



The drivers of wild meat consumption in rural Cameroon: Insights for wild meat alternative project design

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Abstract

Projects providing alternative foods to wild meat in rural areas are commonplace across West and Central Africa to try and curb unsustainable hunting, regarded as a major concern for conservation and local food security. However, there lacks locally specific research on the preferences and drivers of wild meat consumption in rural areas—essential information for guiding such interventions. We carry out semi-structured interviews with 542 people in four rural villages around the Dja Faunal Reserve in Cameroon, to understand the importance of wild meat, explore people's food choices, identify the drivers of wild meat consumption, and explore variation in the drivers and barriers to eating wild meat and its alternatives. We found that wild meat is preferred to meat from domestic livestock or wild caught fish. Many of the most commonly preferred wild meat species (porcupine and blue duiker) are relatively abundant, with the exception of pangolin which is globally endangered but which people reportedly prefer because of its good taste. Good taste, perceived health benefits, and easy accessibility are the key drivers of consumption, while taboos, an off-putting appearance, and health concerns play a strong role in species avoidance, particularly for great apes and large ungulates. Village-level differences in the drivers of consumption were observed, possibly influenced by their proximity to the reserve, to markets, participation in alternatives projects, and to law enforcement. That people in rural Cameroon care about health and taste in their choices, rather than simply availability or cost, challenges the assumptions that underpin many alternative meat projects. Our findings provide an understanding of consumer drivers to help to guide wild meat alternative interventions in rural areas. We urge wild meat alternatives designers to account for the heterogeneity of preferences and drivers within communities, to help ensure that projects reach both their conservation and social objectives.

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KEYWORDS

Africa, bushmeat, hunting, livelihoods, protected area

1 | INTRODUCTION

Wild meat, also referred to as bushmeat, has long been a major source of food for forest and urban dwellers across the tropics, and notably across Africa (Cawthorn & Hoffman, 2015; Milner-Gulland et al., 2003; Nasi et al., 2011). Given its importance for food security and its potential impact on wildlife, unsustainable hunting for wild meat is a major conservation concern. This is especially true in rural areas where those reliant on wild meat have limited access to affordable, sustainable, and culturally appropriate alternatives (Milner-Gulland et al., 2003). In response to conservation and food security concerns, projects aiming to curb reliance on wild meat for both food and income are often implemented (Wicander & Coad, 2018; Wright et al., 2016). These include 'alternatives projects' which provide livelihood alternatives for hunters and alternative sources of protein to rural and urban consumers, for example, through fish and livestock farming or captive-bred rearing of wild species (Booker & Wilson-Holt, 2020).

Despite the common implementation of alternatives projects, there is limited evidence that alternative meat and income projects achieve their conservation and social objectives (Roe et al., 2015; van Velden et al., 2018; Wicander & Coad, 2018). In particular, the assumptions that underpin such projects, such as that wild meat can be replaced by other forms of animal protein if it is comparable in price and easily available, are often incorrect (Wright et al., 2016). Projects that provide alternative meats may not be achieving their objectives because they are not fully appreciating either the underlying reasons that drive people actively to choose to eat wild meat or the barriers to making other food choices. In a review of the evidence on the drivers of wild meat as a food choice, Booker (2019) found a large body of literature on wild meat hunting, trade, and consumption, but very little that specifically dealt with the drivers of wild meat as a food choice. For example, 26 papers noted taste as a driver of food choice in rural areas, but only six provided detailed insights (East et al., 2005; Kümpel, 2006; Kümpel et al., 2010; Ladele et al., 1996; Mwakatobe et al., 2012; Schenck et al., 2006).

Studies in rural areas tend to link consumption with the availability and affordability of meat, while the possible health benefits and cultural motivations for consumption were viewed as secondary drivers of food choice without explicitly testing whether this was the case (Ceppi & Nielsen, 2014; Kiffner et al., 2015; Mavah

et al., 2018; McNamara et al., 2016). Further, few studies investigate the influence of factors such as gender, or age. Additionally, a recent review showed that there is little evidence for many successful wild meat interventions more generally (e.g., behavior change campaigns, livelihood alternative projects) across the tropics, and called for a better understanding of the drivers of consumption, and efforts to evaluate current interventions (Ingram et al., 2021). As such, more research is therefore required to investigate exactly why people choose to eat wild meat to support effective strategies to make consumption more sustainable.

Wild meat is important for livelihoods and food security across rural Cameroon (Nasi & Fa, 2015). Yet wild meat supplies are steadily declining, due primarily to over-harvesting, exacerbated by the commercialization of the wild meat trade (Kamgaing et al., 2019; Wright & Priston, 2010). Despite its global importance for biodiversity, the state of conservation within the Dja Faunal Reserve is precarious, with the reserve now on the World Heritage Sites In Danger list. A couple of recent studies have looked at trends in wild meat harvest and hunting pressure within and adjacent to the reserve, but neither addressed the social dimensions of hunting that may also be driving the observed species population trends (see Ávila Martin et al., 2020; Farfan et al., 2019). A lack of understanding of the drivers of wild meat hunting and consumption means that conservation is not able to effectively address the threat to biodiversity or improve the food security of the communities living adjacent to the Dja Faunal Reserve.

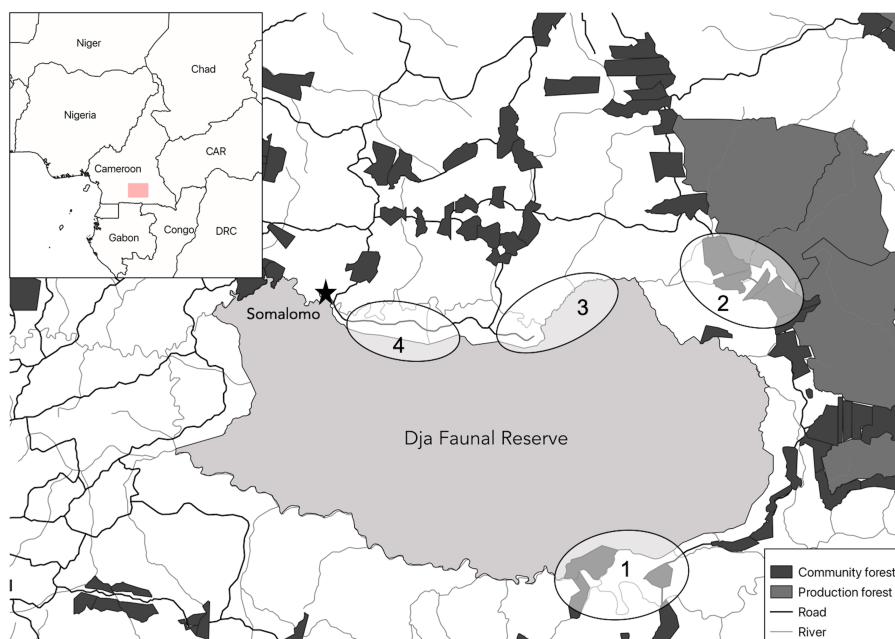
To investigate the drivers of wild meat consumption, we conducted interviews with people in rural villages around the Dja Faunal Reserve in Cameroon. We aimed to: (1) understand the importance of wild meat in people's lives; (2) explore people's food choices; and (3) explore variation in the drivers and barriers shaping these choices. Based on our findings we make recommendations about the future design of wild meat alternative projects in Cameroon, and across sub-Saharan Africa.

2 | METHODS

2.1 | Study area

The Dja Faunal Reserve (DFR) is a World Heritage Site lowland rainforest in south-eastern Cameroon. The DFR

FIGURE 1 Map showing the location of the DFR in Cameroon, and the approximate location of the four villages in relation to the reserve. See Table 1 for a description of each village and their involvement in wild meat alternative projects



is noted for its rich biodiversity and is home to 107 mammal species, several of which are threatened (UNESCO, 2021). As the poorest of Cameroon's regions, many of the inhabitants adjacent to the DFR rely on subsistence farming for food security and livelihoods (World Bank, 2013) and on wild meat hunting as an additional livelihood and source of protein (Bobo et al., 2015). Inhabitants come from a number of different ethnicities predominantly from the east and southern region of Cameroon, namely the Badjoué, Boulou, Fang, Nzimé, and the Baka (UNESCO, 2021), who have different subsistence patterns (Ávila Martin et al., 2020; Fa et al., 2021).

Access and hunting by local people is prohibited within the reserve. Although access is permitted in the surrounding buffer zone, hunting is only permitted if (1) the target species are not listed as a Class A (a term defined in Cameroonian law which protects a species from hunting for any purpose); (2) if hunting relies on 'traditional' implements, which excludes the most commonly used gear such as wire snares and guns and; (3) it is only used for household consumption. Consequently, by outlawing many hunting practices, studies in Cameroon have found that most hunting for subsistence is technically illegal (Yasouka et al., 2015). This legislation was created without local participation, and fails to account for the rights and interests of local communities (Nguiffo & Talla, 2010).

2.2 | Data collection

Research was conducted in four villages situated around the periphery of the DFR (Figure 1), with data collection

carried out in April–June 2019. To ensure the internal validity of the findings and explore the individual, household, and village-level differences in wild meat preference, all willing and available adults over the age of 18 were interviewed in each village, from all available households.

While the research team knew the number of households within the villages, the number of households and inhabitants that are present changes regularly with seasonal work away from the villages. When going from household to household to interview participants, notes were made when people were absent, and the team arranged to return at a time that suited them to explain the work and ask permission to conduct the interview. Table 1 summarizes the variables for which data were gathered and our hypotheses about their importance of meat in local diets, meat preferences, and the drivers of preference. To understand the importance of wild meat for peoples lives, participants were asked how frequently they consumed wild meat during the prior month. We define wild meat as any meat that is taken from animals captured in the wild. This includes insects, reptiles, fish, birds and mammals.

Recognizing the variation of wild meat hunting and availability throughout the year (Alexander et al., 2015; van Vliet & Nasi, 2008), participants were asked whether the rate of wild meat consumption changed or remained consistent throughout the year, whether they perceived other sources of protein to be available, and when such alternatives were available.

To explore participants' food choices, people freelisted the animals that they preferred to eat, and those that they

TABLE 1 Summary of village level wild meat consumption, perceived food security, and availability of alternatives to wild meat in four rural villages adjacent to the Dja Faunal Reserve, South-Eastern Cameroon

Village	Existing projects	Description	Wild meat consumption	Perceived food security	Availability of alternatives	Seasonality of alternatives
1	No wild meat alternatives projects	The closest village to the reserve (5 km) and the most remote of all villages. Most abundant forest with no current commercial drivers.	Weekly = 94.3% Monthly = 5.7%	Always = 14.5% Usually = 30.3% Rarely = 55.2%	Yes = 85.2% No = 14.8%	All year = 21.4% Seasonal = 78.6%
2	Community hunting zone in process of completion	On a main road linking market towns and adjacent to timber concessions and other villages. The most accessible of the villages. Commercial drivers of hunting evident but hunting is reportedly becoming less productive.	Weekly = 75.1% Monthly = 24.9%	Always = 36% Usually = 24.3% Rarely = 37% Never = 1%	Yes = 96.6% No = 3.4%	All year = 45.8% Seasonal = 54.2%
3	Involved in alternative project (wild fishing & cocoa)	70–80 km from Somalomo (see Figure 1), park enforcement and markets.	Weekly = 74.3% Monthly = 25.7%	Always = 9.7% Usually = 23.6% Rarely = 66.7%	Yes = 100%	All year = 14.7% Seasonal = 85.3%
4	Involved in alternative project (wild fishing & cocoa)	50–60 km from Somalomo (see Figure 1), park enforcement and markets.	Weekly = 72.1% Monthly = 27.9%	Always = 19.8% Usually = 21.2% Rarely = 56.7% Never = 2.3%	Yes = 98.9% No = 1.1%	All year = 9.6% Seasonal = 90.4%

Note: N households = 542.

did not like to eat. A ‘freelist’ interview entails listing things in a given category (e.g., ‘species you prefer to eat’ or ‘species you avoid eating’) in whatever order they come to mind. The species cited could be from any source (e.g., wild meat, fish, domestic animals, or bought from the market). The resulting lists reflect local preferences and its variation within, and between the study villages (Quinlan, 2005). The Smith S statistic was used to determine the salience of the species listed in the freelist data by combining both the number of people who mentioned the item and the order in which they mentioned it (Quinlan, 2005). This analytical approach rests on three assumptions: (1) people list in order of preference; (2) participants who prefer more items will list more items on

the list; and (3) items mentioned by more participants represent generally preferred items in the village. Frequently mentioned species indicate consensus, within the culture or community, while differences in list length and content reflect variation (Furlow, 2003).

For each species cited in the freelisting exercise, the research team used open-answer questions to ask why the participant did or did not like that particular species, to explore the drivers and barriers to eating wild meat and protein alternatives. Participants were asked the same questions as part of the interview, but the nature of the semi-structured interview is such that the interviewer can follow-up on additional or relevant information that the participant shares (Newing, 2011).

Household wealth was also hypothesized to be a key factor determining patterns of meat consumption (Wilkie & Godoy, 2001). To obtain a measure of household wealth, we first asked the village chiefs to identify key indicators of wealthy and poor households within their village (Supporting Information S1). These indicators were checked during discussions with both men and women in all villages. The key indicators of wealth identified were comparable to those used by Lau et al. (2018) to measure relative wealth in the same area, based on: the presence of household items (such as a mobile phone, mode of transport); the types of household structures (e.g., materials used for flooring and roofs); and the means to generate ongoing food security and income (e.g., ownership of a field). We also collected information on the stability and adequacy of income throughout the year. Scores for household items and income were combined to give each household a score from one to six, with 1 indicating that their household was one of the poorest and 6 indicating that it was one of the wealthiest.

2.3 | Data analysis

The food preferences freelist data were analyzed using the 'AnthroTools' package in R Studio. First, the two dimensions of salience (the frequency with which the same species appeared on each person's list, and how early or late on the list the species appeared) were plotted against each other to identify any outliers. Species salience was then plotted to identify any differences or groupings according to taxonomic order (e.g., carnivoran, rodent, ungulate). Only species mentioned by 10% or more of all respondents were further analyzed.

Sociodemographic, household, and village-level explanatory variables that may affect the importance of wild meat for peoples lives, and their meat preferences were selected a priori, based on the literature and the experiences of the research team (Supporting Information S2). A binomial generalized linear model was used to explore which sociodemographic variables best explain the frequency of participants' wild meat consumption (e.g., > weekly or < monthly). Multinomial logistic regression was then used where more than two dependent variables existed, such as to draw inferences about individual-level differences in species preferences, using the 'mlogit' package in R (Croissant, 2019).

Minimal adequate models were selected from the global model with the 'dredge' function using the MuMIn package for R Studio version 1.3.1073 (Barton, 2009), which searches all predictor combinations and selects models by comparing values of Akaike's information criterion (AICc or QAIC if $\hat{c} > 1$) (Barton, 2012). The top-ranked models were those

with $\Delta(Q)AICc < 2$ (MacKenzie et al., 2006). When there was more than one top-ranked model, we conducted model-averaging with the 'AICcmodavg' package for R (Burnham & Anderson, 2002). See Supporting Information S6 for the model selection tables.

Interviews were recorded and transcribed in French during the week in which the interviews took place, then translated into English. The drivers of wild meat preference and avoidance discussed in the interviews were coded in nVivo version 12 (QSR International Pty Ltd. 2018). We used an inductive approach, whereby codes were generated while examining the collected data. All statistical analysis was conducted using R Studio version 1.3.1073. All graphs were produced in ggplot2 package in R Statistical Package.

2.4 | Ethics

Before any research was carried out, the research team held village meetings where they explained the objectives and how the data would be used, and gained consent to carry out research. Free informed consent was verbally obtained by each participant prior to their interview, and the research team clarified that participants could withdraw their involvement at any time. To ensure personal anonymity, identification numbers were allocated to each interviewee. Village names are not shown on Figure 1 to ensure anonymity at the community level (St John et al., 2016). Participants were given a gift in return for their time. The gifts were selected to thank participants for the time they gave us, without causing rifts in the village or incentivizing people to take part if they did not want to. Further, such remuneration is important for offsetting the value of the time that households lost during the interview, which could have been spent in other food or income gaining activities. The research was approved by Oxford University's Central University Research Ethics Committee (CUREC) (R6337), and by IIED's Research Ethics Committee.

3 | RESULTS

3.1 | Participant characteristics

In total, we interviewed 542 participants from 177 households (Individuals interviewed per household: mean = 2.93; minimum = 1; maximum = 4; median = 3, Household size: mean = 5.05; minimum = 1; maximum = 11; median = 5) across four villages: 71 (village one); 90 (village two); 135 (village three), and 46 (village four). These interviews captured 80%–95% of the total population of each village. Half (51.3%) of participants

were male, 49.7% female and age-range were: 18–35 (53.1%); 36–55 (29.2%); and 56 years and older (17.7%). A total of 25 ethnicities were identified; 70.8% of participants were Badjoué, reflecting their majority in villages two, three, and four. Fang and Boulou, the most common ethnicities in village one to the south of the reserve, made up 5.4% and 5.9% of the total breakdown respectively. A further 5.1% of those interviewed were Baka; constituting 17.7%, 13.2%, 7.4%, and 3.1% of participants in villages one to four respectively.

Interviews revealed that 73.8% of participants identified agriculture as their primary livelihood activity, although activities such as hunting and fishing were regularly cited as additional important livelihood activities. Of those interviewed, 73.8% also stated that while they had income for part of the year, they were financially insecure during certain periods, because their cash crops (e.g., cocoa) do not produce all year round.

3.2 | Understanding the importance of wild meat as a local food source

Wild meat is an important source of food for people in all villages. Participants in all four villages consumed wild meat on either a weekly or monthly basis. Three-quarters of participants in villages two, three, and four (72.1%–75.1%), and nearly all participants (94.3%) in village one consumed wild meat on a weekly basis (Table 1).

People in all study villages reported that they do not always feel food secure. Villages one (34.8%) and two (60.3%) are home to the greatest number of people who felt that they were always, or usually, food secure. In contrast, only 9.7% of participants in village three reported always feeling food secure, and 66.7% reported that they were rarely food secure.

Regardless of their current involvement in wild meat alternative projects (see Table 1), all four villages reported the presence of alternatives to wild meat within their villages. These include locally produced eggs, locally produced and bought chicken and wild caught river fish, although overwhelmingly wild caught river fish was the most prominent option, and the only alternative cited in all four villages. The greatest proportion of people felt that alternatives were not available to them in village one (14.8%). Alternatives were deemed present all year round by 45.8% of participants in village two (the most accessible village), while 85.3%–90.4% of participants in villages three and four reported that alternatives were only seasonally available.

We fitted a logistic model to explore the factors that influence the frequency of wild meat consumption. The averaged top model included age, gender, village and

TABLE 2 Factors affecting the frequency of wild meat consumption in rural Cameroon (2019), from the averaged generalized linear model with a $\Delta AICc < 2$

Predictors	Frequency of consumption	
	Odds ratios	CI
(Intercept)	22.47***	5.34–94.59
Age_Group 36–55	0.46**	0.28–0.77
Age_Group [56+]	0.19***	0.11–0.34
Gender [male]	2.54***	1.62–4.01
Village [two]	0.19**	0.06–0.57
Village [three]	0.16***	0.05–0.47
Village [four]	0.19**	0.06–0.57
Primary_livelihood [farming]	0.70	0.18–2.67
Primary_livelihood [fishing]	0.21	0.04–1.15
Primary_livelihood [other]	1.01	0.23–4.35
Observations	542	

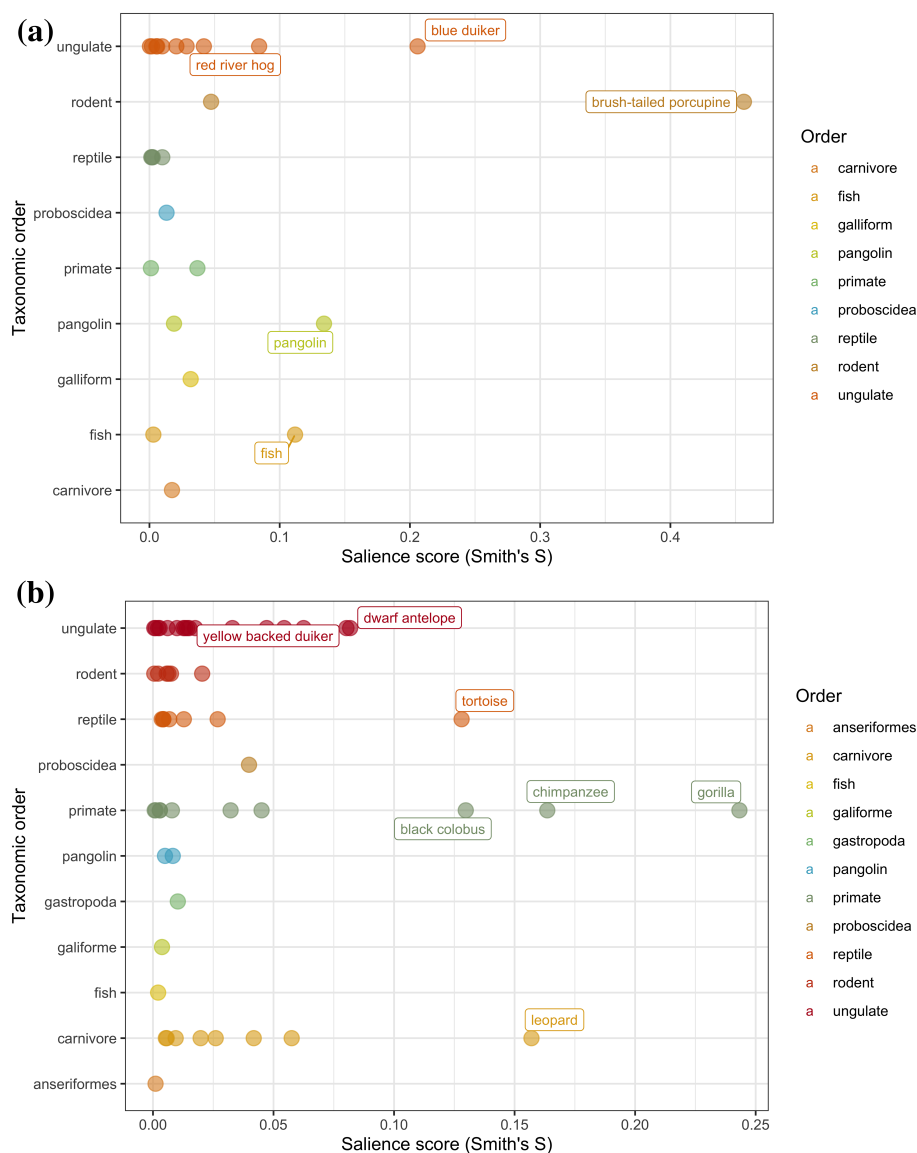
Note: Dependent variable is frequency that wildmeat is consumed (0 = weekly or more, 1 = monthly or less). Intercept: Age = 18–25, gender = female, livelihood = hunting, village = one. ** $p < .01$, *** $p < .001$.

primary livelihood, while respondent ethnicity and household wealth were not included. The model shows that participants aged 36–55 and 56 years and older were less likely than younger participants (aged 16–35) to eat wild meat on a weekly basis. Men were 2.54 times more likely than women to eat wild meat more regularly. People in village two to four were significantly less likely to eat meat as regularly as people in village one (Table 2). Farmers, and in particular fishermen were less likely to consume wild meat more regularly than hunters. For the effects plots, see Supporting Information S3.

3.3 | Species preference and avoidance

Salience analysis showed that 23 preferred species or species groups were listed across all villages, of which four (brush-tailed porcupine (*Atherurus africanus*), blue duiker (*Philantomba monticola*), fish and tree pangolin (*Phataginus tricuspidis*)) were cited by >10% of interviewees. Across all villages, wild species of mammal and reptiles hunted for meat were more salient than domestic mammals or wild-caught fish. The most popular species were brush-tailed porcupine and blue duiker, followed by pangolin. Fish was the most popular non-wild meat option in all villages, above any domestic animal, ranking just below pangolin (Figure 2a). For the frequency of citing in the freelist versus average ranking of the species in the freelist, see Supporting Information S4.

FIGURE 2 The saliency of preferred (a) and avoided (b) species, grouped by species order. Species with a higher Smith S score are most salient (e.g., cited frequently and prioritized regularly). Species cited by >10% of the those interviewed are labeled



Fifty-five species were cited as 'avoided,' of which seven were cited by >10% of those interviewed. Across all villages, primates (predominantly great apes) and carnivorous species were most avoided, followed by reptiles. Of the avoided species, gorilla (*Gorilla gorilla*) and leopard (*Panthera pardus*) were most salient, followed by chimpanzee (*Pan troglodytes*), tortoise, and black colobus (*Colobus satanas*). Carnivorous and ungulate species clustered around similar saliencies, while primate species saliencies were more spread out. Leopards were a clear outlier among carnivorous species, being particularly avoided (Figure 2b).

Breaking saliency down by village, leopard was almost solely cited by participants from village one, while black colobus monkeys were frequently cited in villages three and four (Supporting Information S5a). People commonly avoided gorilla, chimpanzee and yellow-backed duiker (*Cephalophus silvicultor*) in all villages, whereas Bates' Pygmy Antelope (*Neotragus batesi*), commonly referred to

as dwarf antelope, were only avoided in villages three and four (Supporting Information S5b).

3.4 | Drivers of species preference and avoidance

We then wanted to know why people avoided or preferred species (Figure 2). Taste, ease of access, and perceived health benefits of certain meats were key drivers of species preference, while taste, perceived health concerns, tradition and in some cases, appearance, were key reasons for species avoidance. The reasons for species preference and avoidance were relatively consistent across all species, although species-level differences in the importance of each reason were clear (Figure 3).

People liked brush-tailed porcupine and pangolin predominantly for their taste:

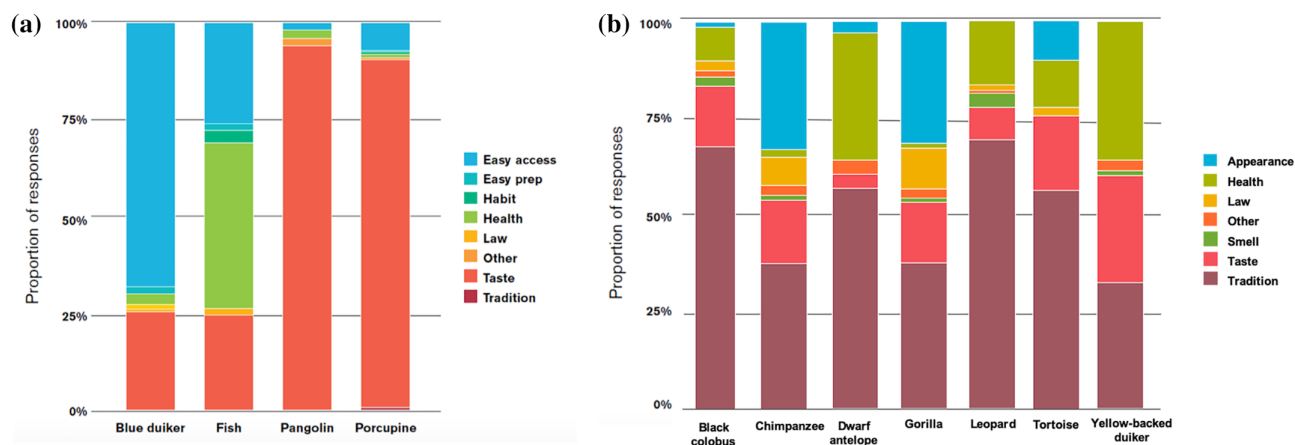


FIGURE 3 The reasons cited for (a) preferring or (b) avoiding each species, shown for species cited by >10% of participants

I love the taste of pangolin, all the others I eat because they are there.

Porcupine tastes good and is easy to catch. Pangolin is tasty but is less easy to hunt. Hog is easy during certain seasons; I love its taste and the fat.

Fish was primarily preferred for its perceived health benefits, which was also mentioned as a reason for preferring porcupine, blue duiker, and pangolin. These 'white meat' species were perceived as lighter on the stomach and as such considered to be 'better for the gut' than other darker meats. Older participants also cited preferring fish, pangolin and porcupine because they are soft meats and therefore easier to eat when they have dental problems:

I like pangolin and porcupine because of their taste, and fish is very good because it doesn't give worms.

I like pangolin and porcupine because they are soft, good for my teeth.

When I eat fish, I feel well. The other meat give worms.

White flesh of fish causes less issues in the body than bushmeat. If I could, I would not eat bushmeat again because of health problems that it causes.

Respondents preferred blue duiker, suggesting that food sources that require less effort to hunt are desirable. Fish were also considered to be easy to access by 25.2% of respondents, however with seasonal variation:

Blue duiker and Peters's duiker are easy to hunt.

I eat blue duiker a lot because that's what gets hunted a lot around here.

Although not a major driver of wild meat preference, tradition was cited by at least 25% of respondents as a reason for avoiding a given species, and was the main reason for black colobus, leopard, tortoise and dwarf antelope avoidance (Figure 3b). Black colobus and leopard were viewed as totem species and as such should not be eaten:

Tradition says that the colobus is our totem, it's an important animal for us, like the leopard too.

I'm not meant to eat it, I'm a twin so my father told me never to eat leopard.

Leopard gives women spots if we eat it. Also, my parents always told me not to eat it... it's just not in our tradition to eat it.

Leopard and colobus are totems of the forest and traditionally we don't eat them as our parents told us not to.

We do not eat le magistrat (black colobus), and sometimes gorilla and elephant are a totem.

Fang men and women can't eat leopard, it's our totem.

I don't eat leopard because its forbidden for women from Nzimé culture to eat carnivores.

Another aspect to tradition was that respondents' parents had not taught them not to eat certain species because they were reserved for older generations, or because ancestors are believed to transform into these species:

Gorilla meat is reserved for older people.

In our Baka family, grand-parents transform into gorilla, chimpanzee, or leopard after they are dead.

People consistently cited taste as a reason for avoiding species (Figure 3b), particularly large duiker and antelope species:

Sitatunga don't have a good taste; yellow-back duiker gives people epilepsy and tastes bad.

Yellow-back duiker has a bad, strong taste.

People also avoid eating ungulate species such as dwarf antelope and yellow-backed duiker due to health concerns. Almost all those who cited dwarf antelope agreed the species can give you epilepsy and has lethal effects on small and unborn children, if eaten while pregnant:

Dwarf antelope gives you epilepsy.

Tradition forbids us to eat white bellied duiker and black colobus. When you eat it, your child dies. When you eat dwarf antelope, your child get epilepsy.

White bellied duiker is forbidden to those who give birth. Dwarf antelope gives epilepsy to children.

Tradition forbids those giving birth to eat dwarf antelope, black colobus, de Brazza monkey, or white bellied duiker. It gives epilepsy.

Dwarf antelope, black colobus, de Brazza monkey, yellow blacked duiker are unadvised to eat for people who still bear children.

More than 25% of people reported avoiding gorilla and chimpanzee due to their off-putting appearance (Figure 3). In all villages, participants frequently shared that gorilla and chimpanzees looked too much like humans, and that the appearance of tortoise was off-putting:

Yellow-backed duiker gives me pain in the lower abdomen, and turtle meat disgusts me. Gorilla and chimpanzee look like a human in a pot- how can I like something that looks like a human? I don't also like their taste.

Please see Supporting Information S6, for the original, untranslated transcripts.

3.5 | Village and individual-level differences in the drivers of species preference and avoidance

The results of the multinomial logistic regression model selection showed no significant individual or village-level differences in wild meat preference, or in the reasons for such preference. However, it did reveal significant village-level differences in the reasons for avoidance (see Supporting Information S7). Respondents in village three were more likely than those in other villages to cite the existence of the law or fear of penalties as a reason to avoid species, possibly reflecting their relative proximity to a base for park rangers and the Ministry of Forests and Fauna (MINFOF) staff, and possibly their involvement in education and awareness activities linked to wild meat alternative projects in their village. Respondents in village one were more likely to cite tradition, a bad taste and health concerns as key barriers compared to law, and more likely to cite these barriers than those in other villages (Figure 4a).

The reasons cited for species preference did not vary significantly between sociodemographic groups (e.g., age, gender, ethnicity or livelihood) or by household wealth. But again, the reasons cited for species avoidance did vary by age and gender: men were significantly less likely than women to cite lack of access as a reason for avoiding a particular species but were more likely to cite health concerns and the legal protection status of the species. Participants aged 36–55 were more likely to cite religious reasons for avoidance than both younger (16–25) and older (56+) participants (Figure 4b).

The reasons cited for avoiding particular species also varied between villages. In village three, 23.2% and 22.4% of participants avoiding gorilla and chimpanzee respectively due to concerns over the law, while in village one the law was not mentioned as a barrier to consumption. All participants in village one avoided black colobus due to tradition, while people in villages three and four also mentioned health and taste concerns. Tradition was the key barrier to dwarf antelope consumption in village four, although health was a greater concern in village three. Health and taste were the primary concerns regarding yellow-backed duiker consumption in villages one and two, while tradition was the dominant barrier in village four (see Supporting Information S9).

4 | DISCUSSION

We found differences in both perceived food security, and in the frequency of wild meat consumption between villages. Participants in village one consume wild meat

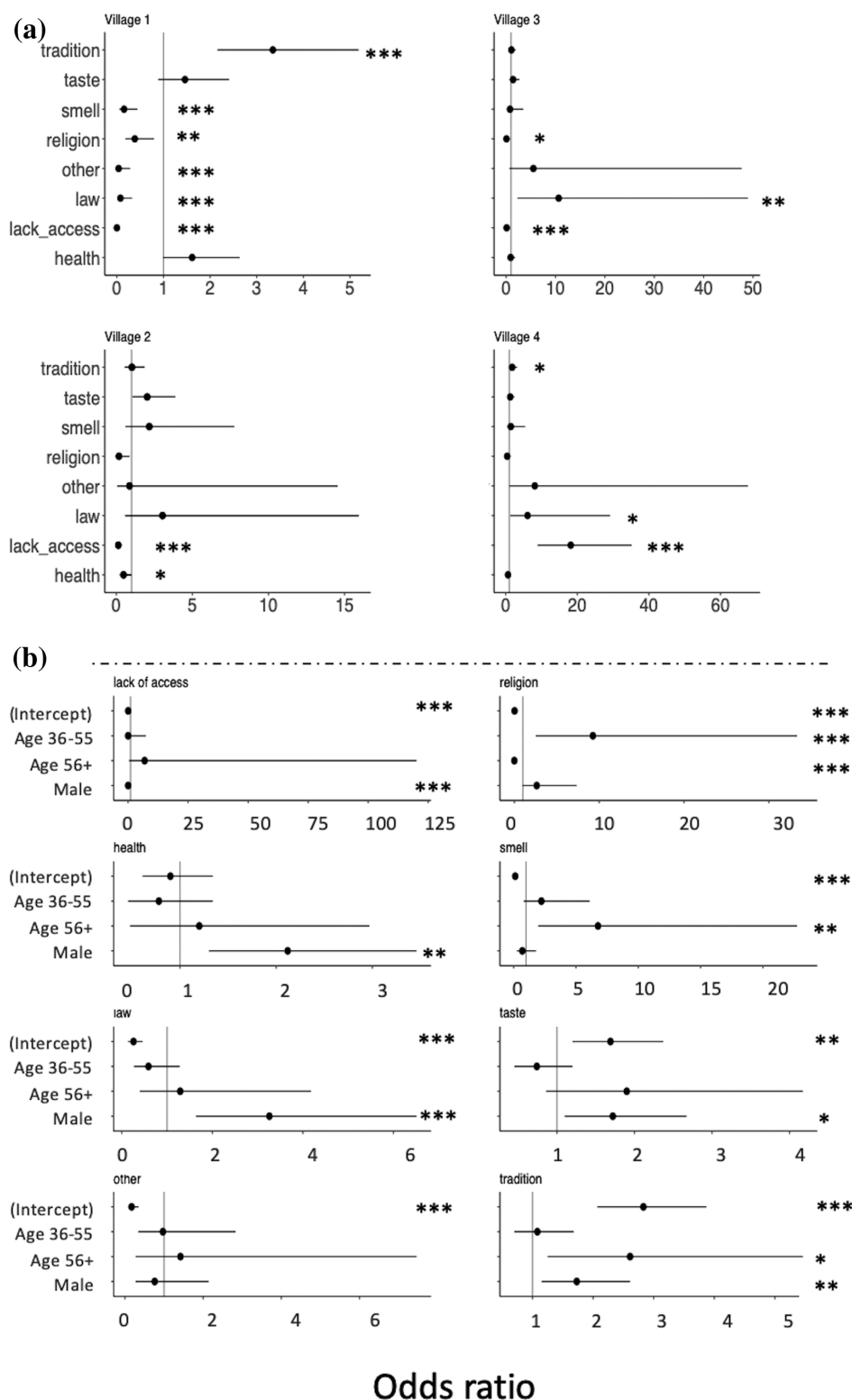


FIGURE 4 The odds estimates from (a) the averaged multinomial logistic regression model assessing village-level differences in the reasons for avoiding species (intercept: reason = law) and (b) the best fit multinomial logistic regression model, assessing sociodemographic factors associated with the reasons provided for avoiding species across all villages (intercept: age = 18 = 25, gender = male). Solid vertical lines indicate the baseline, dots to the right indicate greater odds that a reason is given, and dots to the left indicate reduced odds compared to the baseline. Asterisks (*) to the right of each figure indicate statistically significant factors in the model (* $p < .05$, ** $p < .005$, *** $p < .001$) calculated with Wald tests

more regularly than the other villages, possibly due to the lack of existing alternatives, and the villages remote location and proximity to the reserve and surrounding intact forest (see Table 1). Project implementers must consider the external drivers and pressures that may result in village-level variation in perceived food security

and wild meat consumption, such as the development of wild meat markets (Brashares et al., 2011; Ling & Milner-Gulland, 2006), access to infrastructure (Franzen, 2006), proximity to reserves (Fa et al., 2006; McNamara et al., 2015), and level of law enforcement. Further, the availability of wild meat in the surrounding forests may

influence wild meat consumption (see Foerster et al., 2012; Luiselli et al., 2017; Mgawe et al., 2012; Mwakatobe et al., 2012). Due to this heterogeneity, the perceived willingness or need of communities to participate in a wild meat alternatives project may also differ; villages may or may not regularly experience challenges with their food security or find the consumption of wild meat undesirable, for example. As such, it is unlikely that the same alternatives project would work in multiple locations, even across a single landscape.

Existing alternatives were reportedly available only seasonally in all four villages, despite the presence of alternatives projects in villages three and four. A cost-effective design solution for project designers could therefore be to fill the seasonal gaps of currently available alternatives, rather than aiming to provide an alternative all year round. Then, project resources could focus on ensuring a sustainable and steady supply of alternatives to fill gaps when existing alternatives are not widely available, during the lean agricultural seasons, when hunting may increase to account for a decline in food and income availability, or to provide an alternative when hunting patterns increase in response to prey characteristics (Alexander et al., 2015; Borgerson, 2016; Coad et al., 2010; van Vliet & Nasi, 2008).

4.1 | Species preference and drivers of consumption

In this study, people across all villages preferred wild over farmed species, including wild meat and fish. The preferred species were also consistent across villages. Of the wild meat species cited, people prefer to eat blue duiker and porcupine, which are generally abundant, resilient to overhunting and of least conservation concern (Bruce et al., 2017). This is not a surprise as consumption has been found to be driven predominantly by availability and preferences may change as availability changes (Fa & Gracia Yuste, 2001; Kümpel, 2006; Ndibalema & Songorwa, 2008). Studies in the north-west Lebalele division of rural Cameroon found that species that were most available and abundant, such as porcupine, guenon and blue duiker, all ranked highly according to taste (Wright & Priston, 2010), while a more recent study in Brazil found that species that are more abundant and appreciated for their taste are more likely to be hunted than other species (Chaves et al., 2020). Further, a study of the importance and preferences of wildmeat in Baka communities in Cameroon also found that small mammals such as porcupine, blue duiker and tree pangolin were most preferred due to taste (Duda et al., 2018).

Across all villages, an exception to the finding that generally abundant and resilient species are preferred, was respondents' love of the two small pangolin species (white and black bellied pangolin). Both pangolin species are 'Class A' protected species in Cameroon, with white-bellied pangolin also categorized as Endangered on the IUCN Red List. Pangolins are the world's most traded wild mammal species, commonly hunted for their meat and scales (Challender & MacMillan, 2014; Ingram et al., 2018), and are also a preferred species for consumption in urban areas of Cameroon (Nguyen et al., 2021). The interviews revealed a taste preference for these species in all villages, and a reluctance to stop hunting them. Finding ways to incentivize consumers away from this species may be a significant, although not insurmountable, challenge given the strong taste preference and added potential benefit of value from trading the scales.

Taste was the primary driver of wild meat preference in all four villages, with availability and perceived health benefits as secondary drivers. While taste has been found to be a significant factor in the consumption of wild meat in urban contexts, much of the literature in rural settings primarily links wild meat demand to availability and affordability (e.g., Kiffner et al., 2015; Mwakatobe et al., 2012; Nguyen et al., 2021; Schenck et al., 2006) with few studies explicitly assessing the link between preference and taste (although see Spira et al., 2019; Duda et al., 2018). Our findings provide evidence that taste is an important primary driver of wild meat consumption for certain species in rural areas, with important implications for the design of future alternative projects. When designing wild meat alternatives projects, greater attention needs to be paid to exploring the importance of taste, as well as other cultural drivers, and selecting alternatives which are as tasty as the preferred wild meat species.

Perceived health benefits were also a driver of consumption. Fish in particular, but also pangolin and porcupine, were deemed by some as healthy meats (Figure 3a), supporting previous studies in Equatorial Guinea which found that consumers' top three most preferred foods were fresh fish or wild meat species (i.e., red snapper, porcupine, and blue duiker), and wild meat was regarded as a healthier, more nutritious food choice than frozen domestic meat options (Chausson et al., 2019; East et al., 2005; Kümpel, 2006; Kümpel et al., 2010). Another study also found that wild meat is preferred over domestic meat for reasons including taste, health benefits, habit, ease, price and culture (Abernethy & Ndong Obiang, 2010). Because fish is also preferred, alternative projects offering fish might be viable in our study area.

4.2 | Species avoidance and barriers to consumption

Societal preferences influence food taboos, which in turn may affect demand for certain species (Jones et al., 2008). In our study, traditions played a particularly important role in the species avoided. For example, respondents in all villages commonly cited being put off by the appearance of great apes. In their study in North-West Cameroon, Wright and Priston (2010) also found that gorilla and chimpanzee were absent from lists of preferred species. The authors found that traditional beliefs that humans transform into chimpanzees and gorillas appeared to influence hunting habits, stating “the risk of accidentally murdering a person in disguise, and the subsequent ill fates this may bring, sufficiently deterred many individuals from hunting apes” (Etiendem et al., 2011). Further, studies from Madagascar describe how taboos led to less consumption of wild meat (Jenkins et al., 2011; Reuter et al., 2016). One of these found a clear negative relationship between taste preference and taboos (Jenkins et al., 2011).

Belief in totem species differed significantly between villages but transcended ethnicity, in that ethnicity was not significantly linked to the preference or avoidance of particular species. Village-level differences in totem species may reflect local traditional beliefs (Ceppi & Nielsen, 2014; Mavah et al., 2018; McNamara et al., 2016). In the north of Cameroon, eating wild cats is believed to make the consumer more agile and offer protection from death by motor car accidents (Njiforti, 1996). However, we found the opposite; leopard was a totem species in village one and as such was cited as an avoided species by everyone interviewed. It may be that village-level differences in taboos reflect the already-present variation in species abundance between the four villages; taboos exist to protect certain species where that species is present, and taboos do not exist where they are not present.

Informal institutions such as taboos may be the only effective way to regulate wild meat consumption, especially where capacity to enforce external conservation rules is limited (Jones et al., 2008). In our study area, taboos differed between ethnicities, although these differences did not have a significant effect on wild meat choice or avoidance. The factors that affect adherence to taboos are complex (Golden & Comaroff, 2015). For example, while presented as reasons for avoiding the consumption of species, several participants said that remedies exist to counteract the spiritual bad effects of eating certain species, which suggests that these taboos could degrade over time. As such, species currently cited as avoided may not be avoided far into the future, as other preferred species become harder to hunt (e.g., pangolin),

and wild meat options reduce, which we may expect to see happen in village two in the not-too-distant future. We do not suggest the creation of taboos for conservation gain, which is both culturally problematic and practically complicated. Additional research is also needed to know whether people in these villages still hunt the species cited as avoided for traditional reasons, but for trade rather than consumption (cf Duonamou et al., 2020).

Financial factors were not mentioned as a reason for consuming or avoiding wild meat, contradicting many studies and the common narrative in studies of wild meat, that affordability is the main reason why rural households consume wild meat (Kiffner et al., 2015; Merson et al., 2019). Poverty is often seen as the key driver of hunting, however multidimensional and complex relationships between poverty and hunting are likely to exist which are not always accounted for (Harrison et al., 2015). Studies of urban wild meat consumers and traders in Cameroon show that those from middle-upper income brackets demand wild meat as a sign of wealth and to meet luxury and social status-seeking desires, while those from lower economic classes rely on wild meat (often of different species) to buffer their food security needs (Nguyen et al., 2021; Randolph, 2016). It is also possible that the variation in wealth between households was insufficient within these villages to detect significant effects of wealth on consumption and preferences, or that the study area was not wealthy enough for people to have the ability to make these choices. It may also be that financial factors are masked by the accessibility of wild meat to some extent, given that many households can likely hunt for themselves without having to purchase wild meat. However, that wealth is not a primary factor determining wild meat consumption may be supported by the overall preference for easily accessible, non-protected species across all villages (e.g., porcupine and blue duiker).

4.3 | Future project options

Fish are a preferred alternative to wild meat in the study villages. While alternative projects exist that encourage fishing in these villages, they are not currently ticking all the boxes because they are supporting fishing from the river, which is a seasonal, and largely male orientated activity. Additionally, chicken was another alternative to wild meat that people regularly cited as enjoying, although not as much as fish. Future research could seek to assess the possible impacts that alternative projects may have on the rate of wild meat hunting and consumption in these villages, as well as the sustainability of fishing wild fish to substitute wild meat consumption.

4.4 | Consumption in rural areas

Although frequently conflated, the drivers of hunting and consumption differ (Harrison et al., 2015; van Velden et al., 2020). In this study, we focused solely on the consumption of wild meat in rural areas. This is an overlooked focus, with many studies tending to look at hunting and trade. Yet many wild meat alternative projects focus on consumption, and the lack of understanding of its drivers means that these projects can be based on flawed assumptions. This represents a potentially massive waste of financial resources. In their review of livelihood alternative projects, Wicander and Coad (2018) estimated that the livelihoods projects included in their review amounted to \$2.2 million a year, none of which had demonstrated whether they had a conservation impact or not. We expect that the situation is much the same for wildmeat alternative projects, although this has yet to be quantified. If so, this is a failure both for the biodiversity these projects are meant to safeguard, and for the people who expect their livelihoods and food security to improve as a result of participation in these initiatives. We must better consider rural people's often-ignored needs and preferences, if we are to design acceptable alternatives that achieve both social and conservation goals.

This study provides a rare example of an explicit assessment of the drivers of wild meat preference and consumption, in four rural villages around the Dja Faunal Reserve. That taste and health are primary drivers of preference in rural settings, rather than viewing wild meat as simply available, goes against the standard wisdom in the currently limited literature focussed on the drivers of wild meat consumption in rural areas. As such, wild meat consumption in rural areas is not just about material wellbeing. Rather, intangible components exist that, if not accounted for in alternatives project design, could result in a failure to achieve the intended conservation and social outcomes.

Given the renewed focus on the health and conservation implications of wild meat consumption following Covid-19, we expect the number of wild meat alternative projects to increase. Our findings could help guide projects aimed at reducing demand for wild meat in the Dja area, and our approach could inform the baseline data collection for wild meat alternative projects more widely. We urge conservation practitioners developing wild meat alternative projects to consider the diverse, and often context specific, drivers of wild meat consumption in the planning stages of project design (Brittain et al., 2020). Designers should aim to recognize and account for the heterogeneity of preferences and drivers even within communities, let alone at a landscape level (cf van

Velden et al., 2020). We advise conservation policy makers to support and promote the use of participatory, and rights-based approaches to understanding the drivers of consumption, the species consumed locally, and the challenges people face in shifting to other foodstuffs, to help ensure that projects reach both their conservation and social objectives.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to report.

AUTHOR CONTRIBUTIONS

All authors contributed to conceiving the research idea. Stephanie Brittain designed study design with input from all authors. Cedric Thibaut Kamogne Tagne, Soreya Djibrila Ngomna Tsabong, Salihou Mfone Nteroupe, and Stephanie Brittain collected data and prepared data for analysis. Stephanie Brittain and Cedric Thibaut Kamogne Tagne carried out analysis. Stephanie Brittain led on writing the manuscript, with input and feedback from all authors.

DATA AVAILABILITY STATEMENT

Anonymized data may be made available upon request from the lead author, Stephanie Brittain (stephanie.brittain@zoo.ox.ac.uk).

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