

## RESEARCH ARTICLE

## Achieving Sustainable and Equitable Consumption of Wild Meat

# Bushmeat consumption frequency and preferences among rural households in a West African savanna landscape: Implications for food security and conservation

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**Abstract**

1. The drivers of consumer demand for bushmeat are relatively well studied in tropical forest systems, but much less so in savanna areas. This is important because differing ecological and socio-economic conditions lead to different factors affecting the relationship between local communities and their natural resources.
2. Northern Ghana is an understudied savanna area, with a recognized cross-border and long-distant bushmeat trade. Understanding the role of bushmeat in diets is crucial for food security and conservation policies in the region.
3. We surveyed 471 households in two villages in the Upper East region of Ghana, using questionnaires and focus groups, to examine consumer preferences for bushmeat and the socio-economic factors influencing its consumption.
4. Fourteen bushmeat species were identified as preferred and/or consumed, with the grey duiker (*Sylvicapra grimmia*) and African savanna hare (*Lepus victoriae*) being the most preferred, although preferences differed by village. The prevalence of smaller, resilient species in preference suggests a depletion of the larger bodied mammals typically found in pristine savanna ecosystems.
5. Bushmeat preference was higher in larger, male-headed households, those engaged in hunting and in Doninga village, where bushmeat and fish were equally preferred. While bushmeat was mainly preferred for its taste, it was eaten irregularly because of availability and affordability. Domestic meat followed a similar pattern, although Kayoro villagers ate it more often. These village-level differences may relate to differences in access to slightly more wildlife-rich Protected Areas.
6. Smoked fish was the most preferred protein source, with respondents indicating that small quantities of it can be bought if money is tight, suggesting food insecurity limits access to animal protein.
7. Our findings depict a landscape of depleted wildlife resources and constrained access to animal protein, where bushmeat is sold rather than consumed locally.

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Policy efforts should prioritize improving access to affordable, sustainable protein sources like fish, to support food security. Better understanding is needed of the ecological impacts of local bushmeat consumption and its role in livelihoods and food security. This could support the design of conservation and development interventions in this resource-poor area, for a more sustainable and equitable use of natural resources.

#### KEYWORDS

bushmeat consumption, food security, Ghana, household surveys, importance of bushmeat, wildlife conservation

## 1 | INTRODUCTION

Bushmeat (meat hunted from wild animals) is valued and eaten by a wide range of people in many areas of Africa. Harvesting and consumption of wild animals is however, recognized as a significant threat to biodiversity (Ripple et al., 2016); with demand for bushmeat in urban areas playing a major role in driving bushmeat hunting and trade (McNamara et al., 2019). For many people in urban centres far from sources of wildlife, who typically have a choice of alternative sources of animal protein, bushmeat can represent a luxury dietary item and be more expensive than alternatives (Cawthorn & Hoffman, 2015; Cowlshaw et al., 2005). In contrast, rural consumers may have few or no alternatives to bushmeat (van Vliet et al., 2014; Wilkie et al., 2016). For this reason, there is concern over the potential threat of wildlife depletion caused by overhunting on the food and livelihood security of rural people (Nasi et al., 2011).

Previous studies have shown that people eat bushmeat for various reasons, including taste preferences, cultural factors, price and availability (Nguyen et al., 2021; Schenck et al., 2006; van Vliet & Mbazza, 2011) as well as demographic factors such as ethnicity, household wealth, household size and livestock ownership (Albrechtsen et al., 2007; Ceppi & Nielsen, 2014; East et al., 2005; Fa et al., 2009). These factors vary between areas, and in turn influence the frequency and level of bushmeat consumption. This diversity of factors affecting bushmeat hunting and consumption means it is essential to examine the local context in each case. Without understanding the underlying motivations for bushmeat use in the area where an intervention is planned, it will not be possible to design a project that resonates with local people (Brittain, 2021).

Bushmeat is also recognized as an important economic and nutritional safety net, providing access to animal protein when alternatives are either not available or when household incomes are low, such as during the seasonal lean period when agricultural production is low (Schulte-Herbrüggen et al., 2013, 2017). As such, understanding the role and contribution of bushmeat in household diets is essential for identifying potential food security issues, particularly in rural settings (Cawthorn & Hoffman, 2015). In particular, there may be equity issues if some communities or individuals have access to the benefits of bushmeat as a source of income and nutrition, while others do not (Allebone-Webb, 2009).

The majority of studies on the use of, and reliance on, bushmeat in Ghana have focused on the humid south of the country (e.g. Alexander et al., 2015; Crookes et al., 2007; McNamara et al., 2016; Schulte-Herbrüggen et al., 2013), with limited reference to the dry northern territories, which are quite different socioeconomically and culturally. In one of the few previous studies, Ntiama-Baidu (1998) found that bushmeat played a valuable part in the local diet in some communities in the northern savanna zone. But virtually no comprehensive work has been done since this period, and the lack of current information on the importance of bushmeat in diets and factors driving consumption in this region represents a notable gap in current knowledge.

In this study, we address this knowledge gap using household surveys to provide insights into the importance of bushmeat in the diets of rural households in two villages in northern Ghana. This information is a critical foundation for any future conservation, demand management or food security interventions in the region. Our objectives were to: (1) Understand which bushmeat species are eaten, and their conservation status, in order to highlight species at risk of unsustainable hunting; (2) Examine the frequency of bushmeat and domestic meat consumption among households, in order to understand potential equity and nutritional issues around access to animal protein; and (3) Understand meat preferences of households, and highlight any equity and access concerns arising from the reasons for these preferences. By linking meat preferences, animal protein consumption levels and species being consumed, we highlight potential issues facing communities and wildlife. We then suggest policy interventions that could lead to more equitable and sustainable relationships between local people and wildlife in the study area.

## 2 | METHODS

### 2.1 | Study area

The study was carried out in Ghana's savanna zone, in the Upper East region. The natural vegetation of the area is characterized by open savanna interspersed with grasslands that separate fire- and drought-resistant trees of varying sizes and densities such as the

shea nut *Vitellaria paradoxa* and baobab *Adansonia digitata* (Ghana Statistical Service, 2013). However, anthropogenic activities, such as farming, bushfires and charcoal burning, have significantly impacted the woodlands and led to degradation of the area's natural vegetation cover (Ghana Statistical Service, 2013). The study area experiences two climatic seasons of nearly equal durations; a rainy season which typically extends from May to October, and a dry season lasting from November to April.

Compared to other parts of the country, food insecurity is severe in northern Ghana (Nkegbe et al., 2017). This region has one of the highest poverty incidences in the country, with rural livelihoods mainly reliant on agriculture which provides the primary source of food for the region (Ghana Statistical Service, 2013, 2018). A diverse range of crops, including millet and maize, are cultivated in the study area, while livestock and poultry rearing are also widespread practices. Hunting is practiced by men as an additional occupation, combined with crop farming (Aalangdong, 2010; Sackey, 2020). Hunting activities peak during the dry season, when other food supplies are limited. Some fishing is practiced in local swamps.

## 2.2 | Study site selection

Our study focuses on two villages, Kayoro and Doninga in the Kasena Nankana west and Builsa south districts, respectively.

Together, the two districts contain 230 communities of varied sizes (Ghana Statistical Service, 2014a; Kasena Nankana West District Assembly, 2018). Prior to the main data collection, pilot surveys were carried out in 11 of the largest communities that have area councils (out of 16 town/area councils by political division) to familiarize us with the area, test questionnaires and build rapport with the people. Following the pilot, Kayoro and Doninga were selected for the main surveys. The decision to select these two villages was based on consultation with five key informants during the pilot surveys. The key informants were local people with whom Hannah Sackey (first author) had established a trusting and friendly relationship over the course of fieldwork carried out as part of a parallel research work. The key informants included opinion leaders and individuals who were knowledgeable about the study topic and villages, and provided useful feedback throughout the fieldwork (Newing et al., 2010). These key informant discussions, coupled with the results of pilot questionnaires conducted as part of the pilot surveys, identified Kayoro and Doninga as important hunter villages and source locations supplying bushmeat to the major markets such as Sandema, Fumbisi and Chiana, with good market integration. The villages have different characteristics, ethnic backgrounds and geographical locations that could lead to different relationships between wildlife and people, which enabled interesting comparisons to be made. Further, the two villages were easily accessible by road and the villagers were willing for the research to be carried out in their communities.

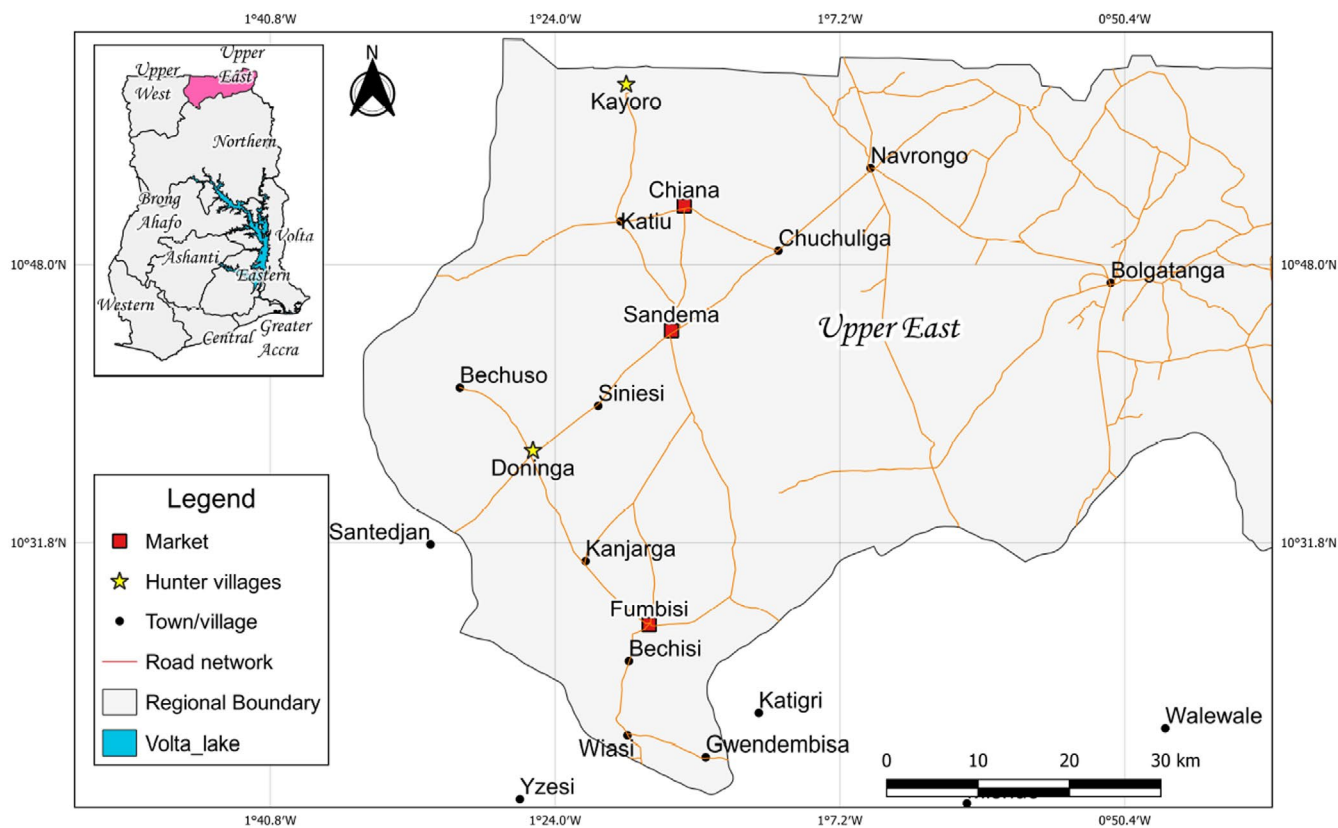


FIGURE 1 Map of the study area and location of the two villages sampled (Doninga and Kayoro).

Kayoro is a remote village with a population of about 5271 people (Ghana Statistical Service, 2014b; Figure 1), located 23 km north of Chiana along the Ghana-Burkina Faso border. Doninga is a community of about 2914 people, situated between Sandema and Fumbisi, approximately 20 km and 24 km from each, respectively (Figure 1). While the immediate surroundings of each village were relatively similar, being largely open savanna habitats, Kayoro benefited from moderately closed tree cover to the north due to its proximity to the Nazinga Game Ranch in southern Burkina Faso. This may have affected the availability and consumption of bushmeat, with implications for conservation and food security, as wildlife populations were comparatively high in Nazinga (Sackey et al., 2022). The inhabitants of Kayoro belong to the Kassena ethnic group and those in Doninga are Builsas. Traditionally, villagers have unrestricted access to natural resources across communal lands, except in areas designated as sacred by customary or state institutions (Ghana Local Government Bulletin, 2016).

### 2.3 | Data collection

From April to July 2019, a six-member team, which included HNKS, a field assistant and four trained local assistants collected the data. Using a structured survey approach, the team conducted 471 household interviews. Survey questions were informed by focus group discussions and key informant interviews. Focus group discussions were held to introduce the team to the community and gather general information on village life. Informal conversations with key informants further informed the main survey's focus. The selection of both focus group participants and key informants focused on individuals who were well placed to provide information pertinent to this study, and included hunters, opinion leaders and senior members of the community.

The focus group discussions involved a small number of individuals, usually 7–14 people (Newing et al., 2010). Four focus groups were held in total, two in each village; one consisting of men and the other consisting of women. This gender separation was culturally appropriate to reduce the likelihood that men would dominate the discussion in mixed groups, and also because men and women might have different gender roles (Brown & Marks, 2007; Willis Key et al., 2025). Questions focused on a village's main livelihood activities, seasonality of livelihood activities such as farming, patterns of their agricultural calendar (e.g. when the planting seasons and associated harvest were and what time of the year was associated with the lean hunting season) and a general discussion about bushmeat hunting, trade and meat consumption. In the male focus groups which included hunters, involvement in hunting and bushmeat trade was also discussed. Information gathered from the focus group discussions helped to inform the more detailed one-on-one surveys carried out with households.

The household interviews (275 in Kayoro and 196 in Doninga) were carried out with heads of households using structured questionnaires (Appendix S1). In a few cases where the household head

agreed his wife was best placed to answer questions on household consumption; the interview was carried out with the wife. The sample size was determined using a power calculation based on household size estimates and population data from the 2010 census (Ghana Statistical Service, 2014a, 2014b). The survey collected comprehensive data on household demographics, livelihood activities and patterns of animal protein consumption, with a particular emphasis on bushmeat.

Specific questions addressed rural livelihoods, sources and frequency of animal protein intake, and preferences for bushmeat species. Respondents were first asked whether their household preferred bushmeat or domestic animal meat. Respondents provided details on preferred species or types for the preferred meat type. The frequency of consumption was recorded using categories: daily, weekly, monthly, occasionally (for special occasions and ceremonies) and rarely (once every 6 months).

Based on their household choices, participants were then asked to rank preferences across various meat types, including bushmeat, beef, goat/sheep, poultry, pork and fish. Data were also gathered on household composition, primary income sources, involvement in hunting activities, and income and wealth indicators, such as house type and roof materials.

Data were not collected at the individual level on preferences for and consumption of bushmeat. Nor was data collected on religious or cultural beliefs of the household. Thus, results represent household-level data only. This approach aimed to capture a collective understanding of household meal choices, rather than individual preferences, as some household members might not have the decision-making power to act on their preferences. Notably, no household declined participation, and respondents appeared comfortable sharing information about their households.

### 2.4 | Ethics

Ethical approval for this study was obtained from the Ethics Committee for the College of Basic and Applied Sciences (ECBAS) of the University of Ghana (ECBAS 040/18-19). This research was conducted in accordance with the Declaration of Helsinki on human subjects' research. Free, Prior and Informed Consent (FPIC) was applied in the study villages. Before conducting interviews at each study site, permission was obtained from village elders following a detailed explanation of the research objectives. Prior to each interview respondents provided informed consent following a brief introduction outlining the purpose of the study. During this introduction, participants were assured that all personal information would remain strictly confidential and that their responses would remain anonymous. They were also informed that the study was part of a university research project examining factors influencing bushmeat trade volume and individuals' trading behaviour and meat consumption patterns and preferences. Respondents were advised that they were not obligated to answer any questions they did not wish to and could withdraw from the interview at any time.

## 2.5 | Data analysis

Statistical analyses were conducted in R, version 4.2.0 (R Core Team, 2022) and SPSS version 20.0 for Windows software. We assessed preference and consumption patterns for four types of domestic meat (poultry, beef, goat/mutton, pork), and two wild-caught meats (bushmeat, fish). A preference score for each animal protein type was calculated by assigning a value of 0 for the least preferred type and 1 for the most preferred type and summing preferences across respondents (Table S1).

Regression analyses were performed to investigate factors influencing household preferences, with explanatory variables based on previous literature. We created a proxy for wealth using Gaussian generalized linear models (GLMs) to assess correlations between wealth factors (land owned, house type, roof type and number of livestock owned) and a household's reported income for the subset of households for which income was available. We chose this method as income data were not available for all respondents. Upon stepwise selection, the number of livestock owned was positively associated with the household's reported income ( $p < 0.01$ ); hence, this factor was included in our bushmeat preference regressions.

We used binomial GLMs to determine the factors influencing households' bushmeat preference, classified as a binomial response where '1' represented preference for bushmeat and '0' represented preference for domestic meats. Explanatory variables included village, number of livestock owned (to proxy for household wealth) and three socio-demographic variables: household size, gender of household head and whether households hunted on their farm. These parameters were chosen based on their importance in determining bushmeat preferences in previous studies (including Albrechtsen et al., 2005; Alexander et al., 2015; Ceppi & Nielsen, 2014; Schulte-Herbrüggen et al., 2013). All models were examined to ensure that model assumptions of homoscedasticity of variance and normality were met (Zuur et al., 2009).

Based on the previous studies, we hypothesized that households in Kayoro, which are more remote and may have more access to wildlife, would consume more bushmeat. We hypothesized that larger, wealthier, male-headed households who hunted on their farms would consume more bushmeat. We also hypothesized that preferences for bushmeat would align with consumption levels.

## 3 | RESULTS

### 3.1 | Household and village characteristics

The majority (87%) of households in the villages were male-headed (Table S2). Household sizes ranged from 1 to 20 individuals, with a mean of six. Crop farming was the most common livelihood activity in both villages, and the primary source of income for 80% of households in Doninga and 61% in Kayoro (Table S2). Some households (Kayoro=31%; Doninga=7%) also relied on livestock as a main source of income, with reliance on livestock for income being five

times greater in Kayoro than in Doninga ( $\chi^2 = 10.7$ ,  $df = 1$ ,  $p < 0.05$ ). Traditionally, livestock are regarded as a symbol of wealth accumulation, and hence in both villages households relied on livestock rearing mainly as an additional income-generating activity rather than using them routinely for meat. According to respondents, this income was often used to cover exceptional expenses or to solve family problems such as the payment of hospital bills and school fees. Consumption of livestock such as cattle and goats is typically reserved for special occasions and traditional ceremonies.

Only a few households (<2%, in both villages) considered hunting as a primary source of income. Hunting was considered a secondary source of income by some households (3.3% of households in Kayoro and 1% in Doninga). Some households reported hunting opportunistically on their farms to protect their food crops from pests. This activity was significantly more prevalent in Doninga (59% of households) than Kayoro (41% of households) ( $\chi^2 = 10.4$ ,  $df = 1$ ,  $p < 0.05$ ). Apart from hunting, some households (Kayoro=1.8%; Doninga=8.2%) also collected and sold non-timber forest products such as shea fruits (*Vitellaria paradoxa*) and locust beans (*Parkia biglobosa*).

### 3.2 | Determinants of preferences for bushmeat versus domestic meat

Overall, preferences for domestic meat (of any type) and bushmeat were evenly split (53% of households indicated a preference for domestic meat, 47% for bushmeat); in Kayoro, 60% of households preferred domestic meat to bushmeat, and 44% in Doninga. All bushmeat species were preferred mainly for their taste and secondarily for their meat quality, while domestic meat (of any type) was preferred primarily because of availability (Figure 2).

Bushmeat preferences varied depending on village, household size, gender of household head and whether the household hunted on their farm (Table 1). Based on the results of the generalized linear model, bushmeat preference was 0.59 times lower in Kayoro than Doninga. Household size was positively associated with bushmeat preference, with a unit increase in household size leading to an 8.5% increase in bushmeat preference. Additionally, households headed by males were 119% more likely to prefer bushmeat than those headed by females. Those households that hunt on their farms (potentially giving them easier access to bushmeat) were 260% more likely to prefer bushmeat than those who did not (Table 1). While livestock ownership was positively correlated with greater bushmeat preference, the effect was not statistically significant.

### 3.3 | Preferred bushmeat species

Fourteen bushmeat species were listed as preferred by respondents, including ungulates, rodents, lagomorphs and birds (Table 2). Respondents preferred only a few species, with five species accounting for 66% of all preferences. The grey duiker (*Sylvicapra grimmia*) was the most frequently mentioned type of bushmeat

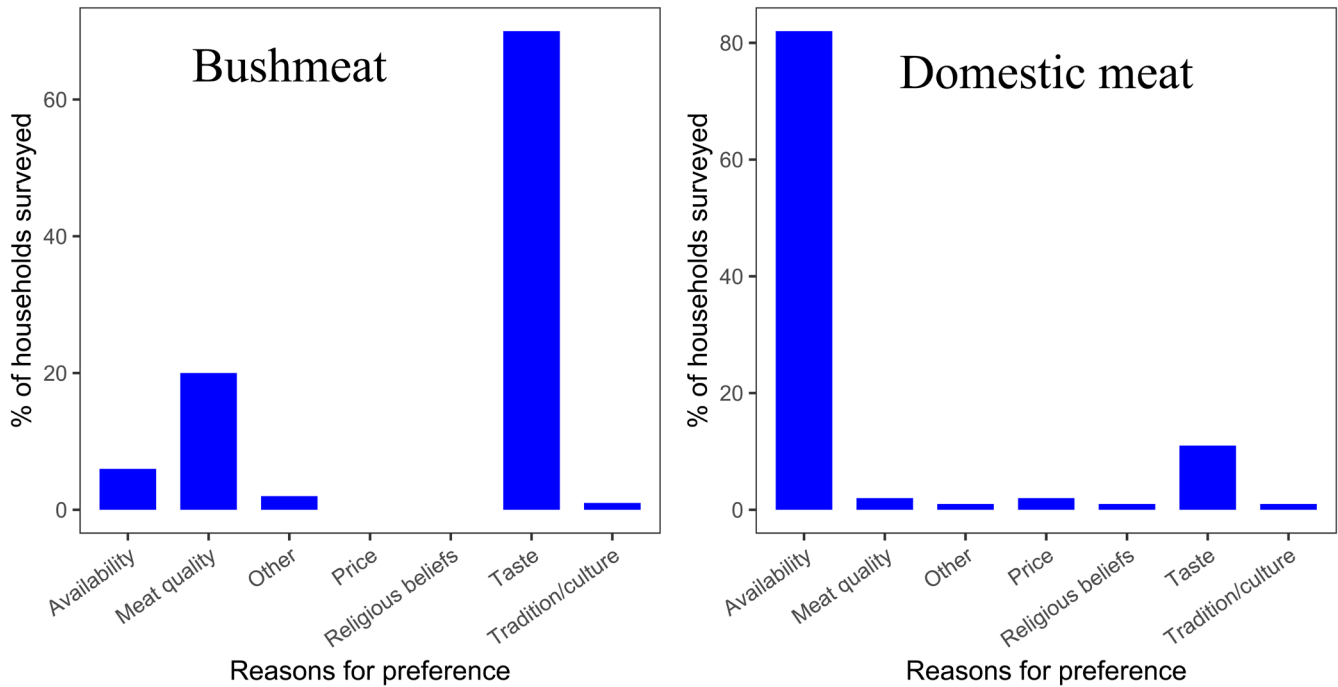


FIGURE 2 Reasons cited by respondents for household preference for either bushmeat ( $N=215$ ) or domestic meat ( $N=249$ ).

Explanatory variables		Estimate	SE	z value	Pr ( $> z $ )
(Intercept)		-1.202	0.483	-2.487	<0.05
Village (Ref: Doninga)	Kayoro	-0.894	0.288	-3.107	<0.01
Household size		0.082	0.041	2.000	<0.05
Gender of household head (Ref: Female)	Male	0.785	0.400	1.965	<0.05
Number of livestock owned		0.022	0.011	1.877	0.06
Farm hunting (Ref: No)	Yes	1.281	0.349	3.673	<0.01

TABLE 1 Results of Binomial GLM analysis assessing factors influencing bushmeat preference, based on household surveys ( $N=471$ ).

preferred in both villages (19.5%). This was followed by the African savanna hare (*Lepus victoriae*) (18.5%) and grasscutter (11.2%). Larger species such as armadillo (*Orycteropus afer*) and bushbuck (*Tragelaphus scriptus*) were preferred by a few households (3.4%). Considerable variation was observed in terms of preferences between households, and between villages. In Kayoro, the grey duiker was the most preferred species (17.5%) followed by the grasscutter (16.5%), and a number of other species were also preferred by several respondents. In Doninga, preferences were more skewed; the African savanna hare (28.4%) was the most preferred species, followed by the grey duiker (21.6%) (Table 2; Figure S1). Bushmeat preferences also reflected taboos in the study area. For example, as gathered from the focus group discussions, wild animals such as monkeys and crocodiles were culturally revered as tabooed animals and either were not mentioned by respondents or only rarely referenced as being a preferred bushmeat species type. Of the 14 wild animal species preferred by respondents, one

is categorized as Near Threatened, the African buffalo (*Syncerus caffer*) with a decreasing population, and five other species are classified as of Least Concern with decreasing populations (IUCN, 2024) (Table 2).

### 3.4 | Ranked preferences for animal protein type

Of all proteins, and on the basis of primary preferences, fish was the most preferred animal protein in Kayoro (33%), followed by poultry (26%) and bushmeat (16%). Mutton and pork were the least preferred (Figure 3). Conversely, in Doninga, fish and bushmeat were equally preferred (31% each) followed by poultry (18%; Figure 3). Overall, across both villages, fish was ranked as the most popular animal protein, followed by poultry and then beef. Bushmeat was ranked the fifth most preferred animal protein, with pork being the least preferred in the two study villages (Table S1).

**TABLE 2** List of the 14 bushmeat species reported as preferred by households during the study period with protection status of each species according to Ghana's Wildlife Law and status on the IUCN Red List.

Species	Number of stated preferences		Legal status (schedule) <sup>a</sup>	Red list status (population trend)
	Kayoro	Doninga		
Aardvark <i>Orycteropus afer</i>	1	0	1	LC (Unknown)
African buffalo <i>Syncerus caffer</i>	3	6	2	NT (Decreasing)
African savanna hare <i>Lepus victoriae</i>	9	29	2	LC (Stable)
Bushbuck <i>Tragelaphus scriptus</i>	5	1	2	LC (Stable)
Common warthog <i>Phacochoerus africanus</i>	10	10	2	LC (Decreasing)
Double spurred francolin <i>Pternistis bicalcaratus</i>	0	8	3	LC (Decreasing)
Giant rat <i>Cricetomys gambianus</i>	3	1	3	LC (Stable)
Grasscutter <i>Thryonomys swinderianus</i>	17	6	*	LC (Unknown)
Grey duiker <i>Sylvicapra grimmia</i>	18	22	3	LC (Decreasing)
Helmeted guinea fowl <i>Numida meleagris</i>	6	10	3	LC (Stable)
Kob <i>Kobus kob</i>	6	1	2	LC (Decreasing)
Crested porcupine <i>Hystrix cristata</i>	12	1	2	LC (Unknown)
Roan antelope <i>Hippotragus equinus</i>	13	0	1	LC (Decreasing)
Striped ground squirrel <i>Xerus erythropus</i>	0	7	3	LC (Stable)
Total	103	102		

Abbreviations: LC, least concern; NT, near threatened (Source: IUCN, 2024).

<sup>a</sup>L.I. 685-WILDLIFE CONSERVATION REGULATION, 1971 and L.I. 1357-WILDLIFE CONSERVATION (AMENDMENT) REGULATION, 1988: First Schedule (1), hunting prohibited; Second Schedule (2), prohibited in closed season and no hunting of young/adult with young; Third Schedule (3) and prohibited in closed season; Unscheduled (\*), no restrictions.

### 3.5 | Frequency of bushmeat consumption and general protein intake of households

Kayoro and Doninga exhibited distinct differences in domestic meat consumption frequencies (Figure 4). In Kayoro, 39% of households ate domestic meat weekly and 3% ate it on a daily basis. On the other hand, only 4% of respondents in Doninga ate domestic meat weekly, with the majority, 85%, reporting consuming it only occasionally, usually during celebrations and traditional ceremonies. The observed difference in consumption frequency of domestic meat between the two villages was statistically significant ( $\chi^2=141.80$ ,  $df=5$ ,  $p<0.05$ ).

Bushmeat was also not eaten frequently in either village, with most households eating it only 'occasionally' (45% in Kayoro and 76% in Doninga), and about half having eaten bushmeat in the previous 6 months; 53% in Kayoro and 48% in Doninga. Some people stated that they 'rarely' ate bushmeat (28% in Kayoro and 15% in Doninga). However, overall, the consumption of both bushmeat and domestic meat was notably higher in Kayoro than in Doninga, with

the implication being that fish was likely important for both communities, but particularly so for Doninga.

The focus group discussions held in both villages not only confirmed this result, but also indicated that households rarely ate meat of any type, be it domestic meat or bushmeat. According to one participant 'within three months one may have eaten meat only once' (focus group discussion in Kayoro, 27 May 2019). Participants indicated that smoked fish (herring) and plant proteins (primarily *dawadawa*—traditionally processed African locust beans *Parkia biglobosa*) were important components of household diets in both villages, with these being eaten more often than meat. Interviewees stated that, even when bushmeat is hunted mainly for sale, parts, such as the head and internal organs may be retained within the household for consumption. On-farm hunting requires less investment of time and equipment than hunting in the forest, and at the same time offers protection of farms from crop pests. The fact that more households hunted on their farms in Doninga than in Kayoro suggests that this behaviour could be related to the observed greater preference for bushmeat in Doninga than Kayoro.

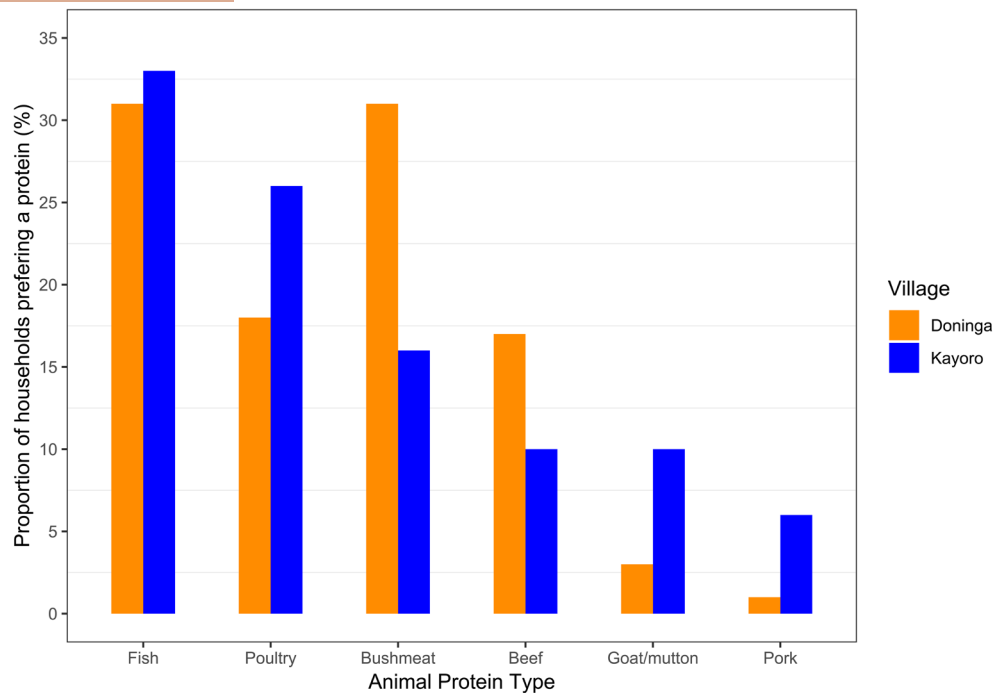


FIGURE 3 Stated first-choice preferences for different types of animal protein among respondents ( $N=455$ ; Kayoro=260, Doninga=195). Results are ranked by order of preference for Kayoro.

## 4 | DISCUSSION

### 4.1 | Factors affecting bushmeat preferences and consumption

We hypothesized that preferences and consumption frequency were aligned; deviation from this null hypothesis might suggest limitations in the availability of the preferred protein type. For example, Fa et al. (2002) found that among residents of Bioko Island, Equatorial Guinea, consumption of bushmeat was mostly associated with availability, with some influence of preferences.

Our results show that bushmeat is neither particularly preferred, nor a frequently consumed form of dietary protein in our study villages in northern Ghana, unlike in the southern part of the country (Alexander et al., 2015; McNamara et al., 2019; Ntiamoa-Baidu, 1998). As regards primary preferences, fish and bushmeat were equally preferred in Doninga, while bushmeat ranked third in Kayoro. However, taking all preferences into account, the households in this study ranked bushmeat only as the fifth most preferred animal protein overall, while fish was ranked as the most preferred. Although fish is a widely consumed animal protein in Ghana, and typically constitutes the main source of animal protein for the majority of people in the country, in other studies bushmeat was generally found to be the most preferred for the majority of people when given the choice (Alexander, 2011; Brashares et al., 2004; Hasselberg et al., 2020; McNamara et al., 2016; Owusu et al., 2004; Sackey, 2014). Our study shows that this preference for bushmeat does not hold in northern Ghana, which is different both ecologically and culturally from the humid tropical zones where previous studies had been carried out.

Those who did prefer bushmeat generally cited its taste. In West Africa, tastiness is commonly cited as a reason for consuming particular species (Alexander, 2011; Luiselli et al., 2019; Schenck et al., 2006; Simo et al., 2024; Taylor et al., 2015). Bushmeat is described as a tastier animal protein than domesticated meat. Urban dwellers in the southern part of Ghana commonly describe taste as an important motivator for their consumption of bushmeat (Ntiamoa-Baidu, 1998; Owusu et al., 2004; Sackey, 2014). In most consumer surveys carried out in the southern part of the country, the grasscutter was the most preferred bushmeat by a majority of the respondents followed by duikers, due to its taste (Ntiamoa-Baidu, 1998; Owusu et al., 2004; Sackey, 2014).

Differences in taste preference can arise from cultural beliefs and norms grounded in ethnic backgrounds, or from religious beliefs. Fa et al. (2002), for instance, provides an example of significant inter-tribe differences in harvest, preference and consumption of bushmeat between the Fang and Bubi ethnic groups in Bioko Island, Equatorial Guinea. Similarly, cultural attributes were identified as stronger predictors of bushmeat consumption and preference than socio-economic factors among Amazonian towns (Morsello et al., 2015). Therefore, perceptions of tastiness may be culturally related. The differences in preference for bushmeat between villages in our survey suggest that similar dynamics may be present in our study area, since Kayoro residents belonged mainly to the Kassena ethnic group, while those in Doninga were Builsa. Unfortunately, the number of people who preferred bushmeat was not large enough to explore these hypotheses statistically, but if cultural preferences do indeed play a part, these need to be taken into account in the design of interventions to improve the sustainability of bushmeat hunting in the region.

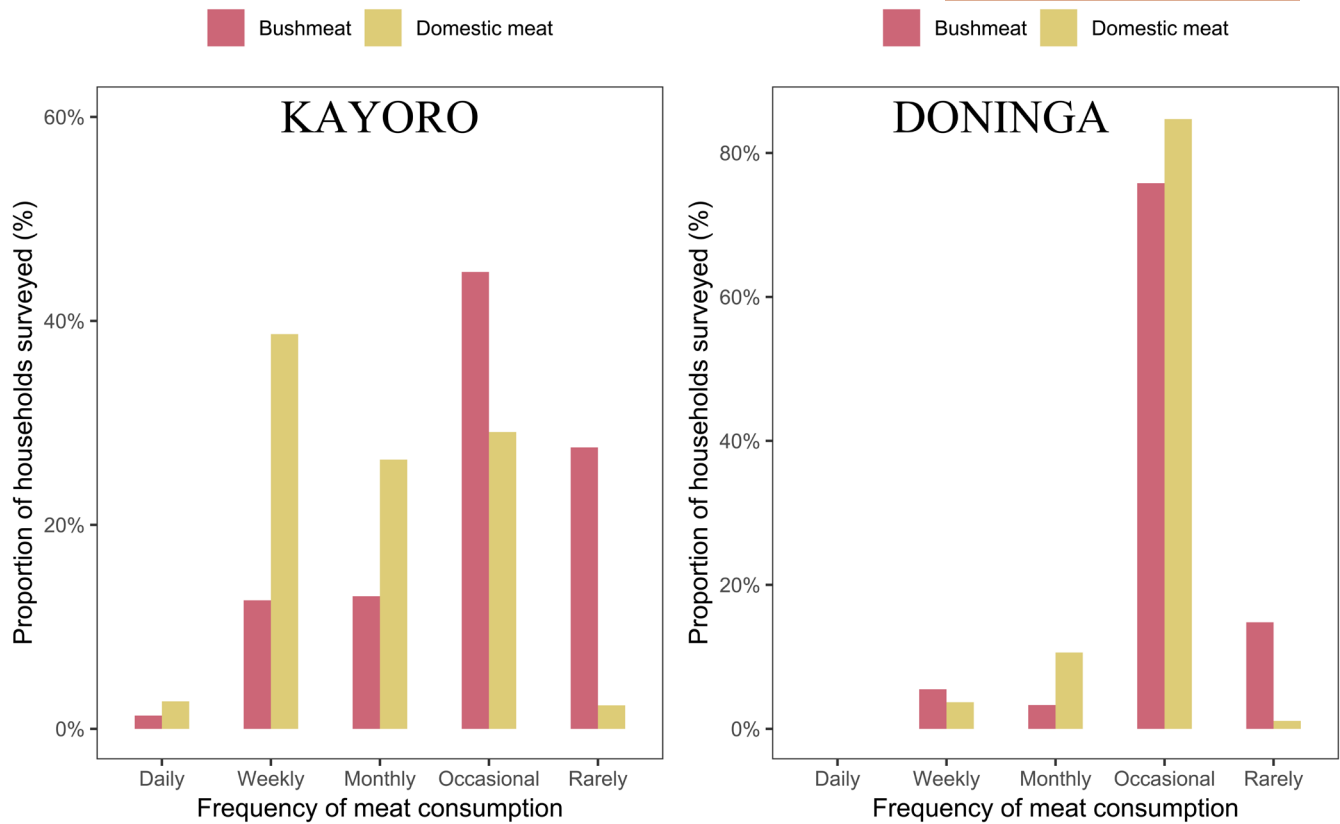


FIGURE 4 The frequency with which bushmeat and domestic meat is eaten by households in (a) Kayoro and (b) Doninga (Bushmeat  $N=421$ , Domestic meat  $N=450$ ).

Differences in the availability of bushmeat in the study villages may also influence the different preference and consumption patterns in the two villages. Availability relates to the density of bushmeat species in the natural environment (which is a function of ecological factors such as rainfall and vegetation cover), offtake rates and the condition of the underlying resource (to what degree it is depleted due to over-hunting) (Robinson & Bennett, 2004). In areas with abundant wildlife, consumption rates may be higher compared to localities where wildlife is depleted (van Vliet et al., 2014). The fact that bushmeat was consumed more frequently in Kayoro than Doninga even though it was ranked as less preferred, and hunting was less important as a livelihood, may in part be due to greater availability of bushmeat around Kayoro. Some support for this suggestion comes from the fact that Kayoro is closer to a protected area, the Nazinga Game Reserve, which is <40km to the north in Burkina Faso. Hunters from both Burkina Faso and Ghana have been reported to poach in the Nazinga Game Reserve (Bouché et al., 2016; Hema et al., 2017; Sackey et al., 2022), and this may therefore partly explain the higher availability and bushmeat consumption rates in Kayoro.

Bushmeat species preferences also differed from other parts of Ghana. For example, in a study of bushmeat consumption in the Central region of Ghana, Sackey (2014) found that the majority (95%) of the eight preferred species stated by consumers were rodents and ungulates. This contrasts with our findings in northern Ghana where

species of birds and lagomorphs were particularly important. This is not surprising, since different species are available in savanna zones compared to forest zones (e.g. the African savanna hare *Lepus victoriae*). For tropical forest areas, there has been a lot of work on how the composition of hunting offtakes could be used as a proxy for sustainability, particularly the rodent:ungulate ratio (e.g. McNamara et al., 2015). However, such analyses have not been done for the species assemblage in savanna zones, despite their potential usefulness for monitoring the sustainability of bushmeat hunting in these areas.

## 4.2 | Relationships between hunting and consumption

A household's involvement in hunting or having a hunter within a household has previously been shown to influence bushmeat preferences and consumption (Alexander et al., 2015; Ceppi & Nielsen, 2014). It can be hard, though, to disentangle whether people hunt because they like bushmeat, or eat bushmeat because they are hunting it, or if it is simply a question of availability. In this study, male-headed households and households that hunted on their farm were more likely to prefer bushmeat. In this part of Ghana, men, particularly male household heads, have a significant influence on household decision-making and therefore are likely to also influence

what the household eats (H. N. K. Sackey, pers. obs., 2019). Further, professional hunters in the area were exclusively men (Sackey, 2020) and this has an influence on hunting by such households as well. It is important to highlight also that any management interventions should consider the important role of hunters and male household heads, as working with these demographic groups could help maximize the effectiveness of policy interventions that aim to improve the sustainability of bushmeat hunting while supporting food security. In general, more research is needed on the role of gender in determining household protein preferences and consumption, as well as hunting behaviour, as this could determine how best to design interventions that resonate with different genders, as well as disentangle potentially gendered issues of food security and equity of access to nutrition.

Our study also suggested that food security may be an issue in the area. Our results implied that not only were few people consuming bushmeat regularly, but that people also did not eat much domestic meat either, relying instead on plant-based protein sources and fish. Our focus groups suggested that this was because these sources could be bought in small quantities, and that it was cost that was preventing them from eating more meat. This behaviour is somewhat at odds with findings in other parts of Ghana. For example, Schulte-Herbrüggen et al. (2017) reported that bushmeat contributed substantially to protein consumption for some rural households in southwest Ghana. Other studies also reported higher reliance on bushmeat than we found in our study area, although in recent years bushmeat consumption has declined markedly in many locations (Alexander et al., 2015; McNamara et al., 2016; Ntiama-Baidu, 1998). The low rates of animal protein consumption could be an indicator of local food insecurity. Indeed, food insecurity is a problem in Ghana and particularly in the north (Nkegbe et al., 2017). Rural areas are particularly vulnerable to periods of food shortages, and this food insecurity may well be exacerbated if local wildlife resources are poor, during the lean agriculture season when farm products are limited, and there is increased use of wild resources.

### 4.3 | Bushmeat consumption and general protein intake of households

One likely reason for the lack of meat consumption in our study area is price. Price was very rarely cited as a reason for the consumption of either domestic or wild meat. However, according to a participant in the focus group discussion, *'you cannot afford to buy meat every market day because it is expensive. Many of us would rather buy fish which can be obtained in smaller affordable portions or dawadawa (traditionally processed African Locust beans Parkia biglobosa). If you want to eat something like bushmeat then you will have to hunt it yourself'*.

Further evidence that price constrains meat consumption in our study is suggested by the tendency of larger households, where poverty and resource limitations are more pronounced, to report a preference for bushmeat. Larger households are likely to have more

males for hunting activities and can therefore obtain bushmeat without having to buy it. Alternatively, if these households include many young men they may have extra workforce that enables higher income levels, facilitating bushmeat consumption (Albrechtsen et al., 2005).

Indeed, studies have shown a direct link between wealth and bushmeat consumption in other places (e.g. van Vliet et al., 2012). A cross-sectional study of the role of prices and wealth in consumer demand for bushmeat in Gabon found that consumption of bushmeat and alternatives such as fish, chicken and livestock all increased with wealth (Wilkie et al., 2005). In a study of three communities in southern Ghana, Tutu et al. (1996) found that scarcity and price were the most frequently cited reasons for decreased bushmeat consumption and thus bushmeat accounted for less than 5% of the total animal protein consumption. More recently, in a report of consumer behaviour in Kumasi, Ashanti region, McNamara et al. (2016) found a significant decline in stated preference for bushmeat between 1997 and 2011 due to high prices, with increasing preference for less expensive proteins. In this same urban setting, bushmeat demand was shown to be positively correlated with income (McNamara et al., 2019). Another finding that suggested that price may be a key driver of both hunting and consumption of bushmeat was the link between livestock ownership and bushmeat reliance. It was notable that in Doninga, where livestock ownership was lower, hunting was more important, while consumption was less frequent. As a store of wealth, the lower ownership of livestock may imply lower wealth in Doninga, which may in turn lead to greater reliance on bushmeat for income (hence higher hunting rates) and lower income availability for purchasing meat (hence lower consumption rates). Lower income levels may also explain the overall lower rates of all protein consumption in Doninga. However, more work would be required to understand this.

Other factors that may explain the low household-level consumption of animal protein include urbanization, trade commercialization and wildlife depletion. Sackey et al. (2022) demonstrated that urbanization and commercialization of the trade in southern Ghana may be incentivizing hunters in the north to sell their catch to traders who are able to pay a price premium as they sell the bushmeat onwards to wealthier southern markets. This likely drives local bushmeat prices beyond the means of many rural poor communities in northern Ghana. For instance, bushmeat prices exhibited greater variability throughout the year and were generally higher than those of domestic meats, such as beef. In contrast, fish prices remained relatively stable from month to month, positioning them as more affordable than most bushmeat species, which could impact their consumption. The same study showed that larger bodied mammals traded for significantly more money, and were consequently targeted by hunters and traders for onward sale to more lucrative bushmeat markets in southern Ghana. More work is required to understand these dynamics; however, a consequence of such behaviour, whereby larger, slower growing mammals are targeted for profit, would likely be the local extirpation of these species, with implications for availability and consumption of bushmeat in local markets.

#### 4.4 | Implications for food security and wildlife conservation

Even though many of the bushmeat species reported as preferred by households during the study are categorized as Least Concern on the IUCN Red List, 43% (6 species) have declining population trends according to Red List data. This includes the grey duiker, which was the most preferred type of bushmeat in both villages (Table 2). Additionally, one of the species preferred, the African buffalo, is categorized as Near Threatened on the IUCN Red List. From a conservation viewpoint, the implications are that these wildlife populations could experience significant declines in the future if management actions are not adopted to monitor and improve the sustainability of the exploitation of these species. Furthermore, two other species (aardvark and roan antelope) are in the first schedule of Ghana's Wildlife Conservation Regulation, and hence they have been identified as being of national importance for conservation and their hunting is prohibited at all times. These findings, together with the broader evidence of an absence of larger mammals in the area, alongside the anecdotal evidence that hunters are encroaching into Nazinga Game reserve in Burkina Faso, highlight how current levels of bushmeat exploitation may well have serious implications for conservation in the region. These findings emphasize the importance of the Forestry Commission and other regulatory authorities developing interventions to protect and ensure the conservation of these ecologically important species in the landscape, as well as securing local food security.

The findings of this study provide useful information on protein preferences and consumption frequency among rural households in northern Ghana. Distinct differences existed between the two villages studied in terms of household protein preferences and consumption frequencies. Even though the frequency of bushmeat consumption was found to be low in the two study villages, bushmeat still played a role in household meat consumption, in addition to fish, domestic meat and plant proteins. Further research could explore whether bushmeat provides an important economic or nutritional safety net, either at food insecure times of year, or through the consumption of by-products from commercial hunting such as the offal, head and other parts of the animal. It could also explore why only some households hunt on-farm, and whether those who hunt on-farm are more food-secure. Furthermore, the reliance on plant-based protein (in the form of locust beans), which by some reports was greater than animal protein, was particularly interesting. This may be a cultural preference, or a response to the high price of animal proteins. If the latter, it would have interesting implications for food security as the protein quality of locust beans alone is considered to be poor (Fetuga et al., 1974). Food consumption surveys, where the nutritional value of food consumed is determined either through food diaries or directly by weighing foods eaten, may offer a more accurate picture of the diet consumed by people in the area (e.g. Allebone-Webb, 2009). This could highlight families at particular risk of food insecurity who could be the focal targets of food-related interventions.

Additionally, if the limited bushmeat consumption is linked to low availability due to depletion, interventions to improve local wildlife populations and sustainability of hunting could be helpful. These might include community hunting zones or community-instituted quotas. Given that preferred species such as hares, guinea fowl and grey duikers are relatively productive, their populations might be able to bounce back quickly if hunting is reduced to sustainable levels. The preferences expressed for larger species such as buffalo, roan antelope and kob may be of more concern, particularly if these species are coming across the border from Nazinga Game Ranch. Nazinga is an island of natural habitat in a highly agricultural landscape (Bouché et al., 2016). It contains significant populations of large mammals including elephants, hartebeest and waterbuck, which appeared to be increasing at the time of the most recent published surveys (Bouché et al., 2016). However, there is evidence of heavy poaching of small wildlife and consequent population declines (Bouché et al., 2016). Therefore, any intervention that reduces hunting and cross-border wildlife trade will benefit a particularly valuable and vulnerable Protected Area.

One approach would be to explore other sources of animal protein with the communities, such as insects or frogs, that are known to be popular sources of protein in the region and are abundant at certain times of the year (Sackey et al., 2022). There may be options for farming frogs and insects, which may be more amenable to captive rearing than mammalian species (so-called 'mini-livestock'; van Vliet, 2011). Importantly, all interventions need to be based on detailed participatory work to understand local priorities and views on feasible options (Brittain, 2021).

Our findings provide an understanding of factors influencing preferences for bushmeat and the patterns of animal protein consumption in rural northern Ghana. This is a rare example of a study of bushmeat consumption in a savanna zone. We have uncovered concerning evidence of limited availability of animal protein, with potential impacts on food security, as well as concerns about the conservation implications of hunting in the region. This study highlights the critical need for more understanding of the relationships between wildlife and people in the area in order to achieve sustainable and equitable wildlife consumption.

#### AUTHOR CONTRIBUTIONS

Hannah N. K. Sackey and Yaa Ntiamoa-Baidu were responsible for the conceptualization of the study. Hannah N. K. Sackey, James McNamara, E. J. Milner-Gulland and Yaa Ntiamoa-Baidu developed the methodology of the study. Hannah N. K. Sackey collected the data. All authors were involved in the data analysis. Hannah N. K. Sackey led the writing of the manuscript. All authors were involved in writing - review and editing of drafts.

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### CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to report.

### DATA AVAILABILITY STATEMENT

All data used in the analyses for this article has been archived and are available through Dryad here: <https://doi.org/10.5061/dryad.p5hqbzm1w>.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

**Appendix S1.** Household survey instrument.

**Table S1.** Ranked preference for different animal protein types by households surveyed.

**Table S2.** Socio-demographic characteristics of households in the two villages surveyed.

**Figure S1.** Proportions of the number of stated preferences for bushmeat species by households in study villages (N=205; Kayoro=103, Doninga=102).

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