


Please cite the Published Version

Luiselli, L, Hema, EM, Segniagbeto, GH, Ouattara, V, Eniang, EA, Di Vittorio, M, Amadi, N, Parfait, G, Pacini, N, Akani, GC, Sirima, D, Guenda, W, Fakae, BB, Dendi, D and Fa, JE  (2019) Understanding the influence of non-wealth factors in determining bushmeat consumption: results from four West African countries. *Acta Oecologica*, 94. pp. 47-56. ISSN 1146-609X

DOI: <https://doi.org/10.1016/j.actao.2017.10.002>

Publisher: Elsevier

Version: Accepted Version

Downloaded from: <https://e-space.mmu.ac.uk/619138/>

Usage rights:  [Creative Commons: Attribution-Noncommercial-No Derivative Works 4.0](https://creativecommons.org/licenses/by-nc-nd/4.0/)

Additional Information: This is an Author Accepted Manuscript of a paper accepted for publication in *Acta Oecologica*, published by and copyright Elsevier.

Enquiries:

If you have questions about this document, contact openresearch@mmu.ac.uk. Please include the URL of the record in e-space. If you believe that your, or a third party's rights have been compromised through this document please see our Take Down policy (available from <https://www.mmu.ac.uk/library/using-the-library/policies-and-guidelines>)

1 ACCEPTED FOR ACTA OECOLOGICA

2

3 **Understanding the influence of non-wealth factors in determining**
4 **bushmeat consumption: results from four West African countries**

5

6 Luca Luiselli^{a,b}, Emmanuel M. Hema^c, Gabriel Hoinsoudé Segniagbeto^d, Valy Ouattara^e,
7 Edem A. Eniang^f, Massimiliano Di Vittorio^g, Nioking Amadi^b, Gnomou Parfait^e, Nic
8 Pacini^{h,i}, Godfrey C. Akani^b, Djidama Sirima^c, Wendengoudi Guenda^e, Barineme B.
9 Fakae^{a,b}, Daniele Dendi^{a,b}, John E. Fa^{j,k}

10

11 ^a IDECC - Institute for Development, Ecology, Conservation and Cooperation, via G. Tomasi di Lampedusa
12 33, I-00144 Rome, Italy.

13 ^b Department of Applied and Environmental Biology, Rivers State University of Science and Technology,
14 P.M.B. 5080, Port Harcourt, Nigeria.

15 ^c Université Ouaga 1 Professeur Joseph KI-ZERBO/CUPD, Laboratoire de Biologie et Ecologie Animales, 09
16 B.P. 848 Ouagadougou 09 - Burkina Faso.

17 ^d Department de Zoologie, Université de Lomé, Lomé, Togo.

18 ^e Groupe des Expert en Gestion des Eléphants et de la Biodiversité de l'Afrique, de l'Ouest, Ouagadougou,
19 Burkina Faso.

20 ^f Department of Forestry and Wildlife, University of Uyo, Akwa-Ibom State, Nigeria

21 ^g Ecologia Applicata Italia s.r.l., via E. Jenner 50, Rome, Italy.

22 ^h Department of Environmental and Chemical Engineering, University of Calabria, Arcavacata di Rende (CS),
23 Italy.

24 ⁱ Centre for Landscape and Climate Research, University of Leicester, UK.

25 ^j Division of Biology and Conservation Ecology, School of Science and the Environment, Manchester
26 Metropolitan University, Manchester M1 5GD, UK.

27 ^k Center for International Forestry Research (CIFOR), Jalan Cifor Rawajaha, Situ Gede, Bogor Barat, Kota
28 Bogor, Jawa Barat 16115, Indonesia.

29 **Abstract**

30 The meat of wild animals (bushmeat) is consumed extensively in many tropical regions.
31 Over the past few decades bushmeat consumption has greatly increased, threatening the
32 survival of some hunted species and the supply of animal protein to countless numbers of
33 people. Understanding patterns of bushmeat consumption is thus vital to ensure the
34 sustainable use of this resource. Although the economic drivers of bushmeat consumption
35 has been well studied, non-wealth correlates have been poorly considered. Here, we analyse
36 how factors such as age and gender influence bushmeat consumption in four West African
37 countries, within the Guinean forests (Togo and Nigeria) and Sahel (Burkina Faso and
38 Niger). We interviewed a total of 2,453 persons (1,253 urban, 1,200 in rural areas) to
39 determine frequency of consumption of bushmeat as well as main species eaten. We found
40 significant differences in bushmeat consumption between rural and urban areas in all four
41 countries. In particular, the proportion of persons not consuming any bushmeat was highest
42 in urban areas. Gender differences in bushmeat consumption was not generally important
43 but young people consistently avoided eating bushmeat, especially in Togo and Nigeria, and
44 in urban areas. The complicated interplay between tradition and evolution of social systems
45 (especially the trends towards westernization) may explain the different perceptions that
46 people may have towards consuming bushmeat in the four studied countries. In addition, we
47 found considerable variation in types of bushmeat eaten, with antelopes and large rodents
48 eaten by the great majority of interviewees, but bats, monkeys, and snakes being avoided,
49 especially in urban settlements.

50 *Key words:* Age; gender; Togo; Burkina Faso; Nigeria; Niger; wildlife; species eaten;
51 frequency.

52

53 1. Introduction

54 Terrestrial wild vertebrates are central to the nutritional wellbeing of many rural
55 people, particularly those inhabiting the world's tropical regions (Fa et al., 2002; Golden et
56 al., 2011). This reliance on wild meat is as much a consequence of the lack of alternative
57 domestic meat resources (Mainka & Trivedi 2002; Nasi et al. 2008), as much as it is an
58 attribute of centuries-old cultural traditions (Milner-Gulland et al., 2003). However,
59 although wild animals have been hunted for millennia, their consumption has greatly
60 increased over the past few decades (Nasi et al., 2011). In West and Central Africa,
61 commercial hunting, especially to supply large urban centres, has risen dramatically, largely
62 driven by a human population growth of 2–3% per year (Nasi et al., 2011). Such
63 intensification of demand for bushmeat will have fatal consequences for many species but
64 particularly large-bodied and slow-growing species if extraction exceeds their replacement
65 rate (Wilkie et al., 2001). Indeed, the decline of some species as a consequence of bushmeat
66 extraction has already been documented for tortoises (Luiselli, 2003) and antelopes (Fischer
67 and Linsenmair, 2001; Grande-Vega et al., 2016; Hema et al., 2017). As a consequence, loss
68 of wildlife may threaten the food security of many marginalized forest foragers, and farmer-
69 forager communities that are isolated from markets and depend on bushmeat as their
70 primary protein source (Eves and Ruggiero, 2001).

71 Few studies have centred on understanding why people eat bushmeat. Knowing
72 what motivates people to eat bushmeat can help in developing politically acceptable ways to
73 manage wildlife hunting and trading with the aim of halting unsustainable exploitation.
74 Bushmeat may be eaten because it is cheaper or there are no alternatives available in the
75 market place (Apaza et al., 2002; Wilkie and Godoy, 2001), because consumers prefer the
76 taste of wildlife (Chardonnet et al., 1995; Trefon and de Maret, 1999) or to add variety to the
77 diet and for special social events and occasions (Njiforti, 1996). Despite this variety of

78 possible reasons that may motivate buyers to eat bushmeat, most studies have focused on the
79 socioeconomic background of consumers as the main reason underpinning their choice (e.g.
80 Wilkie and Godoy, 2001; Brashares et al., 2011). In general, wealthier households consume
81 more bushmeat in settlements nearer urban areas, but the opposite pattern is observed in
82 more isolated settlements (Brashares et al., 2011). Nonetheless, Brashares et al. (2011) also
83 indicate that household wealth is only weakly linked to wildlife consumption, and thus such
84 a lack of a strong correlation could be explained by the undisclosed importance of other
85 factors e.g. spatial differences in wealth. Thus, understanding what may influence
86 consumption patterns, other than wealth, are urgently needed to disentangle the part played
87 by ecological, socioeconomic and cultural factors. Recent studies have shown that price and
88 income have significant roles in determining the level of consumption of bushmeat, fish,
89 chicken, and beef (Apaza et al., 2002; Wilkie and Godoy, 2001; Wilkie et al., 2005).
90 However, few investigations have focused on how bushmeat consumption is affected by
91 geographic location, gender or age of consumers; all attributes of a population that reflect
92 cultural influences (Hema et al., 2017; Luiselli et al., 2017).

93 Household surveys have been extensively used to understand potential linkages
94 between conservation and local livelihoods. Studies reporting on the amounts and
95 preferences of bushmeat consumed have focussed on the collection of quantitative
96 household-level data and have been useful in determining possible socioeconomic
97 characteristics of a community that may be linked to bushmeat consumption. However,
98 household surveys have both theoretical and logistical weaknesses. Logistically, these
99 surveys can be costly in terms of time and resources especially if adequate sample sizes are
100 collected. Theoretically, a given household often includes resident of different ages (from
101 over 80 to less than 5 years old) and scholarization levels (from complete illiteracy to
102 university-level students), and these may be linked to contrasting lifestyles and points of
103 view, including their perception towards bushmeat consumption (Luiselli et al., 2017). Thus,

104 focusing on just households can introduce biases to the overall conclusions. To avoid these
105 biases face-to-face interviews allow the collection of large amounts of qualitative
106 information that can be used to ascertain bushmeat consumption levels and factors that may
107 affect these. Here we use interview responses from inhabitants of rural communities and
108 urban centres in a number of localities in four West African countries to: 1) quantify the
109 frequency of consumption of bushmeat, 2) determine the influence of gender and age, and 3)
110 assess whether location (rural/urban; in forest versus in savannah habitats), and country
111 influenced bushmeat consumption.

112

113 **2. Methods**

114 *2.1. Study sites*

115 We interviewed a total of 2,453 individuals (1,253 urban, 1,200 in rural areas) from
116 27 separate human settlements in Nigeria, Togo, Burkina Faso and Niger (Fig. 1). Study
117 localities in Nigeria and Togo were located within the Guinean Forests of West Africa
118 region; swamp forest and moist rainforest vegetation zones in southern Nigeria (Niger Delta
119 Environmental Survey, 1998; Oates et al., 2004) and in the deciduous moist forest zone of
120 southwestern Togo (Ern, 1979). Sites in Burkina Faso and Niger were found within the
121 Sahel, in Sudanian and Sahel Acacia savannahs (Thiombiano and Kampmann, 2010).

122

123 *2.2. Interviews*

124 To obtain information on bushmeat use, we conducted face-to-face interviews using
125 a standardized questionnaire. All data were gathered during 2012-2016. We selected
126 interviewees at marketplaces, roadsides, canteens, restaurants, hairdressing salons, food
127 shops, and other gathering places. We stopped the first person we encountered after a given
128 time period (in minutes); the time interval was randomly generated by a Random Number
129 Generator. Local scientists (VO, NA, GP, DS, WG, EAE and other students) performed all

130 interviews. All interviewees were informed of the aims of the project and their consent was
131 obtained before proceeding. All interviews were conducted in the local language.

132 We interviewed persons in Ouagadougou, Niamey, Lomé, Benin City, Port Harcourt,
133 Calabar (all cities with more than 500,000 residents) as well as in rural villages (500 to
134 25,000 inhabitants, apart from Pama that has about 40,000 inhabitants). We recorded the
135 interviewees' gender (male or female) and age (≤ 25 years, 26-50 years, ≥ 51 years) but not
136 their names (St. John, 2010; Nuno et al., 2014; Luiselli et al., 2017). To avoid non-
137 independence of the data, we never interviewed two persons of the same family or those
138 living in the same house, even if they were not relatives (see also Hema et al., 2017, for
139 similar procedure).

140 Interviewees were asked the following two questions: (1) Do you like eating
141 bushmeat? (2) If yes, how often do you eat bushmeat? Interviewees would then be asked if
142 they ate bushmeat frequently (at least once a week), rarely (about once per month or less) or
143 never. Persons who answered that they consumed bushmeat only occasionally were then
144 asked whether they selected the type of animal or whether they would just buy/eat whatever
145 kind of bushmeat was available.

146 2.3. *Statistical analyses*

147 We employed Generalized Linear Models (GLZs) to determine the relationship
148 between bushmeat consumption frequency and site (rural versus urban), gender
149 (male/female) and age classes (three categories) (Hosmer and Lemeshow, 2000). The codes
150 for the variables used in the GLZs are given in Appendix 1. In the model, the response
151 "never eat bushmeat" was the dependent variable (i.e. consumption data were converted into
152 a binary variable, 1 = eat (often or rarely) and 0 = never eat bushmeat) and the identity of the
153 link function and a normal distribution of error were used (McCullagh and Nelder, 1989).
154 Three age categories were used for all analyses: persons aged less than 25, aged less than 50,

155 and aged 51 years or more. In the GLZ models, a stepwise forward regression procedure was
156 used to test the statistical significance of each variable in turn, and variables were excluded
157 when they did not correlate significantly with the dependent variable (Wald test $P > 0.05$).

158 To explore deviance and hierarchical partitioning, the selected variables were
159 analyzed in order to determine the comparative influence of each variable (Borcard et al.,
160 1992). The decomposition of the variation into subsets of explanatory variables was carried
161 out by means of a partial regression analysis (Legendre and Legendre, 1998).

162 Frequency differences between groups of interviewed people were analyzed using
163 the χ^2 test, for comparing both differences among frequently-eating, rarely-eating and non-
164 eating bushmeat respondents, and for determining differences in terms of type of bushmeat
165 eaten. The statistical software PASW 11.0 was used for all analyses, and alpha was set at
166 5%.

167

168 **3. Results**

169 *3.1. General patterns*

170 A summary of the data gathered for this study is shown in Table 1, the raw dataset is
171 given in Appendix 2. In general terms, bushmeat was consumed more often by rural than
172 urban interviewees in all countries (Fig. 2). An average total of $70.3 \pm 15.7\%$ of rural
173 respondents answered that they ate bushmeat (either eaten rarely or often) in contrast to only
174 $42.8 \pm 19.0\%$ of urban interviewees. In all countries more rural than urban respondents ate
175 bushmeat; 1.59 times more in Niger, 1.26 times more in Nigeria, 0.46 times in Togo and
176 0.14 times in Burkina Faso.

177 A general GLZ model using data from all countries pooled and type of bushmeat
178 eaten as the dependent variable showed that, the probability of eating ungulates or birds was
179 significantly affected by gender or age of the respondents respectively, while the eating of
180 monkeys, bats, carnivores, crocodiles, snakes and turtles was influenced by the age of the
181 respondents and their urban/rural location (Table 2).

182 We found significant differences in responses between interviewees in Guinean
183 forests and the Sahel region. Age classes, followed by urban/rural location, accounted for
184 the strongest pure effect in the Sahelian localities with gender explaining only a very small
185 proportion of the variance (Fig. 3). Within the Guinean forest localities, urban/rural location
186 was the predominant effect, age had a lesser relevance in terms of explained variance, but
187 gender had almost no effect (Fig. 3).

188 We found a significant effect of distance (in km) of the interviewee to the nearest
189 urban area where the probability of never-eating bushmeat increased in Sahelian countries,
190 but not in the two countries within the Guinean forest region (for Sahel: GLZ estimate =
191 6.56, standard error = 1.34, Wald = 24.0, $P < 0.0001$; for age classes: estimate = -7.62,
192 standard error = 2.32, Wald = 10.79, $P < 0.001$; for Guinean forests: in all cases $P > 0.165$).

193 3.2. *Country effects*

194 Our GLZ model revealed that effect of country on bushmeat consumed were
195 relatively minor (Table 2). Nonetheless, country had a statistical effect on the consumption
196 of primates, with people from the Guinean Forests countries being more likely to eat
197 monkeys than people in the Sahel (Table 2). Thus, apart from primates, there were no other
198 statistical differences between areas of Guinean forest countries and Sahelian countries in
199 terms of the probability of consuming the various types of bushmeat.

200 Overall, there were no significant differences between countries (in all cases, at least
201 $P > 0.225$ at χ^2 test) in the proportion of those respondents who declared that they never ate
202 bushmeat (Table 3) as well as in those that declared to frequently eat bushmeat (Table 4).
203 However, there were clear confounding effects of age, gender and urban/rural location on
204 the pure effect of the country (see below). Overall, patterns for the frequency of ‘often-
205 eaten-bushmeat’ responses were more consistent among countries than in the ‘never-eating-
206 bushmeat’ answers (Table 4).

207 In Togo, there was a significant effect of age in urban and rural areas; the frequency
208 of respondents never-eating bushmeat declined significantly with age in both locations
209 (Table 3). No effect of gender was found, but the differences between rural and urban areas
210 depended on the strength of the frequency decreases of never-eating-bushmeat respondents
211 in these two locations, i.e. rural and urban people in Togo tended to respond similarly. In
212 Nigeria (Table 3), there was no effect of age in urban areas (people do not eat bushmeat in
213 general) but in rural areas (only young people did not eat bushmeat). In addition, there was a
214 significant effect of gender in urban areas, with women avoiding eating bushmeat more than
215 men. The overall differences between rural and urban areas were significant for both gender
216 and age (Tables 3 and 4). In Burkina Faso, there was a significant effect of age in urban
217 areas (more young people did not eat bushmeat) but not for rural areas, where people do
218 generally eat bushmeat independent of their age (Tables 3 and 4). In Niger, there was only a
219 significant effect of age, with more young people responding that they would never eat
220 bushmeat compared to older people, in both urban and rural locations (Table 3).

221 3.3. *Age effects*

222 Our GLZ model revealed that the age of the interviewees affected the probability of
223 consuming primates, bats, carnivores, crocodiles, snakes and chelonians, in all cases older
224 people were more likely to consume these animals than younger people (Table 2).

225 Overall, age had a significantly stronger effect on the likelihood of consuming
226 bushmeat in the Sahelian region compared to the Guinean forest region (Fig. 3).
227 Nonetheless, the tendency was the same in both regions: young people tended to never or
228 very rarely consume bushmeat significantly more than people of >25 years age ($P < 0.001$ at
229 χ^2 test).

230

231 3.4. *Gender effects*

232 Overall, gender effects were negligible in both Sahelian and Guinean forests regions,
233 and contributed little to the hierarchical variance partitioning in the interview dataset (Figure
234 3). Nonetheless, some effects of gender were detected in the attitude of consuming a few
235 types of bushmeat as well as in a few local contexts. Indeed, although most people ate
236 ungulates and rodents, there were significant effects of gender on the consumption of these
237 animals, with men being more likely to eat them than women (Table 2). In addition, females
238 tended to avoid eating bushmeat more frequently than males in some countries such as
239 Nigeria. However, this was not a pure gender effect, as it was mediated by age and
240 rural/urban condition in a rather complicated way (Tables 3 and 4). Overall, the ‘often-
241 eating-bushmeat’ response was especially linked to men in either Guinean forests (e.g. Togo)
242 or Sahel (e.g. Burkina Faso) regions.

243

244 3.5. *Rural versus urban*

245 Whether living in rural or urban locations determined the outcome of the
246 interviewees’ answers in the Guinean forest region but not in the Sahelian region (Fig. 3). In
247 other words, attitude towards bushmeat of people from Sahelian regions was similar in both
248 rural and urban locations, whereas in the Guinean forest region there were differences
249 between locations. In addition, in terms of frequency of never-eating bushmeat people,
250 statistical differences between rural versus urban conditions were much higher ($P < 0.001$ at

251 χ^2 test) than those occurring between countries (see above). Whether a person lived in an
252 urban or rural location affected the probability of consuming bushmeat much more than their
253 country of residence.

254 A total of 41.9% of urban and 67.3% of rural respondents stated they consumed
255 bushmeat (Fig. 4); this difference being significant ($\chi^2 = 231.9$, $df = 2$, $P < 0.0001$).

256 According to the different response categories, most interviewees in rural areas mentioned
257 they frequently ate bushmeat ($\chi^2 = 7.3$, $df = 2$, $P < 0.05$), but in urban areas most said they
258 never ate bushmeat ($\chi^2 = 193.4$, $df = 2$, $P < 0.0001$).

259 Overall, ungulates and rodents were eaten by almost all respondents in either rural or
260 urban areas, but carnivores, monkeys and snakes were eaten rarely (differences significant at
261 $P < 0.00001$ compared to ungulates and rodents, χ^2 test), and mainly in rural areas (Fig. 5).

262 Contingency table analysis showed that there were no significant differences between urban
263 and rural areas in terms of frequency of respondents eating the various bushmeat types ($\chi^2 =$
264 14.48, $df = 8$, $P = 0.0699$). However, our GLZ model revealed that primates, bats,
265 carnivores, crocodiles, snakes and chelonians were significantly more likely to be eaten by
266 rural than by urban people, with the highest estimates being for monkeys and bats (Table 2);
267 it was unlikely that people from urban areas, in any of the surveyed countries, ate monkeys
268 and bats.

269 Differences between urban and rural areas were also strongly mediated by the effects
270 of age and gender (Tables 3 and 4). Overall, there were significant differences in both
271 gender and age between rural and urban areas.

272 4. Discussion

273 Previous studies have suggested that bushmeat was universally preferred “due to its superior
274 taste” (King, 1994) and thus African communities therefore preferred and thus primarily ate

275 bushmeat. These statements were not based on empirical evidence until a study reporting on
276 two-choice taste tests showed that consumers in Gabon had only a weak preference for
277 bushmeat and only rural consumers consistently preferred bushmeat over alternatives
278 (Schenck et al., 2006). This result is particularly important given that it manifests that even
279 though basic desires such as hunger and the need for nourishment can influence food choice,
280 availability and cultural norms also affect these. Thus, it is not simply taste that is driving
281 demand for bushmeat, but that price or other culturally mediated factors such as familiarity,
282 tradition, and prestige play a role.

283 Our analyses indicate a very clear and significant difference in bushmeat
284 consumption among rural and urban peoples in all countries. This effect appeared in 7 out
285 of 7 models, in all four of the investigated countries. This difference has been demonstrated
286 in a number of other studies in the African continent (e.g. in the Democratic Republic of
287 Congo, see Van Vliet et al., 2014) and in Madagascar (Jenkins et al., 2011). This contrast
288 between rural and urban dwellers is largely explained by the availability of bushmeat versus
289 alternative protein sources. Rural dwellers are usually restricted in terms of the availability
290 and accessibility of domestic meats but in a much better position to option these resources
291 from the wild. By contrast, urban dwellers have greater access to alternative proteins (Apaza
292 et al., 2002). Nonetheless, cultural complications also explain the preference of non-
293 bushmeat proteins by urban people (see Luiselli et al., 2017 and below).

294 Our analyses clearly showed that age was important in most countries; the pure effect
295 of age was significant in 5 out of 7 models, in Nigeria, Togo and Niger. Younger
296 interviewees generally ate less bushmeat than older persons. That young people ate less
297 bushmeat can in part be due to a growing ‘westernization’ of the lifestyles, especially among
298 the middle classes. These sector of the community often do not see it as ‘socially acceptable’
299 to consume bushmeat, since this is perceived by them as a sign of ‘being very local’ (i.e. not

300 culturally advanced). In contrast the eating of ‘fast foods’ (hamburgers, pizza, kebab, etc.) is
301 now the favourite ‘social diet’ of young people. This pattern is especially evident in urban
302 Nigeria and Togo (our unpublished observations), where young interviewees not only
303 declared that they would not eat bushmeat, but even commented that eating bushmeat was
304 not acceptable because it produces a loss of personal prestige within their circle of friends.
305 In this regard, it was particularly interesting that, among the rarely-eating bushmeat urban
306 people, a sample of 7 young (<25 years) persons from Togo and 15 from Nigeria declared
307 that they would never eat bushmeat in public, but that very occasionally they do during
308 private family events, and only when they visit their rural relatives. Thus, among the
309 respondents who declared that they rarely ate bushmeat, many would only consume
310 bushmeat in special circumstances. We suggest that in urban areas the lower consumption of
311 bushmeat is not because of lack of access, but that it responds to a more culturally-driven
312 avoidance in response to the changing socio-economic context.

313 By contrast to the effects of age we observed in our study, the pure effect of gender
314 was only apparent in 1 out of 7 models. In terms of mixed factors, ‘Gender X Rural/Urban’
315 were significant in 4/7 models and ‘Age X Rural/Urban’ were significant in 5/7 models,
316 whereas ‘Gender X Age’ in 2/7 models. From these results, we conclude that rural/urban
317 and age are much more important than gender in determining the probability for a person to
318 consume bushmeat. The non-effect of gender is probably related to the enhanced equal
319 rights of women and men in West African societies (especially in Nigeria), with young
320 generations being much more equal in terms of gender and lifestyle (see Gender Equality
321 Index database by the African Development Bank, available at www.afdb.org). Thus, since
322 young men and women typically share a similar life-style (especially in urban areas), even
323 their food preferences tend to be very similar.

324 Since, in all countries, and in urban areas in particular, most of the young
325 respondents stated they never ate bushmeat, this would suggest that bushmeat consumption
326 has been substantially decreasing among the new generations of West Africans,
327 independently on their local culture, religion, ethnicity and level of human development. In
328 Nigeria, where the level of human development (average wealth and scholarization
329 standards) are clearly higher than in the other countries (the country being the 22th economy
330 of the world; World Bank, 2016), only older people in rural areas (age > 51 years) answered
331 that they consumed bushmeat more regularly (Table 2).

332 Although our study is the first to cover a broad spectrum of situations, it is important
333 to note that bushmeat trade analysis are much easier to undertake in the Guinean forests
334 region (such as Ivory Coast, Ghana, Nigeria; e.g. see Fa et al., 2002a, 2002b, 2006) than in
335 Sahel. This difference is related to the fact that in the Sahel region there are no open
336 bushmeat markets and people here may be more reluctant to answer interviewers openly
337 because of social norms (Hema et al., 2017, but see Lindsey et al. 2013). This is also
338 possibly linked to the fact that forest can occur close to urban areas in the Guinean Forest
339 region (e.g., Niger Delta forests surrounding Port Harcourt), whereas the same is not true in
340 the Sahel where all the forested or mature savannah sites (from which most of the bushmeat
341 trade does originate) are situated far from larger urban centres (our unpublished
342 observations). Therefore, ‘hub’ markets (Akani et al., 2015) are more likely to be found
343 nearby large cities in the forest zone than in the savannah zone. In conclusion, we argue that
344 the cultural drivers of wildlife use are crucial to take into account when seeking long-term
345 sustainability solutions of wildlife resource extraction (e.g., Luiselli et al., 2017).

346

347 **Acknowledgements.** We are thankful to several organizations, and in particular to the
348 Rivers State University of Science and Technology (Port Harcourt), IDECC – Institute for

349 Development, Ecology, Conservation and Cooperation (Rome), Mohamed Bin Zayed
350 Species Conservation Fund, Conservation International, Turtle Conservation Fund, Andrew
351 Sabin & Family Foundation, T.S.K.J. Nigeria Ltd., IUCN/SSC TFTSG, Aquater s.p.a. and
352 Snamprogetti s.p.a. for having funded our field projects in the studied countries.

353 **References**

- 354 Akani, G.C., Amadi, N., Eniang, E.A., Luiselli, L. & Petrozzi, F., 2015. Are mammal
355 communities occurring at a regional scale reliably represented in “hub” bushmeat
356 markets? A case study with Bayelsa State (Niger Delta, Nigeria). *Folia Zoologica*, 64,
357 79–86.
- 358 Borcard, D., Legendre, P., Drapeau, P., 1992. Partialling out the spatial component of
359 ecological variation. *Ecology*, 73, 1045-1055.
- 360 Brashares, J.S., Golden, C.D., Weinbaum, K.Z., Barrettc, C.B., Okello, G.V., 2011.
361 Economic and geographic drivers of wildlife consumption in rural Africa. *Proc. Natl.*
362 *Acad. Sci. U.S.A.* 108, 13931–13936.
- 363 Ern, H., 1979. Vegetation Togos. Gliederung, Gefährdung, Erhaltung. *Willdenowia* 9, 295-
364 312.
- 365 Fa, J.E., Peres, C., Meeuwig, J., 2002a. Bushmeat exploitation in tropical forests: an
366 intercontinental comparison. *Conserv. Biol.* 16, 232-237.
- 367 Fa, J.E., Seymour, S., Dupain, J., Amin, R., Albrechtsen, L., Macdonald, D., 2006. Getting
368 to grips with the magnitude of exploitation: Bushmeat in the Cross-Sanaga rivers
369 region, Nigeria and Cameroon. *Biol. Conserv.* 129, 497–510.
- 370 Fa, J.E., Juste, J., Burn, R.W., Broad, G., 2002b. Bushmeat consumption and preferences of
371 two ethnic groups in Bioko Island, West Africa. *Human Ecol.* 30, 397–416.

- 372 Fischer, F., Linsenmair, K.E., 2001. Decreases in ungulate population densities. Examples
373 from the Comoé National Park, Ivory Coast. *Biol. Conserv.* 101, 131–135.
- 374 Golden, C.D., Fernald, L.C.H., Brashares, J.S., Rasolofoniaina, B. J. R., Kremen, C., 2011.
375 Benefits of wildlife consumption to child nutrition in a biodiversity hotspot. *Proc. Natl.*
376 *Acad. Sci. USA* 108, 19653–19656.
- 377 Grande-Vega, M., Farfan, M.A., Ondo, A., Fa, J.E., 2016. Decline in hunter offtake of blue
378 duikers in Bioko Island, Equatorial Guinea. *Afr. J. Ecol.* 54, 49–58.
- 379 Hema, E.M., Ouattara, V., Parfait, G., Di Vittorio, M., Sirima, D., Dendi, D., Guenda, W.,
380 Petrozzi, F., Luiselli, L., 2017. Bushmeat consumption in the West African Sahel of
381 Burkina Faso based on interview campaigns, and the decline of some consumed
382 species. *Oryx*, <https://doi.org/10.1017/S0030605316001721>.
- 383 Hosmer, D.W., Lemeshow, S., 2000. *Applied logistic regression analysis*. 2nd ed. John
384 Wiley and Sons, New York.
- 385 Jenkins, R.K., Keane, A., Rakotoarivelo, A.R., Rakotomboavonjy, V., Randrianandrianina,
386 F.H., Razafimanahaka, H. et al., 2011. Analysis of patterns of bushmeat consumption
387 reveals extensive exploitation of protected species in Eastern Madagascar. *PLoS*
388 *ONE* 6(12), e27570.
- 389 Legendre, P., Legendre, L., 1998. *Numerical ecology*. Elsevier Science. Amsterdam,
390 Netherlands.
- 391 Lindsey, P., Balme, G., Becker, M., Begg, C., Bento, C., Bocchino, C., Dickman, A.,
392 Diggle, R., Eves, H., Henschel, P., Lewis, D., Marnewick, K., Mattheus, J., McNutt,
393 J.W., McRobb, R., Midlane, N., Milanzi, J., Morley, R., Murphree, M., Nyoni, P.,
394 Opyene, V., Phadima, J., Purchase, N., Rentsch, D., Roche, C., Shaw, J., van der
395 Westhuizen, H., Van Vliet, N., Zisadza, P., 2012. Illegal hunting and the bush-meat
396 trade in savanna Africa: drivers, impacts and solutions to address the problem.

- 397 Panthera/Zoological Society of London/Wildlife Conservation Society report, New
398 York.
- 399 Luiselli, L., Petrozzi, F., Akani, G.C., Di Vittorio, M., Amadi, N., Ebere, N., Dendi, D.,
400 Amori, G., Eniang, E.A., 2017. Rehashing bushmeat –interview campaigns reveal
401 some controversial issues about the bushmeat trade dynamics in Nigeria. *Rev. Ecol.*
402 (Terre et Vie) 72, 3-18.
- 403 Mainka, S. A., Trivedi, M., 2002. Links between biodiversity conservation, livelihoods and
404 food security: the sustainable use of wild species for meat. IUCN, Gland,
405 Switzerland.
- 406 McCullagh, P., Nelder, J.A., 1989. Generalized linear models. Chapman and Hall/CRC,
407 London, United Kingdom.
- 408 Milner-Gulland, E.J., Bennett, E.L., the SCB 2002 Annual Meeting Wild Meat Group, 2003.
409 Wild meat: the bigger picture. *Tr. Ecol. Evol.* 18, 351-357.
- 410 Nasi, R., Brown, D., Wilkie, D., Bennett, E., Tutin, C., van Tol, G., Christophersen, T.,
411 2008. Conservation and use of wildlife-based resources: the bushmeat crisis.
412 Technical Series no. 33, Secretariat of the Convention on Biological Diversity,
413 Montreal, and Center for International Forestry Research (CIFOR), Bogor.
- 414 Nasi, R., Taber, A., Van Vliet, N., 2011. Empty forests, empty stomachs? Bushmeat and
415 livelihoods in the Congo and Amazon Basins. *Internat. For. Rev.* 13, 355-368.
- 416 Niger Delta Environmental Survey (NDES), 1998. Environmental and Socio-Economic
417 characteristics, volume 1. NDES, Port Harcourt, Nigeria.

- 418 Nuno, A., Bunnefeld, N., Naiman, L.C., Milner-Gulland, E.J., 2014. Novel Approach to
419 Assessing the Prevalence and Drivers of Illegal Bushmeat Hunting in the Serengeti.
420 *Conserv. Biol.* 27, 1355–1365.
- 421 Oates, J.F., Bergl, R.A., Linder, J.M., 2004. Africa's Gulf of Guinea forests: biodiversity
422 patterns and conservation priorities. *Adv. Appl. Biodiv. Sci.* 6, 1–91.
- 423 St John, F.A.V., Gibbons, J.M., Edwards-Jones, G., 2010. Testing novel methods for
424 assessing rule breaking in conservation. *Biol. Conserv.* 143, 1025–1030.
- 425 Thiombiano, A., Kampmann, D., 2010. Atlas de la biodiversité de l'Afrique de l'Ouest.
426 Tome II. Burkina Faso. Ouagadougou and Frankfurt/Main.
- 427 Wilkie, D. S., Godoy, R.A., 2001. Income and price elasticities of bushmeat demand in
428 lowland Amerindian societies. *Conserv. Biol.* 15, 1–9.
- 429 World Bank, 2016. Statistics: countries and economies. World Bank, New York.

430 Table 1. Synopsis of the interview raw data collected during the present surveys in the four studied countries.

	Urban			Total urban	Rural			Total rural
	Often eaten	Rarely eaten	Never eaten		Often eaten	Rarely eaten	Never eaten	
Burkina Faso								
Males (< 25 yr)	0	0	7	7	4	2	2	8
Males (< 50 yr)	7	69	43	119	66	24	7	97
Males (> 51)	7	12	1	20	17	9	3	29
Females (< 25 yr)	2	1	10	13	1	1	21	23
Females (< 50 yr)	6	52	30	88	17	21	33	71
Females (> 51)	1	8	6	15	9	5	3	17
TOTAL SAMPLE	23	142	97	262	114	62	69	245
Niger								
Males (< 25 yr)	2	2	56	60	20	11	45	76
Males (< 50 yr)	4	6	32	42	30	20	39	89
Males (> 51)	5	6	22	33	33	9	37	79
Females (< 25 yr)	1	0	46	47	14	9	44	67
Females (< 50 yr)	4	7	39	50	24	11	30	65
Females (> 51)	7	7	26	40	22	10	31	63
TOTAL SAMPLE	23	28	221	272	143	70	226	439
Togo								
Males (< 25 yr)	11	9	33	53	14	8	21	43
Males (< 50 yr)	12	16	15	43	33	24	2	59
Males (> 51)	14	12	5	31	24	7	1	32
Females (< 25 yr)	0	11	41	52	4	16	26	46
Females (< 50 yr)	7	17	23	47	14	7	4	25
Females (> 51)	16	11	11	38	16	2	2	20
TOTAL SAMPLE	60	76	128	264	105	64	56	225
Nigeria								
Males (< 25 yr)	7	14	56	77	17	31	11	59
Males (< 50 yr)	12	23	44	79	21	23	8	52
Males (> 51)	16	31	39	86	22	41	5	68

Females (< 25 yr)	3	6	62	71	13	43	14	70
Females (< 50 yr)	7	12	46	65	9	11	2	22
Females (> 51)	19	23	35	77	14	5	1	20
TOTAL SAMPLE	64	109	282	455	96	154	41	291
GRAND TOTAL	170	355	728	1253	458	350	392	1200

431 Table 2. Results of the Generalized Linear Model on the probability of eating bushmeat by type of animals
 432 by country, urban/rural locality, age, sex and gender (female/male). Intercepts are included in all models, and
 433 the explained deviance (in %) is also shown. Negative estimates for gender means a preponderance of male
 434 respondents. Positive estimates for age indicates a preponderance of older age classes respondents.

Variable	Estimate	St. error	Wald	P
Ungulates				
Intercept	211.71	72.41	8.55	0.003
Gender	-1.68	0.82	4.18	0.041
Explained deviance (%)	90.20			
Rodents				
Intercept	295.85	202.43	2.14	0.144
Gender	-5.14	2.29	5.02	0.025
Explained deviance (%)	88.08			
Monkeys				
Intercept	-2079.08	431.87	23.17	0.000001
Country	5.93	2.99	3.92	0.048
Urban/Rural	-31.26	4.89	40.89	0.000001
Age	14.92	2.99	24.85	0.000001
Explained deviance (%)	34.07			
Bats				
Intercept	-1596.00	376.76	17.94	0.000023
Urban/Rural	-29.26	6.03	23.54	0.000001
Age	16.13	3.69	19.08	0.000013
Explained deviance (%)	45.79			
Carnivores				
Intercept	-1408.96	335.10	17.68	0.000026
Urban/Rural	-17.45	5.36	10.58	0.0011
Age	14.22	3.28	18.74	0.000015
Explained deviance (%)	55.90			
Birds				
Intercept	-837.82	493.40	2.88	0.089

Age	7.33	3.42	4.60	0.032
Explained deviance (%)	88.74			
Crocodiles				
Intercept	-1439.25	453.05	10.09	0.0015
Urban/Rural	-22.29	5.13	18.89	0.000014
Age	15.28	3.14	23.68	0.000001
Explained deviance (%)	46.41			
Snakes				
Intercept	-1330.51	345.56	14.82	0.000118
Urban/Rural	-20.61	5.53	13.87	0.000195
Age	13.41	3.39	15.66	0.000076
Explained deviance (%)	55.05			
Turtles				
Intercept	-853.91	296.62	8.29	0.0039
Urban/Rural	-15.25	4.75	10.31	0.0013
Age	9.156	2.9079	9.91504	0.001639
Explained deviance (%)	64.03			

435

436

437 Table 3. Summary of the results of contingency tables on the frequencies of the never-eating bushmeat respondents by country. In this table, ‘towards’ would
 438 indicate the direction of the significant effect. For instance, if in a given area, there was a significantly higher number of ‘never-eating-bushmeat’ respondents for
 439 young people (< 25 years age), this is highlighted in the table with ‘towards young’.

	Differences between gender in rural	Differences between gender in urban	Differences by age in rural	Differences by age in urban	Differences between urban and rural by gender	Differences between urban and rural by age
Togo	P = n.s.	P = n.s.	P < 0.01 (towards young) P < 0.01 (towards old people)	P < 0.01 (towards young)	P = n.s.	P = n.s.
Nigeria Burkina Faso	P = n.s. P < 0.01 (towards men)	P < 0.05 (towards men) P < 0.05 (towards women)	P = n.s. P < 0.05 (towards young)	P = n.s. P < 0.05 (towards young) P < 0.05 (towards young)	P < 0.01 (due to men in urban areas) P < 0.0001 (due to opposite signs of differences)	P < 0.05 (due to age in rural areas) P < 0.05 (due to consistent trends of age: young do not eat bushmeat)
Niger	P = n.s.	P = n.s.	P < 0.05 (towards young)	P < 0.05 (towards young)	P = n.s.	P = n.s.

440

441

442 Table 4. Summary of the results of contingency tables on the frequencies of the often-eating bushmeat respondents by country. In this table, ‘towards’ would
 443 indicate the direction of the significant effect. For instance, if in a given area, there was a significantly higher number of ‘never-eating-bushmeat’ respondents for
 444 young people (< 25 years age), this is highlighted in the table with ‘towards young’.

	Differences between gender in rural	Differences between gender in urban	Differences by age in rural	Differences by age in urban	Differences between urban and rural by gender	Differences between urban and rural by age
Togo	P < 0.05 (towards men)	P < 0.05 (towards men)	P < 0.05 (towards young)	P < 0.01 (towards young)	P = n.s.	P = n.s.
Nigeria	P = n.s.	P = n.s.	P = n.s.	P < 0.01 (towards young)	P = n.s.	P < 0.05 (due to young people responses negative effect)
Burkina Faso	P < 0.001 (towards men)	P < 0.001 (towards men)	P = n.s.	P < 0.0001 (towards young)	P < 0.05 (due to men)	P < 0.05 (due to young people responses negative effect)
Niger	P = n.s.	P = n.s.	P = n.s.	P < 0.05 (towards young)	P = n.s.	P = n.s.

445

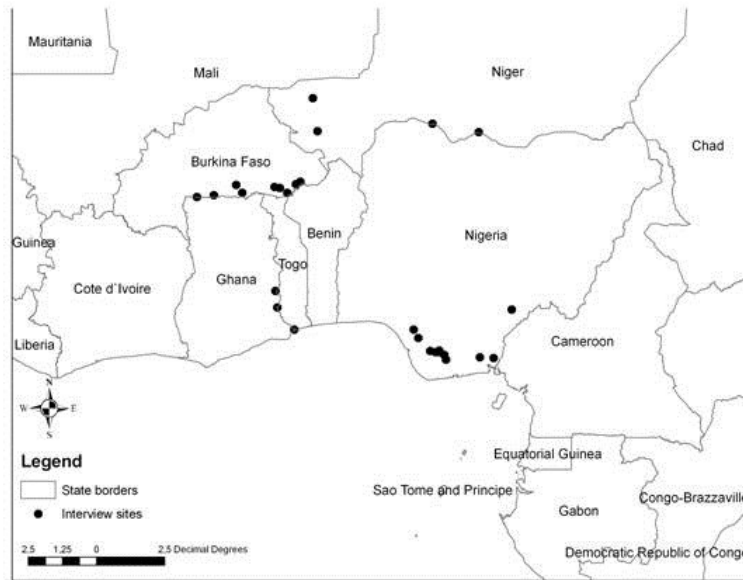
446

447 Table 5. Significant effects ($P < 0.05$; indicated with a X) of the various parameters on the frequency of
 448 respondents claiming to eat bushmeat, by a GLM mixed model analysis.

	Nigeria	Togo	Burkina Faso	Niger	Guinean Forests	Sahel	All pooled
Gender			X				
Age	X	X		X	X		X
Rural/urban	X	X	X	X	X	X	X
Gender X Age		X			X		
Gender X Rural/Urban	X		X			X	X
Age X Rural/urban	X	X		X	X		X

449

450 Figure 1. Map of West Africa showing the study sites where interviews were carried out



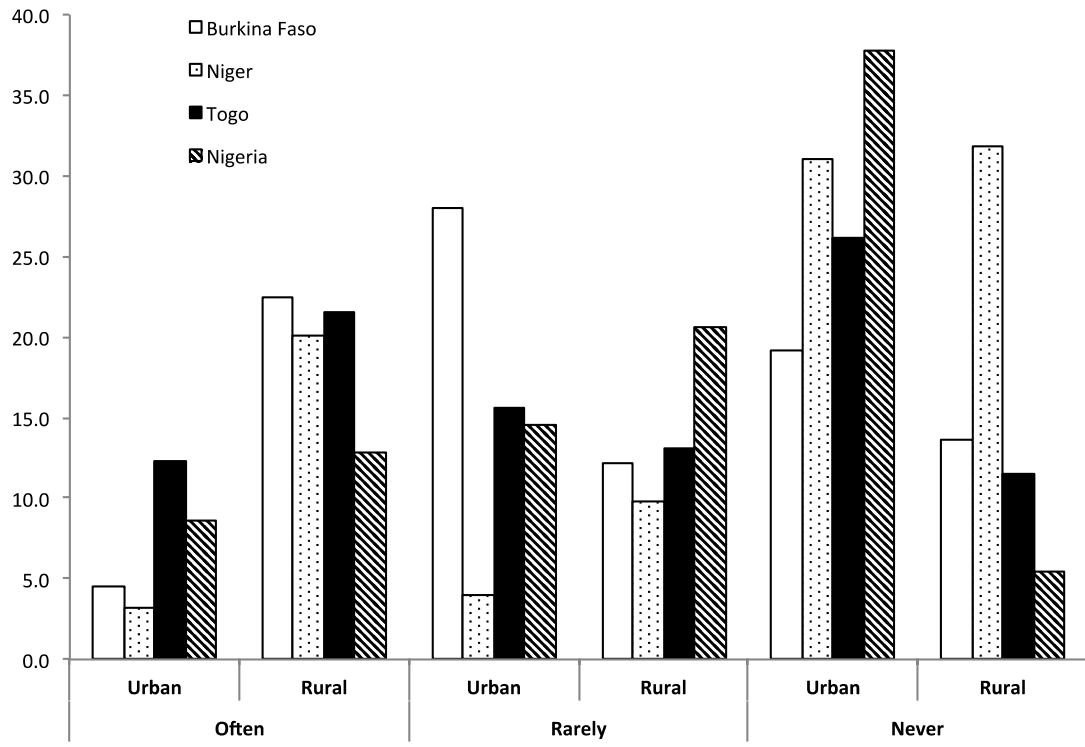
451

452

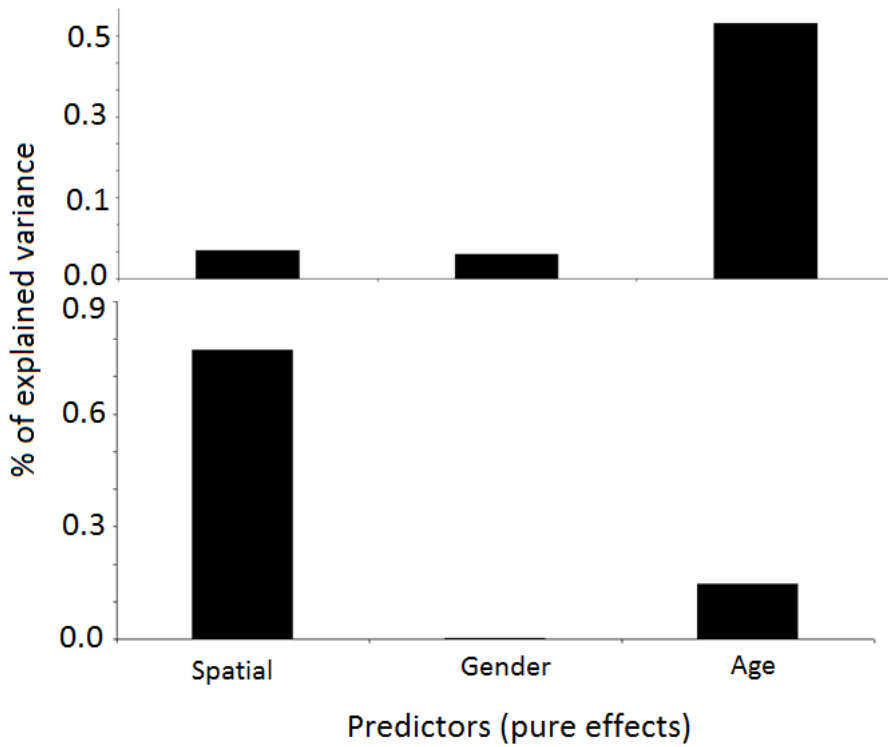
453

454 Figure 2. Percent interviewees responding whether bushmeat was eaten often, rarely or never in urban and
 455 rural settlements in the four countries studied in West Africa.

456



457 Figure 3. Relative importance of predictors (pure effect), as determined by hierarchical variation partitioning,
458 for the model considering all the interviewees' responses as dependent variable, for the Sahel countries
459 (upper graphic) and for the Guinean forests countries (lower graphic). Spatial = urban/rural.

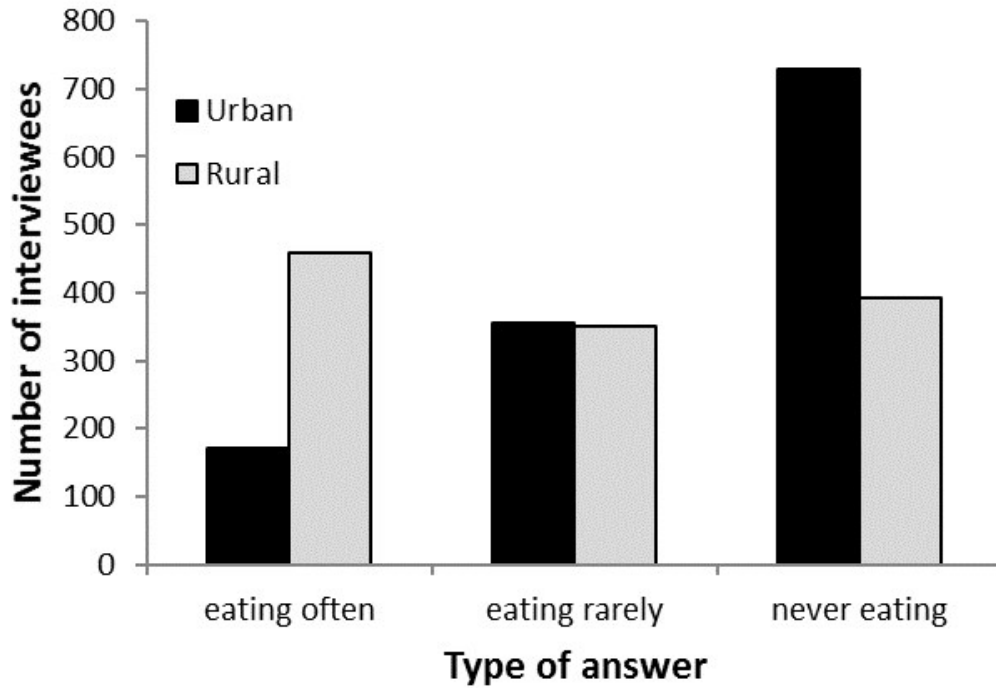


460

461

462

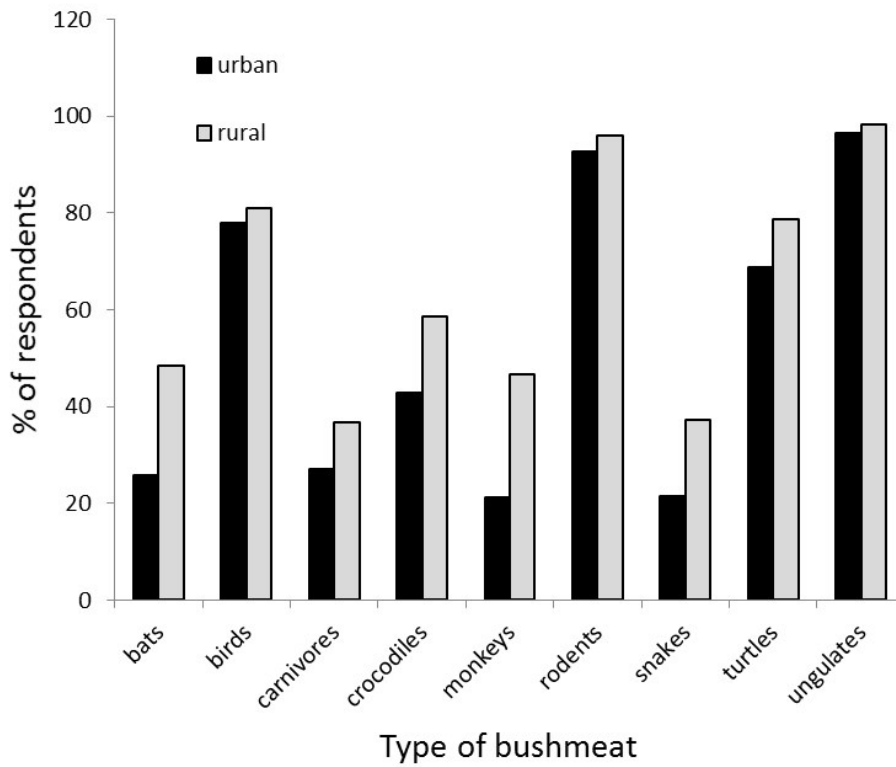
463 Figure 4. Distribution of the various types of answer by respondents in urban versus rural areas in the four
464 studied countries of West Africa as for whether they would eat bushmeat often, rarely or never. All data from
465 the different countries were pooled for this graphic



466

467

468 Figure 5. Distribution of the various types of answer by respondents in urban versus rural areas in the four
469 studied countries of West Africa as for the type of consumed bushmeat is concerned. All data from the
470 different countries were pooled for this graphic



471

472

474 Appendix 1. Codes for the variables used in the Generalized Linear Models (GLZs).

Country	Class	Locality	Cod Loc	Cod age	Cod sex	Never eat bushmeat
Burkina Faso	Males (< 25 yr)	URBAN	1	g	1	7
Burkina Faso	Males (< 50 yr)	URBAN	1	m	1	43
Burkina Faso	Males (> 51)	URBAN	1	a	1	1
Burkina Faso	Females (< 25 yr)	URBAN	1	g	0	10
Burkina Faso	Females (< 50 yr)	URBAN	1	m	0	30
Burkina Faso	Females (> 51)	URBAN	1	a	0	6
Burkina Faso	Males (< 25 yr)	Rural	0	g	1	2
Burkina Faso	Males (< 50 yr)	Rural	0	m	1	7
Burkina Faso	Males (> 51)	Rural	0	a	1	3
Burkina Faso	Females (< 25 yr)	Rural	0	g	0	21
Burkina Faso	Females (< 50 yr)	Rural	0	m	0	33
Burkina Faso	Females (> 51)	Rural	0	a	0	3
Nigeria	Males (< 25 yr)	URBAN	1	g	1	77
Nigeria	Males (< 50 yr)	URBAN	1	m	1	79
Nigeria	Males (> 51)	URBAN	1	a	1	86
Nigeria	Females (< 25 yr)	URBAN	1	g	0	71
Nigeria	Females (< 50 yr)	URBAN	1	m	0	65
Nigeria	Females (> 51)	URBAN	1	a	0	77
Nigeria	Males (< 25 yr)	Rural	0	g	1	59
Nigeria	Males (< 50 yr)	Rural	0	m	1	52
Nigeria	Males (> 51)	Rural	0	a	1	68
Nigeria	Females (< 25 yr)	Rural	0	g	0	70
Nigeria	Females (< 50 yr)	Rural	0	m	0	22
Nigeria	Females (> 51)	Rural	0	a	0	20
Niger	Males (< 25 yr)	URBAN	1	g	1	4
Niger	Males (< 50 yr)	URBAN	1	m	1	4
Niger	Males (> 51)	URBAN	1	a	1	7
Niger	Females (< 25 yr)	URBAN	1	g	0	1
Niger	Females (< 50 yr)	URBAN	1	m	0	9
Niger	Females (> 51)	URBAN	1	a	0	6
Niger	Males (< 25 yr)	Rural	0	g	1	6
Niger	Males (< 50 yr)	Rural	0	m	1	5
Niger	Males (> 51)	Rural	0	a	1	9
Niger	Females (< 25 yr)	Rural	0	g	0	3
Niger	Females (< 50 yr)	Rural	0	m	0	7
Niger	Females (> 51)	Rural	0	a	0	9
Togo	Males (< 25 yr)	URBAN	1	g	1	33
Togo	Males (< 50 yr)	URBAN	1	m	1	15
Togo	Males (> 51)	URBAN	1	a	1	5
Togo	Females (< 25 yr)	URBAN	1	g	0	41
Togo	Females (< 50 yr)	URBAN	1	m	0	23
Togo	Females (> 51)	URBAN	1	a	0	11
Togo	Males (< 25 yr)	Rural	0	g	1	21
Togo	Males (< 50 yr)	Rural	0	m	1	2
Togo	Males (> 51)	Rural	0	a	1	1
Togo	Females (< 25 yr)	Rural	0	g	0	26
Togo	Females (< 50 yr)	Rural	0	m	0	4
Togo	Females (> 51)	Rural	0	a	0	2

475

476

477 Appendix 2. Summary of the raw data on the types of eaten bushmeat by people in the investigated countries.

		Males (< 25 yr)	Males (< 50 yr)	Males (> 51)	Females (< 25 yr)	Females (< 50 yr)	Females (> 51)	Total interviewees
Nigeria		21	35	47	9	19	42	173
	ungulates	21	34	45	9	19	40	
	rodents	21	31	41	9	19	39	
Urban	monkeys	2	7	11	0	3	6	
	bats	3	7	8	1	3	11	
	carnivores	2	10	15	0	2	5	
	birds	15	26	33	5	15	28	
	crocodiles	8	15	27	1	5	9	
	snakes	1	3	5	0	0	3	
	turtles	16	22	26	6	14	32	
Nigeria		48	44	63	56	20	19	250
	ungulates	48	43	61	56	20	19	
	rodents	48	41	55	56	18	19	
Rural	monkeys	6	23	31	3	3	11	
	bats	7	17	22	7	5	13	
	carnivores	9	14	20	21	6	11	
	birds	39	40	55	45	17	17	
	crocodiles	23	21	38	32	9	17	
	snakes	2	8	19	4	6	9	
	turtles	44	33	51	36	16	19	
Togo		20	28	26	11	23	27	136
	ungulates	19	26	25	11	22	25	
	rodents	13	23	24	11	22	23	
Urban	monkeys	4	6	6	0	1	4	
	bats	4	9	6	0	1	3	
	carnivores	8	6	6	0	2	8	
	birds	15	21	21	10	17	23	
	crocodiles	3	18	8	3	6	11	
	snakes	2	4	4	0	1	6	

Togo	turtles	9	16	16	5	15	24	169
		22	57	31	20	21	18	
Rural	ungulates	22	54	31	20	21	18	
	rodents	22	49	31	20	21	18	
	monkeys	14	25	25	2	11	15	
	bats	13	27	27	0	8	17	
	carnivores	3	11	21	1	6	16	
	birds	16	24	31	17	19	18	
	crocodiles	13	26	28	3	8	14	
	snakes	11	22	20	1	6	11	
	turtles	14	41	27	16	17	16	
Niger		4	10	11	1	11	14	51
	ungulates	4	9	11	1	11	14	
	rodents	4	10	11	1	11	14	
Urban	monkeys	0	1	4	0	4	7	
	bats	0	2	3	0	5	11	
	carnivores	0	1	4	0	8	7	
	birds	4	8	9	0	10	12	
	crocodiles	1	6	6	0	7	8	
	snakes	1	4	6	0	7	5	
		turtles	3	8	9	0	10	
Niger		31	50	41	23	35	32	213
	ungulates	30	48	41	22	35	32	
	rodents	29	48	41	23	35	32	
Rural	monkeys	8	21	26	16	20	25	
	bats	12	33	27	14	20	27	
	carnivores	8	19	17	11	16	22	
	birds	21	41	37	18	31	31	
	crocodiles	9	28	33	13	28	28	
	snakes	8	21	27	9	18	25	
		turtles	23	33	38	16	28	

