Comparing hunting practices of urban and rural inhabitants in Western Amazonia: the role of religion, wealth, and livelihoods

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Abstract

Hunting is essential for securing access to energy and nutrients by rural and urban populations throughout the tropics. The hunting patterns of urban hunters are unknown, and we do not know how much they resemble or differ from rural hunters. On the other hand social factors that influence hunting choice of these hunters are still largely unclear. Here we analyzed the impact of socioeconomic and cultural factors on frequency and composition of species hunted by urban and rural Amazonian hunters. Within 10 municipalities in western Amazonia in Brazil, we interviewed 49 urban hunters and 57 rural hunters. A total of 44 species were cited as hunted. Our analyses showed that the probability of engaging in sport hunting (for recreation) was greater in urban hunters. Rural inhabitants, who had overall incomes lower than urban hunters, and were non-practicing Christians and Atheists hunted more frequently. Species hunted or preferred were similar independently of the livelihood or religion of the urban or rural hunters. However, we found that hunting frequency was influenced by the hunters’ socioeconomic and cultural backgrounds, which did not affect the composition of the harvest. This similarity between urban and rural hunters might be related to species distribution and availability and could potentially impact the most hunted species if hunting grounds overlap. Understanding hunting patterns, especially those of urban hunters can be used to manage hunting activities more effectively, improve law enforcement against illegal hunting as well as develop more effective conservation strategies.

Introduction

Humans have hunted animals for food and other benefits from earliest recorded history (Fa et al., 2022). Consumption of wild meat is still an essential component of the lives of millions of rural, forest-dependent families throughout the tropics (van Vliet et al., 2011; El Bizri et al., 2020a). In Amazonia, hunting for wild meat is an essential practice to buttress food security and livelihoods of many Indigenous Peoples and local communities (Nunes et al., 2019a,b). The rise in population numbers in cities and towns in Amazonia, often resulting from migration from rural areas has led to a greater demand for wild meat (e.g., Chaves et al., 2021; Rebello et al., 2022). In recent decades, urban areas in Amazonia have been populated by a variety of rural peoples of different ethnic groups and socioeconomic backgrounds, motivated by better access to health, education, and technology (Parry et al., 2010; Eloy et al., 2015; Sobreiro, 2015). Recent estimates of wild meat in urban centres in central Amazonia indicate that a minimum of 10,000 tonnes per year, of which approximately 15% is consumed by urban hunters themselves (El Bizri et al., 2020b). The persistent connection between urban dwellers and rural culture (especially for those originating from the countryside) means that a considerable number of urban residents still hunt, though not for necessity (Chaves et al., 2019). Better access to firearms and ease of urban-rural transport encourage urban residents to keep hunting (El Bizri et al., 2015; Ingram et al., 2021).

Amazonian hunters in rural areas are influenced by socioeconomic, cultural, and environmental factors on the hunting activities of Amazonian hunters. Among these, they highlight hunter age (Barbosa et al., 2020; Knoop et al., 2020; Nunes et al., 2020), hunting technique preference (Tavares et al., 2020; Oliveira et al., 2022a), religious affiliation (Knoop et al., 2020), schooling (Barbosa et al., 2020), and vegetation cover (Torres et al., 2021). These studies were conducted in isolated communities and some in protected areas (Fernandes-Ferreira & Alves, 2017). To date, hunting by medium and large rural agricultural communities or by urban inhabitants is poorly represented in the literature.

Most studies of urban hunters have focused on low-income populations, which have a high dependence on hunting. van Vliet et al. (2015) confirmed the existence of hunting by urban hunters, mainly rural migrants, in the cities of Benjamin Constant and Atalaia do Norte in the state of Amazonas, Brazil. In these cases, hunting was practiced to supply local markets and to supplement income. However, recent studies show a high prevalence of sport hunting of wild animals by hunters in urban areas that have higher incomes, access to modern weapons, and do not depend on wild meat as a source of food, and mostly hunt illegally for sport (El Bizri et al., 2015; Santos et al., 2022). Religion, like income, plays a significant role in the practice of hunting. The adoption of different religions and the religious taboos associated with the consumption of certain species can determine the animals can be killed and consumed, or avoided (Luzar et al., 2012; Knoop et al., 2020; Lemos et al., 2021).

In this paper we investigated the effects of socioeconomic (age, mean income, and number of people in the household) and cultural (religion) factors on motivations and hunting patterns by rural and urban hunters (livelihoods) in the western Brazilian Amazon. Our central hypothesis was that livelihood, income, age, number of household residents, and religious affiliation influence hunting frequency, the composition of hunted species, and the likelihood for sport hunting by rural and urban Amazonian hunters.

Methods

Study area

This study was conducted in the state of Rondônia, southwestern Northern Brazil. Rondônia occupies an area of 237,765.233 km² and has 52 municipalities (administrative divisions comprising rural areas and a seat city) and is the fifth least populated state (estimated population 1,777,225 inhabitants). The urban population (1,149,180 inhabitants) is almost three times larger than the rural population (413,229 inhabitants) (IBGE, 2017).

Colonization and migration in Rondônia state began in the 17th century, driven by different economic and development cycles: mining, slavery, rubber production, railway development, hydroelectric dams, and, more recently, immigration of international refugees. These migration waves involved a wide variety of internal migrants and immigrants from various nationalities (Cotinguiba & Cotinguiba, 2015). These movements of people into the state has created a multicultural population (Amaral, 2018), where 57.7% are non-native inhabitants (IBGE, 2015).

Data collection

We interviewed a total of 106 hunters (49 urban and 57 rural) in 10 municipalities from October 2018 to February 2020 (Table 1). Hunters were classified as 1) urban: hunters who lived in a city or town in a municipality but traveled to the countryside to hunt and 2) rural: hunters who were not members of any
traditional community (i.e., riverine or Indigenous People) and did not inhabit Protected Areas. All rural hunters were small to large rural agricultural producers. This classification follows that proposed by Oliveira et al. (2022b).

<table>
<thead>
<tr>
<th>Municipalities</th>
<th>Rural</th>
<th>Urban</th>
<th>Area (km²)</th>
<th>Inhabitants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alto Alegre dos Parecis</td>
<td>1</td>
<td>-</td>
<td>3,958.300</td>
<td>13,940</td>
</tr>
<tr>
<td>Ariquemes</td>
<td>-</td>
<td>1</td>
<td>4,426.571</td>
<td>90,353</td>
</tr>
<tr>
<td>Buritis</td>
<td>1</td>
<td>2</td>
<td>3,265.809</td>
<td>32,383</td>
</tr>
<tr>
<td>Cacoal</td>
<td>-</td>
<td>1</td>
<td>3,792.892</td>
<td>78,574</td>
</tr>
<tr>
<td>Candeias do Jamari</td>
<td>4</td>
<td>1</td>
<td>6,843.868</td>
<td>19,779</td>
</tr>
<tr>
<td>Chupinguaia</td>
<td>-</td>
<td>1</td>
<td>5,126.723</td>
<td>8,301</td>
</tr>
<tr>
<td>Itapuí do Oeste</td>
<td>5</td>
<td>-</td>
<td>4,082.580</td>
<td>10,641</td>
</tr>
<tr>
<td>Nova Brasiliândia d'Oeste</td>
<td>2</td>
<td>-</td>
<td>3,265,809</td>
<td>21,592</td>
</tr>
<tr>
<td>Ouro Preto do Oeste</td>
<td>1</td>
<td>1</td>
<td>1,969.850</td>
<td>37,928</td>
</tr>
<tr>
<td>Porto Velho</td>
<td>43</td>
<td>42</td>
<td>34,090.954</td>
<td>428,527</td>
</tr>
<tr>
<td>Total</td>
<td>57</td>
<td>49</td>
<td>70,823.356</td>
<td>729,472</td>
</tr>
</tbody>
</table>

The average size of the sampled municipalities was 4,000 km², and the median number of residents in a municipality was 26.99. Informants were selected using the snowball sampling method (Goodman, 1961). This selection process consisted of identifying the first hunters within the study area, who subsequently suggested other interviewees who also recognized themselves as hunters and were willing to participate in the study. Participants had to be over 18 years of age and should have resided in the state of Rondônia for at least six months (Fig. 1).

We employed semi-structured interviews to gather socioeconomic and cultural information as well as participants’ hunting patterns. The questions included municipality of residence, livelihood (urban/rural), age (in years), religious affiliation (open-ended question), and monthly income (in Brazilian reals). The average monthly income was converted into US dollars using the exchange rate for 27 January 2021 (USD$1.00 = BRL R$5.39), based on the general price index for Brazil estimated by the Getúlio Vargas Foundation. Religious affiliation was either: Catholic, Evangelical (any evangelical denomination), atheist (no religion or belief in God), and non-practicing Christian (believing in a Christian God but not attending services or meetings).

We asked participants to describe their main motivation for hunting (sport, subsistence, or trade), frequency of hunting (in days per month), species hunted (free-lister), and preferred species to hunt and their justification for this preference (i.e., palatability, abundance, and body size). We added another 12 unstructured interviews to apply to Evangelical and Catholic participants to understand and discuss the influence of religion on hunting frequency. These consisted of an open-ended question on why their religion influenced hunting, with an emphasis on the frequency of hunting trips.

All hunters were informed of the objectives of the project, and assured them that their names would not be disclosed, as determined by CNS resolution 466/12 on research involving human subjects. This study was approved by the research ethics committee (CEP) of the Aparício Carvalho University Center (protocol: 2.661.332).

**Data analysis**

Descriptive statistics (mean, standard deviation, and percentage) were used to report the socioeconomic profiles and hunting patterns of the participants. We used a generalized linear mixed model (GLMM) with a Binomial family of distribution to assess the probability of hunting for sport (response variable: 0 for no and 1 for yes) according to the interviewees’ livelihoods (urban vs. rural) and monthly income (fixed predictor variables). We also used the GLMM with the Gamma family of distribution to evaluate the effects of socioeconomic factors on the frequency of hunting of the interviewees. We tested whether hunting frequency (response variable) varied according to the interviewees’ livelihood (urban vs. rural), age, religious affiliation, monthly income, and the number of people living in the household (fixed predictor variables). We also used the GLMM with the ZAGA family (Zero-adjusted Gamma) to evaluate the relationship between citations of hunted species and hunting preference. We assessed the percentage of citations of hunted species and interviewees’ livelihoods (urban vs. rural) as predictor variables and percent hunting preference as the response variable. To account for different sample sizes from different municipalities in the state of Rondônia and the possible effect of factors at the municipality level not considered here, we included municipalities as a random factor in the models. To build the models, we first checked for collinearity among variables; no collinearity was found. We compared combinations of predictor models, from the simplest (null model, no effect of any predictor variable) to the most complex model (effect of all predictor variables). Final models were selected based on the Akaike information criterion (AIC), considering all models with good support as those with delta AIC values smaller than two in relation to the model with the smallest AIC. In cases where more than one model was best fitted, we selected the model with the smallest number of parameters (simplest model). To assess the effect of variables, we considered $p < 0.05$ as significant.

In instances where the local names provided by the informants were not sufficient to unequivocally catalog the species, we used the genus or family. For species classification, we followed the methods proposed by Abreu et al. (2022) for mammals, Pacheco et al. (2021) for birds, and Costa et al. (2021) for...
reptiles. We classified the conservation status of the identified taxa at the species level according to the International Union for Conservation of Nature and Natural Resources Red List version 2022-2 (IUCN) (IUCN, 2023) at the international level, and according to the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) List of species threatened with extinction (MMA, 2022) at the national level.

We assessed the difference in hunted species and hunting preference between urban and rural hunters and by religious affiliation using principal coordinate analysis (PCoA), with the Gower similarity coefficient as a measure of proximity. Additionally, we performed a permutational multivariate analysis of variance (PERMANOVA) with 9999 permutations to validate the PCoA results. In these analyses, we considered that the number of citations of a taxon would reflect the proportion with which it is hunted, as demonstrated by Oliveira et al. (2022b). We used R software (ver. 3.3.3) and the gamlss and vegan R packages for the analyses, and the GGally R package for the collinearity test.

Results

Socioeconomic characteristics of hunters and their relationship with hunting motivations and frequency

The probability of hunting for sport was related to the livelihood of the hunter but not to the average income (Fig. 2A). The main motivation for hunting among the urban population was for sport (88.68%). In contrast, among rural hunters, sport and subsistence hunting had an approximate number of citations corresponding to 50.79% and 44.44%, respectively. Rural hunters hunted at a higher frequency than urban hunters (Fig. 2B). Hunting frequency was significantly influenced by the average monthly income; the lower the income, the higher the hunting frequency (Fig. 2C). Religious practices also influenced hunting frequency: non-practicing Christian and atheist informants hunted more frequently than Catholics and Evangelists (Fig. 2D; Supplementary Table S1). The mean age of urban hunters was 34 ± 12 years and of rural hunters was 37 ± 15 years. The number of residents in the hunters’ household was also similar, 3.23 ± 1.53 and 3.58 ± 1.98 for urban and rural hunters, respectively. Hunter age, number of residents in the household, and length of hunting practice did not influence hunting frequency. No hunter reported using animals for religious or ritualistic purposes.

Composition of hunted taxa

A total of 44 species were recorded as hunted in 609 citations. Urban hunters cited 33 species as hunted, with seven species cited exclusively by this group. Rural hunters cited 36 species, 10 of which were exclusive (Table 2 and Fig. 3). Regarding hunting preference, 17 species were cited (34.69% of the total species hunted cited), with 13 cited by urban hunters and 14 cited by rural hunters. The justification for preference in all citations recorded for both groups of hunters was palatability. Only two urban hunters and six rural hunters indicated no hunting preference. Mammals were the most cited group as hunted (79.09% for urban and 84.78% for rural), followed by birds and then reptiles. The same pattern was observed for preference, with mammals being the group with the highest number of citations (83.33% for urban and 86.51% for rural) (Table 2). Hunting preference was significantly related to the species cited as hunted, where the species with the highest number of citations were the most preferred, regardless of hunter livelihoods (Fig. 4; Table 2).
Table 2
Species cited as hunted and food preferences of urban and rural hunters in Rondônia state. VU = vulnerable, EN = endangered.

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Popular name</th>
<th>Citation</th>
<th>Preference</th>
<th>IUCN</th>
<th>ICMBio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammalia</td>
<td></td>
<td></td>
<td>Urban</td>
<td>Rural</td>
<td>Total</td>
</tr>
<tr>
<td>Carnivora</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Nasu nasua</em></td>
<td>south american coati</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><em>Puma concolor</em></td>
<td>puma</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td><em>Panthera onca</em></td>
<td>jaguar</td>
<td>1</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Cetartiodactyla</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Mazama americana</em></td>
<td>red brocket</td>
<td>18</td>
<td>17</td>
<td>35</td>
<td>2</td>
</tr>
<tr>
<td><em>Mazama nemorivaga</em></td>
<td>amazonian brown brocket</td>
<td>8</td>
<td>12</td>
<td>20</td>
<td>-</td>
</tr>
<tr>
<td><em>Ozotoceros bezoarticus</em></td>
<td>pampas deer</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><em>Dicotyles tajacu</em></td>
<td>collared peccary</td>
<td>33</td>
<td>29</td>
<td>62</td>
<td>5</td>
</tr>
<tr>
<td><em>Tayassu pecari</em></td>
<td>white-lipped peccary</td>
<td>24</td>
<td>31</td>
<td>55</td>
<td>4</td>
</tr>
<tr>
<td>Cingulata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dasypus novemcinctus</em></td>
<td>nine-banded armadillo</td>
<td>29</td>
<td>40</td>
<td>69</td>
<td>4</td>
</tr>
<tr>
<td><em>Dasypus beniensis</em></td>
<td>greater long-nosed armadillo</td>
<td>15</td>
<td>4</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td><em>Euphractus sexcinctus</em></td>
<td>yellow armadillo</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td><em>Cabassous unicinctus</em></td>
<td>southern naked-tailed armadillo</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td><em>Priodontes maximus</em></td>
<td>giant armadillo</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>Didelphimorphia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Didelphis marsupialis</em></td>
<td>Common opossum</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Perissodactyla</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Tapirus terrestris</em></td>
<td>lowland tapir</td>
<td>14</td>
<td>20</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td>Primates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Alouatta puruensis</em></td>
<td>Purús red howler monkey</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td><em>Ateles chamek</em></td>
<td>black-faced black spider monkey</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td><em>Leontocebus weddelli</em></td>
<td>Weddell's saddle-back tamarin</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><em>Saimiri ustus</em></td>
<td>golden-backed squirrel monkey</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td><em>Sapajus apella</em></td>
<td>black-capped capuchin</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Rodentia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Hydrochoerus hydrochaeris</em></td>
<td>capybara</td>
<td>10</td>
<td>18</td>
<td>28</td>
<td>2</td>
</tr>
<tr>
<td><em>Cuniculus paca</em></td>
<td>paca</td>
<td>47</td>
<td>47</td>
<td>94</td>
<td>38</td>
</tr>
<tr>
<td><em>Dasyprocta spp.</em></td>
<td>agouti</td>
<td>11</td>
<td>22</td>
<td>33</td>
<td>2</td>
</tr>
<tr>
<td><em>Coendou longicaudatus longicaudatus</em></td>
<td>long-tailed porcupine</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td><em>Hadrosciurus spadiceus</em></td>
<td>southern amazon red squirrel</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Aves</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tinamiformes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Tinamus solitarius</em></td>
<td>Solitary Tinamou</td>
<td>7</td>
<td>3</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td><em>Tinamus guttatus</em></td>
<td>White-throated Tinamou</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Anseriformes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Dendrocygna spp.</em></td>
<td>Whistling-duck</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td><em>Cairina moschata</em></td>
<td>Muscovy Duck</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>2</td>
</tr>
</tbody>
</table>
The PCoA showed similarities between rural and urban hunters with respect to the composition of hunted species (PERMANOVA $F = 0.0349; p = 0.5$) and species preferences (PERMANOVA $F = 0.0412; p = 0.5$) (Fig. 5A, B). Religious affiliation was also not an influencing factor for the composition of hunted species (PERMANOVA $F = 0.0784; p = 0.3$) (Fig. 5C). The 12 Catholic and Evangelical hunters participating in the unstructured interview reported a preference for participating in religious activities, such as worship services and meetings, than conducting hunting activities. When asked if there was any religious moral or ethical code that prevented or limited hunting, all were emphatic in stating that they were allowed to hunt because animals were created by God to satisfy human needs.

**Discussion**

Our study is one of only a few studies that assessed hunting patterns of urban inhabitants of the Amazon, in addition to investigating the factors that influence hunting frequency. Urban and rural hunters show great similarity in the composition of hunted species and preference for each species, with the most frequently hunted species generally being those they preferred their taste. Furthermore, a study comparing the availability of species with the composition of the most caught species found a relationship between these two variables (Oliveira et al., 2022b). Thus, we can state that hunting effort is directed and not random.

Preference for palatability is an important feature for the consumption of several species (Rosa et al. 2019). This preference was directly reflected in hunting records, where the paca (*Cuniculus paca*) was the main species cited as hunted by urban and rural hunters as well as the most cited preferred species. In agreement with our results, paca has the highest capture record in different regions of the Amazon and is one of the most preferred species in terms of palatability (Valsecchi & Amaral, 2009; El Bizri et al., 2015; Ramos et al., 2020; Torres et al., 2021; de Paula et al., 2022). Although hunters cited 44 species, 56.82% had fewer than three citations per group, and 31.82% had a single citation. Oliveira et al. (2022b) demonstrated that hunters in Rondônia captured 60% of the total species cited as hunted during a freelist interview, and five species were the most targeted (52.7% among urban hunters and 61.6% among rural hunters), including the paca.

Urban and rural hunters in Rondônia share the same consumption pattern of taxonomic groups, similar to that observed in other regions of the Amazon. The preference for mammals over birds and reptiles is observed in Indigenous (Knoop et al., 2020; Shaffer et al., 2017), rural (Mesquita et al., 2018; Ramos et al., 2019; Siqueira et al., 2020; Terceiro et al., 2021), and urban (Cortez et al., 2022) hunters.
2020), riverine (Belfort et al., 2020; Valsecchi & Amaral, 2009), and extractivist (Lemos et al., 2018; Nunes et al., 2020) populations. Although the spectrum of hunted species is wide, hunting is concentrated within a specific group, represented almost exclusively by mammals, presenting high selectivity, an aspect similar to that reported by de Paula et al. (2022). Species hunted and cited exclusively by each hunter group had a maximum of three citations, representing less than 5% of the total number of citations.

Although other studies indicate the killing of felines aimed at control or retaliation (Lima et al., 2020), we observed that the capture of these animals was motivated by both retaliation and consumption. Consumption of the meat of large cats is a one-off behavior that is rarely recorded in the Amazon (Srêbêk-Araujo 2015; Oliveira et al., 2023) and in other areas of the world (Braga-Pereira et al., 2021).

Regarding hunting motivation, the predominance of hunting linked to sport/recreational practices by urban hunters, and a high prevalence of this type of motivation among rural hunters, is an unprecedented record in the Brazilian Amazon. Sport hunting in Brazil is highly widespread (Alves et al., 2009; Castilho et al., 2019), including video sharing and acceptance by the online media consuming public (El Bizri et al., 2015). A study analyzing more than 8,000 comments on videos about sport hunting on social networks showed that only 1.03% of these presented positions that were not in favor of sport hunting in Brazil (El Bizri et al., 2015). The motivation of sport hunters is linked to their emotions and the thrill of chasing animals and not to obtain food. In Rondônia, this is practiced by both urban and rural hunters.

Recreational hunting in the Brazil is only legally allowed for controlling populations of invasive species (Carvalho et al., 2019). In the United States, for example, a proportion of the funds obtained from the sale of hunting licenses and sales taxes on equipment used for hunting are used towards species conservation. In this situation, sport hunting is justified, considering that a lower engagement in hunting would result in a lower financial contribution to conservation actions (Bakner et al., 2022). This activity is still surrounded by considerable debate regarding its impact on target populations and whether it is possible to reconcile it with conservation purposes. Regardless of the debate, all measures (either to suppress or legalize hunting) must be supported by evidence, thus highlighting the need for further research on this subject.

A factor that should be highlighted regarding the existence of urban hunters is related to desire to consume wild meat in this environment. Studies conducted in the Amazon clearly indicate the existence of demand for wild meat in urban settings, often motivated by the flow of people from rural to urban areas. In the Central Brazilian Amazon, rural migrants continue to consume wild meat after moving to urban areas (Chaves et al., 2021). In Iquitos, in the Peruvian Amazon, the increase in wild meat sales has kept pace with urban population growth from 1973 to 2018 (Mayor et al., 2022). Thus, urban demand may affect the stock of game species that can be accessed by the rural population, which is dependent on this resource (Morsello et al., 2015). Hunting grounds accessed by urban hunters should be investigated to verify the existence of an overlap with rural hunter territories.

Our results show that income and religion influence hunting frequency; hunters with lower monthly incomes and those who do not practice any religion hunt more frequently, regardless of their place of residence. Although the motivations of rural hunters are similar, the relationship between income and frequency highlights the importance of wild meat in the diet of low-income populations (Mayor et al., 2007). Wild meat plays an important role in subsistence, and its replacement by other protein sources, especially domesticated ones, is not feasible given the high cost compared to the average income of this population (Nunes et al., 2019a). Our results regarding income corroborate those reported by Parry et al. (2014), demonstrating that lower-income families practice hunting for meat, proving the relationship between low purchasing power and the capture of animals. On the other hand, Torres et al. (2021) in rural communities of Santarém, Belterra and Mojuí dos Campos (Pará-Brazil) and Souza et al. (2022) with residents of the urban and rural areas of Crisópolis (Bahia-Brazil) found that wild animal consumption and capture is independent of family income, and that increasing family income will have little or no impact on wild meat consumption. In these localities, hunting plays an important role in the informal economy, used as a means of exchange, as well as an element to strengthen social relations and essential to the subsistence of the populations studied.

In addition to average income, religious affiliation influenced hunting frequency but was not a determinant of the composition of hunted species. Knoop et al. (2020) in their study with Maragüá Indigenous Peoples in the lower Madeira River (Central Amazon) recorded that Adventist hunters have restrictions on the consumption of certain game species, limiting the consumption mainly to deer, tinamids, curassows, and jacamins, a pattern not observed among non-Adventist hunters. Lemos et al. (2021) reinforces the results of Knoop et al. (2020), highlighting the dietary restriction of Adventists to a restricted group of species. Dietary restrictions based on religious beliefs are common (Luzar et al., 2012); however, the influence of religion on hunting frequency has not yet been documented.

Here, we observed that practicing religious people hunted at a lower frequency than non-practicing religious and non-religious people. This frequency may be influenced by the activities performed by religious practitioners, especially on weekends when more time would be available for hunting. Although it was not possible to quantify the effect of religious activities, the utilitarian view presented by the interviewees, in which animals were created for human benefit, demonstrates that possible factors involving ethics and moralism can be discarded in view of the beliefs of these people. This utilitarian relationship was presented by Lemos et al. (2021), who recorded the non-consumption of primates because they were not animals created by God for consumption as food. Future studies should verify how the frequency of religious activities influence hunting, in addition to the view on the use of fauna in different religions.

Hunting is illegal in Brazil (Law n° 9.605 of February 12, 1998), with some exceptions for Indigenous peoples and local people in need for food. However, hunting is a widespread activity in several parts of the country, including the state of Rondônia. This can be attributed to several factors, including cultural traditions, lack of enforcement of wildlife protection laws, and poverty. Therefore, is crucial to address the issue of illegal hunting, as it has significant impacts on biodiversity conservation and the sustainable use of natural resources in Brazil. Policies such as protected areas, hunting bans, and community-based natural resource management must be implemented to address the issue. Additionally, raising awareness about the importance of biodiversity conservation and the negative impacts of illegal hunting can also play a crucial role in changing attitudes and behaviours towards wildlife. Studies such as ours address the root causes of hunting and are important to furnish information for higher effectiveness of conservation interventions.
Conclusion

Income and religion are important predictors of hunting frequency, regardless of whether the hunters are urban or rural dwellers. The similarity in the composition and preference of hunted species between urban and rural hunters reflects species distribution and availability, as well as cultural factors. Areas that, in principle, would only be accessed by local hunters in the rural environment may now be open to urban hunters, thus increasing extraction and, consequently, changing the composition and abundance of different species, affecting the stocks necessary for the subsistence of rural populations.

Although illegal, hunting is a widely distributed and culturally accepted activity in Brazil and the state of Rondônia, demonstrating the need to create appropriate policies to address the issue. In this scenario, an understanding of the hunting pressure provoked by urban hunters, in conjunction with other anthropogenic pressures currently occurring in the Amazon, such as habitat loss and fragmentation, is needed for an in-depth understanding of the impacts of this activity to help define management and conservation strategies.

Declarations

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Ethical Approval

This study had the prior informed consent of the hunters, authorizations from the National Research Ethics Council (CONEP) (protocol: 2.661.332).

Competing interests

The authors declare that they have no conflicts of interest.

Author contributions

MAO, HREB, TQM, FB-P, JEF, MRM and CRCD wrote the main manuscript text, MAO, HREB, TQM and FB-P performed the statistical analysis, MAO, HREB, TQM and FB-P prepared figures 1-5. All authors reviewed the manuscript

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Availability of data and materials

The data can be directly requested with the correspondence author.

References


**Figures**
Figure 1

Map of the state of Rondônia in the southwestern Brazilian Amazon, indicating the 10 municipalities where we conducted interviews with rural and urban hunters. The green polygon indicates the boundaries of the Amazon basin.
Figure 2

(A) Probability of engaging in sport hunting as a function of place of residence. (B) Relation of hunting frequency to the hunters' average monthly income. (C) Average monthly frequency of hunting as a function of the living environment (urban vs rural). (D) Average monthly hunting frequency as a function of religion declared by hunters. Y-axis are ln transformed.
Figure 3

Species captured by hunters living in urban and rural areas in Rondônia state: (A) *Dasypus novemcinctus*, (B) *Tayassu pecari*, (C, E, and H) *Cuniculus paca*, (D) *Tapirus terrestris*, (F) *Hydrochoerus hydrochaeris*, and (F and G) *Caiman crocodilus*. 
Figure 4

Relationship between the citation frequency of hunting preferences and the citation frequency of hunted species.
Figure 5

Principal coordinate analysis (PCoA) of the composition of hunted taxa, preference and religion among rural and urban hunters

Supplementary Files

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- TableS1.docx
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