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# **ECOLOGICAL SUSTAINABILITY OF MAMMAL HUNTING IN INÍRIDA REGION, COLOMBIAN AMAZON**

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# **ECOLOGICAL SUSTAINABILITY OF MAMMAL HUNTING IN INÍRIDA REGION, COLOMBIAN AMAZON**

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*“A MI ADORADO HIJO,  
MI OTRO YO”*

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## Conceptual Frame

Humans have always made use of other species to survive (Milner-Gulland and Mace, 1998). The rapid expansion of the human population over the last 10.000 years has resulted in an increased number of different cultivated plants and animals (Harris, 1998). However, wood for fuel and building, grass for grazing livestock, wild-caught fish and meat as well as gathered fruits and seeds have remained an important part of our subsistence base. Especially in the developing world, wild species still provide essential goods and services that are not available from any other source (Milner-Gulland and Mace, 1998).

Subsistence hunting provides vital proteins and fats for many rural and indigenous people in Latin America, and is the main source of animal protein in the diet of many peoples of the Amazon. In addition, bushmeat is also related to several aspects of indigenous worldviews (Copa and Townsend 2004, Wood 2001, Redford 1992). Nonetheless, such hunting has threatened the existence of several species, negatively impacting traditional sources of food. The use of destructive practices and intensive extractive technologies increases environment degradation and has led to the decline of local economies and the societies that they support (Secretaría del Convenio sobre la Diversidad Biológica 2004).

However, hunting has not always been unsustainable. Humans have lived in tropical forests for thousands of years, and during the millennia of occupation in the Amazon indigenous peoples used goods and services provided by the forest. A reduction in prey species has only become apparent in the very recent past. With traditional practices of production and extraction, it is assumed that the human-ecosystem relationship was stable until the more recent times. However, currently there are very few places where this relative balance is maintained due to rapid increase in human population densities and sociocultural and economic pressures that have transformed the relationship between humans and their environment (Robinson and Bennett 2000, Wood 2001, Secretaría del Convenio sobre la Diversidad Biológica. 2004).

This balance between humans and their ecosystem require be ecologically sustainable to exist. The term sustainability was created at the beginning of the 1980s by environmental institutions to express the conditions that must be present for the maintenance of an ecosystem for long term (Holden and Linnerud, 2007). In 1982 in the Brundtland Report (United Nations 1982) (<http://www.un-documents.net/wced-ocf.htm>), the term was defined as “development that satisfies the present needs without compromising the ability of future generations to meet their own needs”. According to the report, to be ecological sustainability, sustainable development must not put in danger the natural systems that support life on Earth and should protect species and ecosystems.

The rupture of this relationship threatens wild species through harvesting, as technologies are becoming more and more advanced and efficient. Even when species are not driven to extinction, the size of populations and the number of viable sub-populations are being dramatically reduced by these processes. These unsustainable levels of hunting threaten not only the survival of hunted species and their



ecosystems, but also the livelihoods and food security of the rural poor who are dependent on wildlife as a protein resource (Brown 2003).

Nonetheless, historically this term has been focused on economic aspects and has been misrepresented through the replacing of natural capital with human-made capital to meet current and future human needs (Callicot y Mumford 1997, Holden y Linnerud 2007). Due to this distortion of the concept of sustainability, additional terms have been created by conservationists. The IUCN created the concept of “Sustainable Life”, to refer to economic human activities that do not seriously impact ecological functions and processes (Callicot y Mumford 1997).

In addition, Holden and Linnerud (2007), proposed a hierarchy among sustainable development objectives: 1) to ensure the ecological sustainability in the long term (that natural capital cannot be replaced by other natural or human/made capital), 2) to satisfy the basic human needs (essential needs such as food, energy, house, water, health, and economic development, but not economic growth), and 3) to promote inter and intra generational equity, after which the additional objectives of sustainable development must be subordinated to these first three.

From the perspective of the fields of biology and thermodynamics, ecological sustainability and ecosystem health exist alongside biological preservation and ecological integrity, where ecosystem health is necessary for the preservation of biodiversity (species integrity). However, an ecosystem can be healthy (in functions and process) without a complete biological community. These approaches should be complementary and should tend towards the conservation of biodiversity as an indicator of ecosystem health, because areas with both biological diversity and ecological integrity are more likely to represent the overall health of the ecosystem (Noss 1995; Callicott and Mumford 1997).

Taking into account this perspective, ecological sustainability is understood as the maintenance of certain fundamental characteristics of ecosystems in terms of components and interactions (Secretaría del convenio sobre la diversidad biológica 2004). Throughout my research I abide by the concept of ecological sustainability as understood by Callicot and Mumford (1997), which is the maintenance, in one specific place and time, of two aspects: culturally selected human economic activities and ecosystem health, where the spatial scale of ecological sustainability may vary from watersheds to the biosphere, and the time scale from generations to the indefinite future. So, the concept of ecological sustainability is applied to the conservation of the biota of ecosystems that are occupied by humans and economically exploited (Callicot y Mumford, 1997).

In 2004, the Secretariat of the Convention on Biological Diversity in accordance with Callicot and Mumford's (1997) perspective, defines the Principles and Guidelines of Addis Abeba for the sustainable use of biological diversity. It emphasizes the way in which ecosystems contribute and maintain civilization, society and communities, and explain that for this reason effects that are harmful to ecosystems can also have an adverse impact on these social organizations. Therefore, governments should focus their policies on the promotion of the principles and guidelines of sustainable use as an additional instrument for the protection and maintenance of civilizations and traditional societies, which must participate in the making of decisions and use biological resources in a sustainable manner, according to

traditional and cultural practices and taking into account the socioeconomic, political, biological, ecological, institutional, religious and cultural factors that may influence the sustainability of use (Secretariat of the Convention on Biological Diversity 2004).

Despite the need to consider the socio-cultural context in researching hunting sustainability, this area has historically been studied only through natural science approaches. Weinbaum et al. (2013) carried out a review about the diverse indicator type used to assess the sustainability of wildlife hunting around the world.

These indicators included:

1. Indicators based on population trends over time, known as population abundance/density and Catch-per-unit-effort (CPUE), which depending on increases, decreases or stability, can indicate the sustainability or unsustainability of hunting. Its disadvantages are the need for a large amount of data, that must be monitored over a long period of time, and that the relation between CPUE and abundance is not necessarily straightforward.
2. Demographic models that include Population growth rate ( $k$ ) and Population viability analysis. These models determine how much human added mortality is compatible with population persistence, but require data intensive of all demographic characteristics.
3. Surplus Production Models include the crude sustainability index of Robinson & Redford model 1991, which ranging the sustainable harvest from 0.2 of  $N$  for species with longer lives, to 0.6 for shorter, the Bodmer Unified Harvest Model 1994, Maximum Sustainable Yield (MSY) and US National Marine Fisheries Service algorithm (Potential biological removal) (see Weinbaum et al. 2013).
4. Comparisons between sites contrast aspects as Population abundance/density and age/sex structure between hunted and unhunted (or lightly hunted) sites. Generally hunted sites have lower species abundances which is interpreted as unsustainable, but populations can be harvested 'sustainably' at an infinite number of population sizes, as long as offtake does not exceed production rates. As a result differences in population sizes alone cannot be used to assess sustainability, in the same way that significant differences in population age/sex structure are interpreted as unsustainable but cannot alone be used to assess sustainability.
5. Indirect methods as indicators for sustainability that are known as Market indices. These include indicators such as the cost of game and protein alternatives, quantity of species sold, changes in species composition, and trends in distance of wildlife from source to market. These kinds of data are easier to acquire than species demographic data in many tropical settings, but as only a small proportion of the total offtake may have passed through a formal market, these are likely to underestimate total offtake.
6. Other case-specific indicators do not account for uncertainty or intersite variation in productivity (for a review see Weinbaum et al. 2013).

According to Milner-Gulland and Ackakaya (2001), despite being widely used around the world, there are both practical and theoretical problems with the use of many of these sustainability indices. All indices require an estimate of prey abundance, and in tropical forests these estimates are notoriously prone to error due to the technical difficulties of conducting censuses and population surveys in these ecosystems. Indeed, under reasonable levels of uncertainty, the only index which did not result in local extinction after 50 years is the more precautionary National Marine Fisheries Service index. Simple sustainability indices also fail to account for spatial heterogeneity, and ignore the dynamics between unhunted areas adjacent to hunted areas and the migration of animals, which can have important impacts on sustainability. Measures of CPUE and Market data also hide declines in prey densities, due to changes in hunting techniques (guns), hunting behavior (including movement into new hunting areas) or avoidance behaviour by prey species (Milner-Gulland and Ackakaya 2001, Coad 2007), which can be influenced by multiple factors (e.g. taste preferences, law enforcement, environmental changes, technology changes), thereby confounding sustainability inference (Fa et al, 2005, Weinbaum et al. 2013).

In addition to the above-mentioned indicators and problems with estimating sustainability, the majority of studies suggest that for larger-bodied species, in most countries harvesting rates and scale of bushmeat trade are either currently unsustainable, or will become so in the very near future. This represents a crisis both from a conservation and development perspective (Fitzgibbon et al, 1995, Noss, 2000, Bennett et al, 2007).

Given the singular importance of wildlife for the welfare of rural and indigenous communities, as well as the conservation of the rain forest, and due to recent changes in traditional practices regarding natural resource use, as well as increased human immigration, the development of strategies for the appropriate management and administration by local people are needed. These strategies can be developed in tandem with those that support local cultures and traditional knowledge (Dufour 1990), which can be integrated with complementary scientific knowledge, for the sustainable management of a given species (Ramstad et al. 2007, Cuéllar et al. 2010, Noss et al. 2010). Such integration of knowledge is consistent with the conservation of both biological and cultural diversity.

The hunting of bushmeat can complement local incomes by providing food without the investment of economic resources, but if such basic needs are not provided for, due to the degradation of renewable natural resources (i.e. fauna), communities must obtain additional income in order to obtain external sources of protein, thus losing autonomy over their food security, territory and resources (Copa y Townsend 2004). Because socioeconomic systems, practices, resource use, and the characteristics of the basic needs of a population are largely determined by the cultural norms of the community, it is essential to take into account the importance of the cultural dimension for the sustainable use of natural resources.

As a result, the current focus is now shifting from documenting impacts to understanding the drivers of the hunting of bushmeat, including the use of wildlife by local communities, in order to understand how local communities and local hunters will respond to and are likely to be affected by ecological, economic or social changes (Coad, 2007). In order to obtain an approximation of such drivers in Colombian Amazon, I analyzed my research from a holistic perspective, looking at the biological, socio-economic and cultural factors related to ecological sustainability in the Inirida Region in the Colombian Amazon, in order to

identify the mayor causes of unsustainable hunting, and to show the critical necessity of taking into account the relationship between these various factors to find appropriate solutions.

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# **BIOLOGICAL, SOCIOECONOMIC AND CULTURAL FACTORS RELATED TO THE ECOLOGICAL SUSTAINABILITY OF MAMMAL HUNTING IN THE INIRIDA REGION, COLOMBIAN AMAZON**

## **Abstract**

During hundreds of years, the native indigenous population of the Amazon have lived in balance with their natural resources, but since colonization many regions shows an ecologically unsustainable resources use, representing an ecologic and cultural crisis in the region. To know the drivers of the ecological unsustainability of mammal hunting, I studied three substantial different indigenous communities in the Inirida Region, characterized by an intense evangelization process. Ecological, socio-economic and cultural factors were tacked into account to identify the mayor causes of unsustainable hunting. Semi-structured interviews in a recall survey way were conducted in each community through October–December 2011, and were collected hunting and economic activity, food expenses and cultural relevant information. The data was analyzed in a qualitative way and from a holistic perspective. The results showed the persistence of hunt of rodents in the region and only occasional hunt of large-bodied mammals in the furthest communities dedicated to agricultural and commercial activities, where the diary protein requirements are supplied by bushmeat, in a more sustainable resources use. Contrary, in the community nearest to the town, dedicated to paid work, the protein requirements are not supplied by bushmeat, but the people sold the animals hunted and have highest food expenses. These appear to be the patron in the region, corroborating that the bushmeat is not been used as subsistence resource. The situation has been propitiated by the loss of traditional practices and worldview of the indigenous people, causing the change

of traditional patterns of natural resources use. It indicates that the mayor driver of the actual ecologically unsustainable hunting activity in the region has been the radical evangelization process, plus an external social and governmental commercial pressure. Evidence of the critical necessity of takes into account the cultural context to find appropriate solutions to the bushmeat threat.

**Keywords:** bushmeat, ecological sustainability, religion, culture, large-bodied mammals.

## RESUMEN

Durante cientos de años, las poblaciones indígenas nativas de América han vivido en balance con sus recursos naturales, pero desde la colonización varias regiones muestran un uso de los recursos ecológicamente insostenible, representando una crisis ecológica y cultural en la región. Para conocer las causas de la insostenibilidad ecológica de la cacería de mamíferos, yo estudié tres comunidades indígenas substancialmente diferentes en la región de Inírida, caracterizadas por un intenso proceso de evangelización. Factores ecológicos, socio-económicos y culturales fueron tomados en cuenta con el fin de identificar las mayores causas de insostenibilidad de la cacería. Entrevistas semiestructuradas fueron realizadas en cada comunidad durante Octubre-Diciembre de 2011 y fueron recolectados datos sobre la actividad de cacería y económica, gastos de alimentación e información cultural relevante. Los datos fueron analizados de forma cualitativa y desde una perspectiva holística. Los resultados muestran la persistencia de la caza de roedores en la región y sólo la caza ocasional de mamíferos de gran tamaño en la comunidad más alejada dedicada a las actividades de agricultura y comercial, donde los requerimientos diarios de proteína son suplidos por la carne de monte, con un uso de los recursos más sostenible. Contrariamente, en la comunidad más cercana al pueblo, dedicada al trabajo de jornal, los requerimientos de proteína no son suplidos por la carne de monte, pero la gente vende los animales cazados y tiene los más altos gastos en alimentación. Este parece ser el patrón en la región, corroborando que la carne de monte no está siendo usada como recurso de subsistencia. La situación ha sido propiciada por la pérdida de prácticas tradicionales y visión del mundo de las comunidades indígenas, causando el cambio de patrones tradicionales para el uso de recursos naturales. Esto indica que la mayor causa de la actual insostenibilidad ecológica de la actividad de cacería en la región ha sido el radical proceso de evangelización, sumado a presiones comerciales externas sociales y gubernamentales. Se evidencia la crítica necesidad de tomar en cuenta el contexto cultural para encontrar apropiadas soluciones a la carne de monte amenazada.

**Palabras clave:** carne de monte, sostenibilidad ecológica, religión, cultura, mamíferos de gran tamaño.

## 1. Introduction

A major conservation challenge in the Amazon rainforest is the loss of medium and large mammals (Redford 1992, Wilkie et al. 2011), many of which are on the verge of a mass extinction due to transformations of the landscape and hunting. In addition to being critical to the functional structuring of the Amazonian ecosystem, these large vertebrates are also a vital food source for the survival of indigenous communities in the Amazon and their cultures (Vickers 1991, Redford 1992, Jorgenson 2000).

Subsistence hunting is an activity with nutritional, social, psychological, and ritual importance for the majority of indigenous peoples in tropical forests, and is an ancient and daily social activity among communities, which largely has enabled the survival over centuries of indigenous groups in the Amazon (Carneiro 1995, Hoyuela-Caycedo 1999). A great part of the knowledge and traditions of these communities are based on subsistence hunting, and therefore these has had a decisive role in the adaptation and subsistence of Amazon communities; hunting is fundamental in the protein supply, contributes to the material culture, influences the social organization and is closely linked to the worldview, mythology, religion, art and traditional symbols of human groups (Vickers 1991, Jorgenson 2000).

Unfortunately, current hunting activity is a significant driver of tropical forest fauna depletion due overexploitation. The recent cultural changes caused by socioeconomic and social pressures have resulted in changes to the balanced relationship between human and nature throughout indigenous populations in the Amazon. The overexploitation of rainforest animals is a result of these cultural and economic conditions (which are mostly related to food and commerce), and therefore the ecological sustainability of hunting is itself influenced by ecological, social and economic dimensions (Etter & Crizón 2001, Berkes et al 2003).

The approach of ecological sustainability as a result of the ecological, socioeconomic and cultural dimensions was postulated by The Convention of Biological Diversity (Secretaría del Convenio sobre la Diversidad Biológica, 2004), and is also shared by the socio-ecosystems approach, according to which, the ecologically sustainable use of natural resources should take into consideration and be in accordance with both the biological conservation of species and the cultural, economic and nutritional requirements of the human communities with which that interact. Accordingly, Callicot y Mumford (1997), proposed ecological sustainability as the conservation of the biota of ecosystems that are occupied by humans and economically exploited, maintaining in one determinate place and time two aspects: culturally-appropriate human economic activities and the health of ecosystems.

Nonetheless, throughout the literature on bushmeat, livelihood and food security issues are only occasionally addressed. However, Bennett and Robinson (2000) carried out an analysis of the entire context that affects the activity of hunting and identified that physical, biological, cultural, economic, social and institutional conditions exist that can enhance or diminish the sustainability of hunting. Brown and Williams (2003) also consider that in order to resolve the bushmeat crisis, it is fundamental to first satisfy the livelihood needs of rural populations, particularly the poor, as otherwise such strategies will fail, precisely due to their deficiencies in this regard. Therefore, it is of crucial importance to find a solution to the unsustainability of hunting for the conservation of the Amazon ecosystem, as well as its biodiversity and inhabiting cultures.

Following this approach, the research presented here takes the case of three indigenous communities to explore the hunting of mammals in the municipality of Inirida, in the Colombian Amazon, and addresses the biological, socioeconomic and cultural factors related to the ecological sustainability of hunting in order to respond: 1. How biological and ecological factors of hunted species and the study area influence the ecological sustainability of mammal hunting in the region?; 2. How socio-economic factors related to



food security, influences the ecological sustainability of mammal hunting in the region through to determine the socioeconomic importance of hunting subsistence for the indigenous communities in the region?; and 3. How cultural factors influences the ecological sustainability of mammal hunting in the region?.

## **2. Methods**

### **2.1. Study area**

The study area belongs to the municipality of Inirida, capital of the department of Guainia. Located in the northeastern part of the Colombian Amazon Region, it is part of the Orinoco River Basin and of the Inirida Fluvial Star.

#### **2.1.1. Ecological aspects**

The Guainía department covers an area of 72 238 km<sup>2</sup>, equivalent to 15.1% of the Colombian Amazon region (Salazar et al 2006). The climate of the region is tropical warm-humid and slightly seasonal with monomodal rainfall and a monthly average temperature of 15-20 °C (Etter 2001). According to Holdridge Classification of 1967, it is tropical rainforest, as part of the transitional wet and dry tropical savanna and wet tropical forest (Salazar et al 2006).

Recorded fauna includes 86 species of mammals belonging to 11 orders and 28 families, of which 15 species are found in any category of threat (Ferrer et al. 2009); 202 species of birds distributed in 44 families (Rudas 1998); 31 reptile species belonging to 3 orders and 12 families, of which 7 species have some degree of threat (Renjifo et al. 2009). Of these species, in the territory more than 40 are recognized as animals for consumption, predominantly mammals, followed by birds and reptiles.

#### **2.1.2. Social aspects**

The department has 26 Indian reservations and has recorded more than 200 sites of indigenous settlements, 10 ethnic groups, several mineral reserves and a national natural reserve. Of the 10 ethnic groups, the Curripaco ethnicity represents 46.24% of the total indigenous population, followed by the Puinave with 22.5%, with the remaining 7.51% of the indigenous population being made up of Tucanos, Guananos and five other ethnicities (Gobernacion del Guainia, 2001).

A growing number of nonindigenous and indigenous people are migrating to Inírida urban area in search of money. The advent of foreign-owned shops and business has resulted in changes in the local economy, human demography and ecological and social aspects, including an increase in the number of places to trade alcohol, prostitution, adulteration of products, insecurity and trade of natural resources. In the rural area the activities of commercial bushmeat and wood trade to supply foreign populations and urban centers and the illegal mining are the principal activities that are threatening the forest biodiversity (personal observation).

Agriculture is the main indigenous livelihood activity in the region, and in the villages with some variation. Each family owns 1-2 plantations, mainly worked by women, and the main crops grown are manioc (cassava), pineapple, aji (chili) and plantain, some of which are sold in Inirida, as well as making up a fundamental part of the local diet. Another fundamental household income comes from hunting and commercial fishing for consumption or ornamental fish, and occasional incomes come from sales of wood, fiber, wild fruits and other livelihood activities or paid work. Some population of other communities works in illegal mining activities.

Inside Inirida municipality, I studied three indigenous communities: Coayare (3°57'17.15''N 67°49'54.73''W) on the Guaviare river, Yuri (3°38'52.13''N 68°09'36.22''W) on Bocón spout, and La Ceiba (3°37'45.62N 67°53'01.90''W) on the Inírida river (Figure 1). All of them are located at different distances from Inírida and also all have different size, population, ethnicity, religion, economic activity and land use (Table 1).

Due to the cultural loss of traditional passive animal capture techniques such as trapping, hunting was undertaken actively in the three studied communities. Currently all hunters use guns and occasionally dogs, and the activity is mainly opportunistic using the offtake for food or sale. The principal hunting areas inside the action area of each community is mainly the banks of the rivers, followed by the areas located between farming plots (conucos) and lastly the mature forest, because it is the farthest away from the communities.

Human population growth inside the studied communities has intensified in the past 15 years due the immigration of indigenous population from other departments and remote areas. This phenomenon of immigration and colonization in the region is due to the search for closeness to western urban area of Inirida, looking for money, wage labor, health services and education.

According with the Colombian Interior Ministry data (pers. com.), the human population in all the Indigenous reservations of each community from 1986 to 2005 was increased from 184 to 218 people in Coayare El Coco Indigenous reservation, from 326 to 563 people in Caranacoa Yuri-Laguna Morocoto Indigenous reservation, and from 138 to 154 in Almidon La Ceiba Indigenous reservation.

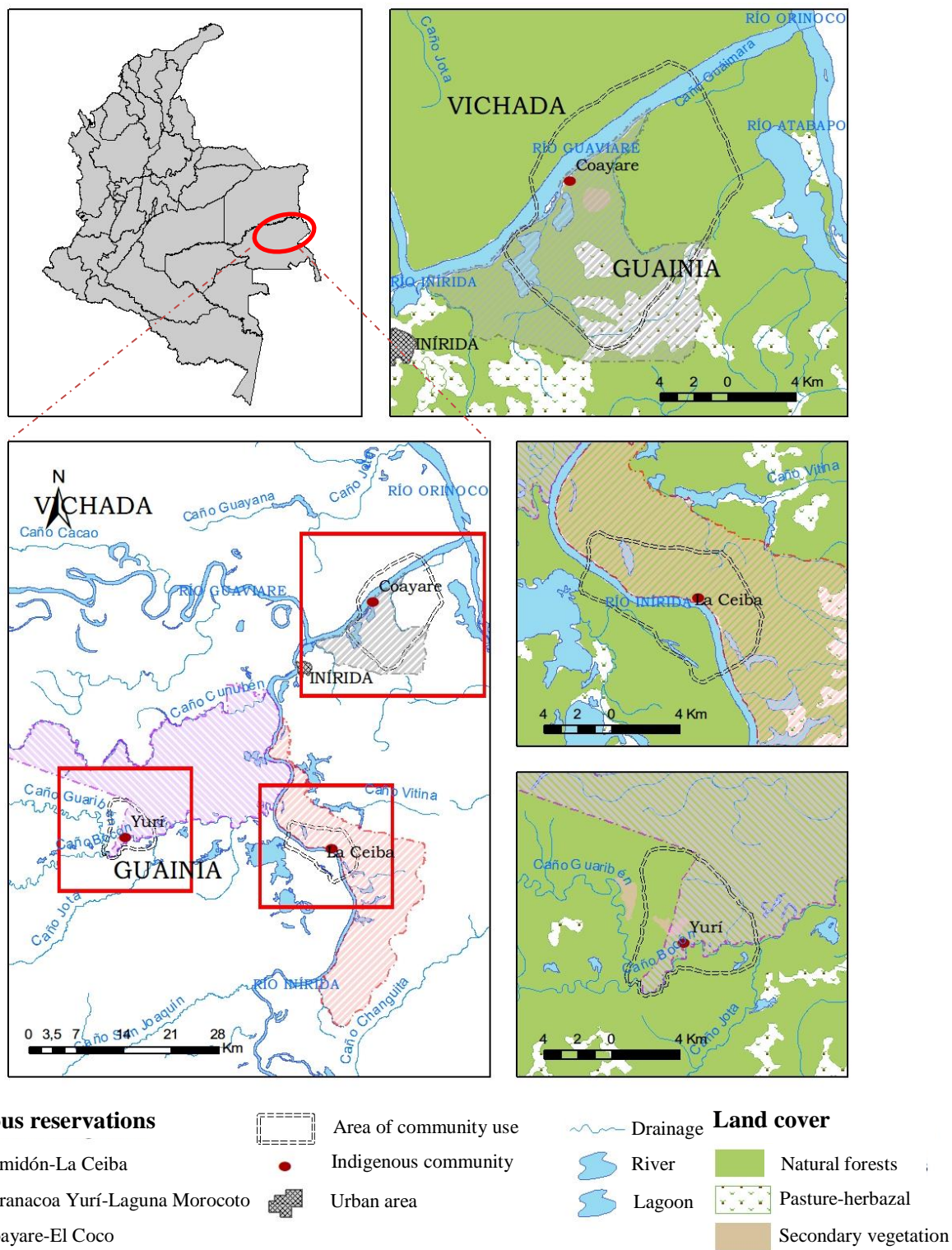


Figure 1. Study Area. Inirida municipality with detail of Coayare, Yuri and La Ceiba Communities inside their corresponding Indigenous reservation.

Table 1. Characteristics of indigenous communities studied in the Inírida Region.

	COMUNIDAD		
	COAYARE	YURI	LA CEIBA
Resolution creating the reserve	25 of 1986 Coayare El Coco	30 of 1986 Caranacoa Yuri -Laguna Morocoto	26 of 1986 Almidon La Ceiba
Ethnic group	Puinave, Piapoco and Curripaco	Puinave and Curripaco	Puinave, Tucano, Curripaco and Cubeo
Religion	Evangelical	Evangelical	Catholic and evangelical
Indigenous communities inside the Indigenous reservation	Coayare, El Coco	Morocoto, Caranacoa, Santa Rosa, Yuri and Moriche	Almidon, La Ceiba, Vitina, Pirritiari, etc,
Extension of the Indigenous reservation	11.840 ha	45.840 ha	40.960 ha
Land Vocation	10% agriculture; 90% forest	10% agriculture; 90% forest	10% agriculture; 90% forest
Number of people in 1986 (in the Indigenous reservation)	184	326	138
Number of families in 1986 (in the Indigenous reservation)	35	66	25
Number of people in 2005 (in the Indigenous reservation)	218	563	154
Families surveyed in the community (corresponding individuals and % of the community)	11 37 individuals 55% of the community	24 103 individuals 100% of the community	14 65 individuals 100% of the community

The ethnic groups inhabiting the Guainia department have been characterized by radical processes of evangelization and introduction to the market economy which produced a cultural change that influenced the way they perceive nature, other social actors and the interaction with them (Salazar et al. 2006). The evangelization process began in the 17th century, but the major impact was in 1943 with the presence of protestant missionaries, Sofia Müller and the “Mision Nuevas tribus” in 1963. This process had a major effect on indigenous communities after the historic process of enslavement for exploitation of rubber. Some of its effects were the loss of memories, traditions, ritual practices, knowledge traditional and worldview, and replacement with a protestant evangelical valuation based on the teaching of commercial interaction with “white people” (Etter 2001).

There are two modern religions in the villages: Catholicism and Evangelism, and La Ceiba have both, but Coayare and Yuri are principally evangelist. The older traditional practices, beliefs and worldview are practiced only by the oldest people and are usually only ones who still maintain a traditional ecological knowledge of their territory and resources, which apply to their use. People of recent generations have forgotten this knowledge.

## 2.2. Data collection

Due to the low number of households among the three villages (58 in total), there was no need for sampling, and all households and individuals that were willing to cooperate were included in surveys during the study. The study covered the total permanent population present in each community at the moment of the interviews.

Fieldwork was conducted through October–December 2011. Semi structured interviews in a recall survey way (Usher and Wenzel 1987, Jones et al. 2008, Aiyadurai et al. 2010) were conducted to the head of household or to the family hunter in each house that agreed to participate in the investigation. As there was quite a lot of movement in and out of the villages by younger men and women attending secondary school or sometimes further education or work in Inirida, Yuri, Bogota and other cities around Colombia; these were not recorded and only the present population was considered as permanent residents.

The following information was recorded: 1. Personal information, 2. Hunting activity in the year, 3. Economic activity (access to external food), and 4. Cultural situation in the region related to natural resources (Annex A). Informal interviews were recorded throughout the study at any free time, daily communication and direct observation of activities in the community allowed many informal opportunities to check information.

Furthermore during November-December 2011, daily hunting activity in each community was registered by their respective captain. These records also collected some information on the biological characteristics of each individual hunted, such as sex, weight and age, but this information wasn't statistically analyzed because of the few mammal hunt episodes in these two months (n=16 individuals hunted in the three villages).

In each community I performed Participatory Resource Mapping (PRM) (Mbile et al, 2003), of traditional boundaries, land use, vegetation cover, hunting areas and species extracted from each area.

## 2.3. Data analysis

### 2.3.1. Biological and ecological factors

Regarding biological and ecological factors, prey species vulnerability was indicated using  $r_{max}$  values (intrinsic rate of natural increase) (Cole 1954), and the relation between land use (land cover) and hunting activity inside each community territories (Coad 2007) were analyzed.

The vulnerability of each species was related with their corresponding  $r_{max}$  values (intrinsic rate of natural increase), as an expression of their life history. The  $r_{max}$  values were taken from Robinson and Redford (1986b), who estimated  $r_{max}$  from Cole's (1954) equation:  $1 = -e^{-r_{max}} + be^{-r_{max}(a)} - be^{-r_{max}(w+1)}$  Where  $a$ , is the age of first reproduction;  $w$ , the age of last reproduction; and  $b$ , the annual birth rate of female offspring

According to Cole (1954), differences between the life histories of species may result in different characteristics of their populations and a life history pattern of a species indicates its ability to survive and control potential population growth.

Taking into account the phylogeny and biomass of each hunted species, the species was grouped according to  $r_{max}$  value as follows:  $<0.35$ ,  $0.35-0.71$ , and  $>0.71$  (Peres 2000a). Then the total amount of biomass contribution by  $r_{max}$  group in each community was summarized. The result was analyzed in terms of the relative contribution of prey species vulnerable to local depletion, to their total harvests (Mena *et al.* 2000; Peres 2000b), considering the absence of species in the offtake prey to reflect the absence of it in the environment. Therefore, the major absence of this kind of vulnerable species was considered as a major process of unsustainable hunting activity.

At the village level I calculated the total extraction per species during 2011 by each village studied as the sum of offtake of each person interviewed. It was calculated by phylogenetic group, species and  $r_{max}$  groups.

The offtake patterns between villages were compared using the weighted average of household hunting activity, using  $r_{max}$  and  $n$  killed by species in each household. Also, was carried out a discriminant analysis between the three villages to know whether there are differences in hunting patterns between the villages using data from the hunting activity of all households in each village.

The relation between the land use and the hunting activity inside each community territories was analyzed using the social cartography or Participatory Resource Mapping (PRM) (Mbile *et al.* 2003), the corroborated geographical information with GPS mapping and the interview's information, combining local knowledge with accurate geographical information. This was used to delimit the action area of each community, and the place where was hunted each individual (inside or outside of the indigenous reservation), the prey species and cover vegetation of each hunting episode. The vegetation cover was distinguishing between mature forest (MF) and secondary growth (SG). The relation between the species harvested and the vegetation cover in each community was analyzed using contingency tables in R 2.15.2 (R Core Team 2012).

### **2.3.2. Socio-economic factors**

The analysis of the socio-economic conditions related with the ecological unsustainability of hunting of mammals in Inirida Region was focused around the importance of bushmeat as food source for the indigenous community and its economic value, aimed to analyze the food and socio-economic needs that access to bushmeat supplies. According to this, the analyzed factors were the contribution of bushmeat to the daily protein requirements of the communities, related to the food expenses and the economic activity per household in each studied community.

To work out the importance of bushmeat as a food source and estimate the economic value that the indigenous receive from the forest through wildlife harvesting, I calculated the total mass (Kg) of harvested biomass obtained from the hunt for consumption, and then transformed this into edible meat by reduction to 70% (animal without no consumable parts e.g. gut, skin) (Townsend 1996). Then I divided this by the number of consumers and the numbers of days of consume register, in order to get the harvest

rate per person per day (gr/per/day). At the end I calculated the economic value of the meat harvested in Colombian currency, taking into account that at that time the price of wild meat in Inirida and the communities was \$10.000 Pesos/kg and the current dollar price was \$1782.53 Colombian pesos (USD\$5.61/kg of bushmeat) (Copa and Townsend 2004). Additionally the total amount of biomass harvested destined for sale was calculated.

Through information obtained from the interviews I calculated the annual food expenses for households and related this to the total edible bushmeat extracted during 2011 by household, in order to know the degree of dependence of the community to the external food. Then I used contingency tables to determine whether there was a relationship between the economic activity, the food expenses and the edible biomass extracted in each household and community through the year. To do this, the variables were categorized as follows for the data obtained in each household: Economic activity: 1. Agricultural and subsistence hunting or fishing, 2. Commercial activity, 3. Occasional wage, and 4. fixed salary; Food expenses: <1500 as low, 1500-3000 as medium and >3000 as high USD per year; and Edible biomass: <150, 150-300 and >300 kg of bushmeat per year.

### **2.3.3. Cultural factors**

As was postulated by the discipline of Ethnoecology, in this research the human groups are treated as social subjects who have intellectual process (they think, believe, have a knowledge and a view of the world) and is through their symbolic meaning and knowledge that they take decisions and conduct activities, use the natural resources (Toledo 1992, Barrera-Bassols and Toledo 2005). Following this approach I focused on the cultural dimension in order to get information about the status of the past and present hunting practices, the changes in the cultural patterns for the access to the natural resources and the perception about the changes in the prey availability in the environment, over time (Aiyadurai 2010). Then the data concerning cultural factors was obtained from semi-structured and informal interviews used as a tool of ethnography method (ANEXO 1) and was analyzed in relation with the following factors: ethnicity, religion, demographic growth and distance of the community to Inirida. Taking into account all this theoretical and methodological approach, the analysis of this data was made since a qualitative approach and a holistic-integrative perspective looking for identified the cultural factors reducing the ecological sustainability of mammal hunting in the region based on the information provided by each respondent and the results of the whole research, therefore the results of this cultural dimension are presented in a descriptive way as its quantification in a statistical way could distort the reality of the historical situation lived in this region by the human groups and the natural resources studied.

### 3. Results

Information was obtained from all households in Yuri and La Ceiba, corresponding to 24 and 14 households respectively. But in the community of Coayare, only 11 out of 20 households agreed to participate in the interviews; the remaining nine households, belonging to the Piapoco ethnic group, (who are not native to the indigenous reservation but immigrated inside it some years ago), refused to give information about their hunting activity. In the three communities studied the largest population belongs to the Puinave and Curripaco ethnic groups, and according with some population from Coayare, the Piapoco people refuse to give information about their hunting activity because they hunt more than allowed and trade hunted animals.

#### 3.1. Biological and ecological factors

The study included the participation of a total of 49 households across the three communities. The study recorded a total of 611 harvested mammals; 76 in Coayare, 389 in Yuri and 146 in La Ceiba throughout 2011 (Table 2). In all the communities Rodents were the most common taxonomic group with the most individuals harvested, followed by Edentates and Ungulates in Coayare and Yuri, and by Ungulates and Edentates in La Ceiba. Primates and Carnivores presented some contribution firstly for Yuri community (Independence Test,  $p < 0.001$ ). In terms of biomass contribution, the Rodents and Ungulates are the groups with the mayor contribution of meat despite the big difference between the numbers of individuals harvested (Figure 2, Table 2).

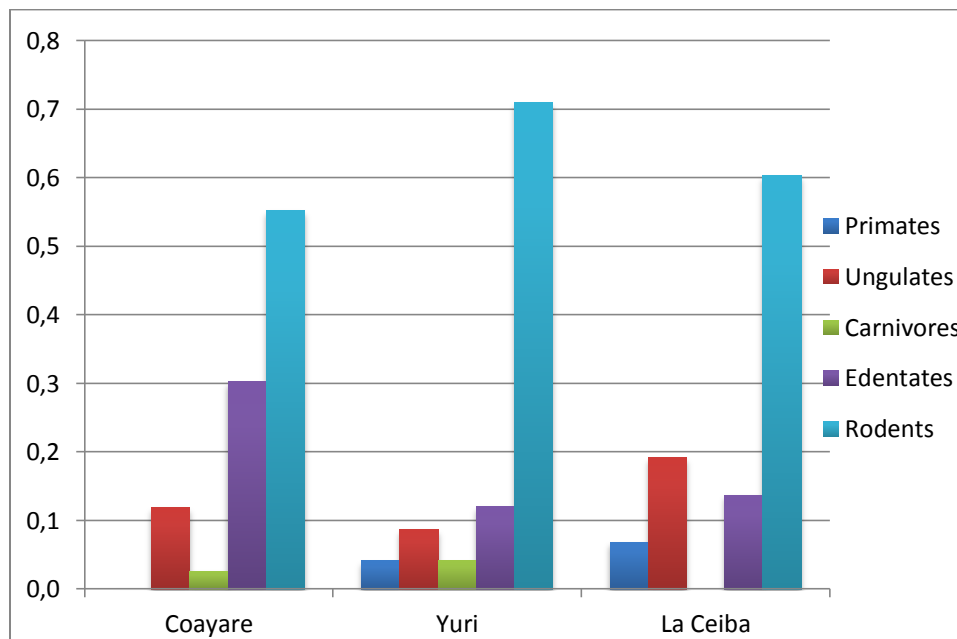


Figure 2. Relative abundance arranged by taxonomic group of animals harvested in each community through 2011.



The species with the highest capture rate in the region was *Cuniculus paca*. The offtakes from the community of Coayare was dominated by *C. paca* and this species was the principal contributor to the total biomass harvested during 2011. The offtake from Yuri was dominated by high numbers of *Dasyprocta fuliginosa* and *C. paca*, but the major contributors to the biomass offtake was *C. paca* and *Tayassu pecari*. Similarly, in La Ceiba the harvest was dominated by individuals of *C. paca* and *D. fuliginosa*, but the highest amount of biomass was contributed by *T. pecari* and *C. paca* (Table 2).

The most commonly hunted species corresponded to that with the highest  $r_{max}$  values ( $>0.71$ ). The Yuri offtake is characterized by a notably high number of species hunted and between the three communities has the highest percent of animals corresponding to the  $r_{max}<0.35$  category. Conversely, Coayare has the lowest diversity of hunted species, and 94.7% of its total offtake correspond to species with  $r_{max} >0.71$  (Table 3).

Table 2. Species harvested by each community during 2011.  $r_{max}$ , biomass (Kg), N killed and related biomass (kg) and Edible biomass (kg).

	$r_{max}$	COAYARE			YURI			LA CEIBA				
		Edible		Number	Edible		Number	Edible		Number	Edible	
		Biomass (Kg)	biomass (Kg)		Biomass (Kg)	biomass (Kg)		Biomass (Kg)	biomass (Kg)			
<b>Primates</b>				<b>0</b>	<b>0</b>	<b>0</b>	<b>16</b>	<b>68</b>	<b>48</b>	<b>10</b>	<b>48</b>	<b>34</b>
<i>A.seniculus</i>	0,17	6	4	0	0	0	8	49	35	5	31	22
<i>C.torquatus</i>	*0.23	1	1	0	0	0	4	5	3	0	0	0
<i>C.apella</i>	0,14	3	2	0	0	0	4	14	10	5	17	12
<b>Ungulates</b>				<b>9</b>	<b>257</b>	<b>180</b>	<b>34</b>	<b>1089</b>	<b>762</b>	<b>28</b>	<b>739</b>	<b>518</b>
<i>T.terrestris</i>	0,2	149	104	0	0	0	1	149	104	0	0	0
<i>P.tajacu</i>	1,25	18	12	0	0	0	0	0	0	3	53	37
<i>T.pecari</i>	0,84	29	20	9	257	180	32	914	640	14	400	280
<i>M.americana</i>	0,4	26	18	0	0	0	1	26	18	11	<b>287</b>	201
<b>Carnivores</b>			0	<b>2</b>	<b>8</b>	<b>5</b>	<b>16</b>	<b>127</b>	<b>89</b>	<b>0</b>	0	<b>0</b>
<i>N.nasua</i>	0,23	4	3	2	8	5	15	58	41	0	0	0
<i>P.onca</i>	0,23	69	48	0	0	0	1	69	48	0	0	0
<b>Edentates</b>				<b>23</b>	<b>91</b>	<b>64</b>	<b>47</b>	<b>202</b>	<b>142</b>	<b>20</b>	<b>94</b>	<b>66</b>
<i>B.variegatus</i>	**0.26	2	2	0	0	0	0	0	0	1	2	2
<i>T.tetradactyla</i>	0,48	5	3	0	0	0	0	0	0	1	5	3
<i>M.tridactyla</i>	0,35	27	19	1	27	19	0	0	0	1	27	19
<i>D.novemcinctus</i>	0,69	4	2	7	25	17	46	163	114	17	60	42
<i>P.maximus</i>	0,59	39	28	1	39	28	1	39	28	0	0	0
<b>Rodents</b>				<b>42</b>	<b>411</b>	<b>288</b>	<b>276</b>	<b>1642</b>	<b>1149</b>	<b>88</b>	<b>574</b>	<b>402</b>
<i>C.paca</i>	0,67 ●	8	6	34	280	196	119	978	685	45	370	259
<i>D.fuliginosa</i>	***1.1	4,75	3	21	100	70	135	641	449	43	204	143
<i>H.hydrochaeris</i>	0,69 ●	32	22	1	32	22	0	0	0	0	0	0
<i>M.pratti</i>	1,42	1	1	0	0	0	22	22	15	0	0	0
<b>TOTAL</b>				<b>76</b>	<b>767</b>	<b>537</b>	<b>389</b>	<b>3128</b>	<b>2189</b>	<b>146</b>	<b>1456</b>	<b>1019</b>

Body mass and  $R_{max}$  from Robinson and Redford (1986b) with the exception of:

\*Extrapolated from *Callicebus moloch*

\*\*Extrapolated from *Bradypus tridactylus*

\*\*\* Extrapolated from *Dasyprocta leporine*

●Emmons and Feer 1999

Table 3. Percentage of animals harvested in each community according to intrinsic rate of natural increase category and corresponding number of species.

Community/ $r_{max}$	< 0.35	0.35-0.7	>0.7	N species
COAYARE	2,6	2,6	94,7	9
YURI	8,5	42,9	48,6	13
LA CEIBA	7,5	51,4	41,1	11

The hunting patterns by household are significantly different between the three communities, with a higher per capita offtake in Coayare, followed by Yuri and La Ceiba (Figure 3). The communities present a general hunting patron at regional level, however at community level the communities show significant differences too, these differences are marked by the hunting of the species *M. Americana* in La Ceiba, *N. nasua* and *C. torquatus* in Yuri and in Coayare by the hunt of the unique individual of *H. hydrochaeris* between the three communities and by the absent of many of the species hunted in Yuri and La Ceiba (Figure 4).

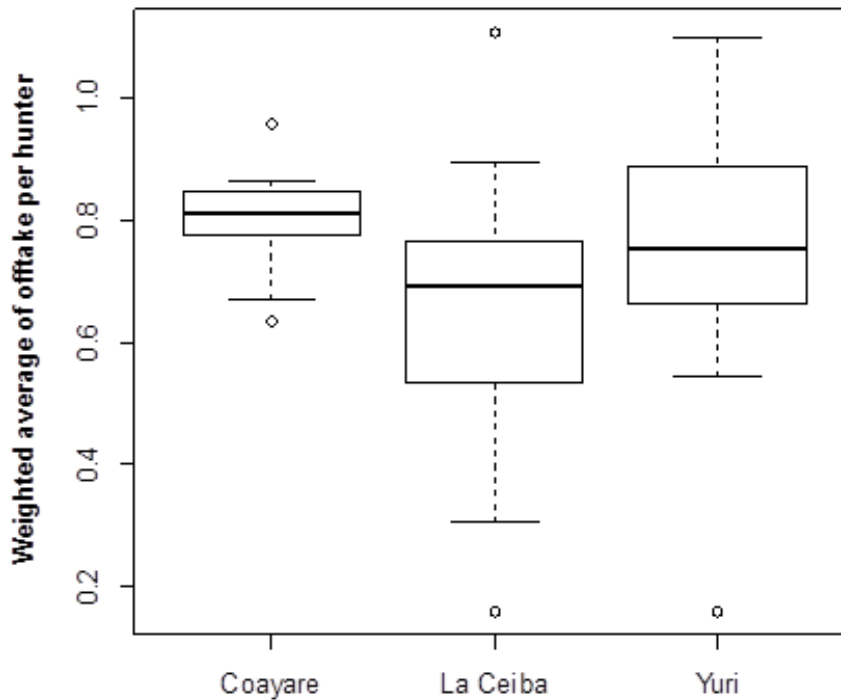


Figure 3. Weighted average of offtake per hunter, using  $r_{max}$  and number of animals killed by species in each community.

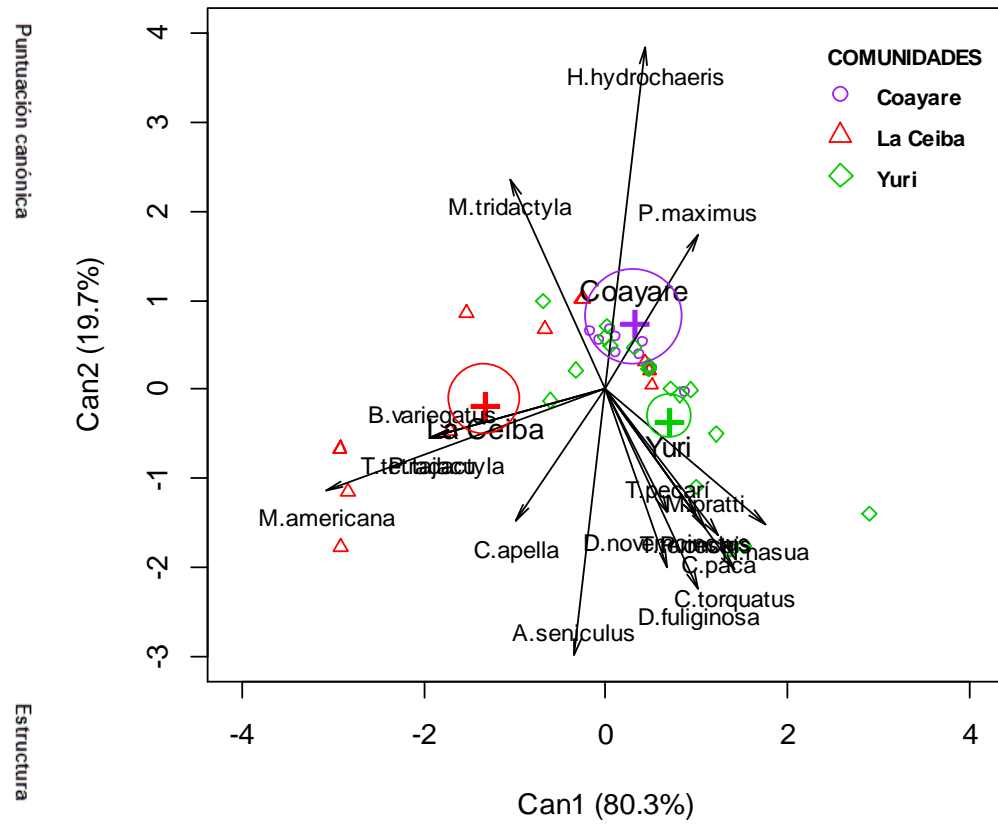
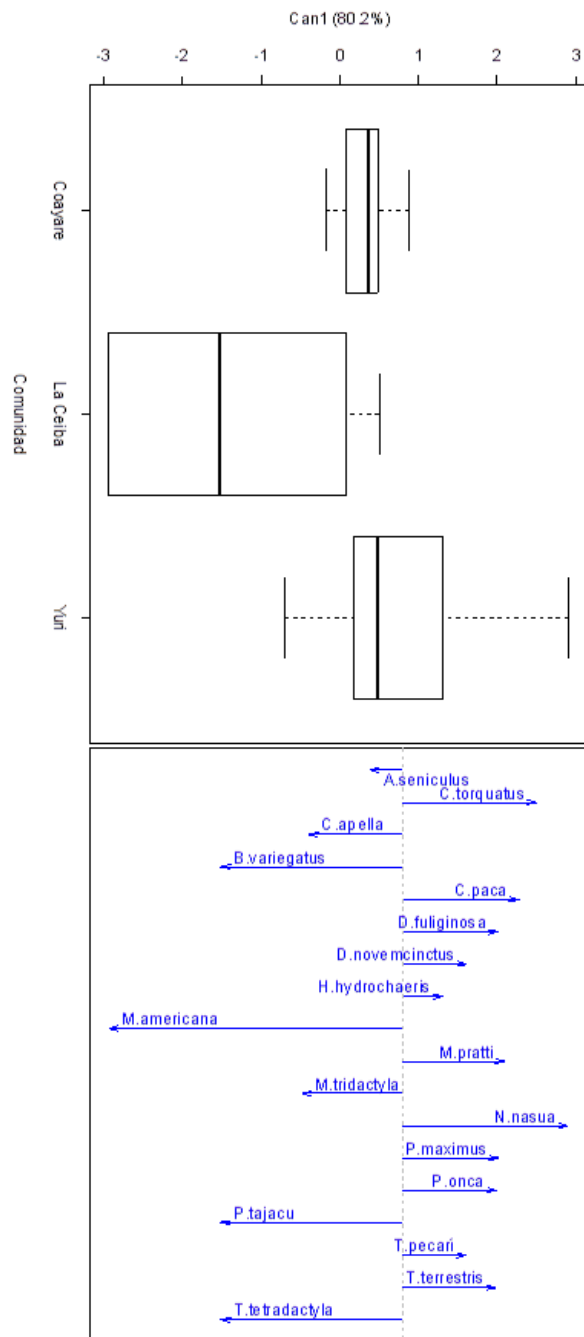


Figure 4. Discriminant analysis between the hunting patterns of Coayare, Yuri and La Ceiba communities

The relationship between land use and hunting across the region and within the communities, showed a significant association ( $\chi^2$  de Pearson  $p=<2.22e-16$ ). Land cover with mature forest (MF) was associated with the high number of hunted individuals corresponding to species with  $r_{max}<0,35$ . Land cover with secondary growth (SG) was associated with hunted individuals of species with  $r_{max}>0,71$  (Figure 5).

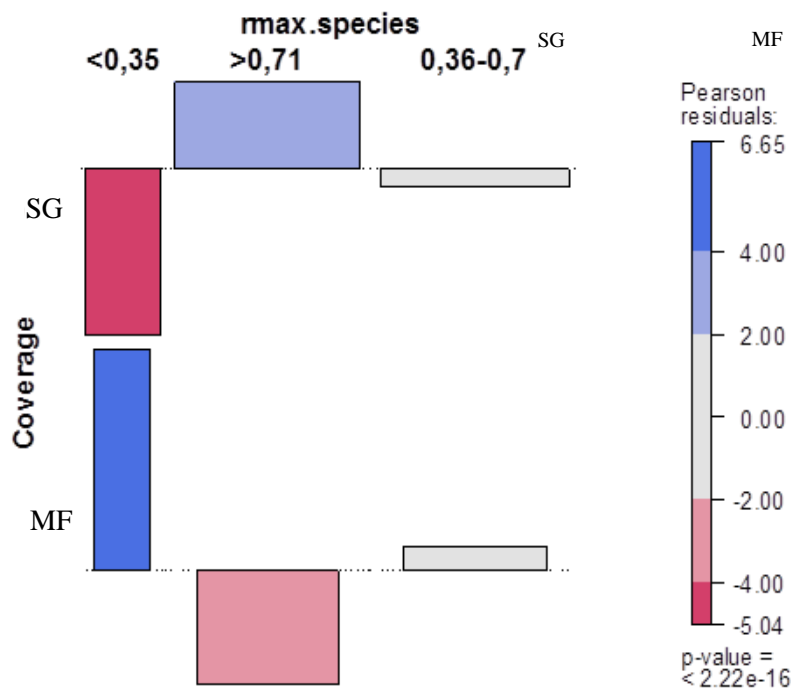


Figure 5. Graphic contingency table of the association between land use (coverage) and hunting activity in the region by  $r_{max}$  groups. The blue color indicate that exist a positive association and the fuchsia color indicate that exist a negative association between the variables, the intensity of the respective color shows the strength of the association.

At the community level, the variables of the land use (coverage: MF and SG), hunting activity (by  $r_{max}$  groups) and place of each event of hunting made inside (I) or outside (O) of the indigenous reservation, shows the following associations: Yuri presents a strong association between the hunting of species with  $r_{max} >0,71$ , the land cover of secondary growth (SG) and hunting inside the indigenous reservation area. Moreover, Yuri and La Ceiba present an association between the hunting of species with  $r_{max}<0,35$ , the land cover of mature forest (MF) and hunting outside of the indigenous reservation, however for Yuri the association is stronger inside the indigenous reservation. For Coayare, the strongest association is between the hunting of animals of  $r_{max} 0,36-0,7$  in forest, outside the indigenous reservation (Figure 6).

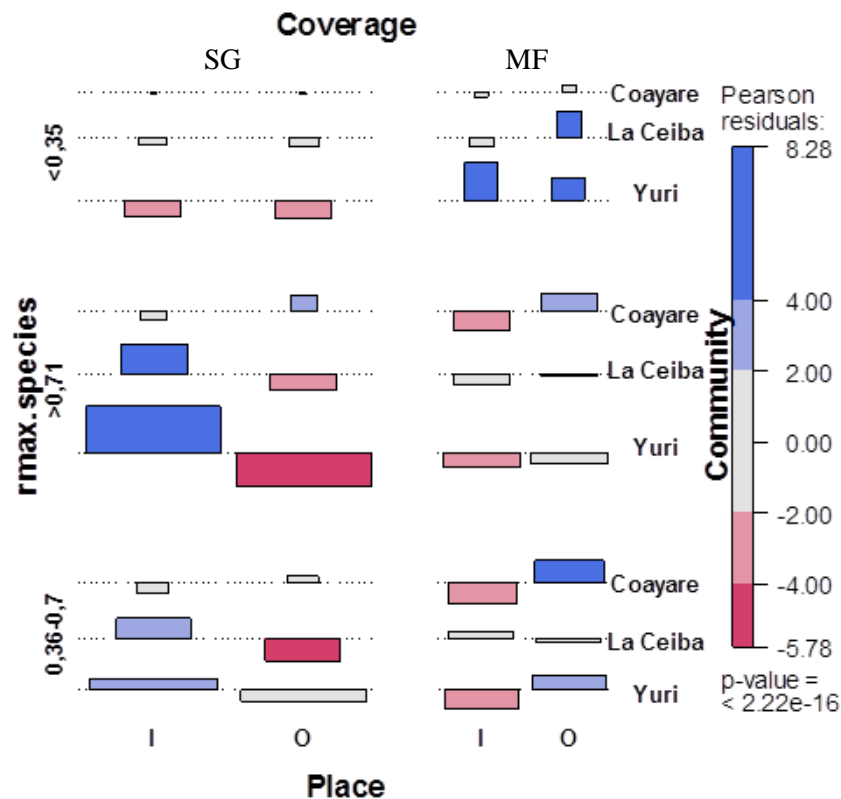


Figure 6. Graphic contingency table of the association at the community level between: land use (coverage: MF and SG), hunting activity by *rmax* groups and place of hunting activity (inside: I and outside: O of the indigenous reservation). The blue color indicate that exist a positive association and the fuchsia color indicate that exist a negative association between the variables, the intensity of the respective color shows the strength of the association.

### 3.2. Socio-economic factors

According to the FAO, the dietary protein requirements for a person weighing 60 kg is 30 gr/day for normal energy requirements. The per capita daily consumption of meat in the studied communities, according to the recorded hunting activity only for consumption, was highest in Yuri with an average of 39.08 gr/per/day. The lowest value of 19.7gr of bushmeat/person/day was found in Coayare. Correspondingly, in Yuri this consumption of bushmeat represents high economic value equivalent to 80.01USD per person for one year; In Coayare bushmeat represents an economic value of 40.33USD per person per year. These values represent the equivalent annual amount of money that each person is consuming through bushmeat if it were not an ecosystem service "free", provided by nature (Table 4).

Table 4. Rate of per capita consumption of bushmeat in each community in grams/person/day and its economic value in 2011. The data of edible biomass correspond to the hunted bushmeat destined only for direct consumption of the people from the studied communities.

Village	# of families	# of people	# of days	Edible biomass (Kg)	Per capita consumption (gr/per/day)	Diary economic value of per capita consumption (USD/person/day)	Annual economic value of per capita consumption USD/person/year)	Annual economic value of village consumption USD/village/year)
<b>COAYARE</b>	11	37	345	251	19,70	0,11	40,33	1492,36
<b>YURI</b>	24	97	350	1327	39,08	0,22	80,03	7762,65
<b>LA CEIBA</b>	14	65	355	701	30,38	0,17	62,21	4043,39
TOTAL ECONOMIC VALUE (USD) OF BUSHMEAT FOR 199 PEOPLE AT 2011=								13298,40

The economic value of bushmeat used only for direct consumption for the whole community was significantly higher in Yuri with 7760.68USD for the bushmeat consumed by 97 people. In Coayare, the community with the lowest per capita bushmeat consumption, the economic value was 1492.36USD for 37 people. In La Ceiba the economic value of bushmeat hunting was an intermediate value of 4043.39USD for 65 people. Overall, the total economic value of bushmeat used only for direct consumption for the 199 people belonging to the three communities in 2011 was 13296.42USD (Table 4). However, for the total amount of edible biomass offtake in all the communities (3743kg, Table 2), which includes bushmeat used for food and sale, the economic value was 20999.95 USD.

The largest offtake of individuals and the highest biomass only for consumption was recorded in Yuri (offtake of individuals: 9.2-SE 10.6 n24; biomass for consumption 52-SE 59 kg n24), and present the lowest food expenses (1065-SE 1832 USD n17) per household per year. In comparison, Coayare presented the lowest offtake of individuals (4.5-SE 4.7 n6) and the lowest consumed biomass (42-SE 48 kg n6), but food expenses were the highest recorded (5770-SE 2706 USD n4). Lastly, in La Ceiba intermediate values of offtake of individuals (8.6-SE 13.4 n15) and of biomass (46-SE 49.7 kg n15) were recorded, with correspondingly average food expenses per household during 2011 (1911-SE 1989 USD n14).

The edible biomass intended for sale between the communities is higher in Coayare, where it was destined the 53% of the total amount harvested for sale, corresponding to 284 kg. The community of La Ceiba showed the lowest value of bushmeat destined to sell, with the 31% or 318kg sold, followed by Yuri with 39% or 862kg of bushmeat for sale.

Economic activities are an important difference between the communities. In Yuri, the predominant activity is agriculture and subsistence hunting or fishing (1); occasionally people sell agricultural products and rarely hunt game outside subsistence use. Of the 24 interviewed households, only three have a salary and five claimed not to hunt. In La Ceiba the principal economic activity is Commerce (2); people regularly sold agricultural products and hunted game in the town. Furthermore, they have an important income from commercial fishing, for consumption and for the ornamental fish trade. Tourism was also provided income, and one household sold wood products. Only two household claimed not to hunt, instead buy when others hunt. Finally, the economic activity in Coayare is dominated by wage or fixed salary activities. 9 of the 11 interviewed families are dedicated to the sale of harvested products such as pineapple, cassava or aji. The same families hunt for consumption or will sell the offtake alongside other

forest products. Two of the interviewed families depend on a fixed salary by occidental work, and all families work for wages at some point (Figure 7).

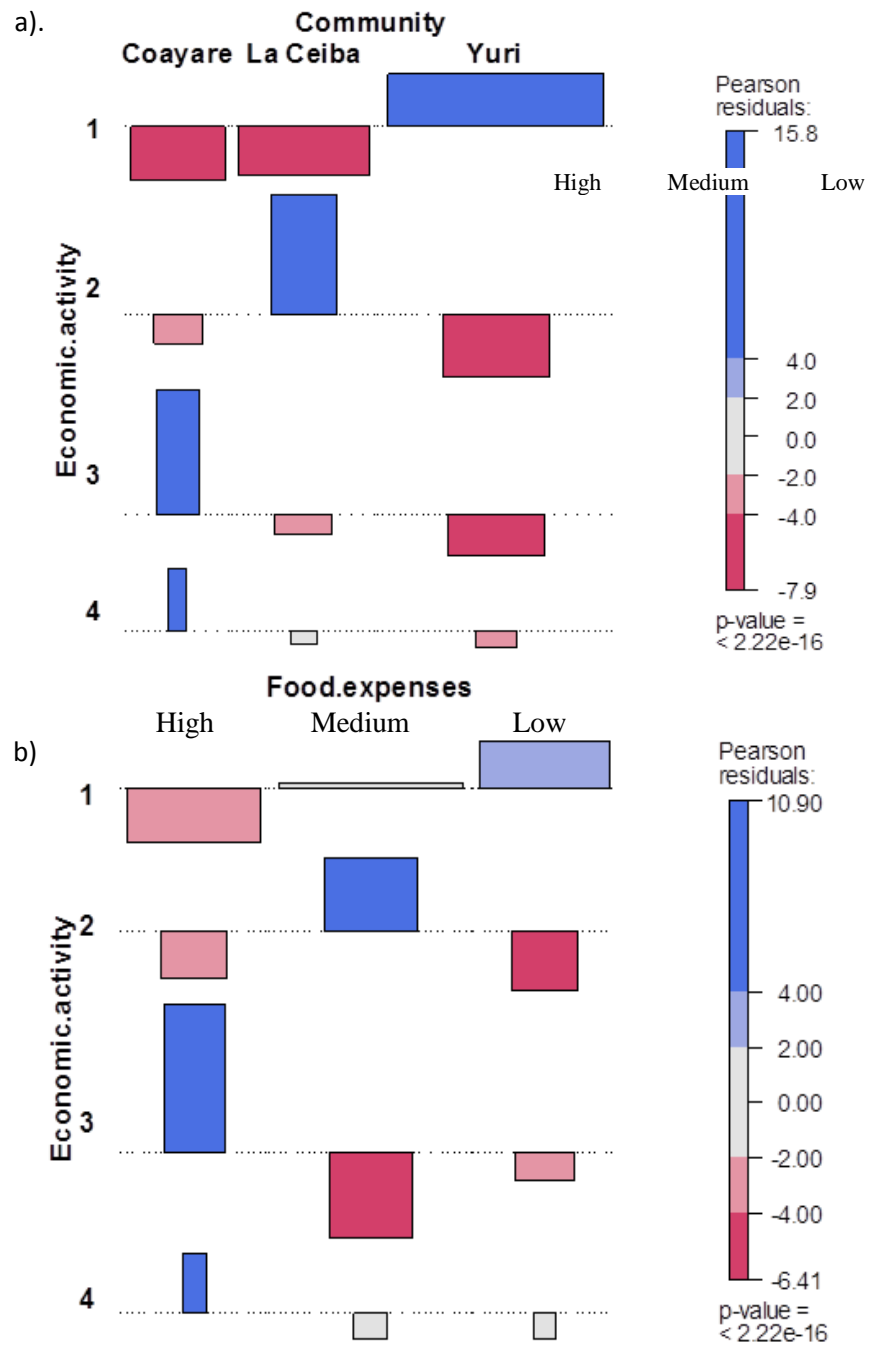


Figure 7. Graphic contingency tables of the association between a) Community and economic activity, and b) Food expenses and economic activity. The blue color indicate that exist a positive association and the fuchsia color indicate that exist a negative association between the variables, the intensity of the respective color shows the strength of the association.

In general, the households with wage income have higher food expenses and will buy the meat hunted by others (Figure 6b). Conversely, the poorest must also buy meat hunted by others, but because they do not have enough money to buy a gun, and consequently their main source of protein is fish.

An association also exists between the households with the higher food expenses and higher offtake of bushmeat with more than 60 animals hunted per year (Figure 8).

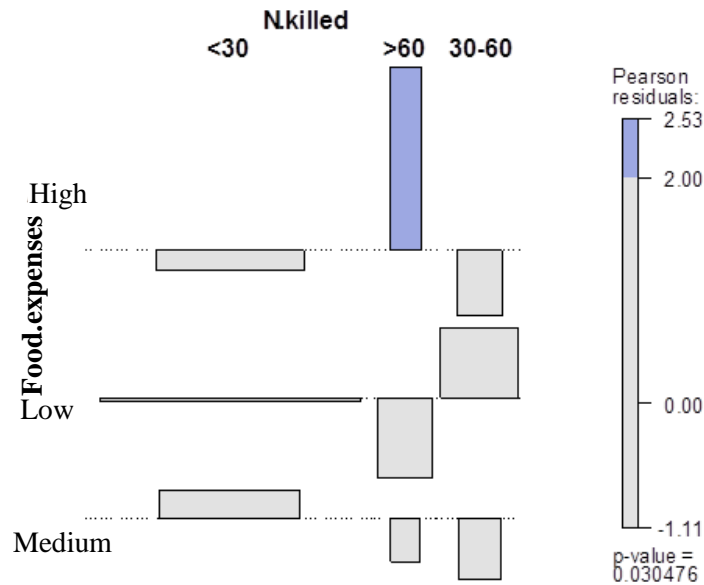


Figure 8. Graphic contingency tables of the association between food expenses and number of animals hunted by household in the region. The blue color indicate that exist a positive association and the fuchsia color indicate that exist a negative association between the variables, the intensity of the respective color shows the strength of the association.

### 3.3. Cultural factors

According to the interviews, the current ethnic groups present in the communities were firstly the Puinave and the Curripaco, native ethnic groups of the region. However, over the last 15 years Coayare has seen an important increase in immigrant families of Piapoco ethnicity. In La Ceiba, the majority of the people are Curripaco and Puinave; only the captain’s family is Tukano. While in Yuri the vast majority of the population is Puinave and only 5 families (21 people) are Cubeo, who arrived in the community around 8 years ago.

Since the process of evangelization began in 1930, the cultural dimension in the region has changed dramatically, and as a result all the communities are now fully or partially evangelical. Of the 49 families studied in this research, 48 are evangelical, which represents that the 98% of the total population of the three communities is evangelical. In this regard Coayere and Yuri are totally evangelical, however in La Ceiba the Curripaco and Puinave are evangelicals (93% of the total population of the community) and the Tukano (the captain’s family) is Catholic (7% of the total population of the community).



The three communities are found inside the Inirida municipality, but each one of them is located at a different distance from the urban area; Coayare: 16.7 km, Yuri: 63.03 km, La Ceiba: 39.14 km. The distance to the town has important implications in respect to the social and economic pressures on culture, and consequently over hunting activity (Spearman's: 0.42597,  $p=0.11$ ), with increased hunting at distances further from town in a traditional context.

Respect to the changes in the hunting practices and techniques, the current methods used are shotguns and dogs; most of the households do not hunt if they do not have a gun. The passive methods of hunting such as traps have been forgotten by their communities, including how to make the poison needed for arrows to hunt large animals or primates. For this reason they affirm that cannot hunt without a gun or a dog.

According to the populations interviewed in the different communities, in the past, before the evangelization of their communities, they only hunted adult animals and hunted a wide variety of species. Now the range of hunted species is very low and there is no selectivity in age or sex between individuals and species or in places to hunt (this was confirmed by the diary hunting activity recorded by the captain of each community during a two month period). Many hunting episodes included the hunt of a mother with her young. Indeed, in the wet season the hunters use to hunt as many individuals as possible, with more than 20 individuals of *C. paca* in one day each hunter.

Posterior the evangelization period, the control of the use of wildlife changed, currently traditional authority figures are not respected; their knowledge has been ignored and is almost completely forgotten. Now even the hunters do not know the ecology of the species, when they are pregnant, how many offspring they have, how long is the gestation period, the longevity or the difference between males and females. The communities also ignore the traditional regulations such as the prohibition of hunting during reproductive season, hunting pregnant females or hunting inside the "houses of the animals" (spaces designed culturally for each species). In fact, any person can hunt any animal in any place, whereas in previous times, only the hunter authorized by the traditional authority (after asking permission from nature) was allowed to hunt and only to extract the animal for food, not to be sold.

In past times direct and indirect regulations existed. The Payé, the cultural figure of authority and wisdom, regulated the use of animals and defined rules for exploitation. Institutions, the Payé, the elders and the rules and laws were respected and followed by the community and many cultural ways existed to pursue them. Also, in this time, only one person in the community hunted, and this person was trained by older people; young people did not hunt as they would only hunt for fun. In the same way, the hunter would prepare to hunt a specific prey and would only hunt that prey; now a hunter will harvest practically the first animal that he sees and will take all animals that he finds. Traditionally it was forbidden to hunt specific species, a specific number of hunted animals were defined and a special rotational management existed between hunt locations (for example hunting of *Tapirus terrestris* in salted areas).

At present, although subsistence hunting is a primary focus, commercial hunting is practiced by some hunters. Some of the reasons for commercial hunting in the villages are economical, for example a number of children were now of secondary school age and families needed to raise enough money for them to continue their education in Inirida. It is unlikely that motivation to earn more money was completely altruistic, as other hunters were the biggest drinkers in the village.

According to the interviewed people even the “lapa” (*Cuniculus paca*), previously the biggest rodent in the area and the most common species in abundance in the nature and in the hunting activity, is now depleted. The local population has also perceived a significant decrease of fish populations and they ensure that this is due to the commercialization of ornamental and consumption fish outside the region, causing overfishing at local and regional level.

The communities clearly noticed a depletion of animals due to human demographic growth and overhunting. It was said that before hunters could take 5-8 “lapas” in one night, but now rarely find one, and numbers of fish have also declined. People believe that animals do not become extinct, and are just hiding and people cannot find them. However, important species such as paca (*Cuniculus paca*), tapir (*Tapirus terrestris*), zaíno (*Pecari tajacu*), cajucho (*Tayassu pecari*), capybara (*Hydrochoerus hydrochaeris*) have been seriously reduced and are now almost locally extinct.

Cash income by sale of bushmeat, parts of animals or their skin, (especially species that have valuable commercial prices such as jaguar, tapir, lapa, turtle, ocelots and otters), was an important reason for hunting within the communities, as evidenced by confiscations made by government authorities, unfortunately these data of seizures represent only a small percentage of the real activity due to various evasive ways that people use to avoid being confiscated illegal merchandise. For the period from January to April 2011, the Corporación para el Desarrollo Sostenible del Norte y Oriente Amazónico-CDA reported the seizure of two specimens for the Department of Guainía, the two belonged to the order Carnivora: 1 individual of the species *Potos flavus* and 1 individual of the species *Cerdocyon thous* (Domínguez 2011). Hunters from the studied communities reported that skins and bushmeat are sold along the borders of Venezuela. Other resources and animals, such as wood and fishes are sold to shopkeepers from Inírida or to outsiders (middlemen) who then sell them in Colombian cities and abroad.

According with the information provided by the older members of the villages, I determined that 20 years ago hunting used to be carried out much closer to the village than it is now, suggesting that hunters have moved further out from the villages in search of animals indicating a decline in wildlife populations around villages.

Since the arrival of the shotguns in the 1920s with the rubber plantations and the “pendare”, here has been a general increase in hunting. Indigenous people became indebted to the heads of the rubber plantations in order to obtain a shotgun. On occasions they may also acquire one from the priests. The expansion of the skin trade meant hunting then focused on jaguars, otters and caimans, and pressure was reduced on other animals. At this time, the sale of skins, meat and animals for the pet trade, was made to purchase things such as salt, clothes, machetes and ammunition. With the extraction of “chiqui-chiqui” fiber and coca between the 1970s and 1990s, indigenous people did not need to hunt, as the heads of the exploitation gave them food or money.

During the 1990s, hunting levels were low as increased economic income allowed for the purchase of domestic meat. Nonetheless, pressure on bushmeat species persisted to cater for illegal sales in urban areas, or in Venezuela, where the sale of bushmeat not permitted, although the sale of Colombian bushmeat is legal. Moreover, in Venezuela and other regions of the Amazon, such as the Caquetá, the presence of a mining dredge resulted in increased hunting pressure on wildlife, evidenced by a substantial reduction in the availability of species such as the “lapa” (*C. paca*).

In the Inirida region the primary activities of the indigenous people are the sale of “conuco” products such as “cassava”, pineapple, “mañoco” and pepper, fishing for consumption and the ornamental trade, the exploitation of wood and any other natural resource that allows the accumulation of monetary income.

## 4. Discussion

This research aims to use a case-study system to explore mammal hunting in the context of Inirida municipality, focusing in identify the mayor biological, socioeconomic and cultural factors causes of ecological unsustainable hunting in the region. This has been achieved using data on individual hunting activity of 49 hunters throughout 2011, and socio-economic and cultural information of their households collected through semi-structured interviews, conducted over October to December 2011 in three indigenous villages in Inirida municipality.

The rapid assessment method was useful to detect trends in the availability and use of wildlife resources as well as socioeconomic and cultural information. This is a low cost method and can be used to create a body of information to recreate a historical statistical series (Jones et al. 2008). In this investigation the information provided by each household was corroborated in the diary communication with members of the community, and I found it very accurate, especially for the biggest animal species. This kind of corroboration has been also carried out in other investigations probing the efficient of the method (Usher and Wenzel 1987, Coad 2007, Jones et al. 2008, Aiyadurai et al. 2010)

Counting with the information of the total population of Yuri and La Ceiba allowed a more detailed analysis of the dynamics of the community. In the case of the Coayare community, 55% of the households of the community participated in the study, which allowed me analyze the hunting and socioeconomic activity of this people, but not of the full community. Therefore, it is necessary take into account that in this community, many of the people who refused to participate in the investigation belong to the Piapoco immigrant ethnic group, who extensively hunts for food and for sale inside the community and then with the data of Piapoco people, the hunting activity could be worst in sustainability terms for the entire community. Nonetheless, the activity patterns founded in the communities represent the general regional situation as are inhabiting by the Puinave and Curripaco ethnicities, which are the domain in all the Guainia department, and share the evangelic religion, then the unique differentiation factor in the intensity of social change through the region is the distance to the urban center.

The biological and ecological differences between species render some more susceptible to overharvesting than others, causing a species-specific response. The large-bodied species with low  $r_{max}$  values, due their lower reproduction rate plus a lower density and higher crude biomass renders these particularly more vulnerable to overexploitation but are object of the greater pressure, and then rapidly decline with increased hunter presence. Contrary, small-bodied species with high  $r_{max}$  values, higher abundance and a substantially lower crude biomass are not pursued by hunters unless no exist possibility of finding a larger

animal and then are resilient to increasingly heavier hunting pressure (Robinson and Bennett 2000, Peres 2000a, 2000b).

As has been founded by many researchers, (Bodmer, 1995, FitzGibbon 1998, Eves and Ruggiero 2000, Peres 2000a, 2000b, Robinson and Bennett 2000, Fa et al. 2005, Coad 2007), the selective overhunting markedly affect the structure of Amazonian vertebrate communities, leads to if not local extirpation of large-bodied taxa, a vertebrate assemblages dominated by rodents and with absence of big mammals object of a high hunting pressure, which become the hunting activity in ecologically unsustainable, situation that is presenting the region.

According to the hunting information, Yuri has the highest number of episodes of hunting with 389 individuals harvested and a medium per capita offtake. These episodes corresponds to the major diversity of species hunted (13) and presents the highest number of most vulnerable, large bodied species with the lowest intrinsic rate of natural increase as primates, carnivores, edentates and ungulates, and particular species as *N. nasua* and *C. torquatus*. In comparison with the other communities, these could indicate that in Yuri the hunting activity has been more ecologically sustainable than in La Ceiba and Coayare, because more vulnerable and large body species are present and available in greater numbers in the environment (Table 2), and has been corroborated that low animal diversity hunted and absence of large animals is evidence of unsustainable hunting activity (Robinson and Redford 1986b9a, 1986b, Peres 2000). Nonetheless, even Yuri has a medium number of animals extracted from the total offer of the nature, firstly respect primates and ungulates.

In contrast, in La Ceiba and in Coayare, a lower number of animals and species were extracted, corresponding to species with the highest intrinsic rate of natural increase, firstly rodents as *C. paca* and *D. fuliginosa*, which are some of the least vulnerable to overexploitation between the game species (Peres 2000a, 2000b). It could indicate the decreasing availability of vulnerable large bodied species in the environment and accordingly a hunting activity that has been historically less sustainable (Table 2 and 3).

The Optimal Foraging Theory establishes that hunters selectively target the large bodied primates and then move on to increasingly smaller animals such as peccary, deer and large-bodied rodents once the large primate species be depleted (MacArthur and Pianka 1966, Peres 2000a,b; Mena et al 2009). Hunting activity in Inirida Region, as in other Amazon parts evidence this behavior. In the studied communities the principal hunted animal was *C. paca*, a rodent resilient to very high hunting pressure, but animals such as carnivores, primates or edentates, which are the most hunting vulnerable, only present a few episodes in Yuri (Figure 2, Table 3). As predicted by Optimal Foraging Theory, humans hunt according to the relation cost-benefit of hunt that prey, but especially extractive and commercial communities as this, not take into account directly the availability of that species and hunt without any restriction (Franzen 2006, Zapata-Ríos et al. 2009).

Because animals are still hunted despite their low availability could be the underlying reason that the hunting in this and many others regions is not sustainable. The hunters only hunt small bodied mammals as the last feasible option, although they are more abundant, resilient to hunting and are available in the habitat.

In addition to the hunter's behavior, the Amazonian situation has been fostered by the cultural change of the relationship between the nature and the society promoted by the occidental religion, particularly the

evangelization and catholicization in this region. The change of traditional hunting practices to more effective hunting methods, without traditional cultural controls nor taboos, in a context of socio-economic changes and commercial pressure increase the demand and depleted wildlife populations with no limit (Zapata-Ríos et al. 2009, Bennett & Robinson, 2000), a situation that is common throughout most of the indigenous communities of the Amazonian forests.

Cultural changes, dominated by a capitalist development model and prompted by religion, in which is instituted the idea of superiority of men, economic development, civilization and the right to do whatever the human want with animals and natural resources has deep effects in the human-nature indigenous relation. The change in this relation has implied the commercialization of any natural resource, the change in the land use and the diary practices.

An evidence of the cultural changes due the evangelism and its effects in the interrelation human-nature is the abandonment of the ancient indigenous practices of rotational crops (conuco) and its association with some animal species for refuge and food supply. This practice allowed the closeness of the people to some animal species and provided resources to their survivor. Currently, crops' opening is more intense but no represents food for mammal species, whereas remove forest habitat necessary for it survival, firstly for big animals. The increase of secondary grow areas also reduce the availability of big mammals, which are associated to mature forest to survive, in contraposition this land use promotes the development of small animals resilient to anthropogenic pressure, as rodents.

The studied communities corroborate the negative cultural effects and the consequent catastrophic situation in the human-nature relationship which may cause the intrusion of western culture in traditional indigenous communities. In Yuri and La Ceiba, exist a high association between the hunt of small-bodied species with higher  $r_{max}$  values (rodents) and secondary growth areas, inside the indigenous reservation; however, in Yuri also exist an important association between the hunt of large-bodied mammals with lowest  $r_{max}$  values in mature forest. Then the availability of large-bodied mammals is also depleted by the land use in the region. It has critical negative effects in the source-sink dynamics (Novaro et al., 2000), in the structuring and functioning of the forest ecosystem due that the majority of large mammals in tropical forests are frugivores (including frugivore-granivores, frugivore-herbivores and frugivore-omnivores), and that these species are important in seed dispersal and predation landscapers' (Fa and Peres, 2001) and inside the populations, due the hunter preferences towards larger, adult, and males animals, producing biased sex ratios, which can reduce female fecundity (Ginsberg & Milner-Gulland, 1994).

Despite the situation of ecological unsustainability in this respect, some authors establish (Coad 2007) that from a social point of view (i.e. the production of enough protein for village inhabitants) the sustainability of hunting may be possible through the persistence of these "weedy", fast growing, small-bodied animals. Although, for a short term it could be sustainable, for long term, even from a social point of view, with the current patterns of hunting activity plus deforestation and habitat fragmentation, the situation is totally unsustainable. If the current hunting patterns are maintained plus an increases deforestation and habitat fragmentation to supply the requirements of a growing human population, the game species will be locally or totally extinct, because the forest resources will not enough to support the large-bodied animal populations and then neither land nor animals may provide enough food for the people.

The indigenous population in Inirida region could live that situation in a closer future. This population used to use the land for subsistence crops, but now these crops are also to sell the products harvested, then they have to deforested more land to more crops. That sale is with the purpose of get a monetary income to buy food, guns or “luxury” items. The contradictory situation is that they sold them traditional food and natural resources to buy other kind of occidental food, or to buy guns with which hunt, and then sold the animal hunt to buy other food.

The current situation in Coayare corroborated the above statements. In this community the land is not enough anymore for the big human population. A large proportion of the territory is deforested and then there are no large or small animals to hunt, and the amount hunted for the most part is outside of the territory of the community and is not enough to supply the protein requirements of the people. According with the FAO the diary protein requirements are of 30gr/60 kg person/day, but in Coayare the estimated per capita consume was of 19.70 gr/protein/day (Table 4). However, from the total bushmeat hunted in the community, the 53% (284 kg) was sold, and the people could use the money income to buy other protein sources, because they have the highest annual food expenses of 5770-SE 2706 USD.

The other two communities, although meet the daily requirement of protein with bushmeat, they also sold a large proportion of their total offtake, corresponding to the 39% (862kg) in Yuri and the 31% (318kg) in La Ceiba. But, even they supply their protein requirements, the population have annual food expenses of 1911-SE 1989 USD in La Ceiba and 1577-SE 1832 USD in Yuri. That monetary expenses are supplied firstly by the occasional sold of agricultural, hunting or fishing products in Yuri, by the intensive commercial sold of natural resources in La Ceiba and by the daily wage or fixed salary in Coayare, and exist a direct association between the high biomass income, the low food expenses and the agricultural economic activity in Yuri, and in opposition the low biomass income, higher food expenses and the salary economic activity.

However, also was found an important association between the higher food expenses and the higher number of killed animals in the region, which corroborated that the population with higher offtake is using the hunted animals to sell and not for food, and are using that monetary income to buy others items as clothes, TVs, computers or alcohol and cigarettes. This association is very important in the debate over the role of bushmeat in poverty alleviation, because is evidence that the bushmeat is not being used by the poorest families, but by the more wealthy families who are the largest traded of hunted animals and generally use the monetary income to drink or other items. Unfortunately, is widely known among anthropologists, the serious situation of men's alcoholism that has the indigenous population of different ethnicities throughout Colombia and mournfully researchers are found the same situation even in other continents, as Africa (Coad 2007).

From a socioeconomic point of view, hunting incomes provide less benefit to rural households than other sources of income, such as those from women agriculture work, due that incomes from agriculture are much more likely to influence household wealth and food security than the incomes from bushmeat sales which income is direct by the men to drink. The FAO (1996) in search of poverty alleviation strategies, suggested in South America the increased power of female heads of households as one of the most effective strategies for bringing communities out of poverty and ensure food security, nutrition and the reduction in traded hunting, benefiting rural livelihoods by reducing the pressure on an important food security resource (Brown 2003).

The general regional situation is evidenced of the occidental influences in indigenous communities, the capitalization of activities and the dependence of a living pay, of a monetary income and the loss of autonomy and sovereignty in all the aspects, but far as this research, firstly the loss of food sovereignty. Currently, the indigenous population cannot supply all they necessities by the access to natural resources, because of its depletion, now they must eat occidental food, and to buy that food they need a monetary income which depend of find a job or commercialize more natural resources. They were autonomous, self-reliant, but now are totally dependent on the western context that surrounds them, even to eat, and then are more vulnerable to external forces such as trade. The regional situation get worse due the international interest in the exploitation of oil, coltan, gold and natural resources which will increase the settler population, the commercialization, the rupture of social joints and the upwelling of social degradation as insecurity, violence, prostitution and alcoholism. Effects historically know through all Colombia and directly associated with the presence of multinational extractive companies.

The differences in the bushmeat consumed and the level of dependence on western food between the studied communities is strongly related with the distance to Inirida. Coayare, with the shorter distance from Inirida, presents the strongest effects, showing the major influence on the traditional parameters of feeding, work and social interaction. This community, due to the high dependence on external products, currently has six stores, the majority of people works during the day and sold hunted animals and agricultural products to buy western food. Due that situation is almost imperceptible the traditional indigenous traits, and then the differences between this indigenous community and a peasant community.

In contrast, Yuri, the community furthest from Inirida, even it is great the transformation of customs, the economic activity of the community still is the subsistence hunting, fishing and agriculture and their diary activities are traditional. In contraposition, La Ceiba, despite being at an average distance to Inirida, its population is principally dedicated to tourism, commercial fishing for consumption and ornamental and wood commerce. Some households show a higher preference for western products, particularly those involved in tourism and commerce, which is predominantly the chieftan's family, and it can cause in a closer future a radical tourism dependence and the total loss of traditional knowledge and diary activities.

Indeed, the serious regional biological and cultural situation, this can be aggravated by the intense loss of younger population, who leave the indigenous communities to seek employment elsewhere and not learn anything about their culture, knowledge that only have the very few elders from the communities. However, in occasions the lack of permanent paid employment in the towns forces men to return to their reserves and rely on hunting as a quick source of income, hunting and selling any animal that they see. This is also the case for local immigrants from other regions of the country. So the indigenous communities inhabiting the region are characterized by people who do not know any about their traditional indigenous culture but are in the territory just as the unique option to get monetary income through the commercialization of natural resources of the indigenous reservations and surrounding lands.

Besides, during the last years, the human population growth in the studied communities was significant and has been causing overpopulation inside the communities and in Inirida city. This population growth has caused an unprecedented demand for food which has increased the hunting pressure in an unsustainable way and caused resource access problems between the population.

For the studied communities the actual consumption of edible biomass was of 3743.42 kg with an annual market value of US\$ 20999.95 for values of US\$5.61/Kg bushmeat in 2011, just for 199 persons. Which is

a considerable quantity that any, nor the government, nor the indigenous communities, nor any NGO's, will assume at the moment that the nature cannot supply the necessary number of animals, and this amount was just for 199 people.

The economic value of bushmeat is huge, but the cultural and health value is greater. The benefit of wildlife for the nutrition of many indigenous and rural families has not been included in national or international estimates, despite having a billionaire value and importance in protein intake for the welfare of thousands of local people (Van Holt et al. 2010). A research in Africa (Golden et al. 2011), show the association between consumption of more wildlife and higher hemoglobin concentrations, and that the remove of access to wildlife would induce a 29% increase in the numbers of children suffering from anemia in the poorest households. The powerful and far-reaching effects of lost wildlife access on a variety of human health outcomes, including cognitive, motor, and physical deficits. So, is of crucial importance, that both, the hunters and the authorities recognize the contribution of the forest and its economic value and prevent the overexploitation of any of it natural resources (Van Holt et al. 2010).

Many researchers reported a regional pattern in diverse human communities throughout the Amazon, where the wildlife use are unsustainable, which is going to cause local and regional extinctions of preferred species and people who depend of this income will no longer be able to obtain a sufficient protein supply from hunting, resulting in negative ecological and socioeconomic impacts (Zapata-Ríos et al. 2009). At the regional level, Tafúr (2011) found similar data in a closer indigenous community located inside a National Natural Park, an extraction rate of mammal hunting of 541 individuals belonging to 16 mammal species hunted by 18 local hunters in four years, corroborating the regional pattern in the hunting activity at regional level.

In the Amazon, the pervasive changes in vertebrate community structure associated with game hunting are clearly becoming more severe and widespread as (1) rapid rural population growth places heavier demands on game resources; (2) changes in land-use patterns degrade pristine forest habitat, particularly for species averse to secondary forest, fragments, and forest edges (Robinson 1996); (3) changes in transport and weapon technology increase hunter mobility and game mortality over larger catchment areas; (4) increased integration into the market economy encourages sales of salted and smoked meat surpluses, thus blurring the distinction between subsistence and commercial hunting; and (5) traditional practices break down, eliminating folklore, myths, and taboos that once served to protect forest wildlife (Peres 2000). The increased commercialization of the bushmeat trade, as rural-urban migration increases urban demand, has been cited as another reason for increased unsustainability (Bowen-Jones and Pendry, 1999).

The last point aforementioned is the major cause of ecological unsustainability of hunting in the Inirida region. The changes in the traditional practices and beliefs in the region due the evangelization process, the loss of taboos to hunt particular species, the conversion to collective lands to hunt and the absence of regulation and respect of access to the resources, has been causing the overexploitation and decrease in the availability of game species which in the past were culturally forbidden. In ancient times some large species were never hunted due to taste and taboos, for example Edentates and Tapirs, and hunters showed partial preferences for some species. Additionally, older people in the past hunted by day, and it was the reduction in prey that had forced them to now hunt at night and opportunistically, as part of another activity such as fishing or agriculture.



Indeed, communities converted to western religion currently do not consider the traditional prohibitions around hunting, which regulated the species, places, number of individuals, sex, and age of animals allowed to hunt. In addition, behaviors around sharing meat and which parts of the animals' people can eat, also have changed. The migration of more and more young people out of villages, into the towns to find employment, might also help to break down old traditions.

The use of parts of wild animals in traditional medicine is currently incipiently implemented. As mentioned above, the change to catholic, evangelical and christian religions, appears to affect hunting traditions in all its aspects. Aiyadurai et al. (2010), also observed these effects in the north-east of India, where the traditional communities had a greater sense of conservation, but the westernized communities where the christianity lead to an erosion of hunting taboos, overexploit their natural resources without any control. In Inirida region, the evangelism, even has promoted the intensive and extensive hunt for religious meetings and a cultural change towards raising domestic animals which changes the land use to pastures.

Occidental religions have an anthropocentric, utilitarian and monetary vision about the animals and all natural resources, and naturally encourage the sale of products to get money from it and make profits at any costs. Currently, in the region the importance of the animals is based on their use as food and material for survival, other ways does not matters. Due it, the traditional cultural value of nature is not present any more and prevalent the utilitarian evangelistic vision in which the communities hunt a great amount of bushmeat for their monthly, semiannual and annual meetings, and can sell anything at any time.

The occidental vision imply a change in traditional practices to western technologies for hunt, which currently include dogs and shotguns, and a major efficiency and an absence of selectivity criteria for age, sex or species, decreasing even more the ecological sustainability of the hunting although socially may require less energy and be more sustainable. However, the use of these technologies requires an economic expenditure, obtained from exploitation of natural resources, which in turn creates a preference for activities with higher economic remuneration such as commercial fishing for consumption, extraction of wood or animal traffic, intensifying the relations of indigenous population with market economies.

In Inirida region, the wealthier households have the economic resources to get a shotgun and use it to hunt, so these households collect bushmeat directly. Poor households, without resources to buy a gun or a hunting dog must purchase bushmeat from wealthier households. Then, as in other regions undoubtedly, subsistence hunting may contribute to livelihoods at a household level by providing meat. But, the hunting revenues in food or incomes, is not being used for subsistence. So it is important to distinguish between the main users of a resource and those who are most dependent on the resource.

In addition, the abandonment of traditional practices to control human population growth and the forbidden of mechanism of birth control by the evangelic and catholic religions has been producing a greater population growth. A low human population density plus use of traditional weapons plus cultural management of hunting, is equal to reduced pressure on wildlife and a more sustainable hunting pressure, but this is not the situation in the region. Contrary, the development strategies promoted by the government are related with the extensive monocrops for biofuels extraction, causing a high increase in the settlers immigration looking for accumulation of money thought the mining boom.

In general, the cultural patterns for access to natural resources has changed dramatically, today the people access to natural resources as they want and sell it to get money for other material goods. Since the

subjection to evangelical and catholic religions, the perception of the indigenous communities of this region have come to regard nature as an object which can be used as they want, just as the religion declares, and have lost the traditional knowledge and practices which differentiate them from other occidental and rural population and today the new generations are ashamed of their roots and do not value natural resources.

Bennett and Robinson (2000) identified many cultural and socio-economic conditions which are increasing the unsustainability of hunting of mammals around the world, and precisely many of it are present in the Inirida region, but the one that has had the greatest effect in the region, is the imposition of the western religion. This imposition caused the loss of an invaluable ecological and cultural knowledge of which almost nothing remains. In the region, the ethological, reproductive and seasonal ecological knowledge about the species and ecosystems is very limited, and much more in regard to traditional medicine and cultural aspects. But the saddest aspect is that the own indigenous population does not care and does not develop any strong action to recover their traditions and knowledge, in contraposition to some Colombian indigenous communities who exercising their right to isolation to protect and maintain their culture.

So, I consider that the deep cause of moving the hunting activity to the unsustainability in this region as in many others is the loss of traditional cultural patterns, in this case caused by the religion imposition. The western religion has been characterized by the use of natural resources as property of the human, a substantial difference with the native worldview, in which the human is considered as part of the nature and the ecosystem and then act accordingly with the availability of resources, because depend of them. Due that, the traditional indigenous communities hunt very few large-bodied mammals, because know that are less abundant; in contradiction with the studied indigenous communities were hunt without any restriction. Then, the intrinsic vulnerability of the species ( $r_{max}$ ) is not the reason of the unsustainability of the hunting, it is the contradictory *modus operandi* of the people who hunt animals with small populations and reduced reproductive rates. In the same way, the fact of having a land use not propitious to the development of large-bodied mammals is not a factor of the land per se, it is of the human who use that land, of their philosophical conception of the world and is the human who currently is using the land following a development model extractive.

In conclusion, the driver of hunting unsustainability in the region is the change of religion from indigenous values and myths to occidental principles of power the man over the nature, because that is the reason why the people follow an economic activity, consequently have food expenses, and sell it natural resources to supply their economic expenses to have a life as is designed by the religion and the occidental development model. Bushmeat is therefore a crucial issue for both wildlife conservation and human development, and initiatives to tackle the crisis need to provide for both of these, often opposing, needs (Coad 2007). However, it is possible to corroborate my assertion by the comparison between a really traditional community and a western religion community.

So, the cultural and biologic future in the region is very disturbing. The current indigenous population do not know almost anything about their culture and their future generations even least will know. The general interests of the population are obtaining money, but the wage labor supply is very limited in Inirida, forcing the population to turn to another source of money which generally is the commercialization of natural resources. Then, if the rights and special considerations for the indigenous population in Colombia are based on their traditional practices and cultural knowledge, which in this case

does not exist, and it is likely that this indigenous population continue to increase the overexploitation of natural resources. I think that is necessary, under the vision that the indigenous population can decide for themselves, consider two definitive possibilities for this region: 1). define that are settler that are in the process of consolidation and create strategies of cushioning for their total income in the market economy, as would enter as part of the social group of low-income in Colombia, ending their special access rights to natural resources, or 2). establish an agreement which specify standards of access to natural resources, protection of the same by the community, the preservation of traditional cultural activities and livelihoods, and if carried out exploitation activities not allowed, application of severe penalties which at a limit number of recurrence will cause permanent deprivation of their special access rights to natural resources.

This work is evidence of the crucial necessity of take into account the context in which is implicated the natural resources use as “ignoring the human factor in the sustainable management of bushmeat is a clear recipe for failure” (Stevenson and Newby 1997).

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## Supplementary material

### A. Interview guide applied to each householder

<b>INTERVIEW GUIDE: RESEARCH ON ECOLOGICAL SUSTAINABILITY OF HUNTING OF MAMMALS</b>
<p><b>PERSONAL INFORMATION:</b></p> <p>What is your name?                      Ethnicity at what you belong?                      Where are you from?                      How long ago are you living in the community?                      How many people are living in the household?                      How old is each of the people who live here?</p>
<p><b>HUNTING ACTIVITY IN THE YEAR:</b></p> <p>Which and how many animals you hunted during the year?                      Dantas?, monos?, venados?, tigres?, cerdos?, lapas?, picures?,...                      Where did you hunt each of these animals?                      When and how did you hunt each animal? In what season and what technique did you use?                      What kind of vegetation is in that place? Mature forest or secondary growth vegetation?                      What for you hunted that animal? For food or sell?</p>
<p><b>ECONOMIC ACTIVITY (ACCESS TO EXTERNAL FOOD):</b></p> <p>Which food product you buy in the town?                      How much money you spend buying them?                      How often you buy these products?                      Which main economic activities are carried out in the house? (Sale of cassava, bushmeat, wood, trade of consumption or ornamental fishes, daily wages, etc.)</p>
<p><b>CULTURAL SITUATION:</b></p> <p>Which is your personal appreciation about the cultural situation in the region? What do you think about how are currently your culture, your traditions and practices?                      How has been changed in the time in the region?                      How has been changed the traditions respect the natural resources use? (number of people and it effects)                      How are changed in the time the natural resources availability in the community? The forest and the animals' availability?                      Why did you think that the animals and resources have been depleted? Which are the drivers of the reduction of natural resources in the region?</p>