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Bushmeat and food security in the Congo Basin: linkages between wildlife and people's future

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SUMMARY

Tropical moist forests in Africa are concentrated in the Congo Basin. A variety of animals in these forests, in particular mammals, are hunted for their meat, termed bushmeat. This paper investigates current and future trends of bushmeat protein, and non-bushmeat protein supply, for inhabitants of the main Congo Basin countries. Since most bushmeat is derived from forest mammals, published extraction (*E*) and production (*P*) estimates of mammal populations were used to calculate the per person protein supplied by these. Current bushmeat protein supply may range from 30 g person^{-1} day^{-1} in the Democratic Republic of Congo, to 180 g person^{-1} day^{-1} in Gabon. Future bushmeat protein supplies were predicted for the next 50 years by employing current *E*:*P* ratios, and controlling for known deforestation and population growth rates. At current exploitation rates, bushmeat protein supply would drop 81% in all countries in less than 50 years; only three countries would be able to maintain a protein supply above the recommended daily requirement of 52 g person^{-1} day^{-1}. However, if bushmeat harvests were reduced to a sustainable level, all countries except Gabon would be dramatically affected by the loss of wild protein supply. The dependence on bushmeat protein is emphasized by the fact that four out of the five countries studied do not produce sufficient amounts of non-bushmeat protein to feed their populations. These findings imply that a significant number of forest mammals could become extinct relatively soon, and that protein malnutrition is likely to increase dramatically if food security in the region is not promptly resolved.

Keywords: protein supply, bushmeat, long-term stability, mass balance, recommended daily amounts, agricultural statistics

INTRODUCTION

Deforestation is a significant cause of biodiversity collapse in African tropical rainforests, but hunting of wildlife to satisfy people's need for meat (bushmeat) may currently represent an even greater threat (Wilkie & Carpenter 1999; Fa & Peres 2001). Bushmeat, generally the flesh of forest mammals (Fa *et al*. 2003), but also the meat of some reptiles (snakes, crocodiles, lizards, and tortoises) and birds (hornbills, turacos), is a cheap and plentiful supply of protein in regions where often meat from domestic animals is scarce and more expensive. Although precise estimates of the significance of wild animal protein to the diets of tropical forest-living peoples are still lacking, the prevailing opinion is that such protein is an important contributor to food security (FAO [Food and Agricultural Organization of the United Nations]/WHO [World Health Organization] 1992*a*, *b*; Ntiamoa-Baidu 1995; Pinstrup-Andersen *et al*. 2001). Up to 90% of the total animal protein may be derived from wild animals (Olatunbosum *et al*. 1972; Ajayi 1978; Prescott-Allen & Prescott-Allen 1982; Asibey 1987; Hladik 1987).

Bushmeat extraction is a significant problem throughout Africa. However, depletion of wildlife and its impact on the peoples reliant on it have been highlighted for the Congo Basin tropical moist forests (rainforests). These forests occupy 5.3 million km^2, only 7% of the African continent (Wilkie & Carpenter 1999; Fa *et al*. 2002). The Congo Basin rainforests are found within six main countries, namely Cameroon, the Central African Republic (CAR), the Democratic Republic of Congo (DRC), Equatorial Guinea, Gabon and the Republic of Congo (Congo). Over half of the Basin rainforests are found within the DRC, occupying from 8.4% of the land surface of the CAR to virtually all of Gabon (85%). A total of 34 million people (urban and rural) live within the Congo Basin moist forest region, 26 million of these (76%) are in the DRC (Wilkie & Carpenter 1999). The highest population growth rate in this region (2.4% yr^{-1}) is also typical of the DRC, population growth rates being lowest (1.6% yr^{-1}) in CAR and Gabon. Annual forest loss varies from 0.2% in Congo to 0.7% in the DRC. Mean human population density in cities as well as smaller settlements in the forest region is *c*. 18 km^{-2}, with Gabon being the least densely populated (3 km^{-2}), and Cameroon and DRC having densities of >20 km^{-2} (FAO 2002). All Congo Basin countries have relatively low human development indices (HDIs), but the CAR and DRC have low HDIs, Cameroon and the Congo have intermediate HDIs and Gabon has a relatively high HDI (World Bank 2002*a*, *b*). Gabon has the highest gross national product per person (>US$ 3000 yr^{-1}) whilst

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the DRC has the lowest (US$ 90 yr^{-1}). The proportion of the countries' populations dependent on agriculture ranges from 38% in Gabon to 60–70% in the CAR and DRC.

In the Congo Basin countries, non-bushmeat protein (mainly starchy root crops such as manioc, or animal-derived products that include meat, seafood and fish) derives from domestic agriculture and from imports that vary from 6% of total supply in the DRC to 55% in the Congo. Apart from Gabon, most domestic non-bushmeat protein supply comes from vegetal products (FAO 2002). Gabon's main source of non-bushmeat protein supply is imported, partly as a result of declining food production (a drop of 13.6% in the last 40 years), recent fluctuations in oil prices, and a fall in demand for timber and rubber exports (FAO 2002).

Approximately 44% of Cameroon's gross domestic product (GDP) is derived from agriculture, employing 53% of the country's population. Food production per person in Cameroon has not increased significantly in the last 40 years, although in the early 1980s the country was perceived as one of Africa's success stories (FAO 2002). In contrast to the neighbouring countries, Gabon's economy, which relies on oil, timber and other natural resources, is relatively prosperous. The CAR remains poor, with a falling GDP per person since 1976, but agriculture accounts for 54% of GDP and employs the largest proportion of the population. Non-bushmeat protein supply in the CAR is primarily from domestic production, which has increased by 24% over the last 40 years (World Bank 2002*a*). In the Congo, which is dominated by crude-oil production and an urbanized service economy, <50% of the non-bushmeat protein supply is produced in-country. During the last 40 years, the Congo's food production has declined by over 10% annually. The largest country in the region, the DRC, is the most economically depressed, having suffered from virtual collapse of its formal economy in the last few decades due to mismanagement and instability (Draulans & Van Krunkelsven 2002). In the DRC, the GDP per person in the 1980s was only a third that of 1962, and this has declined further in the 1990s. Non-bushmeat protein supply in the DRC is almost entirely from domestic production, and agriculture accounts for 54.2% of GDP, employing 63.2% of the population (World Bank 2002*a*).

This paper presents an analysis of the contribution made by bushmeat protein to the food security of the people living in the Congo Basin countries. We use previously published estimates of bushmeat extraction for the region to extrapolate the amount of wild animal protein likely to be available in the future, and relate this to the amount of non-bushmeat protein produced by the countries currently and likely quantities in the future. Our ultimate goal in developing this approach was two-fold, namely to (1) provide a heuristic tool that can be used to draw inferences about the dependence on bushmeat protein, and (2) assess whether the region can produce sufficient alternate protein sources to supplant the amount derived from wild meat.

METHODS

Here, protein supply refers to the volume of the resource that is potentially available to consumers, and does not infer actual consumption. For this paper, our protein availability calculations are means per person, where we assume equal opportunities to secure entitlement to food and services (Osmani 1993). Within this working scenario, we estimated current bushmeat protein supply in the main Congo Basin countries, from extraction (E) and production (P) figures in Fa *et al.* (2002). Current E (kg yr^{-1}) was estimated from field surveys of hunters (see Fa *et al.* 2002); P (kg yr^{-1}) estimates were maximal (and assume wildlife populations at optimal levels for maximal production) and derived from empirical equations quantifying productivity as a function of body size (see Hennemann 1983).

We determined future bushmeat protein supply by extrapolating from these numbers. We contrasted bushmeat protein supplies with the availability of alternative protein (animal and plant) derived from the agricultural sector, and estimated future trends. The supplies of both protein sources per person are compared against the average recommended daily allowance (RDA) of protein. The RDA is defined as the lowest continuing intake level of a nutrient that for a specified indicator of adequacy will maintain a defined level of nutrition in an individual (FAO/WHO 1985). The chosen criterion on which nutritional adequacy for a nutrient is based may differ according to the life stage or gender of the individual. We used an average RDA of 52 g $person^{-1}$ day^{-1} for human adults (FAO/WHO 1985).

We determined extraction (E) of mammals in the Congo Basin as:

$$E = \Sigma(E_t A_o) \quad (1)$$

where E_t is the taxa-specific extraction rate (tonne yr^{-1}), and A_o the area of occupancy (km^2) for each species within Congo Basin moist forests, derived from Kingdon (1997). We used data on the extraction rates of mammal species in the Congo basin from a review of hunting studies (Fa & Peres 2001). Data on the number of animals and biomass extracted per species were derived from anthropological studies that reported animal kills brought into 14 rural settlements during a period >1 year. An average extraction rate for each species was calculated from all studies that reported the species as hunted in the settlement. We used mean body mass (from Fa & Purvis 1997), to estimate extraction rates (kg km^{-2} yr^{-1}) for a total of 57 mammalian taxa in the Congo Basin.

Production (P) was calculated for mammal species in the Congo Basin moist forests as:

$$P = B\, r_{\max}\, A_f \quad (2)$$

where B is the exploited mammal standing biomass (kg), $r_{\max}$ the intrinsic rate of increase derived empirically from mean body mass (kg) for the entire Congo Basin, and A_f the area of

forest (km^2). The *E*:*P* ratio for the Congo Basin was extraction divided by production (Fa *et al*. 2002).

We calculated future *E*:*P* ratios by taking into account (1) loss of forest and therefore habitat shrinkage for bushmeat species and (2) increases in human consumers. The volume of bushmeat extracted annually for the period 2000–2050 was derived from the current extraction rate multiplied by the predicted future human population sizes, the latter taken from extrapolations by the FAO (2002). These figures take into account the impact of AIDS/HIV on population growth. For this paper, we employed only data on human populations living within the moist forests areas of the Congo Basin (Wilkie & Carpenter 1999). However, for estimates of future population sizes, we assumed that the forest population (urban and rural) would remain a fixed percentage of the total population in each country. Because deforestation and human population growth act synergistically on bushmeat production rates, we estimated their joint effect on *E*:*P* ratios for each country over time. Future bushmeat production was the current production rate multiplied by the observed deforestation rate (from WRI [World Resources Institute] 2002) and human population living within rainforests for each country.

What is known of the nutritional composition of bushmeat species suggests that these provide an equivalent and in some cases greater quality of food than domestic meats (Ajayi 1978). The average protein value of wild meat was estimated at 29.4 ± 12.7 g protein per 100 g of meat (Ajayi 1978; Asibey 1987). Bushmeat protein supply was estimated by converting the actual meat volume extracted derived from our mass balance equations (Fa *et al*. 2002) into bushmeat protein supply per person per day (*BP*) for the population at a time *t* ($Popn_t$) in each country:

$$BP_t = \frac{E_t 0.0294}{Popn_t 365} \tag{3}$$

Bushmeat protein supply was then projected for the next 50 years using population growth and deforestation figures, maintaining current *E*:*P* ratios. We present data in a no-change and in a sustainable harvest scenario. An *E*:*P* ratio of 0.2 was used here as the sustainable harvest for all bushmeat species (Robinson & Redford 1991).

Non-bushmeat protein supply from domestic production

For each Congo Basin country, data on availability (in tonnes yr^{-1}) of vegetal and animal food products were obtained from the most recent food balance sheets (1999) from the FAO (2002). From these, domestic production (in tonnes yr^{-1}) of the major food groups was calculated as a proportion of total food supply (%*DFS*) that includes imports, exports and stock changes. The %*DFS* was then multiplied by total protein supply (ΣPS, expressed in g $person^{-1}day^{-1}$) given in the 1999 food balance sheets (FAO 2002). A per person domestic protein supply (*DNBP*) was estimated as:

$$DNPB = \%DFS\Sigma PS \tag{4}$$

Projections of non-bushmeat protein supply

Future supply of non-bushmeat protein produced in the country was estimated as the product of daily protein supply per person multiplied by the mean food production growth rate per annum for each country. We used the equation from Musters *et al*. (2000), which assumes no increase in agricultural land in the future, to determine food production per hectare (*FP*) from FAO (2002). Production per hectare in each country was defined from FAO food production indices for each year, divided by the total FAO agricultural area for that year. We calculated food production growth rate (ΔFP) by:

$$\Delta FP = \frac{FP_{t+1} - FP_t}{FP_t} \tag{5}$$

From indices in FAO (2002), the ΔFP was calculated for the 32-year period (1961–1993) as the mean ± standard deviation (SD) for each country, namely Cameroon (2.18 ± 0.04%), CAR (2.60 ± 0.04%), Congo (1.73 ± 0.02%), DRC (2.23 ± 0.02%) and Gabon (2.16 ± 0.02%).

Future *DNBP* was estimated by converting *DNBP* in Eq. (4) into tonnes yr^{-1} (*DNBPT*).

$$DNBPT_t = DNPB_t Popn_t 365 \tag{6}$$

DNBPT was then multiplied by the average ΔFP for each country to calculate future *DNBPT*, which was then converted back to produce future daily domestic protein supply per person (*DNBP*).

$$DNBP_t = DNBPT_t \frac{\Delta FP}{Popn_t 365} \tag{7}$$

RESULTS

Changes in bushmeat *E:P* ratios

The overall *E:P* ratio for the Congo Basin was 1.07, with extraction slightly exceeding production (Table 1). This ratio varied among countries, from a low of 0.19 in Gabon to a high of 1.36 for Cameroon. In all countries, the effect of deforestation on decreased production was significantly less than the influence of increased demand from rising numbers of consumers, but changes in the *E*:*P* ratio for forest loss and population growth combined were highest for the DRC where the ratio was predicted to increase to 4.7 between 2000 and 2050 (Fig. 1). As expected, the smallest changes in the *E*:*P* ratio of 2.7 and 3.0 were typical of the CAR and Gabon, respectively.

Table 1 Total exploitation and extraction rates of bushmeat (undressed meat) for Congo Basin countries from baseline estimates in Fa *et al*. (2002). *Based on per caput exploitation rates of 64.3 kg person^{-1} yr^{-1}; †based on specific production of 1111 kg km^{-2} yr^{-1}.

Locality	*Total exploitation (kg yr^{-1})**	*Total production (kg yr^{-1})†*	*E:P*
Cameroon	233 963 266	172 571 630	1.36
Central African Republic	48 821 704	58 034 196	0.84
Democratic Republic of Congo	1 665 972 491	1 322 908 807	1.26
Equatorial Guinea	12 937 737	18 891 444	0.68
Gabon	49 069 902	252 752 500	0.19
Republic of the Congo	189 234 900	237 087 400	0.80
Congo Basin	2 200 000 000	2 062 245 977	1.07

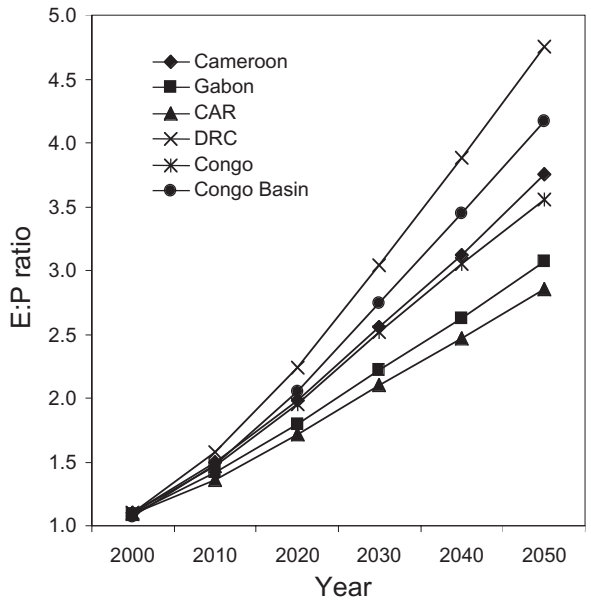

Figure 1 Increasing extraction to production (*E*:*P*) ratios for the combined effects of deforestation and population growth.

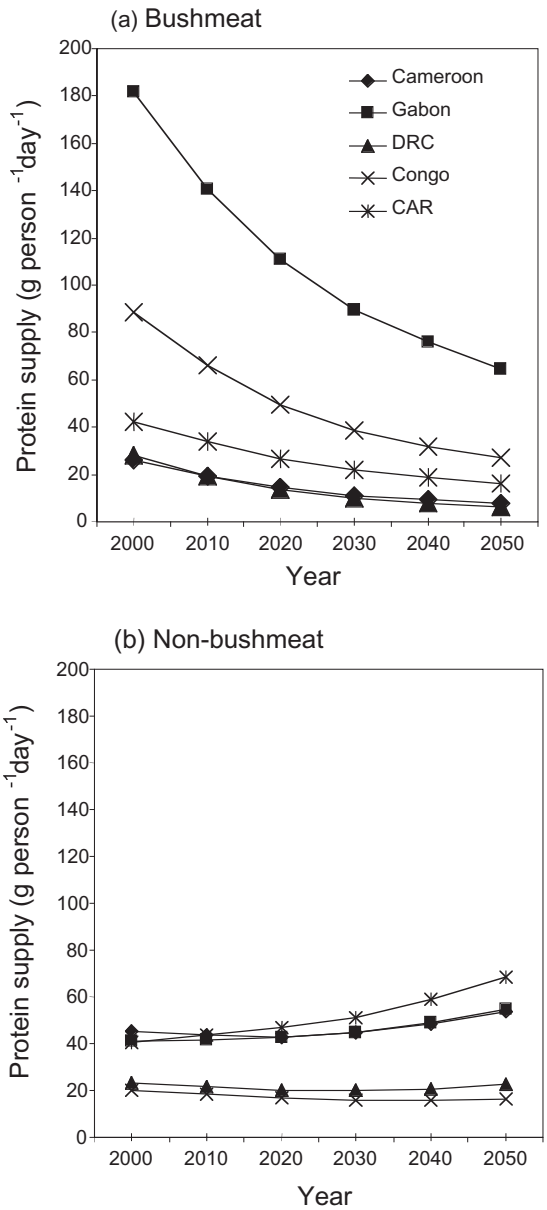

Figure 2 Projected changes within the main Congo Basin countries in: (*a*) bushmeat protein supply for the current *E*:*P* ratio and (*b*) non-bushmeat protein supply for 2000–2050.

Changes in bushmeat protein and non-bushmeat protein supply

Country bushmeat protein supplies for 2000 were different between the high bushmeat producers such as Gabon (180 g person^{-1} day^{-1}) and Congo (89 g person^{-1} day^{-1}), and the lowest producers, namely Cameroon (26 g person^{-1} day^{-1}) and the DRC (28 g person^{-1} day^{-1}). Projected declines in bushmeat protein supply were significantly different between Gabon and Congo, and the other countries (Fig. 2*a*). We calculated drops in bushmeat protein supply would vary from a minimum of 61% in the CAR to 78% in the DRC (Fig. 2*a*).

The in-country *DNBP* did not exceed 50 g person^{-1} day^{-1} in any Congo Basin country in 2000 (Fig. 2*b*). For the period 2000–2050 the *DNBP* is not expected to grow significantly in any of the countries, the average (± SD) increasing by 40.6 ± 26.3%, and ranging from 19% in Cameroon to 70% in the CAR. Negative growth is expected to appear for the DRC (−3%) and Congo (−19%) in the 50-year period. Extrapolations indicate that the *DNBP* for the most productive country, the CAR, would not be greater than 69 g person^{-1} day^{-1}. In the case of the Congo and the DRC, in 2050 the *DNBP* would barely surpass 20 g person^{-1} day^{-1}.

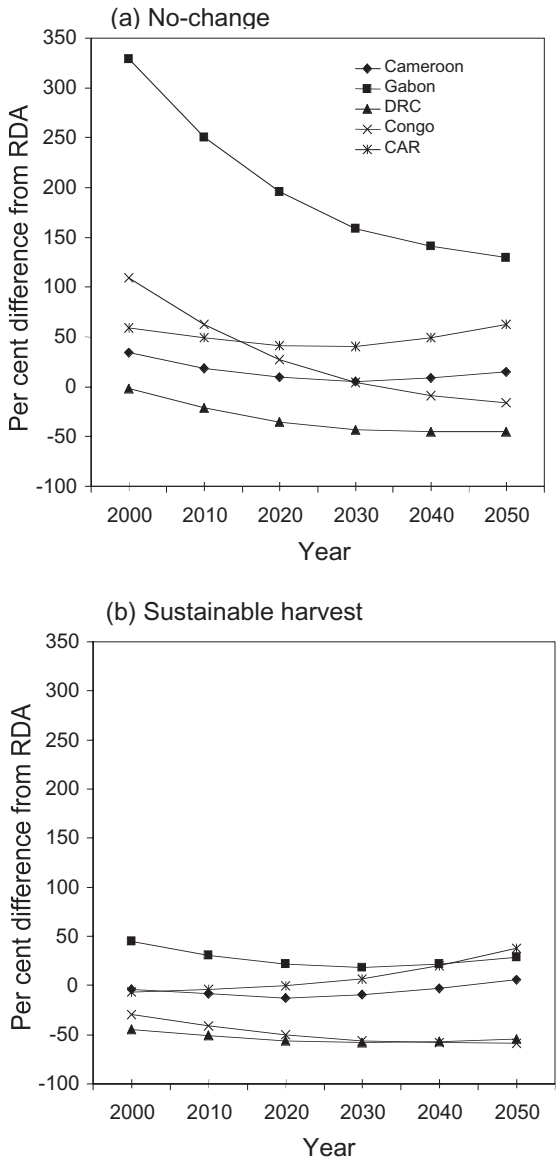

Figure 3 Projected percentage deviation from g person^{-1} day^{-1} protein RDA, for: (*a*) a no-change and (*b*) a sustainable bushmeat harvest scenario.

Meeting daily protein needs

Our figures for bushmeat protein versus non-bushmeat protein supply in a no-change scenario indicate that for the Congo Basin as a whole, the bushmeat protein contribution would fall from 55% in 2000 to 23% in 2050 (Fig. 3). For 2000, the highest bushmeat protein contribution would be seen in Gabon (82%) and the Congo (81%), with the lowest in Cameroon (37%). Contribution figures would fall by 2050 to 13% in Cameroon, 19% in the CAR, 23% in the DRC, and 54% in Gabon. The highest bushmeat protein contribution of 63% in 2050 is expected for the Congo. In a sustainable bushmeat harvest scenario, bushmeat protein supply would contribute close to half of all protein (45%) in the Congo and Gabon, but significantly less (10–18%) in Cameroon, the DRC, and the CAR. The BP contribution would drop to 3–5% in Cameroon, the CAR, and the DRC, and to 18% and 24% in Gabon and the Congo, respectively.

The no-change scenario suggests that only Cameroon, the CAR, and in particular Gabon, would remain above the average RDA value throughout the time period 2000–2050 (Fig. 3*a*). The Congo is expected to show an above average situation until 2030, when percentage deficits of up 10% would arise. In contrast, within a sustainable bushmeat harvest scenario, only Gabon would remain above the average RDA. Some recovery is expected in the CAR and Cameroon after 2030, as a result of a drop in population numbers.

In a no-change scenario, where bushmeat contributed substantially to protein supply in 2000 (an annual figure in excess of 0.7 million tonnes of protein for the region), by 2010 there would be a shortfall of 0.2 million tonnes yr^{-1}, the deficit increasing by 2050 to −3.1 million tonnes yr^{-1}. In accordance with the patterns shown in Figure 3, the DRC is in protein deficit from the start at –0.06 million tonnes yr^{-1}, and this would drop to –3.8 million tonnes yr^{-1} by 2050. If sustainable harvests were enforced, the protein supply situation would be severely affected. In 2000, the region starts at a protein deficit supply of −1.3 million tonnes yr^{-1}, dropping to -4.5 million tonnes yr^{-1} by 2050. All countries, except Gabon, would be in protein deficit, ranging from –0.01 million tonnes yr^{-1} in the CAR to –1.2 million tonnes yr^{-1} in the DRC at the start, to –0.3 million tonnes yr^{-1} in the Congo and –4.5 million tonnes yr^{-1} in the DRC in 2050. Cameroon and the CAR would have an excess of *c.* 0.2 million tonnes yr^{-1} protein by 2050.

DISCUSSION

Using countrywide statistics and extrapolations based on multiple hunting studies, we believe that we can characterize the bushmeat crisis in the Congo Basin as not only catastrophic for wildlife but also for the people who rely on it. We asked to what level bushmeat protein is available now and might be in the future to the human population living in Congo Basin rainforests and whether the countries involved have the capacity to produce enough non-bushmeat protein to feed their growing populations. We suggest that if current extraction levels continue, there will be a significant decline in available wild protein by 2050, and there will be insufficient non-bushmeat protein produced to replace the amounts supplied by wild meats. Using published extraction figures, we predict a severe loss of bushmeat protein in the future, which will no doubt have a negative impact on a large number of medium and large-sized forest mammals (Fa *et al.* 2002).

The accuracy of our predictions hinges upon how realistic our bushmeat protein extraction figures are, and on the accuracy of FAO statistics. Indeed, a shortcoming of our bushmeat extraction data is that they are based on a number of studies, undertaken at different times, which may or may not reflect the current situation on the ground. However, our

calculations of extraction rates for the Congo Basin are applicable to the entire study region since they are not affected by different attitudes to eating wild meat, as occurs in other African countries (such as differences between Muslim and Christian regions in Guinea; Ham 1998). Given this, we believe that extraction of bushmeat in the Congo Basin can be seen as a density-dependent phenomenon, extraction increases linearly with human population growth and non-linearly with increase in income. We are aware, however, that extraction may not be totally linear since mammal production per unit area may increase as habitat availability diminishes if density compensation occurs (Peres & Dolman 2000), or may decrease rapidly due to Allee effects (Petersen & Levitan 2001).

What clearly emerges from our *E*:*P* calculations is that there are strong inter-country differences in *E*:*P*; the CAR, DRC and Congo show rapidly escalating *E*:*P* ratios, whereas Cameroon and Gabon have much more slowly rising *E*:*P* ratios. This suggests that the most critical areas are in the central part of the Congo Basin. In terms of protein supply, only Gabon is able to depend on bushmeat. All the other countries will have to find other sources of protein from the agricultural sector. Our projections show that even if bushmeat protein supply were reduced to a sustainable level, non-bushmeat protein could not supply enough to cover the needs of the population in these countries, apart from Gabon.

The bushmeat crisis can be solved, at least in theory, by lowering demand for it through controlling the supply (Milner-Gulland & Akçakaya 2001), or by educating consumers about other options (Wilkie & Godoy 2001). Most conservationists argue that curbing commercial wild meat supply to consumers, especially those in urban areas, is ultimately the most pragmatic answer (Robinson *et al.* 1999). Some organizations have suggested that the key to the problem is to stop the involvement of logging companies in facilitating extraction and transportation of bushmeat (World Society for the Protection of Animals 1995; Ape Alliance 1998). Indeed, given the widespread and increasing number of forestry concessions in Congo Basin countries (for example in Cameroon; Globalforestwatch 2002) and the lucrative commercial incentives that drive hunting, logging may unwittingly ease the process and amplify the threat to wildlife. But, if bushmeat supply is stopped, can consumers within the region rely on alternative protein sources? Consumer behaviour is affected by meat prices, thus if cheaper alternative domestic meats such as beef, pork, chicken or goat were available, people might purchase significantly less bushmeat (Wilkie & Godoy 2001). However, bushmeat substitutes, not just animal but also vegetal products, can only be part of the solution if these are regularly and widely available, and above all economically accessible to potential buyers. Such alternatives are either produced by the country's agricultural sector or imported, and both are linked to the prosperity of the nation (Barnes & Lahm 1997; Sachs *et al.* 2001). Obviating the wider food security context in which the bushmeat crisis is entangled, and especially the position of alternative protein sources, may unintentionally espouse a proverbial *Qu'ils mangent de la brioche* (let them eat cake) situation, as Queen Marie-Antoinette was alleged to have said when famine struck Paris in the 1770s.

Given the rapid population growth in the region, increasing smallholder agricultural productivity is essential to reduce demand for bushmeat from urban as well as rural areas. This must be achieved by providing alternative animal and vegetal protein supplies and generating alternative employment and income opportunities to increase the opportunity costs of bushmeat hunting. Increasing smallholder agricultural productivity will require: (1) changes in policies and institutions that encourage private investment and more effective public investment in basic education, health, and nutrition; (2) research extension; (3) development of appropriate technologies; (4) rural infrastructure; (5) developing and strengthening social organizations representing farms and local communities; and (6) approaches that address the needs of women farmers. The search for alternatives to extensive slash-and-burn should focus on existing systems where the economic, environmental, and social potential and limitations are known (FAO 1999; Dixon *et al.* 2001). A fundamental problem has been that investment in agricultural development and research has declined substantially over the past 10 years because of reductions in both bilateral and multilateral overseas aid and the pursuit of urban-biased development policies by national governments (World Bank 1997; International Fund for Agricultural Development 2001; Pinstrup-Andersen & Pandya-Lorch 2001). Consequently, countries such as those in the Congo Basin have not yet developed the basic research, information and dissemination systems of agricultural development, built the rural infrastructure required, or adopted the appropriate technology to provide sufficient food and income-earning opportunities in rural areas.

Against this background of increasing food insecurity and poverty, bushmeat has become an important source of protein for rural households and a significant source of revenue, which has few rivals in terms of trade, because it is accessible, highly transportable, has a high value:weight ratio, is preserved at low cost, and has good storage qualities when smoked (Inamdar *et al.* 1999). We believe that, given the steadily growing population, low income and an ever-increasing gap between food consumption and production, protein deficiency must be promptly addressed. The underlying tenet is that agriculture growth and development are necessary to address the problem of bushmeat exploitation, because they are required to meet the growing food needs of a rapidly growing population. Increasing the opportunity costs of bushmeat hunting by creating alternative employment and income generation possibilities in rural areas must similarly be pursued (Musters *et al.* 2000; Pinstrup-Andersen & Pandya-Lorch 2001).

Last-minute solutions, such as providing food aid when crisis scenarios threaten, are inadequate. Additionally, they suppress the stimulus to generate deliberate food policies,

and public investment and the development of markets. However, whilst there is some debate about biophysical limitations of productive capacity where slash-and-burn or shifting cultivation is the dominant mode of agricultural production levels (Barnes & Lahm 1997), there is some recognition that sub-Saharan countries have not run out of productive land, but merely require technologies appropriate to more intensive settled cultivation and better management of soils (Donovan 1996; World Bank 1997; Pinstrup-Andersen & Pandya-Lorch 2001).

A final point to highlight is that, despite the caveats that countrywide data sources may introduce to such a study, because we have dealt with overall trends for the region, we are confident that the general picture that we have painted is realistic. The picture is indeed a bleak scenario, not only for wildlife, but also for the region's inhabitants, especially because of the low in-country protein production. Thus, the future of the Congo Basin's tropical rainforest wildlife and its people lies in whether the academic, social and political sectors can collaborate to find a solution now. If not, protein malnutrition will increase dramatically against a background of emptied forests. We also acknowledge that strong emphasis on agricultural development needs to be combined with habitat and protected area management to effectively address the linked issues of food insecurity and bushmeat overexploitation.

We conclude that trends of protein supply for the region are highly pessimistic, simply because of the uncontrolled increase in human numbers. This is also the conclusion of FAO/WHO (1992*a*, *b*) who foresaw that the number of chronically undernourished people in sub-Saharan countries would rise from 180 to 300 million by the year 2010. We believe that total food insecurity for the countries in the Congo Basin is buttressed at present by wild animal protein.

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