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## Research Article

# Bushmeat consumption in western Tanzania: A comparative analysis from the same ecosystem

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### Abstract

Consumption of bushmeat is a problem around many protected areas, but successful mitigation programs are proving difficult to design, in part because anthropogenic pressures are often treated as uniform. In Eastern Africa, where bushmeat consumption has become a major problem, most studies focus on threats emerging from a single site or single ethnic group. In this study, we interviewed two groups of people, indigenous inhabitants of Mpimbwe and refugee dwellers in Katumba, who both hunt in the same ecosystem, in order to compare their consumption of bushmeat and their knowledge of hunters' activities. We related our findings to economic and other differences between them. More than four-fifths of the sampled population in Mpimbwe consumed bushmeat whereas just over half did in Katumba, and frequency of eating bushmeat was higher in the former. Mpimbwe residents hunted principally in the wet season, whereas Katumba residents hunted more in the dry season. We attributed greater consumption of bushmeat in Mpimbwe to a comparative shortage of eggs and pork there, to greater ease of access to large mammals, and to a lower price of bushmeat. Our study draws attention to the variation in bushmeat consumption between groups hunting in the same general area and demonstrates how site-specific data can be used to hone different strategies for reducing illegal hunting in the same region.

**Key words:** Bushmeat, consumption, hunting, Katavi, Rukwa

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## Introduction

Considerable strides have been made in understanding the patterns and causes of bushmeat consumption in west Africa [e.g., 1, 2] and central Africa [3,4], but studies in East Africa are rather less advanced (Kenya [5], Uganda [6,7], Tanzania [8,9]). In Tanzania, for example, research on bushmeat hunting, defined as wildlife hunted for human consumption [10], has focused almost entirely on a single area, the Serengeti National Park [11]. Studies conducted there show that illegal hunting occurs mostly in the dry season when the huge herds of migratory herbivores arrive [12,13]; that people hunt with dogs and snares [14]; that bushmeat is substantially cheaper than domestic meat [15]; that hunting is principally a means of generating cash although it is also used in household consumption [8]; that cultural and social requirements affect consumption [16]; and that people who have access to alternative incomes are less likely to hunt [8,17].

While some studies in East Africa acknowledge that different ethnic groups may exploit wildlife in different ways [e.g., 18], and also model the potential for zonal variation in wildlife exploitation [19], the vast majority of studies still treat bushmeat consumption as a uniform activity. This results in policies based on the assumption that the economic and ecological constraints of people living around one protected area are the same, and that one solution therefore fits all. Only one empirical study, again around Serengeti, has compared bushmeat hunting originating from multiple areas, at least as indexed by ethnicity [20]. It found that non-immigrants and households with above average livestock holdings are typically more involved in hunting than recent migrants and livestock-poor households. It also showed that ethnicity affected hunting preferences and reasons for hunting: the Maasai living to the east of the park preferred small-sized mammals and hunted only for protein, whereas farmers and foragers (comprising principally Natta, Sukuma, Ikoma, Kuria, Taturu and Ikizu ethnicities) to the west, preferred larger-bodied mammals and hunted additionally for income. It is not clear how general such comparative findings may be, especially since the Serengeti is a migratory ecosystem, has high wild mammal biomass, and has a “hard” western boundary with a very high human population density outside [21], but the diversity of threats around Serengeti suggested that a similar approach might usefully be taken elsewhere.

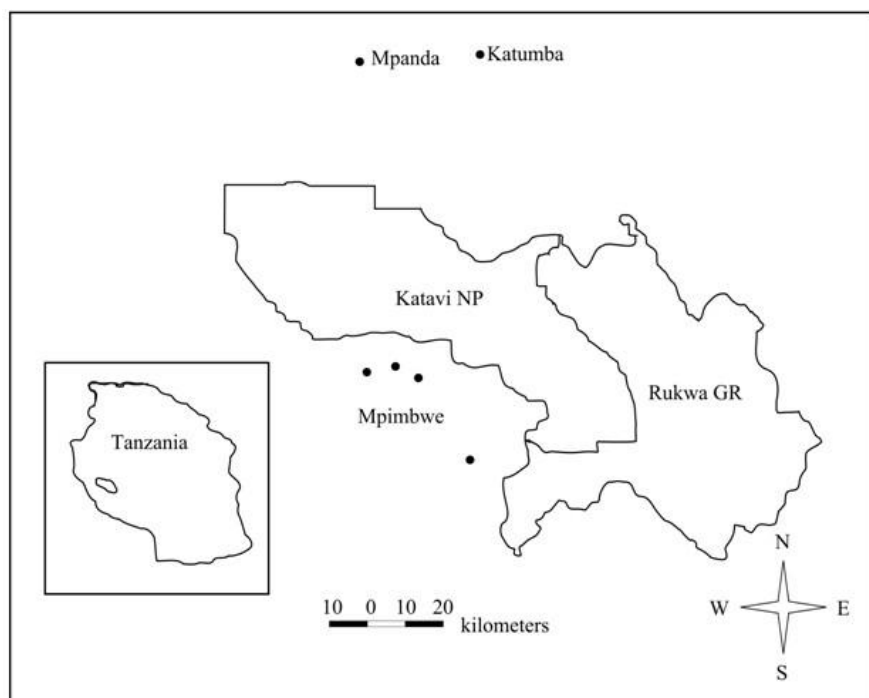
In an effort to make more general comparative statements about bushmeat consumption in rural Tanzania, and to draw the attention of Tanzanian authorities to bushmeat consumption as a national issue, we examined protein consumption in another area. We chose the Katavi-Rukwa ecosystem, an area of western Tanzania where illegal hunting is well documented [22] and may be driving wild mammal population declines [23,24], and we focused on two different communities. The specific aim of this paper is to document, through quantitative analysis, the similarities and differences in bushmeat consumption and hunting activities of different people living adjacent to the same protected area. This enables us to provide not only specific on-site advice but also general recommendations for reducing bushmeat consumption. By considering bushmeat hunting in other parts of Tanzania, we use our data to make general statements about bushmeat hunting in East Africa.

## Methods

### *Study Site*

This study was carried out in Mpanda District of Rukwa Region of western Tanzania in two areas around Katavi National Park (KNP) and Rukwa Game Reserve (RGR) that comprise the Katavi-Rukwa ecosystem. KNP, the third largest national park in the country [25], lies in the Rukwa Valley and is 4471 km<sup>2</sup> in area. KNP is managed by the Tanzania National Parks Authority (TANAPA), and photographic tourism is permitted within the Park. RGR (4323 km<sup>2</sup>) borders KNP to the southeast (Fig. 1) and is managed by the

Wildlife Division (WD); tourist hunting is allowed there from July to December. Both areas consist of miombo woodland, dry forest habitat characterized by *Markamia*, *Grewia*, *Terminalia*, *Syzygium*, *Acacia* and *Combretum* tree genera [26-28], but KNP additionally has four large floodplains that attract high concentrations of wildlife in the dry season [29]. The Katavi-Rukwa ecosystem receives 600–1200 mm of rain per year [30].



**Fig. 1.** The location of the two sites (Katumba Ward and Mpimbwe Division) outside Katavi National Park and Rukwa Game Reserve. Msaginia Forest Reserve lies immediately north of Katavi National Park but its borders are ill-defined. Black dots show the location of the villages where interviews were conducted (except for Mpanda, the District capital). Inserts shows the location of the study area in Tanzania.

In Tanzania, wildlife hunting requires a permit issued to residents by district or regional game officers and to foreign hunters by the Wildlife Division. The vast majority of bushmeat hunting is carried out by local people without any license and is therefore illegal. Selling of bushmeat is illegal, too. Our study took place in communities outside two protected areas. The first, Katumba Ward, which lies north of Msaginia Forest Reserve that borders KNP on the north (Fig. 1), has an estimated population of 96,451 (Tanzania Ministry of home affairs, 2008) and is principally occupied by Hutu refugees from Burundi who practice intensive agriculture. Few native Tanzanians live here, as it was originally a forest reserve before becoming a refugee camp. Poaching of animals and forest products by refugees is often claimed to be rampant in the area [31]. The second area is Mpimbwe Division (estimated population 100,000, E. Carabine and M. Borgerhoff Mulder, unpublished data) which lies immediately to the south of KNP and RGR (Figure 1) and is occupied by native Tanzanian Pimbwe, Fipa and Sukuma (but not Hutu), who farm and keep livestock; like the Hutu, the Pimbwe and Fipa have a history of hunting and fishing [25]. The main species taken are impala (*Aepyceros melampus*), common duiker (*Sylvicapra grimmia*), warthog (*Phacochoerus africanus*), buffalo (*Syncerus caffer*), bushbuck (*Tragelaphus scriptus*), bushpig (*Potamochoerus porcus*) and zebra (*Equus quagga*), and also include another 12 medium to large-sized mammals [24].

### *Data collection*

Data were collected from Mpimbwe in April 2008 and May 2008 at the end of the rainy season; data from Katumba were collected from December 2008 to January 2009 in the middle of the rainy season. Four out of 11 villages were surveyed in Mpimbwe Division. Villages were first clustered into four zones depending on location, and one village was selected randomly in each zone. Three of these villages bordered KNP and one bordered RGR (Figure 1). Thirty randomly selected households were interviewed in each village (120 in total out of an estimated 5,895 households in the Division). In Katumba 73 households were interviewed in four refugee settlements, each of which bordered Msaginia Forest Reserve (immediately adjacent to KNP to the south). All interviews were conducted in Kiswahili by AM, a Tanzanian national who does not live in the area. Unless otherwise specified, in reporting our findings all percentages and means are calculated out of 120 respondents in Mpimbwe and 73 respondents in Katumba. For analyses we examined all households in Mpimbwe villages together and all households in settlements in Katumba together, because we expected no differences among nearby villages within wards in different Divisions.

A structured questionnaire was used in both study areas; interviews were mostly directed at parents (heads of the household), but in a few cases other adult members of the family were interviewed if parents were unavailable. Prior to interviewing households, meetings were held with village officials to solicit their consent and obtain household lists from which households were picked randomly. We used neutral guides who lived in the villages to introduce us to each household. In some villages these guides were picked randomly, but in some they were assigned to AM by village officials. Because bushmeat consumption is an illegal activity and therefore we might not get straight forward answers from respondents, we developed a questionnaire that started with general questions concerning biographical information, including occupation and income, and then moved on to ask about sources of protein in the village, followed by information about access to bushmeat, meat prices and preferences, and finally information about hunters' activities in the village and the bushmeat market.

## **Results**

### *Importance of bushmeat*

Our study revealed a significant difference in the reported consumption of bushmeat between the two communities (Table 1). Eighty-five percent of respondents in Mpimbwe and 52% in Katumba reported that they used bushmeat ( $n = 193$  respondents,  $\chi^2 = 24.62$ ,  $df = 1$ ,  $P < 0.0001$ ). Amongst consumers, bushmeat was reported to be consumed more frequently in Mpimbwe than in Katumba ( $n = 141$  respondents,  $\chi^2 = 22.77$ ,  $df = 1$ ,  $P < 0.0001$ ). Respondents also reported the use of a variety of other kinds of protein, with inhabitants of Mpimbwe showing significantly lower consumption of eggs and pork (Table 2).

Seventy-five percent of respondents in Mpimbwe and 42% of respondents in Katumba claimed that hunters hunted principally for selling to others rather than obtaining food for themselves. This was corroborated by the finding that only a very small proportion of those who reported consuming bushmeat also reported that they hunted themselves (2% and 0% from Mpimbwe and Katumba respectively); more commonly, consuming households said that their meat came from middlemen (26%, 4%), from hunters (35%, 36%), or from both hunters and middlemen (37%, 60%) in Mpimbwe and Katumba respectively. In Mpimbwe most of the bushmeat was sold in the village (as reported by 85%) or in nearby villages (77%), or outside the area (43%,  $n=120$  respondents in all cases). In Katumba bushmeat was sold within the refugee settlement (81%), in nearby villages (68%), or away from the Katumba refugee settlement area (16 %,  $n=73$ ).

Table 1. Number (and percentage) of respondents reporting rates of bushmeat consumption in Mpimbwe (n=120 respondents) and Katumba (N=73 respondents).

	Mpimbwe	Katumba
More than once a year	62 (52)	5 (7)
Once a year	41 (34)	33 (45)
No consumption	17 (15)	35 (48)

### *Price of bushmeat*

Despite the similarity in income in the two sites (mean household monthly income was 25,100 Tsh (US\$20.08) and 24,200 Tsh (US\$19.36) for Mpimbwe and Katumba respectively), bushmeat was more expensive to purchase in Katumba than in Mpimbwe (Table 3), in both absolute terms and relative to domestic meat prices. The reasons for this difference are not well understood, since there is no apparent shortage of protein in Katumba that might drive up prices for both domestic meat and bushmeat due to scarcity; indeed, Table 2 shows a greater consumption of pork and eggs in Katumba. Greater variations in wealth in Katumba than Mpimbwe could be forcing Katumba meat prices up as a result of the rich monopolizing the meat supply and thereby escalating demand in relation to supply, but the data suggest wealth variation is actually greater in Mpimbwe than in Katumba (SDs = 16,300 Tsh (US\$10.80) and 8200 Tsh (US\$5.40) respectively).

Table 2. Number (and percentage) of respondents in Mpimbwe (n = 120 respondents) and Katumba (n = 73 respondents) reporting consumption of different sources of protein in 2008 and 2009.

Protein source	Mpimbwe	Katumba	X <sup>2</sup> , df, and P value
Bushmeat	103 (85)	38 (52)	X <sup>2</sup> = 24.62, df =1, P <0.0001
Egg	43 (36)	60 (82)	X <sup>2</sup> = 37.35, df =1, P <0.0001
Pork	78 (65)	67 (92)	X <sup>2</sup> = 16.02, df =1, P <0.0001
Chicken	82 (68)	52 (71)	X <sup>2</sup> = 0.7, df =1, P =0.79
Goat	103 (85)	66 (90)	X <sup>2</sup> = 0.50, df =1, P =0.47
Fish	97 (81)	63 (86)	X <sup>2</sup> = 0.61, df =1, P =0.43
Beef	105 (87)	67 (92)	X <sup>2</sup> = 0.47, df =1, P =0.49

### *Pattern of hunting*

Hunting was reported to occur at different times of year in the two areas. Mpimbwe residents were reported to hunt more in the wet season than in the dry season (73% and 13% respectively) whereas Katumba residents hunted more in the dry season than wet season (45% and 30% respectively, (n=193 respondents  $X^2 = 31.09$ , df =1,  $P < 0.0001$ ). Fifty-four percent (n=32 respondents who mentioned wet season) in Mpimbwe reported that wet season hunting occurred because patrols cannot enter the area due to dirt roads being impassable, although 37% also mentioned that thick bushes help to hide poachers from rangers and game scouts; other reasons mentioned included ease of locating animals near farms, and economic stress during the rainy season. Katumba residents principally listed thick bushes (59 %) and seasonal economic hardship 41 % (n=22 respondents who mentioned wet season) as major reasons for hunting in the wet season. As for the dry season in Katumba, 66% mentioned it is because there is no rain in the bush and 18% because of no farming activities (n=33 respondents who mentioned dry season). Responses regarding whether hunting occurs at night or during the day, hunting techniques, and location of hunting activity showed no significant differences between the two areas.

Table 3. Modal, minimum and maximum meat prices in Tanzania shillings in the two areas.

Type of meat	Price per kilogram					
	Mpimbwe (n = 120 respondents)			Katumba (n = 73 respondents)		
	Modal	Minimum	Maximum	Modal	Minimum	Maximum
Domestic meat	1500	1000	2000 *	3500	2500	4000
Bushmeat	500 <sup>+</sup>	250	1500	2000	1500	2500

\*Dropping one outlier respondent reporting 5000 shillings per kilogram of domestic meat in Mpimbwe

+ Different species of wild mammals sell for the same prices.

### *Suggestions about hunting*

Eighty-five percent of our sampled residents of Mpimbwe and 78% of residents in Katumba thought that hunting frequency was declining in their area; in Mpimbwe and Katumba this was attributed to successful arrests made by authorities (respectively 83% of 102 respondents, and 91% of 57 respondents who mentioned declines).

In Mpimbwe respondents suggested that improved farming activities (49%), conservation education programs (39%), increased patrol teams in the field (23%), establishment of community hunting areas (16%), villager involvement in anti-poaching activities (11%), poultry and goat keeping (10%), income-generating programs (8%), and a formal bushmeat supply program (6%) could all be potential solutions to bushmeat consumption in the area. Unfortunately, this question was not asked in Katumba.



## Discussion

Our study extends the number of studies of bushmeat consumption in Tanzania and importantly provides comparative data on two groups “mining” the same wildlife populations from the same ecosystem [see also 32,33]. Our principal conclusions are that bushmeat consumption is significant in this part of Tanzania, but that the pattern of consumption differs between areas. Ancillary conclusions – that most bushmeat consumed comes either directly from hunters (for cash) or through middlemen, and the low number of consumers who report that they themselves hunt – may reflect a preference among consumers to avoid disclosure of their own hunting exploits. Such natural reluctance emphasizes the utility of focusing on consumption rather than harvesting in bushmeat research; although both the harvest and the consumption of bushmeat are currently illegal in Tanzania, the former is associated with more stigma and fear of arrest than the latter, and is therefore far more likely to be underestimated. While our sample sizes are modest, representing only 2% of households in Mpimbwe and an estimated 0.8% of people in Katumba (assuming 10 people per household), we are confident that our focus on consumers provides a robust indication of the scale and the variability in western Tanzania’s bushmeat problem, corroborated by a different but parallel study that focused on Mpimbwe hunters themselves [24, 34].

Our comparative data show that in some respects, the nature of illegal hunting is very similar between the two areas that we sampled. Mpimbwe and Katumba residents hunted using the same sort of weapons, muzzle loaders; and most of the hunting was carried out in KNP. In addition, residents of both areas are in agreement that hunting was declining. However, there were major differences between the two sites surrounding the Katavi-Rukwa ecosystem in that more than four-fifths of the population of Mpimbwe ate bushmeat compared to about half of the population of Katumba. Furthermore, the frequency of eating bushmeat was higher in Mpimbwe than Katumba. This is interesting in its own right, as it contradicts many informal (and often prejudicial) statements made by Tanzanians about Hutu refugees being the most important threat to wildlife in western Tanzania.

There are at least four possible (and non-exclusive) explanations for the difference in bushmeat consumption between these areas: (i) people in Katumba do not like bushmeat as much; (ii) there is a shortage of alternative protein in Mpimbwe; (iii) people in Katumba are poorer than Mpimbwe, or (iv) there is a shortage of bushmeat in Katumba. The first reason addresses cultural preferences, but we have no evidence that the people of Katumba are culturally less predisposed to eating bushmeat than the Pimbwe; to the contrary, interviews suggested the residents of Katumba like bushmeat very much, and this preference may indeed be driving up the price. Furthermore, Hutu are renowned for eating bushmeat in Burundi [35]. The second reason (shortage of alternative protein in Mpimbwe) is supported by the comparatively low intake of pork and eggs in Mpimbwe, and long term studies reveal that Pimbwe people are indeed short of domestic protein: they have insufficient cash to buy goats and their chickens die of disease [36]. While bushmeat is cheaper than domestic meat in Mpimbwe, it is typically only land-wealthy households in Mpimbwe who have the cash available for bushmeat purchases [22]; bushmeat is a luxury good, by which we mean not that its consumption is rare, but that it is enjoyed primarily by the wealthy.

The third and fourth reasons may also contribute jointly to the greater consumption of bushmeat in Mpimbwe than Katumba. While Katumba households are no poorer on average (in terms of household income) than Mpimbwe households, the relative cost of bushmeat (compared to domestic protein alternatives) is higher in Katumba. One possible reason for the price difference is our fourth reason – scarcity of supply. Katumba residents live farther from high densities of wildlife than do people in



Mpimbwe Division. The former have to leave Katumba and travel on foot or bicycle a distance of 40 km through Msaginia Forest Reserve, which has low densities of large mammals [36], before they enter KNP. In contrast, Mpimbwe residents live much closer to high wildlife densities in KNP (2-19 km) - an easier walk or bicycle ride - and a parallel study indicates that more wild animal carcasses enter Mpimbwe villages situated closer to protected areas [22]. The effort to acquire bushmeat is therefore greater in Katumba. This is a case study in the benefits of national parks having a buffer zone (Msaginia Forest Reserve) rather than a hard boundary (Mpimbwe, which abuts the National Park directly).

We documented that Mpimbwe residents hunted principally in the wet season because park patrols were unable to conduct effective patrols there: swollen rivers prevent them from reaching the southern boundary of KNP. In the wet season illegal hunters have virtually unlimited access to the animals in KNP. Here our recommendation is to increase KNP investments in wet season patrols, including starting regular foot and bicycle patrols. Katumba residents, on the other hand, hunted all year, although slightly more in the dry season, when patrols by TANAPA and the Wildlife Division are more frequent. Our recommendation is to patrol along well-worked routes that poachers use from Katumba to KNP. Our study did not find noticeable differences in the species targeted or where hunting occurred (data not shown), but it did uncover marked differences in consumption between Katumba and Mpimbwe, which we attribute to the relative scarcity of bushmeat at Katumba, which drives higher prices. To our knowledge, only one other study has compared bushmeat consumption of different populations living around the same national park in Tanzania. Mfunda and Roskaft [20] compared Ikoma and Natta hunter-gatherers, and Sukuma, Taturu and Ikizu agro-pastoralists (all in the west), with Maasai pastoralists to the east of Serengeti. They found that Ikoma, Natta and Maasai were more involved in hunting than other groups. Maasai preferred to hunt small species around villages and bushmeat constituted just a small proportion of protein for Maasai; in contrast, the other ethnic groups hunted large to mid-sized species in more heavily protected areas, and bushmeat made up nearly two thirds of their protein intake. Despite these differences, the authors make similar recommendations for both zones: more investment in community-based conservation schemes.

At least ten studies of bushmeat hunting have been conducted in Tanzania (Table 4) using different methodologies. Arrest records, self-reporting about illegal activities, and asking about bushmeat consumption can lead to different conclusions, although the first and last methods are sometimes congruent [41]. Despite differences in methodologies, however, current information shows that Tanzanians illegally hunt a large variety of mammalian species, ranging in size from elephants *Loxodonta africana* to elephant shrews; that they use snares, traps and guns to catch wild animals; and that they hunt for both direct consumption and for selling meat. In some places, bushmeat constitutes the chief source of animal protein. These studies indicate that bushmeat consumption is commonplace in Tanzania and supports a growing awareness in the country that illegal hunting is rife [e.g., 38,43] and constitutes a threat to wildlife populations in some areas [23,35]. Nonetheless, Table 4 shows that illegal hunting in Tanzania appears principally geared for local consumption either through local sales or by the hunter and his family. While there is some evidence of sale of meat to nearby cities, for example, such as Mpanda in our study (J. Gara, Personal Communication 2009), this does not seem to occur on such a large scale as in West Africa [e.g., 44], and certainly little appears to be exported abroad [45].

Table 4: Summary of bushmeat studies in Tanzania.

Principal area	Ethnic group	Principal tools	Main season	Main species hunted	Protein contribution of bushmeat	Reasons for hunting	Association with	Reference
Serengeti National Park (NP)	Kurya	Snares	Dry	Wildebeest, zebra, impala, Thomson's gazelle	Chief source	Sale and direct consumption	Negatively with wealth	8,12,15,16
Serengeti NP	Sukuma	Snares	All year	Wildebeest, zebra, impala, Thomson's gazelle	Chief source	Sale and direct consumption	Negatively with wealth	8,12,15,16
Serengeti NP	Ikoma, Natta, Sukuma, Tatura, Ikuzu	Snares		Wildebeest, zebra, buffalo	Chief source	Sale and direct consumption		20
Serengeti NP	Maasai	Snares		Impala, Grant's gazelle, Thomson's gazelle	Low	Direct consumption		20
Katavi NP	Mpimbwe	Muzzle loaders, dogs, spears	Wet	Impala, duiker, warthog, buffalo, bushbuck, bush pig, zebra	One of many	Sale in village		24, this study
Katavi NP	Hutu	Muzzle loaders, dogs, spears	All year	Buffalo, antelopes, warthog, bush pig	One of many	Sale in settlements		This study
Burigi Game Reserve	Burundi refugees	Guns	All year	Impala, zebra, buffalo, topi, warthog, eland	Unknown	Local consumption	Positively with food shortages	35
Udzungwa Scarp Forest Reserve (FR) and New Dabaga Ulangambi FR	Not given	Snares, trpas	All year	Elephant shrew, cane and pouched rat, hyrax, duikers, bush pig	Approximately one quarter	Local consumption	Negatively with wealth	39,40
Uvumira FR (Tabora Region)	Banyamwezi	Guns, traps	All year	Dik-dik, bush duiker, hare, genet		Local consumption		42

## Implications for conservation

Two factors affect patterns of bushmeat consumption in this area of western Tanzania: a scarcity of wild mammals near Katumba, and a shortage of affordable domestic protein in Mpimbwe. We concur that ecological and economic rather than cultural factors are responsible for the observed differences between sites and ethnic groups [46]. On a practical level, given the availability of bushmeat in Mpimbwe and the limited availability of alternative sources of protein, we support recent interventions that encourage raising chickens and pigs there. In Katumba, bushmeat consumption can be lowered by reducing the price of domestic meat (through subsidies or enhanced production). In both areas, but especially in Mpimbwe, increasing protection activities, which are the Government mandated responsibility of TANAPA (KNP) and the Wildlife Division (RGR), would help to reduce poaching. In the longer term, education about the value of ecosystem services provided by the Katavi-Rukwa protected areas may help. In addition, future revenues from tourism and controlled exploitation under proposed Wildlife Management Areas outside these protected areas might increase appreciation of the environment.

By Tanzanian law, killing large and medium-sized wild mammals is illegal without a license, but a number of studies now show it to be widespread in the country. From a practical standpoint, Tanzania needs to tackle the problem of bushmeat consumption using several strategies in tandem [47]: increasing livestock production so as to reduce the price of domestic meat [48], increasing protection of protected areas through a greater commitment to on-the-ground enforcement, and through education. The importance of these implementation strategies is likely to vary by location as shown by our comparative study around KNP and RGR.

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## References

- [1] Brashares, J.S., Arcese, P., Sam, M.K., Coppolillo, P.B., Sinclair, A.R.E. and Balmford, A. 2004. Bushmeat hunting, wildlife declines, and fish supply in West Africa. *Science* 306: 1180-1183.
- [2] Waite, T.A. 2007. Revisiting evidence for sustainability of bushmeat hunting in West Africa. *Environmental Management* 40: 476-480.
- [3] Fa, J. & Yuste, J.G. (2001) Commercial bushmeat hunting in the Monte mitra forests. Equatorial Guinea: extent and impact. *Animal Biodiversity and Conservation* 24: 31-52.
- [4] Rist, J., Rowcliffe, M., Cowlishaw, G. and Milner-Gulland, E.J. 2008. Evaluating measures of hunting effort in a bushmeat system. *Biological Conservation* 141: 2086-2099.
- [5] Kiringe, J.W., Okello, M.M. and Ekajul, S.W. 2007. Managers' perceptions of threats to the protected areas of Kenya: prioritization for effective management. *Oryx* 41: 314-321.

- [6] Lwanga, J.S. 2006. The influence of forest variation and possible effects of poaching on duiker abundance in Ngogo, Kibale National Park, Uganda. *African Journal of Ecology* 44: 209-218.
- [7] Olupot, W., Mcneilage, A.J. and Plumptre, A.J. 2009. An analysis of socioeconomics of bushmeat hunting at major hunting sites in Uganda. Wildlife Conservation Society, working paper number 38.
- [8] Loibooki, M., Hofer, H., Campbell, K.L.I. and East, M.L. 2002. Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income. *Environmental Conservation*, 29: 391-398.
- [9] Thirgood, S., Mosser, A., Tham, S., Hopcraft, G., Mwangomo, E., Mlengeya, T., Kilewo, M., Fryxell, J., Sinclair, A.R.E., and Borner, M. 2007. Can parks protect migratory ungulates? The case of the Serengeti wildebeest. *Animal Conservation* 7: 113-120.
- [10] Bowen-Jones, E., Brown, D. and Robinson, E.J.Z. (2003) Economic commodity or environmental crisis? An interdisciplinary approach to analyzing the bushmeat trade in Central and West Africa. *Area* 35: 390-402.
- [11] Sinclair, A.R.E., Packer, C., Mduma, S.A.R. and Fryxell, J.M. 2008. *Serengeti III: Human impacts on ecosystem dynamics*. University of Chicago Press, Chicago, IL.
- [12] Holmern, T., Muya, J. and Roskaft, E. 2007. Local law enforcement and illegal bushmeat hunting outside the Serengeti National Park, Tanzania. *Environmental Conservation* 34: 55-63.
- [13] Nyahongo, J.W., Holmern, T., Kaltenborn, B.P. and Roskaft, E. 2009. Spatial and temporal variation in meat and fish consumption among people in the western Serengeti, Tanzania: the importance of migratory herbivores. *Oryx* 43: 258-266.
- [14] Holmern, T., Mkama, S., Muya, J. and Roskaft, E. 2006. Intraspecific prey choice of bushmeat hunters outside the Serengeti National Park, Tanzania: a preliminary analysis. *African Zoology* 41: 81-87.
- [15] Ndibalema, V.G. and Songorwa, A.N. 2007. Illegal meat hunting in Serengeti: dynamics in consumption and preferences. *African Journal of Ecology* 46: 311-319.
- [16] Kaltenborn, B.P., Nyahongo, J.W. and Tongstad, K.M. 2005. The nature of hunting around the western corridor of Serengeti national park, Tanzania. *European Journal of Wildlife Research* 51: 213-222.
- [17] Johannesen, A.B. 2005. Wildlife conservation policies and incentives to hunt: an empirical analysis of illegal hunting in western Serengeti, Tanzania. *Environment and Development Economics* 10: 271-292.
- [18] Galvin, K.A., Polasky, S., Costello, C. and Loibooki, M. 2008. Human responses to change: modeling household decision making in western Serengeti. In: *Serengeti III: Human Impacts on Ecosystem Dynamics*. Sinclair, A.R.E., Packer, C., Mduma, S.A.R. and Fryxell, J.M. (Eds.), pp. 325-345. University of Chicago Press, Chicago.
- [19] Costello, C., Burger, N., Galvin, K.A., Hilborn, R. and Polasky, S. 2008. Dynamic consequences of human behavior in the Serengeti ecosystem. In: *Serengeti III: Human Impacts on Ecosystem Dynamics*. Sinclair, A.R.E., Packer, C., Mduma, S.A.R., and Fryxell, J.M. (Eds.), pp. 301-324. University of Chicago Press, Chicago.
- [20] Mfunda, I.M. and Roskaft, E. 2010. Bushmeat hunting in Serengeti, Tanzania: an important economic activity to local people. *International Journal of Biodiversity and Conservation* 2: 263-272.
- [21] Sinclair, A.R.E. and Arcese, P. (1995). *Serengeti II: Dynamics, Management, and Conservation of an Ecosystem*. University of Chicago Press, Chicago.
- [22] Mgawe, P., Borgerhoff Mulder, M., Caro, T., Andimile, M. and Kiffner, C. Under review. Factors affecting bushmeat consumption in the Katavi-Rukwa ecosystem of Tanzania.

- [23] Caro, T. 2008. Decline of large mammals in the Katavi-Rukwa ecosystem of western Tanzania. *African Zoology* 43: 99-116.
- [24] Martin, A. and Caro, T. In press. Illegal hunting in the Katavi-Rukwa ecosystem. *African Journal of Ecology*.
- [25] Borgerhoff Mulder, M., Caro, T. and Msago, O.A. 2007. The role of research in evaluating conservation strategies in Tanzania: the case of the Katavi- Rukwa ecosystem. *Conservation Biology* 2: 647-658.
- [26] Rodgers, W.A. 1996. The miombo woodlands. In: *East African Ecosystems and their Conservation*. McClanahan, T.R. and Young, T.P. (Eds.), pp. 299-325. Oxford University Press, New York.
- [27] Schwartz, M.W., Caro, T.M. and Banda-Sakala, T. 2002. Assessing the sustainability of harvest of *Pterocarpus angolensis* in Rukwa Region Tanzania. *Forest Ecology and Management* 170: 259–269.
- [28] Banda, T.M., Schwartz, M.W. and Caro, T.M. 2006. Woody vegetation structure and composition along a protection gradient in a miombo ecosystem of western Tanzania. *Forest Ecology and Management* 230: 179–185.
- [29] Caro, T.M. 1999. Abundance and distribution of mammals in Katavi National Park, Tanzania. *African Journal of Ecology* 37: 305-313.
- [30] Meyer, B., Mwangulango, N. and Balozi, J.J. 2005. Description of the Katavi- Rukwa Ecosystem. Unpublished, KRCD/GTZ/TANAPA.
- [31] Institute of Resource Assessment. 2005. An Assessment for a Community Based Natural Resources Management Area in Mpanda District – Ugalla Ecosystem. Unpublished report. 3 – 4.
- [32] Fa, J.E., Juste, J., Burn, R.W., and Broad, G. 2002. Bushmeat consumption and preferences of two ethnic groups in Bioko Island, West Africa. *Human Ecology* 30: 397-416.
- [33] Wilcox, A.S. and Nambu, D.M. 2007. Wildlife hunting practices and bushmeat dynamics of the Banyangi and Mbo people of southwestern Cameroon. *Biological Conservation* 134: 251-261.
- [34] Martin, A., Caro, T. and Kiffner, C. In press. Prey preferences of bushmeat hunters in an East African savannah ecosystem. *Animal Conservation*.
- [35] Jambiya, G., Milledge, S. and Mtango, N. 2007. ‘Night time spinach: conservation and livelihood implications of wild meat use in refugee situations in north-western Tanzania. TRAFFIC East/Southern Africa.
- [36] Hadley, C., Borgerhoff Mulder, M., and Fitzherbert, E. 2007. Seasonal food insecurity and perceived social support in rural Tanzania. *Public Health and Nutrition* 10: 544-551.
- [37] Caro, T.M. 1999. Densities of mammals in partially protected areas: the Katavi ecosystem of western Tanzania. *Journal of Applied Ecology* 36: 205-217.
- [38] Caro, T. and Andimile, M. 2009. Does Tanzania have a bushmeat crisis? *Miombo* 33: 7-9/17.
- [39] Nielsen, M.R. 2006. The importance, cause and effect of bushmeat hunting in the Udzungwa Mountains, Tanzania: implications for community based wildlife management. *Biological Conservation* 128: 509-516.
- [40] Topp-Jorgensen, E., Nielsen, M.R., Marshall, A.R., and Pedersen, U. (2003) Relative densities of mammals in response to different levels of bushmeat hunting in Udzungwa Mountains, Tanzania. *Tropical Conservation Science* 2: 70-87.
- [41] Knapp, E.J., Rentsch, D., Schmitt, J., Lewis, C. and Polasky, S. 2010. A tale of three villages: choosing an effective method for assessing poaching levels in western Serengeti, Tanzania. *Oryx*, 44: 178-184.
- [42] Carpaneto, G.M. & Fusari, A. 2000. Subsistence hunting and bushmeat exploitation in central-western Tanzania. *Biodiversity and Conservation* 9: 1571-1585.
- [43] Baldus, R.D. 2002. Bushmeat: some experiences from Tanzania. Bushmeat training development workshop at MWEKA 7-9<sup>th</sup> May 2002.

- [44] Juste, J., Fa, J.E., Perez del Val, J., and Castroveijo, J. 1995. Market dynamics of bushmeat species in Equatorial Guinea. *Journal of Applied Ecology* 32: 454-467.
- [45] Chaber, A-L., Allebone-Webb, S., Lignereux, Y., Cunningham, A.A. and Rowcliffe, J.M. 2010. The scale of illegal meat importation from Africa to Europe via Paris. *Conservation Letters* 3: 317–323.
- [46] Brashares, J.S., Golden, C.D., Weinbaum, K.Z., Barrett, C.B. and Okello, G.V. 2011. Economic and geographic drivers of wildlife consumption in rural Africa. *Proceedings of the National Academy of Sciences* 108:13931-13936.
- [47] Lindsey, P.A., Romanach, S.S., Matema, S., Matema, C., Mupamhadzi, I. and Muvengwi, J. 2011. Dynamics and underlying causes of illegal bushmeat trade in Zimbabwe. *Oryx* 45: 84-95.
- [48] East, T., Kumpel, N.F., Milner-Gulland, E.J. and Rowcliffe, J.M. 2005. Determinants of urban bushmeat consumption in Tio Muni, Equatorial Guinea. *Biological Conservation* 126: 206-215.