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


*Corresponding author
Abstract

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

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

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

Contrasting and combining results from studies at regional or national scales, can help to identify spatial and temporal patterns (and outliers) in bushmeat use, and where time-series data are available, can be used to track changes in bushmeat use and indicators of ecological depletion. Such information could assist decision-makers to develop evidence-based conservation strategies (van Vliet et al., 2012b). To date, some studies have employed systematic literature reviews to determine regional bushmeat offtake trends within the Congo Basin (Wilkie & Carpenter, 1999), or to compare between continental forest regions (Fa et al., 2002,
While these studies illustrate the potential for meta-analyses to shed light on regional trends in bushmeat use, they have been limited by the availability of raw data from published studies (<40 sites).

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

In response to these calls we have developed the Central and West Africa Bushmeat database, using a systematic approach to identify quantitative datasets on bushmeat use. This region was chosen as initial literature searches on global wildlife harvest yielded substantially more information from West and Central Africa, and the authors have established networks of conservation researchers in the region. We present initial results on research effort, describing the spatial and temporal extent of quantitative research into offtakes, consumption and market sales of bushmeat over 30 years. We ask the following preliminary questions of the database: 1) How many quantitative studies of bushmeat use exist for the West and
Central African regions, and how has research effort varied through time?; 2) Where geographically has the majority of research effort occurred?; 3) What types of data have been collected?; 4) What levels of sampling effort have been employed at each site; and 5) Which species are represented within the current research effort?

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

Definition of the term bushmeat and geographic scope

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

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

Literature search and e-mail campaign

A comprehensive search of the available data sources was conducted from June 2012 to June 2013. We searched scientific bibliographic databases, thesis archives, specialist, academic search engines and conservation NGO websites (Supplementary Materials, S1). We used relevant keywords and secondary terms in English, French and Spanish (S2) to find sources. In addition, we contacted a number of relevant conservation and development organisations (S1; many organisations then sent our request out to their contact lists) stating our project goals and asking for further contacts and/or any quantitative raw data. This
‘snowball’ sampling technique (Noy, 2008) resulted in additional unpublished data sources added to the database.

Data inclusion criteria

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

Data extraction and database terminology

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

- **Source** refers to the source of the data, either a scientific publication, NGO report or raw data.
- **Site** refers to the location where the data were collected. The ‘Site’ table holds the geographic coordinates of the site as well as information on site characteristics (e.g. country, settlement type, population size).
- **Sample** refers to the data collected over a specific delimited time period at a specific site, and collecting a specific data type (market,
consumption or offtake, see below). The ‘sample’ table holds data on
the dates of the sample, the data type and the sampling methods and
effort. Where the same sample was published in multiple references,
we only included the sample once, from the earliest reference.

- **Harvest data** refers to the meat hunted, offered/sold or consumed.
The ‘Bushmeat’ table holds data on the number or biomass of each
species recorded for each sample.

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

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

  - ‘Consumption’ data collected on the number/biomass of each taxon
    consumed by a household.

  - ‘Offtake’: Data collected on the number/biomass of each taxon caught by a
    hunter or household.

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

Data types, sites and samples

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

Geographical distribution of research effort

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

Type of data collected

The proportion of data types (market, consumption and offtake) sampled was similar across regions (Appendix Figure 6). In Central Africa, market samples were the most commonly collected data type (50.7%), followed by offtake (26.8%) and consumption (22.5%). In West Africa market samples comprised the majority
(79.4%), followed by offtake (17.5%) and consumption (3.2%). Only two consumption samples were collected in West Africa, at two sites in Liberia (Figure 3d).

**Time and duration of samples**

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

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

**Species represented in the database**

A total of 179 different species from 27 orders have been recorded in the database, 75% of these were mammals (Table 1; see S7 for full species list).
Although the majority of species are classified by IUCN Red List as Least Concern (64%), 17.3% were classified as Critically Endangered, Endangered or Vulnerable.
Discussion

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

Despite the large number of references identified during this study, we suspect that further datasets exist, but are not currently publicly available. The majority of identified datasets were published in peer-reviewed journals or as academic theses online. For many sources we needed to contact the authors to get access to the original raw data to fully complete the database records as only summary data were available in the published papers. However, many NGO reports are published internally within the organisation, or on NGO websites, and can remain undetected, despite holding valuable site-specific information. Studies included in this project were also most likely to have been published in the last decade. Although this probably reflects a genuine increase in research effort, it may also partly reflect an increase in online publication of student theses and NGO
reports, which would previously have been published only as hardcopy and therefore may not have been found by this study. Many older reports are only available in country, or directly from the authors, and we would ask that anyone who knows of any datasets that may have been overlooked by this study contact the corresponding author. In the medium to long term we envisage that the database will be developed to function as a live, public repository for both published and unpublished datasets of bushmeat, to allow near real-time, comprehensive information on bushmeat indicators to be made available to decision makers.

Market data was the most commonly collected data type, possibly reflecting the relative ease with which data can be collected at urban bushmeat markets. However, changes in the species composition of bushmeat markets may not reflect changes in species composition of the surrounding area, due to changes in hunting areas, effort and hunting technologies, and therefore studies of urban markets alone must always be inconclusive (Ling and Milner Gulland 2006). In comparison, few data are currently available on bushmeat consumption and consumer choices, especially in West Africa where data on bushmeat consumption were only available for Liberia. Consumer demand, as indicated by consumption, is potentially a critical aspect to monitor, since we expect changes in demand to be a key determinant of future hunting and trade efforts and ultimately sustainable resource use (Van Vliet, 2010). This highlights a need for increasing research efforts on consumption studies and the need to better understand consumers’ preferences. Offtake studies, either through direct observations of hunter follows, bag counts and interviews enable estimation of CPUE (Catch per unit effort), often used to assess sustainability. However caution must also be taken when collecting and analysing recall data as
hunters can underestimate their catch if not all traps had been checked, if they had eaten individuals whilst hunting or simply forgotten every species caught (Hickey 2008).

A geographical bias also exists, with more sites surveyed in Central Africa than in West Africa, and disproportionate focus on certain countries within Central Africa (Gabon, Equatorial Guinea, Cameroon and Nigeria). This may partly reflect the accessibility of the research sites, as well as the interests of research institutions and donor organisations, and that of the lead authors. It may also reflect a focus on areas perceived to be experiencing higher bushmeat hunting and trade intensities, and hence higher levels of threat. West Africa has already lost much of its original tropical forest and has seen much higher hunting intensities than the less fragmented Central African forests (Schulte-Herbrüggen et al, Bennet et al, 2007; Craigie et al, 2010). There is therefore a perception that West Africa is now in a ‘post-depletion’ phase, having already lost larger wildlife species from most of the region (Cowlishaw et al, 2005). This could be, and perhaps has been, taken to imply that studies are more urgent in the less depleted parts of Central Africa, where there are still extensive wildlife populations to protect. However, this characterisation of West Africa as being more depleted, is a generalisation that probably masks considerable variation in patterns of depletion, trade and consumption within this region (Data from a wider geographical range of sites would be desirable, including more depleted areas in both West and Central Africa. Furthermore, by concentrating on sites that are perceived to have high levels of hunting activity, research may simply track the leading edge of a depletion wave while failing to reflect accurately the regional dynamics in bushmeat hunting.
Hunting sustainability cannot be inferred from static data (Coad et al. 2013), but of
the sites identified in this study, less than 5% had repeat samples of the same data
type. Few studies have therefore been able to track changes in hunting
consumption or offtakes over time (but see Coad et al, 2013; Gill et al. 2012). To
reduce this problem, a more systematically selected and regularly monitored set of
sites would be desirable, spanning a range of current depletion levels in both
regions. NGO’s and research institutions should capitalise on the wealth of baseline
data presented in this database and resample sites, to increase our knowledge of
how (and why) bushmeat use changes over time. For example monitoring systems
such as SYVBAC (Système de suivi de la filière viande de brousse en Afrique
Centrale: Development of a Central African Bushmeat Monitoring System), a newly
developed and anticipated approach will operate under the Central African Forests
Observatory, aims to support the development of policies and strategies for the
sustainable use of bushmeat in Central Africa (see TRAFFIC 2008, Van Vliet 2010a
and 2010b). The objectives of SYVBAC are to collect data on key indicators to track
bushmeat offtake, trade and consumption, impacts of bushmeat hunting on wildlife
populations, and ultimately the sustainability of current hunting levels, at
systematically selected sites (to represent villages, towns, community hunting
zones, sport hunting areas, logging /mining concessions, protected areas and buffer
zones) across Central Africa. This database can be a valuable tool throughout the
development, implementation and review stages of such projects.

Based on our very preliminary collation and analyses of bushmeat data for
West and Central Africa, we suggest the following priorities for bushmeat research
and policy that would benefit from using this database:
• Investigate the drivers of bushmeat use, consumption and sales at national and regional levels by undertaking a meta-analysis of existing studies;

• Develop indicators for measuring bushmeat use and sustainability, designed to inform national and regional policy on bushmeat hunting. Indicators should be scientifically robust, as well as practically feasible to collect;

• Identify knowledge gaps and future research priorities for bushmeat. The studies collated in this database provide an overview of past research effort in West and Central Africa. However, they were originally collected as individual studies, rather than undertaken with one overriding research goal in mind. This database can now function as an evolving baseline for bushmeat research, enabling researchers, in collaboration with conservation practitioners, to take stock, and identify the key questions for future bushmeat research.
Acknowledgements

Gemma Taylor, Lauren Coad and Shonil Bhagwat acknowledge funding and technical support from the Oxford Martin School, the John Fell Fund, University of Oxford and the Zoological Society of London.

TRAFFIC acknowledges the German Federal Ministry for Economic Cooperation and Development (BMZ), the French Development Agency (Agence Française de Développement, AFD).

Thanks go to Daniel Ingram for early comments on the manuscript.


Figure 1: Schematic diagram of the Central and West African bushmeat database. Arrows indicate the connections by which information from different tables can be linked. Asterisks highlight where multiple data columns are summarised, for ease of illustration.
Figure 2: Cumulative numbers of samples of bushmeat consumption (blue), market trade (red) and hunter offtake (green) over the last three decades, as currently recorded in the database. Bars show the start year for each sample. The large increase in market studies in 2002 reflects the survey of 86 markets in the Cross-Sanga region of Cameroon and Nigeria by Fa et al. (2006).
Figure 3: Distribution of samples across West and Central Africa by data type. (a) Total with time series sites highlighted (star symbol) (b) Offtake data (c) Market data (d) Consumption data. West African countries shown in grey (n = 6) and Central African countries in beige (n = 5).

Comentario [GT5]: These maps are still being worked on at the moment.
Table 1: The number of orders and species in the database for the 3 most common taxa: Mammals, birds and reptiles. Also shown are the number of species classed as Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) on the IUCN Red List.

<table>
<thead>
<tr>
<th>Taxa</th>
<th>Number of orders</th>
<th>Number of species</th>
<th>Red list classification (number of species)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammalia</td>
<td>12</td>
<td>134</td>
<td>4/5/14</td>
</tr>
<tr>
<td>Aves</td>
<td>9</td>
<td>24</td>
<td>0/0/2</td>
</tr>
<tr>
<td>Reptilia</td>
<td>3</td>
<td>18</td>
<td>2/1/2</td>
</tr>
</tbody>
</table>