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Note and Record

What 50 years of trophy records illustrate for hunted African elephant and bovid populations

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Introduction

Harvest has consequences. The demographic effects of harvest may include the disruption of age and sex structure (Mysterud, 2011) and decline in population size (Milner-Gulland *et al.*, 2003). Evolutionary effects may include loss of variance or the shift in a heritable trait (Coltman *et al.*, 2003).

The extent of these impacts can vary across regions according to a number of sociopolitical factors, such as regulation, localized scientific capacity and government transparency (Lindsey *et al.*, 2007). Harvest type will also have varying consequences. Snaring, for example, tends to be random in selection, whereas recreational harvest is selective by nature. Trophy hunters will target individuals that possess an easily seen trait, such as horn size. If that trait is heritable, then persistent hunting of large-horned individuals may precipitate a shift towards more smaller-horned individuals within a population (Coltman *et al.*, 2003; Allendorf & Hard, 2009). These undesirable evolutionary consequences – if not regulated – will lead to hunter dissatisfaction and loss of income and to the detriment of the numerous African communities dependent on the hunting industry (Lindsey *et al.*, 2006).

The most robust approach to determine the impact of hunting is through long-term population and genomic studies (Clutton-Brock & Sheldon, 2010), but these are costly. One exploratory alternative is to use long-term trophy data. Here, we use data from an international record book to look for signal of change in trophy size among African bovid and elephants.

Methods

African herbivores are prized by recreational hunters worldwide. There are no data on the distribution of horn size across populations, so one alternative is to use trophy records. This is not ideal given that these scores indicate maximum horn or tusk size only, but signal may lead to scientifically more robust field-based studies. Thus, we used long-term data available on subscription through Safari Club International's (SCI) online record book (http://www.scirecordbook.org).

We focused on African bovids and bush elephant (*Loxodonta africana*), important to the safari hunting industry across Africa. Data were sourced through SCI from 1960 through to 2011. We used the SCI scoring system (see http://www.scirecordbook.org) to estimate trophy size, based on horn length and circumference, or tusk mass for elephant. Individual age and body weight were not provided through SCI. Ultimately, we derived a data set for 45 species (inclusive of subspecies) across 30 countries (list available from the corresponding author).

To test for temporal trends, we took the following steps: (i) data were saved as spreadsheets for each species, comprising score, year and country, (ii) we fitted generalized linear mixed models to these data using the lme4 package within the R language (R Development Core Team, 2013), where trophy scores were the response variable and year the fixed effect. To correct for spatial nonindependence of data, country was included as a random effect. Then, (iii) species-specific model intercept and slope (change in trophy score as a function of time) were saved in a new database.

We then carried out some additional descriptive tests. First, we tested whether trophy score trend (as model slope) was linked to mean male mass. We simply assigned mass for each species following literature review (http://animaldiversity.ummz.umich.edu). Second, we plotted a comparative distribution of model slope across countries, according to the results for species shot within each country.

Finally, as the elephant data were based on a separate scoring system, we simply plotted change in elephant tusk size (as trophy scores) through time. We split the data

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Results and discussion

We found no clear signal of temporal change in maximal trophy size of hunted African bovids, with the dispersion of model slope approximately normally distributed around the mean (Fig. 1 inset). There were no apparent clusters of trophy decline by species body size (Fig. 1). Model coefficients are available on request.

Similarly, there are no clear trends by country (Fig. 2). Our separate analyses for African elephant showed a trend towards smaller tusks (Fig. 3a). These pooled data were misleading, as when these are split between southern (Fig. 3b) and central, east and western Africa (Fig. 3c), there was no clear trend in tusk weight, over time in southern Africa, but in central and east Africa the situation is different. This may simply be through lack of data for most central African countries, due to hunting bans and the decline of the industry in politically unstable countries.

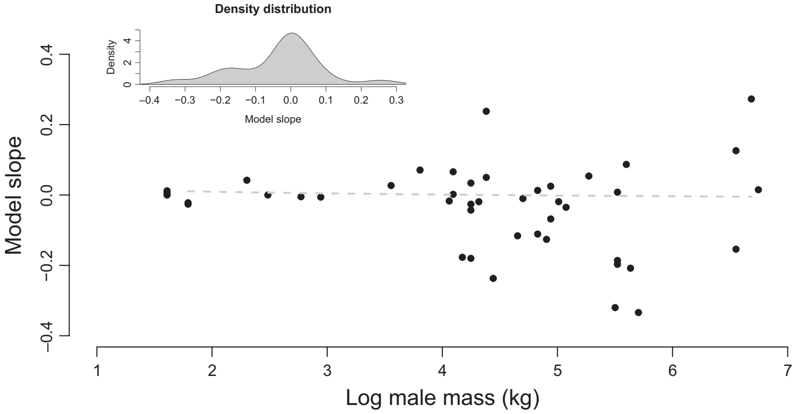

Fig 1 The association between African bovid trophy model slope (from species-specific generalized linear mixed models where trophy or horn score was a function of time [year], with location as a random effect) and mean male mass. Model slope thus represents change in horn size as a function of time. The fitted linear model line is for illustration only. The histogram inset shows the kernel density distribution of model slope from all generalized models, across all bovid species

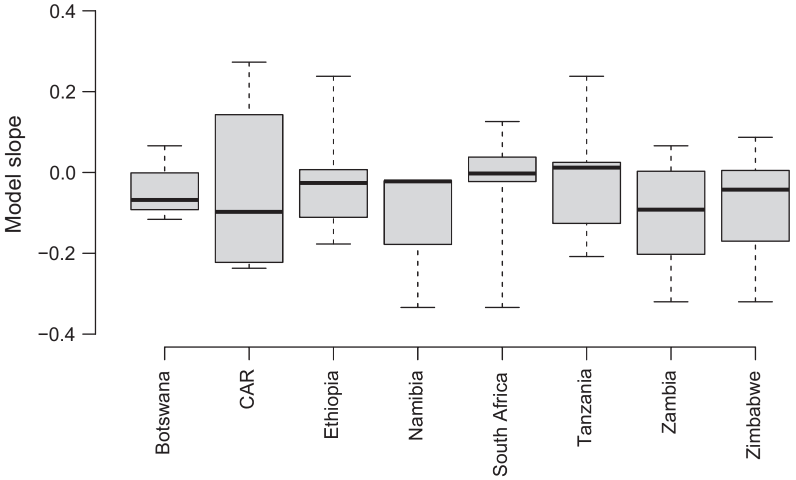

Fig 2 Box-plot representation showing African bovid trophy slope (as in Fig. 1) by country. For Botswana, CAR, Ethiopia, Namibia and Zimbabwe, $n < 10$

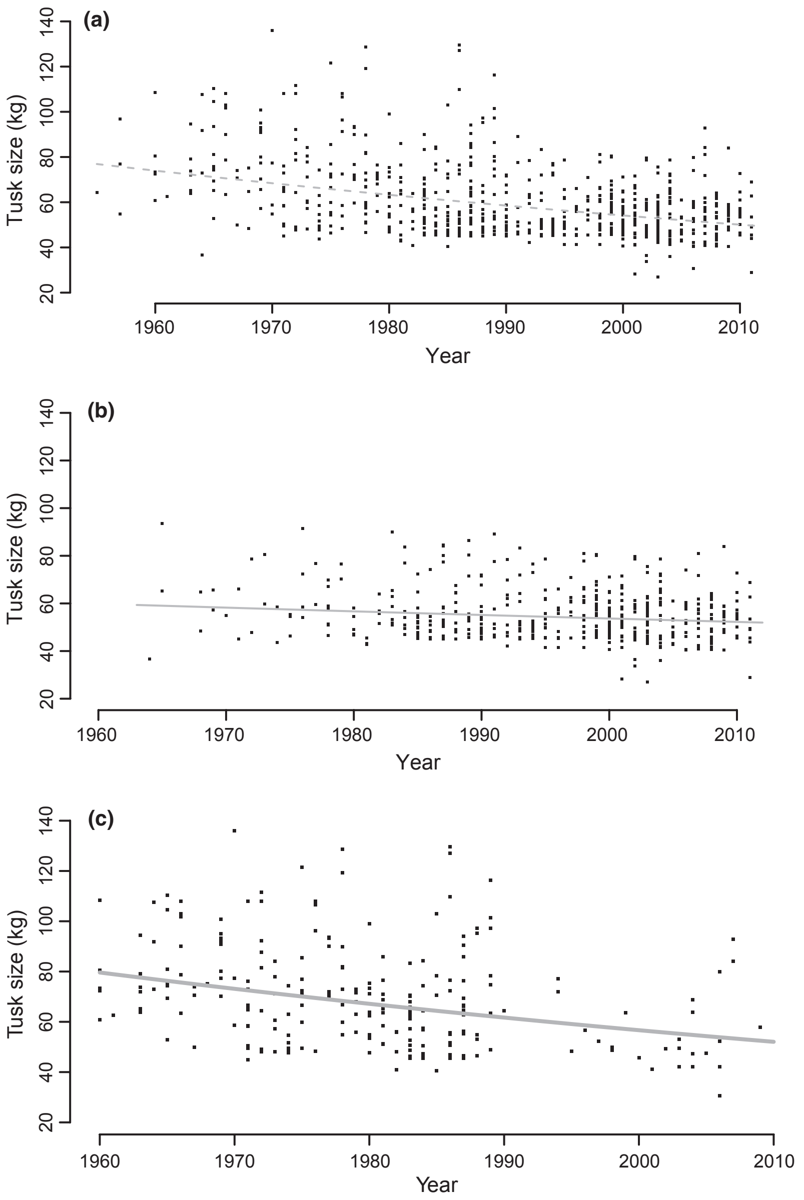

Fig 3 Graphical illustration of all African (savanna or bush) elephant tusk weight (in kilograms) records over ~50 years, across both sexes and for all countries in sub-Saharan Africa (a). When split between regions, (b) shows data on tusk weight for elephant hunted in southern Africa (Botswana, Mozambique, Namibia, South Africa, Zambia and Zimbabwe) and then (c) central, east and western Africa (Angola, Cameroon, Central African Republic, Chad, Ethiopia, Kenya, Somalia, Sudan, Tanzania and Uganda). The fitted nonlinear model lines are for illustrative purposes

Given the data, there is no apparent decline in bovid trophy (maximal horn) size across Africa. There are a number of caveats however. First, we cannot account for the increased efficiency of hunting technique, and second SCI records do not provide an accurate picture of the distribution of horn size within and across populations – just maximal values. Further, we do not have access to species-specific population data, such as abundance, age and sex structure. We would only be able to better understand the impacts of hunting if these data were available (e.g., Coulson *et al.*, 2001). Thus, sports hunting associations should fund population monitoring programmes, and thereby the science that will determine the consequences of selective harvest.

The data presented for elephant tusk weight are interesting. Again these do not account for shifts in elephant age and sex structure, or mortality through poaching, but do show the disparity between data availability in southern Africa versus central, east and western Africa. There is some trend towards smaller tusks in southern Africa, but this may be due to the fact that large 'tuskers' are shot out before reaching late-adulthood.

As scientists, we look for signal and temporal shifts in a heritable trait, such as horn size within a hunted population can signal undesirable change (Coltman, 2008). We did not find any signal, but given our caveats, cannot draw any strong conclusions. This research emphasizes the need for population-level monitoring programmes.

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