Application of food balance sheets to assess the scale of the bushmeat trade in Central Africa

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TRAFFIC

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*W*ildlife is estimated to be a significant and direct source of protein for more than 34 million people living in the Congo Basin. Prevailing scientific opinion warns that the trade in bushmeat (also referred to as wild meat and game meat) represents the most immediate threat to the Congo Basin's forest mammalian biodiversity. This study attempts to assess the relationship between trends of the bushmeat trade in the Congo Basin and various variables of environmental change and socioeconomic development in Cameroon, Republic of Congo, Democratic Republic of Congo, Gabon and Central African Republic between 1990 and 2005. Bushmeat data were derived from food balance sheets provided by the FAOSTAT database. Despite the overall trend of decreasing forest cover in Central Africa, the FAOSTAT data lead to the conclusion that overall bushmeat extraction has increased in the Congo Basin. On the other hand, according to the same source, the gradient of bushmeat production per forest area has been on the decline in certain countries since the turn of the millennium. The results indicate that bushmeat consumption per capita is higher in countries with a larger urban population. The current trend of urbanization throughout Central Africa may trigger an increase in the per capita consumption of bushmeat. The outcome of the study also leads to the conclusion that bushmeat consumption increases significantly with personal wealth throughout the Congo Basin range States. Although the FAOSTAT bushmeat data are estimates and should therefore be regarded with caution, the data are the most readily available official sources of information on production of wild meat in the Congo Basin. In the context of rapid changes in human populations and forest exploitation that currently take place throughout much of Central Africa, this study indicates that data derived from the FAOSTAT database may be used as makeshift indicators to monitor trends of bushmeat production and consumption.

INTRODUCTION

Since the early 1990s, much research has been undertaken on the nature and scale of bushmeat exploitation and its possible impact on wildlife populations (Redford, 1992; Wilkie and Carpenter, 1999; Robinson and Bennett, 2000, 2002; Fa *et al.*, 2003). Though for decades deforestation has been cited as the most immediate threat to tropical wildlife in forest habitats, contemporary belief is that hunting is cause for greater concern. First mentioned by Redford (1992), the term "empty forest syndrome" has been introduced to acknowledge major global anxiety over commercialized hunting and the widespread prediction that large forest-dwelling species will disappear long before their habitats do. The commercial trade in bushmeat occurs across almost all of tropical Africa, Asia and the Neotropics, but it is most prevalent in the densely forested regions of Central and West Africa (Fa *et al.*, 2003).

Most studies have voiced concerns about the scale and impact of bushmeat exploitation in the Congo Basin tropical moist forests. These forests occupy 5.3 million km², and are mainly found within six countries, namely Cameroon, the Central African Republic, the Democratic Republic of Congo, Equatorial Guinea, Gabon and the Republic of Congo (Fa *et al.*, 2003). The Congo Basin contains the world's second-largest rainforest, housing more than half of Africa's animal species (Redmond *et al.*, 2006). Bushmeat harvesting is perceived to be a threat to globally endangered wildlife. There is prevailing scientific opinion that if current trends continue, unsustainable levels of bushmeat hunting are likely to extirpate tropical forest mammalian biodiversity (Redford, 1992; Terborgh, 1999; Bennett and Robinson, 2000). Often heavy-bodied forest species with important roles in maintaining forest structure and composition are targeted (Hawthorne, 1993). Uncontrolled and illegal bushmeat hunting in this region therefore threatens the health of a forest ecosystem of planetary importance, both in terms of biodiversity and of global climate stability. In the Congo Basin, researchers estimate that up to five million tonnes of bushmeat—which is 3.4 million tonnes of dressed meat—are traded annually (Wilkie and Carpenter, 1999; Fa *et al.*, 2002). Although it is difficult to assess the magnitude of the bushmeat trade, Robinson and Bennett (2002) estimate that hunting levels in Central Africa exceed six times the sustainable rate. Primates are not excluded from the hunting regime and there is evidence that primates of international conservation value are hunted to dangerously low levels, with harvesting rates at up to 28 times the sustainable rate (Fa *et al.*, 1995). Local extinctions have been recorded in Preuss' Red Colobus *Procolobus preussi* (Waltert *et al.*, 2002), as has the extinction of Miss Waldron's Red Colobus *Procolobus badius waldroni* throughout much of its range of distribution (Whitfield, 2003).

BACKGROUND

Bushmeat, also referred to as game meat or wild meat, is the term commonly used for the flesh of forest mammals, but also the meat of some reptiles and birds (Fa *et al.*, 2003). It often provides a cheap and plentiful source of protein in regions where meat from domestic animals, such as cattle, goats and chickens, is scarce or more expensive. Bushmeat is one of those forest products which have been demonstrated to have major significance for rural communities, particularly in the humid and sub-humid tropics.

Wildlife has been hunted for food for centuries, and people have traditionally hunted game for subsistence use or for barter. Historically, in Republic of Congo and Cameroon, bartering existed between Ba'Aka pygmies and Bantu farmers, who exchanged wild meat and agricultural products respectively (Pearce and Ammann, 1995). Matsura (2004) reports that subsistence use of

HUNTER AND DEAD MONKEY, GABON (LEFT); DUIKERS KILLED BY SUBSISTANCE HUNTERS ARE DISPLAYED BY THE ROADSIDE FOR SALE TO PASSING MOTORISTS, GABON (RIGHT).

bushmeat is still important among some pygmies in Gabon. However, the past 20 years have seen the emergence of the commercial bushmeat market due to the imperative that rural people are increasingly involved in the cash economy. The sale of bushmeat allows people to purchase materials and items that a subsistence life cannot provide, as well as generating income for shelter, clothing, taxes and schooling (Ziegler *et al.*, 2002). Wildlife is estimated to play a significant and direct part in the lives of more than 34 million people living in the Congo Basin (Brown and Williams, 2003). Game meat provides protein for many poor rural families without land or access to agricultural markets. Often, there is no replacement for bushmeat, which represents 80% of all animal-based household protein consumed in much of Central Africa (Draulans and Van Krunkelsven, 2002). The current non-bushmeat protein sources in Central Africa are mainly agricultural meat, fish and seafood. Given the fact that food production in this region has not increased significantly throughout the last 40 years (Fa *et al.*, 2003), those who most depend on wildlife resources are in a dilemma: their food security is threatened due to non-sustainable levels of hunting and the absence of abundant alternative sources of protein.

BLUE DUIKER *CEPHALOPHUS MONTICOLA* (LIMBE, CAMEROON, 2008), ONE OF THE SPECIES MOST COMMONLY FOUND IN BUSHMEAT TRADE IN CENTRAL AFRICA.

Although there is a growing body of research on hunting and bushmeat use in the African rainforest, much of the existing information is based on site-specific data, often collected over a short period of time. Comparison across studies is problematic as it is often unclear if consumption estimates are based on whole carcass, dressed, or boned-out weights. Furthermore, much of the evidence of bushmeat harvest and consumption patterns is site-specific and may lead to misinterpretation if scaled-up to the national level, as shown for deforestation by Fairhead and Leach (1998). This paper seeks to review the relationship between recent trends of bushmeat trade and various variables of environmental change and development. One of the greatest challenges associated with the management of exploitation of wildlife resources in Central Africa is the paucity of biological and socio-economic data on a national scale that would help decision-makers to assess impacts on and benefits from the bushmeat resource. The author intends to overcome this problem by reviewing bushmeat production data that are derived from food balance sheets and captured in the FAOSTAT database. The FAOSTAT bushmeat data are not calculated from market or consumption surveys but are estimates generated by FAO, which is a less than perfect source. However, for the time being, the FAOSTAT data are the most readily available official sources of information on production of game meat within the Congo Basin. An approach was applied that discusses the sustainability of the bushmeat harvest from transformed food balance data. Furthermore, the value of national bushmeat data from the FAOSTAT database was discussed to help develop policies designed to conserve wildlife and secure bushmeat-dependent livelihoods.

METHOD

This study assessed the relationship between recent bushmeat production trends in the Congo Basin and various variables of environmental change and socio-economic development. Therefore, the author was interested in defining a set of proxy variables, reflecting both the condition of the forest resource as the primary habitat of the hunted species, and the status of development and livelihoods. Table 1 provides an overview of the time series databases consulted in this review. Although all databases were updated frequently, the volume of the incoming data determines the frequency of these updates so that the most recent complete set of analysed data derives from 2005. The analysis was restricted to the period 1990 to 2005, mainly due to data constraints for years prior to 1990. It needs to be stressed that the precision of the analysis hinged upon the accuracy of the assessed databases, and particularly upon the game meat production data of the Food and Agriculture Organization of the United Nations (FAO). FAOSTAT provides data on game meat production which must not be interpreted directly as the ecological productivity of the sum of all game species within the forest ecosystem. In this paper, the term game meat production is employed as it has been used by FAO, as a measure of bushmeat harvest.

Variable	Source	Date assessed
Forest cover	http://faostat.fao.org/site/405/default.aspx	29 May 2008
Forest area per capita	http://faostat.fao.org/site/405/default.aspx	
	http://esa.un.org/unup/index.asp?panel=1	16 June 2008
Protected areas	http://www.wdpa.org/Default.aspx	11 Nov. 2008
Rural population	http://esa.un.org/unup/index.asp?panel=1	7 May 2008
Population density	http://esa.un.org/unpp	7 May 2008
Human Development Index	http://hdr.undp.org/en/media/hdr_20072008_en_complete.pdf	16 June 2008
Gross Domestic Product based on purchasing power parity	http://www.econstats.com/weo/V019.htm	16 June 2008
Domestic meat consumption	http://faostat.fao.org/site/569/DesktopDefault.aspx?PageID=569	29 May 2008
Production of bushmeat	http://faostat.fao.org/site/569/DesktopDefault.aspx?PageID=569	29 May 2008

Table 1. List of variables analysed in this study and sources of online-databases.

Food balance sheets

The author assessed the FAOSTAT database that provides time-series and cross-sectional data relating to food and agriculture for some 200 countries. For this study, the geographical focus was on Cameroon, Republic of Congo, Democratic Republic of Congo, Gabon, and Central African Republic. Food balance sheets present a comprehensive picture of the pattern of a country's food supply during a specified reference period. Food balance sheets bring together the larger part of the food and agricultural data in each country to serve in the detailed examination and appraisal of the food and agricultural situation in a country. Traditionally, information on the availability of food at some aggregate level and on the structure of its distribution among households has been used for measuring and monitoring the status of food security. The food balance sheet shows for each food item—i.e. game meat in this research—the total quantity of foodstuffs produced in a country added to the total quantity imported and adjusted to any change in stocks that may have occurred since the beginning of the reference period. The FAOSTAT game meat entry is not calculated from market or consumption surveys, but production is estimated by FAO on the basis of the returned food balance sheets. FAO defines game meat production as the difference between the amount of non-bushmeat protein available and the product of the number of inhabitants, times the daily protein supply per person.

FAOSTAT time series provide game meat production data that are traditionally expressed in terms of carcass weight. To allow for comparison regarding the productivity of forest ecosystems, carcass weight was adjusted to live weight by using a conversion factor of 1.54 as described by Hill and Hawkes (1983).

The author used the live weight production data to compute bushmeat harvest per unit area and year. Since forest was considered as the primary habitat of most of the hunted game species (Haltenorth and Diller, 1992), production was defined as harvest per forest area, and subsequently discussed in terms of sustainability.

Given that the bushmeat harvested was largely destined for domestic use and that international bushmeat trade is negligible at country level, it was considered appropriate to regard the quantity supplied to the market (i.e. the harvest) as similar to the quantity demanded by the market (i.e. consumption). Thus, dividing the annual FAOSTAT production data by the number of inhabitants in the corresponding year of reference resulted in the composite variable bushmeat consumption per capita. This variable was discussed at country level and tested for statistical relationship with the variables of environmental change and socioeconomic development.

Statistical analyses

The author tested whether there is a significant linear relationship between the variables of environmental change or socioeconomic development and bushmeat consumption per capita. Regression can be interpreted as a method for accounting for some of the variation of the dependent variable in terms of variation of the independent variable (Sokal and Rohlf, 1995). Bushmeat consumption per capita was considered the dependent variable whose magnitude depends on a set of independent variables: the selected proxy variables, reflecting the condition of forest, and the status of development and livelihoods. The author calculated the mean from the time series 1990, 1995, 2000 and 2005 by country (Cameroon, Republic of Congo, Democratic Republic of Congo, Gabon, and Central African Republic) for all independent variables, as well as for bushmeat consumption per capita.

It should be noted that the statistical conclusions reached in this report cannot necessarily be extrapolated beyond the individual States. Moreover, it is necessary to point out that the statistical relationships between bushmeat consumption per capita and individual variables representing environmental change and economic development are not necessarily indicative of the causal drivers of the bushmeat trade, or that other factors, such as cultural and religious preferences, are irrelevant.

Country	Year	Forest cover (%)	Forest area (ha/capita)	Forest area (x1000 ha)	Protected area (%)	Rural population (%)	Population (x1000)	Pop. density (inhabitants /km²)	GDP PPP[1] (USD)	HDI[2]	Domestic meat consumption (kg/capita/yr)	Bushmeat consumption (kg/capita/yr)
CM	1990	52.70	2.01	24 545	4.4	59.29	12 239	26	1749.5	0.529	12	3.60
CM	1995	50.40	1.67	23 445	4.4	54.67	14 058	30	1551.7	0.513	10	3.27
CM	2000	48.00	1.41	22 345	5.4	50.14	15 861	33	1849.7	0.525	11	3.03
CM	2005	45.60	1.19	21 245	7.3	45.73	17 795	37	2283.6	0.532	12[3]	2.81
Mean		*49.18*	*1.57*	*22 895*	*5.38*	*52.46*	*14 988*	*31.5*	*1858.6*	*0.525*	*11.25*	*3.18*
CG	1990	66.50	9.38	22 726	1.9	45.66	2 422	7	1052.5	0.559	8	4.54
CG	1995	66.30	8.11	22 641	3.3	43.57	2 793	8	1046.9	0.546	13	4.37
CG	2000	66.10	7.04	22 556	6.5	41.68	3 203	9	1144.3	0.518	9	5.00
CG	2005	65.80	6.22	22 471	12.1	39.83	3 610	11	1379.3	0.548	153	5.54
Mean		*66.18*	*7.69*	*22 599*	*6.0*	*42.69*	*3 007*	*8.8*	*1155.8*	*0.543*	*11.25*	*4.86*
CD	1990	62.00	3.70	140 531	5.0	72.18	37 942	16	1136.6	0.423	3	2.06
CD	1995	60.80	3.04	137 869	5.8	71.57	45 339	19	748.9	0.391	3	1.90
CD	2000	59.60	2.67	135 207	5.8	70.16	50 689	22	592.0	0.375	2	1.78
CD	2005	58.90	2.27	133 610	6.0	67.89	58 741	25	675.3	0.411	23	1.51
Mean		*60.33*	*2.92*	*136 804*	*5.7*	*70.45*	*48 178*	*20.5*	*788.2*	*0.4*	*2.5*	*1.81*
GA	1990	85.10	23.89	21 927	6.8	30.83	918	3	5931.4	0.525	21	20.15
GA	1995	84.90	20.72	21 877	6.8	24.62	1 056	4	6803.4	N/A	36	17.99
GA	2000	84.70	18.47	21 826	7.8	19.86	1 182	4	6612.2	N/A	37	17.77
GA	2005	84.50	16.87	21 775	19.1	16.42	1 291	5	6976.7	0.677	203	16.27
Mean		*84.80*	*19.99*	*21 851*	*10.1*	*22.93*	*1 112*	*4*	*6580.9*	*0.601*	*28.5*	*18.05*
RCA	1990	37.20	7.71	23 203	16.0	63.16	3 008	5	1068.4	0.398	19	3.55
RCA	1995	37.00	6.68	23 053	16.4	62.78	3 450	6	1080.7	0.390	21	3.53
RCA	2000	36.80	5.93	22 903	16.4	62.36	3 864	6	1170.1	0.394	25	3.49
RCA	2005	36.50	5.43	22 755	16.5	61.93	4 191	7	1163.0	0.384	273	3.34
Mean		*36.90*	*6.44*	*22 979*	*16.3*	*62.56*	*3 628*	*6*	*1120.6*	*0.392*	*23*	*3.45*

Table 2. Variables of environmental change and socioeconomic development as well as bushmeat consumption in selected countries within the Congo Basin between 1990 and 2005.
Country codes according to ISO 3166 (CM–Cameroon; CG–Republic of Congo; CD–Democratic Republic of Congo; GA – Gabon; CF–Central African Republic).

[1]Gross Domestic Product based on purchasing power parity.
[2]Human Development Index.
[3]Data derived from 2003.

Furthermore, although the study intends to examine the extent to which bushmeat trends are associated with high levels of environmental change and economic development, it needs to be stressed that the presence of multicollinearity means that the relative contribution of different variables is difficult to isolate.

RESULTS

Environmental change and socioeconomic development

Forest cover and protected areas as well as socio-economic data at country level are summarized in Table 2. According to the data obtained in this study, forest cover in Central Africa has declined continuously since 1990, but deforestation has varied widely in individual countries. Forest loss in absolute figures was highest in Cameroon and Democratic Republic of Congo, where, respectively, 33 330 km² and 69 210 km², of forest were lost between 1990 and 2005. During this period, Cameroon lost 13.4% of its forest cover; the lowest rate of forest loss was observed in Gabon, where only 0.6 percent of the country's forest cover disappeared throughout the years of reference. Amongst the Congo Basin States, forest cover was highest in Gabon where more than 84% of the land area was still forested in 2005. Total area of protected zones (defined as IUCN categories I-VI and other areas, such as hunting zones) also increased from 1990 to 2005. The surface of protected areas nearly doubled in Republic of Congo after 2000. A similar pattern was observed in Gabon where the total protected area increased by more than 140% within five years from 2000 onwards.

In 1990 the population density in the countries of concern was 11.4 inhabitants/km²; 15 years later this value had increased to 17 inhabitants/km². Population density varied among the Congo Basin range States, with the highest recorded in Cameroon (37 inhabitants/km²) and the Democratic Republic of Congo (25 inhabitants/ km²) and the lowest in Gabon with five inhabitants/km² for the reference year of 2005. Forest loss in combination with population increase throughout the region meant that the forest area per capita declined in all five countries. The lowest values were in Cameroon and Democratic Republic of Congo, where in 2005, one inhabitant had on average 40% less forest at his/her disposal as compared to 1990. In absolute numbers, one Cameroonian could theoretically claim a forest area of 1.19 hectares in 2005, whereas the corresponding value in Gabon was almost 17 hectares.

All Congo Basin countries were characterized by relatively low Human Development Indices (HDIs), and within the test sample, Central African Republic and Democratic Republic of Congo had the lowest HDIs, Cameroon and Republic of Congo had intermediate HDIs and Gabon had a relatively high HDI. Gabon had the highest GDP based on purchasing power parity with almost USD7000 per capita in 2005, while Democratic Republic of Congo had the lowest (USD675.3) for this reference year. The relatively prosperous state of Gabon's


FAMILY SELLING BUSHMEAT, KISANGANI, DEMOCRATIC REPUBLIC OF CONGO, 2009 (LEFT); BUSHMEAT, INCLUDING AN ELEPHANT TRUNK, FOR SALE AT MARKET, GABON (RIGHT).

economy can be attributed to its mineral oil resources. Throughout the 1990s, a substantial proportion of countries in the tropical forest zone suffered from substantial economic stasis and decline, resulting in lower levels of governance and service provision. The domestic meat (cattle, goats, sheep, horses, rabbits, and chickens) production tables in the FAOSTAT database were also assessed. Most recent data of domestic meat consumption per capita were from 2003. Although the absolute meat production increased throughout much of Central Africa since 1990, the production increase was partly offset by population growth. Consumption of domestic meat remained more or less stagnant in Cameroon and Democratic Republic of Congo throughout the years of reference. In Gabon, a drop in domestic meat consumption from 37 kg/capita/year in 2000 to 20 kg/capita/year in 2003 was recorded. Republic of Congo and Central African Republic were able to increase the annual intake of domestic meat by 87.5% and 42%, respectively.

Bushmeat production

Bushmeat production in the Congo Basin increased considerably between 1990 and 2005. Yield, as expressed in absolute figures, rose most prominently in the Democratic Republic of Congo where the FAOSTAT data show a total growth of 12 000 t, from 78 000 t/year in 1990 to 90 000 t/year in 2000 (Figure. 1). Bushmeat harvest in the Republic of Congo nearly doubled, from 11 000 t/year to 20 000 t/year throughout the reference period. A linear growth rate equal to 400 t per year characterized the bushmeat production in Cameroon.

Despite the observed trend of decreasing forest cover, the FAOSTAT production table leads to the conclusion that bushmeat production per forest area has increased throughout Central Africa since 1990 (Table 3). This boost has been most prominent in the Republic of Congo where production increased by 85%, from 74 kg/km²/year in 1990 to 137 kg/km²/year in 2005. The relative change in bushmeat production per forest area is computed in
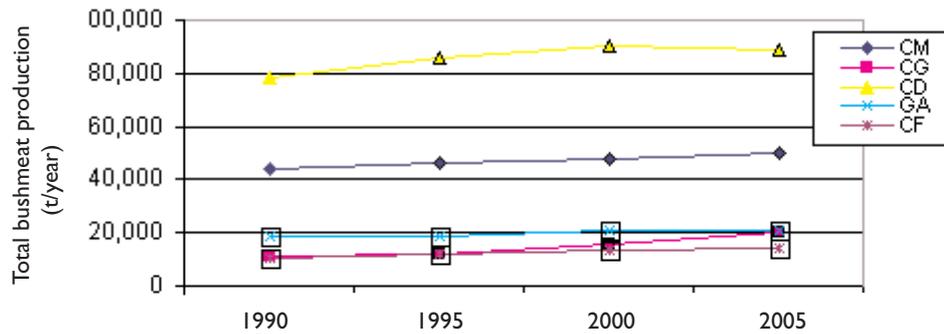
Figure 1. Total bushmeat production in selected countries within the Congo Basin between 1990 and 2005.
Country codes are according to ISO 3166 (CM–Cameroon; CG–Republic of Congo; CD–Democratic Republic of Congo; GA–Gabon; CF–Central African Republic).

Figure 2. Data were compared to the base year 1990 and the development of the bushmeat production index was plotted. The enhanced bushmeat production in the Republic of Congo after 1995 is evident. Figure 2 also shows that the gradient of the bushmeat production index line for Central African Republic, Gabon, and the Democratic Republic of Congo, flattened to some extent after the turn of the millennium. This was most pronounced in Democratic Republic of Congo, where the bushmeat production index even diminished by one kg/km²/year from 2000 to 2005. In the same reference period, the overall bushmeat production declined by 1265 t in Democratic Republic of Congo.

With live weight production values between 276 and 362 kg/km²/year, Cameroon clearly outnumbered its neighbours: in any of the four reference years (1990, 1995, 2000, and 2005), bushmeat production per unit area was at least twice as high as in the Democratic Republic of Congo, Gabon, Republic of Congo, and Central African Republic, as can be seen from Table 3.

Bushmeat consumption

According to the FAOSTAT data, consumption of bushmeat in the Congo Basin was highest in Gabon where inhabitants consumed on average more than 16 kg of bushmeat per year between 1990 and 2005—almost four times the amount consumed in other Central African countries (Table 2). Average bushmeat consumption in all countries was 6.78 kg/capita in 1990 but fell to 5.89 kg/capita in 2005, though the difference between the means is not significant (t-test; $t = 0.21$, d.f. $= 8$, $p = 0.8389$). With the exception of the Republic of Congo, bushmeat consumption per capita decreased in Central Africa throughout the years of reference. This was most clear for Gabon, where the data from 2005 showed that, on average, each inhabitant consumed almost four kilogrammes less bushmeat per year compared to 1990. The trend of declining bushmeat consumption was moderate in Cameroon, Democratic Republic of Congo and Central African Republic, with less than one kilogramme of bushmeat/year per capita throughout the reference period (1990 to 2005). In the Republic of Congo, the period from 1990 to 1995 was characterized by a drop in bushmeat consumption, but afterwards consumption per capita increased by an annual rate of 2.7 percent and achieved an annual intake of 5.54 kg/capita in 2005 (Table 2).

There is a trend that bushmeat consumption per capita is linked to forest area per capita. In countries with a higher value of forest area per inhabitant, more bushmeat per capita was consumed and vice versa. This trend is
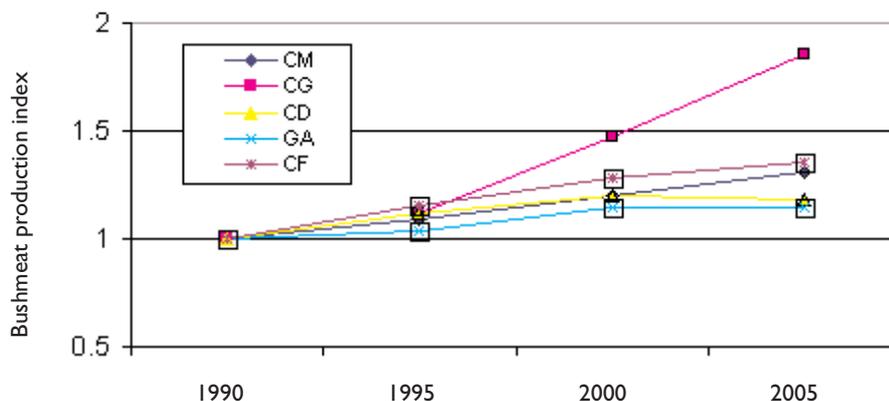
Figure 2. Development of the bushmeat production index with 1990 as the base year for selected countries within the Congo Basin between 1990 and 2005. Country codes are according to ISO 3166 (CM–Cameroon; CG–Republic of Congo; CD–Democratic Republic of Congo; GA–Gabon; CF–Central African Republic).

Country	Year	Bushmeat production (t/year)	Forest area (x1000 ha)	Carcass weight production (kg/km²/yr)	Live weight production (kg/km²/yr)
CM	1990	44 000	24 545	179	276
CM	1995	46 000	23 445	196	302
CM	2000	48 000	22 345	215	331
CM	2005	50 000	21 245	235	362
CG	1990	11 000	22 726	48	74
CG	1995	12 200	22 641	54	83
CG	2000	16 000	22 556	71	109
CG	2005	20 000	22 471	89	137
CD	1990	78 000	140 530	56	86
CD	1995	86 000	137 869	62	96
CD	2000	90 000	135 207	67	103
CD	2005	88 735	133 610	66	102
GA	1990	18 500	21 927	84	129
GA	1995	19 000	21 877	87	134
GA	2000	21 000	21 826	96	148
GA	2005	21 000	21 775	96	148
CF	1990	10 680	23 203	46	71
CF	1995	12 170	23 053	53	82
CF	2000	13 490	22 903	59	91
CF	2005	14 000	22 755	62	96

Table 3. Bushmeat production in selected countries within the Congo Basin between 1990 and 2005.
Country codes according to ISO 3166 (CM–Cameroon; CG–Republic of Congo; CD–Democratic Republic of Congo; GA–Gabon; CF–Central African Republic).

highly significant (R^2 = 0.9395, p = 0.0064, n = 5) and only applies to the composite variable forest area per capita because neither forest cover nor population density alone showed statistical significance (Table 4). The regression analyses found a negative correlation (r = -0.8985) between rural population and bushmeat consumption. Rural population refers to the number of inhabitants living in areas classified as rural according to the criteria used by each country as a percentage of the total country population. Although this statistical relationship is hampered by the small sample size (n = 5), it may indicate that bushmeat consumption per capita decreases with a higher proportion of the rural population.

Table 4 also indicates that bushmeat consumption increases significantly with personal wealth, expressed as GDP at purchasing power parity per capita (R^2 = 0.9613, p = 0.0032, n = 5). The hypothesis as to whether increasing purchasing power leads to higher domestic meat (cattle, chickens, goats) consumption was also tested, but no significant correlation was found (R^2 = 0.5299, p = 0.163, n = 5). No significant correlation was found for bushmeat consumption per capita and longevity, knowledge and income expressed as the composite indicator HDI. Regression analysis of bushmeat consumption and domestic meat consumption supports the null hypothesis and is therefore not significant (Table 4).

DISCUSSION

Ecological perspective

In evergreen moist forests, maximum biomass of mammal species larger than one kilogramme rarely exceeds 3000 kg/km² (Brown and Williams, 2003). The variation in mammalian biomass is mainly accounted for by the variation in ungulates whose body mass is generally less in tropical forests (Jarman, 1974).

This notably affects the amount of bushmeat that can be harvested in a forest habitat, and thus the maximum yield that can be secured by human hunters. Bushmeat production, with annual extraction rates in the Democratic Republic of Congo reaching 90 000 t/year according to FAOSTAT data, as well as the fundamentally extractive type of exploitation, raises issues of future sustainability. According to Robinson and Bennett (2000), annual sustainable harvest of game meat from tropical forests is generally under 200 kg/km² and is likely to be around 150 kg/km². If production of game meat from a forest ecosystem is about 150 kg/km²/year, and if 65% of live weight is edible meat (Hill and Hawkes, 1983), then each square kilometre of rainforest will produce 97 kg of edible meat per year.

Based on the FAOSTAT table, most annual live weight production rates in Central Africa still lie below

150 kg/km², with the exception of Cameroon where production exceeds this value by more than 100%. Furthermore, the game meat production estimates in 2005 for Gabon and the Republic of Congo are getting fairly close to Robinson and Bennett's sustainability threshold. However, it is important to note that there is no mutual agreement on average sustainable production in tropical forests. Fa *et al.* (2002) report a productivity of 1111 kg/km²/year for the Congo Basin. This shows that the range of maximum sustainable yield varies considerably and is prone to uncertainty, particularly if applied to huge areas. Therefore, any quota setting or policy decision regarding the bushmeat resource should be carried out with extreme caution. From a conservation perspective, the precautionary principle should apply and the lowest productivity should be considered (Nasi *et al.*, 2008).

There are also voices pointing out the fact that the link between bushmeat extraction from tropical forests and unsustainable use is likely to be more complicated (Cowlishaw *et al.*, 2005). Much of the conservation interest relates to pristine forest ecosystems, whereas hunting often takes place in the more productive farm-bush ecotone along forest edges that are characterized by a much higher mammal biomass. Some bushmeat species, such as duikers, thrive in secondary forest and may be able to sustain relatively high levels of hunting pressure; others may be pest species that succeed in agricultural mosaics and have both ecological and economic value. Barnes (2002) points out that forest edge is twice as productive as the interior. For example, duiker biomass estimates vary from 101 to 1497 kg/km² across the Congo Basin (Wilkie and Carpenter, 1999), and it is evident that the variance in production mirrors the range in density estimates. This may help to account for the frequent discrepancy between estimated stock levels and the actual offtake. Without doubt, African societies have harvested and traded bushmeat for centuries, and the hunted species would have disappeared a long time ago if sustainability was not somehow elemental to the system (Lewicki, 1974; Mendelson *et al.*, 2003). Thus, as referred to by several authors (Kormos *et al.*, 2003; Cowlishaw *et al.*, 2005), the extent to which the bushmeat trade is sustainable or unsustainable is both complex and dynamic. There are a number of variables, contingent on a variety of supply-and-demand factors, price elasticity, accessibility, distance to markets, and human density, as well as the ecology of the hunted species.

As can be seen from the results in this research, Central Africa is characterized by net deforestation and forest is the primary habitat of most of the hunted game species (Haltenorth and Diller, 1992). Thus, deforestation has an impact upon the quantity of game meat harvested and consumed. Vast areas of formerly isolated forest have been opened up for logging throughout Central Africa. Consequently the quantity of game meat supplied to the bushmeat markets is likely to increase initially, which corresponds to the observed trend in Table 3. Fa *et al.* (2000) report a similar pattern in Equatorial Guinea where, in absolute numbers, more carcasses appeared in the bushmeat markets in 1996 as compared to 1991. Furthermore, recently opened up forest frontier areas have often been newly settled by substantial numbers of frequently landless migrant people seeking new livelihoods and/or employment opportunities with logging operations, and thus increasing the demand for bushmeat. Fa *et al.* (2003) note that the extraction of bushmeat in the Congo Basin can be seen as a density-dependent phenomenon, since extraction increases linearly with human population growth. The offtake by commercial hunters in the Lobeke region of south-eastern Cameroon was found to be ten times more per immigrant hunter than for local subsistence hunters, for whom it was only 2.9 animals/hunter/month (WCS, 1996).

Gradual declines in wildlife as a result of over-hunting have been documented in Cameroon (Maisels *et al.*, 2001): the process of species extirpation in the Kilum-Ijim area began over 100 years ago with the loss of megafauna, possibly beginning with elephants (several generations ago), and certainly with buffalos (at least 20 years ago). In contrast to gradual declines, Barnes (2002) points out that a sudden, unexpected collapse of forest animal populations is more likely—similar to the boom-and-bust situation observed in fisheries. This could prove to be problematic as decision-makers might not act until it is too late because governments are hesitant to address the bushmeat trade during the boom phase of a good harvest. Therefore, the raw FAOSTAT data as expressed in tonnes per year might be misleading since they largely acknowledge an increase of presumed bushmeat harvest throughout the years of reference. However, if production is adjusted to a unit of area and indexed to a base year, a trend becomes obvious that the production gradient diminishes in several countries, namely Democratic Republic of Congo, Gabon and Central African Republic.

Livelihood perspective

Bushmeat hunting is a key component of many peoples' livelihoods in Central Africa. Within the last 20 years, much of this hunting is believed to have become increasingly unsustainable. A greater proportion of hunting was previously often largely subsistence in nature, employing local, relatively low impact, technologies and carried out by relatively small numbers

	BUSHMEAT CONSUMPTION PER CAPITA		
	r (correlation)	R² (coefficient of determination)	p (corresponding two-tailed probability)
Forest cover (%)	0.7888	0.6222	0.113
Forest area per capita	0.9693	0.9395	0.0064
Protected area (%)	0.1829	0.0335	0.7699
Rural population (%)	-0.8985	0.8073	0.0383
Population density	-0.5535	0.3063	0.3335
HDI	0.732	0.5358	0.1598
GDP based on PPP per capita	0.9805	0.9613	0.0032
Consumption of domestic meat per capita	-0.0068	0.0001	0.9926

Table 4. Results of test of significance of regression for bushmeat consumption per capita.

CHILDREN SELLING MEAT OF THE AFRICAN BRUSH-TAILED PORCUPINE *ATHERURUS AFRICANUS*, SOUTH-WEST CAMEROON, 2008 (LEFT).

A LOGGING TRUCK BEING CHECKED BY FOREST GUARDS IN SOUTH-EAST CAMEROON. LOGGING TRUCKS ARE OFTEN USED TO TRANSPORT ILLEGAL BUSHMEAT TO THE COUNTRY'S MAJOR CITIES (BELOW).

of long-term forest-resident peoples. However in recent years, the nature of bushmeat hunting has radically changed. The causes of this transformation are complex but include population growth, urbanization and socio-economic development (Redmond *et al.*, 2006).

The transformed FAOSTAT data appear to be an underestimate of the total bushmeat consumption in Central Africa, particularly if compared to the suggestive values provided by Wilkie and Carpenter (1999) who provide an average consumption rate for Central Africa of 36.31 kg/person/year. On the other hand, it is evident that precise evaluation of the quantity of wild meat consumed per capita fluctuates widely, with hunter-gatherers eating between 36 kg and 144 kg of bushmeat per year, while rural and urban populations consume between 14 kg and 57 kg and one kilogramme and 33 kg, respectively (Nasi *et al.*, 2008). Chardonnet *et al.* (2002) calculated the game meat consumption for forest and savannah/forest ecological regions at 5.3 and 3.3 kg/person/year, respectively, which is lower than the average bushmeat consumption for the Congo Basin range States according to the FAOSTAT data at 6.2 kg/person/year. It is evident that more standardized data are required to assess systematically the consumption of bushmeat at national level and the FAOSTAT data seem to be hugely compromised. This is crucial as Fa *et al.* (2003) predict that bushmeat protein supplies would drop by 81% in all Central Africa in less than 50 years, and that only Gabon would be able to maintain a protein supply above the recommended daily requirement of 52 g/person/day (FAO/WHO, 1985).

Furthermore, the results indicate that with the urbanization of African societies, the demand for bushmeat also increases. It is not clear at this stage whether an improved road system as well as changes in hunting technology, with access to new, non-traditional and more efficient hunting technologies may be accounted for. However, it is certain that the growing urban population creates very substantial and significant demands on natural resources over forest areas hundreds of kilometres distant (Ape Alliance, 1998).

De Merode *et al.* (2004) found that among those on an income of less than one US dollar per day, most bushmeat was sold on the market and not consumed. The evidence suggests that the long-term prospects for bushmeat relate primarily to survival strategies and safety-net functions rather than to rural transformation. Thus, the potential of bushmeat as a driver of socio-economic development needs to be investigated further (Davies, 2002). Furthermore, both fish and bushmeat exhibited the characteristics of superior goods since bushmeat sales were influenced by the economic status of the household (De Merode *et al.*, 2004). The results in this study are overwhelmingly supported by this

BUSHMEAT MARKET, MAKOKOU, GABON, 2007 (LEFT).

FUELWOOD IN LIMBE, CAMEROON, 2008, (BELOW). UNSUSTAINABLE AND ILLEGAL FUELWOOD COLLECTION TRIGGERS THE BUSHMEAT CRISIS.

argument since the consumption of bushmeat is positively correlated to purchasing power. Therefore, policy makers must ensure that raising household wealth through development assistance does not result in undesirable impacts on the conservation status of wildlife. Wilkie *et al.* (2005) found that fish and bushmeat were dietary substitutes in Gabon and suggest that economic levers such as taxation or supply reduction through better law enforcement can be used to change demand for wildlife. On the other hand, the role of domestic meat as a substitute for wild meat appears to be limited: reducing the price of domestic meat does not reduce the consumption of bushmeat (Damania *et al.*, 2005).

Methodological issues

An apparent limitation of the FAOSTAT data is that they neither differentiate the range of species taken nor capture the actual volume of bushmeat exploited. Rodent, snail and insect species, which are often consumed by the hunter and his family, hardly appear in the markets and therefore do not appear in the statistics (Ntiamoa-Baidu, 1997).

Nowadays, there is overwhelming scientific evidence that the current bushmeat trade in Central Africa is having a negative impact on populations of vulnerable species, resulting in local extinctions that could ultimately lead to global extinctions (Fa *et al.*, 2003). Forty-two mammalian species of international conservation concern are identified in the commercial African bushmeat trade (CITES, 2000; Redmond *et al.*, 2006), the majority of which are primates (20) and duikers (10). WWF (2003) estimates that as many as 3000 to 6000 great apes are being killed annually across Africa for the bushmeat trade. There is also anecdotal evidence that elephants are hunted for their meat in Central Africa (Stephenson, 2007). Although large-bodied species such as elephants and gorillas are a small percentage of the total trade, this level of offtake is a real conservation problem.

The incompleteness and inaccuracy of bushmeat production statistics are the major problem encountered in developing countries. In such instances, FAO estimates annual production figures by multiplying population numbers and per capita food consumption data derived from secondary sources. These estimates are based on the limited records reported to wildlife departments or on food consumption surveys, such as those reported by FAO. Currently, the data collection is not based on a standardized survey method. Therefore, varying effort in data capture and/or reporting might influence changes in the game meat production. Although FAO reports the estimates of production of game meat to its Member States, there is general concern from within FAO regarding the accuracy of the underlying basic statistics of population, supply and consumption of foods and of their nutritive value. These vary a great deal between countries, both in terms of coverage as well as in accuracy and are likely to be compromised. Furthermore, different conversion factors for calculating live weight estimates from dressed or smoked bushmeat species must be taken into consideration. Among the practical issues that often

must be addressed in constructing food balance sheets, a conceptual problem frequently arises with respect to the coverage of the basic data: production statistics are mostly confined to commercialized major food crops. Under conditions such as those prevailing in many developing countries, an appreciable part of total bushmeat production is non-commercial or subsistence production, and there is imminent risk that this substantial part of the low consumption level of animal protein is completely excluded from the food balance sheets (FAO, 2009).

However, it should be noted that despite problems related to their accuracy, national food balance sheets as well as nutritional and consumption surveys are the most readily available official sources for information on production of game meat at the national level (Ntiamoa-Baidu, 1997). Through data derived from the food balance sheets, it is possible to calculate values of bushmeat production per unit area and consumption per capita. Although the FAOSTAT data are most probably underestimates of the actual harvested bushmeat volume in Central Africa and should, therefore, be regarded with caution, they may indicate trends of bushmeat production and consumption. In the context of rapid changes in human populations and forest exploitation, these trends have the potential to formulate the baseline generalizations that are necessary to inform and direct solutions to the bushmeat problem. Therefore, transformed data from food balance sheets as described in this study, may serve as makeshift indicators to support a system with which trends of bushmeat production and consumption can be monitored. In order to design effective conservation strategies to address the bushmeat problem in the long-term, more sophisticated bushmeat trade indicators need to be developed for which detailed information on markets and preferences is required.

RECOMMENDATIONS

This paper is meant to serve to alert researchers, resource managers and decision-makers that FAO has a statistical system in place that captures and reports the annual production of bushmeat in Cameroon, Republic of Congo, Democratic Republic of Congo, Gabon and the Central African Republic. The system is based on estimates derived from food balance sheets. Although the FAOSTAT figures may lead to the conclusion that bushmeat exploitation is below the sustainability threshold for certain countries, the conservation opinion largely supports the view that the current situation of bushmeat hunting in Central African rainforests is more precarious than previously thought. Until recently, no nationwide bushmeat monitoring system has been developed which allows trends in bushmeat harvest and wild meat consumption to be estimated. Data derived from the FAOSTAT and additional online-databases provide useful information that can be used as an initial step to design a cost-effective national environmental management system with which the state of the bushmeat resource and the pressure upon it can be monitored. Thus, there is an urgent need for streamlining and validation of data from various ecological and socioeconomic sources to help better manage the bushmeat resource. The author recommends that FAO, decision-makers in Central Africa and conservationists discuss further how provisions can be put in place to improve on the limitations of the game meat production data in the FAOSTAT database and increase accuracy.

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