frontiers in Ecology and Evolution

ORIGINAL RESEARCH
published: 29 May 2019
doi: 10.3389/fevo.2019.00180

Assessing the Minimum Sampling Effort Required to Reliably Monitor Wild Meat Trade in Urban Markets

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Specialty section:
This article was submitted to Conservation, a section of the journal Frontiers in Ecology and Evolution

Received: *02 March 2019*
Accepted: *06 May 2019*
Published: *29 May 2019*

Citation:
Mayor P, El Bizri HR, Morcatty TQ, Moya K, Solis S and Bodmer RE (2019) Assessing the Minimum Sampling Effort Required to Reliably Monitor Wild Meat Trade in Urban Markets. Front. Ecol. Evol. 7:180. doi: 10.3389/fevo.2019.00180

The trade of wild meat generates great economic returns for local communities but at a cost of increasing harvest rates of game species. Monitoring wild meat trade in urban markets is a low-cost method that can be employed to assess impacts of hunting on game populations. Nevertheless, wild meat markets are complex systems to monitor since they often vary over time, are illegal in some countries, and often vendors distrust researchers. We investigated the wild meat trade in the Belén market in Iquitos, Peru, the largest wild meat market in the Amazon, to estimate the minimum sampling effort required to obtain reliable estimates of the amounts and prices of wild meat sold. During two 12-month surveys (Sept. 2006–Aug. 2007, Sept. 2017–Aug. 2018), we conducted a total of 4,524 vendor interviews in 320 sample days. By modeling 10 possible scenarios in which sampling size and amount of meat traded varied, we calculated the accuracy and precision of different survey protocols. We found that in scenarios where the daily amount of wild meat on sale was between 40 and 650 kg, a sampling effort equal to or >2 sampling days per month provided good accuracy (>90%) and precision (>85%). However, in scenarios where wild meat traded was less frequent, or for rarer species, an effort of at least one interview per week is required. Vendor declaration of the daily amounts of meat sold was similar to the quantity on sale (accuracy = 98%), suggesting that sellers are aware of the volume of wild meat brought to market. To accurately monitor the trade of wild meat in urban markets, we recommend a minimum sampling effort, ranging from two interviews per week to two interviews per month, depending on the amount of wild meat traded; in other occasions, a punctual interview on meat sellers' perception may also be useful.

Keywords: bushmeat, wildlife trade, sampling effort, accuracy, amazon

INTRODUCTION

Wild meat represents an important source of protein and income for local people in tropical forests in Africa, Asia, and Latin America (van Vliet and Nasi, 2008; Zapata-Ríos et al., 2009; van Holt et al., 2010; Fa et al., 2015). In many of these regions, the trade of wild meat to supply urban markets is considered a main cause of population declines of many game species (de Thoisy et al., 2005; Zapata-Ríos et al., 2009). Although the sale of wild meat by local hunters can be an important source of revenue for poor families, a greater emphasis on profits will cause a significant rise in wildlife harvest rates (Morsello et al., 2015). The observed intensification in wild meat harvest levels in many parts of the tropics has been linked to a greater commitment by indigenous and rural populations to supply city markets, in turn fuelling greater demand for wildlife products in urban areas (Ohl-Schacherer et al., 2007; Suarez et al., 2009; Fa et al., 2015; Kirkland et al., 2018).

The trade in wild meat has proved to be a very accessible and cost-effective indicator of the regional dynamics of game populations (Fa et al., 2000, 2015). Trends in the volumes of wild meat sold in urban markets can be used as evidence of hunting sustainability in the rural areas supplying the urban center (Fa et al., 2004; Morcatty and Valsecchi, 2015). For instance, in only 2 years of sampling in the Bioko Island, Africa, Albrechtesen et al. (2007) predicted unsustainable hunting in the surrounding areas through reductions of wild meat availability in urban markets. Therefore, developing statistically robust techniques to understand the wild meat trade in urban markets is essential to enable appropriate management strategies to emerge for the control of demand and supply of wild species used for food.

One of the main hindrances in monitoring the trade of wild meat in markets in most tropical countries is the fact that this is an illegal activity and, therefore, difficult to investigate directly. Thus, studies assessing the wild meat trade have usually consisted of short-term surveys, making the reliability of this information uncertain. In addition, wild meat markets have been shown to be complex systems that may change considerably over time based on supply- and demand-driven forces (McNamara et al., 2016), causing the availability of species, amount of wild meat, and their prices to vary daily, seasonally, and annually. Therefore, any survey intended to effectively monitor the wild meat trade must acknowledge this variation. However, there is still a lack of studies assessing what should be the minimum effort needed to obtain reliable estimates of the wild meat trade. To date, only one study in Africa investigated the performance of different sampling regimes from long-term data from five wild meat markets in West and Central Africa. This study showed that the accuracy and precision of samplings increased with sample size, and for the markets with the highest amounts of wild meat, these parameters started reaching an asymptote with an effort of around 28 and 35 sampling days per year (Fa et al., 2004).

In the Amazon, where the commercial route of goods depends on the distribution of rivers, the supplying of wild meat usually concenters in the largest urban markets along large rivers; surveying these markets may provide useful indicators of the status of wildlife populations at the regional scale (Fa et al. 2004). However, differently from Africa, there is still no consensus on what should be the minimum effort to reliably monitor Amazonian markets, and how this effort varies according to the amount of meat traded. In this study, we used two monitoring datasets collected from wild meat sellers in the Belén Market in Iquitos, Peru—the most important and largest open market in wildlife in the Amazon—to model the minimum effort required to obtain reliable information on the amount and trends of wild meat trade in Amazonia. We assessed the efficiency of using different sampling efforts and the sellers' perception to measure the volume and the price of wild meat traded.

MATERIALS AND METHODS

Study Area

The Belén Market is located in Iquitos, the largest city in the Peruvian Amazon (437,376 inhabitants). It is one of the most important Amazon markets in terms of volume of wild meat sold (Bodmer and Pezo, 2001). This market offers countless different types of goods extracted from the rainforest, from traditional medicines and pets to fresh fruits and vegetables.

In the Belén Market, wild meat is sold openly, thus making it relatively easy to track. Wild meat is typically supplied directly by intermediaries or by hunters that travel from their villages to the cities to sell their products to market vendors, household consumers, or restaurants (Bendayan, 1991). Although wild meat is not consumed daily, being secondary to the more commonly eaten poultry and fish, it is eaten as a traditional dish, where some species are considered luxury.

Data Collection

Two 12-month surveys were conducted in the Belén market during Sept. 2006–Aug. 2007 and Sept. 2017–Aug. 2018. Before the start of the surveys, we identified vendors to interview with the help of local informants. To gather information on the volume and price of the traded meat of wild species in the market, we used informal interviews and participant observation. All informants participated voluntarily after being primed of the project's aim. Anonymity of all participants was respected.

Since vendors display their wild meat products upon open-air market stalls, we could count volumes and species sold. Interviews were conducted twice daily between 6:00 a.m. and 12:00 p.m.; after midday, sales decreased substantially or sold out. The following data were recorded: date, species sold, type of meat preservation (fresh, salted fresh, salted dry, or smoked), selling price per kilogram, amount of wild meat brought by sellers at the start of the day, including the amount of wild meat displayed on the stall and stored indoor, and amount left at the end of the day. The amount of wild meat sold was calculated from the difference between the amounts on sale at the beginning minus the amount left at the end of the day. Although vendors were asked to confirm the taxa on sale, we independently verified each species. Since mammals make up over 80% of all wild meat traded in this market, we focused only on this group (Bodmer and Pezo, 2001).

In 2006–2007, we interviewed 29 vendors, a total of 2,443 interviews (203.6 $\pm$ 35.1 monthly interviews) in 182 sampling

days, covering 50.1% of days per year (one sampling every 1.99 days). During 2017–2018, we performed 2,081 interviews (173.4 ± 59.3 monthly interviews), 30 vendors during 138 sampling days, 37.8% of days per year (one sampling every 2.64 days). These vendors, a large sample of all active ones in the markets, were regular sellers of wild meat who agreed to participate throughout the whole study period. Occasional vendors, those who sold only a small volume of wild meat (along with other rainforest goods), were not considered in this study.

At the end of the 2017–2018 survey we interviewed 11 of the most frequent wild meat sellers so as to obtain their opinion on the average price and average daily amount of wild meat sold year-long.

Data Analysis

The amounts of meat (salted fresh, salted dry, and smoked) recorded per species were transformed into fresh meat using the conversion indexes proposed by Bardales-García et al. (2004). For those species for which we did not have conversion indices, we applied the index for a taxonomically related species of similar body mass. The daily price in US dollar (US$) per kilogram of wild meat was calculated for all mammal species and all kinds of meat. To convert Peruvian Soles (S$) into US dollars, we used the exchange rate from 10 October 2007 (S$ 3.00 = US$1.00) for the survey 2006–2007 and from 04 October 2018 (S$ 3.32 = US$1.00) for the survey 2017–2018.

We achieved 182 and 138 interview-days during the 2006–2007 and 2017–2018 survey periods, respectively. To assess the effectiveness of different survey efforts, we modeled 10 scenarios using different sample sizes. We reduced the number of sampling days within each year-survey by using a progressive random selection of interview-days homogenously distributed along the year: 182 and 132 (maximum effort), 90 and 75 (with 2 replicates per survey), 45, 24, 12, 6, 4, and 3 (with 5 replicates per survey), and 2 interview-days (with 10 replicates per survey). We also modeled two seasonal sampling periods, consisting of interviews performed every 2 days for the months with the highest and lowest water levels of the Amazon River (Servicio de Hidrografía, 2015).

For every scenario, we calculated the average and standard deviation of the price and total amount of fresh-converted wild meat sold per day. We considered that the maximum survey effort (hereafter "reference model") was the most reliable information, and any reduction in sampling effort would bias the reference model. Bias is a reduction in the accuracy and precision of the price and amount of meat sold. Accuracy refers to the level of proximity, in percentage, of the average relative to the reference model. Precision refers to how variable estimates from different samples were compared with each other, and was estimated based on the standard deviation of the different parameters. To predict accuracy, we calculated the relative difference between the daily average in any experimental effort with respect to the reference model. Similarly, to predict precision, we calculated the relative difference of the daily standard deviation in each experimental effort compared to the reference model. Values close to 1.00 (or 100%) meant maximum accuracy or precision relative to the reference model. We considered effective sampling for those efforts that concomitantly combined accuracy and precision values higher than 90%. We also presented the amount of wild meat sold and the accuracy and precision in each sampling scenario for seven different taxa: *Cuniculus paca*, *Pecari tajacu*, *Tayassu pecari*, *Mazama* sp., *Hydrochoerus hydrochaeris*, *Tapirus terrestris*, and *Lagothrix* sp. Since these species presented different trading volumes in the market, they were used to assess the influence of different amounts of wild meat on the precision and accuracy obtained.

We used multiple regressions to model the relationship between sample size and accuracy or precision with the software CurveExpert 2.4 (©Copyright 2017, Daniel G. Hyams). Functions that best fitted the plots were selected by employing those with the highest correlation coefficient (r).

For interviews conducted in October 2018 on sellers' perceptions, we used a paired t-test to compare average price and daily amount of wild meat sold throughout a year by comparing records for the 11 most important sellers for amounts of wild meat sold in the reference model and their own perception.

Randomization of the survey days for building the models was performed using R-Studio version 3.3.3 (RCore Team, 2017). Results with $P < 0.05$ were considered significant.

RESULTS

In 2006–2007, sellers sold a total of 220,487 kg of wild meat, an average of 663.1 ± 188.7 kg per day, at an average price of US$ 3.82 ± 0.19 per kg. The total amount of wild meat sold in 2017–2018 was 288,336 kg, an average 886.2 ± 399.0 kg per day, at an average price of US$ 6.04 ± 0.33 per kg. For both years pooled, the average daily amounts of wild meat traded differed among species. Meat of *Pecari tajacu* and *Cuniculus paca* was the most traded (197.6 ± 96.0 and 190.4 ± 107.6 kg, respectively), while *Lagothrix* sp. had the lowest sale rate (2.8 ± 7.3 kg; $P < 0.001$). *Tayassu pecari*, *Mazama* sp., *Hydrochoerus hydrachoerus*, and *Tapirus terrestris* had intermediate sales rates (124.8 ± 94.5, 57.9 ± 43.3, 38.8 ± 34.0, and 22.1 ± 23.5 kg, respectively; **Figure 1**).

Accuracy and precision of the price and of the amount of wild meat sold increased proportionally to sampling effort (**Figures 2**, **3**, **Table 1**). Nevertheless, no significant differences were observed between 12 and 182 interview-days in the average accuracy for both price and amount of total wild meat sold (96.7 ± 2.1% and 96.5 ± 3.0%, respectively): an average precision of 87.7 ± 12.2% for price and 90.4 ± 9.9% for amount of meat (**Figure 2**, **Table 1**). Scenarios with lower sampling efforts, between six and two annual interviews, resulted in decreased accuracy for price (79.6 ± 5.6%) and total amount of wild meat (87.9 ± 9.7%). Similarly, we also detected a decreased precision for price (66.8 ± 22.3%) and total amount of wild meat (55.9 ± 26.3%) within this effort range. The seasonal experimental design showed similar accuracy compared to the reference model (total amount 82.6% and price 92.9%), but precision was considerably lower (total amount 77.3% and price 29.3%).

Accuracy and precision varied according to the amount of meat sold. In the case of *Pecari tajacu* and *Cuniculus paca*, which represented a daily sale between 190 and 200 kg, the

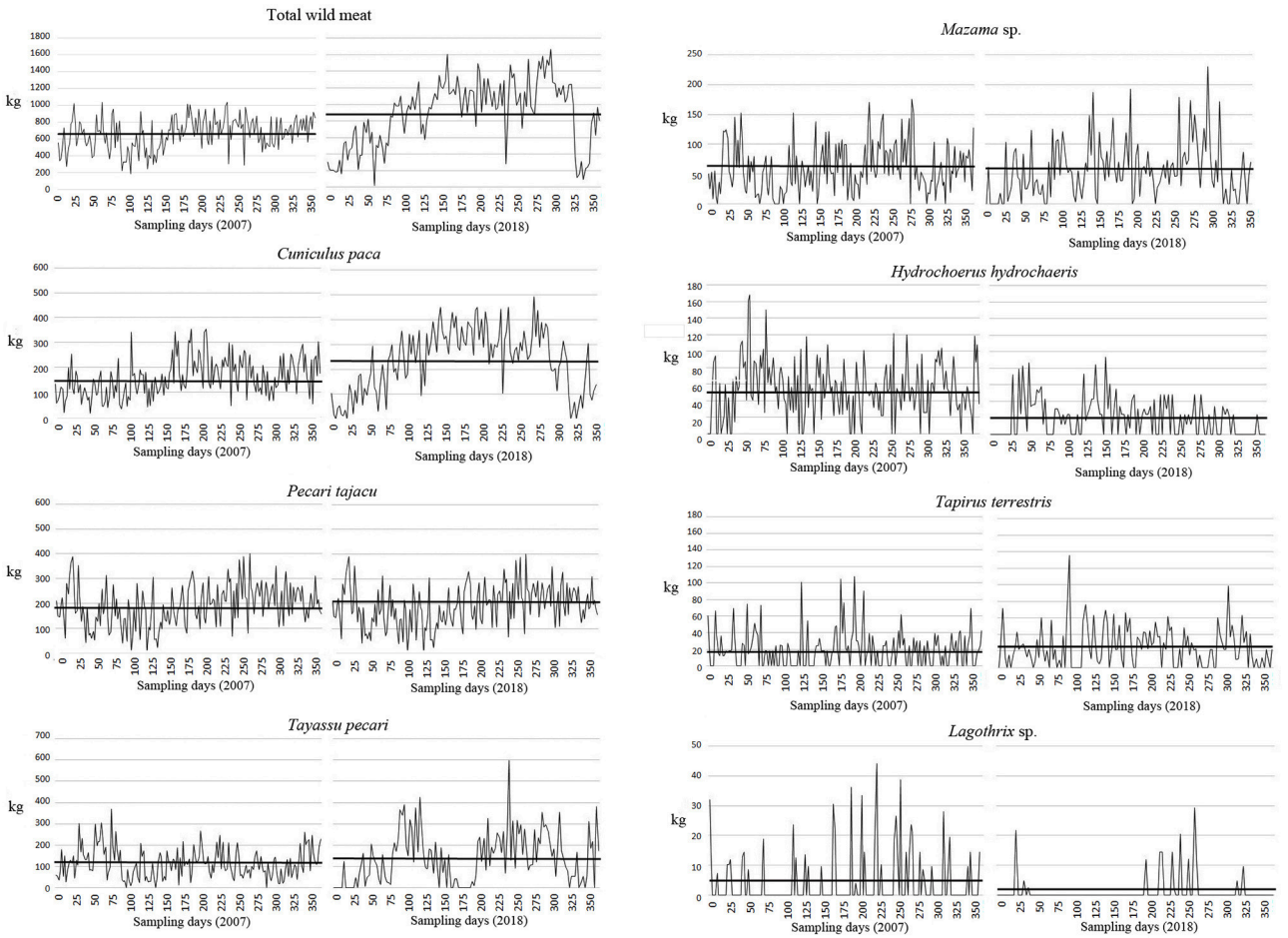

FIGURE 1 | Trends in the total amount of wild meat (in fresh-converted kilograms) and the amount of meat for the most traded species, *Pecari tajacu*, *Cuniculus paca*, *Tayassu pecari*, *Mazama* sp. *Hydrochoerus hydrochaeris*, *Tapirus terrestris*, and *Lagothrix* sp. in the Belén Market (Iquitos) in two 12-month surveys conducted in 2006–2007 and 2017–2018. Solid bold lines represent the average amount of wild meat (in fresh-converted kilograms) commercialized per species and year.

accuracy with 12–45 annual interview-days remained close to 95%, and precision with 24–45 annual interview-days was higher than 90%. In scenarios with daily sales between 40 and 125 kg of wild meat (*Hydrochoerus hydrachoerus* and *Tayassu pecari*, respectively), accuracy was at least 85% and 95% at an effort of 12 and 75 annual interview-days, respectively, but precision decreased to 86% with a sampling effort of 1 monthly interview. In species with daily sales of 22 and 3 kg (*Tapirus terrestris* and *Lagothrix* sp.) accuracy was at least 90% only with 75 and 90 annual interview-days, respectively (**Figure 3**; **Table 1**).

Results of our sellers' perception interviews indicated that vendors accurately assessed 78.2 ± 96.4% of the amount of wild meat traded within our year-long survey ($t_{10=}$ −2.815, P = 0.018). Conversely, vendors' perception of meat available was similar to the amount of wild meat on sale at the beginning of the day, showing an accuracy of 97.7 ± 41.3% ($t_{10=}$ −0.452, P = 0.661). In addition, their perception of price was also similar to the average price obtained in the year-along survey: an accuracy of 98.2 ± 9.5%.

DISCUSSION

Despite some caveats, information on the amounts and species of wild meat traded in urban markets can be used to understand the impact of hunting over large geographical areas (Fa et al., 2004; Fa, 2007), especially for the most frequently sold species. Nevertheless, since wild meat trade is forbidden in some tropical countries, this activity is excluded from official statistics. Although several studies have been recently conducted in markets of some Neotropical countries (Bodmer and Pezo, 2001; van Vliet et al., 2015), their reliability can be compromised due to the evasive behavior of meat sellers and buyers. In this context where long-term monitoring of wild meat markets can be expensive or even too risky, defining efficient and adequate minimum sampling effort has been a priority (Fa et al., 2004). In this study, we assessed the efficiency of different sampling efforts for monitoring the largest market of wild meat in the Amazon. Although the trade in wild products in urban markets is forbidden in Peru (Law No 29763), the surveillance authorities have been unable to enforce this law due to logistical

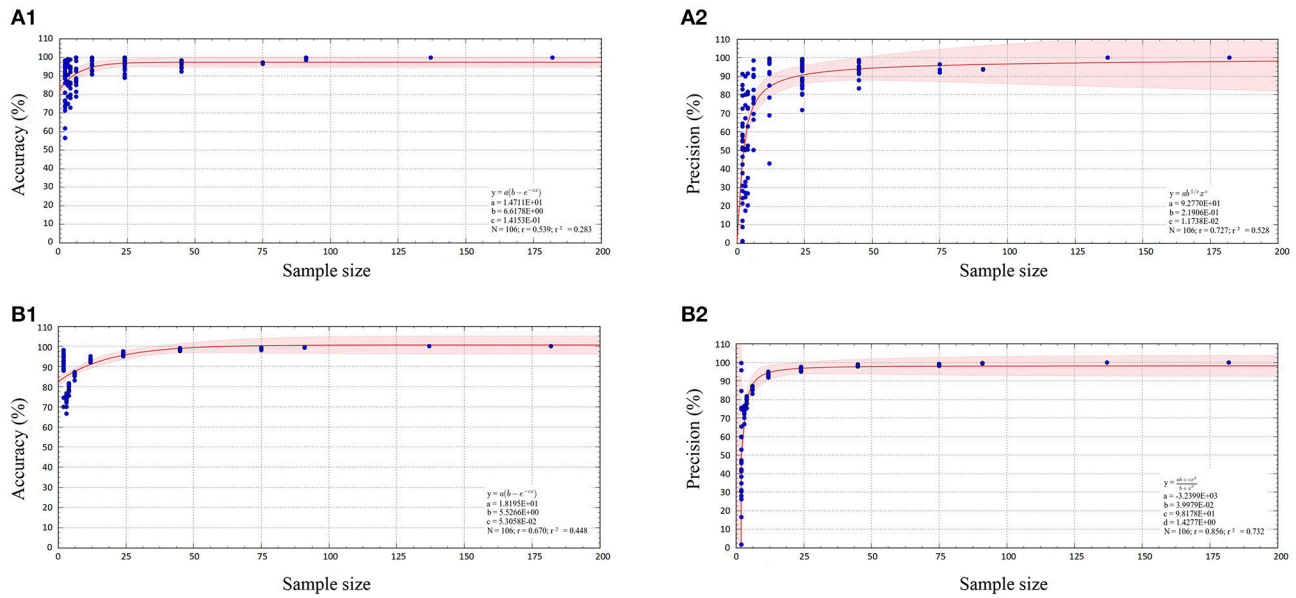

FIGURE 2 | Trends in the accuracy (1) and the precision (2) of **(A)** the amount of total wild meat and **(B)** the price of wild meat in relation to the results obtained with the maximum sampling effort in two 12-month surveys conducted in 2006–2007 and 2017–2018.

and financial limitations and the high traditional demand for wild meat.

Our study suggests that the optimal sampling effort would range between two weekly interviews to two sampling days per month depending on the amount of meat sold in the market. Since financial and personnel resources are often limited in research projects (Garden et al., 2007), the sampling design may be adjusted within this optimal range according to available resources. While two sampling days per month resulted in high accuracy and precision values compared to the long-term inter-day sampling effort for the total wild meat and for common species in the market, a minor sampling effort of one interview per month resulted in an acceptable accuracy (>90%) but a decreased precision (<90%). As also detected for African markets, the minimum effort depends on the average amount of wild meat sold (Fa et al., 2004). However, these differences are slight for the most traded species, and we suggest that in markets with sales volumes between 40 and 650 kg, including total wild meat or particular traded species, a minimum monthly effort of two interview-days should be maintained. The ability to estimate the trade of less frequent or rarer species requires a higher effort of at least 1 weekly interview. In addition, in the Amazon, any short-term seasonal experimental design showed very low precision, compromising the reliability of the data obtained. A temporally distributed sampling over the year also resulted in higher accuracy and precision for estimations of the amount of meat traded in African markets and should be employed in future studies (Fa et al., 2004).

The unique interview on the sellers' perception was considerably effective at estimating the meat available for trade (approximately 98% of accuracy). This result suggests that sellers are aware of the amount of wild meat brought daily to the market, but they do not control the volume of products they actually trade. Occasional vendors would probably show a perception farther away from reality due to the lower repetitiveness of sales events. In contrast, the sellers' perception on the price was well-adjusted to the average annual price, presenting both high accuracy and precision, probably because this parameter presents lower variability along the year.

Therefore, this sampling strategy may be useful to determine the amounts of animals removed from the forests and their prices but should be used with caution. Besides the reduced number of sampling days, the level of confidence between surveyor and seller may also influence the reliability of results. This relationship may depend on the degree of openness of the market, the regularity of the sale, and the amount of wild meat sold. The Belén Market, sampled in this study, is well-known for having being largely studied for around 20 years (see Bodmer and Pezo, 2001). In the last 10 years, we carried out several studies in this market, which allowed us to gain the confidence from some important sellers of wild meat. Nevertheless, even with this trustful relationship, we observed that some sellers distrust our purposes and fear an alliance with researchers and local governmental institutions. In hidden markets, it is expected that the wild meat trade might be more difficult to observe, increasing uncertainness and likely leading to underestimations of the amounts of wild meat sold. Illegal sellers, such as those participating in the wild meat sector, may respond hindering the truth due to fear of legal consequences. Therefore, we advocate that punctual interviews, or even long-term monitoring schemes, should be used only when trust from the sellers is obtained.

In the Amazon, where most areas have a scarcity of roads and most products are supplied through fluvial transportations, the commercial route of goods depends on the distribution of rivers, and wild meat trade usually concenters in the largest urban markets along large rivers; surveying these markets may

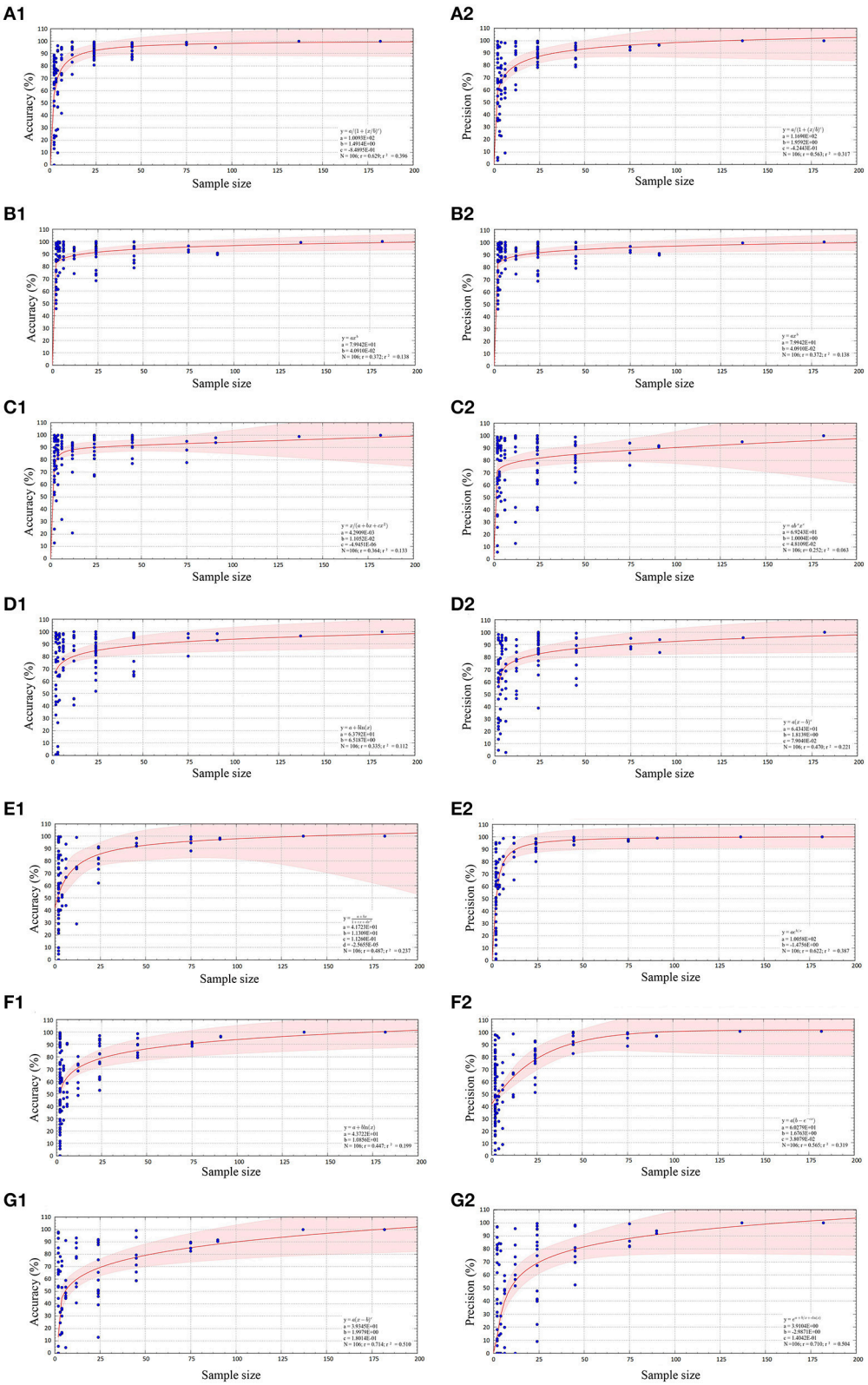

FIGURE 3 | Trends in the accuracy (1) and the precision (2) of the amount of meat of **(A)** *Pecari tajacu*, **(B)** *Cuniculus paca*, **(C)** *Tayassu pecari*, **(D)** *Mazama* sp. **(E)** *Hydrochoerus hydrochoeris*, **(F)** *Tapirus terrestris*, and **(G)** *Lagothrix* sp. (in fresh converted kilograms) in relation to the results obtained with the maximum sampling effort in two 12-month surveys conducted in 2006–2007 and 2017–2018.

TABLE 1 | Accuracy and precision (in %) of the daily amount of wild meat sold according to different experimental efforts in two 12-month surveys conducted in 2006–2007 and 2017–2018.

N° sampling days	Accuracy of the daily average							
	Total wild meat	*Cuniculus paca*	*Pecari tajacu*	*Tayassu pecari*	*Mazama* sp.	*Hydrochoerus hydrochaeris*	*Tapirus terrestris*	*Lagothrix* sp.
Daily meat sold	758.5 ± 316.8 kg	190.4 ± 107.6 kg	197.6 ± 96.0 kg	124.8 ± 94.5 kg	57.9 ± 43.3 kg	38.8 ± 34.0 kg	22.1 ± 23.5 kg	2.8 ± 7.3 kg
Frequency of sale (% days on which the species was detected)	100.0%	98.7%	99.7%	90.9%	89.9%	73.0%	78.1%	17.5%
90	99.3 ± 0.8	99.3 ± 0.2	98.8 ± 0.0	94.9 ± 0.1	96.6 ± 0.0	97.9 ± 0.7	96.3 ± 0.5	91.0 ± 0.8
75	96.9 ± 0.3	93.3 ± 0.7	94.6 ± 5.3	98.0 ± 1.2	95.6 ± 6.1	94.8 ± 5.0	90.6 ± 1.6	86.6 ± 3.4
45	96.7 ± 1.9	92.7 ± 3.7	94.2 ± 5.6	93.0 ± 5.1	94.1 ± 46.0	93.8 ± 2.9	87.0 ± 7.4	75.4 ± 15.1
24	96.8 ± 3.4	92.8 ± 4.9	92.7 ± 5.8	92.5 ± 5.1	89.1 ± 7.2	84.7 ± 8.3	77.3 ± 15.1	63.1 ± 24.0
12	95.1 ± 3.2	95.0 ± 3.0	90.4 ± 7.7	91.7 ± 7.8	86.5 ± 14.9	71.9 ± 19.3	66.4 ± 11.1	71.7 ± 19.0
6	92.1 ± 6.5	90.5 ± 9.5	88.4 ± 10.6	81.8 ± 16.7	67.8 ± 16.3	69.9 ± 14.3	63.8 ± 22.9	49.0 ± 23.7
4	87.4 ± 8.1	86.9 ± 9.2	83.3 ± 12.9	64.7 ± 29.2	66.3 ± 29.2	58.1 ± 14.1	56.0 ± 17.0	41.6 ± 22.4
3	89.1 ± 8.9	80.1 ± 13.9	67.5 ± 25.1	60.7 ± 24.3	58.6 ± 36.2	59.6 ± 23.4	58.7 ± 19.5	39.6 ± 21.4
2	85.7 ± 11.6	76.0 ± 16.8	73.2 ± 21.2	61.9 ± 24.9	68.1 ± 30.2	52.3 ± 33.2	51.4 ± 32.1	13.0 ± 29.1
Precision of the Daily Average								
90	93.7 ± 1.0	97.6 ± 0.3	94.8 ± 0.1	96.5 ± 0.0	95.5 ± 0.1	98.9 ± 0.0	96.3 ± 0.2	99.8 ± 11.4
75	94.1 ± 3.1	95.1 ± 3.1	98.8 ± 1.3	93.7 ± 1.7	88.2 ± 6.2	97.2 ± 0.7	94.9 ± 5.0	87.4 ± 8.2
45	93.0 ± 4.6	93.9 ± 4.4	94.7 ± 3.4	91.0 ± 5.7	87.2 ± 8.4	95.8 ± 2.6	93.2 ± 6.2	77.7 ± 15.2
24	91.3 ± 5.8	91.8 ± 5.7	89.3 ± 6.9	89.3 ± 6.8	87.0 ± 8.9	94.2 ± 4.8	77.5 ± 12.2	65.6 ± 29.2
12	88.9 ± 11.2	88.3 ± 9.3	84.9 ± 12.3	86.7 ± 11.1	86.9 ± 13.0	89.4 ± 11.0	64.9 ± 18.0	61.1 ± 28.6
6	75.1 ± 17.2	72.8 ± 16.4	69.0 ± 21.0	62.2 ± 26.9	69.5 ± 23.3	80.0 ± 12.0	41.5 ± 25.8	35.2 ± 23.6
4	62.4 ± 25.2	73.0 ± 19.4	60.4 ± 22.4	64.3 ± 31.7	57.5 ± 21.7	74.5 ± 14.6	39.4 ± 29.0	33.3 ± 32.4
3	51.2 ± 24.4	74.6 ± 25.8	63.4 ± 21.9	61.8 ± 22.8	56.3 ± 40.8	63.7 ± 7.8	55.5 ± 20.8	20.7 ± 34.8
2	46.8 ± 26.5	54.8 ± 30.0	68.0 ± 28.2	60.1 ± 30.4	55.2 ± 28.6	47.6 ± 32.2	45.9 ± 27.5	12.1 ± 26.8

provide useful indicators of the status of wildlife populations at regional scale. Consequently, the long-term monitoring of Amazonian urban markets can stand as a better indicator of the regional conservation status of wildlife and is essential to anticipate management strategies that provide a response to population crisis of game species. Ultimately, the use of cost-effective and accurate tools to obtain key market indicators allows comparing annual trends in the volumes of wild meat sold for certain species. In this context, we consider that accuracy and precision values higher than 90% are acceptable.

Since wild meat trade is forbidden in most tropical rainforests, efficient and adequate sampling strategies have rarely been developed. Our study, conducted in the largest open market of wildlife in the Amazon, provides appropriate estimations of the minimum effort required to monitor wild meat trade. Since the cultural importance of the wild meat consumption is shared among almost all Amazonian countries, we believe that the minimum effort estimated here may apply to other Amazonian urban markets. Finally, a sampling effort ranging from two weekly interviews to two interviews per month homogenously distributed over the year, or a punctual interview with sellers on their perceptions may provide accurate estimates of both amount and price of wild meat, as far as a trustful relationship is attained and bearing in mind the limitations these data may have at informing trade rates.

DATA AVAILABILITY

The datasets generated for this study can be found in Pangaea (doi.pangaea.de/10.1594/PANGAEA.898710).

AUTHOR CONTRIBUTIONS

PM and HEB were responsible for idea conception, study design, analyses, and manuscript preparation. KM and SS contributed to the field work. TM designed the statistical analyses and participated in the manuscript preparation. RB was responsible for idea conception and study design.

FUNDING

This work was supported by the Museo de Culturas Indígenas Amazónicas. The publication of this manuscript was possible thanks to the financial support from USAID, through

the Bushmeat Research Initiative, from CIFOR and the CGIAR Forests, Trees and Agroforestry Programme. HEB received scholarship from the National Council for Scientific and Technological Development (CNPq) (grant number 201475/2017-0). TM is supported by the WCS Graduate Scholarship Program, a program of the Wildlife Conservation Society and the Christensen Conservation Leaders Scholarship, and by the Wildlife Conservation Network Scholarship Program through the Sidney Byers Scholarship award.

ACKNOWLEDGMENTS

We thank all the vendors of wild meat in the Belén Market of Iquitos who kindly participated in the data collection.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer, DI, declared a past co-authorship with one of the authors, HEB, to the handling editor.