the slaughter of pregnant females or with young.

MATERIAL AND METHODS

Study area

The Cazumbá-Iracema Extractive Reserve (750,000 hectares, 09°06'45.26" S and 68°55'02.18" W, datum WGS 84) is located southwest of the Brazilian Amazon, in the Purus River basin, State of Acre (Figure 1). The study was conducted in the Núcleo do Cazumbá, old Seringal Cazumbá in which is located a population concentration (156 inhabitants), which has as source of protein the hunting and the fishing of subsistence, where it has signed the Hunting Agreement.

The main source of income is the sale of flour (cassava), followed by small cattle ranches, corn, rice, rubber extraction and Brazil nut harvesting (ICMBio 2007). Residents were invited to participate in the research, being clarified about the objectives of the project, the free right to participate or not in the research, the right to withdraw from it at

any time and the anonymity guarantee of the information provided. The project was approved by the Biodiversity Authorization and Information System (Sistema de Autorização e Informação de Biodiversidade -SISBIO) under the number 25701. The guides Emmons (1997) and Wilson & Reeder (2005) were used to identify the species of mammals and Sigrist (2008) for the birds.

Hunting Agreement

The Hunting Agreement entered into force in January 2001, one year and eight months before the creation of Extractive Reserve (Resex) (Decree without number of September 19th, 2002), and was applied to all residents of the Núcleo do Cazumbá, once elaborated and approved by 44 community members. With the creation of the Conservation Unit (UC), the Hunting Agreement was incorporated into its Management Plan (ICMBio 2007). The Agreement arose from the perception of the reduction of hunting species and the compromise of food safety, with the objective of improving the use of fauna. It expired after two years, having been extended by equal period, remaining presently. The Agreement provides for the gradual punishment of associate residents who fail to comply with the Agreement, which may lead to the expulsion of Resex.

For the development of the Agreement, a Fauna Refuge area was established with nine thousand hectares that had as north limit the Núcleo do Cazumbá, to the east the left bank of the stream Santo Antônio and to the west the stream Maloca, and its south limit a locality called Colocação dos Gama (Figure 1). Later with the creation of the CU, this area came to be denominated Fauna Management Zone that had as objective to assure an area without hunting activities, or with hunting employing methods and rules that reduce its impact, aiming at the recovery of the stocks of fauna (ICMBio 2007).

The following prohibitions were set: a) opportunistic hunting with dogs, b) hunting of pregnant female or with young, c) slaughter of more than one individual by hunting, d) hunting of the birds: macaws (*Ara* spp.), parrots (*Amazona* spp.), white-eyed parakeet (*Psittacara leucophthalmus*), and razor-billed Curassow (*Mitu tuberosum*); and the mammals: tapir (*Tapirus terrestris*), white-lipped peccary (*Tayassu pecari*) and chamek spider monkey (*Ateles chameck*). After the end of this first period, in January 2003, a further meeting was held to extend the validity period for a further two years for these animals, with a ban for an indeterminate period on the hunting of the birds: macaws (*Ara* spp.), parrots (*Amazona* spp.), white-eyed parakeet (*P. leucophthalmus*) and the mammal: tapir (*T. terrestris*). The ban on hunting of these species was based on local perception, where the decrease of their abundances in the vicinity of the houses was observed. Bans on hunting with dogs, hunting of pregnant females or with young, slaughtering more than one individual per chase were also maintained.

Methodology

The sampling comprised the months of June to November of 2011, being sampled 19 families (60% of the families). All hunters sampled had knowledge of the Hunting Agreement and its restrictions, having participated in its elaboration and approval, with the exception of two hunters under the age of 13.

To verify hunting preference, a semi-structured interview method was used (Albuquerque *et al.* 2010). During the interviews, hunters were invited to freely list their hunting preferences by taxonomic group, since people tend to list the terms in order of familiarity (Quinlan 2005). The interviews were conducted prior to the start of the application of the calendars in a single period.

For hunting record, the hunting calendar method was used, in which each sheet corresponds to one month. Each leaf was composed of boards of the animals that are hunted in the Resex or that are potential hunting target. Below the image of each animal, there was a table, where every time an animal was slaughtered, a cell would be filled. An option labeled "Other" was inserted to encompass animals that did not occur on the calendar. An accessory questionnaire was used to collect information from animals marked on the calendar, composed of the following questions: site of capture, number of hunters involved, hunted species, gender and age of species, time, type of environment, weapon used, strategy of hunting, reproductive stage, destination, sharing of hunting and observations. The reproductive stage of the females was only defined after the preparation of the animal. Its application was carried out with residents who had a member of the family who

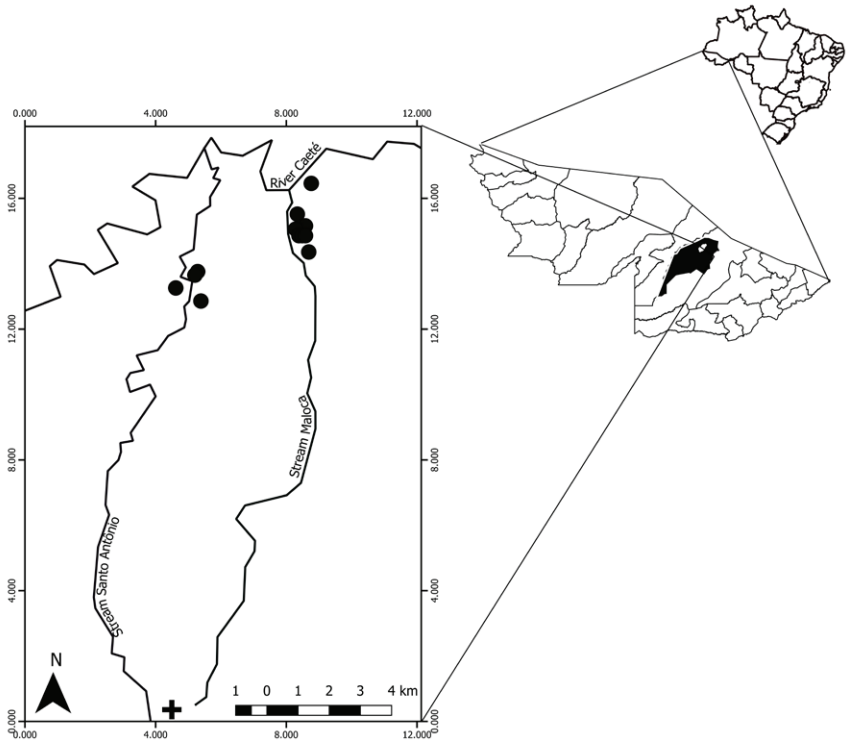

Figure 1. Location of the study area, the Extractive Reserve of Cazumbá-Iracema,Acre, Brazil. Black circles indicate the location of the families that had their hunting activity monitored and were interviewed. The water bodies represented are the north, east and west limits of the area defined as Fauna Refuge and the cross represents the Colocação dos Gama, the southern limit of the zone.

hunted and who volunteered to participate in the research, besides the guarantee of anonymity.

As in a single house it was possible to have more than one hunter, the hunting calendar was treated as sampling unit. The calendar consisted of a notebook similar to a conventional calendar, in which each sheet corresponds to one month. Each sheet was composed of drawings of animals that are hunted by hunters. Each time a hunter slaughtered a species with a hunting ban, he was asked why it was slaughtered and the relationship to the restrictions imposed by the agreement.

Data analysis

To assess whether the predominance of capture of animals that were not listed as prohibited or restricted in the Hunting Agreement was applied in the Student T test. The assumption is that there is the predominance of capture species of free permission. The categories of assessment were: without the prohibition of hunting with species with prohibition of hunting, of ovate females and females not ovated, strategies of hunting without prohibition and with strategy of hunting with prohibition. Additionally, the test was employed to assess whether the non-slaughter justifications of each species with hunting ban were related to the restrictions of the Hunting Agreement or other factors. The application of the test followed the assumptions, as informed by Sokal & Rohlf (1995). For statistical analyses the PAST 3.20 program was employed (Hammer *et al.* 2001).

For the definition of species of greater hunting preference, the ordination technique was used, considering only the first five citations. Preference data were counted and presented in a matrix, where a value was assigned to each species, in the form of an inverted ranking (where the last item in each list received the value equal to 1, the penultimate equal to 2 and so on up to the first item in each list). The values obtained for each species were added, and the sum was divided by the total number of interviewees. Based on the mean obtained, the values were ordered by importance (Albuquerque *et al.* 2010).

RESULTS

Hunted species

Regarding hunting, 101 birds were slaughtered, of which 87 were without hunting ban and 14 were prohibited, including *Ara* spp. (N = 4), *Amazona* spp. (N = 4) and *P. leucophthalmus* (N = 6). The mammals totaled 198 records of slaughter, with a single species (*T. terrestris*; N = 1) with a registered hunting ban. The comparison of the absolute abundance of species with prohibition and species without prohibition of hunting showed a significant difference, showing that there is a greater slaughter of species without hunting prohibition ($t = 4.8049$, $df = 60$, $p < 0.05$).

Checking the hunter preference per taxonomic group, among the hunted species and those not allowed to be hunted, *Ara* spp. and *P. leucophthalmus* were recorded among the five most preferred bird species. The hunting preference of *Ara* spp. comprises the two species of red macaws, *A. macao* and *A. chloropterus*, with no distinction between species. In the case of mammals, even though it is a species among the restricted species, *T. terrestris* is recorded with the highest food preference (Table 1).

The absolute abundance of the five most slaughtered species presents a pattern different from that observed in the interviews. Tinamids appear among the three species of birds with the highest slaughter rate, while *Cuniculus paca*, indicated as the fifth on the preference scale, appears as the mammal with the highest slaughter rate (Table 2).

Were registered eight birds with eggs, *Crypturellus soui* (N = 1), *C. undulatus* (N = 1), *C. cinereus* (N = 2) and *Tinamus major* (N = 4) and a mammal pregnant female of the species *Dasypus novemcinctus* (four cubs). Females with young birds were not registered. The comparison of slaughtering of ovate females and without ovate shows that there was a significant difference, with more slaughter of ovate females ($t = 3.196$, $d.f. = 16$, $p = 0.002$).

Table 1. Most preferred species of birds and mammals according to the method of ordination of the Núcleo do Cazumbá, Extractive Reserve of Cazumbá-Iracema.

Species	Mean	Order
Penelope jacquacu	2.15	1
Ara spp.	2.25	2
Psittacara leucophthalmus	2.85	3
Psophia leucoptera	3.85	4
Tinamus major	3.90	5
Tapirus terrestris	1.50	1
Mazama americana	2.55	2
Tayassu pecari	2.60	3
Pecari tajacu	4.10	4
Cuniculus paca	4.35	5

Table 2. Species of birds and mammals most slaughtered according to the hunting calendar method of the Núcleo do Cazumbá, Extractive Reserve of Cazumbá-Iracema.

Class	Species	Common name	N
Birds	*Tinamus major*	Great tinamou	23
	Crypturellus undulatus	Undulated tinamou	13
	Crypturellus cinereus	Cinereous tinamou	10
	Ramphastos spp.	Toucan	10
	Penelope jacquacu	Spix guan	7
Mammalia	*Cuniculus paca*	Lowland paca	50
	Dasyprocta fuliginosa	Black agouti	29
	Hadrosciurus spadiceus	Red squirrel	24
	Mazama americana	Red brocket	19
	Pecari tajacu	Collared peccary	18

Analyzing whether hunters agree to the Hunting Agreement, 14 reported agreeing to the Agreement and that it has shown positive results for the community. Five agree in part with the Agreement, citing that some restrictions should be reviewed. While three do not agree with the continuity of the Agreement due to changes in the abundance of some species. In relation to the hunting preference and the justification for the slaughtering or not of the animal, variations can be observed according to the species that is considered (Table 3).

Evaluating the justification for non-slaughter of a species under a hunting ban is determined by the Hunting Agreement, it is possible to observe a variation. The bird *Ara* spp. ($t = 4.1267$, $df = 19$, $p < 0.05$), and the mammals *T. terrestris* ($t = 2.7065$, $df = 19$, $p < 0.05$) and *T. pecari* ($t = 3.559$, $df = 19$, $p < 0.05$) presented significant statistical differences, where the Hunting Agreement is presented as the main justification. The birds *Amazona* spp. ($t = 4.1267$, $df = 19$, $p = 0.21$) and *P. leucophthalmus* ($t = -0.31215$, $df = 19$, $p = 0.75$) showed no significant differences, and Hunting Agreement is not the main justification for non-slaughter.

Hunting strategies

Four hunting strategies were recorded with the use of the hunting calendar methodology: opportunistic hunting (N = 177), sit-and-wait (N = 132), trap (N = 5) and use of dogs (N = 7), the last prohibited modality. The opportunistic hunting strategy had the record of three sub-modalities: opportunistic hunting

Table 3. Justifications for the slaughter or not of species with a prohibition on hunting in the Núcleo do Cazumbá, Extractive Reserve of Cazumbá-Iracema. N = no; S = yes

Species	Slaughter	Justification	N
Ara spp.	N	Hunting Agreement.	14
	N	Difficulty in slaughtering the animal (height of the nest and modification of pieces of lead in bullet-like forms, known as projectile).	3
	S	The abundance of *Ara chloropterus* and *Ara macao* near the houses indicates that the species is no longer in decline.	2
	S	The slaughter of individuals distant from the núcleo region, even inside the Fauna Refuge area, does not interfere with the abundance of the species.	1
Amazona spp.	N	Hunting Agreement.	7
	N	Spending on ammunition and the low return of meat does not justify slaughter.	11
	S	The abundance of species in the vicinity of the houses indicates that the species is no longer in decline.	2
	S	The slaughter of individuals distant from the núcleo region, even inside the Fauna Refuge area, does not interfere with the abundance of the species.	1
Psittacara leucophthalmus	N	Hunting Agreement.	8
	N	Spending on ammunition and the low return of meat does not justify slaughter.	9
	S	The abundance of species in the vicinity of the houses indicates that the species is no longer in decline.	2
Tapirus terrestris	N	The species is not sighted in the vicinity of the núcleo, which makes it impossible to slaughter.	5
	N	Hunting Agreement	14
	S	The slaughter of individuals distant from the núcleo region, even inside the Fauna Refuge area, does not interfere with the abundance of the species.	1
Tayassu pecari	N	Absence of animal.	5
	N	Hunting Agreement.	15

with a firearm (96%), opportunistic hunting with a sling (3%) and opportunistic hunting with a machete (1%). The sit-and-wait was divided into two subcategories, waiting at strategic sites (95%) and waiting with feeder (5%). The trap strategy had two modalities in trap of fall-and-apprising traps (80%) and trap with firearm (20%). The comparison of the hunting strategies allowed and not allowed was not significant ($t = 4.9362$, $df = 320$, $p < 0.05$), showing that the adoption of the hunting with dogs is punctual (2.2% of the total number of hunts).

DISCUSSION

The results indicate that where the Hunting Agreement is respected, there is a higher rate of capture of animals without hunting restrictions. The low use of deleterious hunting strategies indicates a clear preference for more selective targeting strategies, and this model of Hunting Agreement adopted in other protected areas in Brazil is considered as a traditional knowledge-based fauna management tool.

All species targeted for hunting are among the most targeted in the Brazilian Amazon (Peres 2000) and are more susceptible to intensive hunting due to their low reproductive rates, long life cycles and extensive intergenerational intervals (Bodmer *et al.* 1997) and consequently, greater vulnerability to extinction risk (Leopold 1933). Overhunting of these species can lead to a decline in their densities, reducing their chances of encounter and slaughter. The mammal species *C. paca, Dasyprocta fuliginosa, Hadrosciurus spadiceus, Mazama americana* and *Pecari tajacu* are described as resistant to high hunting pressure (Bodmer *et al.* 1997, Bodmer & Robinson 2004) and this factor would lead to a higher rate of encounter and slaughter.

The Hunting Agreement appears as the main justification for the non-slaughter of the bird *Ara* spp., and the mammals *T. terrestris* and *T. pecari*. However, *T. terrestris* has low local density and *T. pecari* is not present in the vicinity of the Núcleo, and compliance with the Agreement may be facilitated by this low density or absence. Compliance with the Agreement in the non-slaughter of certain species depends on their abundance and the positive cost-benefit ratio of meat return. Other aspects such as economic, cultural, access to alternative sources of protein and monitoring of the Agreement should be evaluated for the concrete analysis of compliance with the Agreement.

Comparing the categories of hunting strategies shows that there is predominance of allowed strategies, especially sit-and-wait and at opportunistic hunting. At opportunistic hunting with dog strategy is a punctual element within the community practiced by a single resident. Almeida *et al.* (2002) describe the opportunistic hunting strategy as a strategy employed independent of other daily activities. The use of this strategy is similar to that found by Calouro & Marinho-Filho (2005) and Rosas & Drumond (2007). Unlike Rosas & Drumond (2007), in the present study, at opportunistic hunting is not a punctual activity, being rather an element of the daily life of local hunters. This strategy has partial selectivity, different from that found by Almeida *et al.* (2002). Because hunters do not track the animals, the response time of sighting and firing a weapon should be very fast, not allowing a selection of prey.

The sit-and-wait strategy is the main hunting strategy employed at Chico Mendes Resex and the Chico Mendes Agroextractive Settlement Project (Rosas & Drumond 2007), differently than in the present study. The sit-and-wait strategy comprises one of the main learning rites, where more experienced hunters teach younger hunters about ecological and behavioral aspects of target species, as well as forest characteristics and guidance. One of the main aspects of learning is the auditory recognition of the form of locomotion of each species. This recognition is fundamental, especially for night hunting, where the hunter hears the approach of the prey (Almeida *et al.* 2002). This selectivity is partial, although superior to that related to the opportunistic hunting strategy. Due to the need for a fast response time of illumination relative to the shot, it is not possible to accurately evaluate the prey before firing the shot. This method has better hunting and sustainability results.

The two less selective hunting strategies are the use of dogs and a trap with firearm, since the hunter does not see the prey, and there is the possibility of killing species under a hunting ban or with the existence of food taboos. The frightening of prey related to the strategy using dogs does not make it preferable among hunters, as reported by Calouro & Marinho-Filho (2005), Almeida *et al.* (2002) and Rosas & Drumond (2007), which may represent

a positive factor in the inspection and control of this strategy. However, the effects of frightening on the Núcleo do Cazumbá may be greater due to population densities and overlapping of hunting areas. Another situation related to the presence of dogs is related to the possibility of introducing etiological agents, facilitating the contact of wild species with these agents, causing the spread of diseases (Vilela & Lamim-Guedes 2014).

The strategy of trapping with firearm is indicated as the strategy with lower occurrence record due to its lethal potential (Calouro & Marinho-Filho 2005, Almeida *et al.* 2002, Rosas & Drumond 2007). Thus, it is recommended to extend the prohibition to this hunting strategy, and this decision-making is carried out by the residents, in a form of participatory management. The natural aversion to this strategy due to the possibility of accidents (Calouro & Marinho-Filho 2005, Rosas & Drumond 2007) facilitates their complete ban, even in areas further away from the Núcleo.

The results indicate a greater slaughter of species without a hunting ban. However, this result may be masked by other factors, such as abundance and spatial distribution of prey and the dynamics of hunting territories (Collinge 2001, Constantino 2015, Pereira *et al.* 2017), as later evidenced by the justifications for not hunting certain species. These factors will also influence the rate of slaughter. The hunting preference does not necessarily reflect a higher slaughter rate, as also observed by Rosas & Drumond (2007). To better understand this scenario is important to know the multidimensional context in which hunting activities are inserted on scenario in which the contribution of ethnozoology research is essential (Alves *et al.* 2018). This type of research can contribute to the understanding of perceptions and conceptualization developed by human communities on the nature and different uses and ways of handling natural resources (Figueiredo & Barros 2015, Nunes *et al.* 2017).

Monitoring the density and/or abundance of Resex hunting species is a fundamental tool for the quantification of the density of species with and without prohibition, in order to analyze density fluctuations due to hunting. The continued application of hunting calendars for the systematic recording of slaughter of pregnant female and with young can contribute to the development of a local calendar of seasonal slaughter seasons, especially for the most sensitive species, such as those with low birth rates. Additional actions aimed at raising public awareness about the importance of species conservation should be used as an accessory tool for wildlife management.

The implementation of the Hunting Agreement pervades not only the population awareness of the population lag of the target species, but mainly cultural, behavioral, economic and legislative changes. These changes are gradual and achievable in the long run. The adoption of measures of fauna management from the environmental perception of the inhabitants represents an effective tool for conservation of hunting species. This study demonstrates that the discussion of the Hunting Agreement in the Cazumbá-Iracema Resex generated some awareness among the residents evaluated, which shows the potential of this methodology in management.

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