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1 Synthesising bushmeat research effort in West and
2 Central Africa: an introduction to a new regional
3 database.

4 **Taylor, G., Scharlemann, J.P.W., Rowcliff, M., Kümpel, N., Harfoot, M., Fa, J.E.,**
5 **Melisch, R., Milner-Gulland, E.J., Bhagwat, S.,** Abernethy, K.A., Abugiche, A.S.,
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7 A., Brown, E., Brugiere, D., Carpaneto, G.M., Colell, M., Cowlshaw, G., Crookes,
8 D., De Merode, E., Dethier, M., Dupain, J., East, T., Edderai, D., Fargeot, C.,
9 Fossung, E.E., Gill, D., Greengrass, E., Hayashi, K., Hickey., Hodgkinson, C.,
10 Hoffman, M., Jeanmart, P., Juste, J., Linder, J.M., MacDonald, D.W., Mbete, P.
11 Muchaal, P.K., Noss, A.J., Okorie, P.U., Okouyi, V.J.J., Pailler, S., Poulsen, J.R.,
12 Puit, M., Riddell, M., Rist, J., Shulte-Herbruggen, B., Starkey, M., Schleicher, J.,
13 Thibault, M., van Vliet, N., Whitham, C., Wilcox, A.S., Wilkie, D.S., Wright, J.H.,
14 **Coad, L.***

15 *Corresponding author

16

17

18

19 **Abstract**

20 Unsustainable hunting threatens both biodiversity and local livelihoods. Despite the
21 high level of research effort that has focussed on understanding the dynamics of the
22 bushmeat trade and bushmeat consumption, current research is largely site
23 specific. Without synthesis and quantitative analysis of available case studies, the
24 national and regional characteristics of bushmeat trade and consumption remain
25 largely speculative, impeding efforts to inform national and regional policy on the
26 bushmeat trade. Here we describe the structure and content of the Central and
27 West African bushmeat database which holds quantitative data on bushmeat sales,
28 consumption and offtake from 268 sites across 11 countries in the region, spanning
29 three decades of research. We find that despite this wealth of available data, there
30 are important biases in research effort. Few data exist for West Africa, and the
31 majority of studies in both regions have collected market data, which although
32 providing a useful record of bushmeat sales, are limited in their ability to track
33 changes in hunting offtake. In addition, few studies have been able to track changes
34 over time, using repeat sampling. With new initiatives in the region to track
35 indicators of bushmeat hunting, the creation of this database represents an
36 opportunity to synthesise current data on bushmeat hunting, consumption and trade
37 in West and Central Africa, identify gaps in our understanding, and systematically
38 target future monitoring efforts.

39 Introduction

40 In tropical forests worldwide, hunting of wild animals is an important source
41 of food and income for many rural peoples (Milner-Gulland & Bennett 2003;
42 Abernethy et al. 2013). In West and Central Africa in particular, present hunting
43 levels are considered unsustainable, largely driven by the demand of the
44 burgeoning human population (Wilkie & Carpenter 1999; van Vliet et al. 2012a;
45 Abernethy et al. 2013). The loss of wildlife resources in these forests will not only
46 have detrimental impacts on biological diversity and ecosystem integrity, but also
47 affect people's livelihoods (Kaltenborn et al. 2005; Nasi et al. 2011).

48 Despite a wealth of studies documenting offtakes, consumption and trade of
49 wild meat in tropical forests across Africa since the 1960s (e.g. Asibey, 1966), most
50 studies have targeted small catchment areas (often around single sites) over short
51 time periods (but see Fa et al. 2002). While such studies provide valuable site-level
52 data, information on bushmeat use on a larger scale (and over longer time frames)
53 is currently lacking.

54 Contrasting and combining results from studies at regional or national scales,
55 can help to identify spatial and temporal patterns (and outliers) in bushmeat use,
56 and where time-series data are available, can be used to track changes in
57 bushmeat use and indicators of ecological depletion. Such information could assist
58 decision-makers to develop evidence-based conservation strategies (van Vliet *et*
59 *al.*, 2012b). To date, some studies have employed systematic literature reviews to
60 determine regional bushmeat offtake trends within the Congo Basin (Wilkie &
61 Carpenter, 1999), or to compare between continental forest regions (Fa et al., 2002,

62 2005). While these studies illustrate the potential for meta-analyses to shed light on
63 regional trends in bushmeat use, they have been limited by the availability of raw
64 data from published studies (<40 sites).

65 The Convention on International Trade in Endangered Species of Wild Fauna
66 and Flora (CITES) and the Convention on Biological Diversity (CBD) since 2000
67 and 2008, respectively, require Parties to comply with recommendations,
68 resolutions and decisions related to 'bushmeat' issues and call upon Parties and
69 organizations with relevant expertise to build databases and provide knowledge in
70 the context of bushmeat harvest, trade and use. At the recent CBD 11th Conference
71 of Parties Parties agreed on '*sustainable use of biodiversity: bushmeat and*
72 *sustainable wildlife management*' explicitly calling for the development of
73 '*...appropriate monitoring systems of bushmeat harvest and trade [that] should be*
74 *based on an integration of traditional, indigenous and scientific knowledge* (Decision
75 XI/25, CBD 2012)'.
76

76 In response to these calls we have developed the Central and West Africa
77 Bushmeat database, using a systematic approach to identify quantitative datasets
78 on bushmeat use. This region was chosen as initial literature searches on global
79 wildlife harvest yielded substantially more information from West and Central Africa,
80 and the authors have established networks of conservation researchers in the
81 region. We present initial results on research effort, describing the spatial and
82 temporal extent of quantitative research into offtakes, consumption and market
83 sales of bushmeat over 30 years. We ask the following preliminary questions of the
84 database: 1) How many quantitative studies of bushmeat use exist for the West and

85 Central African regions, and how has research effort varied through time?; 2) Where
86 geographically has the majority of research effort occurred?; 3) What types of data
87 have been collected?; 4) What levels of sampling effort have been employed at
88 each site?; and 5) Which species are represented within the current research effort?

89 We discuss research gaps, and potential applications of the database, and
90 propose plans to make the database an open-access resource for the conservation
91 community.

92 **Methods**

93 **Definition of the term bushmeat and geographic scope**

94 We used the term “bushmeat hunting” as defined by the CBD’s Liaison
95 Group on Bushmeat ‘as the harvesting of wild animals in tropical and sub-tropical
96 countries for food and for non-food purposes, including for medicinal use’ (CBD,
97 2011). Bushmeat is described as ‘as any non-domesticated terrestrial mammal,
98 bird, reptile and amphibian harvested for food. Insects, crustaceans, molluscs and
99 fish are excluded from this definition’ (Nasi et al., 2008).

100 Our study region included all 10 Central African countries in the Central
101 African Forests Commission (COMIFAC www.comifac.org), and all countries
102 within the Economic Community of West African States (ECOWAS
103 www.ecowas.int).

104 **Literature search and e-mail campaign**

105 A comprehensive search of the available data sources was conducted from
106 June 2012 to June 2013. We searched scientific bibliographic databases, thesis
107 archives, specialist, academic search engines and conservation NGO websites
108 (Supplementary Materials, S1). We used relevant keywords and secondary terms in
109 English, French and Spanish (S2) to find sources. In addition, we contacted a
110 number of relevant conservation and development organisations (S1; many
111 organisations then sent our request out to their contact lists) stating our project
112 goals and asking for further contacts and/or any quantitative raw data. This

113 'snowball' sampling technique (Noy, 2008) resulted in additional unpublished data
114 sources added to the database.

115 **Data inclusion criteria**

116 Datasets were included if they: 1) provided a quantitative measure of
117 bushmeat offtake, consumption and/or market availability/sales; 2) used non-biased
118 data collection methods (e.g. all species were recorded) and settlements/hunters
119 were sampled systematically to prevent selection bias; 3) identified carcasses to the
120 species level (but see exceptions that were included at the genus level in S3) which
121 were then 4) recorded either as number of carcasses or as total biomass (kg). In
122 those cases where data were only partially provided, we requested additional
123 information directly from the authors.

124 **Data extraction and database terminology**

125 Data Sources that matched the above criteria for inclusion had the required
126 data extracted and stored in a purpose-built Microsoft Access database (2010) .

- 127 ○ **Source** refers to the source of the data, either a scientific publication,
128 NGO report or raw data.
- 129 ○ **Site** refers to the location where the data were collected. The 'Site'
130 table holds the geographic coordinates of the site as well as
131 information on site characteristics (e.g. country, settlement type,
132 population size).
- 133 ○ **Sample** refers to the data collected over a specific delimited time
134 period at a specific site, and collecting a specific data type (market,

135 consumption or offtake, see below). The 'sample' table holds data on
136 the dates of the sample, the data type and the sampling methods and
137 effort. Where the same sample was published in multiple references,
138 we only included the sample once, from the earliest reference.

139 ○ **Harvest data** refers to the meat hunted, offered/sold or consumed.
140 The 'Bushmeat' table holds data on the number or biomass of each
141 species recorded for each sample.

142 ○ **Data type** - We categorised data as one of three different types:

143 'Market' data collected on the number/biomass of each taxon offered or sold
144 at a market (not individual shops, restaurants or chopbars).

145 'Consumption' data collected on the number/biomass of each taxon
146 consumed by a household.

147 'Offtake': Data collected on the number/biomass of each taxon caught by a
148 hunter or household.

149 A full list of references, sites and samples held in the database on 1st June
150 2013 is provided in S4.

151 **Results**

152 **Data types, sites and samples**

153 The June 2013 version of the database holds data gathered from 67 sources, which
154 have collected data from 268 sites across the region. These sites hold a further 276
155 samples. Of these sources, 36 were published scientific papers, eight NGO
156 reports, 15 academic theses and seven raw data sets, from which data has been
157 published, and one unpublished raw dataset. Although the first samples were
158 collected in 1981, the majority (80%) of samples, for which exact dates were known,
159 were collected between 2001 and 2011 (Figure 2), with a mean of 20 (SE+/-33)
160 samples per year in this period compared to 5.1 (SE+/-4.4) per year from 1991-
161 2000 and 1.3 (SE+/-0.5) per year from 1981- 1990.

162 **Geographical distribution of research effort**

163 Research effort has focussed more on Central Africa, with data available for
164 six of 10 countries (213 samples), compared to West Africa, with data for five of 15
165 countries (63 samples; Figure 3). Sample numbers by country are provided in S5).
166 Surveyed sites were concentrated in the Cross-Sanga region of Nigeria and
167 Cameroon, where Fa et al. (2006) collected market data at 86 sites.

168 **Type of data collected**

169 The proportion of data types (market, consumption and offtake) sampled was
170 similar across regions (Appendix Figure 6). In Central Africa, market samples were
171 the most commonly collected data type (50.7%), followed by offtake (26.8%) and
172 consumption (22.5%). In West Africa market samples comprised the majority

173 (79.4%), followed by offtake (17.5%) and consumption (3.2%). Only two
174 consumption samples were collected in West Africa, at two sites in Liberia (Figure
175 3d).

176 **Time and duration of samples**

177 For samples where the exact dates of collection were known (n = 253
178 samples) the mean length of data collection was about six months (174 days SE
179 14.2 days). Samples of market data tended to be collected over longer periods of
180 time (192 ± 20 days) compared to samples of offtake (152 ± 22 days) or
181 consumption (109 ± 16 days).

182 Forty-two sites (37 Central, 5 West) have been surveyed more than once.
183 For the majority of these (30 Central, 3 West), two different data types were
184 collected (e.g. the site had a market survey and a consumption survey). Repeat
185 surveys of the same data type at the same site in different years, which would
186 permit time-series analyses, have been collected at 13 sites (Figure 3a). Ten of
187 these sites were located in Central Africa (Cameroon, Equatorial Guinea, Gabon
188 and DRC) and three in West (Ghana and Cote d'Ivoire). These repeat samples
189 were either offtake or market studies with between two and four repeats per site
190 separated by between 0.5 and 15 years, the mean being 5.4 years.

191 **Species represented in the database**

192 A total of 179 different species from 27 orders have been recorded in the
193 database, 75% of these were mammals (Table 1; see S7 for full species list).

194 Although the majority of species are classified by IUCN Red List as Least Concern
195 (64%), 17.3% were classified as Critically Endangered, Endangered or Vulnerable.

196 **Discussion**

197 Conservation practice and policy have been criticized for being based on
198 anecdotal sources rather than empirical evidence (Sutherland *et al.*, 2004).
199 According to the CBD (2012), '*management decisions should be made based on*
200 *the best available and applicable science, the precautionary approach and the*
201 *practices and traditional knowledge of indigenous and local communities*'.
202 Systematic reviews or meta-analyses can provide an important evidence base to
203 inform conservation decisions (Sutherland *et al.*, 2004). The West and Central
204 African Bushmeat database has been created with the aim of synthesising all
205 quantitative bushmeat studies in the region, and providing a tool for analysing
206 trends in bushmeat harvest, consumption and trade at the national and regional
207 level.

208 Despite the large number of references identified during this study, we
209 suspect that further datasets exist, but are not currently publicly available. The
210 majority of identified datasets were published in peer-reviewed journals or as
211 academic theses online. For many sources we needed to contact the authors to get
212 access to the original raw data to fully complete the database records as only
213 summary data were available in the published papers. However, many NGO reports
214 are published internally within the organisation, or on NGO websites, and can
215 remain undetected, despite holding valuable site-specific information. Studies
216 included in this project were also most likely to have been published in the last
217 decade. Although this probably reflects a genuine increase in research effort, it may
218 also partly reflect an increase in online publication of student theses and NGO

219 reports, which would previously have been published only as hardcopy and
220 therefore may not have been found by this study. Many older reports are only
221 available in country, or directly from the authors, and we would ask that anyone who
222 knows of any datasets that may have been overlooked by this study contact the
223 corresponding author. In the medium to long term we envisage that the database
224 will be developed to function as a live, public repository for both published and
225 unpublished datasets of bushmeat, to allow near real-time, comprehensive
226 information on bushmeat indicators to be made available to decision makers.

227 Market data was the most commonly collected data type, possibly reflecting
228 the relative ease with which data can be collected at urban bushmeat markets.
229 However, changes in the species composition of bushmeat markets may not reflect
230 changes in species composition of the surrounding area, due to changes in hunting
231 areas, effort and hunting technologies, and therefore studies of urban markets alone
232 must always be inconclusive (Ling and Milner Gulland 2006). In comparison, few
233 data are currently available on bushmeat consumption and consumer choices,
234 especially in West Africa where data on bushmeat consumption were only available
235 for Liberia. Consumer demand, as indicated by consumption, is potentially a critical
236 aspect to monitor, since we expect changes in demand to be a key determinant of
237 future hunting and trade efforts and ultimately sustainable resource use (Van Vliet,
238 2010). This highlights a need for increasing research efforts on consumption studies
239 and the need to better understand consumers' preferences. Offtake studies, either
240 through direct observations of hunter follows, bag counts and interviews enable
241 estimation of CPUE (Catch per unit effort), often used to assess sustainability.
242 However caution must also be taken when collecting and analysing recall data as

243 hunters can underestimate their catch if not all traps had been checked, if they had
244 eaten individuals whilst hunting or simply forgotten every species caught (Hickey
245 2008).

246 A geographical bias also exists, with more sites surveyed in Central Africa
247 than in West Africa, and disproportionate focus on certain countries within Central
248 Africa (Gabon, Equatorial Guinea, Cameroon and Nigeria). This may partly reflect
249 the accessibility of the research sites, as well as the interests of research
250 institutions and donor organisations, and that of the lead authors. It may also reflect
251 a focus on areas perceived to be experiencing higher bushmeat hunting and trade
252 intensities, and hence higher levels of threat. West Africa has already lost much of
253 its original tropical forest and has seen much higher hunting intensities than the less
254 fragmented Central African forests (Schulte-Herbrüggen *et al*, 2013, Bennet *et al*,
255 2007; Craigie *et al*, 2010). There is therefore a perception that West Africa is now in
256 a 'post-depletion' phase, having already lost larger wildlife species from most of the
257 region (Cowlshaw *et al*, 2005). This could be, and perhaps has been, taken to imply
258 that studies are more urgent in the less depleted parts of Central Africa, where there
259 are still extensive wildlife populations to protect. However, this characterisation of
260 West Africa as being more depleted, is a generalisation that probably masks
261 considerable variation in patterns of depletion, trade and consumption within this
262 region (Data from a wider geographical range of sites would be desirable, including
263 more depleted areas in both West and Central Africa. Furthermore, by
264 concentrating on sites that are perceived to have high levels of hunting activity,
265 research may simply track the leading edge of a depletion wave while failing to
266 reflect accurately the regional dynamics in bushmeat hunting.

267 Hunting sustainability cannot be inferred from static data (Coad et al. 2013), but of
268 the sites identified in this study, less than 5% had repeat samples of the same data
269 type. Few studies have therefore been able to track changes in hunting
270 consumption or offtakes over time (but see Coad et al, 2013; Gill et al. 2012). To
271 reduce this problem, a more systematically selected and regularly monitored set of
272 sites would be desirable, spanning a range of current depletion levels in both
273 regions. NGO's and research institutions should capitalise on the wealth of baseline
274 data presented in this database and resample sites, to increase our knowledge of
275 how (and why) bushmeat use changes over time. For example monitoring systems
276 such as SYVBAC (Système de suivi de la filière viande de brousse en Afrique
277 Centrale: Development of a Central African Bushmeat Monitoring System), a newly
278 developed and anticipated approach will operate under the Central African Forests
279 Observatory, aims to support the development of policies and strategies for the
280 sustainable use of bushmeat in Central Africa (see TRAFFIC 2008, Van Vliet 2010a
281 and 2010b). The objectives of SYVBAC are to collect data on key indicators to track
282 bushmeat offtake, trade and consumption, impacts of bushmeat hunting on wildlife
283 populations, and ultimately the sustainability of current hunting levels, at
284 systematically selected sites (to represent villages, towns, community hunting
285 zones, sport hunting areas, logging /mining concessions, protected areas and buffer
286 zones) across Central Africa. This database can be a valuable tool throughout the
287 development, implementation and review stages of such projects.

288 Based on our very preliminary collation and analyses of bushmeat data for
289 West and Central Africa, we suggest the following priorities for bushmeat research
290 and policy that would benefit from using this database:

- 291
- Investigate the drivers of bushmeat use, consumption and sales at national
292 and regional levels by undertaking a meta-analysis of existing studies;
- 293
- Develop indicators for measuring bushmeat use and sustainability, designed
294 to inform national and regional policy on bushmeat hunting. Indicators should
295 be scientifically robust, as well as practically feasible to collect;
- 296
- Identify knowledge gaps and future research priorities for bushmeat. The
297 studies collated in this database provide an overview of past research effort
298 in West and Central Africa. However, they were originally collected as
299 individual studies, rather than undertaken with one overriding research goal
300 in mind. This database can now function as an evolving baseline for
301 bushmeat research, enabling researchers, in collaboration with conservation
302 practitioners, to take stock, and identify the key questions for future
303 bushmeat research.

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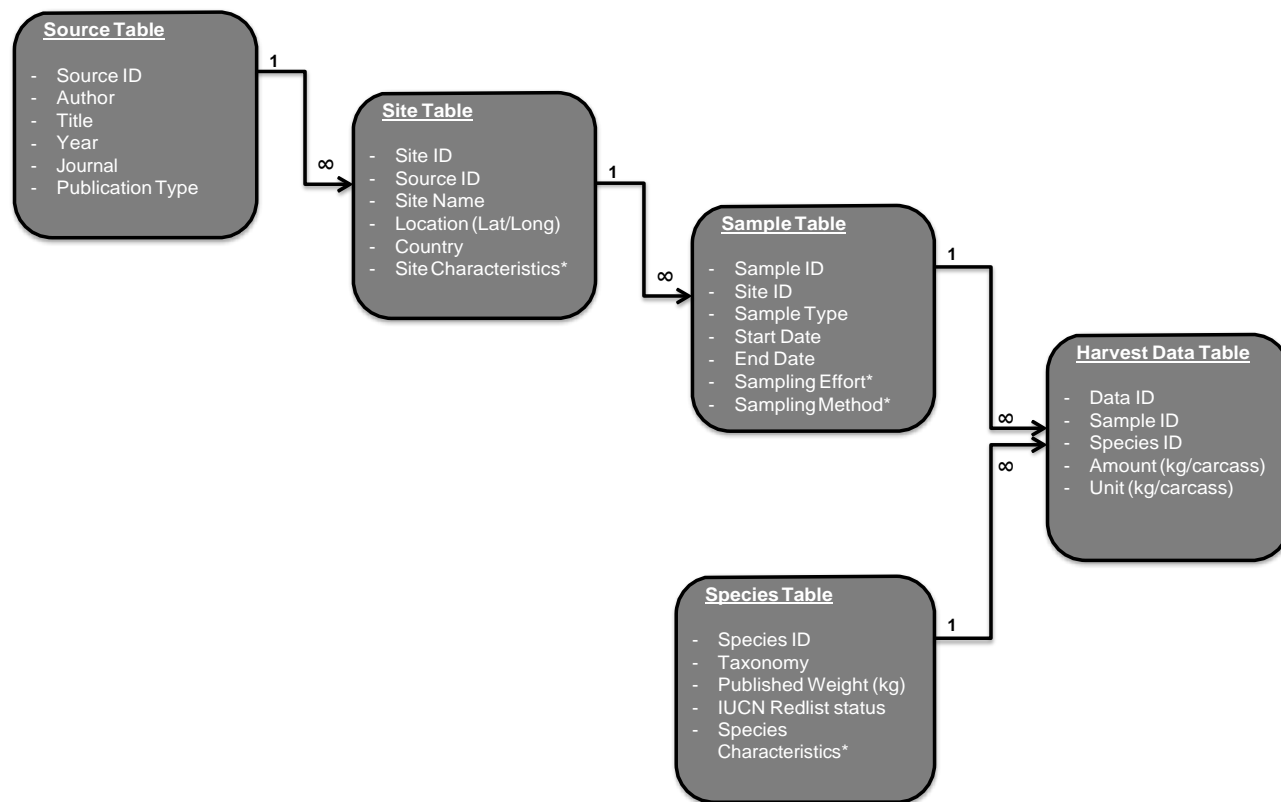
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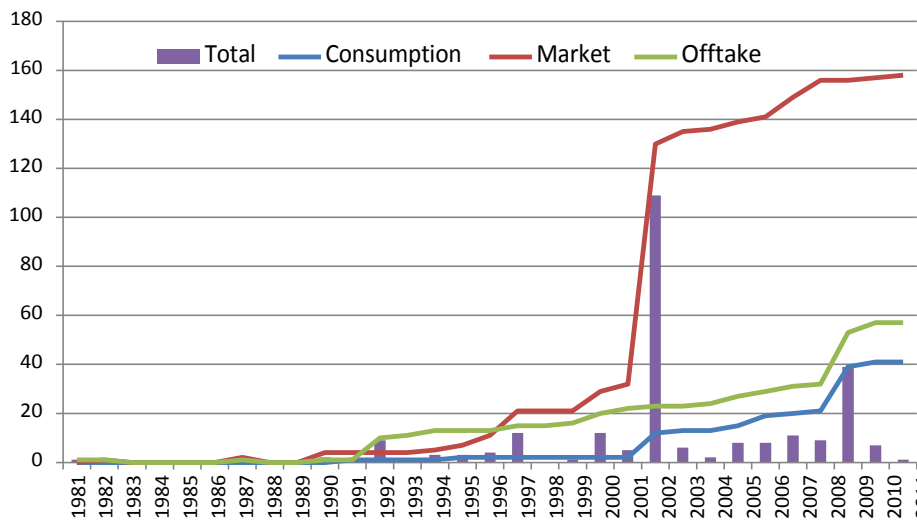
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411 **Figures**



412

413 **Figure 1: Schematic diagram of the Central and West African bushmeat database.** Arrows indicate the connections by which
 414 information from different tables can be linked. Asterisks highlight where multiple data columns are summarised, for ease of illustration.



415

416 **Figure 2: Cumulative numbers of samples of bushmeat consumption (blue), market**

417 **trade (red) and hunter offtake (green) over the last three decades, as currently**

418 **recorded in the database.** Bars show the start year for each sample. The large increase in

419 market studies in 2002 reflects the survey of 86 markets in the Cross-Sanga region of

420 Cameroon and Nigeria by Fa et al. (2006).

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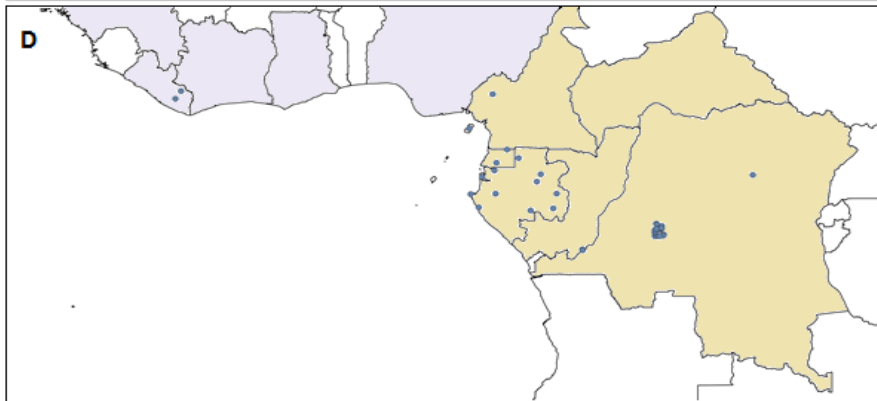
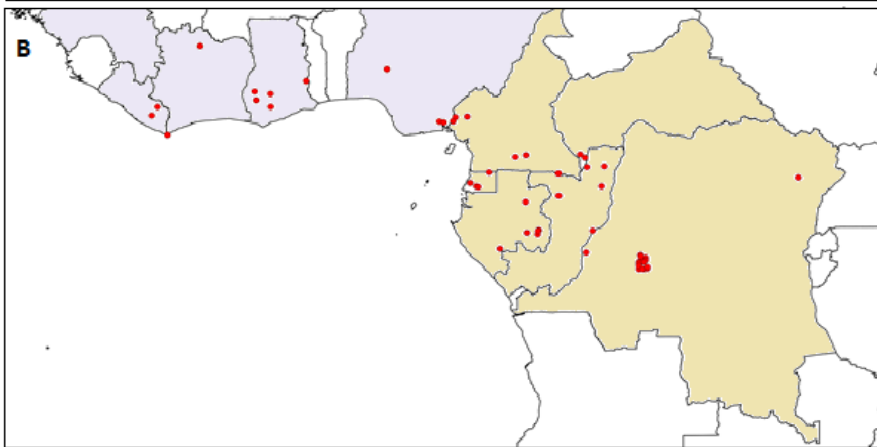
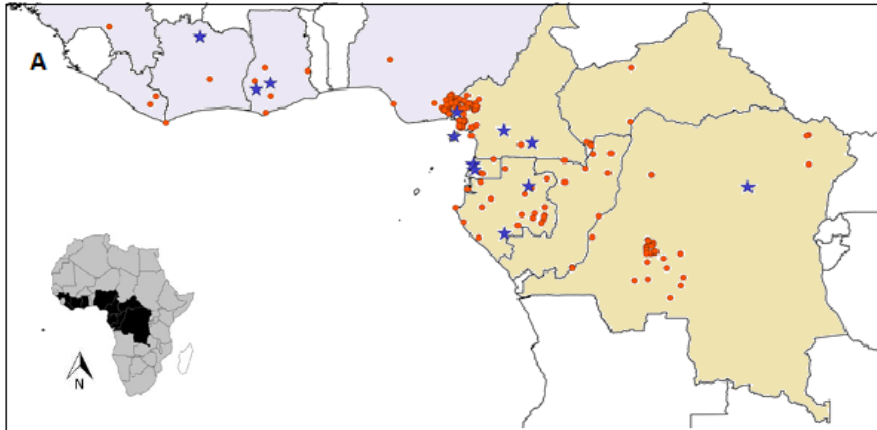
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429 **Figure 3: Distribution of samples across West and Central Africa by data type.** (a)
430 Total with time series sites highlighted (star symbol) (b) Offtake data (c) Market data (d)
431 Consumption data. West African countries shown in grey (n = 6) and Central African
432 countries in beige (n = 5).

433 **Table 1: The number of orders and species in the database for the 3 most common**
 434 **taxa:** Mammals, birds and reptiles. Also shown are the number of species classed as
 435 Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) on the IUCN Red List.

	Number of orders	Number of species	Red list classification (number of species) CR/EN/VU
Mammalia	12	134	4/5/14
Aves	9	24	0/0/2
Reptilia	3	18	2/1/2

436