# Illegal meat hunting in serengeti: dynamics in consumption and preferences

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## Abstract

Although wild meat is an important source of protein across Africa, patterns and reasons for its demand are poorly defined. A study was conducted on consumption by inhabitants of ten villages in five districts to the west of Serengeti National Park, Tanzania. The first sample of 600 villagers was systematically selected from village registers and surveyed using a questionnaire. The second sample consisted of 341 arrested illegal meat hunters. Nine species dominated by eland (*Taurotragus oryx*) and wildebeest (*Connachaetes taurinus*) in terms of meat taste and hunting vulnerability respectively were found to be most preferred or consumed. There were remarkable variations in consumption and preferences for each species amongst ethnic groups and localities. The economics of protein consumption indicates that wild meat is consistently cheaper and hence consumed more frequently than other meats. Respondents' topmost tasty meat – eland and topi (*Damaliscus lunatus*) – were rare; consequently, common species e.g. buffalo (*Syncerus caffer*) and wildebeest were the substitutes mostly consumed to supplement beef and fish. Presence of carnivore species on the menu clearly demonstrates survival techniques when availability changes. Wildlife managers should, therefore, bestow attention to the conservation of all species for a balanced ecosystem and species survival.

*Key words:* hunters, meat taste, protein, Serengeti, Tanzania, wild meat

## Résumé

Bien que la viande de brousse soit une importante source de protéines dans toute l'Afrique, le schéma et les raisons de cette demande sont mal définis. On a réalisé une étude sur la consommation des habitants de dix villages dans cinq districts situés à l'ouest du Parc National de Serengeti, en Tanzanie. Le premier échantillon de 600 villageois fut systématiquement sélectionné sur les registres du village et suivi au moyen d'un questionnaire. Le second échantillon se composait de 341 chasseurs illégaux qui avaient été arrêtés. On a découvert que neuf espèces, dominées par l'éland (*Taurotragus oryx*) et le gnou (*Connochaetes taurinus*) en ce qui concerne le goût et la vulnérabilité à la chasse, avaient la préférence et étaient plus consommées. Il y avait de remarquables variations de consommation et de préférences pour chaque espèce selon les groupes ethniques et les localités. L'économie de la consommation de protéines indique que la viande de brousse est notablement moins chère et donc consommée plus fréquemment que les autres viandes. La viande la plus appréciée des répondants, l'éland et le topi (*Damaliscus lunatus*) était rare. Par conséquent, les espèces communes comme le buffle (*Syncerus caffer*) et le gnou étaient les substituts les plus consommées pour compléter le bœuf et le poisson. La présence de carnivores au menu montre bien les techniques de survie lorsque la disponibilité évolue. Les gestionnaires de la faune sauvage devraient donc accorder leur attention à la conservation de toutes les espèces pour la survie des espèces elles-mêmes et d'un écosystème équilibré.

## Introduction

Traditionally, wild meat has provided a secure protein source for rural people of Africa (Juste *et al.*, 1995; Loibooki *et al.*, 2002) and has been a supplemental source of income (Campbell & Hofer, 1995; Campbell, Nelson & Loibooki, 2001; Damania, Milner-Gulland & Crookes, 2005). In recent years, a growing number of studies have expressed concern about the scale of illegal exploitation of

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wild meat. But, studies on linkages between wild meat consumption and preferences among African hunting societies have been few and focused on moist forests (Njiforti, 1996; Fa *et al.*, 2002). Nevertheless, this is a different system in terms of productivity and alternative livelihoods compared to Serengeti ecosystem where most hunting is illegal and there is no open market for wild meat. Until recently, licensed hunting was allowed in the protected areas adjoining Serengeti National Park but local villagers were excluded.

Illegal wild meat hunting in Serengeti ecosystem (Arcese, Hando & Campbell, 1995; Mduma, 1996; Kideghesho *et al.*, 2005) has received a great deal of attention from wildlife managers, ecologists and conservationists because, apart from the hunting methods (mostly wire snaring) being inhumane, untargeted species are killed (Arcese *et al.*, 1995; Hofer *et al.*, 1996; Noss, 1997). Migratory species especially wildebeest represent the bulk of killed herbivores (Holmern *et al.*, 2002; Loibooki *et al.*, 2002). Although the hunting is mostly for meat, some is for subsistence while the greater part is commercial. There are reports that 34.3% of traders in the area rely on illegally acquired wild meat as their sole source of income (Barnett, 2000) and also that 75% of arrested hunters are hunting for cash or trade (Campbell, 2001 in Elliott, 2001). However, the boundary between the two types of poaching is blurred. Regarding distribution of this illegal activity, many studies (Holmern *et al.*, 2002; Loibooki *et al.*, 2002; Thirgood *et al.*, 2004) report that it is concentrated in the western boundary of the ecosystem where human density is high.

Hunting activities have profound direct effects on wildlife populations and indirect effects on ecosystems (Redford, 1992). In Serengeti ecosystem, for example, the combined effects of human population growth (URT [United Republic Of Tanzania], 2002), poverty (Campbell *et al.*, 2001; Kideghesho *et al.*, 2005) and lack of cheap alternative sources of protein (Loibooki *et al.*, 2002) have accelerated illegal off-take of wild meat. Moreover, hunters have traditionally maintained their popular belief that wild meat is healthier than domestic meat thereby creating demand for the former. This is a well established fact because ungulates have superior meat with less fat (Crawfold *et al.*, 1970 in Trac, 2000; Eltringham, 1984 in Mockrin, Bennett & Labruna, 2005) and greater amount of edible protein per unit of live weight than domestic animals (Ledger, 1967). Wild meat, therefore, is on high local demand and hunting is commercialized through 'open' access to the seasonally abundant migratory ungulates whose population viability is still questionable. Although the hunting methods prove to be more effective on abundant migrating species, harvesting rates of less abundant herbivores such as buffalo (Dublin *et al.*, 1990), giraffe (*Giraffa camelopardalis*), impala (*Aepyceros melampus*), topi (Campbell & Borner, 1995; Hofer *et al.*, 1996; Holmern *et al.*, 2006) and even the resident wildebeest in parts of their ranges are alarming. The situation is getting worse in the western edge of Serengeti National Park in Serengeti, Bunda, Magu, Bariadi, Tarime, Maswa and Meatu districts with higher human population growth rates (Arcese *et al.*, 1995; Packer, 1996). In 2002, human population in the area was estimated to be over two million (URT [United Republic Of Tanzania], 2002) and the growth is largely accelerated by immigration caused by fertile lands and illegal hunting (Hofer *et al.*, 2000).

An examination of factors affecting consumer characteristics and preference is crucial as meat price, availability, taste and culture may influence the rate of disappearance of any given animal species. It is not uncommon to find people across Africa eating wild meat for cultural and/or taste reasons, even when they have inexpensive alternatives (Bennett, 2002). But, as a hunter's motive is to search for economically 'profitable' game species, there is a need to establish preference patterns around Serengeti National Park to underscore the impacts of key socioeconomic parameters on off-take and consumption basing on preferences. This is also important for management and policy decisions and species survival. In this paper preference is defined as the 'act of consumers selecting the favoured game meat from choices set' by hunters as well as availability. The authors (1) explore differences in the consumption patterns of game meats in the study area as a reflection of availability/accessibility, taste preferences and cultural variations; (2) assess if the patterns of wild meat preference correlate with the proportions of available wild stock measured from annual illegal off-take; and (3) ascertain if the patterns of wild meat preference might change given species availability and discuss its implication for wildlife conservation.

## Material and methods

### *Study area*

This research was carried out in ten villages located in five districts adjoining Serengeti National Park to the southwest, west and northwest (Fig. 1). There are about two

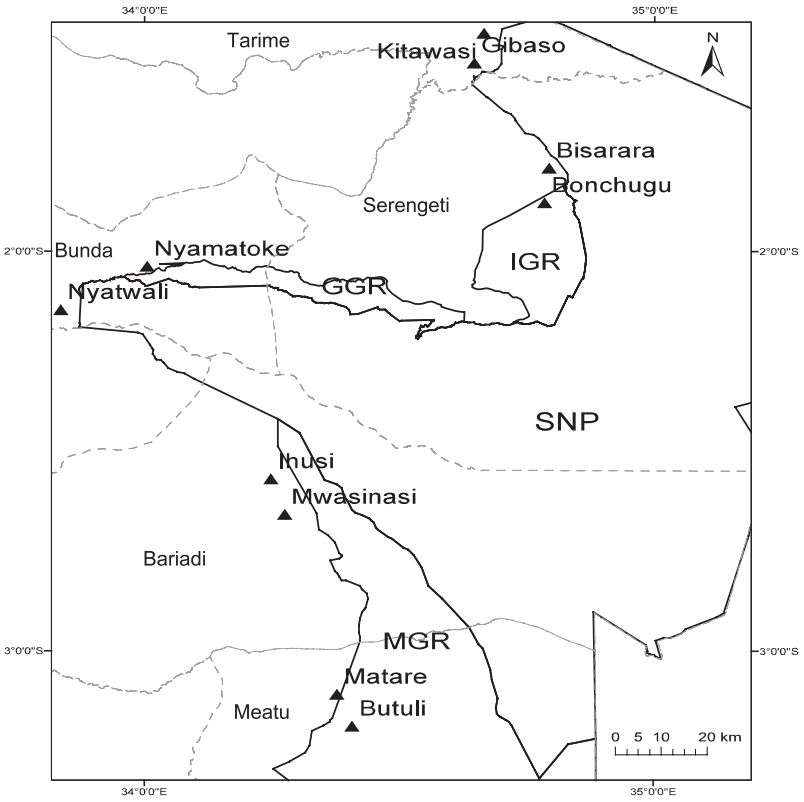


**Fig 1** Map indicating locations of surveyed villages marked by filled triangles in Serengeti, Bunda, Meatu, Bariadi and Tarime District

million people in the area a greater part of which is densely populated, with a growth rate of 2.9% per annum (URT [United Republic of Tanzania], 2002). In 1988, the population was estimated to be just over one million with the annual population increase of 2.8% (Campbell & Hofer, 1995). About 0.4 million people lived within a 12 km zone from Serengeti National Park where sampling was carried out. The area has diverse cultures that comprised over 25 different languages but dominated by Sukuma and Kurya in the southwest and northwest respectively. Majority of the residents are agro-pastoralists who subsist also on illegally extracted wild resources from adjacent protected areas (Turner, 1987 in Loibooki *et al.*, 2002; Arcese *et al.*, 1995; Holmern *et al.*, 2002).

*Methods*

Based on previous illegal hunting records (Campbell *et al.*, 2001; Loibooki *et al.*, 2002) and Serengeti National Park's annual reports, villages whose residents customarily participate in illegal hunting were selected (stage one of purposive or judgmental sampling) with the aid of maps. In each District, the villages selected at stage one were then ranked according to distances from the protected area (Campbell & Hofer, 1995) and the two closest to the protected area selected (stage two of purposive sampling) (Fig. 1). A total of ten villages were purposely selected in five districts (Fig. 1) and, in each village, three subvillages were systematically selected from the village register. Twenty persons, mainly household heads (mostly men) in each subvillage were systematically selected (every fifth household) from the village register, making 120 persons per district and a total of 600 persons for the household questionnaire survey. There was only a small proportion of female respondents (16.5%) compared to male (83.5%) respondents and these were from female-headed households and those where male heads could not be found. No prior notification was given to the respondents. Basic questions were easily answered but information related to household meat consumption and preferences had to be probed for. Positions of the surveyed villages were marked and georeferenced using a hand-held GPS set and later imported into the computer to find their relative positions and distances on a map using ArcGIS software (ESRI, Redlands, CA, USA).

The second set of respondents comprised arrested illegal meat hunters. Trained game scouts and park rangers interviewed sections of these at their respective posts in a friendly manner and all answers were verified by village cell leaders. In addition, informers and village game scouts allied to Serengeti National Park together, and group discussions were used to cross-check reliability of the information collected. Data from arrested poachers were collected from July 2003 to November 2005 and included information related to possession of land parcel and livestock, walking time (in hours) to the hunting sites, hunting seasons, gears used and species killed. Regular visits were made to ranger/game posts to ascertain if the questionnaires were administered properly.

Economics of hunting based on unit prices of respective meat was calculated to establish reasons why people show persistent preference for wild meat even when there are alternative sources of animal protein. The unit prices for meat were compared to establish rationale for high demand for wild meat. To recall consumption from each household, accurately purchased and consumed meats over the previous 3 days were recorded and later computed to kilogram per person per day. Further more, household consumptions were summed and divided by the total number of household members in the survey. To minimize biases over different consumption levels within household members (i.e. children versus adults), household sizes were converted into number of adult male equivalents. Prices for meats were inspected in the market except for the meats derived from illegally hunted species; and in this case the arrested hunters were the main source of data, which were later cross-checked by purchasing pieces of game meat in the black market.

The prices here are only indicative. They are not accurate enough to determine precisely consumers' responses to prices and household economics as they were strictly based on the quality of meat and location of carcass (Fig. 2), which considerably varied with average size (weight) and species. Domestic and wild meat prices were compared with an estimated equivalent 1 kg of dried wild meat from illegal hunters. The corresponding unit prices for 1 kg of dried meats (weighed each time by a spring balance) in the open and black markets were averaged across the market throughout the entire study period. Where domestic and fish meats were sold fresh, the equivalent price for dried meat was extrapolated from standard values given by apparent moisture loss during drying process (Cutter, 2000). There were variable prices for fish and domestic meat across markets and seasons but these differences did not radically influence our results.

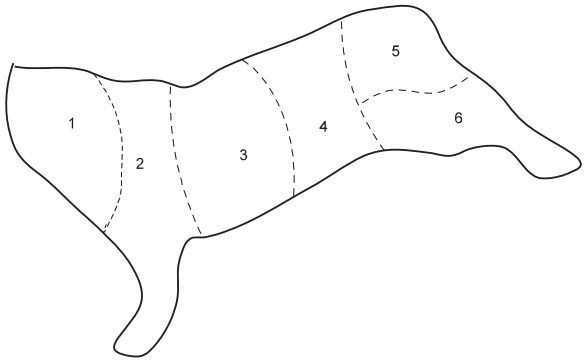


**Fig 2** Locations of various cuts on a wildebeest carcass producing eleven pieces: 1 = neck (one piece), 2 = arm roast (two pieces), 3 = rib (two pieces), 4 = loin (two pieces), 5 = rump (two pieces), 6 = shank (two pieces)

As most hunted species were vulnerable to exploitation, their off-take percentages were correlated to the population total. Tribes with fewer respondents (i.e. less than 10% of the total) were pooled together and a Kruskal–Wallis test was performed to ascertain if the preference of certain ungulate species could influence the off-take rate and consequently consumption of certain wild ungulate species. Preference order by tribes for wild meats was obtained by summing up the respondents' frequencies from the available list of game species. Differences in meat consumption among groups/categories were tested nonparametrically using One-Way ANOVA [*post hoc* multiple comparisons for unequal variance (i.e. Games-Howell test)]. Lastly, a correlation analysis between preference order and the species rank in hunting kills was carried out using SPSS 14.0 for Windows (SPSS Inc., Chicago, IL, USA).

## Results

### *Meat consumption patterns and protein economy*

There were significant variations in consumption rates and preferences amongst ethnic groups and localities. Consumption rates between Kurya and Sukuma tribes were significantly different compared to those between Kurya and Ikoma & other tribes (Table 1). Despite high variability in the consumption of wild meat amongst Ikoma and other tribes, the patterns between Sukuma and Ikoma & others

**Table 1** Pair-wise comparison to test for the differences in the meat consumed by different ethnic groups located adjacent to Serengeti National Park (One-Way ANOVA: *post hoc* multiple comparisons – Game-Howell test)

| | | 95% CL | | |
|---|---|---|---|---|
| Ethnic group (pair) | Meat type | Lower | Upper | *P*-value |
| Kurya versus Sukuma | Wild | −0.055 | −0.016 | 0.000 |
| Kurya versus Ikoma and others | Wild | −0.075 | −0.008 | 0.149 |
| Kurya versus Sukuma | Domestic | −0.012 | −0.002 | 0.12 |
| Kurya versus Ikoma and others | Domestic | −0.073 | −0.020 | 0.000 |
| Kurya versus Sukuma | Fish | −0.049 | −0.023 | 0.000 |
| Kurya versus Ikoma and others | Fish | −0.133 | −0.056 | 0.000 |

(mean ± 95% CL, 0.087 ± 0.043 $kg^{-1}person^{-1}$ day and 0.092 ± 0.036 $kg^{-1}person^{-1}$ day respectively) did not significantly differ; although they all ate wild meat significantly more frequently than Kurya (0.063 ± 0.08 $day^{-1}$) (Table 2). All over, Ikoma and others ate meats (0.147 ± 0.065 $kg^{-1}person^{-1}$ day of fish and 0.107 ± 0.021 $kg^{-1}person^{-1}$ day of domestic) significantly more frequently than other tribes ($P < 0.001$) (Table 2) with domestic meat (0.055 ± 0.008 $kg^{-1}person^{-1}$ day) and fish (0.042 ± 0.004 $kg^{-1}person^{-1}$ day) being less consumed amongst Sukuma and Kurya tribes respectively (Table 2).

Respondents' locations significantly influenced the overall wild meat consumption patterns (Kruskal–Wallis, $P < 0.001$). On average, respondents from Serengeti district ranked high in consumption of wild meat (0.089 ± 0.023 $kg^{-1}person^{-1}$ day) followed closely by Meatu and Bariadi districts (Table 2). Nevertheless these patterns do not reflect wild meat as a substitute for other kinds of meat as records from domestic and fish meats indicate reasonable contribution in the daily protein intake. Generally, Bunda district recorded higher consumption rates of fish (0.098 ± 0.018 $kg^{-1}person^{-1}$ day) and domestic meat (0.202 ± 0.088 $kg^{-1}person^{-1}$ day) compared with others; whereas Tarime district had relatively lower rates of recorded meat consumption (0.03 ± 0.032 $kg^{-1}person^{-1}$ day of wild, 0.019 ± 0.003 $kg^{-1}person^{-1}$ day of domestic and 0.012 ± 0.005 $kg^{-1}person^{-1}$ day of fish (Table 2). A multivariate test also indicated that the interaction between districts and tribes is significantly different when comparing the consumption of wild meat (GLM-model, $F = 3.14$, $P < 0.01$) than when comparing fish and domestic meat ($P$ = NS).

Overall results from arrested poachers (n = 111) and market survey (n = 51) indicate that the mean prices for dried kilogram of wild meat extrapolated from various cuts made by hunters was relatively lower (U.S. $0.76) compared with that of fish (U.S. $2.23) and domestic meat (U.S. $3.1) (Table 3). However, most hunters could not immediately establish the price list for all species hunted, except the regular ones, i.e. wildebeest, Thompson's gazelle (*Gazella thompsoni*) and zebra (*Equus burchelli*).

**Table 2** Frequency of meat consumption among respondents' ethnic groups and localities

| | | Meat consumption in $kg^{-1}person^{-1}$ day (95% CL) | | |
|---|---|---|---|---|
| Category | n | W | D | F |
| (a) Tribe | | | | |
| Sukuma | 307 | 0.087 ± 0.043 | 0.055 ± 0.008 | 0.057 ± 0.024 |
| Kurya | 180 | 0.063 ± 0.08 | 0.072 ± 0.026 | 0.042 ± 0.004 |
| Ikoma and others | 61 | 0.092 ± 0.036 | 0.107 ± 0.021 | 0.147 ± 0.065 |
| (b) Districts | | | | |
| Serengeti | 117 | 0.089 ± 0.023 | 0.049 ± 0.005 | 0.05 ± 0.002 |
| Tarime | 60 | 0.03 ± 0.032 | 0.019 ± 0.003 | 0.012 ± 0.005 |
| Bunda | 134 | 0.059 ± 0.026 | 0.098 ± 0.018 | 0.202 ± 0.088 |
| Bariadi | 119 | 0.078 ± 0.053 | 0.047 ± 0.005 | 0.03 ± 0.011 |
| Meatu | 118 | 0.082 ± 0.036 | 0.055 ± 0.007 | 0.049 ± 0.021 |

W, wild; D, domestic; F, fish.

 

**Table 3** Average price of dried meat calculated from percent usable meat of different herbivore species. Mean prices for popular fishes and domestic meat are based on unit fresh weight since vary considerably in the study area due to the market forces

| Type of animal | Biomass (Kg) | % Usable meat | Pieces from usable meat | Dry weight per piece | Price (U.S. $) per piece | Price (U.S. $) per 1 kg[d] |
|---|---|---|---|---|---|---|
| Wild herbivores | | | | | | |
| Wildebeest | 123 | 60[a] | 11 | 2.3 | 1.1 | 0.47 |
| Zebra | 200 | 55[b] | 9 | 4.3 | 1.1 | 0.23 |
| Thompson's gazelle | 15 | 64[a] | 4 | 0.8 | 1.1 | 1.31 |
| Eland | 340 | 65[a] | 12 | 6.4 | 6.0 | 0.94 |
| Topi | 100 | 60[c] | 9 | 2.3 | 2.0 | 0.87 |
| Fish | | | | | | |
| Nile perch (*Lates niloticus)* | | | | | | 1.0 (2.4) |
| Dagaa (*Rastrineobola argentea)* | | | | | | 0.5 (2.0) |
| Tilapia (*Oreochromis niloticus)* | | | | | | 1.0 (2.4) |
| Domestic stock | | | | | | |
| Cow | | | | | | 1.0 (2.2) |
| Goat | | | | | | 1.1 (3.1) |
| Poultry | | | | | | 1.5 (4.0) |

[a]Blumenschine & Caro (1986).
[b]Marks (1973).
[c]Topi and cow assumed to be the same as wildebeest and goat.
[d]The conversion in 2003 (I U.S. $ = 1000 Tshs). The equivalent prices for the dry weight conversion of fish/domestic meat (in bracket) and the wild meat in kilograms are calculated proportionate to 65% moisture loss during smoking/frying or sun drying.

*Wild meat preferences, reasons for the choices and species ranking*

In the survey, the proportions of males and females were 83.5% and 16.5% respectively. There was no significant difference in meat preferences between the sexes. Overall meat taste ranking by the respondents indicates that eland, buffalo and topi (30%, 20% and 18% frequency respectively) were among the ungulate species preferred most. Other species (in decreasing order of magnitudes) included wildebeest, Thompson gazelles, zebra, hartebeest (*Alcelaphus buselaphus*), warthog (*Phacochoerus aethiopicus*) and giraffe (Table 4). The top most three in preference order based on hunters' preferences included wildebeest (50%), zebra (15%) and buffalo (8%). Preference here does not mean what they actually hunt but what they would want to hunt, if availability was not a problem. Annual means of weapons confiscated from the arrested hunters from 2002 to 2004 included wire snares (8208), bows (279), arrows (2735), machetes (162), knives (444) and spears (106). For the 3 years wire snares claimed over 90% of all hunted animals in the following order of deceasing magnitude: wildebeest (43.5%), zebra (15.2%), impala (13.6%), Thompson's gazelle (8.1%), Topi (7.6%), buffalo (5.6%), warthog (3.2%), giraffe (2.6%), and Grant's gazelle (*Gazella granti*), hartebeest and eland <1% each.

Results for taste preferences indicate that residents of Meatu, Bariadi and Bunda districts (dominated by Sukuma) rank eland high whereas topi is the most valued among Kuryas of Serengeti and Tarime districts. Buffalo meat ranked second on the preference list among the Sukumas and Kuryas (Table 4). The differences in preference (percent frequency) order were significantly different between the Sukumas ($\chi = 47.2$, d.f. = 2, $P < 0.001$) and Kuryas ($\chi = 18.6$, d.f. = 2, $P < 0.001$).

*Proportion of preferred species in illegal off-take*

The fractional ranking of illegally hunted species corresponded more closely with the density of dominant herbivores as inspired by availability (Table 4). Over 75% of household respondents claimed to prefer wild meat to domestic meat. Reasons advanced were the quality of the meat, good taste and easy availability of chosen species. Generally, however, all respondents ranked wild ungulates for good meat taste although preferred ones were accessible in fairly small proportions, indicating that their off-takes could rarely be reflected by popular hunting

**Table 4** Overall ranking of wild meat preferences, species density and fractions harvested through illegal hunting in the study area. Illegal off-take is based on data collected from 2002 to 2004

| Reason for preference and species rank | Frequency of respondents' choice (% f requency of total) | Proportional density (N km$^{-2}$) | Annual mean off-take |
|---|---|---|---|
| Taste | | | |
| Eland | 102 (30) | 7 (0.93)[a] | 9 (1) |
| Buffalo | 70 (20) | 5 (1.40)[b] | 5 (79) |
| Topi | 61 (18) | 4 (7.40)[a] | 4 (108) |
| Wildebeest | 35 (10) | 1 (96.2)[b] | 1 (606) |
| Thompson's gazelle | 27 (8) | 2 (25.2)[a] | 3 (114) |
| Zebra | 21 (6) | 3 (14.8)[a] | 2 (213) |
| Hartebeest | 12 (4) | 6 (1.06)[a] | 8 (3) |
| Warthog | 9 (3) | 9 (0.50)[a] | 6 (45) |
| Giraffe | 4 (1) | 8 (0.70)[a] | 7 (37) |
| Species availability | | | |
| Wildebeest | 66 (50) | 1 (96.2)[b] | 1 (606) |
| Zebra | 20 (15) | 3 (14.8)[a] | 2 (213) |
| Buffalo | 11 (8) | 5 (1.40)[b] | 5 (79) |
| Eland | 9 (7) | 7 (0.93)[a] | 9 (1) |
| Topi | 8 (6) | 4 (7.40)[a] | 4 (108) |
| Thompson's gazelle | 6 (5) | 2 (25.2)[a] | 3 (114) |
| Warthog | 5 (4) | 9 (0.50)[a] | 6 (45) |
| Giraffe | 2 (2) | 8 (0.70)[a] | 7 (37) |

Census data from [a]Campbell & Borner (1995).
[b]CIMU [Conservation Information Monitoring Unit] (2000).

methods as the proportional ranks of most abundant species suggest (Table 4). Nevertheless, arrested hunters (n = 341; Kurya = 60%, Sukuma = 34%, Ikoma = 6%) explained that eland is easily speared upon a chase because it does not endure long distances. Although anti-poaching operations spread all over following large migratory herds, arrests were largely dominated by Kurya hunters, followed by Sukuma. Over 91% of arrested Kurya hunters hunted during wildebeest migration (June to November). Sukuma hunters on the other hand claimed to hunt the year round, although the dry season is more preferred (55%) than the wet season (45%).

## Discussion

This study has demonstrated the place of wild meat in daily protein consumption relative to domestic and fish meats in communities living along the western edge of Serengeti ecosystem. Consumption levels are still alarming (Arcese *et al.*, 1995; Campbell *et al.*, 2001; Kideghesho *et al.*, 2005) notwithstanding extensive anti-poaching operations and community participation in wildlife conservation. The differences in what ethnic groups consume or prefer strongly suggest an unusually higher consumption rate amongst Ikoma and others in Bunda District (0.092 kg$^{-1}$person$^{-1}$ day) than Sukuma (0.087 kg$^{-1}$person$^{-1}$ day) and Kurya households (0.063 kg$^{-1}$person$^{-1}$ day).

Although it has long been known that Kuryas are notorious wild meat hunters (J. Hando, pers. comm. 2003), these results reveal a decreasing catch per unit effort amongst Kurya hunters. This could be a reflection of intensive anti-poaching operations, increased awareness through community conservation schemes or both. Inhabitants of Bunda district seem to consume proportionally bigger quantities of wild meats irrespective of abundant protein sources. There is a clear preference for wild meat because, if the problem was availability of proteins, Bunda District would rank low in terms of quantities of wild meats consumed. Evidence from West Africa suggests that bush meat availability can negatively affect the consumption of fish (Rowclie, Milner-Gulland & Cowlishaw, 2005) but not the other way round. This is an important fact to consider especially when seeking ways of reducing demand for wild meat through supply of alternatives. A potential substitute is livestock, as a shift from bush meat to domestic meats could be achieved through improved livestock production. But, this is unlikely because of many factors, including diseases and competition from other land uses.

All respondents and discussion groups claimed that wild meat is their prime source of animal protein because it is readily available and cheaper than domestic meat and fish. Our conservative estimates indicate that wild meat in Serengeti is about 250% less costly compared with other protein sources (Table 3). A comparison with other countries puts prices in Serengeti ecosystem lower than in Kenya (129%), Zimbabwe (75%) and Botswana (30%) (Traffic, 2000).

Also, residents in the area prefer wild meat for its good taste and nutritional quality relative to domestic meat and fish. Domestic meat and fish are alleged to have widespread health effects. Their disputations were examined along with available reports, which compare fresh wild meat favourably with domestic meat in terms of yields of lean meat per kilogram of live weight, mineral and protein content (Ledger & Smith, 1964; Asibey & Eyeson, 1975), superior fat content (Hoogesteijn, 1979) and medicinal

values (Eaton *et al.*, 1998). Although fish stocks in the Lake Victoria are heavily depleted (Lake Victoria Fisheries Research Project (LVFRP), 2000), there are potential health risks from fish, arising from unscrupulous fishing practices (Sharrif & Kathleen, 1999).

The preference order of wild meats (Table 4) indicates adaptation (and beliefs) by ethnic groups to certain food habits and influence on the conservation status of certain species. If the consumption patterns of these meats would reflect preference on account of taste and availability alone, eland (and probably buffalo and topi) could be exterminated, given their availability in small populations (Campbell & Borner, 1995). But, these species do not rank high on the illegal hunters' menu. By default the hunters consider the economics of hunting, which is governed by availability and effectiveness of their gears (wire snares) (Campbell *et al.*, 2001). This clearly shows that hunters' preferences are motivated by hunting profitability whereas those of the consumers are influenced largely by meat taste. But, meat preferences can change because of availability (Table 4), reflecting more food security and/or livelihood than mere traditions. The continued frequency of arrested Sukuma hunters with dried hyena meat is a clear testimony to an expansion in the consumers' diet breadth for the first time in Serengeti history, involving predatory species. This clearly indicates that people prefer certain meat types only when available and virtually could eat unpopular meats when they are not food secure.

The results above suggest that, although there are consumer and hunter preferences, hunting among Serengeti hunters is indiscriminate, with off-take being determined largely by relative abundance rather than intrinsic preferences. It is also economically justifiable for conventional hunters to optimize opportunistically their return on abundant but low-priced species. As the majority of the preferred species are nonmigratory, they might be caught by nonconventional hunting methods in all seasons.

This study, therefore, suggests a need for monitoring levels of illegal hunting on less abundant species, given preference indices, as their continued off-take might lead to population collapse. Through casual discussions with a cross-section of arrested illegal hunters and prominent village elders, it was also established that preserved meat from highly valued (in this case rare) species is stored and served later to special guests or at important occasions. The continued illegal off-take of herbivore species with tasty meat could endanger rare species, which are ecologically important. From conservation viewpoint, wildlife managers should focus their attention on ethnically valued species regardless of population size, season and location.

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