Article

Perception of subsistence hunters in Lower Madeira on the impact of the Santo Antônio Hydroelectric Power Plant

Márcio José Silva Belfort[1], Glêidson da Silva Barbosa[1], Carolina Pereira da Silva[1], Marcela Alvares Oliveira[1,2*]

[1] Centro Universitário Aparício Carvalho, Porto Velho, Rondônia, Brasil.
[2] Programa de Pós-graduação em Biodiversidade e Biotecnologia da Amazônia Legal, Universidade Federal de Rondônia-UNIR, Porto Velho, Rondônia, Brasil.
*Autor para correspondência. E-mail: marcela.mugrabe@gmail.com, ORCID: https://orcid.org/0000-0002-4129-993X

Abstract

Brazil has one of the highest levels of biodiversity in the world, much of which is located in the Amazon region. The populations inhabiting this region guarantee their livelihood with natural resources, among which hunting stands out. The purpose of this study was to conduct a survey on the impacts caused by the Santo Antônio Hydroelectric Power Plant (HPP) to subsistence hunting downstream in Madeira River, Porto Velho-Rondônia. Interviews were conducted in eight communities downstream of the Santo Antônio HPP: São Carlos, Brasileira, Curicacas, Cuniã, Cavalcante, Agrovila, Nazaré, and Terra Caída. Data were collected through semi-structured questionnaires, from June to October 2019. Thirty-two hunters older than 18 were interviewed: 31 males and one female. Ten species were recorded: seven mammals, two birds, and one reptile. In relation to mammals, the species with the highest number of citations was *Cuniculus paca,* which was also the most cited hunting species among the three classes. The hunters' preference for mammals is related to the availability and volume (quantity) of meat. These species have a long life cycle, with low demographic densities and relatively low reproductive capacities, making them more sensitive to unrestrained or irrational hunting. During the research, a reported decrease in abundance was recorded for eight of the ten species mentioned after the construction of the dam. The information collected in this study confirmed that the construction of the Santo Antônio HPP contributed directly to the decrease in abundance of target species, impairing subsistence hunting in the evaluated communities.

Keywords: Interviews, Rondônia, *Cuniculus paca*, Human ecology, Traditional knowledge.

Resumo

A biodiversidade brasileira é uma das maiores do mundo, grande parte dessa diversidade está localizada na região Amazônica. As populações que habitam essa região garantem seu sustento através da utilização dos recursos naturais, dentre eles se destaca a caça. O objetivo deste trabalho foi realizar o levantamento sobre os impactos causados pela Usina Hidrelétrica de Santo Antônio a caça de subsistência em comunidades do Baixo Madeira, Rondônia. Foram realizadas entrevistas em oito comunidades: São Carlos, Brasileira, Curicacas, Cuniã, Cavalcante, Agrovila, Nazaré e Terra Caída localizadas no Baixo Madeira, a jusante da Usina Hidrelétrica de Santo Antônio. Os dados foram coletados através de questionários semiestruturados. Foram entrevistados 32 caçadores maiores de 18 anos, sendo 31 pessoas do sexo masculino e 1 do sexo feminino. Foram registradas 10 espécies, sendo sete mamíferos, duas aves e um réptil. Em relação aos mamíferos, a espécie com maior número de citações foi a *Cuniculus paca* que também foi a espécie alvo de caça mais citadas em relação às três classes citadas. A preferência por mamíferos está relacionada com a disponibilidade e o rendimento da carne. Contudo, essas espécies apresentam um longo ciclo de vida, com baixas densidades demográficas e com capacidades reprodutivas relativamente baixas, o que as torna mais sensíveis à pressão de caça. Durante a pesquisa foi registrada a diminuição na abundância em oito das dez espécies citadas. Através das informações levantadas ao longo do estudo foi confirmado que a construção da UHE de Santo Antônio, contribuiu diretamente para diminuição na abundância de espécies alvos, prejudicando a caça de subsistência, consequentemente a segurança alimentar das comunidades avaliadas

16

Palavras-chave: Entrevistas, Rondônia, *Cuniculus paca*, Ecologia humana, Conhecimento tradicional.

Introduction

Humanity has had a relationship with fauna since primitive times (Alves & Souto, 2011) Hunting stands out as being one of the oldest human-fauna interactions known, being humanity's main food source for millennia. The first hunting utensils appeared in the Neolithic period as spearheads and arrows chipped from stone, knives made from animal bones, and needles made from thorns or stones, which were used to sew the skins of slaughtered animals to make clothing (Alves *et al.*, 2012). Subsistence hunting was and continues to be fundamental for acquiring protein, controlling predators, and curing diseases in traditional riverside communities (Vasconcelos Neto *et al.*, 2012; Fernandes-Ferreira & Alves, 2017).

Although scientific and technological advances have developed agriculture and animal domestication, there are still isolated populations across the globe, especially in tropical forests, that depend on traditional fishing and hunting to meet their food needs. A wide spectrum of species are used by these communities for their livelihoods, including birds, mammals, and reptiles (Bodmer & Pezo, 1999). These species are important nutritional sources for these communities, with high fundamental protein value that provides subsistence and community maintenance (Fonseca & Lourival, 2001).

Approximately 60 million wild animals are slaughtered every year in Brazil through hunting (Mesquita *et al.*, 2018), resulting in population declines, reduced rates of reproduction, and local extinctions, which compromises the future of the many species of wildlife (Thiollay, 2005). Medium and large mammals suffer increased catch pressure to meet availability and yield (Cullen *et al.*, 2001), followed by birds and reptiles (Robinson & Redford, 1994).

There are several factors that influence the dynamics of hunting, among which we highlight hydrological variation. When the rainy season arrives, flooded land areas increase. This long period of floods causes changes in the eating habits of communities that stop hunting due to a temporary shortage of mammals as they move away from communities for higher, dry areas. For this reason, isolated communities start to use aquatic fauna as a protein source (Fonseca & Lourival, 2001), such as fish and turtles/chelonians (Rebêlo & Pezzuti, 2000).

Anthropogenic changes to this water regime can impact these populations' food security (Fonseca & Lourival, 2001). The development of Hydroelectric Power Plants are one of the largest current drivers of these changes. The Amazon has seen large hydroelectric developments, as it presents ideal conditions for energy production through hydroelectric generation. There is no denying the importance of a Hydroelectric Power Plant for a given region (Travassos, 2001). However, these enterprises generate many impacts on the environment, directly affecting the biodiversity of rivers, flora and fauna (Santos *et al.*, 2017). These damages include changing the physical and chemical properties of water, removing vegetation cover, promoting isolation, fragmentation and habitat loss for terrestrial fauna

Fishing is almost always associated with hunting in Amazonian traditional communities (Valsecchi & Amaral, 2009), and the literature describes only the impacts on subsistence fishing caused by the Santo Antônio Hydroelectric Power Plant (HPP) (e.g. Lima *et al.*, 2017). As such, there is a need to investigate the impact of this dam on subsistence hunting. In this context, the use of environmental perception is an important tool, as social participation in the identification of environmental problems can assist governing bodies in the planning of actions and guidelines for

decisions at the political, socioeconomic, and developmental levels of a locality (Del Rio & Oliveira, 1996). The objective of this work was to evaluate and characterize subsistence hunting and the perception of residents on the impacts of the Santo Antônio HPP, focusing on the subsistence hunt of downstream riverside communities on the lower Madeira River.

Material & Methods

The study was carried out in eight communities, all located downstream of the Santo Antônio HPP on the Madeira River, about 75 kilometers from the urban perimeter of Porto Velho (Table 1).

Table 1. Sampled communities located downstream of the Santo Antônio HPP. I= interviews.

Communities	Bank	I	Access	Geographic coordinate (WGS84)	
São Carlos	Left	19	Fluvial and terrestrial	8°26'90.65"S	63°29'50.29"W
Brasileira	Right	2	Fluvial and terrestrial	8°28'32.80"S	63°31'20.54"W
Nazaré	Left	1	Fluvial	8°19'58.47"S	63°19'70.76"W
Cuniã	Left	1	River and terrestrial	8°18'28.20"S	63°29'25.41"W
Curicaca	Left	2	Fluvial	8°26'11.77"S	63°30'60.19"W
Cavalcante	Right	1	Fluvial	8°23'27.74"S	63°23'57.89"W
Terra Caída	Left	4	Fluvial and terrestrial	8°20'15.41"S	63°24'56.23"W
Agrovila	Right	1	Fluvial and terrestrial	8°27'41.97"S	63°30'21.46"W

The main sources of income in these communities are artisanal fishing and agriculture, focused, mainly, on cassava powder production. All communities are on the banks of the Madeira River (Figure 1).
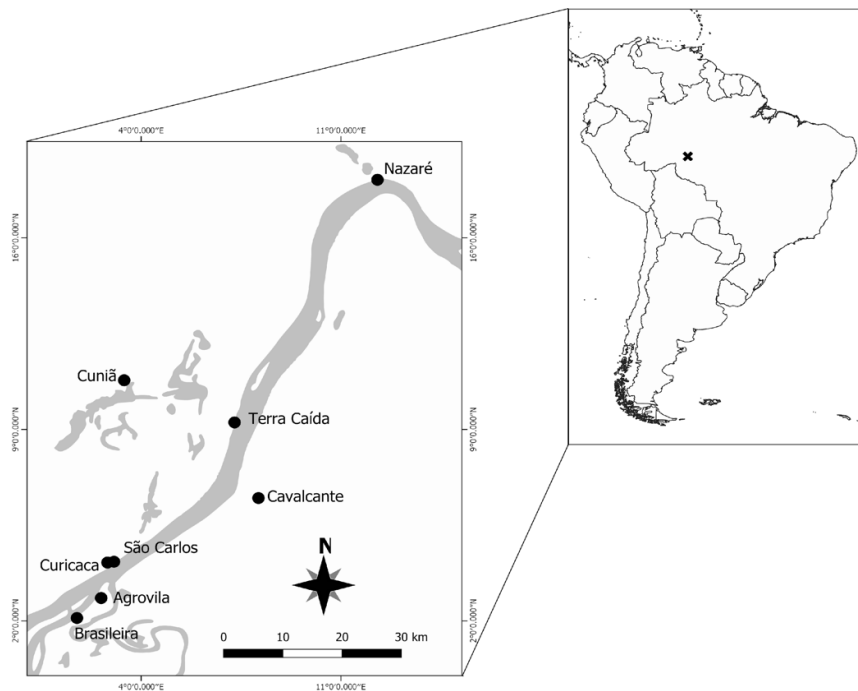

Figure 1. Geographical location of the communities sampled from Madeira river, downstream of the Santo Antônio HPP.

The methodology used for data collection was semi-structured interviews. In this type of interview, the questions are partially formulated by the researcher before going to the field, but are kept flexible to allow deeper assessment of new elements that may arise during the interview (Alburquerque *et al*., 2010). To assist in the identification of the species, photographs were used. The interview script was divided into two stages, the first with questions about the socioeconomic profile of the interviewees and the second stage with questions referring to the profile of the hunt (Table 2).

Table 2. Stages of interviews and variables gathered to survey the hunting profile and impacts on downstream communities of the Madeira River.

Interview step	Variables
Profile of the interviewees	Sex
	Age group of residents
	Birthplace
	Dwelling time
	Number of residents in the house
	Source of Income
Profile of the hunting	Species hunted before and after HPP
	Changed hunting territory
	Preference
	Strategies
	Number of hunter
	Number of firearm
	Frequency
	Hunting time
	Packaging
	Zootherapics

The type of hunting was divided into two categories: intentional and opportunist. The first was characterized by hunting events in which the hunter leaves their house to perform only this activity. The opportunist is characterized by hunters leaving to perform other activities, such as fishing and agriculture, and hunt when they encounter a target species.

This work was submitted to the Research Ethics Committee, via Plataforma Brasil, which was approved under opinion number 2 661 332. The selection of the informants was performed using the "snowball" method (Davis & Wagner, 2003). Based on the profile of the questionnaire, we randomly chose the first interviewees and started a network of indications, where each interviewee indicates another. An interview was conducted with only one hunter per residence. The conservation status of each species was obtained from the list maintained by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio, 2018) and the international list from the International Union for the Conservation of Nature (IUCN 2020).

Descriptive statistical techniques (mean and standard deviation) were adopted for the analysis of the socioeconomic profile. For the definition of more hunted species, the ordering technique (Albuquerque *et al*., 2010) was used. To verify that there was a difference in the number of citations between mammals, birds, and reptiles, a Kruskal-Wallis test was used. The Shannon-Wiener Diversity Index was used to calculate the diversity of species recorded before and after the construction of the dam and comparison between scenarios was performed using the diversity t-test

(Begossi, 1996). For the tests, the significance level of 5% was adopted and the analyses were performed in the software PAST v3.25 program (Hammer *et al.*, 2001).

Results

Thirty-two hunters were interviewed from June to October 2019. Of this total, 96.88% were male (n=31). The mean age of the interviewees was 46.93±11 years and the mean length of housing was 22.8±5 years. The average size of the families was 3.96±1.75 members. The mean number of adults and children per family was 2.40±0.87, and 1.56±1.52, respectively, demonstrating that most families were composed of two adult members with one or two children. Of all respondents, 98% were born in the interview location.

The main source of income recorded was fishing at 41.67%, followed by agriculture at 31.25% and retirement at 16.67%. 93.75% of interviewees confirmed they practice subsistence hunting. The number of hunters per family was 1.25±0.50 on average. Of the total hunters, 96.88% had electricity in their homes, and for this reason 71.88% of hunters froze their catch to conserve animal protein, followed by salting at 18.75%.

Regarding subsistence hunting, 71.88% of respondents stated that the activity is opportunistic. For 75% of the interviewees, subsistence hunting is associated with another activity. Among the activities pointed out by the hunters, fishing stood out at 65.71%, followed by agriculture at 11.43%. We found that the number of firearms per family was 1.34± 0.74 on average. Respondents reported hunting twice a week on average, preferably during the new moon as darker nights had greater success. Respondents reported a preference for hunting at night (69.70%) as opposed to daytime (30.30%).

Respondents reported hunting ten species (n=161), seven of which were mammals (n=119), two of which were birds (n=20) and one of which was a reptile (n=22). Mammals were the most cited group among the interviewees, while the citations between birds and reptiles did not differ (H=56.16 p<0.05). The diversity of species cited prior to the construction of the dam was low (H= 2.05) and significantly decreased after construction (H'=1.89; t= 2.01; df= 108; p<0.05). Hunters reported a preference for eight species, with *C. paca* as the most preferred and also the most cited (Table 3).

Table 3. Target species and preference cited by hunters from communities in downstream Madeira, Porto Velho, Rondônia. B= before; A= after; P= preference, VU= vulnerable; EN= endangered.

Class	Scientific Name	Vernacular name	B	A	P	IUCN	ICMBio
Mammalia	*Dasypus novemcinctus* Linnaeus	Nine-banded Armadillo	24	8	17	-	-
	Tapirus terrestres (Linnaeus)	Tapir	20	10	6	VU	VU
	Tayassu pecari (Link)	White-lipped Peccary	4	1	0	VU	VU
	Mazama americana (Erxleben)	Red Brocket Deer Common	2	0	2	-	-
	Lagothrix cana cana (É. Geoffroy Saint-Hilaire)	Peruvian Woolly Monkey	14	5	3	EN	EN
	Dasyprocta spp. Illiger	Agouti	25	12	14	-	-
	Cuniculus paca (Linnaeus)	Paca	30	18	25	-	-
Reptilia	*Melanosuchus niger* (Spix) or *Caiman crocodilus* (Linnaeus)	Caiman	22	6	5	-	-
Birds	*Pauxi tuberosa* (Spix)	Razor-billed Curassow	1	0		-	-
		Birds	19	5	7		-

A change in the abundance of hunted species was reported by 96.88% of the interviewees, with citations for eight species (Table 3). All interviewees reported that this change was due to the flooded area killing riparian vegetation that was the main food source for the hunted species. All interviewees stated that they changed their hunting territory due to this vegetation mortality. Prior to the construction of the Santo Antônio HPP, these territories were located in the riparian forest and in the vicinity of hunters' villas, but after construction and flooding they had to be moved to more distant areas.

Four hunting strategies were cited by the respondents. The most common strategy was the "waiting game in the barley" (56.25%), followed by "persistence hunting on foot" (21.88%), "waiting game in a fruit tree" (12.50%) and "persistence canoe hunting" (12.5%). The waits occurred near fishing areas. The interviewees reported using the same strategies even after the construction of the dam. 93.75% of respondents said they hunted to acquire animal protein, whereas 6.25% hunted for medicinal purposes. In relation to the use of zootherapeutic drugs, three species and their fat were mentioned (Table 4).

Table 4. Species and respective items cited by by hunters from the downstream communities of Madeira used to treat diseases (zootherapeutic).

Species	Part used	Form of preparation	Use	Disease	N
Tapir	Fat	Melting and storage	Ingestion	Asthma	2
			Friction	Influeza	2
			Plaster	Pneumonia	2
			Plaster	Skin lesions	2
Caiman	Fat	Melting and storage	Ingestion	Suffusion	1
			Ingestion	Convulsion	1
			Ingestion	Epilepsy	1
Yellow-footed Tortoise	Fat	Melting and storage	Ingestion	Luxation	1
			Plaster	Inflammation	1

Discussion

This work presents the first data on downstream communities' perceptions of impacts caused by the construction of the Santo Antônio HPP on subsistence hunting in the Madeira River. The connection between human being, animals, and the environment spans millennia, and has perpetuated itself over time in a relationship that is both predatory and symbiotic (Alves & Souto, 2010). This intrinsic relationship has been shaken in the Amazon region of Brazil's north by the construction of large hydroelectric dams in river basins. These anthropogenic interventions have directly affected the socioeconomic profile of riverside communities, where people fish to supplement their income and hunt to complement their diets with animal protein (Lima *et al*., 2012). Our results show that hunting is performed predominantly by men, corroborating the findings of Valsecchi and Amaral (2009) and Figueiredo and Barros (2015).

We found that most respondents were born in their respective communities, suggesting greater reliability in our data due to a closer relationship between respondents and their local natural resources, i.e. Local Ecological Knowledge (LEK) (Silvano & Begossi, 2005).

Fishing stood out as the main source of animal protein for the interviewees, followed by hunting. This demonstrates the close relationship between fishing and hunting, because fishermen go out armed to fish and will hunt other animals when they have the opportunity. This corroborates the findings of Figueiredo and Barros (2015), who suggested that environmental conditions, seasonality, climatic cycles, and other activities affect hunting practices. The factor that defined a change in hunting territory was the flooding and destruction of vegetation and not the overexploitation of game species. The latter was the main factor in an increase in the distance covered and the hunting spectra in other locations (Levi *et al.*, 2011; Benítez-López *et al.,* 2017). Thus, hunting strategies were preserved, as well as species hunted.

This study identified four hunting techniques already described in the literature (Alves *et al.*, 2018), where "waiting game in a fruit tree" is the strategy with best hunting and sustainability results (Oliveira & Calouro, 2019). The most-hunted species in the communities were mammals and large- and medium-sized birds. Mammals being the most cited group corroborates the pattern previously recorded for the Brazilian Amazon (Souza-Mazurek *et al.,* 2000; Mesquita & Barreto, 2015). The low diversity of species we recorded may demonstrate that medium and small animals are not targeted despite potential reductions in large animals (Benítez-López *et al.*, 2017). However, the preference for these species can lead to over-exploration (Begossi *et al.*, 1999).

Of all the species mentioned as a source of protein, interviewees reported a population decline in eight species. This decrease associated with unrestrained or irrational hunting can lead to changes in the hunting spectrum (Melo *et al.,* 2015), shifting hunting to medium and small species (Pezzuti & Chaves, 2009; Mesquita & Barreto, 2015). This change of preference and increased hunting spectrum can cause deleterious effects on the species populations, mainly to the endangered one (Valsecchi & Amaral, 2009). Additionally, that reduction in the abundance can contribute to the reduction of the nutritional source of the communities.

This study showed that the interviewees hunt for a complementary source of protein, but also use animal by-products for medicinal purposes, which may be related to distance from urban medical facilities and a dependence of natural resources, traditional knowledge and traditional medicine**.** It is estimated that approximately 80% of the world's population uses folk medicine to treat diseases, which are often confirmed as effective by scientific research and used to develop new therapies and medicines (Moura & Marques, 2008).

According to Lima *et al.* (2012) and based on LEK, the impact we recorded on the reported abundance of cited target species occurred due to a combination of excessive hunting, changes in the water regime, and unavailability of alternative food items, which was directly enhanced by floods in 2014. Anthropogenic hydrological changes paired with natural factors caused an increase in flooded areas, decreasing land area and killing vegetation, especially fruit species that were a food source for target species and thereby underpinned food security in downstream communities.

By studying communities involved in these processes, we provide a better understanding of the relationship between humanity and nature, and also seek solutions to promote the conservation of local biodiversity. By using the perception of traditional peoples, it is possible to identify the positive and negative aspects of human being in relation to nature.

Conclusion

By analyzing the interviewees' perceptions, we concluded that the construction of the Santo Antônio HPP caused direct impacts on their subsistence hunt by increasing flooded areas, suppressing vegetation, and decreasing the abundance of target species, thereby directly harming food security of

downstream localities, Madeira River in Porto Velho, Rondônia (Brazil). Knowing hunting patterns, land use in new areas, and the role of game meat in resident diets is essential to understand the changes imposed by Santo Antônio HPP.

Acknowledgements

References

Albuquerque U. P., Lucena, R. F. P. & Alencar, N. L. (2010) Métodos e técnicas para a coleta de dados etnobiológicos. In: Albuquerque, U.P.; Lucena, R.F.P. & Cunha, L.V.F.C. (Ed.), *Métodos e técnicas na pesquisa etnobiológica e etnoecológica.* NUPEEA: Recife, pp. 39-64.

Alves, R. R. N. & Souto, W. (2010) Panorama atual, avanços e perspectivas futuras para etnozoologia no Brasil. In: Alves, R. R. N., Souto, W. M. S. & Mourão, J. S. (Eds.). *A Etnozoologia no Brasil: importância, status atual e perspectivas.*NUPEEA: Recife, pp. 19-40.

Alves, R. R. N. & Souto, W. (2011) Ethnozoology in Brazil: current status and perspectives. *Journal of Ethnobiology and Ethnomedicine*, 7(22), 1-18. doi: https://doi.org/10.1186/1746-4269-7-22

Alves, R. R. N., Gonçalves, M. B. R. & Vieira, W. L. S (2012) Caça, uso e conservação de vertebrados no semiárido Brasileiro. *Tropical Conservation Science,* 5(3), 394-416. doi: https://doi.org/10.1177/194008291200500312

Alves, R. R. N., Souto, W. M. S., Fernandes-Ferrreira, H., Bezerra, D. M. M., Barboza, R. R. D. & Vieira, W. L. S. (2018) The importance of hunting in human societies. In: Alves, R. R. N. & Albuquerque, U. P. (Ed.), *Ethnozoology: Animals in our lives,* Academic Press, pp. 95-118. doi: https://doi.org/10.1016/B978-0-12-809913-1.00007-7

Begossi, A. (1996) Use of Ecological Methods in Ethnobotany: Diversity Indices. *Economic Botany* 50(3): 280-289.doi: https://doi.org/10.1007/BF02907333

Begossi, A., Silvano, R. A. M., Amaral, B. & Oyakawa, O. T. (1999) Uses of fish and game by inhabitants of an Extractive Reserve (upper Juruá, Acre, Brazil). *Environment, Development and Sustainability*, 1(1), 73-93. https://doi.org/10.1023/A:1010075315060

Benítez-López, A., Alkemade, R.; Schipper, A. M., Ingarm, D. J., Verweij, P. A., Eikelboom, J. A. J. & Huijbregts, M. A. J. (2017) The impact of hunting on tropical mammal and bird populations. *Science*, 356 (6334), 180-183. doi: https://doi.org/10.1126/science.aaj1891

Bodmer, R. E. & Pezo, E. (1999) Análisis económico del uso de fauna silvestre em la Amazonía Peruana**.** In: Fang, T. G., Montenegro, O. L. & Bodmer, R. E. (Eds.). *Manejo y Conservación de Fauna Silvestre en América Latina*. Editorial Instituto de Ecología: Bolivia, pp.171-182.

Cullen JR., L., Bodmer, R. E. & Padua, C. V. (2000) Effects of hunting in habitat fragments of the Atlantic forest, Brazil. *Biological Conservation*, 95(1), 49-56. doi: https://doi.org/10.1016/S0006-3207(00)00011-2

Davis, A. & Wagner, J. R. (2003) Who knows? On the importance of identifying "experts" when researching local ecological knowledge. *Human Ecology*, 31(3), 463-489. doi: https://doi.org/10.1023/A:1025075923297

Del Rio, V. & Oliveira, L. (1996) *Percepção ambiental: a experiência brasileira.* São Paulo, Studio Nobel São Carlos, 265 pp.

Fernandes-Ferreira, H. & Alves, R. R. N. (2017) The researches on the hunting in Brazil: a brief overview. *Ethnobiology and Conservation*, 6(6), 1-6. doi: http://dx.doi.org/10.15451/ec2017-07-6.6-1-7

Figueiredo, R. A. A. & Barros, F. B. (2015) A comida que vem da mata: conhecimentos tradicionais e práticas culturais de caçadores na Reserva Extrativista Ipaú-Anilzinho. *Fragmentos de Cultura* 25(2), 193-212.doi: http://dx.doi.org/10.18224/frag.v25i2.4181

Figueiredo, R. A. A. & Barros, F. B. (2016) Sabedorias, cosmologias e estratégias de caçadores numa unidade de conservação da Amazônia. *Desenvolvimento e Meio Ambiente, Curitiba*, 36, 223-237. doi: http://dx.doi.org/10.5380/dma.v36i0.43351

Fonseca, G. A. B. & Lourival, R. F. F. (2001) Análise de sustentabilidade do modelo de caça tradicional, no pantanal Nhecolândia, Corumbá, MS. In: Garay, I. & Dias, B. (Eds.). *Conservação da Biodiversidade em Ecossistemas Tropicais*. Vozes: Petrópolis, pp. 150-156.

Hammer, Ø., Harper, D. A. T. & Ryan, P. D. (2001) PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica* 4(1), 1-9.

ICMBio (2018) *Livro Vermelho da fauna brasileira ameaçada de extinção: volume II—mamíferos*. Instituto Chico Mendes de Conservação da Biodiversidade, Brasília, 625p.

IUCN (2020). *Red List*. Recovered http://www.iucnredlist.org (accessed on: 2019/04/13).

Levi, T., Lu, F. Yu, D. W. & Mangel, M. (2011) The behaviour and diet breadth of central-place foragers: an application to human hunters and Neotropical game management. *Evolutionary Ecology Research*, 13(2), 171–185.

Lima, M. A. L., Doria, C. R. C. & Freitas, C. E. C. (2012) Pescarias artesanais em comunidades ribeirinhas na amazônia brasileira: perfil socioeconômico, conflitos e cenário da atividade.*Ambiente & Sociedade*, 15(2), 73-90. doi: http://dx.doi.org/10.1590/S1414-753X2012000200005

Lima, M. A. L., Kaplan, D. A. & Doria, C. R. C. (2017) Hydrological controls of fisheries production in a major Amazonian tributary. *Ecohydrology,* 10(8), e1899. doi: https://doi.org/10.1002/eco.1899

Melo, É. R. de A., Gadelha, J. R., Silva, M. de N. D. da, Júnior, A. P. da S. & Pontes, A. R. M. (2015) Diversity, abundance and the impact of hunting on large mammals in two contrasting forest sites in northern amazon**.** *Wildlife Biology*, 21(5), 234–245. doi: https://doi.org/10.2981/wlb.00095

Mesquita, G.P. & Barreto, L. N. (2015) Evaluation of mammals hunting in indigenous and rural localities in Eastern Brazilian Amazon**.** *Ethnobiology and Conservation*, 4: 1-14.doi: http://dx.doi.org/10.15451/ec2015-1-4.2-1-14

Mesquita, G.P., Rodriguez-Teijeiro, J. D. & Barreto, G.P. (2018) Patterns of Mammal Subsistence Hunting in Eastern Amazon, Brazil. *Wildlife Society Bulletin,* 42(2), 272–283. doi: http://dx.doi.org/10.1002/wsb.873

Moura, F. B. P. & Marques, J. G. W. (2008) Zooterapia popular na Chapada Diamantina: uma medicina incidental? *Ciência & Saúde Coletiva*, 13(2), 2179-2188.doi: http://dx.doi.org/10.1590/S1413-81232008000900023

Oliveira, M. A. & Calouro, A. M. (2019) Hunting Agreements as a strategy for the conservation of species: the case of the Cazumbá Iracema Extractive Reserve, state of Acre, Brazil**.** *Oecologia Australis,* 23(2), 357-366. doi: https://doi.org/10.4257/oeco.2019.2302.13

Pezzuti, J. C. B. & Chaves, R. P. (2009) Etnografia e manejo de recursos naturais pelos índios Deni, Amazonas, Brasil. *Acta Amazonica*, 39(1), 121-138. doi: http://dx.doi.org/10.1590/S0044-59672009000100013

Rebêlo, G. & Pezzuti, J. (2000) Percepções sobre o consumo de Quelônios na Amazônia: sustentabilidade e alternativas ao manejo atual**.** *Ambiente & Sociedade*, 3(6/7), 85-104. doi: http://dx.doi.org/10.1590/S1414-753X2000000100005.

Robinson, J. G. & Redford, K. H. (1994) Measuring the sustainability of hunting in tropical forests. *Oryx*, 28(4), 249-256. doi: http://dx.doi.org/10.1017/S0030605300028647

Santos, E. S., Cunha, A. C. & Cunha, H. F. A. (2017) Usina Hidrelétrica na Amazônia e impactos socioeconômicos sobre os pescadores do município de Ferreira Gomes-Amapá. *Ambiente & Sociedade,* 20(4), 191-208. doi: http://dx.doi.org/10.1590/1809-4422asoc0088r2v2042017

Silvano, R. A. M. & Begossi, A. (2005). Local knowledge on a cosmopolitan fish: ethnoecology of *Pomatomus saltatrix* (Pomatomidae) in Brazil and Australia. *Fisheries Research*, 71(1), 43-59.

Souza-Mazurek, R.R.S., Pedrinho, T., Feliciano, X., Hilário, W., Gerôncio, S. & Marcelo, E. (2000) Subsistence hunting among the Waimiri Atroari Indians in central Amazonia, Brazil. *Biodiversity and Conservation*, 9(5), 579-596. doi: http://dx.doi.org/10.1023/A:1008999201747

Thiollay, J. (2005) Effects of hunting on Guianan forest game birds**.** *Biodiversity and Conservation*, 14(5), 1121-1135. doi: http://dx.doi.org/10.1007/s10531-004-8412-4

Travassos, L. E. P. (2001) Impactos Gerados pela UHE Porto Primavera Sobre o Meio Físico e Biótico de Campinal, Presidente Epitácio, SP. *Revista de Biologia e Ciências da Terra*, 1(1), 1-8.

Valsecchi, J. & Amaral, P. V (2009) Perfil da caça e dos caçadores na Reserva de Desenvolvimento Sustentável Amanã, Amazonas – Brasil**.** *Uakari*, 5(2), 33-48. doi: http://dx.doi.org/10.31420/uakari.v5i2.65

Vasconcelos-Neto, C. F. A., Santos, S. S., Sousa, R. F., Fernandes-Ferreira, H. & Lucena, R. F. P. (2012) A caça com cães (*Canis lupus familiaris*) em uma região do semiárido do nordeste do Brasil. *Revista de Biologia e Farmácia*, 1, 1-16.