TROPHY HUNTING AND TROPHY SIZE IN UGALLA GAME RESERVE, WESTERN TANZANIA

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ABSTRACT

The present paper explores trends and variations in trophy size among wildlife species hunted in the Ugalla Game Reserve (UGR) of western Tanzania, in relation to hunting success (animals shot species^{-1} quota^{-1}). Data on trophy hunting from 2006 – 2010 were obtained from the UGR office in Tabora Region. Forty-seven species were targeted by trophy hunters. Hunting success differed significantly across the species (Generalised Linear Model [GLM] with a binomial error structure: deviance chi-square [χ^2] = 9.64, d.f. = 44, p<0.001). Twenty-eight species had trophy size measurements, but only 6 species had measurements taken consistently throughout the data period. Although most of the shot animals were above their minimum trophy size limits (official trophy limits below which animals could not be removed) there was significant variation among species (GLM with normal errors: $F_{5,201}$ = 509.12, p<0.001). Time (years) had no significant effect on trophy size, but the trend over time in trophy size differed significantly among species ($F_{5,194}$ = 5.42, p<0.001). Of the trophy species, greater kudu (Tragelaphus strepsiceros) had the largest mean trophy size, whereas warthog (Phacochoerus africanus) had the lowest trophy size and showed a considerable decline. The majority of the animals had trophy sizes hovering just above their minimum limits. This should be monitored rigorously to avoid removing large numbers of actively breeding animals.

INTRODUCTION

For decades, Tanzanian wildlife has been consumptively utilised through legal and illegal subsistence and trophy hunting (also referred to as tourist hunting) (Caro *et al*. 1998, Baldus and Cauldwell 2004, Caro and Andimile 2009). Subsistence hunting is principally hunting for protein (Nasi *et al*. 2008, Magige 2012), although it can involve small- and large-scale income generation activities (Brasheres *et al*. 2004, Kalternborn *et al*. 2005). It is the most unsustainable and widespread type of consumptive utilisation in Africa (Davies and Brown 2007). Trophy hunting is a selective form of wildlife off-take, which through effective management is considered to be economically and ecologically sound (Caro *et al*. 1998).

Trophy hunting is said to be an important conservation tool (Caro *et al*. 1998) since the revenues generated from it can pay for conservation (Baldus 2008). However, there are several requirements for a successful trophy hunting industry. These include: significant reduction of wildlife poaching in the hunted areas (Caro *et al*. 1998, Zeppel 2006, Grimm 2008), generation of tangible benefits for local communities, connectivity between hunting and non-hunting areas to provide refuge for severely exploited species, regular monitoring to assess impacts of hunting (Grimm 2008), active involvement of local communities in conservation activities (Zeppel 2006), and the income generated to be substantially and truthfully directed to the conservation of hunted areas (Baldus 2008). Of these, monitoring is the most critical element as it determines the intensity with which trophy species can be sustainably hunted. Monitoring, especially of trophy sizes,

reveals short- and long-term changes in populations and other parameters of the hunted species (Milner-Gulland and Rowcliffe 2007).

Since trophy hunting is selective according to species, density, sex and age of the animals to remove (Coltman *et al*. 2003), monitoring can be useful in minimising any actual or potential impacts on harvested populations. For example, trophy hunting can induce a biased sex ratio in some ungulate species such as impala (Setsaas *et al*. 2007) and saiga antelope *Saiga tatarica tatarica* (Milner-Gulland *et al*. 2003). This, as a result, affects species productivity and overall population performance (Milner *et al*. 2006). It also targets older individuals (Packer *et al*. 2010) by selecting the sizes of the trophies such as horn, skull and body. Nevertheless, for other species reliance on trophy size can lead to the accidental removal of younger animals, as described for buffalo (Taylor 2007) and bighorn rams *Ovis canadensis* (Festa-Bianchet *et al*. 2004). There are also those individuals of different species which do not meet the specified quarry attributes, yet are deliberately (in fact, illegally) shot by hunting clients, not to mention species removed over and above their quota (recommended number of individuals of different species that can be shot) (Caro and Andimile 2009).

To ensure sustainable trophy hunting activities, the government of Tanzania (apart from other measures) introduced standard trophy sizes for each species below which a species cannot be removed (Baldus and Cauldwell 2004). Unfortunately, scant attention has been paid to the relationship between standard trophy size, trophy size of hunted species or actual trophy size (hereinafter referred to as trophy size) and off-take of individuals of the species actually hunted. The present paper is aimed at contributing towards understanding this relationship which, as Baldus and Cauldwell (2004) suggested, would improve the way in which trophy hunting is managed. The paper presents an analysis of trophy hunting in the Ugalla Game Reserve of western Tanzania. Specifically, it addresses the following: the trend, over time, in trophy size across species under trophy hunting scheme; the relationship between trophy size and standard trophy size; and the association between hunting success (animals shot per species per hunter's quota) and trophy size.

Trophy hunting is the main economic activity in Ugalla Game Reserve. It is conducted in two hunting blocks: Ugalla west and Ugalla east. Hunting quotas are allocated annually to the various species under the trophy hunting scheme. The management of trophy hunting is geared towards conserving wildlife populations, generating foreign income, involving trophy hunting companies in the protection and development of the reserve, ensuring that the hunting itself is conducted according to the Wildlife Conservation Act of 1974, and ensuring that allocated hunting quotas for hunted species reflect the ability of the wildlife populations to sustain off-take levels.

METHODS

The study area, Ugalla Game Reserve (Fig. 1), is found between 5^{o}-6^{o} South and 31^{o}-32^{o} East, and covers approximately 5000 km^2. The dominant vegetation is miombo woodland containing species of the genera *Brachystegia*, *Julbernadia* and *Isorberlinia*. A number of wildlife species consisting of large, medium and small mammals, as well as game birds are found in the area. The area experiences a tropical climate defined by wet season (December – May) and dry season (June – November). The rainfall ranges between 700 – 1000 mm per year, and mean maximum and minimum temperatures range between 28-30^{o}C and 15-21^{o}C respectively. Trophy hunting

activities are carried out in certain months of the year, but normally in dry seasons.

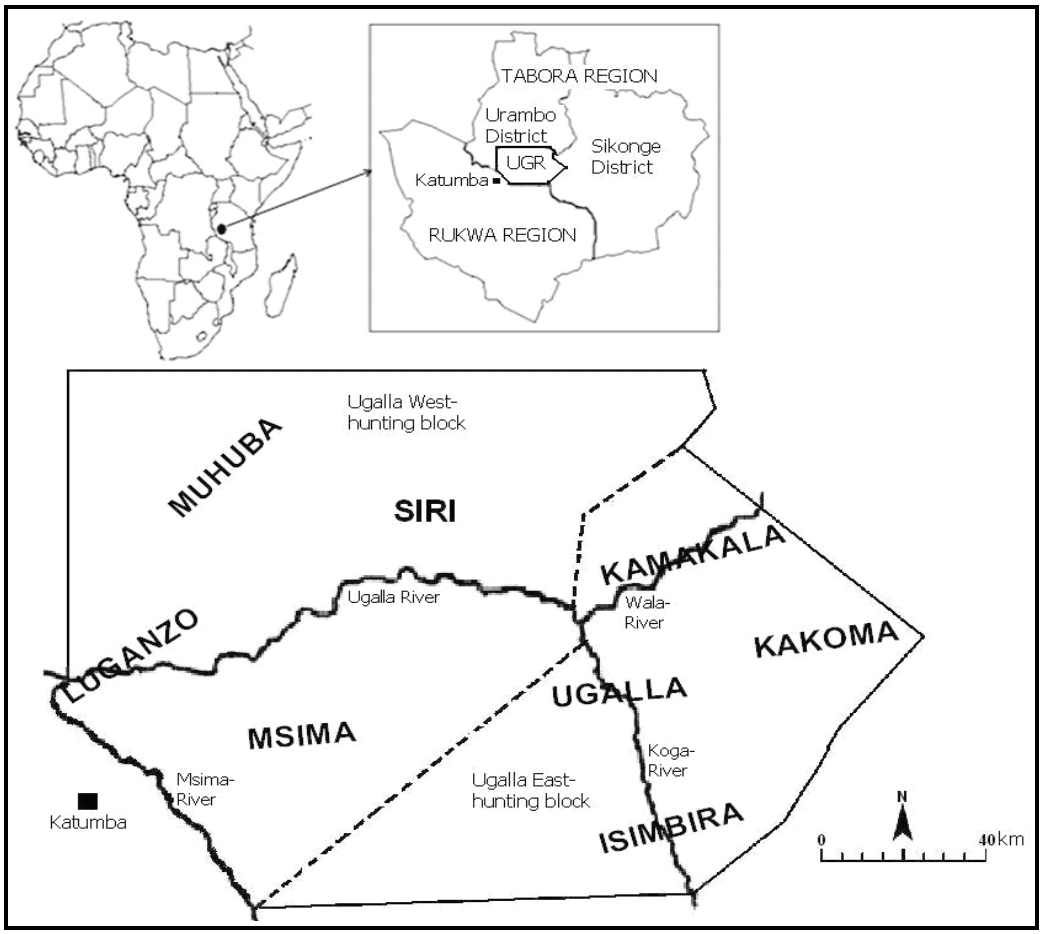

Figure 1 Ugalla Game Reserve showing important trophy hunting zones, main rivers and hunting blocks. Inset maps of Africa and western Tanzania show locations of Tanzania and the reserve respectively. Location of Katumba area (mentioned in the text) in which refugee camps are found is also shown.

Data on trophy hunting from 2006 – 2010 were obtained from the Ugalla Game Reserve office based in Tabora, western Tanzania. Trophy hunting concessions and quota in the reserve were assigned, by the Wildlife Division of Tanzania, to authorised tourist hunting companies. The hunting companies were then responsible for guiding hunting clients while the reserve management team monitored the whole trophy hunting exercise. Game rangers from the reserve office were sent out to supervise each trophy hunting expedition within the reserve. They were given special forms to fill in information about hunting activities and hunted species. The information consisted of species hunted, individuals shot, trophy measurements (in inches or feet), hunting quota, and effective hunting days spent by trophy hunting clients. However,

the trophy size measurements were missing for some species in certain years. Only 6 species had measurements taken consistently in 5 years from 2006 – 2010, but it was important to understand trophy size and off-take patterns using available data. Trophy measurements were taken using different approaches for different species; for example, the tip to tip measurement of the horn was used for African buffalo, horn length measurements were taken for species like impala and greater kudu, and skull length measurements were taken for most of the carnivores. Trophy measurements were normally cross-checked against the minimum standard measurements set by Safari Club International and Rowland Ward Minimus for Tanzanian species. The aim here was to find whether the actual measurements exceeded the minimum standard measurements for any species, which could mean that the species was unsustainably utilised.

Statistical analysis

All statistical analyses were conducted using GenStat version 10 (Payne *et al*. 2007). The analysis of the trend in trophy size involved 5 years, and 6 species with trophy size estimates in each of the years. A generalised linear model (GLM) with a normal error distribution was used to analyse variation in trophy size across species and years. Actual trophy size was correlated with minimum trophy size for some species to determine whether the trophy size of a species was related to its minimum standard trophy size set to ensure sustainable off-take. Hunting success was calculated for each of the hunted species. Hunting success was considered in this study instead of just individuals shot in order to control for hunting quota. A GLM with a binomial error structure and a logit link function was used to find the best predictors of hunting success. Four predictors were tested: hunter days, species, and year. The relationship between trophy size and hunting success was examined using Pearson's correlation for species with trophy size information in each year.

RESULTS

Hunted species

In general, 47 species were allocated hunting quota for at least one year from 2006 – 2010, but only a total of 28 species was consistently targeted by trophy hunters in the period of 5 years (Table 1), comprising 461 individuals shot (mean ± s.e. = 16.5 ± 5.4). The number of individuals hunted (off-take) ranged from 1 – 53. Standard and mean trophy sizes of the hunted species ranged from 3 – 52 inches and 11.08 – 51.20 inches respectively. Greater kudu, buffalo and impala appeared to have larger trophy sizes than the rest of the species in the trophy hunting scheme. Horn length was a common trophy size measurement, but a few species such as hippopotamus, lion and bushpig had other types of trophy measurements taken. Eight species had no trophy size measurements, mostly game birds.

Trophy size

Variation in trophy size among species was significant ($F_{5,\ 201} = 509.12$, $p<0.001$, Fig. 1). There was no significant difference in trophy size across years (parameter estimate ± s.e. = -0.004 ± 0.002, $F_{1,\ 195} = 3.26$, $p = 0.072$), but the interaction Year x Species was statistically significant ($F_{5,\ 194} = 5.42$, $p<0.001$), meaning that trends over time in trophy size differed significantly among species (Fig. 2). Of all the species, warthog showed a somewhat clear trend downward since 2006. Standard trophy size had a significant positive correlation with mean trophy size ($p<0.001$, Fig. 3), indicating that species with higher standard trophy size also had higher mean trophy size.

Table 1: Wildlife removed through trophy hunting inside Ugalla Game Reserve from 2006 – 2010. Only species hunted throughout this period are shown. Species arranged in order of either decreasing mean trophy size or decreasing standard trophy size. Alphabetical order is followed for those without both standard and mean trophy sizes.

Species	**Off-take**	**Measurement**	**Standard trophy size (inches)**	**Mean trophy size (inches)**
Greater kudu *(Tragelaphus strepsiceros)*	7	Horn length	52	51.20
African buffalo *(Syncerus caffer)*	50	Horn length (tip-tip)	42	38.97
Impala *(Aepyceros melampus)*	37	Horn length	26.4	22.84
Hartebeest *(Alcelaphus buselaphus)*	34	Horn length	18.5	18.63
Topi *(Damaliscus korrigum)*	53	Horn length	16	16.17
Common warthog *(Phacochoerus africanus)*	35	Tusk length	13	11.08
Sable antelope *(Hippotragus niger)*	27	Horn length	41.88	
Eland *(Turotragus oryx)*	1	Horn length	33	
Hippopotamus *(Hippopotamus amphibious)*	20	Tusk length	29.9	
Waterbuck *(Kobus defassa)*	24	Horn length	28	
Roan antelope *(Hippotragus equines)*	14	Horn length	27	
Lion *(Panthera leo)*	1	Skull length	24	
Bushbuck *(Tragelaphus scriptus)*	16	Horn length	16	
Leopard *(Panthera pardus)*	9	Skull length	15.38	
Bohor reedbuck *(Redunca redunca)*	21	Horn length	14	
Oribi *(Ourebia ourebi)*	13	Horn length	5.88	
Klipspringer *(Oreotragus oreotragus)*	2	Horn length	4.13	
Bushpig *(Potamochoerus larvatus)*	3	Tusk length	3.9	
Common Duiker *(Sylvicapra grimmia)*	2	Horn length	3.9	
Kirk's dik-dik *(Madoqua kirkii)*	2	Horn length	3	
Olive baboon *(Papio anubis)*	3			
Wild dove *(Columba livia)*	22			
Coqui Francolin *(Peliperdix coqui)*	2			
Egyptian Goose *(Alopochen aegyptiacus)*	4			
Sharpe's grysbok *(Raphicerus sharpei)*	1			
Helmeted guineafowl *(Numida meleagris)*	47			
Spotted hyena *(Crocuta crocuta)*	8			
Black-backed jackal *(Canis mesomelas)*	3			

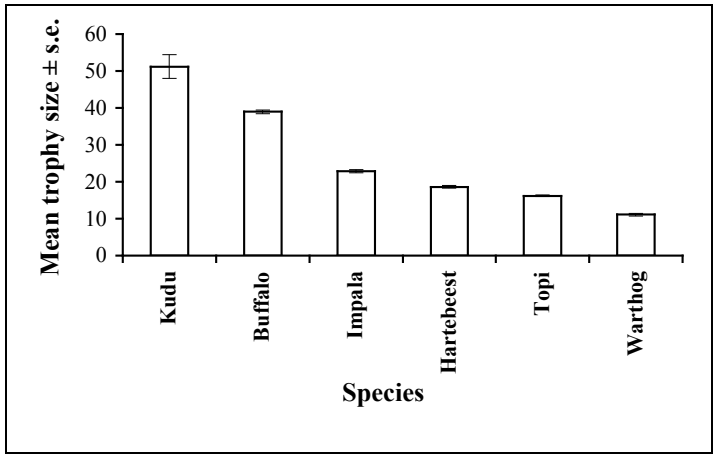

Figure 1: Trophy size (inches) across different species hunted in Ugalla Game Reserve.

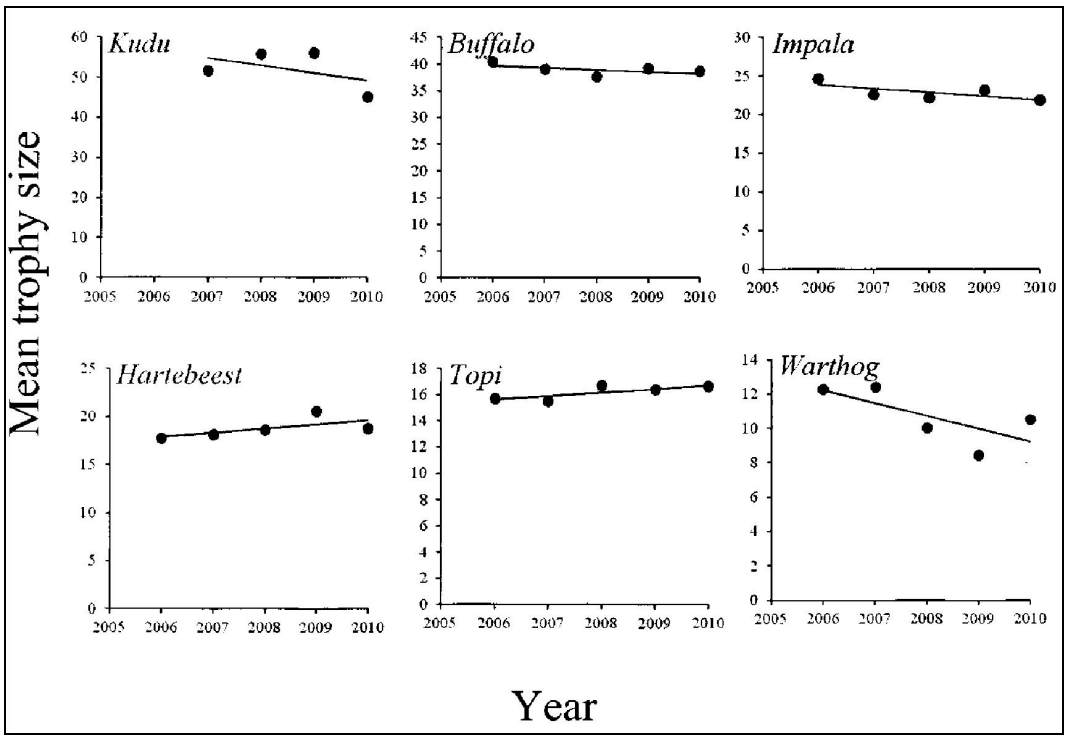

Figure 2 Time (year) plotted against trophy size (inches) for different species removed through trophy hunting in Ugalla Game Reserve.

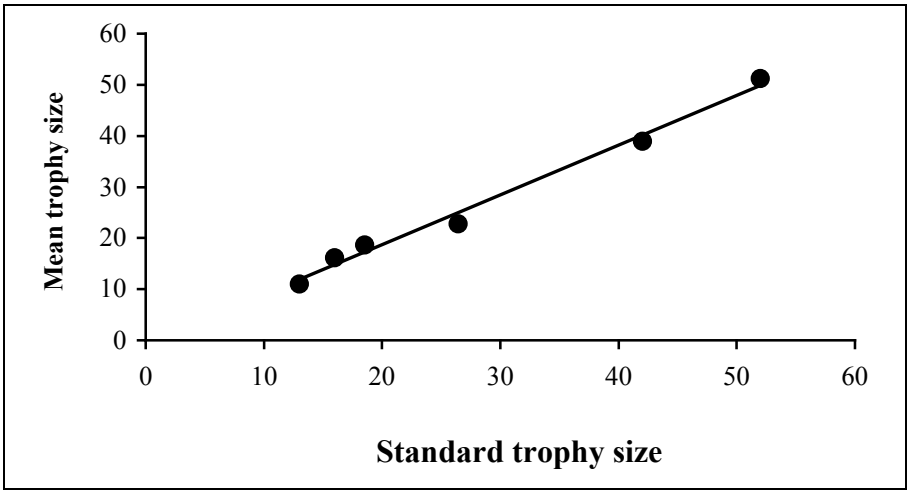

Figure 3: Standard trophy size plotted against mean trophy size.

Hunting success and trophy size

Hunter days and species were the best predictors of hunting success (Table 2). Hunting success varied tremendously among species (Fig. 4), sable hunters had the highest level of success, followed by topi and reedbuck hunters. Most of the bird species (for example, francolins, doves, and geese) were less likely to be hunted. Days spent hunting decreased with hunting success.

Trophy size showed statistically significant negative correlation with hunting success for species with trophy size estimates across the entire data period (n = 6 species, r = -0.8428, p = 0.0173, Fig. 5).

Table 2: Generalized linear model showing terms associated with hunting success.

	Estimate ± s.e.	**d.f. (change, residual)**	**Deviance**	**Probability**
Days	-0.066 ± 0.018	1,891	12.71	<0.001
Species		44,937	9.64	<0.001
Year	-0.15 ± 0.19	1,890	0.66	0.416

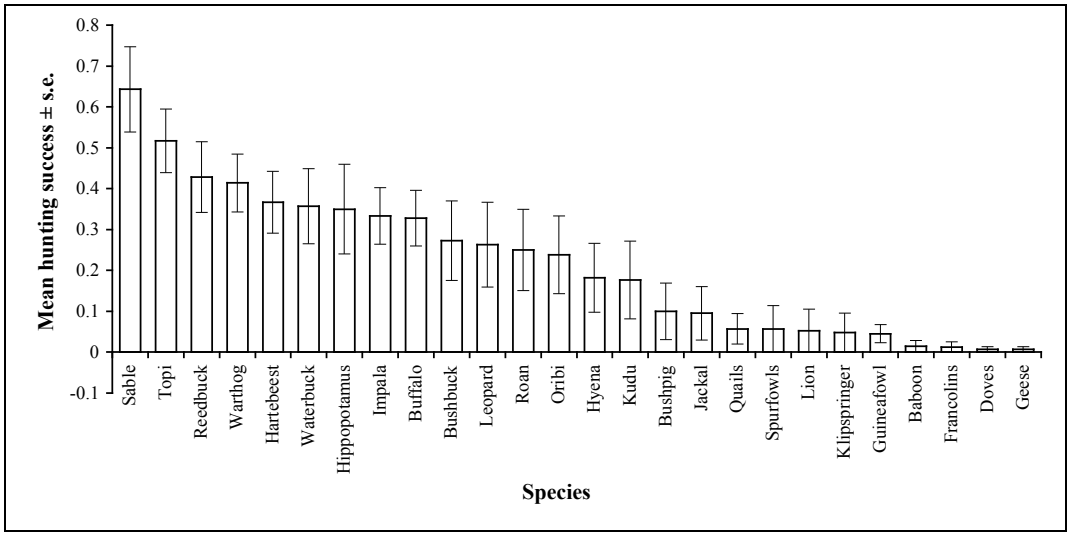

Figure 4: Mean hunting success across different species. Species with zero mean success have been ignored to avoid congestion. These are: civet, dikdik, ducks, duiker, elephant, eland, genet, grysbok, ratel, patridge, porcupine, oryx, sitatunga, sandrouse, serval, springbok, zorilla, waterfowl, wildcat, zebra and steinbuck.

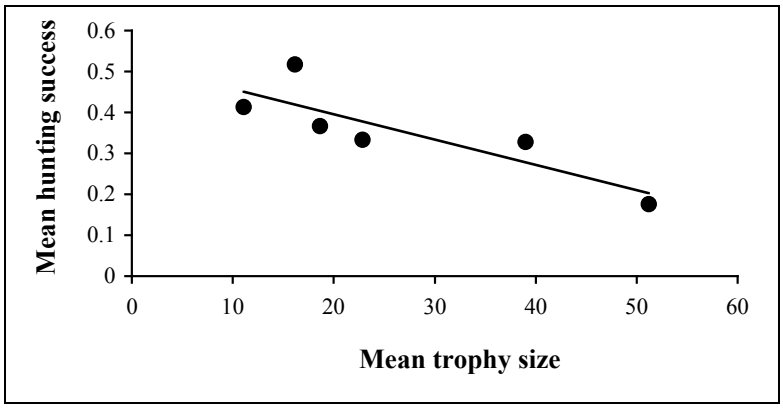

Figure 5: Relationship between trophy size and hunting success for wild ungulates in Ugalla Game Reserve.

DISCUSSION

Most of the animals removed through trophy hunting in Ugalla Game Reserve had trophy sizes above their specified standard (or minimum) trophy sizes. The Minimum trophy size limits were introduced by the Wildlife Division of Tanzania to ensure effective management of trophy hunting (Baldus and Cauldwell 2004). Elsewhere in Tanzania, however, hunting of animals with trophies under the minimum limits seems to be a common behaviour (Caro and Andimile

2009). The minimum trophy limits were set according to interspecies differences in the life span, body size and other attributes (Baldus and Cauldwell 2004). For example, greater kudu (Fig. 6) was the largest trophy species in this study and, consequently, had the highest minimum trophy size limit. Thus it is not surprising that the trend, over time, in trophy size varied across species.

Figure 6 Sixty-inch trophy of a Greater kudu *(Tragelaphus strepsiceros)* obtained from Ugalla Game Reserve during 2009/2010 trophy hunting season. Photo by Ugalla Game Reserve office.

Trends in trophy size are useful when exploring the sustainability of trophy species (UGR 2009). With the exception of warthog, all the species with trophy size measurements were performing fairly well. The downward trend in the warthog trophy size could mean that its population is contracting, probably due to intensified off-take. It is generally known that in western Tanzania the population of warthog is rapidly declining due to various reasons, the most important one being illegal subsistence hunting (poaching) (Stoner *et al*. 2007, Caro 2008). In Ugalla Game Reserve, wildlife poaching is a problem, especially because of notorious poachers from a refugee camp in the nearby Katumba area (see Fig. 1). Although wildlife poaching (particularly as illegal bushmeat hunting) has also been responsible for population declines of other trophy species across the country (Hofer *et al*. 1996, Caro *et al*. 1998, Mfunda and Røskaft 2010), the ability to withstand higher off-take levels differ among species (Greene *et al*. 1998, Wright 2003). Impala, for example, is a commonly exploited species (Setsaas *et al*. 2007), yet it is among the most abundant and widely distributed species in sub-saharan Africa (Nersting and Arctander 2001, van Bonnel *et al*. 2006).

One of the factors that might have been responsible for the variation in trophy size across species is the frequency of encountering a prey (Baldus and Cauldwell 2004, Reis 2009). The more frequently a hunter encounters individuals of a species shown on his hunting licence, the faster the quota for that particular species will be realised (see Milon and Clemmons 1991). Notwithstanding the fact that getting a "record trophy" is an incentive for trophy hunting (Damm 2008), in circumstances where such trophy sizes are hardly obtainable, shooting anything provided it does not fall below the minimum trophy size

limits can be equally beneficial to hunters. On balance, this necessitates the consideration of species' trophy sizes above the minimum trophy size limits when allocating hunting quotas (Baldus and Cauldwell 2004).

The significance of integrating trophy size into the allocation of hunting quotas is elucidated by hunting success. Here, hunting success simply means the ability to realise one's allocated hunting quota for a given species. This study suggests that hunters spent an amount of time just long enough to realise their quotas. The hunters' goal was not to spend many days hunting, but instead to get what they were looking for (UGR 2009). As a result, those who spent fewer hunting days seemed to be more efficient or successful than those who spent many days. Hunting success may also have been influenced by the efficiency of hunting gear and hunter competence (see Liebenberg 2006). These were not addressed by the present study, but are worth taking into consideration in the future when looking at the trophy hunting activities in Ugalla Game Reserve. The observed variation in hunting success among the trophy species serves as suggestive evidence of the difference in the availability of individuals with trophy sizes well above the minimum limits. Furthermore, most of the species whose quotas were successfully realised had smaller trophy sizes. This is a worrying scenario as it indicates that a majority of the removed individuals were not old enough. Caro (2006) argued that such a tendency can cause adverse effects on populations of trophy species. Whitman *et al*. (2004) showed how the hunting of relatively young individuals would lead to a severe decline of African lion populations. The trophy hunting industry should more rigorously incorporate age alongside other population parameters such as species density in the allocation of trophy sizes and hunting quotas (Damm 2005). While there are minimum trophy size limits, we also need to keep an eye on trophy sizes above these limits for sustainable trophy hunting in Tanzania.

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REFERENCES

Baldus RD & Cauldwell AE 2004 *Tourist Hunting and its Role in Development of Wildlife Management Areas in Tanzania.* Unpublished Report, Dar es Salaam, Tanzania.

Baldus RD 2008 *Wildlife: can it pay its way or must it be subsidized*? In: Baldus RD, Damm GR & Wollscheid KU, eds., Best practices in sustainable hunting: a guide to best practices from around the world. CIC-International Council for Game and Wildlife Conservation, Hungary, 12-16.

Brashares JS, Arcese P, Sam MK, Coppolillo PB, Sinclair ARE & Balmford A 2004 Bushmeat hunting, wildlife declines, and fish supply in west Africa. *Science* **306**: 1180-1183.

van Bommel FPJ, van Heitkonig IMA, Epema GF, Ringrose S, Bonyongo C & Veenendaal EM 2006 Remotely sensed habitat indicators for predicting distribution of impala (*Aepyceros melampus*) in the Okavango Delta, Botswana. *J. Trop. Ecol.* **22**: 101-110.

Caro T & Andimile M 2009 Does Tanzania have a bushmeat Crisis? *Miombo Newsletter* **33**. http://www.bushmeatnetwork.org/?cat=35.

Caro T 2006 *Rolf Baldus Interviews Tim Caro, Professor, Dept. of Wildlife, Fish and Conservation Biology University of*

California. African Conservation Forums. http://www.africanconservation.org/forum/

Caro T 2008 Decline of large mammals in the Katavi-Rukwa ecosystem of western Tanzania. *Afr. Zoology* **43**: 99-116.

Caro T, Pelkey N, Borner M, Severre ELM, Campbell KLI, Huish SA, Kuwai JO, Farm BP & Woodworth BL 1998 The impact of tourist hunting on large mammals in Tanzania: an initial assessment. *Afr. J. Ecol.* **36**: 321-346.

Coltman DW, O'donoghue P, Jorgenson JT, Hogg JT, Strobeck C & Festa- Bianchet M 2003 Undesirable evolutionary consequences of trophy hunting. *Nature* **426**: 655-658.

Damm GR 2008 *Recreational trophy Hunting*: "*What Do We Know and What Should We Do*?". Best Practices in Sustainable Hunting. ftp://ftp.fao.org/docrep/fao/010/aj114e/aj114e01.pdf

Damm GR 2005 Hunting in South Africa: Facts, risks and opportunities. *Afr. Indaba e- Newsletter* **3** : 4-5. www.africanindaba.co.za

Davies G & Brown D (eds.) 2007 *Bushmeat and Livelihoods: Wildlife management and poverty reduction*. Blackwell Publishing Ltd. & Zoological Society of London, UK.

Festa-Bianchet M 2003 *Exploitative wildlife management as a selective pressure for the life history evolution of large mammals*. In: Festa-Bianchet M & Apollonio M, eds., Animal Behaviour and Wildlife Conservation. Island Press, Washington, 191-207.

Greene C, Umbanhowar J, Mangel M & Caro T 1998 *Animal breeding systems, hunter selectivity, and consumptive use in wildlife conservation*. In: Caro T, ed., Behavioral Ecology and Conservation Biology. Oxford University Press, New York, 271-305.

Grimm U 2008 *Trophy hunting for endangered species*. In: Baldus RD, Damm GR & Wollscheid KU, eds., Best Practices in Sustainable Hunting: a guide to best practices from around the world. CIC-International Council for Game and Wildlife Conservation, Hungary, www.cic wildlife.org/fileadmin/Press/Technical_Series/

Hofer H, Campbell KLI, East ML & Huish SA 1996 *The impact of game meat hunting on target and non-target species in the Serengeti*. In: Taylor VJ & Dunstone N, eds., The Exploitation of Mammal Populations. Chapman & Hall, London, U.K, 117-146.

Kaltenborn BP, Nyahongo JW & Tingstad KM 2005 The nature of hunting around the western corridor of Serengeti National Park, Tanzania. *Eur. J. Wild. Res.* **51**: 213-222.

Lieberberg L 2006 Persistence hunting by modern hunter-gatherers. *Current Anthropology* **47**: 1017-1026.

Magige FJ 2012 Human-wildlife interaction in Serengeti and Ngorongoro districts of Tanzania: a case study on small mammals. *Tanz. J. Sc.* **38(1)**: 95-103.

Mfunda IM & Røskaft E 2010 Bushmeat hunting in Serengeti, Tanzania: An important economic activity to local people. *Int. J. Bio. & Cons.* **2**: 263- 272.

Milner JM, Nilsen EB & Andreassen HP 2006 Demographic side effects of selective hunting in ungulates and carnivores. *Cons. Bio.* **21**: 36-47.

Milner-Gulland EJ & Rowcliffe JM 2007 *Conservation and sustainable use: a handbook of techniques*. Oxford University Press, Oxford.

Milner-Gulland EJ, Bennett EL & the SCB 2002 Annual Meeting Wild Meat Group 2003 Wild meat: the bigger picture. *Tr. Ecol. & Evol.* **7**: 351-357.

Milon J & Clemmons R 1991 Hunter's Demand For Species Variety. *Land Econ.* **67(4)**: 401-412.

Nasi R, Brown D, Wilkie D, Bennett E, Tutin C, van Tol G, & Christophersen T 2008 *Conservation and Use of Wildlife-Based Resources: The Bushmeat Crisis.* CBD Technical Series Number 33. Secretariat of the Convention on Biological Diversity, Montreal, Canada & Centre for International Forestry Research, Bogor, Indonesia. www.cbd.int/doc/publications/cbd-ts-33-en.pdf.

Nersting LG, Arctander P 2001 Phylogeography and conservation of impala and greater kudu. *Mol. Ecol.* **10**: 711-719.

Packer C, Brink H, Kissui BM, Maliti H, Kushnir H & Caro T 2010 Effects of trophy hunting on lion and leopard populations in Tanzania. *Cons. Biol.* **25**: 142-153.

Payne RW, Murray DA, Harding SA, Baird DB & Soutar DM 2007 *GenStat for Windows (10th Edition) Introduction*. VSN International, Hemel Hempstead.

Reis AC 2009 More than the kill: hunters' relationships with landscape and prey. *Curr. Iss. Tour.* **12(5)**: 573-587.

Setsaas T, Holmern T, Mwakalebe G, Stokke S & Røskaft E 2007 How does human exploitation affect impala populations in protected and partially protected areas? – A case study from the Serengeti Ecosystem, Tanzania. *Biol. Cons.* **136**: 563-570.

Stoner C, Caro T, Mduma S, Mlingwa C, Sabuni G & Borner M 2007 Assessment of effectiveness of protection strategies in Tanzania based on a decade of survey data for large herbivores. *Cons. Biol.* **21**: 635-646.

Taylor W 2007 *The Influence of Trophy Measurement in Cape Buffalo*. In: Trophy Hunting, Hunting Trophies and Trophy Recording. Afr. Indaba e-Newsletter **5(3)** (special issue). http://www.africanindaba.co.za/Archive07/AfricanIndabaVol5-3.pdf.

Ugalla Game Reserve [UGR] 2006 *A Checklist of Plants, Animals and Birds in Ugalla Game Reserve*. Unpublished Report, Ugalla Game Reserve Project, Tabora, Tanzania.

UGR 2009 *Tourist hunting report for the year 2008.* Unpublished Report, Ugalla Game Reserve, Tabora, Tanzania.

Whitman K, Starfield M, Quadling S & Packer C 2004 Sustainable trophy hunting of African lions. *Nature* **428**: 175-178.

Wright SJ 2003 The myriad consequences of hunting for vertebrates and plants in tropical forests. *Pers. Pl. Ecol., Evol. & Syst.* **6**: 73-86.

Zeppel H 2006 *Indigenous ecotourism: ecotourism series: sustainable development and management.* CABI Publishing, Oxford, UK.