

# The bushmeat market in Kisangani, Democratic Republic of Congo: implications for conservation and food security

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**Abstract** Given the important contribution of urban consumption in bushmeat trade, information on bushmeat sales in urban markets can provide valuable insights for understanding the dynamics of this trade and its implications for conservation and food security. We monitored bushmeat traded in the market of Kisangani (the provincial capital of the Province Orientale in the Democratic Republic of Congo) and compared data collected in surveys in 2002 and 2008–2009. In both periods more than two-thirds of the carcasses sold were of rodents and ungulates. From 2002 to 2008–2009 the number of carcasses increased by 44% but the equivalent biomass by only 16% because of a significant decrease in medium-sized species (10–50 kg) and an increase in small species (< 10 kg). The number of carcasses of large species increased between the two periods and those of diurnal monkeys increased fourfold. In both periods smoked bushmeat was one of the cheapest sources of protein available year-round, together with caterpillars, which were only available during the rainy season, and pork. Prices of other domestic meat were significantly higher. This study identified an increase in the market of highly threatened species such as okapi *Okapia johnstoni* and small diurnal monkeys and the continued presence of protected species, and also highlights the food security role that bushmeat plays for poor urban people who cannot afford alternative sources of protein.

**Keywords** Bushmeat trade, Democratic Republic of Congo, DRC, food security, urban market data, wildlife conservation

## Introduction

Wildlife meat derived from the forest or the bush, termed bushmeat, is a significant source of animal

protein in Central African countries (Wilkie et al., 2005; Bennett & Robinson, 2000) and a crucial component of food security in the region (Fa et al., 2003). In rural communities bushmeat is often the most easily tradable item, both in terms of value-to-weight ratio and transportability (Fa & Brown, 2009). Bushmeat is consumed regularly in urban areas and constitutes a significant source of revenue for a large informal sector (Milner-Gulland et al., 2003). Many sustainability assessments focusing on tropical forest wildlife in the region have warned about the increasing unsustainability of hunting and associated ecological impacts (Fa & Brown, 2009). Although humans have been hunting in the forests of Central Africa for millennia there are several reasons why hunting is not sustainable in all places and for all species. Civil conflict or insecurity, poor governance and inadequate law enforcement are some of the drivers of non-sustainability. The growth of extractive industries, such as logging and mining, indirectly facilitate hunting in remote areas by building roads and camps, thus providing or facilitating transportation for hunters and market trade and increasing local demand (Thibault & Blaney, 2003; Poulsen et al., 2009). The loss of both traditional hunting territories and methods (e.g. hunting zone rotations) allows open access to the resource and concentration of hunting, with negative implications for the sustainability of hunting (Poulsen et al., 2009; Kumpel et al., 2010). Increasing consumer demand from growing human populations and a lack of acceptable alternative sources of protein are widely assumed to be the primary drivers of the increasing levels of bushmeat offtake in Central Africa (Juste et al., 1995; Davies, 2002). Although per capita consumption of bushmeat is low in urban areas, aggregate urban consumption is higher than aggregate rural consumption because of the high population density in urban areas (Starkey, 2004).

Given the important contribution of urban consumption in the bushmeat trade, urban markets have been widely used to estimate the state of hunted faunal assemblages and infer the sustainability of hunting (Juste et al., 1995; Brashares et al., 2004; Albrechtsen et al., 2005; Cowlshaw et al., 2005; Crookes et al., 2005; Wilkie et al., 2005; de Merode & Cowlshaw, 2006; Fa et al., 2006; Brugiere & Magassouba, 2009). Bushmeat markets are found in almost every town and village in Central Africa and are important concentration points of wildlife harvests from surrounding hunting

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catchments (Juste et al., 1995; Fa et al., 2000; Fa & Yuste, 2001). Collecting bushmeat data at the market level is more efficient than conducting interviews with hunters when data at the level of the hunting catchment are needed. Several market-based indicators have been proposed for assessing the sustainability of the bushmeat trade. The indicators are generally based on the hypotheses that in overharvested areas rare and threatened species decline first, larger sized species become rarer, the proportion of small, fast-reproducing species increases, hunting catchment areas increase and the proportion of smoked meat and prices increase.

However the effectiveness of market data to provide information about offtake and the sustainability of hunting has been criticized (Crookes et al., 2005), with evidence that overall extraction of bushmeat may be far greater than the visible market trade (Bakarr et al., 2001; Fa et al., 2002; Rose, 2002). Data collected in established markets provide information about only one part of the market chain. As much bushmeat may pass through informal channels, such as from rural hunters directly to urban consumers, formal bushmeat markets represent an unknown proportion of total urban consumption (Starkey, 2004). Crookes et al. (2005) identified two main problems with using market data to infer sustainability. Firstly, most urban markets sell bushmeat from a large and variable catchment area; sustainability may then be incorrectly inferred from apparent market stability when the meat is simply coming from a previously untapped source. Secondly, offtake calculated from animals sold in markets underestimates the real harvest rate because only part of hunting offtake is sold in markets (van Vliet & Nasi, 2008). Moreover, bushmeat markets are highly dynamic systems, with the volume of items for sale and their species composition varying over both daily and seasonal timescales.

Here we use bushmeat market data not as a way to provide an absolute measure of sustainability but rather to provide information about trends, describe the relative contribution of traded species and highlight implications for conservation and food security. We compare bushmeat traded in the main market of Kisangani in the Democratic Republic of Congo (DRC) for 2002 and 2008–2009, with a particular focus on the following indicators: (1) change in the percentage of carcasses from the most hunted species, (2) change in biomass versus change in number of carcasses, (3) change in the percentage of small-, medium- and large-sized species, (4) change in the proportion of protected, partially protected and non-protected species, (5) change in hunting catchment area, and (6) prices of the most common bushmeat species compared to prices of the most common protein alternatives.

## Study area

Our study site is the main market of Kisangani, the provincial capital of the Province Orientale and the third

largest city in DRC. Kisangani lies along the Congo River, in the district of Tshopo (Fig. 1). The city suffered from political unrest from the 1990s until 2002 during the fighting between Ugandan and Rwandan forces. Since 2002 peace and conflict have alternated, with numerous militia and armed groups still active in the east of DRC. Kisangani is connected by river to Yangambi and by road to the main towns of Opala, Lubutu and Ubundu to the south, Buta to the north, and Mambassa (Ituri) to the east. Several important protected areas lie < 400 km from Kisangani (Maiko National Park to the south-east, Okapi Wildlife Reserve to the east, Rubi-Tele hunting reserve to the north and Yangambi Biosphere Reserve < 50 km to the west along the Congo River).

## Methods

We monitored bushmeat traded in the main market of Kisangani during January–December 2002 and from July 2008 to June 2009, with a focus on mammal species (the animal group most traded in the market). With prior permission from market authorities and the agreement of the traders (all of whom are women), the market was visited every 3 days. We visited on 124 days in 2002 and 131 in 2008–2009. Although the market is open all day, bushmeat arrives early in the morning and is sold before noon, when bushmeat traders depart, and thus our visits were in the morning. On each visit all traders agreed to provide data on species, number, piece (entire animal, in pieces), origin and price of the carcasses sold that day. Whole animals were also weighed to convert prices per carcass to prices per kg. In 2008–2009 additional information on hunting technique used (gun, traps, nets) and state (smoked, fresh) was also collected. Only carcasses that arrived at the market on the day of the visit were taken into account (stocks were not considered as they were observed only rarely). Small diurnal monkeys were not always identified to species and were thus combined into one category. We also collected prices and weights for the other major sources of protein available: fresh fish, chicken, pork, beef, goat and smoked caterpillars.

We analysed the data collected for species richness, species composition and biomass for the two periods. We compared the proportion of small-sized (< 10 kg), medium-sized (10–50 kg) and large-sized species (> 50 kg) and the proportion of protected, partially protected and unprotected species. Because the traders have agreements with specific hunters and transporters they have a good knowledge of the trading routes but not always about the particular village from where the meat is brought. As a result it was not possible to assess the size of the hunting catchment. However, we assessed the number and the species composition of carcasses originating from different trade routes in both years.

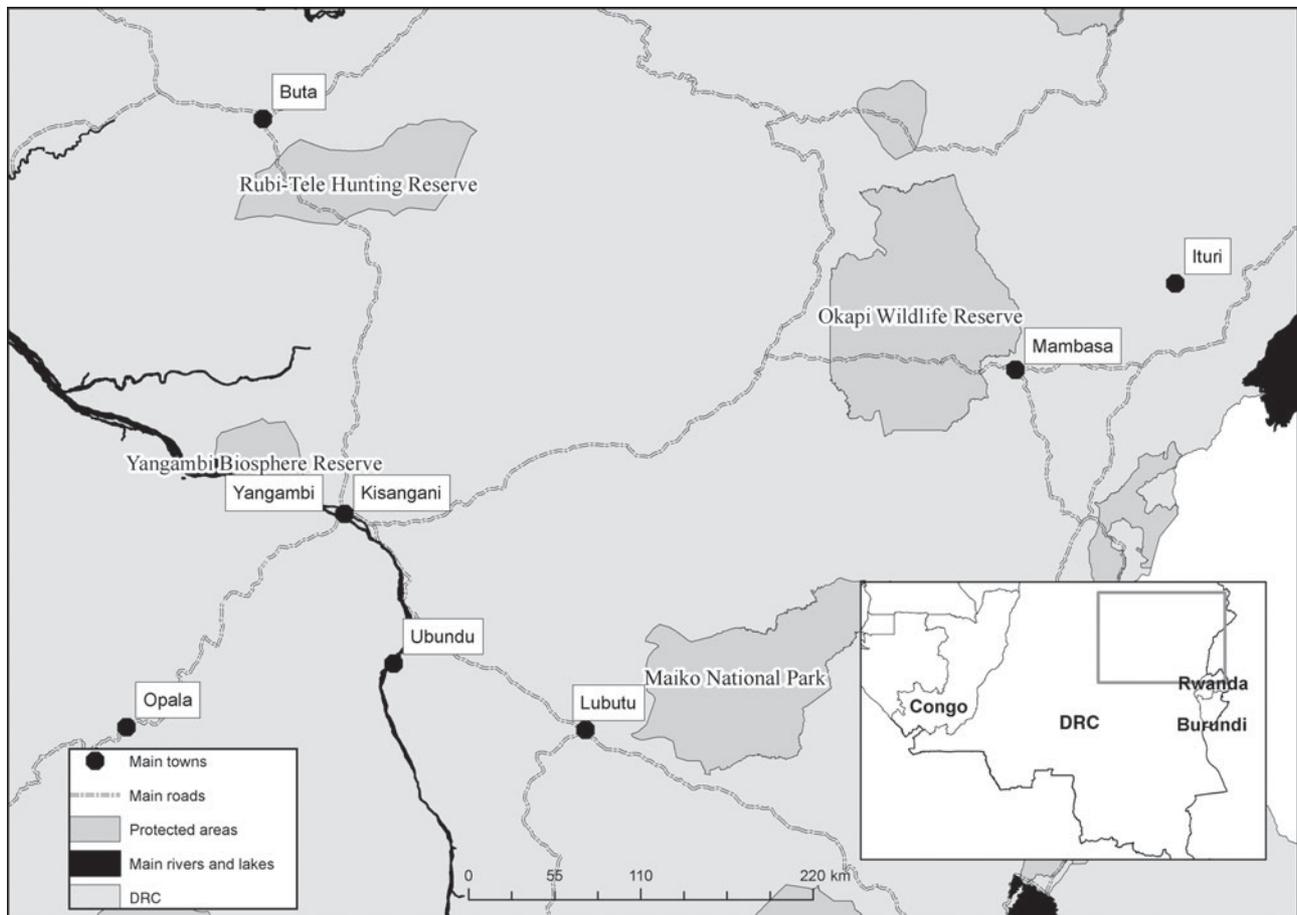


FIG. 1 The location of Kisangani and neighbouring towns, the river and road connections between them, and nearby protected areas. The rectangle on the inset indicates the location of the main map in the Democratic Republic of Congo (DRC).

We calculated prices per kg for the two periods based on prices and carcass weights measured on 30 carcasses of each of the four most abundant taxa sold as an entire piece (brush-tailed porcupine *Atherurus africanus*, blue duiker *Cephalophus monticola*, small diurnal monkeys, and Emin's pouched rat *Cricetomys emini*). As the inflation rate was correlated with the exchange rate between 2002 and 2008 (Menga, 2010), prices in CDF recorded in 2002 and 2008–2009 were made comparable by converting to USD using the daily local exchange rates in 2002 (1 USD = 240 CDF) and 2008–2009 (1 USD = 840 CDF). We compared prices of the four most commonly sold bushmeat species and of the other alternative sources of protein available in the market between 2002 and 2008–2009 using pair-wise Mann–Whitney tests.

We then compared prices of bushmeat species with sources of alternative protein available in the Kisangani market (fresh chicken, pork, beef and fish, and smoked caterpillars). Prices per kg were not comparable because bushmeat was sold smoked, whereas other sources of protein were sold fresh (except caterpillars). According to Dieval (2000) and C. Fargeot (pers. comm.) 6 kg of fresh meat (including bones) would render c. 5 kg of smoked

carcass. Therefore, the price of 1 kg of smoked carcass equals 6/5 times the price of 1 kg of fresh meat. To facilitate the comparison of fresh alternative sources of protein with smoked bushmeat we multiplied the price per kg of smoked carcass by 5/6 to obtain the price per kg of the equivalent weight of fresh meat. We computed an analysis of variance (ANOVA) and pairwise post hoc analysis with the Bonferroni correction to test the difference in prices per kg among bushmeat species and alternatives for the two periods.

## Results

In 2008–2009 87% of the carcasses were smoked and only 3% were sold fresh (boiled, alive or brazed). Eighteen mammal species were recorded in 2002 and 22 in 2008–2009. One Endangered species (bonobo *Pan paniscus*), two Near Threatened species (okapi *Okapia johnstoni*, leopard *Panthera pardus*) and the common warthog *Phacochoerus africanus* were found in the market in 2008–2009 but not in 2002. The abundance of all species was greater in 2008–2009 than in 2002 except for the sitatunga *Tragelophus spekei*,

TABLE 1 Number of carcasses of the mammal species recorded in the Kisangani market in 2002 and 2008–2009, with protection status of each species according to the Forest Law 2006 of the Democratic Republic of Congo and status on the IUCN Red List.

Species	2002	2008–2009	Protection status	Red List status*
Brush-tailed porcupine <i>Atherurus africanus</i>	1,182	3,571	None	LC
Bay duiker <i>Cephalophus dorsalis</i>	3,256	1,236	Partial	LC
Blue duiker <i>Cephalophus monticola</i>	2,788	4,650	Partial	LC
Black-fronted duiker <i>Cephalophus nigrifrons</i>	693	1,053	None	LC
Yellow-backed duiker <i>Cephalophus sylvicultor</i>	93	196	Partial	LC
Small diurnal monkeys <i>Cercopithecus</i> spp.; <i>Cercocebus</i> spp.	2,221	8,228	Partial	
Emin's pouched rat <i>Cricetomys emini</i>	5,716	6,457	None	LC
Fruit bats <i>Eidolon helvum</i>	1,647	292	None	LC
Bush pig <i>Potamochoerus porcus</i>	671	423	Partial	LC
Water chevrotain <i>Hyemoschus aquaticus</i>	195	409	Partial	LC
Forest elephant <i>Loxodonta africana cyclotis</i>	16	28	Total	VU
Giant pangolin <i>Manis gigantea</i>	7	49	Total	NT
Arboreal pangolin <i>Manis tricuspis</i>	1	1	None	LC
Orycterope <i>Orycteropus afer</i>	12	16	Partial	LC
Chimpanzee <i>Pan troglodytes</i>	97	103	Total	EN
Baboon <i>Papio anubis</i>	7	139	Partial	LC
Forest buffalo <i>Syncerus caffer</i>	48	70	Partial	LC
Sitatunga <i>Tragelaphus spekei</i>	135	72	Partial	LC
Okapi <i>Okapia johnstoni</i>	0	3	Total	NT
Leopard <i>Panthera pardus</i>	0	5	Total	NT
Bonobo <i>Pan paniscus</i>	0	17	Total	EN
Common warthog <i>Phacochoerus africanus</i>	0	3	Partial	LC
<b>Total</b>	<b>18,785</b>	<b>27,021</b>		

\*EN, Endangered; VU, Vulnerable; NT, Near Threatened; LC, Least Concern (IUCN, 2011)

bush pig *Potamochoerus porcus*, fruit bat *Eidolon helvum* and bay duiker *Cephalophus dorsalis* (Table 1). The abundance of small diurnal monkeys increased fourfold from 2002 to 2008–2009 and that of the brush-tailed porcupine tripled. The species composition changed between the two periods (Fig. 2). In 2002 Emin's pouched rat *Cricetomys emini* represented 30% of the carcasses, the bay duiker 17%, the blue duiker *Cephalophus monticola* 15%, the small diurnal monkeys 12% and the brush-tailed porcupine 6%. In 2008–2009 five species accounted for 89% of the carcasses sold: small diurnal monkeys (30%), Emin's pouched rats (24%), blue duikers (17%), brush-tailed porcupines (13%) and bay duikers (5%). Rodents and ungulates represented 78% and 68% of the carcasses sold in the market in 2002 and 2008–2009, respectively.

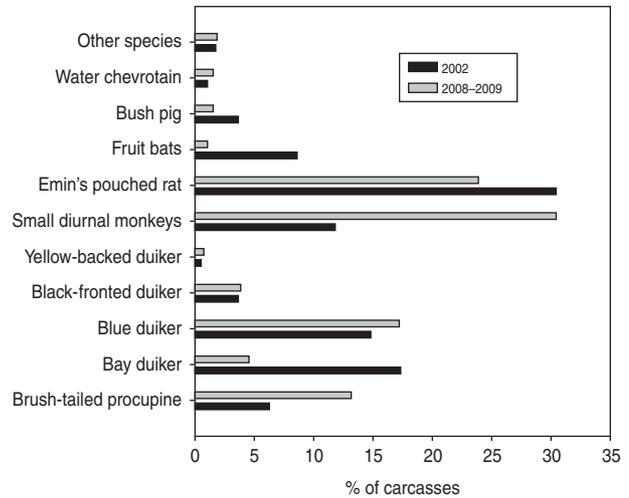


FIG. 2 Species composition (percentage number of carcasses) of bushmeat traded in the market of Kisangani in 2002 and 2008–2009.

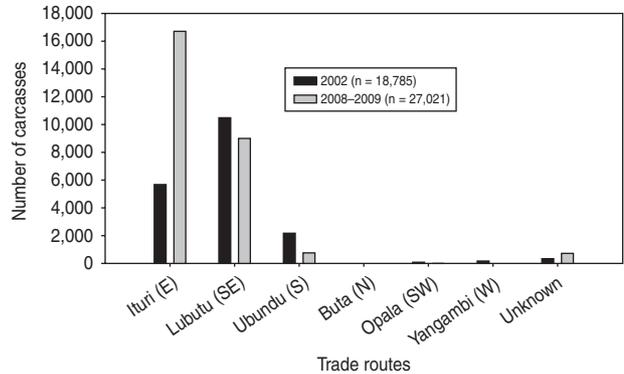


FIG. 3 Number of carcasses entering the bushmeat market of Kisangani from seven trade routes (Fig. 1; with their compass direction from Kisangani in parentheses) in 2002 and 2008–2009.

In 2008–2009, 54% of the animals were hunted using traps and 46% using guns.

The number of carcasses was 44% greater in 2008–2009 (Table 1) but biomass increased by only 16% (234 tonnes in 2002 and 271 tonnes in 2008–2009). The number and percentage of medium-sized species was greater in 2002 (4,066, 22%) than in 2008–2009 (2,496, 9%), that of small-sized species was higher in 2008–2009 (13,554, 86%) than in 2002 (23,198, 72%), and that of large-sized species was approximately the same in the two periods (2002: 1,166, 6%; 2008–2009: 1,349, 5%). Totally protected species comprised 1% of the carcasses in 2002 and 2008–2009 and partially protected species 50% in 2002 and 66% in 2008–2009.

The relative contribution of the various trade routes supplying bushmeat to Kisangani shifted from the south-east in 2002 to the north-east in 2008–2009 (Fig. 3). In 2002, 55% of the carcasses originated from Lubutu, 12% from Ubundu and 30% from Ituri. In 2008–2009, 63% of the

TABLE 2 Prices of bushmeat carcasses and alternative sources of protein in the market of Kisangani in 2002 and 2008–2009, with probability of pairwise Mann–Whitney tests between the two periods.

	Mean price $\pm$ SD in 2002	Mean price $\pm$ SD in 2008–2009	P
<b>Wild species, smoked (with equivalent value for fresh meat in parentheses)</b>			
Brush-tailed porcupine (n = 30)	3.6 $\pm$ 0.7 (2.98)	2.9 $\pm$ 0.5 (2.44)	0.001
Blue duiker (n = 30)	3.2 $\pm$ 1.3 (2.66)	3.2 $\pm$ 1.1 (2.68)	0.90
Small diurnal monkeys (n = 30)	2.7 $\pm$ 1.0 (2.26)	3.3 $\pm$ 0.7 (2.77)	0.01
Emin's pouched rat (n = 30)	3.7 $\pm$ 1.0 (3.09)	3.2 $\pm$ 0.5 (2.70)	0.01
Caterpillars (n = 30)	1.8 $\pm$ 0.2 (1)	0.3 $\pm$ 0.3 (0.26)	< 0.0001
<b>Alternative protein, fresh</b>			
Goat (n = 30)	15.8 $\pm$ 0.2	4.5 $\pm$ 0.1	< 0.0001
Chicken (n = 30)	10.2 $\pm$ 0.2	3.5 $\pm$ 0.2	< 0.0001
Pork (n = 30)	3.3 $\pm$ 0.2	1.1 $\pm$ 0.2	< 0.0001
Beef (n = 30)	13.9 $\pm$ 0.2	6.1 $\pm$ 0.2	< 0.0001
Fish (n = 30)	5.1 $\pm$ 0.3	4.9 $\pm$ 0.4	0.193

carcasses came from Ituri, 34% from Lubutu and 3% from Ubundu. The increased relative contribution of Ituri compared to Lubutu in 2008–2009 is not because of the small reduction of the absolute abundance of carcasses coming from Lubutu but rather because of an increase in the number of carcasses from Ituri. In both periods the percentage of totally protected species coming from Ituri and Lubutu was equal (3%).

The mean prices of beef, chicken, goat and pork were significantly lower in 2008–2009 than 2002 while the price of caterpillars increased significantly and the price of fish was approximately the same (Table 2). The prices of small diurnal monkeys and Emin's pouched rat were significantly higher and the price of brush-tailed porcupine significantly lower in 2008–2009 compared to 2002, whereas the price of blue duiker was approximately the same (Table 2).

In 2002 the cheapest source of protein was caterpillars (only available during the rainy season of April–October). The most expensive source of protein was goat, followed by beef and chicken. Of mammal bushmeat species Emin's pouched rat (the most readily available species and an agricultural pest) was the most expensive but prices were not significantly different among bushmeat species (Table 3). None of the bushmeat species was significantly more expensive than pork and caterpillars but all were significantly less expensive than goat, beef, chicken and fish.

In 2008–2009 the most expensive source of protein was beef, followed by fish and goat. Of the mammal bushmeat species, small diurnal monkeys were the most expensive but there were no significant differences among species. The cheapest sources of protein were caterpillars and pork. All bushmeat species were significantly more expensive than caterpillars and pork but significantly cheaper than beef, fish, goat and chicken.

## Discussion

Rodents and ungulates combined represented 78% and 68% of the carcasses sold in the market of Kisangani in 2002 and 2008–2009, comparable to other markets in West and Central Africa: 78% in Republic of Guinea (Brugiere & Magassouba, 2009), > 67% in Ghana (Ntiemoa-Baidu, 1997), 79% in Nigeria (Fa et al., 2006) and 71% in Cameroon (Fa & Brown, 2009). Cowlshaw et al. (2005) showed that vulnerable taxa (large-bodied, slow-reproducing species) are often depleted in hunted areas whereas robust taxa, such as rodents and small antelopes (Kumpel et al., 2010), persist sustainably even in agricultural landscapes around cities, where there is high hunting pressure. The abundance of rodents in the Kisangani market could also be explained by the high number of people who are farmer-hunters (trapping mainly agricultural pests around their fields).

In Kisangani 87% of the carcasses were sold smoked in 2008–2009. The proportion of smoked meat is often cited as an indication of the size of the hunting catchment area. However, the high proportion of smoked meat in the market could also indicate poor transport conditions or lack of facilities to conserve meat (few people can afford refrigerators and there is only one cold room in Kisangani). In Gabon, where > 90% of the meat is sold fresh (Starkey, 2004; Okouyi, 2006), the meat arrives fresh to the market but is then conserved frozen and defrosted before sale (N. van Vliet, pers. obs.).

The lower percentage of bay duikers in the Kisangani market in 2008–2009 compared to 2002 and the similarity of the percentage of blue duikers between the two periods is similar to the evidence obtained in Makokou, north-east Gabon (van Vliet et al., 2007), where bay duikers appeared to be more vulnerable to the effect of hunting than blue duikers. The lower abundance of fruit bats in the market in 2008–2009, the presence of the common warthog and the increased abundance of small diurnal monkeys are unexpected. The lower abundance of fruit bats could be because of high hunting pressure. Fruit bats are known to be much appreciated for their meat and because of their low reproductive rate they are severely affected by hunting (Mickleburgh et al., 2009). The common warthog is a savannah species present in neighbouring countries on the eastern border of DRC and not around Kisangani, suggesting that some carcasses may come from other

TABLE 3 Pairwise post hoc tests of difference, with the Bonferroni correction (bold values indicate a significant difference with a corrected  $\alpha = 0.001$ ), of prices (all converted to the equivalent of fresh meat) of bushmeat species and alternative sources of protein in 2002 (below diagonal) and 2008–2009 (above diagonal).

	Blue duiker	Brush-tailed porcupine	Small diurnal monkeys	Emin's pouched rat	Fish	Pork	Caterpillars	Goat	Chicken	Beef
Blue duiker										
Brush-tailed porcupine	0.318									
Small diurnal monkeys	0.208	0.086								
Emin's pouched rat	0.186	0.727	0.011							
Fish	< 0.0001	< 0.0001	< 0.0001	< 0.0001						
Pork	0.095	0.423	0.006	0.631	< 0.0001					
Caterpillars	0.189	0.029	0.835	0.015	< 0.0001	0.051				
Goat	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001			
Chicken	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001		
Beef	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	

countries. Small diurnal monkeys comprised 12% of carcasses in 2002 and 30% in 2008–2009, whereas in Nigeria and Cameroon small diurnal monkeys comprised 10 and 16.9% of carcasses, respectively (Fa et al., 2006). Small diurnal monkeys could be increasingly hunted if a shift from trapping to hunting with guns has occurred. In 2008–2009 hunting with guns was responsible for 46% of the carcasses sold in the market. Although our data do not allow a comparison of hunting techniques between the two periods, Hart (2000) showed that hunting with guns was extremely rare and only nets, traps and bows were used in the Ituri region in the late 1970s, suggesting a shift to hunting with guns. In north-east Gabon van Vliet & Nasi (2008) found that the proportion of small diurnal monkeys in hunting offtake increased because of a change from trapping to hunting with guns. In Equatorial Guinea the increase in hunting with guns was responsible for the decrease in the abundance of small diurnal monkeys and the local depletion of the black colobus *Colobus satanas* (Kumpel et al., 2008). The high percentage of small diurnal monkeys observed in Kisangani market warrants special attention. An investigation of the abundance of this group in the Ituri forest could complement our results and help understand the impacts of trade on the sustainability of small monkey populations.

The changes in species composition and number of carcasses between 2002 and 2008–2009 could also be explained by a shift in hunting catchment areas. The improvement of the road from Kisangani to Ituri and the relative political stability has made it possible for hunters and traders in villages along the road to become involved in commercial hunting. That most bushmeat was coming from Lubutu in 2002 does not mean that hunting pressure in the Ituri forest was low. The forest was actually heavily hunted in an open-access system that was exploited by a large number of low-ranking soldiers (de Merode & Cowlshaw, 2006) who relied on bushmeat for subsistence. Our results show that the increased relative contribution of Ituri as a hunting catchment area for Kisangani is because of an absolute increase in the number of animals traded along the Ituri road and not because of a decrease in the number of carcasses coming from Lubutu. The presence of okapi meat in the market in 2008–2009 (the species was not recorded in 2002) could be attributed to higher hunting pressure around and within the Okapi Wildlife Reserve, accessible by the road that leads to Ituri.

The increase in the number of carcasses from small-sized animals and decrease of medium-sized species has also been observed in the Takoradi market in Ghana (Cowlshaw et al., 2005), where rodents and other small, fast-reproducing species have gained in importance in long-established markets because slow-reproducing and large species have been depleted (Cowlshaw et al., 2005). In Kisangani, however, the percentage of large-sized species was approximately the same in 2002 and 2008–2009,

suggesting that hunting of slow-reproducing species (often protected and threatened species) is still profitable in this region. Profitability can be dependent on prey availability, travel costs, demand and law enforcement. Armed conflicts facilitate trade in protected species (de Merode & Cowlshaw, 2006) because the trade is in the hands of uncontrolled military troupes moving in remote forests independently of the laws and limits of protected areas.

Our results also show that prices of bushmeat are not necessarily linked to availability but can also reflect preferences (such as for Emin's pouched rat and small diurnal monkeys). A cultural preference for specific bushmeat species may encourage consumers to pay high prices for bushmeat. In Nigeria, using a combination of taste tests and questionnaires, Emin's pouched rat was rated the highest by consumers but was consumed less than mutton and beef because of constraints of cost and availability (Ladele et al., 1996).

In Kisangani bushmeat is not a luxury product, as it is elsewhere (Bowen-Jones, 2003; Cowlshaw et al., 2005), and smoked bushmeat is one of the cheapest sources of protein year-round. Other sources of protein, except pork and caterpillars, are significantly more expensive. In contrast, in Ghana, bushmeat was more expensive than domestic meat or fish and prices reflected differences in supply: bushmeat production was low in volume and occurred at considerable distances from urban centres, whereas domestic meat production was high in volume and occurred in close proximity to city markets (Cowlshaw et al., 2005). In urban Nigeria and Gabon bushmeat is also a luxury item for which individuals are willing to pay a premium over other sources of animal protein. For example, in urban Nigeria bushmeat is more costly than all other meats except premium imported steak (Ladele et al., 1996). In Libreville bushmeat is 1.5 times more expensive than the most costly beef (Starkey, 2004). The analysis of the role of wealth in bushmeat consumption needs to distinguish between rural and urban settings. In rural towns of Gabon and around Garamba National Park (DRC), bushmeat consumption was higher in wealthier households (de Merode et al., 2004; Wilkie et al., 2005) because the poorest households in the village could not afford hunting tools or somebody able to hunt. In urban settings such as in Kisangani where households no longer have access to free natural resources the poorest seek the cheapest source of protein available in the market. Given the higher cost of production of domestic meat and the disruption of supply during the armed conflict (de Merode & Cowlshaw, 2006), bushmeat remains one of the cheapest sources of protein. As bushmeat is sold in small piles costing < USD 0.10 each, whereas domestic meat is sold on piles ranging from 500 g to 1 kg, the former is more affordable to the poor who manage on small daily budgets.

In 2008–2009, while caterpillars (only during the rainy season) and pork were cheaper than bushmeat, other

proteins (beef, chicken, fish and goat meat) were more expensive and therefore probably not considered as substitutes. However, bushmeat prices increased between the two periods whereas prices of domestic meat decreased, suggesting that domestic meat and bushmeat could reach competitive prices in the future. The need to support domestic meat production has been included in the National Bushmeat Strategy for DRC (ICCN, 2009) and the technical expertise is available nationally but a clear policy through credits and access to inputs is needed to upscale the existing small scale pilot projects, taking into account national and local cultural and taste preferences for protein alternatives.

Market data such as those presented in this study can provide valuable information to policy makers and managers by raising the alarm when rapid changes are observed, indicating the capacity of particular sources of protein to become substitutes for bushmeat, describing the role of prices in consumer choices and analysing the effects of policy and management decisions on food security and conservation. However, as concluded by Crookes et al. (2005), indicators measured at the market level should be supplemented with information about other processes, including stock depletion, economic behaviour by consumers, traders and hunters, and gear selectivity, to infer conclusions about the sustainability of the trade. When combined with longitudinal information from along the supply chain (wildlife populations, hunters, traders and consumers) and with information about the political, social, economic and ecological context, market data are a key element to inform decision making.

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