Received: 27 August 2024 | Revised: 15 November 2024 | Accepted: 10 February 2025

DOI: 10.1111/cobi.70056

Conservation Biology

CONTRIBUTED PAPER

Socioeconomic drivers of wild meat consumption in the city of Iquitos, Peru

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Article impact statement: Conservation programs related to wild meat should target older consumers living in the suburbs along the Iquitos–Nauta Road.

Abstract

Wild meat represents a vital source of micro- and macronutrients for forest-dwelling people; however, city dwellers with access to animal protein from different animals may also consume large amounts of wild meat as part of their customs and traditions, to diversify their diets, to maintain connections to their rural kin, and to access meat without having to pay the high prices of domestic meat in the city. The aggregate urban and rural demand for wild meat consumption demonstrates a great risk for overhunting highly preferred and vulnerable species and degrading already fragile Amazonian ecosystems and the food security of people in rural areas. We assessed the effects of socioeconomics factors on wild meat consumption in the city of Iquitos in the Peruvian Amazon. We conducted 1548 interviews with consumers across the city of Iquitos and collected socioeconomic and wild meat consumption data. We used a double hurdle model to estimate simultaneously the probability of a consumer eating wild meat each week and their consumption rate based on 10 variables. In final parsimonious models, monthly income, location in the city (district and distance to market), amount of education, and amount of time spent in Iquitos were all important factors determining consumption rate. We predicted that consumption rates would vary across the city and in some areas would be as high as >7 kg·person^{-1}·year^{-1}. The spatial distribution of wild meat consumption showed that people in newer, rapidly growing parts of the city consumed more wild meat and were therefore more dependent on sustainable supply chains. We recommend that consumers who have very high predicted consumption rates may be useful targets for conservation efforts to reduce that consumption, such as culturally relevant, informal educational programs. In our study, these people migrated from rural areas and live along the Iquitos–Nauta Road and are wealthy consumers in downtown Iquitos.

KEYWORDS
Amazon, bushmeat, food security, game meat, hunting, sustainability

INTRODUCTION

Wild meat is a vital source of micro- and macronutrients for Amazonian forest-dwelling people who have access to a limited number of protein options due to the remoteness of where they live (Mayor et al., 2017; Peres & Nascimento, 2006; Redford, 1992; Robinson & Redford, 1994; Shepard et al., 2012; Smith, 2008). However, consumers in Amazonian cities can diversify their diets with fish and domestic animal meat, including beef, pork, and poultry. Despite the wealth of types of meat available, evidence shows that urbanites still consume a great deal of wild meat (Bizri et al., 2020; Chaves et al., 2020). In Peru, it was estimated that 442 t of wild mammal meat was eaten in Iquitos (486,338 inhabitants) in 2018 (Mayor et al., 2021). In the Amazonian trifrontier between Colombia, Peru, and Brazil (153,536 inhabitants), about 473 t of wild meat was traded per year (van Vliet, Mesa, et al., 2014). It is evident that although wild meat consumption in rural areas can be justified by the need people

have to maintain their protein intake, livelihoods, and cultures, urbanites are choosing to eat wild meat despite the availability of other types of meat and that some types, such as chicken, are often much cheaper than wild meat (Mayor et al., 2021).

Wild meat consumed in Amazonian cities is accessed via commercial sources (e.g., markets, local fairs, food stalls, restaurants, docks, hawkers, riverboats, private residences, and directly from hunters who sell meat to houses of relatives) and noncommercial sources through consumers' social networks (gifts from neighbors, gifts from rural family members or friends, etc.) (Bizri et al., 2020; Chaves et al., 2020; Parry et al., 2014; Van Vliet et al., 2015; van Vliet, Quiceno, et al., 2014). Urban consumers seldom hunt their own wild meat; thus, rural hunters are the leading direct and indirect suppliers of wild meat in the city (Bizri et al., 2020; Mayor et al., 2021). Wild meat sales generate revenue not only for rural hunters, but also for the entire supply chain in the wild meat trade, including intermediaries, market sellers, wholesalers, retailers, restaurants, and street food stalls (Van Vliet et al., 2015; van Vliet, Quiceno, et al., 2014).

Although hunting to supply urban consumption can generate significant income for people involved in the trade of wild meat (Griffiths & Gilmore, 2022), it remains one of the most important drivers of large vertebrate population decline. Unsustainable hunting may result in the depletion or extirpation of game species (Constantino, 2016; Laurance, 1999; Peres, 2000; Peres & Lake, 2003; Redford, 1992; Robinson & Redford, 1994). Declines in animal populations due to unsustainable hunting disrupts ecological interactions between wildlife and plants, leading to detrimental changes in ecological processes of forest ecosystems, changes that may be exacerbated by forest fragmentation and climatic variability (Constantino, 2016; Wright, 2010). The conservation challenge is to prevent overhunting and the extirpation of wildlife and to safeguard the food security and economic stability of people in rural areas who base their livelihood on wildlife resources.

Understanding the cultural, economic, and social drivers of urban wild meat consumption is key in designing effective conservation strategies for vulnerable species targeted for consumption. Research on the factors influencing wild meat consumption has centered around generating a change in the behavior of wild meat consumers and reducing urban demand for wild meat and the flow of wild meat from rural to urban areas. A wealth of economic, social, and cultural factors have been tested to investigate the drivers of hunting, wild meat species preferences, acceptability of wild meat consumption, and frequency of consumption of wild meat (Carignano Torres et al., 2021; Morsello et al., 2015). Some of the most studied factors are household income, per capita gross domestic product (GDP), wealth, time living in the city, education, occupation, market access, number of people in a household, taboos around consumption of particular species, social relations, peoples' origins (Indigenous, non-Indigenous, place), hunting frequency, and consumption frequency (e.g., Chaves et al., 2020; Mayor et al., 2021; Nasi et al., 2011; Parry et al., 2014; Patricia Carignano Lemos et al., 2021; Torres et al., 2021). Studies have also included beliefs about the scarcity of wild meat, legality of wild meat sales, and perceptions of whether wild meat consumption affects forest conservation (Morsello et al., 2015).

Understanding the factors that drive the consumption of wild meat in Iquitos, the economic center of the Peruvian Amazon, is critical to creating effective conservation initiatives that also ensure the economic stability and food security of local people. We sought to investigate the effect of household-level socioeconomic factors on wild meat consumption in Iquitos city. We surveyed 1548 households across the city of Iquitos, including small suburban towns connected to Iquitos via the Iquitos–Nauta Road and Santo Tomas Road. We collected data on parameters previously used in other studies of wild meat consumption in Amazonian cities (some mentioned above) and used a double hurdle model to identify the most influential factors driving wild meat consumption in Iquitos in 2019.

METHODS

Study site

The city of Iquitos (3° 44′ 57″ S; 73° 14′ 40″ W) is in the province of Maynas in the department of Loreto in the northeastern Peruvian Amazon (Figure 1a). Iquitos is the capital city of the department of Loreto and has a population of 413,556 people (INEI, 2018). Iquitos has 4 districts: Iquitos, Punchana, Belen, and San Juan Bautista. We focused on medium- and small-sized urban and suburban towns connected to the city via the Iquitos–Nauta Road and in the San Juan Bautista district, which allowed us to include recently established and smaller settlements, account for wild meat consumption in areas without easy access to the central city's main markets, and consider the dietary habits of recent migrants from rural areas and individuals with few resources living farther from the center of Iquitos.

Residents of Iquitos have access to a variety of animal proteins, including beef, pork, fish, poultry, and wild meat, to meet their dietary needs. Despite the numerous options for including animal proteins in their diet, people still consume a great deal of wild meat (Mayor et al., 2021). At present, wild meat is sold openly in the markets of Iquitos (D'Cruze et al., 2021). Most such sales in Iquitos are considered illegal, and revenue from sales from wild meat is not included in official city statistics (Mayor et al., 2021).

Semistructured interviews

Fieldwork was conducted in Iquitos from June to October 2019. All sampling protocols were approved by the George Mason University Institutional Review Board (project number 1436180–1), and prior informed consent (PIC) was obtained from each research participant before being interviewed. We divided the city of Iquitos into 1-km grid cells for sampling (Figure 1b). To include newer urban and suburban areas in the San Juan Bautista district, which are connected to Iquitos via

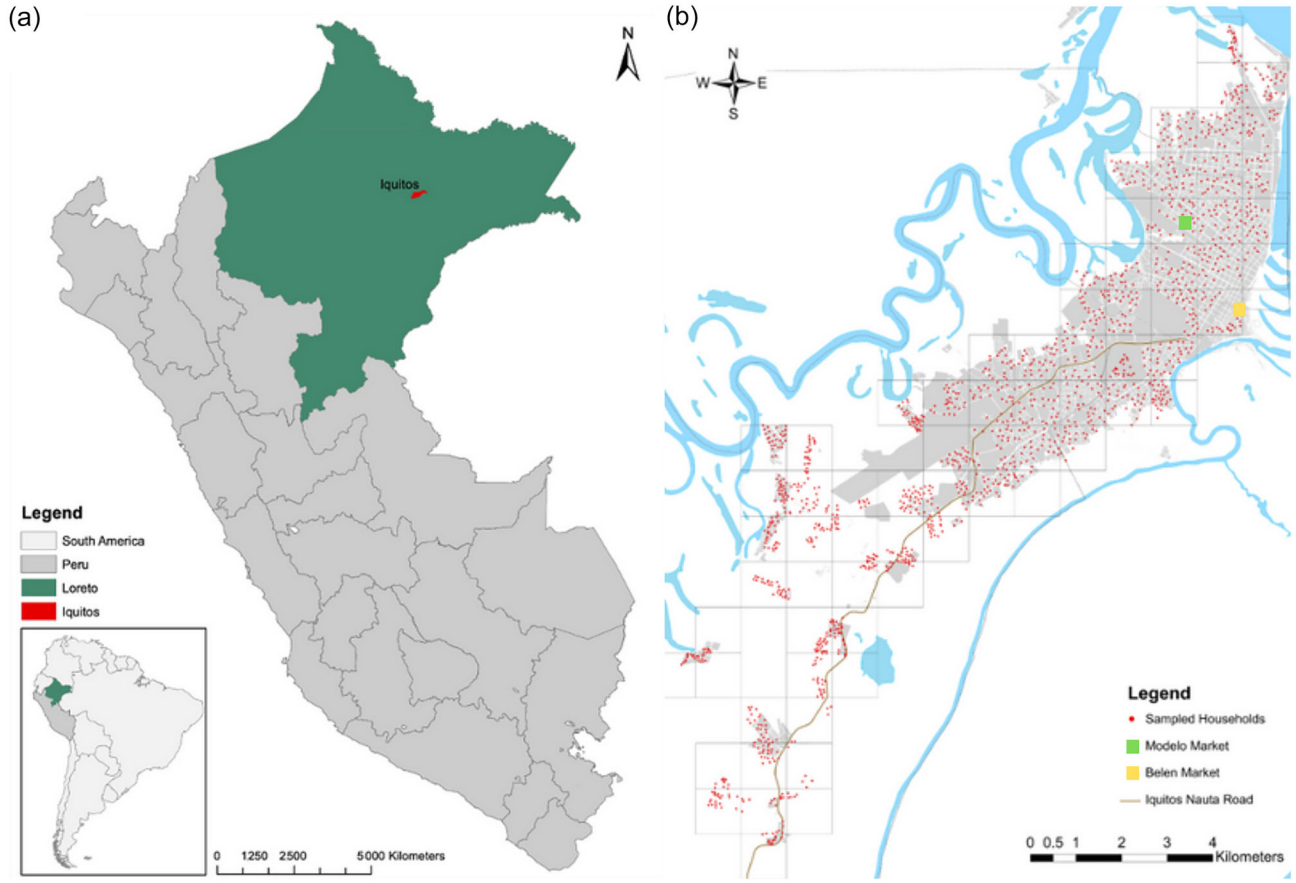

FIGURE 1 (a) Study area, Iquitos, capital of the Department of Loreto in the Peruvian Amazon and (b) sampling strategy and sampled households in Iquitos, Peru. Adapted from Briceño Huerta (2022).

the Iquitos–Nauta Road and Santo Tomas Road, we expanded our study area to 64 km^2. We used Google Earth images to identify additional developed cells. Overall, 4 core large urban centers (*centros poblados*) were sampled: Iquitos, Belen, Punchana, and San Juan Bautista. Additionally, 5 medium-sized suburban towns were sampled: Santa Clara, Santo Tomas, Quistococha, Zungaro Cocha, and Los Delfines. Ten small-sized suburban towns were also sampled: Rumococha, Laguna Azul, La Union, La Paz, 25 de Enero, 12 de Diciembre, Union Progreso, Peña Negra, and 2 with unidentified names (not included in the national census). In each of these grid cells, we conducted 5–30 semistructured interviews (Bernard, 2011) with household heads. We adjusted the number of interviews based on the cell's population to avoid oversampling less-populated areas. Households were randomly chosen by starting at the cell center, locating the nearest road, and interviewing the first available household. To reduce the likelihood of interviewing related households, which is common in Iquitos, we maintained a minimum distance of 3 houses between each interviewed household. Interview questions are in Appendix S2.

Interviews, typically lasting 20–40 min, were mostly conducted on weekdays from 0800 to 1800. Some took place on weekends from 0900 to 1300. Interviews were conducted with heads of household with a specific focus on women or men who purchase meat and cook in the household. Initial questions focused on demographic information, such as place of birth, migration history, duration of residence in Iquitos, household composition, and monthly household income. Heads of households were then asked about their wild meat consumption in the past week. If they had consumed wild meat, further questions were asked regarding the type of meat, quantity, price, and sources. Restaurants were not included in the survey. For those selling food informally from their homes, we considered only the wild meat amounts relevant to their household consumption.

Data analyses

When participants reported consuming wild meat in a unit of measurement other than kilograms (e.g., arm, leg, plate of food), we assigned a weight in kilograms to the item based on estimates for pieces of animals and the price of the plate of food (Briceño Huerta, 2022). We converted all reports of smoked or salted meat to kilograms of fresh meat based on species-specific conversation factors (Bardales et al., 2004). Then, we calculated the total amount of meat that the head of household reported eating in the past week by adding up all individual food items.

TABLE 1 Hypotheses and covariates tested as part of the double-hurdle model on wild meat consumption in Iquitos, Peru, and distributions in the raw data.

Covariate	Hypothesis	Mean (SD) or distribution ($n = 1465$)
District	Wild meat consumption patterns vary spatially in Iquitos according to variables not directly assessed.	Belen: 10.51%; Iquitos: 18.43%; Punchana: 11.88%; San Juan Bautista: 59.18%
Age	Older generations are more likely to consume wild meat because they have stronger cultural ties.	42.23 (15.56) years
Years in Iquitos	Older generations who have lived in Iquitos a long time are more likely to consume wild meat because they have stronger cultural ties to it.	32.65 (17.70) years
Years in school	Educated consumers consume less wild meat because they are exposed to conservation programs.	11.99 (3.51) years
Monthly income	Wealthier consumers consume more wild meat as a luxury product.	S/. 1718 (1330.50)
Distance to market	Wild meat is more accessible near major markets.	1830.7 (2017.53) m
Born rural or urban	Consumers born in a rural area are more likely to consume wild meat because hunting is typically a rural activity.	Rural: 32.56%; urban: 67.44%
Legality of wild meat	Consumers are less likely to consume wild meat if they think it is illegal.	Legal: 17.54%; illegal: 52.49%; doesn't know: 29.97%
Ecosystem damage of hunting	Consumers are less likely to consume wild meat if they think it is harmful to the ecosystem.	Yes: 65.46%; no: 16.72%; doesn't know: 17.82%
Where immigrated from	Consumers are more likely to consume wild meat if they immigrated from the rainforest or are from Iquitos originally.	Coast: 1.77%; rainforest: 38.91%; mountains: 0.55%; Iquitos: 58.77%

We divided the total by the number of people residing in the house to get the mass of wild meat consumed per person in the house in the past week.

We used a double hurdle model (Cragg, 1971) to quantify the predicted consumption rates of consumers. The double hurdle model consisted of 2 parts: a binomial model that estimated the probability that consumers ate any wild meat in the past week ($n = 1465$ interviews with sufficient data) and a log-linear model that estimated the mass of wild meat consumers ate in the last week in grams per person in the household per week ($n = 462$ households that consumed wild meat). We used this model structure to simultaneously test the probability that a consumer had eaten wild meat in the past week, and if they had, how much they consumed. We constructed a global model that included sociodemographic and spatial characteristics of households (Table 1). Responses with missing data were removed and not considered. All covariates were checked for collinearity before including them in the global model. The correlation cutoff for inclusion was 0.70 (Dormann et al., 2013). We validated the global model by checking residual plots. We used a backward stepwise model selection approach to select each optimal model, dropping one covariate at a time, which resulted in the largest decrease in Akaike information criterion (AIC) until AIC was minimized (Murtaugh, 2009). The optimal model was used to predict the influence of each covariate on wild meat consumption rates. We created coplots of the model covariates to demonstrate marginal effects of sociodemographic covariates. We also mapped predicted consumption rates with actual characteristics of households in each grid cell. We assigned a predicted game meat consumption for each cell that represented the mean of the households sampled in that cell.

All analyses were conducted in R 4.4.0 (R Core Team, 2024).

RESULTS

We interviewed 1548 households. After removing responses with missing data, the sample size for analysis was 1465 households (7415 people, 59.43% adults, 40.57% children). Sample size varied by district: 18.43% (of 1465 total respondents) of respondents located in Iquitos, 10.51% in Belen (154 respondents), 11.88% in Punchana (174 respondents), and 59.18% in San Juan Bautista (867 respondents) (Table 1). A greater effort was focused on sampling the San Juan Bautista district because it covered a larger geographic area compared with other districts, contained more people, and contained all the suburban towns we sampled.

Most heads of household were born in urban areas (67.44%). The mean number of years heads of households had lived in Iquitos was 32.65 (SD 17.70). The mean number of years respondents attended school was 11.99 (3.51) years (Table 1). The mean monthly income of sampled houses was S/1718.00 (1330.50).

Fifty-two percent (52.49%) of interviewees declared that wild meat sales were illegal, 29.97% did not know whether wild meat sales were legal or illegal, and 17.54% thought that wild meat sales were legal (Table 1). Most respondents (65.46%) said that wild meat consumption posed a problem to forest and animal conservation. Most households (70.38%) reported that they did not consume wild meat in the past week.

Overall, the sampled population consumed 957.22 kg of wild meat in the week before the interview. The average consumption rate was 129 $g \cdot person^{-1} \cdot week^{-1}$. Consumers reported 13 species—9 mammals and 4 reptiles—at least 3 times during interviews. Paca (*Cuniculus paca*) and collared peccary (*Pecari tajacu*) were the most commonly (220 and 124 responses,

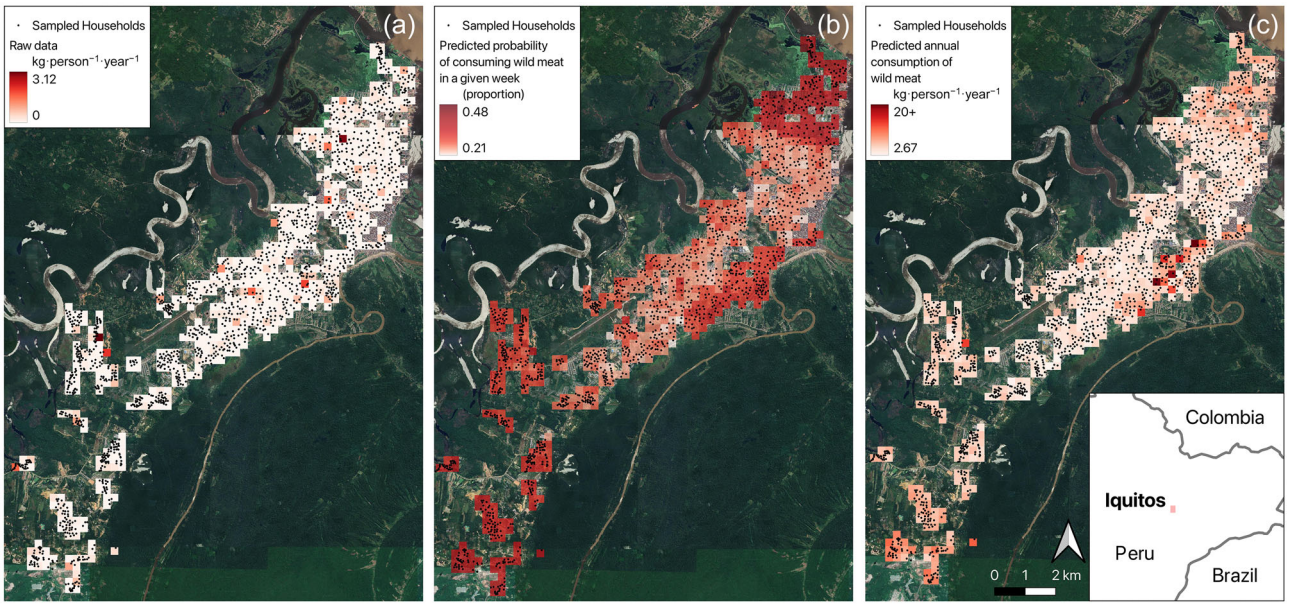

FIGURE 2 In Iquitos, Peru, (a) Raw data on consumption of wild meat by sample population in the week before interviews of 1465 consumer households, (b) results of the binomial half of the double-hurdle model showing mean predicted probability of a household consuming wild mammal meat in a given week, and (c) results of the double-hurdle model showing mean predicted consumption rate of wild mammal meat based on raw data from interviews of 1465 consumer households.

respectively) and heavily (311 and 170 kg, respectively) consumed species (Appendix S1). Three reptiles, the spectacled caiman (*Caiman crocodilus*), yellow-footed tortoise (*Chelonoidis denticulatus*), and the yellow-spotted river turtle (*Podocnemis unifilis*), were among the 5 most reported species. The South American river turtle (*Podocnemis expansa*) was the third most consumed species by mass (Appendix S1). The lowland tapir (*Tapirus terrestris*), woolly monkey (*Lagothrix lagotricha*), and white-lipped peccary (*Tayassu pecari*) were reported infrequently, each fewer than 6 times.

Of all meat consumed, 51.53% was purchased in markets, 18.39% was purchased outside of markets, and 29.56% was not purchased. The remaining wild meat did not have a source identified. Based on the spatial distribution of game meat consumption, most households did not consume wild meat, but wild meat consumption was distributed throughout the city (Figure 2a).

The optimal binomial half of the model, evaluating the variables that influence the likelihood that a consumer ate wild meat in the past week, included years in school, district, and distance to market (Table 2). Consumers in Punchana were most likely to consume wild meat, particularly those with less schooling who lived in rural areas far from markets (Figure 2b; Appendix S1).

The optimal log-linear model included born rural/urban, district, monthly income, distance to market, damage caused by hunting to the ecosystem, and the interaction between district and monthly income. When predicted consumption rates were mapped based on sociodemographic and spatial characteristics of households, clear patterns emerged. Households near the city center of Iquitos were predicted to have relatively low rates of consumption of game meat (<2 kg·person^{-1}·year^{-1}). The highest rates of consumption were predicted to occur in more rural areas along the Iquitos–Nauta Road, in recently established settlements far from the city center, and in isolated parts of downtown Iquitos. Our models predicted mean consumption rates up to 12–14 kg·person^{-1}·year^{-1} in these suburban towns (Figure 2c).

Generally, Punchana was predicted to have the highest rate of game meat consumption among the districts, followed by Belen. Monthly income had the largest effect on wild meat consumption (estimate = 0.490 [SE 0.179]) (Table 2). Households with greater income consumed more wild meat in Belen and San Juan Bautista but less wild meat in Punchana and Iquitos (Figure 3). Consumers far from markets and those originally from rural areas had higher predicted consumption rates than consumers near markets or from urban areas (Table 2; Appendix S1). Consumers that perceived that hunting did not affect conservation were predicted to have marginally higher consumption rates than those who indicated hunting was harmful. However, respondents who did not know what impact hunting had on conservation had the lowest predicted consumption rate (Appendix S1).

Competitive alternate binomial models (ΔAIC <2 compared with the optimal model) included years in Iquitos, born rural or urban, and monthly income (Appendix S1). A competitive alternate log-linear model (ΔAIC <2 compared with the optimal model) included years in Iquitos.

DISCUSSION

Interview responses showed that paca and collared peccary made up the majority of wild meat eaten by consumers (50.25% of all meat consumed). The tapir, woolly monkey, and white-

TABLE 2 Model[a] summary of the optimal double hurdle model predicting wild meat consumption rates in Iquitos, Peru.

Covariate	Coefficient estimate	SE	*p*
Binomial			
Years in school[b]	−0.116	0.058	0.047
District: Iquitos (reference: Belen)	−0.231	0.224	0.304
District: Punchana (reference: Belen)	0.282	0.235	0.230
District: San Juan Bautista (reference: Belen)	−0.287	0.204	0.160
Distance to market[b]	0.147	0.067	0.028
Log linear			
Boran rural/urban: urban (reference: rural)	−0.203	0.104	0.052
District: Iquitos (reference: Belen)	0.489	0.339	0.150
District: Punchana (reference: Belen)	0.410	0.321	0.203
District: San Juan Bautista (reference: Belen)	0.288	0.290	0.321
Monthly income[b]	0.490	0.179	0.006
Distance to market	0.107	0.060	0.074
Hunting harmful: doesn't know (reference not harmful)[b]	−0.379	0.167	0.024
Hunting harmful: yes (reference not harmful)	−0.025	0.130	0.846
District: Iquitos (reference: Belen): monthly income[b]	−0.0004	0.0002	0.015
District: Punchana (reference: Belen): monthly income[b]	−0.0004	0.0001	0.006
District: San Juan Bautista (reference: Belen): monthly income[b]	−0.0003	0.0001	0.015

[a]Consists of a log-linear half, which predicts consumption when consumption rate is >0, and a binomial half, which predicts the probability that consumption rate is >0.
[b]Statistically significant covariates ($p < 0.05$).

lipped peccary are all mammal of conservation concern that are vulnerable to overhunting (Bodmer et al., 1997; Bowler et al., 2014; Mayor et al., 2017). These species made up only 6.67% of all wild meat consumed. The clear preference for paca and collared peccary over these other, more vulnerable mammals has clear conservation implications. The paca and collared peccary are widely considered the species that holds the greatest potential for a sustainable supply chain of wild meat to urban centers due to their broad distribution and relatively fast reproductive rate for an animal of their body size (Spironello et al., 2023). Our results are consistent with those from other studies, which show a slow shift in the preference of consumers, away from tapir, white-lipped peccaries, and primates, and toward the paca and collared peccary, including in Iquitos (Mayor et al., 2021). Because our sampling included consumers, rather than focusing on market vendors (e.g., Mayor et al., 2021), our results add considerable weight to this hypothesized shift in preference.

Four reptiles made up 34.88% by mass of the wild meat consumed by respondents, collectively representing more wild meat consumed than the collared peccary. Turtle meat and eggs are a luxury protein source and are quite expensive in the city of Iquitos relative to other options (Mayor et al., 2024). Other studies show a preference for turtle meat by urban consumers in the Amazon, which is on par with many mammal species in other regions as well (El Bizri et al., 2020; Pantoja-Lima et al., 2014; van Vliet, Quiceno, et al., 2014). These turtle species are all globally threatened (Rhodin et al., 2018), largely due to the trade of meat causing local extirpation. Although the spectacled caiman is a species of least concern (as listed on the International Union for Conservation of Nature Red List due to its fast reproductive rate) (Balaguera-Reina & Velasco, 2019), high local consumption rates and the supply chain should be explored in more detail to assess whether hunting pressure can cause local population declines or whether it may represent a sustainable protein option (e.g., Da Silveira & Thorbjarnarson, 1999), similar to the paca and collared peccary.

Our model results showed that the determinants of whether or not a consumer eats wild meat were mostly spatial in nature and based on the income and number of years of schooling. Educated individuals were much less likely to consume wild meat than those with limited schooling, particularly those consumers living in downtown Iquitos nearby major markets. A consumer with 15 years of schooling living very close to a major market in the Iquitos district was predicted to have only about a 24% chance of eating wild meat in a given week. Residents living in recently established towns in more rural areas, particularly along the Iquitos–Nauta Road in San Juan Bautista, were much more likely to consume wild meat. The importance of distance from the city center was also found in central Brazil, where El Bizri et al. (2020) found that people living far from the city center eat more wild meat because domestic meat is expensive. Other studies have also demonstrated the effect of schooling on the probability of consuming wild meat. For example, Carignano Torres et al. (2021) observed that education played a role in predicting the probability of hunting. For people with Amazonian and non-Amazonian origin, the likelihood of hunting increases through elementary, peaking at the third quantile but decreasing with high-school education. The importance of years in school may demonstrate that learning about conservation in school is an effective means of shifting consumer behavior.

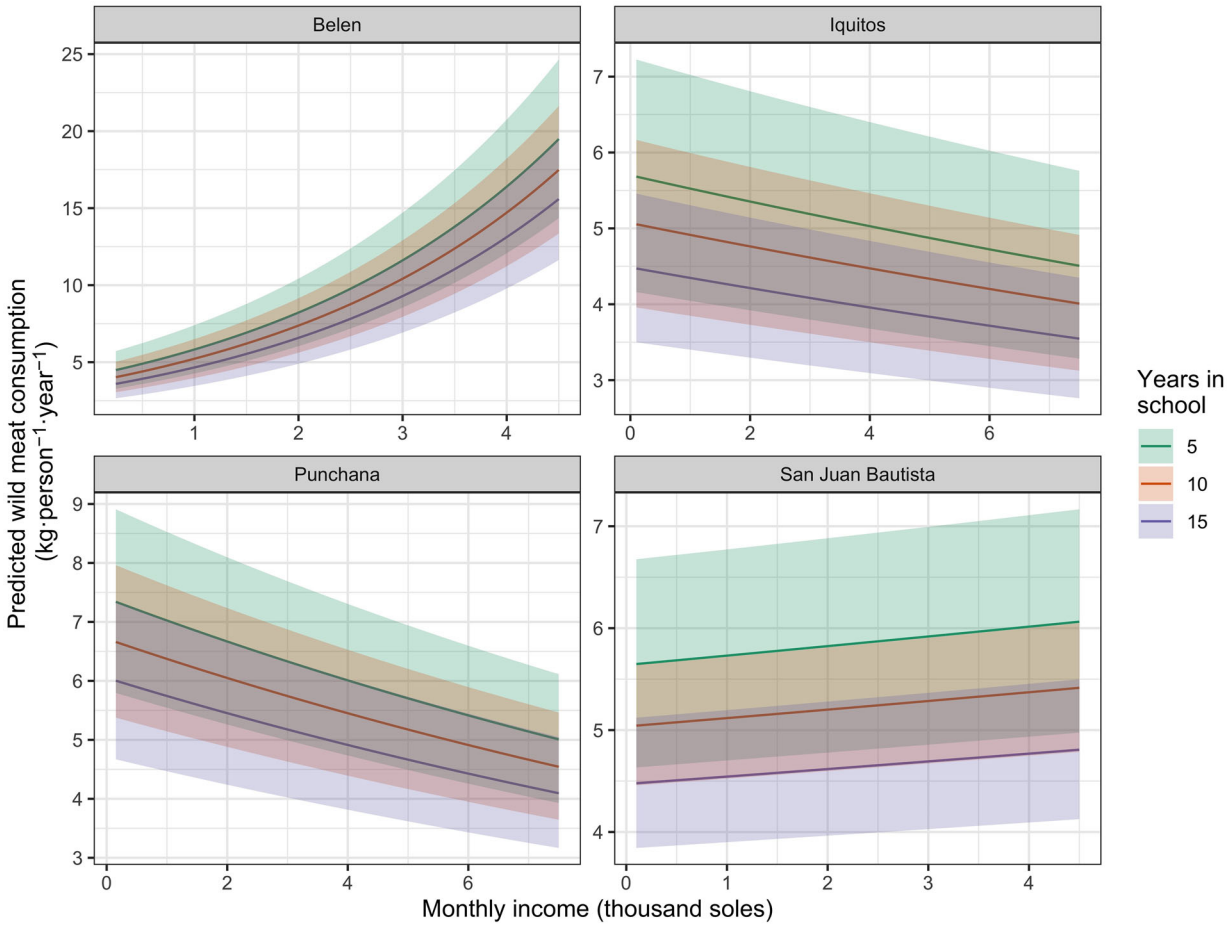

FIGURE 3 Effect of monthly income and years in school on wildmeat consumption in 4 districts in the Peruvian Amazon (categorical covariates: born in rural area outside major city, opinion that hunting does not cause ecosystem damage). Other continuous covariates held at district mean for the purpose of displaying marginal effects.

The structure of the double hurdle model showed that the drivers of consumption rates of wild meat differed from the determinants of consumption. Distance from the market was still important in the model and showed the same trend as the binomial portion, indicating that consumers living in downtown Iquitos were typically eating very little wild meat when they did eat it. However, the maps of predicted consumption showed some isolated hotspots of consumption in downtown Iquitos. The model results for income in this district suggest that these hotspots contained wealthy consumers living downtown, who may be consuming more protein in general and supplementing their diet with wild meat as a sort of luxury protein option. It has been hypothesized by others that wild meat is increasingly being eaten by wealthy consumers as a luxury product (Chaves et al., 2019; Parry et al., 2014; Van Vliet et al., 2015), rather than a culturally important source of food security. For people of higher economic status, wild meat can represent a way to diversify the type of meat consumed in their diet rather than for necessity (Castro et al., 1976). It is possible that our model results are showing this same theme in Belen in particular, whereas increased consumption in more rural, poorer areas is a source of food security.

Consumers' perceptions of the potential harm of wild meat consumption had a small influence on consumption rate, which may indicate that some consumers had been exposed to conservation messaging in the city that has been marginally effective. When our model results were considered on the whole, schooling had a huge impact on predicted consumption. Highly educated individuals were predicted to eat much less meat across all districts, particularly those who were from urban areas. Other studies show opposite effects of the amount of time lived in an urban center on wild meat consumption. For example, in Brazil, the longer rural migrant heads of households live in the city, the less likely it is that turtles are consumed in the household (Chaves et al., 2020). Similarly, Lemos et al. (2021) found that the proportion of time people live in rural areas is a significant predictor of primate consumption. It is possible that these species-specific trends also exist in our data because the majority of consumption was of preferred species (paca and collared peccary), which would drive model results.

In most other studies in Amazonian urban centers, markets or market vendors are the focal points of sampling, which may create a bias toward those consumers who are visiting markets to obtain meat and therefore purchasing it. Our sampling methods included an enormous amount of wild meat that was not purchased at all (29.56% of all wild meat by mass) and some that was purchased outside markets. Furthermore, distance from the market was extremely important in our models but showed a

negative effect; the majority of wild meat was consumed far from markets and in the city center. We hypothesize that wealthy consumers purchasing wild meat as a luxury product do buy it from markets and that population is overrepresented by sampling only markets. In a study in 4 urban municipalities in Brazil and Colombia, Morsello et al. (2015) evaluated household-level economic parameters (income, wealth, and price perception) to determine the likelihood of acceptability, preference, and consumption of wild meat. They found that income is a significant determinant of frequency of wild meat consumption, wealth is a significant determinant of preference, and price perception is a significant determinant of acceptability and that income correlates negatively with the frequency of wild meat consumption. Despite the significance of income, Morsello et al. (2015) pointed out that other cultural and social factors have a greater effect in determining the frequency of consumption. The diversity of the supply chain captured by Morsello et al. (2015) likely contributed to the opposite effect of income, as we hypothesize here.

The importance of wild meat to the food security of consumers in Iquitos cannot be overstated. Our results showed that this importance increased dramatically in more rural centros poblados along the Iquitos–Nauta Road and that other consumers in the city center likely had more access to diverse protein sources and the income to purchase them. Our data showed and our models predicted annual consumption rates of wild meat much higher than those reported by other authors.

The only other study that focused on the drivers of wild meat consumption in Iquitos evaluated the effect of per capita GDP (from government statistics) on the index of consumption per capita of meat eaten in Iquitos (Mayor et al., 2021). The index of consumption per capita of all meat was calculated by taking into consideration the sale of sheep, buffalo, pork, poultry, beef, and wild meat together. GDP alone did not have an effect on wild meat consumption (Mayor et al., 2021). Furthermore, metrics on meat consumed, wild or domestic, were calculated based only on the quantities of meat sold in 2 city markets; half the supply chain of wild meat was missing. Mayor et al. (2021) showed that there is a yearly increase in quantities of domestic meat eaten from ~30 to ~90 kg·person^{-1}·year^{-1}, but wild meat remained constant in people's diets. Thus, they concluded that the total amount of wild meat consumed in Iquitos (442 t annually) increases parallel to population growth (1.3% increment/year due to natural growth and migration). Although demand from markets may be changing parallel to growth, it is possible that the same trend does not exist for informal wild meat supply chains, and this should be explored in future studies. Given the diversity of species represented in this informal supply chain relative to markets (Briceño Huerta, 2022), we recommend conducting species-specific studies across multiple years; our study provides only a holistic snapshot of consumption.

Overall, our models showed that education may effectively reduce wild meat consumption, and they provide a target population for educational programing in Iquitos: consumers living in suburban towns along the Iquitos–Nauta Road who have migrated from rural areas and received minimal education. Although these consumers will not be going back to school, it is possible that conservation programing can act as informal education and work to shift consumption to more sustainable species, such as the paca (Spironello et al., 2023). We still found significant amounts of wild meat being traded in markets, and it is possible that the consumers in downtown Iquitos who are wealthier are those who are buying wild meat in markets as a luxury product as has been described elsewhere. These consumers also present an effective audience for conservation programing because they may have the economic capacity to make a decision about their protein sources, rather than relying on the social network supply chain for needed protein and food security.

Hunting is a critical activity for the food security of rural and urban consumers and a potentially devastating practice for populations of vulnerable species. Through understanding of the drivers and consumption rates of wild meat, socially and culturally relevant education materials for urban consumers and targeted management for urban areas can be crafted. We show that rates of consumption of wild meat may be higher than previously thought and highest in previously unsampled areas of the largest Amazonian city in Peru. We recommend close monitoring of the trade of vulnerable species in these areas and conservation programing for consumers.

ACKNOWLEDGMENTS

We thank all the interview participants in Iquitos who welcomed us into their homes and shared their invaluable insights and stories. Additionally, we thank D. Meza for her indispensable support during data collection in Iquitos. We also extend our gratitude to E. Freeman and C. Edwards for their invaluable guidance during the conception of this study.

Open Access funding enabled and organized by Georgetown University Lauinger 2025.

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How to cite this article: Huerta, F. B., Gilmore, M. P., Bowler, M., & Griffiths, B. M. (2025). Socioeconomic drivers of wild meat consumption in the city of Iquitos, Peru. *Conservation Biology*, e70056. https://doi.org/10.1111/cobi.70056