



## Social Correlates of and Reasons for Primate Meat Consumption in Central Amazonia

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### Abstract

Traditionally, humans have consumed nonhuman primates in many places, including throughout the Amazon region. However, primate consumption rates are changing with rising urbanization and market access. We characterize primate consumption in central Amazonia using 192 qualitative interviews with inhabitants in three rural villages and in the city of Tefé. We used a generalized linear model to investigate how individual consumer characteristics, such as age and gender, and livelihoods affected primate consumption. We also used principal coordinate analysis (PCoA), and word clouds and network text analyses, to describe reasons people gave for eating or avoiding primates. Our results show that men were more likely to say that they eat primates than women, and that the probability that a person said that they eat primates correlated positively with the percentage of their life lived in rural areas. People gave sentiment and ethical reasons not to eat primates. Custom influenced whether people said they eat primates both positively and negatively, while taste positively influenced whether people said they eat primates. A preference for other wild meats in rural areas, and for domestic meats in cities negatively influenced whether people said they eat primates. People also cited the perceptions that primates have a human-like appearance and that primate meat is unhealthy as reasons not to eat primates. People in urban areas also cited conservation attitudes as reasons for not eating primates. Our findings provide an understanding of factors influencing primate consumption in our study area and will be useful for designing tailored conservation initiatives by reducing hunting pressure on primates in rural settings and increasing the effectiveness of outreach campaigns in urban centers.

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## Introduction

Numerous tropical forest people worldwide consume primates (Estrada *et al.* 2017; Fa *et al.* 2002). In the Brazilian Amazonia alone, estimates suggest that around 3.8 million primates are consumed by rural populations annually (Peres 2000), and in the Congo Basin, this number is as high as 106 million (Fa and Peres 2001). This intense level of extraction may cause sharp declines of primate populations (Meijaard *et al.* 2011; Puertas and Bodmer 1993). Since primates are important seed dispersers, their removal can have significant negative impacts on the ecological functioning of forest ecosystems (Peres *et al.* 2016). A decline in the availability of primate meat may also contribute to food insecurity in many low-income, marginalized human populations (Fa *et al.* 2003; Nasi *et al.* 2011). Although primates are not predominant in terms of hunted biomass in Amazonia (de Thoisy *et al.* 2009), they are more vulnerable to overhunting than other game taxa due to their lower rates of reproduction, which may increase their likelihood of local extinction if harvests are unsustainable (Bodmer *et al.* 1997; Mayor *et al.* 2017).

There are also reports of primate meat being eaten in urban centers in tropical forest areas (Bodmer 1995a). In West Africa, more than 150,000 primates were traded in one year in Nigerian and Cameroonian markets (Fa *et al.* 2015), while urban residents of five cities in central Amazonia consumed around 1500 primates annually (El Bizri *et al.* 2020a). The harvest of primates for commercial purposes generates more than US\$104,000 for the rural sector in the Peruvian Amazon (Bodmer and Lozano 2001). Therefore, understanding the interconnectivity between rural areas—the source of primates and other game species—and urban centers can allow us to develop conservation measures to mitigate the impacts of demand on this group.

Increases in urbanization and in migration from rural areas to cities are recent phenomena in Amazonian history (Browder and Godfrey 1990). In Amazonas state, the largest state in the Brazilian Amazon, the urban population increased from 45% to 73% between 1970 and 2010 (IBGE 2010). This change has had an important effect on the relationship between rural and urban areas, as many people living in Amazonian cities were either born in rural areas, lived in rural areas for a long period, or still have relatives in rural areas. These rural–urban family networks in Amazonia encourage the establishment of urban wild meat markets (El Bizri *et al.* 2020b; Padoch *et al.* 2008). At the same time, however, city dwellers with links to the countryside are influenced by greater access to domestic meats and the cash economy, and better schooling and progressively distance themselves from habits such as hunting or consuming wild meat (Piperata *et al.* 2011; van Vliet *et al.* 2015a).

The consumption of wild meat, including primates, is grounded in social norms related to culture and individual identity and also depends on ecological and economic factors such as species abundance and body size, hunting strategy, or market price (Chausson *et al.* 2019; Fa and Brown 2009). Primates are mainly consumed to address dietary needs though are often not the most important items in rural diets or in market sales (El Bizri *et al.* 2020a; Fa *et al.* 2015; Peres 2000). Primates may also be consumed as a substitute for other more preferred species, such as ungulates or rodents, when these are not available or depleted (Robinson *et al.* 2016). In western Amazonia, rural Peruvian families include

small-bodied primates in their diets when there is a lack of preferred prey, such as large mammals, which are frequently sold to the city markets (Bodmer 1995a).

Meat flavor also drives preference for specific taxa (Koster *et al.* 2010), and primate consumers usually state that primate meat is tasty, in some cases even considering it the tastiest meat among mammals hunted in South America (Mittermeier 1987). In some contexts, primate meat is considered a delicacy or a luxury item (Nekaris and Bergin 2017; Pi and Groves 1972). In other situations, primate meat is desired for its zootherapeutical properties, including perceived effectiveness in treating malaria, pox, and cholera (Alves *et al.* 2010). In contrast, primates may not be eaten in some societies because they are viewed as sacred entities, evil omens, or reincarnated humans (Cormier 2006; Mittermeier 1987).

Aspects such gender or age may affect preferences for and perceptions of different food types. In the Colombian Amazonia, women were less likely to eat wild meat than men, and consumption of wildlife increased with the age of consumer (Morsello *et al.* 2015). If consumption changes across generations and if younger people continue to avoid wild meat as they grow older, the demand for wild meat might drop over time (e.g., Chaves *et al.* 2020). Thus, the characteristics of individual consumers according to their age or gender or other features can be used to develop specific campaigns to reduce consumption of primates. This is because people in a group may demand or consume primate meat for reasons that reflect their own identity, background, or experiences, and that the influence of these individuals may change a group's behavior toward primates.

Ethnoprimateological studies are key to understand the relationships between the socioeconomic conditions and peoples' perceptions of nonhuman primates and relations maintained with these species, including their rates of primate meat consumption (e.g., Alves and Souto 2015; Renoux and de Thoisy 2016). Ethnoprimateology research studies the diverse interconnections between people and non-human primates, aiming to benefit primate conservation and promote coexistence between humans and other primates (Estrada 2013; Fuentes 2012). Understanding the reasons why people eat primates in urban and rural settings and how this is affected by socioeconomic factors is essential to provide a basis for implementing appropriate conservation measures (Fuentes *et al.* 2016).

We use an ethnoprimateological approach to assess how individual characteristics (gender, age, and percentage of life in rural areas) influence primate meat consumption, and the reasons people give for eating or not eating this type of meat in three rural villages and in a city in central Amazonia.

## Methods

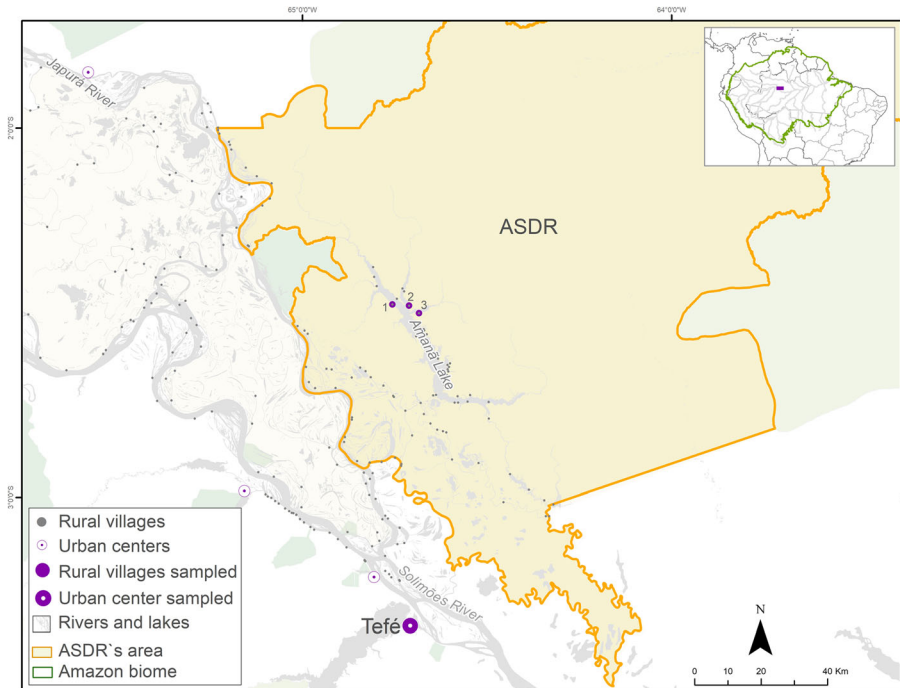
### Study Areas and Cultural Context

We conducted this study in the Amanã Sustainable Development Reserve (ASDR) (2°29'S, 64°43'W), and in the city of Tefé, Brazil (3°20'S, 64°42'W). The ASDR is located between the Negro and Japurá rivers, categorized as a "sustainable use conservation unit" by the Brazilian legislation and is an IUCN category VI protected area (Amazonas 2020; IUCN 2020). Local people can live in the reserve and use its natural resources following a management plan. The study area in the ASDR was Amanã Lake (Fig. 1), where there are 9 communities and 17 small settlements along the edge of the

lake and along small rivers feeding the lake. The population density is 0.39 inhabitants/km<sup>2</sup> (Amazonas 2020). The population of Amanã Lake is largely made up of descendants of immigrants from northeastern Brazil, who moved during the turn of the 19th to the 20th century to work on rubber extraction; and by descendants of *Miranha*, *Ava-Canoeiro*, *Kokama*, *Kambeba*, and *Mura* indigenous peoples (Amazonas 2020).

We interviewed people from three communities located along the lakeside (Fig. 1): village 1 had 300 residents in 71 households, village 2 had 80 residents in 13 households, and village 3 had 35 residents in seven households (Amazonas 2020). Eight primate species are found in the surroundings of Amanã Lake: *Saguinus inustus* (Callitrichinae/Cebidae) *Cebus albifrons*, *Sapajus macrocephalus*, *Saimiri sciureus cassiquiarensis* (Cebinae/Cebidae) *Aotus vociferans* (Aotinae/ Cebidae), *Cacajao melanocephalus* (Pitheciniae/Pitheciidae), *Cheracebus lucifer* (Callicebinae/Pitheciidae), and *Alouatta seniculus juara* (Alouattinae/Atelidae). Local inhabitants consume all these species (Amazonas 2020).

Tefé city is situated 100 km from Amanã Lake, around 12 hours by boat. It is the main place where rural inhabitants can obtain market products, processed goods, and basic services such as healthcare, make cash transactions and undertake official transactions within the western Middle Solimões River region. The city's population was 50,072 people in 2010, when the last census was conducted (IBGE 2010). We undertook interviews in “Feira Municipal Eduardo Nunes Sá” central city market. The



**Fig. 1** Map of the region of the Middle Solimões River and the locations of the rural communities on Amanã Lake, in the Amanã Sustainable Development Reserve (ASDR), and the city of Tefé, Brazil, sampled in this study in February and March 2020. Source: Caetano L. B. Franco/Mamirauá Institute for Sustainable Development.

market has a daily average of 5,000 visitors, and sells fresh take-out foods, agricultural products, tools, clothing items, and a great variety of other industrialized goods. Its central position in the city makes it a meeting point for residents of different regions of the city, periurban farms, nearby rural areas such as upper Tefé River, the floodplains of the middle Solimões and lower Japurá rivers, and the Amanã Lake region.

The forested areas surrounding Tefé city harbour a primate community of 14 species: *Cebuella pygmaea niveiventris*, *Leontocebus fuscicollis avilapirensi* and *Saguinus mystax mystax* (Callitrichinae/Cebidae), *Cebus unicolor*, *Saimiri macrodon* and *Sapajus macrocephalus* (Cebinae/Cebidae), *Aotus nigriceps* and *A. vociferans* (Aotinae/Cebidae), *Cheracebus purinus* and *Plecturocebus cupreus* (Callicebinae/Pitheciidae), *Pithecia albicans* (Pitheciinae/Pitheciidae), *Alouatta puruensis* (Alouattinae/Atelidae), and *Ateles chamek* and *Lagothrix cana* (Atelinae/Atelidae) (Rossato *et al.* 2017). There is evidence of trade in and consumption of large-bodied primates *A. chamek*, *A. puruensis*, *L. cana*, and *S. macrocephalus* in Tefé (El Bizri *et al.* 2020a; Rossato *et al.* 2017).

## Data Collection

A team of seven researchers conducted semistructured interviews (Bernard 2011) in the rural villages and in Tefé (Electronic Supplementary Material). In rural areas, 2 researchers, a woman and a man aged *ca.* 30 yr old, with 5 yr of work experience in the study villages and familiar to local people, approached interviewees in their home or neighborhood. In the city, 5 researchers, 2 women and 3 men, 20–33 yr old, all with at least 3 yr of previous experience in conducting research on biodiversity use in the region, approached interviewees in the city market. Five of the interviewers were residents of the studied region, three of whom had been born and lived their whole lives in the region.

Each interviewer approached people at random. Interviewees were from different origins and gender and age classes (>18 yr old). We sought to minimize bias resulted from positionality and cultural differences between researchers and participants by guaranteeing that researchers were familiar with the contexts in which interviews took place, and that they had experience with the study of wildlife use in Amazonia. We sought to address other sources of interview bias, such as misunderstanding, induction, and mistrust by using precise questioning (Electronic Supplementary Material), and by standardizing interviewer's approaches and recording procedures of responses during two meetings prior to data collection. We are aware that bias resulting from the different positionalities are, to a certain extent, inevitable, so in this study we assume that our data consist of statements and may not necessarily reflect the real rates of wildlife consumption.

We conducted interviews in February 2020 in the rural areas and in early March 2020 in the city. In both locations, we selected interviewees based on their availability and willingness to answer questions (e.g., during their break after lunch, people walking in the market or in the village's gathering points, legal market sellers—not including wild meat traders—who were not occupied with customers, or farmers who were not occupied with their crops). During interviews, we asked for the age of the interviewee, whether they were born in the rural/urban area (Yes/No), whether they eat primates (Yes/No), and why (open question). For people living in the rural area, we

asked whether and for how long (in years) they had lived in the city; while in the city, we asked whether and for how long (in years) the person had lived in rural areas (Electronic Supplementary Material).

In contrast to rural subsistence hunters in our studied communities who are allowed by Brazilian legislation to hunt when in need for food (Brasil 1998), urban interviewees may underreport primate consumption because wildlife trade is prohibited in Brazil (Brasil 1967). To mitigate this, interviewers identified themselves as members of the Mamirauá Institute for Sustainable Development (MISD), an institution that has been carrying out participatory research in the region for the past 25 yr. MISD's historical involvement with local people in the region has increased their trust and their willingness to participate in research, including interviews. The interviewers also guaranteed anonymity of the interviewees. After the interviews in the city, we also provided participants with a leaflet produced by the authors of this study explaining how MISD has used previous data on hunting (Electronic Supplementary Material). We considered that consumers were comfortable answering direct questions about wildlife consumption because surveillance actions are usually directed at wildlife traders; thus, urban consumers do not perceive their actions as illegal and do not fear persecution (Chaves *et al.* 2019). Several other studies have used direct interviews to measure wildlife consumption in small towns in the Brazilian Amazonia (e.g., El Bizri *et al.* 2020a; Parry *et al.* 2014; Torres *et al.* 2017), and in our case only one of 193 people we approached for this research (0.5%) refused to participate in the interview.

## Data Analyses

*Primate Consumers' Profile* For each interview, we scored responses given by interviewees as 1 if they said they consumed primates and 0 if they said they did not consume primates. First, we used a chi-squared test to assess the difference in the proportion of people saying they consumed primates by study site (rural area vs. urban area). Next, we analyzed primate consumption responses using generalized linear models (GLM) with a binomial distribution to assess the probability that interviewees said they consumed primates according to the following predictor variables: gender, age, and percentage of life in rural areas calculated as (number of years in rural areas / interviewee age)  $\times$  100. We built a null model (no effect of predictor variables) and models with different combinations of predictor variables, from simplest (only one predictor variable) to the most complex (all variables in the model). We included an interaction between the percentage of life in rural areas and gender. We compared final models using Akaike information criterion (AIC) values and considered all models within a cumulative Akaike weight  $\geq 0.95$  from the top model as strongly supported (Harrison *et al.* 2018). Among the models with strong support, we considered the best-fitted model as the one with the lowest number of parameters, given that AIC tends to favor overly complex models (Harrison *et al.* 2018). However, we present all models with good support in the Electronic Supplementary Material. We based inferences about the effects of predictor variables on the slope (estimate) of each variable and their respective confidence intervals.

*Reasons for Consuming Primates* We noted responses to the questions “Do you eat primates? Why (not)?” of participants as the interviewee spoke, or shortly after the interview finished. We noted key phrases revealing preferences, cooking methods and overall reasons for consuming or not consuming primates, such as “*primates are a gift*



of nature” or “I like eating howler monkeys a lot, specially cooked with Brazil nut milk” as quotations. We then organized responses into seven categories of reason for consuming primates: 1) preference, 2) custom, 3) sentiment, 4) conservation attitudes, 5) ethical background, 6) economic features, and 7) health (Table I). For each individual response, we attributed a score of 1 if the response fitted a particular category and a score of 0 if not; a response could fit in more than one category. We then used the *vegan* R package to conduct two principal coordinate analyses (PCoAs), one for reasons for consuming primates and another for reasons not to consume primates. In the PCoA, we assessed whether gender (women and men) and place of residence (rural and urban) influenced the reasons given for consuming or not consuming primate meat. Because the response was binary, we used the Jaccard similarity coefficient, a presence–absence similarity index in the PCoA. We also performed an analysis of similarity (ANOSIM) to obtain the statistical significance of dissimilarities/similarities in reasons reported by interviewees according to gender and place of residence.

We labeled each sentence of a response using the words that were most related to the attributes of primates, target species, cooking methods or feelings expressed by interviewees (for example, we categorized “I eat monkeys because they are tasty” as “tasty,” and “Primates are too human-like and I don’t eat them” as “human-looking”) and used word clouds and network text analysis to obtain the main arguments for eating or avoiding primate meat. We based the preparation and textual analyses on work by Bail (2016) and Welbers *et al.* (2017). We used the *spacyr* R package to organize and analyze responses. This tool tokenizes and categorizes the entire response into individual terms and their grammatical classes (for example: “I love monkey,” “I” = subject, “love” = verb, “monkey” = noun). For our analysis, we considered only adjectives, verbs, and nouns, as they grammatically represent the feelings expressed by the interviewees. We then transformed the terms used into a textual matrix using the *quanteda* R package, to obtain the frequency of citations for each term. We used the *ggwordcloud* and *ggplot2* R packages to create word clouds to highlight the most frequent terms in the reason categories from the PCoA.

For the network text analysis, we used the *texmets* R package. We created the network using the *PrepText* function, which creates a quadratic matrix where lines are words and columns are argument categories (Bail 2016). Then, we created two networks, one for consuming and one for not consuming primate meat. For both networks, we established the number of clusters using the *TextCommunities* function, which uses Louvain's community detection algorithm to automatically determine the ideal number of clusters. In addition, we calculated the centrality (“cultural betweenness”) among clusters using the *TextCentrality* function, which uses a variant of Dijkstra's algorithm to determine the shortest path between two nodes (e.g., Opsahl *et al.* 2010).

We present descriptive statistics as mean  $\pm$  standard deviation and percentages. We used R 3.6.3 software (R Core Team 2017) for all statistical analyses.

## Ethical Note

We explained the goals of this research to all participants and conducted the interview only if previously agreed by each interviewee. In addition to obtaining individual

**Table 1** Categories of reasons people gave for consuming or not consuming primates in Central Amazonia, Brazil, in February and March 2020

Category	Definition	Indicators	Eat primates	Examples of participant statements
1. Preference	Arguments related to comparisons and choices, based mainly on meat properties and availability, among primate species or in relation to other types of meat	Voluntary abandonment of consumption	No	"You start getting older and you don't like certain types of food anymore."
		Primate meat characteristics, such as smell and taste	No	"It's a disgusting meat."
		Primates as a nonpriority prey choice	No	"I tried it and I thought it was bad." "I never ate it, and I think I would never eat, I prefer chicken."
				"There's a lot of fish out there for us to eat."
				"People only eat monkeys when they don't have food. Nobody kills monkeys unnecessarily."
		Primates as an emergency prey	Yes	"I eat monkeys only during the hunger period."
		Primates as favorite prey choice	Yes	"For me it is the best wild meat!"
		Primate meat characteristics appreciation, such as smell and taste in their different forms of preparation	Yes	"I like it, I find the meat delicious." "The stew of primate meat is very tasty."
		Curiosity in those who never tasted primates before	Yes	"Howler monkey is a delicious food." "I would eat out of curiosity."
		2. Custom	Arguments related to the habit of consuming primates	Lack of custom of hunting, consuming or processing carcasses of primates
Consumption in specific situations, such as in other locations or in childhood	No			"When I lived in the countryside, I used to eat it, but not today."
Consumption derived from regional or ethnic cultural heritage	Yes			"I learned to eat primates with my parents, when I was young and lived in Maranhão." "My father used to hunt and process the carcass, he was indigenous."



Table 1 (continued)

Category	Definition	Indicators	Eat primates	Examples of participant statements
3. Sentiment	Arguments related to sentimental identification with primates, which include affection, pity, and admiration, inspired particularly by the appreciation of similarities shared with human beings	Affection due to raising primates as pets	No	"I already raised a monkey such as a dog is raised, and because of that I don't eat it nowadays; but I've already eaten it before."
		"Lack of courage" to eat them after preparation; feeling sorry for killing them or seeing them dead; great discomfort in processing the carcass or watching it being processed.	No	"If I have to kill and process, I don't eat it, I'm sorry." "I've killed two, but I didn't eat, it spoiled. I didn't have the courage to try it."
		Traumatic situations such as attacks suffered or witnessing primates being killed	No	"I have a trauma. A squirrel monkey bit my son and I, and then I had to take a lot of injections."
		Disgust for features of primate morphology and behavior	No	"They are like people, they just don't speak." "I can't look at it because it looks like a child."
4. Conservation attitudes	Arguments related to personal perceptions of need to protect primates and primates being part of nature	Stopped consuming primates due to measures adopted to protect natural ecosystems	No	"Since the protected area was created, I stopped eating."
		Defense of primates as wild animals	No	"It is an animal from the forest, I feel sorry for them."
		Defense of the symbolic value of primates as representatives of the Amazonian fauna	No	"Monkeys are a symbol of the Amazon."
5. Ethical reasons	Arguments related to moral values defined by and shared in social groups, such as religious denominations, and formal regulations, such as environmental legislation.	Perceptions of conservation status and threats to primates	No	"They kill them, and primates start to get closer to extinction."
		Compliance with Christian religious food taboos	No	"God didn't create the monkey for us to eat, he left other things for that." "I am an Adventist, and the Bible recommends eating only fish with scales and fused-nail animals that ruminates;"

Table 1 (continued)

Category	Definition	Indicators	Eat primates	Examples of participant statements
6. Economic features	Arguments related to economic issues, such as the cost-effectiveness of primate hunting, and the defense of crops and native fruits by killing and consuming primates	Compliance with the legal prohibition of primate consumption	No	<p>"Not today, but 30 years ago I would eat, when it was not yet banned."</p> <p>"It is a wild animal, I am against hunting."</p> <p>"I am against it, I never ate and I am against those who kill. I think people are ignorant."</p> <p>"I don't like those who kill primates, I like to appreciate them alive."</p> <p>"I'm against who eats primate. I already saw one killing it and I complained."</p> <p>"Sometimes, it takes two or three shots, and one monkey doesn't feed a family."</p> <p>"They killed monkeys because they attacked chestnut trees and threw unripe fruits on the ground."</p> <p>"I ate howler monkey once, but I got sick and vomited during the night."</p> <p>"I once saw a monkey being butchered and its belly was full of worms."</p> <p>"Among wild meats, the strongest is from the monkey. It has more vitamins. The person who eats monkeys is strong."</p>
		Negative perception of hunting and consumption of primates based on personal judgments	No	
7. Health	Arguments related to the health of primates and of those who eat them	Consideration of the low profitability of primate hunting	No	
		Consumption to minimize losses from primates foraging on crops	Yes	
		Report of malaise and nausea after primate consumption	No	
		Occurrence of diseases, such as worms, in some species.	No	
		Benefits of primate meat, such as its high nutritional value	Yes	

consent, the Amanã Lake villages' association and the local market administration in Tefé city approved the interviews. We conducted all research in compliance with a research protocol approved by the Research Ethics Committee of the Mamirauá Institute for Sustainable Development (License CAAE 0422919.4.0000.8117). The authors declare that they have no conflict of interest.

**Data Availability** The data sets used and analyzed during the current study are available from the corresponding author on reasonable request.

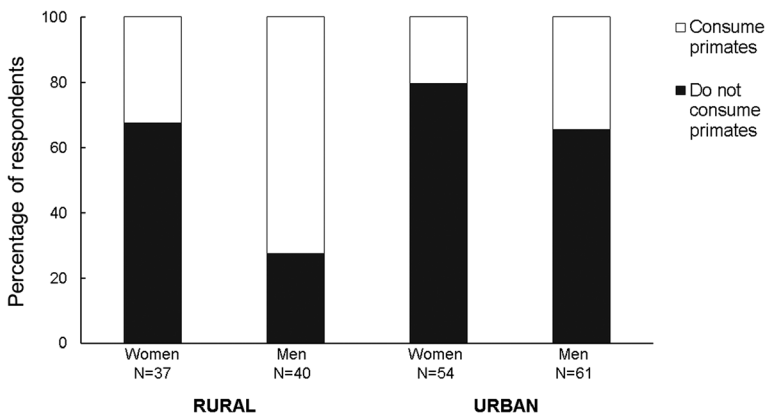
## Results

We obtained 192 interviews, 77 (40%) in Amanã Lake (hereafter rural area), consisting of 40 (52%) men and 37 (48%) women, and 115 (60%) in Tefé city (hereafter urban area), consisting of 61 (53%) men and 54 (47%) women.

### Interviewees' Consumption Profile

The mean age of rural residents was  $37.0 \pm \text{SD } 15.0$  (range: 18–80) yr for men, and  $36.7 \pm \text{SD } 14.8$  (range: 18–77) yr for women. The mean age of urban residents was  $45.4 \pm \text{SD } 16.9$  (range 18–76) yr for men,  $41 \pm \text{SD } 16.4$  (range 18–77) yr for women. Of the 115 urban interviewees, 70 (61%) said they had lived in rural areas for a mean period of  $19.7 \pm \text{SD } 16.9$  (range 0.42–67) yr, while 45 (39.1%) said that they had lived only in the city. Among the 77 rural inhabitants, 14 (18%) said they had lived in urban areas for a mean of  $6.3 \pm \text{SD } 6.4$  (range 1–20) yr, while 63 (82%) had been born and lived only in the countryside.

Sixty-two percent ( $N = 119$ ) of all interviewees said that they did not eat primates, while 38% ( $N = 73$ ) said they did. The proportion of people saying that they ate primates was smaller than that of those who said that they did not in both rural and urban areas (Fig. 2). The difference between urban and rural areas was significant ( $\chi^2 = 12.64$ ;  $df = 1$ ;  $P < 0.001$ ), and the number of interviewees who said they ate primates in



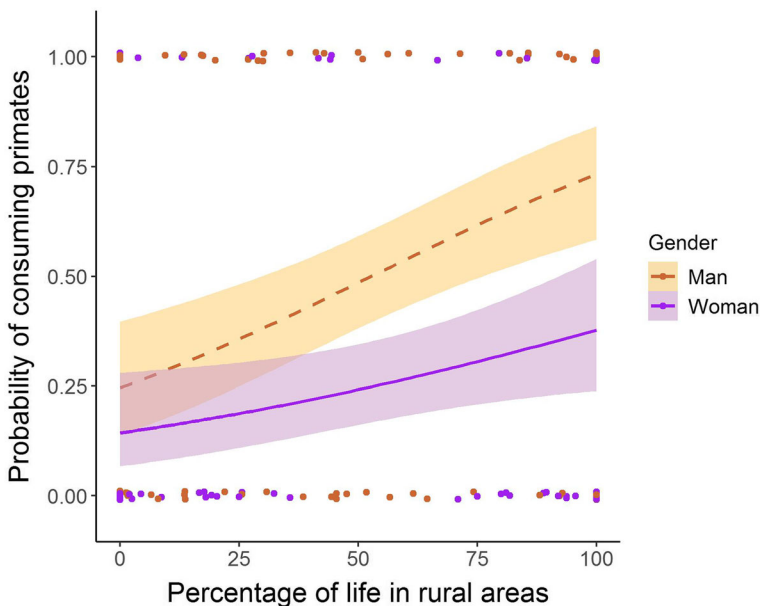
**Fig. 2** Reported consumption of primates by men ( $N = 101$ ) and women ( $N = 91$ ) from urban and rural areas in Central Amazonia, Brazil. We conducted interviews in February and March 2020.

rural areas was higher than in the city, especially for men. The lowest proportion of respondents saying they ate primates was among urban women (Fig. 2).

The best fit GLM included gender and percentage of life in rural areas as covariates, without an interaction. For each woman who said she ate primates, 1.15 men said they ate primates. For both genders, each 1% increase in the percentage of life in rural areas increased the probability of saying that they ate primates by 2% (Fig. 3, Table II). The age of the interviewee was not retained as a covariate in the selected model. Alternative models were similar to the selected model, but the first alternative model included an interaction between the predictor variables, and the second included the age of the interviewee. However, in both models the confidence interval of the slope values (estimate  $\pm$  SE  $\times$  1.96) contained zero, meaning that the predictors did not have a significant effect on the outcome (Electronic Supplementary Material).

### Reasons to Consume Primates

People gave all categories of reasons not to eat primates, such as not eating primates because their meat is not tasty, because one is not used to eat primates, due to primate species' conservation status, because of people's religious background or because primates are "too cute" to eat; while they gave reasons relating to preference, economic, custom, and health for both eating and not eating primates. For example, one person said they would not eat primates because they are unhealthy, while other people said they eat primate meat because it is more nutritious than domestic meat (Table I).



**Fig. 3** Probability that interviewees from Central Amazonia, Brazil, said they consumed primates by gender (man = dotted line; woman = continuous line) and percentage of life in rural areas. We conducted interviews in February and March 2020. Each point represents one of 192 people interviewed. Shaded areas represent the 95% confidence interval.

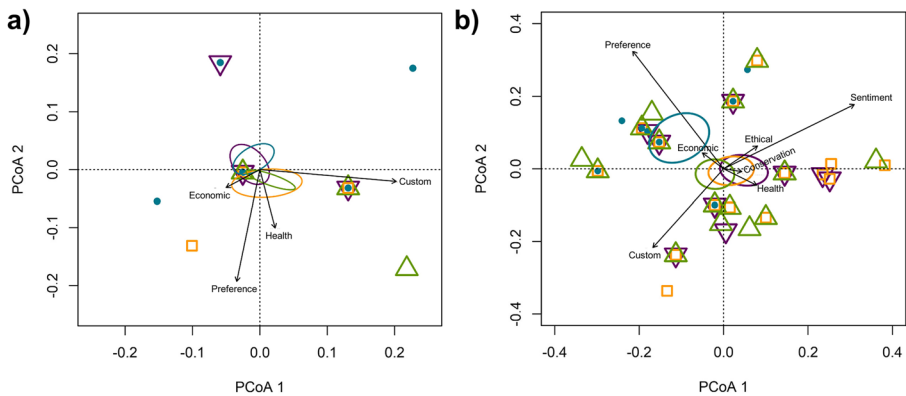
**Table II** Details of the best-fit generalized linear model for the probability that interviewees from Central Amazonia, Brazil, said they ate primates. We conducted interviews in February and March 2020. Akaike information criterion for the selected model (AIC) = 227.50, difference between the AIC of the selected model and the AIC of the null model ( $\Delta$ AIC null) = 29.54, AIC weight of the model (wAIC) = 0.5064, and number of parameters (k) = 3. We used the Binomial family of distribution with a logit link function.

Response variable	Predictor variables	Estimate (SE)
Probability of consuming primates	(Intercept)	-0.93 (0.30)
	Percentage of life in rural areas	0.02 (0.004)
	Gender (woman)	-1.15 (0.35)

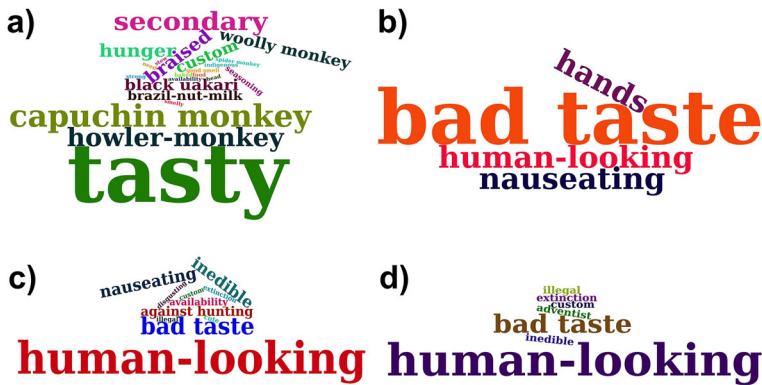
Among interviewees who said that they ate primates, there was no difference between men and women or between city and rural interviewees in the reasons given (ANOSIM R: 0.006,  $P = 0.43$ ), with preference and custom reasons being most common reasons given for eating primates, followed by health and economic reasons (Fig. 4a). We also found no significant differences between men and women or between city and rural interviewees in the reasons given for not eating primates (ANOSIM R: 0.067,  $P = 0.07$ , Fig. 4). Preference for primate meat was relevant in rural men, while women gave sentiment and, to a lesser degree, ethical reasons for not eating primates in both rural and urban areas. Custom was the most important reported reason for not eating primates in urban men (Fig. 4b). Economic, conservation, and health reasons played a minor role in influencing why people did not eat primates (Fig. 4).

Interviewees who said they ate primates used keywords related to preference and pointed out primate species that they consume to explain primate consumption (Fig. 5a) while people who said they did not eat primates used keywords related to sentiment reasons (Fig. 5b–d).

We identified four word clusters for people who said they ate primates: health and custom clusters, with no keyword playing a central role in defining these clusters; and



**Fig. 4** Principal coordinate analysis (PCoA) scattergram of the reasons reported by interviewees from Central Amazonia, Brazil, for (a) eating or (b) not eating primates, split by gender and place of residence. We conducted interviews in February and March 2020. Inverted triangle = rural women; square = urban women; filled circle = rural men; triangle = urban men. Ellipses with the same tones of the points represent the 95% confidence intervals for each group. Sizes of symbols are irrelevant.



**Fig. 5** Word clouds of the main arguments reported by (a) all interviewees for eating primates and by (b) rural men, (c) urban and rural women, and (d) urban men for not eating primates. We conducted interviews in Central Amazonia, Brazil, in February and March 2020.

two preference clusters, one related to positive aspects of primate meat; and the other related to people consuming primates as a nonpriority or secondary item, with “hunger” playing a central role in this cluster (Fig. 6).

We identified six keyword clusters for people that said they did not eat primates (Fig. 7): a health cluster interconnected to a negative preference cluster with the term “nauseating” connecting these two clusters; a custom cluster, with no central word defining it; and three separate clusters involving sentiment, conservation and ethical terms with no central word in them. Keywords related to economic reasons did not group into any cluster. Among species, only *Cacajao melanocephalus* appeared in reasons given for both eating and not eating primates, being linked to keywords such as “tasty,” and to “bad taste” and “disgusting” (Fig. 7).

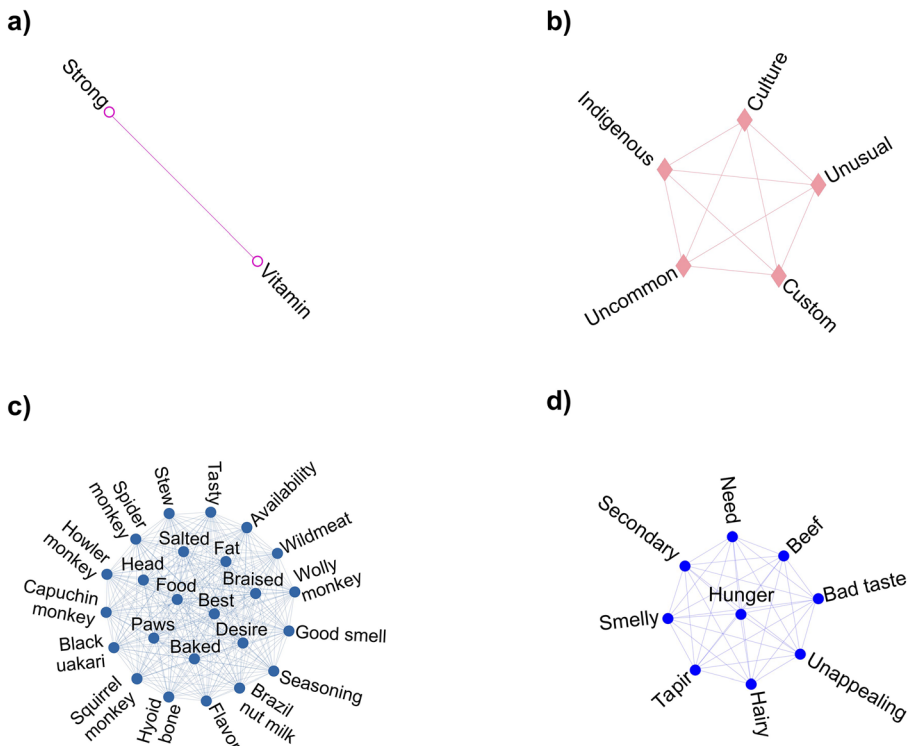
## Discussion

A main finding of our study was the fact that people in rural areas were more likely to say that they ate primates than people living in the urban center. People’s cultural background (expressed as the proportion of their lives spent in rural areas) and gender influenced whether or not they ate primates: women were less likely to say that they ate primates than men were. People in urban and rural areas also gave different reasons for eating or not eating primates. City dwellers and rural women said they did not eat primates for symbolic reasons but rural men seemed to be constrained by practical aspects such as hunting returns.

In isolated rural areas where access to markets is low, hunting is one of the main means of obtaining food, meaning that wild meat is a *necessity good* for forest dwellers (Wilkie and Godoy 2001). The importance of primates as a source of food in our study reflected this, with a higher proportion of people in rural communities saying they eat primates than in the city. Primate meat can play a vital role for rural people living in Amazonian flooded forests, where large terrestrial vertebrates are absent, and primates consist of the main targets for hunters (Peres 1997).

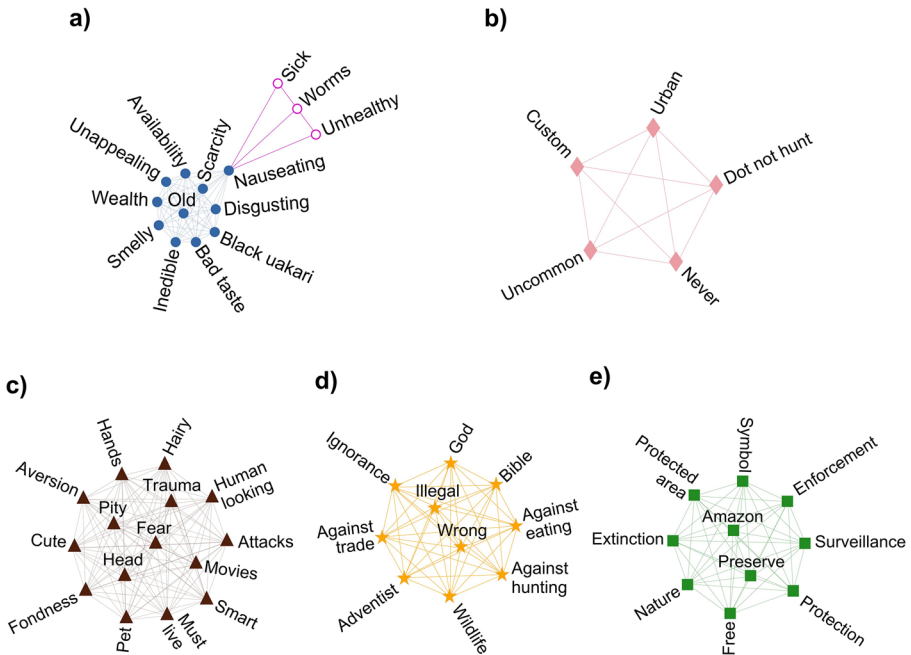
People from rural areas who lived in the city were less likely to say that they ate primates than those who had never lived in the city. There are several possible reasons for this pattern. Urbanization and greater access to industrialized goods may change people’s dietary behavior (Chaves *et al.* 2017, 2020). Primate consumption may reduce with the availability of domestic meats and as preferable wild species become more available (Fa *et al.* 2015). In cities in Amazonas, for instance, primates are among the least preferred wild game (17th of 20 types of wild meat consumed), suggesting that the availability and trade of primates in urban centers may be reduced because of low urban demand for primate meat (El Bizri *et al.* 2020a).

People in the city who had lived in rural areas for longer were more likely to say that they ate primates than those who had lived in rural areas for a shorter time. Given that the trade in primate meat in Amazonian cities is low (El Bizri *et al.* 2020a), primate consumption in urban centers may be actively maintained by direct, ongoing contact of the urban people with rural sources, whether by having family members or other kind of middleperson in rural areas who support their demand for rural products (Peluso 2015). Therefore, urban citizens may be likely to eat primates only if previously exposed to this wild meat as a dietary item either in their past or from continuing trips to rural areas (Schenck *et al.* 2006). Consequently, the demand for primate meat in cities will reflect the proportion of urban inhabitants that have come from rural settings



**Fig. 6** Network of keywords used by people from Central Amazonia, Brazil when explaining why they eat primates according to the following categories of reasons: **(a)** health, **(b)** custom, **(c, d)** preference, including arguments in which primates are preferred (c) and arguments in which primates are perceived as non-primary food items (d). We conducted interviews in February and March 2020.





**Fig. 7** Network of keywords used by people from Central Amazonia, Brazil when explaining why they do not eat primates according to the following categories of reasons: **(a)** preference (filled points) and health (open points), **(b)** custom, **(c)** sentiment, **(d)** ethical, and **(e)** conservation. We conducted interviews in February and March 2020.

recently (Chaves *et al.* 2019; van Vliet *et al.* 2015b). Indeed, wild meat consumption in Amazonian urban centers is higher when the head of the household is a migrant from rural areas, and the longer rural migrants live in urban areas, the lower their consumption rates are (Chaves *et al.* 2020). Similar shifts in wild meat consumption were also detected in the main cities in four West African countries (Luiselli *et al.* 2019).

The differences in the reasons given for eating or not eating primates between rural and urban residents, and between women and men, may be linked to context. Rural men, usually the hunters of primates and responsible for bringing home food, are influenced by factors such as the amount meat obtained per effort and cost in a hunting trip (Alvard 1993; Levi *et al.* 2011), often considering primates as of low profitability. However, they may hunt, and consequently, eat primates if they find primate meat tasty. Conversely, people who are usually not involved in hunting, such as rural women and city inhabitants, are more influenced by non-material factors. Aspects related to health—such as choosing healthy meat or avoiding unhealthy meat—or the maintenance of customs, such as what comprises a typical family meal, are important drivers for these consumers (Lowassa *et al.* 2012; Rose 2002).

Although primates are used for zootherapeutical purposes in our study region, the health reasons people gave for eating primates did not include their medical properties but related to their perceived greater nutritional value than domestic meats. The lack of reports about the use of primate meat in local medicine suggests that it is consumed as food, although body parts may be used in zotherapy as a byproduct of meat consumption (Alves *et al.* 2010). However, people mentioned health concerns during our

interviews as reasons not to eat primates, suggesting that, at least at some degree, people are aware of and concerned by the risks of zoonosis. Primates are zoonotic hosts of infectious diseases such as simian immunodeficiency diseases and ebola virus (van Vliet *et al.* 2017). The fear of getting sick by consuming primate meat may reduce the consumption of primates and enhance disease prevention if meat substitutes are included in local diets to guarantee food security (Friant *et al.* 2020).

The reasons for eating or not eating primates identified in this study were similar to those observed in a pan-tropical analysis (Mittermeier 1987), suggesting that perceptions of primates not being a food resource can be maintained over time in central Amazonia. Participants frequently cited the human-like appearance of primates to explain why they do not eat them. Humans may be particularly reluctant to kill and eat animals that they perceive as being similar to themselves, intelligent and capable of suffering, and those that they consider companions, such as pet primates (Cawthorn and Hoffman 2016). Resemblance to humans is also an important reason why people do not eat *Hylobates klossii* in Sumatra, *Indri indri* in Madagascar, *Brachyteles arachnoides* in southeastern Brazil, *Ateles paniscus* in Guyana, *Cacajao calvus calvus* and *Alouatta* spp. in Amazonia (Ayres 1986; Cawthorn and Hoffman 2016; Cormier 2006; Mittermeier 1987; Prado *et al.* 2020).

Urban people who do not eat primates give sentiment and ethical reasons for this (Morsello *et al.* 2015). In this study, some people held taboos about certain species (e.g., *Cacajao melanocephalus*), which may vary with an individual person's choices and sociocultural background (e.g., Colding and Folke 2001). Religious beliefs have been related to taboos and avoidance of wild meat in various parts of Amazonia (Knoop *et al.* 2020). Our findings reflect this: people we interviewed who were related to particular Christian groups were unlikely to eat primates. However, as shown by the interaction of the keywords such as "tasty" and "availability" in the reasons network, if individuals or families are accustomed to eating primates, and consider it "tasty," they continue to obtain it from the forest or purchase it in urban markets, even when other protein sources are available. In many parts of the world, including the Central Amazon, people continued to consume wild meat even after provided with price incentives to purchase domestic meat (Bennet 2002; Chaves *et al.* 2018).

People also said that they ate primates because of individual taste preferences and ways of preparing primate meat, especially from *Sapajus macrocephalus*, *Cacajao melanocephalus*, and the atelids. These species are preferred all over Central and South America (Stafford *et al.* 2017), and the meat of fruit-eating species is perceived "sweeter" and more likely to be favored by Amazonian hunters (Nasi *et al.* 2011). The apparent selectivity for those species is worrying because they are susceptible to overhunting due their slow reproduction (Bodmer 1995b; Mayor *et al.* 2017). Hunters and consumers of wild meat do not always adopt a predictable behavior of adding or excluding primates to their menus based solely on the animals' body mass or their availability, since social norms and culture may play a role in affecting people's choices of what to hunt and eat (Koster *et al.* 2010). For instance, we found people say that they eat primates because they preferred their taste, as well as because they fulfilled their dietary needs. Sustainability assessments and actions to reduce the effects of hunting on these species should therefore include cultural preference for the meat of certain species.

In the urban context, our study revealed consumer profiles which can inform outreach programs. Urban respondents were more likely to give surveillance and other

enforcement campaigns as reasons not to eat primates than rural people. This result supports the influence of schooling and other forms of education such as research-based conservation information ([Electronic Supplementary Material](#)), social values that include ecological and health issues relating to wildlife, in changing primate consumption patterns (e.g., Manfredo *et al.* 2020). In addition, women are likely to be good ambassadors for primate conservation, given that they are more likely to say that they do not eat primates in both rural and urban settings. For these reasons, awareness campaigns that are culturally aware, and that include attitudinal and health issues, allowing women to participate in programs for the sustainable use of wildlife will benefit (Woman in Conservation 2019).

Our study shows that the local demand for resources by rural and urban populations, as well as the interconnectivity between rural and urban areas, will affect what people say about eating primates in the central region of Amazonia. What people mention in an interview may not reflect their actual behavior. However, our findings suggest that although urban centers provide people with industrialized goods and domesticated meats, it is the flow of people and practices between rural and urban settings that perpetuates primate consumption in urban centers. We also found differences in the reasons that rural and urban people give for eating or not eating primates, suggesting that primate consumption may change with the social-ecological context. This highlights the need for a contextualized design of conservation initiatives that considers local and individual features (Milner-Gulland *et al.* 2003; van Vliet 2018) and that speaks to all sectors of the society (Garber 2019). The correlates of primate consumption identified here are useful for designing locally based conservation actions and identifying target publics to promote primate conservation, alleviating hunting pressure in rural areas and increasing the effectiveness of outreach campaigns for urban inhabitants. To further improve our understanding of the demand of primate meat, we strongly suggest the use of ethnographic data, including study of individuals' choices and practices when exposed to primate meat and hunting primates. Such observations would further clarify whether and how the reasons given in this study translate into positive or negative behaviors related to primate consumption.

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