



A conspiracy of silence: Subsistence hunting rights in the Brazilian Amazon

André Pinassi Antunes^{a,b,*}, George Henrique Rebêlo^{a,b}, Juarez Carlos Brito Pezzuti^{a,c},
Marina Albuquerque Regina de Mattos Vieira^{a,d}, Pedro de Araujo Lima Constantino^a,
João Vitor Campos-Silva^{a,e}, Rogério Fonseca^{a,f}, Carlos César Durigan^{a,g},
Rossano Marchetti Ramos^{a,h}, João Valsecchi do Amaral^{a,i}, Natalia Camps Pimenta^{a,j},
Tiago Juruá Damo Ranzi^{a,k}, Natália Aparecida Souza Lima^{a,l}, Glenn Harvey Shepard Jr^{a,m}

^a RedeFauna – Rede de Pesquisa em Diversidade, Conservação e Uso da Fauna da Amazônia, Brazil

^b Laboratório de Manejo de Fauna, Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Amazonas, Brazil

^c Núcleo de Altos Estudos Amazônicos (NAEA), Universidade Federal do Pará (UFPA), Belém, Pará, Brazil

^d Instituto Socioambiental (ISA), Boa Vista, Roraima, Brazil

^e Instituto de Biologia e Ciências da Saúde, Universidade Federal do Alagoas (UFAL), Maceió, Alagoas, Brazil

^f Laboratório de interações fogo, fauna e florestas protegidas-LalFFF, Departamento de Ciências Florestais, Faculdade de Ciências Agrárias, Universidade Federal do Amazonas, Manaus, Amazonas, Brazil

^g WCS Brasil – Associação Conservação da Vida Silvestre, Manaus, Amazonas, Brazil

^h Núcleo de Pesquisa e Monitoramento, Prevfogo, Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), Brasília, Distrito Federal, Brazil

ⁱ Grupo de Pesquisa em Ecologia de Vertebrados Terrestres (ECOVERT), Instituto de Desenvolvimento Sustentável Mamirauá (IDSMA), Tefé, Amazonas, Brazil

^j Instituto Socioambiental (ISA), São Gabriel da Cachoeira, Amazonas, Brazil

^k RESEX do Cazumbá-Iracema, Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio), Sena Madureira, Acre, Brazil

^l Centro de Triagem de Animais Silvestres (CETAS), Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA), Manaus, Amazonas, Brazil

^m Museu Paraense Emílio Goeldi/MCTI, Belém, Pará, Brazil

ARTICLE INFO

Keywords:

Wildlife use and management
Food security and sovereignty
Indigenous rights
Traditional people rights
Environmental Brazilian legislation
Sustainable use reserves
Indigenous lands

ABSTRACT

Subsistence hunting is an important cultural activity and a major source of dietary protein and other products for indigenous and non-indigenous populations throughout Amazonia. Nonetheless, subsistence hunting occupies an uncertain legal status in Brazil, leaving many traditional and rural Amazonian populations subject to arbitrary interpretation and enforcement of contradictory laws. The Brazilian Wildlife Protection Act of 1967, which helped to stem the slaughter of wild animals for the international hide market, made the hunting of all wild animals illegal. Later, only indigenous peoples had their rights to hunting explicitly recognized in Brazilian laws. Exceptions for other traditional and rural populations were then introduced, allowing subsistence hunters to own and license guns and hunt with them in a “state of necessity” or “to quench hunger” through the Brazilian Disarmament Statute and Environmental Crimes Law. These legal inconsistencies mean that there is no single regulatory framework for subsistence hunting in Brazil. This scenario of uncertainties jeopardizes the establishment of consistent sustainable hunting management practices across Brazilian indigenous lands, sustainable use reserves and agrarian reform settlement areas. This article analyzes the relevant legislation and examines evidence from key studies with a view towards implementing robust, scientifically informed and practically feasible co-management strategies for indigenous and sustainable use reserves in the Brazilian Amazon. By focusing on subsistence rights, food sovereignty and organizational autonomy as guaranteed in international agreements ratified in Brazil, the framework presented here involves empowerment and technical training of local people in Amazonia to monitor and manage their own resource base.

1. Introduction

“What are the hidden factors of the true conspiracy of silence around hunger? Is it simply a work of chance that this theme has not

properly attracted the interest of the speculative and creative minds of our time? We do not believe so. This phenomenon is so marked and presents itself with such regularity that, far from a work of chance, it seems conditioned by the same general laws that regulate other social

* Corresponding author. Present/permanent address: Estrada do Bexiga 2584, Bairro Fonte Boa, Tefé, Amazonas. CEP: 69553-225, Brazil.

E-mail address: aapardalis@gmail.com (A.P. Antunes).

<https://doi.org/10.1016/j.landusepol.2019.02.045>

Received 15 July 2018; Received in revised form 26 February 2019; Accepted 27 February 2019

Available online 07 March 2019

0264-8377/ © 2019 Elsevier Ltd. All rights reserved.

manifestations of our culture. It is a silence premeditated by the soul of culture itself: it was the interests and discriminations of moral, political and economic orders of our so-called Western civilization that turn hunger a forbidden subject, or at least unwise to be approached publicly”.

–Josué de Castro (1946), former FAO president

Josué de Castro's (1946) words referred to the uncomfortable relationship of avoidance that mid-century elites maintained towards the topic of food security among marginalized peoples of the world. Brazil's Wildlife Protection Act of 1967, and its subsequent ratification of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1973 helped put an end to more than a half century of uncontrolled slaughter of wild animals for the international market in luxury pelts and hides (Antunes et al., 2016). Yet these legislative victories for biodiversity conservation has, once again, led a new “conspiracy of silence” around the topic of food security for marginalized peoples: the generalized ban on wildlife hunting made it technically illegal to hunt wild game, though of course traditional and rural populations, especially in Amazonia, continued hunting as they had for centuries. Ever since, traditional and rural populations of the Amazonian hinterlands have occupied a dubious legal space, hunting at the margins of legality and subject to unpredictable, arbitrary enforcement of wildlife laws.

Hunting is an important element of subsistence and economic self-reliance for indigenous, traditional and rural communities in Amazonia. Yet the connections of traditional peoples with wildlife run deeper than just food security, touching on fundamental questions of identity, spirituality, cosmology and health (Castro, 1996; Descola, 1998; Fausto, 2007; Shepard, 2015).

This article emerged from the workshop entitled “Caça de Subsistência em Áreas Protegidas no Estado do Amazonas: Conhecimento Atual, Questões Legais e Desafios práticos para o Manejo” (Subsistence Hunting in Protected Areas in Amazonas State: Current Knowledge, Legal Issues and Practical Challenges to Management, in free translation from Portuguese), held in November 2016 in Manaus, Amazonas state. The meeting included the voices of traditional community leaders, indigenous people, field technicians and wildlife researchers from governmental agencies, non-governmental organizations, universities and research institutions. The workshop's central goal was to define subsistence hunting in a more nuanced way than typically treated in environmental law and conservation science, and bring hunting out of the informality and “silence” to which it has been relegated by Brazilian law. The meeting also sought to contest the 2016 opinion of a federal prosecutor attached to Brazil's federal wildlife management agency, the Chico Mendes Institute for Biodiversity Conservation (ICMBio), who supported an almost complete ban on subsistence hunting in federal “sustainable use” reserves, a category that includes National Forests, Extractive Reserves, and Sustainable Development Reserves (Legal Opinion 0553/2014/PFE-ICMBIO-SEDE/PGF/AGU). The RedeFauna - Rede de Pesquisa em Diversidade, Conservação e Uso da Fauna da Amazônia - (Research Network on Diversity, Conservation and Use of Wildlife of Amazônia) emerged from this meeting. The network has evaluated a law proposal, still under consideration by the Brazilian Congress (Proposed Law 6268/2016), which would revise the historic Wildlife Protection Act. Though the 1967 law is clearly in need of updating, the current initiative, supported by conservative politicians, emphasizes commercial and sport hunting while mostly disregarding traditional livelihoods and subsistence hunting.

The recognition that hunting, along with fishing, trapping and gathering from forested areas, an important factor in maintaining traditional livelihoods, is enshrined within the universal definition of subsistence economy and traditional activities in Convention 169 of the International Labor Organization (ILO 1989). In addition, traditional and indigenous peoples also have the right to participate in decision-making on the use, management and conservation of the natural

resources pertaining to their lands according to their institutions and worldview. In this, we believe that the regulation of subsistence hunting on traditional peoples' lands could work as a driving force to legitimize their engagement in environmental decisions affecting them.

In Brazil, over 250 different groups of Amerindian peoples are legally considered to be indigenous peoples, with ancestral land rights specifically guaranteed in the 1988 Brazilian Federal Constitution and 1973 Indian Statute. Among non-indigenous traditional peoples, only Afro-Brazilian communities known as “quilombolas” are legally and explicitly recognized (Article 68th of the 1988 Brazilian Federal Constitution). According to the National Policy for the Sustainable Development of Traditional Peoples and Communities (NPTPC, Decree 6040/2007), traditional communities (“quilombolas”, “ribeirinhos”, “seringueiros”, “castanheiros”, “quebradoras-de-babaçu”, “caiçaras” and others non-indigenous traditional peoples) constitute “culturally differentiated groups that recognize themselves as such, who have their own forms of social organization, occupy and use territories and natural resources as a condition of their cultural, social, religious, ancestral and economic reproduction, by using knowledge, innovations and practices generated and transmitted through tradition” (Article 3). These groups are distinct from rural populations and peasants, who typically are agricultural laborers or small farmers living in rural areas. For the scope of this article, analyzing both legal and technical perspectives for the regulation of subsistence hunting in the Amazon, we treat “indigenous peoples”, “non-indigenous traditional peoples” (from now on, “traditional peoples”) and “peasants” or “rural populations” separately, since legal regulatory frameworks in Brazil are often independent from each other.

In Brazil, there is a wide-ranging but fragmented set of legal instruments that in fact pertain to the rights of indigenous, traditional and rural populations on the issue of subsistence hunting, without regulating it *de jure*. First, there are regulations and penal sanctions that relate to the protection of hunted fauna, and are essentially prohibitive in nature. These include the Wildlife Protection Act and the 1998 Environmental Crimes Law, which states that hunting in Brazil is only legal when the hunter or his family is in a “state of necessity”. This first category also includes the only Brazilian law that uses the term ‘subsistence hunter’ explicitly—namely (and somewhat ironically) the “Disarmament Statute.” Second, there are national laws and international treaties that pertain to human rights, and to traditional peoples more specifically. Finally, there are regulations pertaining to land use that define where, how and by whom natural resources can be accessed, used and managed. Such land use regulations include legislation about parks and protected areas in Brazil, indigenous lands formally recognized by governments, sustainable use conservation units or extractive reserves where human populations are allowed to reside and use natural resources, and other kinds of protected areas. Given the lack of broader regulations and definitions, many subsistence hunters remain in a situation of dubious rights and legality.

In this article we first evaluate the legal rights of indigenous peoples with regard to hunting, as defined in Brazilian laws and international treaties. Then we expand our analysis to traditional peoples and other rural populations for whom subsistence hunting is an important cultural activity and a fundamental part of food security and sovereignty. Then we discuss case studies and model projects of participatory hunting monitoring that are appropriate for contrasting the legal context of indigenous lands and extractive reserves in Brazil. We identify practical solutions for implementing legal rights in these specific reserve categories and overcoming the reigning policy of informality. These two specific categories of protected areas, indigenous lands and extractive reserves, provide model settings where subsistence hunting rights can be regulated and implemented. Finally, we suggest that hunting rights should be expanded by strengthening the involvement of other traditional peoples, peasants and rural populations inhabiting remote areas not included in the above-mentioned categories of protected area.

Box 1

Chronological list of the main Brazilian legal instruments on hunting, wildlife use, conservation, wildlife and territorial management, and rights of indigenous, traditional and rural populations. See also Fig. 1.

1. Law 3071 / 01 January 1916 - Civil Code
2. Decree 23672 / 02 January 1934 - Hunting and Fishing Code
3. Decree-Law 1210 / 12 April 1939 - Hunting Code
4. Decree-Law 5894 / 20 October 1943 - New Hunting Code
5. Ordinance 123 / 26 March 1945 - Regulates Article 6 of the Decree-Law 5894
6. Ordinance 64 / 13 April 1953 - Regulates Article 6 of the Decree-Law 5894
7. Law 5197 / 03 January 1967 - Wildlife Protection Act
8. Law 6001 / 19 December 1973 - Indian Statute
9. Brazilian Federal Constitution / 05 October 1988
10. Convention 169 of the International Labor Organization (ILO) / 07 June 1989
11. Decree 592 / 06 July 1992 - Universal Declaration of Human Rights (UDHR)
12. Legislative Decree 02 / 03 February 1994 - Approves the text of the Convention on Biological Diversity
13. INCRA Ordinance 268 / 23 October 1996
14. Law 9605 / 12 February 1998 - Law of Environmental Crimes
15. INCRA Ordinance 477 / 04 November 1999
16. Law 9985 / 18 July 2000 - National System of Conservation Units (SNUC)
17. Decree 4340 / 22 August 2002 - Regulates articles of Law 9985 (SNUC)
18. Environment Ministry (MMA) Normative Instruction 26 / 21 November 2002
19. Law 10826 / 22 December 2003 - Disarmament Statute
20. INCRA Normative Instruction 15 / 30 March 2004
21. Decree 5051 / 19 April 2004 - Promulgation of ILO Convention 169
22. Decree 5758 / 13 April 2006 - National Plan for Protected Areas (PNAP)
23. Law 11346 / 15 September 2006 - National System of Food and Nutritional Security (SISAN)
24. Decree 6040 / 08 February 2007 - National Policy for the Sustainable Development of Traditional Peoples and Communities (NPPTC)
25. Decree 6514 / 22 July 2008 - Provides for administrative infractions and sanctions to the environment
26. Law 11959 / 29 June 2009 - Fishing Code
27. Complementary Law 140 / 08 December 2011 - Regulates Article 23 of CF
28. Decree 7747 / 05 June 2012 - National Policy for Territorial and Environmental Management of Indigenous Lands - PNGATI
29. Dispatch 0430/2013/PFE-ICMBIO-SEDE/PGF/AGU / 10 June 2013
30. Opinion 0553/2014/PFE-ICMBIO-SEDE/PGF/AGU / 03 December 2014
31. Environmental Ministry (MMA) Ordinance 162 / 11 May 2016
32. Proposed Law 6268/ Presented on 10 October 2016 - Revokes Law 5,197/1967 and provisions of Law 9605/1998
33. Opinion 00098/2017/COMAF/PFEICMBIO/PGF/AGU / 08 June 2017
34. Opinion 00176/2017/COMAF/PFE-ICMBIO/PGF/AGU / 20 November 2017
35. Decree 9311 / 15 March 2018

2. Methods

We analyzed Brazilian legal instruments and international conventions to which Brazil is a signatory, focusing on those making reference to hunting, wildlife use and conservation within the context of the rights of indigenous peoples and non-indigenous traditional and rural populations (Box 1; Fig. 1). We evaluate important case studies and discuss the scientific data concerning subsistence hunting and regulation, weighing the demographic and ecosystemic impacts of hunting against evidence for socioecological resilience. We discuss the legal meanings and social indicators surrounding the concept of “state of necessity”, the tenuous loophole upon which the legality of subsistence hunting in Brazil has depended since the 1998 Law on Environmental Crimes. In order to better conceptualize the field of study, we assess the long history and socioecological diversity of subsistence hunting in Amazonia. Finally, we consider future scenarios for the sustainable use of wildlife within a legal regulatory framework that would reconcile the cultural and territorial rights and food sovereignty of indigenous and traditional populations and peasants with sustainable uses of biodiversity and ecosystem conservation.

3. Results**3.1. Hunting rights of indigenous peoples**

The cultural importance of hunting is enshrined in article 23 of the International Labor Organization’s Convention 169 on Indigenous and Tribal Peoples (ILO 1989), signed in Geneva on 27 June 1989, and formally adopted in Brazil by Decree 5051/2004. The Convention provides a broad definition of subsistence economy and other traditional activities, asserting the deep connections of indigenous peoples to wildlife and legitimizing their engagement in environmental decisions that affect their lands and livelihoods:

“The rights of the concerned peoples to the resources within their territories should be specially protected... Traditional and subsistence-related activities of the peoples concerned, such as *hunting*, fishing and harvesting, should be recognized as important factors in maintaining their culture, self-sufficiency and economic development. With the participation of these peoples, and where appropriate, governments should strengthen and encourage these activities” (ILO 1989, Article 23) (emphasis added).

Despite the lack of clarity in the definitions of the Wildlife Protection Act of 1967, hunting rights for indigenous people in Brazil were unquestionably assured by later legislation. The Indian Statute of

Conflicting or discretionary laws	<p>Wildlife Protection Act (Law 5,197 /1967) It is prohibited the use, persecution, destruction, hunting or harvesting of wildlife" (Art. 01).</p> <p>Law of Environmental Crimes (Law 9,605/1998) "It is not a crime to slaughter an animal when in a state of necessity, to quench the hunger of the agent or his family" (Art. 37).</p> <p>Disarmament Statute (Law 10,826/2003) "Residents in rural areas who are more than twenty-five (25) years old who prove to be dependent on the use of firearms to provide for their family's food subsistence will be permitted by the Federal Police to possess a firearm in the category 'subsistence hunter' and to use a shotgun of 16 gauge or less (Art. 06).</p>		
	Indigenous peoples	Traditional peoples	Rural populations and peasants
	<p>International Covenant on Civil and Political Rights (Decree 592/1992) "All people may freely dispose of their wealth and natural resources. In no case shall a people be deprived of their means of subsistence." (Art. 01)</p> <p>Brazil's 1988 Federal Constitution "Basic social rights are enumerated: "education, health, food, work, (...)" (Art. 215). "The full exercise of cultural rights to everyone" (Art. 215). "Adequate use of available natural resources and preservation of the environment" (Art. 186). "It is the responsibility of the Union, States and Federal District to legislate concurrently on: VI - forests, hunting, fishing, wildlife, nature conservation, soil and natural resource protection, protection of the environment and pollution control" (Art. 24).</p> <p>National System of Food and Nutrition Security (NSFNS, Law 11,346/2006) "Adequate food is a fundamental right of human beings, inherent to the dignity of the human person and indispensable to the realization of the rights enshrined in the Federal Constitution, such that the public power must adopt policies and actions that are necessary to promote and guarantee food and nutritional security of the population" (Art. 02). "(...) based on practices promoting health and respecting cultural diversity" (Art. 03). "Food and nutritional security cover: conservation of biodiversity and sustainable use of resources" (Art. 04).</p>		
Explicit or implicit legal instruments supporting the right to subsistence hunting by indigenous peoples, traditional and rural populations and peasants	<p>Convention 169 of the International Labor Organization (Decree 5,051/2004) "The rights of the concerned peoples to the resources within their territories should be specially protected". "Traditional and subsistence-related activities of the peoples concerned, such as hunting, fishing and harvesting, should be recognized as important factors in maintaining their culture, self-sufficiency and economic development. With the participation of these peoples, and where appropriate, governments should strengthen and encourage these activities" (Art. 23).</p>		
	<p>Brazil's 1988 Federal Constitution "Ancestral rights over lands that traditionally occupy" "The lands traditionally occupied by the Indians are those inhabited by them on a permanent basis, those used for their productive activities, those indispensable for the preservation of the environmental resources necessary for their well-being and those necessary for their physical and cultural reproduction, according to their uses, customs and traditions" (Art. 231).</p> <p>Indian Statute (Law 6,001/73) "Exclusive exercise of hunting and fishing in the areas they occupy" (Art. 24).</p>	<p>National Policy for the Sustainable Development of Traditional Peoples and Communities (NPTPC, Decree 6,040/2007) "Food and nutritional security is a right of traditional peoples and communities to regular and permanent access to quality food in sufficient quantity without harming access to other essential needs, based on food-promoting health practices that respect cultural diversity and that are environmentally, culturally, economically and socially sustainable" (Art. 03)</p> <p>National System of Conservation Units (SNUC) (Law 9,985/2000) "Protecting the natural resources necessary for the subsistence of traditional populations, respecting and valuing their knowledge and culture and promoting them socially and economically (Art. 04)</p>	
Legal instruments of wildlife management or territorial management	<p>National Policy for Territorial and Environmental Management of Indigenous Territories (PNGATI) (Decree 7,747/2012) "recognition, valorization and development of environmental management as an instrument to protect the territories and environmental conditions necessary for the physical, cultural and well-being of indigenous peoples and communities" (Art. 03). "ethnomapping and ethnozoning are tools for territorial and environmental management of indigenous lands" (Art. 02).</p>		
	<p>Wildlife Protection Act (Law 5,197 /1967) "If regional peculiarities allow hunting, the formal permission will be established in a regulatory act by the Federal Public Power" (Art. 01).</p> <p>Ordinance MMA 162/2016 "The National Lists should be elaborated considering regional aspects and the needs of use and management tools, in order to allow the sustainable use of endangered species" (Art. 01).</p> <p>Decree 9,311/2018 "Settlement Project - territorial unit destined to the settlement of families of farmers or rural workers created or recognized by the National Institute for Agrarian Reform (INCRA) (Art. 03).</p>		
	<p>Ordinance INCRA 268/1996 Agroextractive Settlement Project (PAE)</p> <p>Ordinance INCRA 477/1999 Sustainable Development Project (PDS)</p> <p>National System of Conservation Units SNUC (Law 9,985/2000) "Management Plan: technical document that establishes its zoning and the norms that should govern the use of the area and the management of natural resources" (Art. 02).</p> <p>Decree 4,340/2002 "The term of commitment should indicate the areas occupied, the limitations necessary to ensure nature conservation, and duties of the management agency regarding indemnities, ensuring access of these populations to their sources of subsistence and safeguarding their ways of life" (Art. 39).</p> <p>Normative Instruction MMA 26/2002 "establishment of norms for the sustainable use of not threatened Brazilian wildlife, traditionally used by traditional populations in Extractive Reserves" (Art. 1)</p> <p>Normative Instruction 15/2004 Federal Settlement Project (PA)</p>		

Fig. 1. Brazilian legal instruments on hunting, wildlife use and conservation, wildlife and territorial management, and rights of indigenous, traditional and rural populations.

1973 guarantees their “exclusive exercise of hunting and fishing in the areas they occupy” (Article 24, Paragraph 2). Article 231 of the Federal Constitution of 1988 further guarantees their rights to traditional territories and use of natural resources. Indigenous people continue hunting in their lands throughout Amazonia with little discussion about their permission to do so (Souza-Mazurek et al., 2000; Pezutti and Chaves, 2009; Linke, 2009; Carneiro, 2015; Constantino, 2015). However, given the rapid and widespread socioecological changes in Amazonia (Levi et al., 2009; Parry et al., 2010; Sarti et al., 2015; Constantino, 2016), appropriate management through an adaptive perspective that respects indigenous rights and involves them in decision making seems timely.

3.2. Subsistence hunting restrictions for traditional and rural peoples

Outside recognized indigenous lands, the situation for traditional peoples, peasants and other rural populations, and even indigenous peoples is quite different. Contradictory laws and incongruous legal concepts regarding human rights vs. wildlife protection result in an uncertain legal status for the practice of subsistence hunting. According to the Wildlife Protection Act of 1967 the “use, persecution, destruction, hunting or harvesting” of wildlife is universally prohibited throughout Brazil. Brazil’s adoption of the CITES treaty further reinforced the prohibition, through the regulation of international wildlife trade. Thus in theory, hunting in Brazil became illegal. However, in practice, it merely fell into silence: unreported, undocumented, an inconvenient reality that was best overlooked. Nevertheless, the 1967 Wildlife Protection Act contains the following caveat: “If regional peculiarities allow hunting, the formal permission will be established in a regulatory act by the Federal Public Power”.

Three decades later, the Law of Environmental Crimes (9605/1998) clarifies that hunting is considered legal when practiced “in a state of necessity, to quench the hunger of the agent or his family”. The lack of a clear legal definition or adequate technical regulations regarding subsistence hunting means that individual hunters are subject to the interpretative whims of law enforcement and wildlife protection agents in judging their “state of necessity”. This ambiguity has resulted in the insecurity and marginalization of subsistence hunters at multiple levels: social, nutritional, legal, and jurisdictional. In repeated instances, Brazilian law enforcement has criminalized subsistence hunting.

Further confusion is illustrated in the Brazilian Disarmament Statute (10826/2003), which implicitly contradicts the 1998 law by establishing that “residents in rural areas who are more than twenty-five (25) years old who prove to be dependent on the use of firearms to provide for their family’s food subsistence will be permitted by the Federal Police to possess a firearm in the category ‘subsistence hunter’ and to use a shotgun of 16 gauge or less”.

In addition as noted previously, the 23rd Article of ILO Convention 169 further seeks “to guarantee to traditional peoples and communities their territories and access to natural resources they traditionally use for physical, cultural and economic reproduction”, calling governments to assume responsibility to “ensure that these activities are encouraged and strengthened”. While ILO Convention 169 makes direct mention of indigenous and tribal peoples, it is not clear if this convention also encompasses other traditional peoples communities (Oliveira Júnior, 2014), whose social, cultural and economic conditions likewise distinguish them from other segments of the national population, and whose activities are regulated wholly or partially by their own customs and traditions.

The Brazilian National Policy for the Sustainable Development of Traditional Peoples and Communities (NPTPC, Decree 6040/2007) represents a crucial legal instrument defining traditional peoples and establishing guidelines, objectives and actions aimed at guaranteeing their rights. In contrast to ILO Convention 169, NPTPC does not contain a clear statement on hunting rights. However, the commitment of NPTPC to the food sovereignty of traditional populations is evident:

“Food and nutritional security is the right of traditional peoples and communities to regular and permanent access to quality food in sufficient quantity without harming access to other essential needs, based on food-promoting health practices that respect cultural diversity and that are environmentally, culturally, economically and socially sustainable.” The policy also explicitly promotes “articulation and integration with the National System of Food and Nutrition Security (NSFNS)”.

In contrast to the dubious status of hunting, subsistence fishing is clearly defined, regulated and legalized in the Brazilian Fisheries Code (Law 11959/2009) “when used for domestic consumption or exchange for non-profit purposes and using gear permitted by specific legislation.” Historically, however, hunting and fishing were regulated jointly beginning with the 1916 Civil Code. The subsequent 1934 Hunting and Fishing Code (Decree 23672) established specific permissions for fishermen and hunters throughout national territory. In 1939, the Hunting and Fishing Code was revoked and replaced by the Hunting Code (D.L. 1210), stating that all “Brazilians in the exercise of their civil rights” could hunt, while defining the distinctive categories of “professional hunter,” who obtained profit from hunting activities, as opposed to “amateur hunter,” who “aims exclusively for purposes of sport” (Article 7). In 1943 a new Hunting Code (D.L. 5894) was promulgated, with the same structure as the previous one. The Fishing Code was established in a separate law, and from that moment onward, fishing and hunting have followed contrasting legal and regulatory pathways, despite the fact that they are complementary activities for obtaining protein in much of rural Brazil, especially the Amazon. In 1945 and 1953, Ordinances 123 and 64, respectively, offered the most complete regulatory instruments for hunting in Brazilian history, dividing species into categories of “game animal”, “rare”, “dangerous” and “protected” and establishing hunting seasons, refuge areas, rules and annual quotas for hunters, all defined according to regional specificities. While specific government agencies were created to regulate and monitor fisheries within an adaptive legal framework that sought to guarantee sustainability, hunting regulation has been left to individual environmental law enforcement agents. Since the 1967 Wildlife Act and especially the 1998 Law of Environmental Crimes, such environmental agents have been instructed by prosecutors to cite hunters caught with dead animals and guns, leaving it up to the judge or police to assess whether the defendant was in a “state of necessity” or not. Penalties and legal jeopardy for hunters depend on the subjective perceptions and discretionary whims of the authorities.

3.3. Hidden subsistence hunting in ancillary laws for traditional and rural peoples

Adding still more layers to this complex and chaotic legal situation, subsistence hunting rights are also open to interpretation within the framework of ancillary socioenvironmental laws that, although making no specific reference to hunting, do guarantee traditional peoples’ access to natural resources. These laws create a broad framework that could be used to assert, as fundamental civil rights, both ancestral and contemporary forms of resource use that are crucial for cultural and physical reproduction, nutrition and well-being. The International Covenant on Civil and Political Rights (enacted in Brazil by Decree 592/1992) specifies “all people may freely dispose of their wealth and natural resources. In no case shall a people be deprived of their means of subsistence.” Brazil’s 1988 Federal Constitution states that the state will guarantee: the “adequate use of available natural resources and preservation of the environment” (Paragraph II, Article 186, Chapter III, Title VII – Economic and Financial Order); “the full exercise of cultural rights to everyone” (Article 215, Section II, Chapter III, Title VIII – On the Social Order); “to protect wildlife and wild plants, and prohibit by law those practices that endanger their ecological function, cause extinction of species or expose animals to cruelty” (Section VII, Article 225, Chapter VI, Title VIII – On the Social Order). Among the

basic social rights are enumerated: “education, health, food, work, housing, leisure, security, social security, maternity, child protection, assistance to impoverished people”; “Everyone has the right to an ecologically balanced environment, of common use to people and essential for health, imposing on the Government and the community the duty to defend and preserve it for present and future generations” (Article 225, Chapter VI, Title VIII – On the Social Order). Finally, article 24 specifically states, “It is the responsibility of the Union, States and Federal District to legislate concurrently on: VI - forests, hunting, fishing, wildlife, nature conservation, soil and natural resource protection, protection of the environment and pollution control” (Chapter II, Title III - Organization of the State).

The National System of Food and Nutrition Security (NSFNS), created by Law 11346/2006, establishes that “adequate food is a fundamental right of human beings, inherent to the dignity of the human person and indispensable to the realization of the rights enshrined in the Federal Constitution, such that the public power must adopt policies and actions that are necessary to promote and guarantee food and nutritional security of the population” (Article 2), “...based on practices promoting health and respecting cultural diversity” (Article 3). Article 4 states that “food and nutritional security cover: conservation of biodiversity and sustainable use of resources”.

3.4. Land use categories and sustainable hunting management

The National Policy for Territorial and Environmental Management of Indigenous Territories (PNGATI), created by Decree 7747/2012, is the main legal instrument with general guidelines for territorial and environmental management of indigenous lands, guaranteeing autonomy to indigenous peoples in managing their territories and natural resources. The “Management Plans” that have resulted from this policy encompass locally specific regulations concerning the use of wildlife by indigenous people, ranging from informal social norms to specific harvest rules to restrict overhunting. PNGATI promotes “recognition, valorization and development of environmental management as an instrument to protect the territories and environmental conditions necessary for the physical, cultural and well-being of indigenous peoples and communities” (Art. 03).

Maintenance of traditional livelihoods is also central to the National System of Conservation Units (SNUC), through the publication of Law 9985/2000. One of its objectives is “protecting the natural resources necessary for the subsistence of traditional populations, respecting and valuing their knowledge and culture and promoting them socially and economically” (Article 4). The main goal of sustainable use conservation units is to reconcile biodiversity conservation with the sustainable exploitation of resources by human populations inhabiting protected areas, promoting resource management strategies that include broad participation of reserve inhabitants. An Extractive Reserve (RESEX) is defined as an “area used by traditional populations whose livelihood is based on extractivism... and its basic objective is to protect the livelihoods and culture of these populations.” Similarly, the Sustainable Development Reserve (RDS) “is a natural area that shelters traditional populations whose existence is based on sustainable systems of exploitation of natural resources”. Both RESEX and RDS are managed through formal management plans and deliberative councils that involve a broad participation of local actors in decision-making about natural resource use. National Forests (FLONA) also aim to promote “the sustainable, multiple use of forest resources”. Finally, the Wildlife Reserve (Art. 19) is a category intended for “technical and scientific studies on the sustainable economic management of wildlife resources”, however, somewhat ironically, no reserves in this category have been created to date.

Environment Ministry (MMA) Normative Instruction 26/2002 establishes “norms for the sustainable use of non-threatened Brazilian wildlife, traditionally used by traditional populations in Extractive Reserves” (Art. 1) through the development of a Technical Project

proposed by residents.

Even rural or traditional people living inside strictly protected conservation units (national parks, biosphere reserves) have some legal rights to natural resources through the so-called Terms of Commitment clause (Decree 4340/2002), establishing that “as long as [the inhabitants] are not resettled, the conditions of permanence of traditional populations... will be regulated by a Term of Commitment negotiated between the management agency and local populations, after consultation of the strictly protected area’s council” (Article 39). “The term of commitment should indicate the areas occupied, the limitations necessary to ensure nature conservation, and duties of the management agency regarding indemnities, ensuring access of these populations to their sources of subsistence and safeguarding their ways of life” (Article 39).

Decree 5758/2006 establishes the National Strategic Plan for Protected Areas (NPPA), reinforcing the importance of protected areas while considering the conditions in which local inhabitants live, establishing that populations living within and around protected areas should participate in their management. Among the principles listed in the NPPA are: “promotion of participation, social inclusion and the exercise of citizenship in the management of protected areas, permanently seeking social development, especially for populations inside and surrounding protected areas”; “consideration of gender balance, generations, culture and ethnicity in the management of protected areas”; and “promoting social participation in all stages of NPPA implementation and evaluation.” According to this document, “the establishment of new protected areas, as well as the collaborative management of existing protected areas, should consider the interfaces of biological diversity with sociocultural diversity, economic aspects, infrastructure necessary for national development, South American integration, security and national defense.”

The National Institute of Colonization and Agrarian Reform (INCRA) guarantees land rights and promotes the social function of land to rural peoples and peasants through redistributing rural properties. One of INCRA’s main mechanisms is the establishment Settlement Projects. A Settlement Project is a “territorial unit destined to the settlement of families of farmers or rural workers created or recognized by INCRA” (Decree 9311/2018), and has specific territorial regulation based on economic viability, environmental sustainability and territorial development. A wide legal framework has been constructed in Brazil since the 1960s, including the Land Statute (Law 4504/1964). Beneficiary families include peasants, “farmers or rural workers - peoples engaged in agricultural or non-agricultural activity in rural areas” (Decree 9311/2018). In accordance with INCRA’s Normative Instruction 15/2004, Settlement Projects “consist of a set of actions, in an area intended for agrarian reform, with interdisciplinary and multisectoral planning, integrated with territorial and regional development, defined based on precise diagnoses about the beneficiary public and the areas to be exploited, oriented for the rational use of physical spaces and existing natural resources, aiming at the implementation of sustainable living and production systems, with a view to fulfilling the social function of the land and the economic, social and cultural promotion of the rural and of their families”.

The environmentally differentiated project modalities include the Agroextractive Settlement Project (PAE), a “project for the exploitation of areas with extractive wealth, through economically viable, socially just and ecologically sustainable activities, to be carried out by the populations that traditionally occupy the respective area”, and Sustainable Development Project (PDS) – “project of social and ecological interest destined to the populations that base their subsistence in extractivism, family-based agriculture and other activities of low environmental impact”. Though not mentioned specifically, hunting is also as an important source of protein and livelihood for these communities. For this reason, they suffer from legal inconsistencies where hunting is involved (Fragoso and Santos, 2000).

3.5. “State of necessity” and food sovereignty

The status of subsistence hunting for non-indigenous peoples in contemporary Brazil depends largely on legal interpretations of the phrase “state of necessity” in the 1998 Environmental Crimes Law. A 2014 opinion by Brazil’s environmental regulation agency, ICMBIO (opinion 0553/2014/PFE-ICMBIO-SEDE/PGF/AGU) revealed the fragility of these rights in the face of idiosyncratic legal interpretations. This opinion argued against formal adoption of hunting management agreements with local inhabitants of Tefé National Forest in Amazonas State. The argument hinged on a strict interpretation of the phrase “state of necessity,” claiming that, even though traditional populations can continue to inhabit historical territories included within a protected area’s boundaries, hunting is only legal if the hunter is unable to find another animal protein source. In other words, hunting is the exception, not the rule. Such idiosyncratic and arbitrary decisions by state officials would appear to threaten the fundamental rights, dignity, social well-being, food security, culture, and environmental quality of local peoples as tacitly (though not explicitly) guaranteed in other relevant laws and policies. In practice, this legal opinion would make it impossible to legally regulate wildlife management and subsistence hunting in sustainable use reserves. The opinion in turn undermines governance and social mobilization surrounding socioenvironmental management processes already initiated in some reserves, initiatives that might otherwise strengthen conservation and sustainable use of biodiversity.

The economy of indigenous and traditional populations in the Amazon remains dependent on traditional subsistence activities such as hunting, fishing, extractivism, foraging and swidden cultivation, which are all unpredictable sources of food sustenance. The daily diet of Amazonian societies generally shows a restricted repertoire, sufficient in carbohydrate and protein intake but sometimes lacking in fat and calories for most adults (Siren and Machoa, 2008; Dufour et al., 2016). Traditional diets may also be deficient in micro- and macronutrients for children, pregnant and lactating women due to their higher requirements (Dufour et al., 2016). However, broad, multi-seasonal studies are scarce, and Amazonian diets may be much more complex and diverse than once thought (Clement, 2019), especially when taking into account the tremendous diversity of plant protein sources and the broad local knowledge on food plants (Machado, 2018). Nonetheless, garden staples such as bitter or sweet manioc (*Manihot esculenta*) and plantains (*Musa* spp.) provide between 50% and 80% of the total dietary energy and up to 20% of the protein ingested by Amazonian populations. Other cultigens and domesticated or wild fruits complement the intake of micro- and macronutrients on a variable basis (Aguar, 1996; Dufour et al., 2016).

Hunting has been shown to provide between 8 and 72% of total protein consumed by Amazonian populations (Calouro and Marinho-Filho 1995, Sarti et al., 2015; Dufour et al., 2016), depending on the socioecological and cultural contexts. Per capita ingestion of bushmeat in some indigenous and traditional people varies from 150 g to 280 g per day (Robinson and Bennett, 2000; Nunes, 2018). Bushmeat ensures that vitamin C and iron intake remain generally above typical daily recommendations (Sarti et al., 2015). Meat is a particularly important source of sustenance in the Amazon, where micronutrient deficiency diseases such as scurvy, beriberi, and anemia are recurrent and often aggravated by other endemic diseases, including intestinal parasites and malaria (Castro, 1946; Neumann et al., 2003; Taddei et al., 2011). In addition, amino acids from animal protein are responsible for metabolizing residual cyanogens from processed bitter manioc, which in high concentration can be toxic, affecting cell oxygen transport (Dufour et al., 2016).

Although widespread in other rural areas of Brazil, the raising of cattle, pigs and chicken is not common among many traditional Amazonian peoples. Domestic animal husbandry could be considered as a strategy to minimize pressure on wildlife populations, especially in heavily fragmented areas inhabited by colonists. However, in forested

areas of Acre State, for example, the overwhelming majority of husbandry initiatives in raising chicken, duck, sheep, pig or fish to serve as protein sources have collapsed for technical, social and environmental reasons (P. Constantino pers. obs.). In this region, complex infrastructure and technology would be required to produce enough meat from husbandry to substitute the amount of wildmeat consumed in subsistence hunting communities (Nunes, 2018). Moreover, domestic animal husbandry also implies severe impacts on biodiversity, including habitat conversion or deforestation to create space for animals to live and for their food production, the use of chemical fertilizers and pesticides chemical inputs and the introduction of herd diseases, which can cause much greater impacts on wild fauna and ecosystems than hunting itself (Nunes, 2018). Meanwhile, replacing the same amount of bush meat with chicken implies reducing iron intake by 65%, zinc intake by 24% and vitamin C intake by 17% (Sarti et al., 2015). In addition, people who eat game meat have a healthier nutritional intake, consuming less carbohydrates (-10%), more protein (+46%), iron (+151%) and zinc (+23%) (Sarti et al., 2015).

From the perspective of historical ecology, why raise domestic animals if it is possible to manage animals within the surrounding forest landscapes, as has been practiced for centuries? Especially given the fact that resource use is a recognized right of traditional populations, it would appear that relegating subsistence hunting by traditional populations to a mere “state of necessity” is seriously inappropriate. Although game meat is an indispensable resource for the nutritional status of human populations in the Amazon, subsistence hunting rights must be supported by broader legal instruments that encompass this practice under the perspective of an ancestral and cultural activity in accessing natural resources.

Interpretations of “state of necessity” do not take into account the social and environmental reality of local people. Indeed, one might argue that the historic violation of their territorial rights, the predatory extraction of natural resources by outside actors, and the large-scale environmental degradation resulting from dams, deforestation, highways, livestock and commercial monoculture have left these people in a constant “state of necessity” with only the minimal natural resources necessary for their survival, including hunting. Indigenous and other forest peoples living along the “deforestation arc” stretching across the southern to central-western Amazon have seen their territories fragmented or completely deforested. The calamitous state of malnutrition among the Guarani-Kaiowá indigenous people in Mato Grosso do Sul constitute on ongoing “state of necessity,” with animal populations so depleted in their traditional territories that hunting no longer provides food security.

3.6. The multiplicity of subsistence hunting in the Amazon

Any interpretation of the suite of Brazilian laws that does not consider subsistence hunting as a traditional resource use activity threatens fundamental rights to an activity with ancient roots in the Amazon (Roosevelt et al., 1991; Porro, 1995; Prestes-Carneiro et al., 2016). We provide a brief conceptualization of subsistence hunting in Amazonia in Box 2. In a biome with a continental scale, still quite preserved and mostly on the margins of the global market, the main protein intake for approximately 8 million Brazilian rural people still comes from hunting and fishing.

Hunting assumes a socially structuring function around the food supply (Morsello et al., 2015). Although mostly a male activity, through which the hunter conceives his social status, women play a fundamental role in the preparation and cooking of meat, as well as in its distribution and circulation, acting directly in the construction and maintenance of family and community ties (Siskind, 1973; Constantino et al., 2008). From the family and community level, to small urban areas, trade and exchange of surplus meat, though devoid of any profit-making purpose, can be a structuring factor of subsistence hunting, allowing rural communities (sometimes in extreme isolation) to exchange for goods

Box 2

A conceptual framework for subsistence hunting in Amazonia.

Along with fishing, gathering, extractivism and swidden cultivation, hunting is an important traditional practice and fundamental component of the subsistence economy for indigenous and non-indigenous populations from remote areas of the Amazon, for obtaining food as well as other culturally important by-products. Hunting assumes a socially structuring function around the food supply in these societies. Often, surplus meat is locally traded and exchanged to obtain essential items for local welfare, without any profit-making purpose. Hunting is based on knowledge accumulated throughout generations about natural history, ecological interactions, use of territory and social norms, permeating a complex normative universe of prohibitions, taboos and preferences. Game offtake profiles, hunting techniques and the relative importance of hunting in relation to fishing vary in space and time throughout the high complexity of socioecological systems of Amazonia

essential to local welfare, such as food, clothing, shoes, toiletries etc. (van Vliet et al., 2015).

Hunting is based on knowledge accumulated through generations about natural history, ecological interactions, use of territory and social norms, regulating the interactions between the hunter, wildlife, society and the forest that surround them. The hunter's choices are not merely shaped by the optimization of economic rationality around the costs of obtaining food and energy benefits from the prey. Rather, they permeate a complex normative universe of prohibitions and preferences (Ingold, 2004; Shepard, 2015). Indigenous and traditional Amazonian societies reveal systems of taboos and hunting rules that function as informal social institutions, structuring economic and social practices in the use of natural resources (Ross, 1978; Colding and Folke, 2001; Shepard, 2002; Hurtado-Gonzales and Bodmer, 2004; Luzar et al., 2012; Vieira and Shepard, 2017). Such prohibitions are often surrounded by symbolic notions of the social and spiritual relations of human beings to animals (Castro, 1996; Descola, 1998; Fausto, 2007).

The game offtake profiles and the relative importance of hunting in relation to fishing vary in space and time throughout the complex socioecological systems in Amazonia. In riverine communities along the larger rivers and tributaries, especially those established in floodplains periodically inundated by white waters, daily fish consumption is among the highest in the world (Isaac and Almeida, 2011). However, river turtles (Podocnemidae) and their eggs, some birds (Anseriformes, Phalacrocoracidae and Cracidae), capybaras (*Hydrochaeris hydrochaeris*) and primates (*Alouatta* spp.) are also significant (Lopes et al., 2012). In non-flooded terra firme forests, game is more diverse and can reach similar values or even higher protein offtake than fishing (Calouro and Marinho-Filho, 2005), due especially to the greater richness and abundance of ungulates, caviomorphous rodents (*Cuniculus paca* and *Dasyprocta* spp.), large primates (especially Atelidae), and tortoises (*Chelonoidis* spp.). In traditional communities of central Amazonia with access to both terra firme and floodplains, fishing is relatively more important year round (Endo et al., 2010; Morcatty and Valsecchi, 2015). During high water season, however, fish disperse across aquatic landscapes, making their catch more difficult. In this season, hunting becomes an essential activity (Terra, 2007; Vieira et al., 2015), as animals disperse from floodplains and inundated forests to upland terra firme. Subsistence hunting is also an activity of great importance for rural communities and peasants settled along the highways constructed in the Amazon since the 1970s (Smith, 1976; Ayres and Ayres, 1979; Bonaudo et al., 2005).

4. Discussion

Intending to put an end to uncontrolled commercial hunting, in which millions of animals were slaughtered to supply the international market in hides and pelts (Antunes and Venticinque, 2014, 2016), the Wildlife Protection Act of 1967 played a key role in the recovery of wildlife populations in the Amazon. However, it also made subsistence hunting illegal in Brazil, ignoring the crucial importance of this activity for the food security, livelihoods and culture of millions Amazonian

peoples (Box 2).

Fifty years after the enactment of Brazil's Wildlife Protection Act, there is no consistent regulatory framework governing subsistence hunting in Brazil. There has been no progress in regulating subsistence hunting in this country, highlighting a certain "necessity of the state" to broaden its legal, technical and scientific understandings about hunting. Regulating hunting will prove to be a fundamental step to ensuring the nutritional and food security, empowerment and autonomy of indigenous peoples, non-indigenous peoples and rural peasants, as well as for reducing impacts on animal populations. However, the 1967 law did make provisions allowing for "regional peculiarities," creating a loophole that might permit governmental regulation of hunting activities deemed sustainable.

Over the last thirty years, a large body of scientific evidence has focused on the sustainability of subsistence hunting in Amazonia. Multiple studies have found that subsistence hunting locally reduces the density, abundance and biomass of large and medium-sized game species populations (Bodmer et al., 1994; Bodmer, 1995; Alvard et al., 1997; Robinson and Bennett 2000; Peres, 2000a, 2000b), with greater impacts on species with low inherent rates of population growth (Bodmer et al., 1997). More recent studies have been somewhat critical of these conclusions, noting that transect methods for estimating animal densities (Buckland et al., 2004) may underestimate game densities. Such transect studies have been the main tool used to assess hunting sustainability and make decisions regarding wildlife management (Constantino et al., 2008; Fragoso et al., 2016). Furthermore, the "sustainability index" used for assessing hunting sustainability (Robinson and Redford, 1991) does not take into account migration from nearby refuge areas (Joshi and Gadgil, 1991; Novaro et al., 2000; Shepard et al., 2012). These so-called source-sink dynamics turn out to be one of the main mechanisms maintaining hunting sustainability in Amazonia (Antunes et al., 2016). Moreover, when subsistence hunting is evaluated at a landscape scale, and when not associated with other sources of environmental impact such as deforestation or commercial hunting, it often shows positive signs of sustainability even for highly vulnerable prey species such as large monkeys and tapir (Novaro et al., 2000; Levi et al., 2009; Constantino, 2016), species which have predicted to be locally extinct using traditional sustainability indices (see Ohl-Schacherer et al., 2007).

Many such studies also focus only on hunting as a source of game depletion, disregarding management as an inherently socioecological process, and also ignoring opportunities for and an interdisciplinary studies and management to achieve sustainability. Such hunting impact studies often ignore the socioeconomic role of hunting, local management rules and the in-depth knowledge of traditional hunters about the natural history of animals and ecosystems, as well cultural mechanisms of wildlife management. Through self-organization and social mobilization, traditional peoples have developed adaptive strategies supported by local rules and institutions, and become more resilient to socioecological changes (Kates et al., 2019; Olsson et al., 2004; Ostrom, 2009; Campos-Silva et al., 2017). Thus, subsistence hunting should be understood in a broader perspective and evaluated according to

questions such as: Who hunts? Why, what, when and where? An interdisciplinary approach is imperative to resolve the conflicts that have persisted for half a century in the Amazon and the rest of Brazil.

An appropriate regulatory framework can contribute to establishing the governance and management conditions to enhance the sustainability of subsistence hunting. Several Brazilian laws and international conventions guarantee fundamental civil rights, both ancestral and contemporary forms of resource use, that are crucial for cultural and physical reproduction, nutrition and well-being. Notably, regulations with a territorial focus tend to recognize the right of local populations in managing their territory and the natural resources they historically use: Management Plans for Protected Areas (provided in SNUC/2000), Plans for Territorial and Environmental Management of Indigenous Territories (established in PNGATI/2012) and Agrarian Reform Settlements Projects. These policies encourage active participation of local populations in conservation and management of natural resources, and are promising tools for subsistence hunting management. The interface between local and scientific knowledge is essential for the elaboration of management plans capable of promoting intercultural dialogue, often mediating negotiations between local populations, other social actors and government.

One of the main tools for territorial management provided in SNUC and PNGATI is spatial land use zoning. Based on a participatory process, spatial zoning consists of the delimitation within protected areas of specific regions under different ecological and socioeconomic characteristics, providing rules and categories for the use of natural resources in zones of protection, extensive and intensive uses. Such an approach is in consonance with territorial management perspectives historically undertaken by indigenous and non-indigenous peoples, who traditionally preserve sacred areas or places of special spiritual protection (Joshi and Gadgil, 1991; Wadley and Colfer, 2004; Read et al., 2010) and maintain strategies of displacement throughout their territory in regard to wildlife migration, phenology and conflict with neighboring groups (Albert and Le Tourneau, 2007).

Faced with uncertainties about the ecology and resilience of wildlife, as well as the numerous variables that affect conservation (Milner-Gulland and Akçakaya, 2001), the delimitation of protected zones surrounded by harvest areas allows territorial regulation in a way analogous to refuge-harvest area dynamics (or source-sink dynamics), which comprises one of the most effective wildlife conservation strategies in Amazonia, especially when it involves participatory research and local knowledge perspectives (Shepard et al., 2012; Campos-Silva et al., 2017; Constantino et al., 2018).

This system has been successfully used in wildlife management by the Kaxinawa indigenous people that inhabit the Indigenous Land in the Jordão River, in the border of Brazil and Peru. In 1992 their most highly prized game animals, the lowland tapir, white-lipped peccary, woolly and spider monkeys, piping guan, and curassow (Constantino, 2016) were deemed locally extinct, and several others were rare (Peres, 1993). Aware of the situation, the Kaxinawa agreed on delimiting a refuge area inside their Indigenous Land that integrated a larger source area identified in the adjacent Kaxinawa/Asheninka do Rio Breu Indigenous Land (Constantino et al., 2008) and the Alto Juruá Extractive Reserve (Ramos, 2005). In 2005, most of Kaxinawa villages were able to feed their families with game meat from all the species deemed locally extinct or rare ten years earlier, most likely as a consequence of the migration of animals from the source protected area and the exclusion of outside hunters (Constantino et al., 2008). Provided with information from community-based hunting monitoring and zoning, Kaxinawa wildlife management was recognized through the Territorial and Environmental Management Plan (CPI/AC and AMAAIAC 2012). However, the refuge area delimited in the Jordão Indigenous Land alone is not enough to ensure sustainable indigenous hunting (Constantino et al., 2018), requiring a regional approach that would involve decision-makers in the Alto Juruá Extractive Reserve (RESEX) to protect a larger source area. Such an approach is unlikely to occur

because community-based hunting monitoring systems are not officially recognized in the RESEX, and because of a broader lack of clear institutional understandings of subsistence hunting and traditional peoples rights, as described above (Almeida and Panjota, 2004).

Moreover, the prohibition of hunting jeopardizes the very goals of Extractive Reserves. It is important to emphasize that the Extractive Reserves emerged as a result of rubber tappers' demands, led by the charismatic leader Chico Mendes in 1982, in search of agrarian reform adapted to the rubber tappers' way of life, and aiming to halt deforestation (Allegretti, 1994; Almeida et al., 2002). The weakening of Extractive Reserves can accelerate the process of economic dependence on more destructive activities such as cattle ranching and large-scale commercial agriculture, which have caused a recent increase in deforestation in the Chico Mendes Extractive Reservation in the state of Acre (Vadjunc et al., 2009).

It is imperative that animal populations and game harvest are monitored scientifically to evaluate hunting sustainability through time. In developing countries, often lacking in environmental governance, financing and human resources, participatory monitoring experiences have been efficient in the implementation of conservation actions concomitant with data collection (Danielsen et al., 2000; Constantino et al., 2012; Vieira et al., 2015). Monitoring of wildlife use and population stocks should be enhanced through the ongoing training of local monitors, who, once empowered with the information they collect, can act as decision makers on a local and regional scale. Promising results have been demonstrated in monitoring systems that involve local hunters in data collection and application of this information to develop management strategies and new research questions (Vieira et al., 2015). Women, especially hunters' wives, also play a key role in hunting monitoring, since they are responsible for meat when it arrives in the community. Another way to develop an effective monitoring system can be achieved through partnerships with local schools, where children conduct participatory research on wildlife harvests, hunting practices and preferences, thus supporting the community in decision-making on local wildlife management, while also providing remarkable pedagogic opportunities.

In recent years, this interdisciplinary approach has guided global conventions on biodiversity conservation. The International Union for the Conservation of Nature establishes that wildlife use, if sustainable, is an important conservation tool, since both social and economic benefits derived from this use provide incentives for people to conserve them (International Union for Conservation of Nature, 2000). In accordance, the Convention on Biological Diversity encourages and invites its parties to develop a participatory agenda for building sustainable systems of biodiversity resource use activities, including subsistence hunting (Convention on Biological Diversity, 2016). Subsistence hunting should be treated in the core of the global conservationist agenda, as one of its priorities in building a more sustainable and less unequal human society.

5. Conclusions

Brazilian Wildlife Act since 1967 has prohibited hunting, ignoring not only basic foundations for human dignity but also contradicting legal precedents that protect and value traditional ways of life. This and other prohibitive laws also disregard the natural mechanisms of resilience of animal populations to subsistence hunting as evidenced by scientific studies on source-sink effects. Finally, such laws and interpretations do not consider the processes of community self-organization in managing territories and natural resources. As a consequence, the "state of necessity" has been established by the state itself, keeping traditional and rural populations at the margins of their legal and natural rights, in a constant state of fear, subject to legal, nutritional and social insecurity when they are deprived of access to a crucial resource for their survival.

Wildlife management does not mean unrestricted subsistence

hunting activity. The state can and should develop laws, regulations and actions for proper management aiming at conservation and sustainable use of wildlife by local populations. Unfortunately, prohibitive interpretation of the laws and a system of repression in relation to subsistence hunting over the last 50 years has resulted in both the infringement of traditional peoples' rights and also the unregulated cascading of impacts on wildlife, which might be minimized if the activity were regulated, managed and monitored with state support.

The Brazilian Amazon is the largest and most species-rich tropical system in the world, playing a pivotal role in global climate regulation and harboring hundreds of traditional and indigenous cultures that rely directly on natural resources for their livelihoods. Regulation of natural resource use is a complex but necessary task in guaranteeing regional development and sustainable use, as we have seen for fishing and forestry resources. The regulation of hunting could contribute to the development of a new conservation paradigm in Brazil. Regulating subsistence hunting through the direct involvement of indigenous and traditional communities will foster the development of effective tools with tremendous potential to contribute to biodiversity conservation and the empowerment of Amazonian peoples. But first, the conspiracy of silence must be broken.

Acknowledgements

We are very grateful to all participants of the workshop entitled “Caça de Subsistência em Áreas Protegidas no Estado do Amazonas: Conhecimento Atual, Questões Legais e Desafios Práticos para o Manejo” (Subsistence Hunting in Protected Areas in Amazonas State: Current Knowledge, Legal Issues and Practical Challenges to Management, in free translation from Portuguese), held in November 2016 in Manaus, Amazonas state, Brazil. We thank Wildlife Conservation Society – Brazil for organizing this memorable event, which contributed to many of the ideas in this article. This work was supported by the National Council of Technological and Scientific Development (CNPq, protocol 441435/2017-3).

References

- Aguiar, J.P.L., 1996. Tabela de composição de alimentos da Amazônia. *Acta Amazônica* 26 (1/2), 121–126.
- Albert, B., Le Tourneau, F., 2007. Ethnogeography and resource use among the Yanomami: toward a model of “reticular space”. *Curr. Anthropol.* 48 (4), 584–592.
- Allegretti, M.H., 1994. Reservas Extrativistas como alternativas para o desmatamento na Amazônia. In: Arnt, R. (Ed.), *O Destino da Floresta: Reservas extrativistas e Desenvolvimento Sustentável na Amazônia*. Relume-Dumará, Rio de Janeiro, Brazil.
- Almeida, M.W.B., Panjota, M.C., 2004. Justiça local nas Reservas Extrativistas. *Raízes* 23, 27–41.
- Almeida, M.W.B., Wolff, C.W., Costa, E.M.L., Franco, M.C.P., 2002. Habitantes: Os seringueiros. In: Cunha, M.C., Almeida, M.C.P. (Eds.), *A Enciclopédia da Floresta. O Alto Juruá: Práticas e Conhecimentos das Populações*. Companhia das Letras, São Paulo, Brazil, pp. 105–146.
- Alvard, M.S., Robinson, J.G., Redford, K.H., Kaplan, H., 1997. The sustainability of subsistence hunting in the Neotropics. *Conserv. Biol.* 11 (4), 977–982.
- Antunes, A.P., Shepard Jr., G.H., Venticinque, E.M., 2014. O comércio internacional de peles silvestres na Amazônia brasileira no século XX. *Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas* 1 (1), 487–518.
- Antunes, A.P., Fewster, R.M., Venticinque, E.M., Peres, C.A., Levi, T., Rohe, F., Shepard Jr., G.H., 2016. Empty forest or empty rivers? A century of commercial hunting in Amazonia. *Sci. Adv.* 2 (10), e1600936.
- Ayres, J.M., Ayres, C., 1979. Aspectos da caça no alto rio Aripuanã. *Acta Amazonica* 9 (2), 287–298.
- Bodmer, R.E., 1995. Managing Amazonian wildlife: biological correlates of game choice by detribalized hunters. *Ecol. Appl.* 5 (4), 872–877.
- Bodmer, R.E., Fang, T.G., Moya, L., Gill, R., 1994. Managing wildlife to conserve Amazonian forests: population biology and economic considerations of game hunting. *Biol. Conserv.* 67 (1), 29–35.
- Bodmer, R.E., Eisenberg, J.F., Redford, K.H., 1997. Hunting and the likelihood of extinction of Amazonian mammals. *Conserv. Biol.* 11 (2), 460–466.
- Bonaudo, T., Le Pendu, Y., Faure, J.F., Quanz, D., 2005. The effects of deforestation on wildlife along the transamazon highway. *Eur. J. Wildl. Res.* 51 (3), 199–206.
- Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L., Thomas, L., 2004. *Advanced Distance Sampling*. Oxford University Press, UK, pp. 416.
- Calouro, A.M., Marinho-Filho, J.S., 2005. A caça e a pesca de subsistência entre seringueiros ribeirinhos e não-ribeirinhos da Floresta Estadual do Antimary (AC). In: Drumond, P.M. (Ed.), *Fauna do Acre*. EDUFAC, Rio Branco, Acre, Brazil, pp. 109–135.
- Campos-Silva, J.V., Peres, C.A., Antunes, A.P., Valsecchi, J., Pezzuti, J., 2017. Community-based population recovery of overexploited Amazonian wildlife. *Perspect. Ecol. Conserv.* 15 (4), 266–270.
- Carneiro, D.B., 2015. *Como eu vivo, me sustento: Formas indígenas de usos de recursos naturais*. Master thesis. UFOPA.
- Castro, J.D., 1946. *A Geografia da Fome no Brasil*. Gryphus Editora, Rio de Janeiro, Brazil, pp. 348 pp.
- Castro, E.V.D., 1996. Os pronomes cosmológicos e o perspectivismo ameríndio. *Mana* 2 (2), 115–144.
- Clement, C.R., 2019. Domesticação da floresta & subdesenvolvimento da Amazônia. In: Santos, G.M. (Ed.), *Grupo de Estudos Estratégicos Amazônicos, Caderno de Debates*, Tomo XIV. INPA, Manaus, Brazil.
- Colding, J., Folke, C., 2001. Social taboos: “invisible” systems of local resource management and biological conservation. *Ecol. Appl.* 11 (2), 584–600.
- Constantino, P.A.L., 2015. Dynamics of hunting territories and prey distribution in Amazonian Indigenous Lands. *Appl. Geogr.* 56, 222–231.
- Constantino, P.A.L., 2016. Deforestation and hunting effects on wildlife across Amazonian indigenous lands. *Ecol. Soc.* 21 (2).
- Constantino, P.A.L., Fortini, L.B., Kaxinawa, F.R.S., Kaxinawa, A.M., Kaxinawa, E.S., Kaxinawa, A.P., Kaxinawa, L.S., Kaxinawa, J.M., Kaxinawa, J.P., 2008. Indigenous collaborative research for wildlife management in Amazonia: the case of Kaxinawá, Acre, Brazil. *Biol. Conserv.* 141, 2718–2729.
- Constantino, P., Carlos, H., Ramalho, E., Rostant, L., Marinelli, C.E., Teles, D., Fonseca Jr., S., Fernandes, R.B., Valsecchi, J., 2012. Empowering local people through community-based resource monitoring: a comparison of Brazil and Namibia. *Ecol. Soc.* 17 (4).
- Constantino, P.A.L., Benchimol, M., Antunes, A.P., 2018. Designing indigenous lands in Amazonia: securing indigenous rights and wildlife conservation through hunting management. *Land Use Policy* 77, 652–660.
- Convention on Biological Diversity (CBD), 2016. Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity. XIII/8. Sustainable Use of Biodiversity: Bushmeat and Sustainable Wildlife Management. Thirteenth meeting Cancun, Mexico.
- Danielsen, F., Balet, D.S., Poulsen, M.K., Enghoff, M., Nozawa, C.M., Jensen, A.E., 2000. A simple system for monitoring biodiversity in protected areas of a developing country. *Biodivers. Conserv.* 9 (12), 1671–1705.
- Descola, P., 1998. Estrutura ou sentimento: a relação com o animal na Amazônia. *Mana* 4 (1), 23–45.
- Dufour, D.L., Piperata, B.A., Murrieta, R.S., Wilson, W.M., Williams, D.D., 2016. Amazonian foods and implications for human biology. *Ann. Hum. Biol.* 43 (4), 330–348.
- Endo, W., Peres, C.A., Salas, E., Mori, S., Sanchez-Vega, J., Shepard Jr., G.H., Pacheco, V., Yu, D.W., 2010. Game vertebrate densities in hunted and nonhunted forest sites in Manu National Park. *Peru. Biotropica* 42 (2), 251–261.
- Fausto, C., 2007. Feasting on people: eating animals and humans in Amazonia. *Curr. Anthropol.* 48 (4), 497–530.
- Fragoso, J.M.V., Santos, M.C., 2000. Wildlife and hunting practices of seringueiros in Seringal São Salvador. Report. Pesacre. Acre.
- Fragoso, J.M., Levi, T., Oliveira, L.F., Luzar, J.B., Overman, H., Read, J.M., Silvius, K.M., 2016. Line transect surveys underdetect terrestrial mammals: implications for the sustainability of subsistence hunting. *PLoS One* 11 (4), e0152659.
- Hurtado-Gonzales, J.L., Bodmer, R.E., 2004. Assessing the sustainability of brocket deer hunting in the Tamshiyacu-Tahuayo Communal Reserve, northeastern Peru. *Biol. Conserv.* 116 (1), 1–7.
- Ingold, T., 2004. The optimal forager and economic man. In: Descola, P., Pálsson, G. (Eds.), *Nature and Society*. Taylor & Francis, pp. 35–54.
- International Union for Conservation of Nature IUCN, 2000. IUCN Policy Statement on Sustainable Use of Wild Living Resources. IUCN World Conservation Congress, Amman, Jordan.
- Isaac, V.J., Almeida, M.C., 2011. El consumo de pescado en la Amazonia brasileña. *COPESCAALC Documento Ocasional* 13. FAO, Rome, Italy.
- Joshi, N.V., Gadgil, M., 1991. On the role of refugia in promoting prudent use of biological resources. *Theor. Popul. Biol.* 40 (2), 211–229.
- Kates, R.W., Clark, W.C., Corell, R., Hall, J.M., Jaeger, C.C., Lowe, I., McCarthy, J.J., Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Gallop, G.C., Grubler, A., Huntley, B., Jager, J., Jodha, N.S., Kaspersen, R.E., Mabogunje, A., Matson, P., Mooney, H., Moore, B., O'Riordan, T., Svedin, U., 2019. Sustainability science. *Science* 292 (5517), 641–642.
- Levi, T., Shepard Jr., G.H., Ohl-Schacherer, J., Peres, C.A., Yu, D., 2009. Modelling the long-term sustainability of indigenous hunting in Manu National Park, Peru: landscape-scale management implications for Amazonia. *J. Appl. Ecol.* 46 (4), 804–814.
- Linke, I.H.V.V., 2009. Caracterização do uso da fauna cinegética em aldeias das etnias Wayana e Aparai na TI Parque Indígena do Tumucumaque. Master Thesis. Universidade Federal do Pará, Belém.
- Lopes, G.P., Valsecchi, J., Vieira, T.M., Amaral, P.V., da Costa, E.W.M., 2012. Hunting and hunters in lowland communities in the region of the middle Solimões, Amazonas, Brazil. *Sci. Mag. Uakari* 8 (1), 7–18.
- Luzar, J.B., Silvius, K.M., Fragoso, J.M., 2012. Church affiliation and meat taboos in indigenous communities of guyanese Amazonia. *Hum. Ecol.* 40 (6), 833–845.
- Machado, C., 2018. Conhecimento e consumo de plantas alimentícias em comunidades da Reserva de Desenvolvimento Sustentável Piagaçu-Purus. Master Dissertation. Instituto Nacional de Pesquisas da Amazônia, Amazonas, Brazil.
- Milner-Gulland, E.J., Akçakaya, H.R., 2001. Sustainability indices for exploited populations. *Trends Ecol. Evol.* 16 (12), 686–692.

- Morcarty, T.Q., Valsecchi, J., 2015. Social, biological, and environmental drivers of the hunting and trade of the endangered yellow-footed tortoise in the Amazon. *Ecol. Soc.* 20 (3), 3.
- Morsello, C., Yagüe, B., Beltracchi, L., van Vliet, N., Adams, C., Schor, T., Quiceno-Mesa, M.P., Cruz, D., 2015. Cultural attitudes are stronger predictors of bushmeat consumption and preference than economic factors among urban Amazonians from Brazil and Colombia. *Ecol. Soc.* 20 (4), 21.
- Neumann, C.G., Bwibo, N.O., Murphy, S.P., Sigman, M., Whaley, S., Allen, L.H., Guthrie, D., Weiss, R.E., Demment, M.W., 2003. Animal source foods improve dietary quality, micronutrient status, growth and cognitive function in Kenyan school children: background, study design and baseline findings. *J. Nutr.* 133 (11), 3941S–3949S.
- Novaro, A.J., Redford, K.H., Bodmer, R.E., 2000. Effect of hunting in source-sink systems in the neotropics. *Conserv. Biol.* 14 (3), 713–721.
- Nunes, A.V., 2018. Socioecologia da caça de subsistência em populações tradicionais do sudoeste da Amazônia, PhD Thesis. Universidade Federal de Mato Grosso do Sul, Mato Grosso do Sul, Brazil.
- Ohl-Schacherer, J., Shepard Jr, G.H., Kaplan, H., Peres, C.A., Levi, T., Yu, D.W., 2007. The sustainability of subsistence hunting by Matsigenka native communities in Manu National Park, Peru. *Conserv. Biol.* 21 (5), 1174–1185.
- Olsson, P., Folke, C., Berkes, F., 2004. Adaptive comanagement for building resilience in social-ecological systems. *Environ. Manage.* 34 (1), 75–90.
- Ostrom, E., 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325 (5939), 419–422.
- Parry, L., Day, B., Amaral, S., Peres, C.A., 2010. Drivers of rural exodus from Amazonian headwaters. *Popul. Environ.* 32, 137–176.
- Peres, C.A., 1993. Biodiversity Conservation by Native Amazonians: a Pilot Study in the Kaxinawá Indigenous Reserve of Rio Jordão. Acre, Brazil. Technical report. WWF, Washington DC.
- Peres, C.A., 2000a. Effects of subsistence hunting on vertebrate community structure in amazonian forests. *Conserv. Biol.* 14 (1), 240–253.
- Peres, C.A., 2000b. Evaluating the impact and sustainability of subsistence hunting at multiple amazonian forest sites. In: Robinson, J.G., Bennett, E.L. (Eds.), *Hunting for Sustainability in Tropical Forests*. Columbia University Press, New York, USA, pp. 31–57.
- Pezutti, J., Chaves, R.P., 2009. Etnografia e manejo de recursos naturais pelos índios Deni, Amazonas, Brasil. *Acta Amazonica* 39, 121–138.
- Porro, A., 1995. O Povo das Águas: Ensaios da Etno-história Amazônica. Editora Vozes, Petrópolis, EdUSP, São Paulo, Brazil, pp. 204.
- Prestes-Carneiro, G., Béarez, P., Bailon, S., Py-Daniel, A.R., Neves, E.G., 2016. Subsistence fishery at Hatahara (750–1230 CE), a pre-Columbian central Amazonian village. *J. Archaeol. Sci.* 8, 454–462.
- Ramos, R.M., 2005. Estratégia de caça e uso da fauna na Reserva extrativista do Alto Jurua, Acre. Thesis. Universidade de São Paulo, São Paulo, Brazil.
- Read, J.M., Fragoso, J.M., Silvius, K.M., Luzar, J., Overman, H., Cummings, A., Giery, S.T., de Oliveira, L.F., 2010. Space, place, and hunting patterns among indigenous peoples of the Guyanese Rupununi region. *J. Latin Am. Geogr.* 9 (3), 213–243.
- Robinson, J.G., Bennett, E.L., 2000. *Hunting for Sustainability in Tropical Forests*. Columbia University Press, New York, New York, USA 519 pp.
- Robinson, J.G., Redford, K.H., 1991. *Neotropical Wildlife Use and Conservation*. University of Chicago Press, Chicago, USA 520 pp.
- Roosevelt, A.C., Housley, R.A., Da Silveira, M.I., Maranca, S., Johnson, R., 1991. Eighth millennium pottery from a prehistoric shell midden in the Brazilian amazon. *Science* 254 (5038), 1621–1624.
- Ross, E.B., 1978. Food Taboos, diet, and hunting strategy: the adaptation to animals in Amazon cultural ecology. *Curr. Anthropol.* 19 (1), 1–36.
- Sarti, F., Adams, C., Morsello, C., Van Vliet, N., Schor, T., Yagüe, B., Tellez, L., Quiceno-Mesa, B., M. P., Cruz, D., 2015. Beyond protein intake: bushmeat as source of micronutrients in the Amazon. *Ecol. Soc.* 20 (4).
- Shepard, G.H., 2002. *Primates in Matsigenka subsistence and world view*. Cambridge Stud. Biol. Evol. Anthropol. 101–136.
- Shepard, 2015. Hunting in Amazonia. Pages Article ID: 382704, Chapter ID: 9909 In: Selin, H. (Ed.), *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*. Springer, USA.
- Shepard Jr., G.H., Levi, T., Neves, E.G., Peres, C.A., Yu, D.W., 2012. Hunting in ancient and modern Amazonia: rethinking sustainability. *American Anthropologist* 114 (4), 652–667.
- Siren, A., Machoa, J., 2008. Fish, wildlife, and human nutrition in tropical forests: a fat gap? *Interciencia* 33 (3), 186–193.
- Siskind, J., 1973. *To Hunt in the Morning*. Oxford University Press, Oxford, UK, pp. 224.
- Smith, N.J., 1976. Utilization of game along Brazil's transamazon highway. *Acta amazonica* 6 (4), 455–466.
- Souza-Mazurek, R.R., Pedrinho, T., Feliciano, X., Hilário, W., Gerôncio, S., Marcelo, E., 2000. Subsistence hunting among the Waimiri Atroari Indians in central Amazonia, Brazil. *Biodivers. Conserv.* 9, 579–596.
- Taddei, J.A., Lang, R.M.F., Longo-Silva, G., Toloni, M.H.A., Vega, J.B., 2011. *Nutrição em Saúde Pública*. Editora Rubio, Rio de Janeiro, Brazil.
- Terra, 2007. A caça de subsistencia na Reserva de Desenvolvimento Sustentável Piagaçu-Purus e na Terra Indígena Lago Ayapua, Amazônia Central, Brasil. Master Dissertation. Universidade Federal do Amazonas, Amazonas, Brazil.
- Vadjunec, J.M., Gomes, C.V.A., Ludewigs, T., 2009. Land-use/land-cover change among rubber tappers in the Chico Mendes Extractive Reserve, Acre, Brazil. *J. Land Use Sci.* 4 (4), 249–274.
- van Vliet, N., Fa, J., Nasi, R., 2015. Managing hunting under uncertainty: from one-off ecological indicators to resilience approaches in assessing the sustainability of bushmeat hunting. *Ecol. Soc.* 20 (3).
- Vieira, M.A.R.M., von Muhlen, E.M., Shepard Jr, G.H., 2015. Participatory monitoring and management of subsistence hunting in the Piagaçu-Purus reserve, Brazil. *Conserv. Soc.* 13 (3), 254–264.
- Vieira, M.A.R.M., Shepard, G.H., 2017. “A anta tem muita ciência”: racionalidade ecológica e ritual da caça entre ribeirinhos amazônicos. In: Marchand, G., Vander Velden, F.F. (Eds.), *Olhares Cruzados sobre as Relações entre Seres Humanos e Animais Silvestres na Amazônia*. EDUA, Brasil, Guiana Francesa, pp. 41–63.
- Wadley, R.L., Colfer, C.J.P., 2004. Sacred forest, hunting, and conservation in West Kalimantan, Indonesia. *Hum. Ecol.* 32 (3), 313–338.