Contributed Paper

Factors Determining the Choice of Hunting and Trading Bushmeat in the Kilombero Valley, Tanzania

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Abstract: *Regulation of illegal bushmeat trade is a major conservation challenge in Africa. We investigated what factors are most likely to induce actors in the bushmeat trade to shift to an alternative occupation by conducting a choice experiment with 325 actors in the bushmeat trade in the Kilombero Valley, Tanzania. Specifically, we asked respondents to choose between hunting or trading bushmeat and alternative salary-paying work, in a set of hypothetical scenarios where the attributes of these alternatives were varied and included measures of command and control, price of substitute meat, daily salary in the work option, and whether or not cows were donated to the respondent. We modeled the choice contingent on socioeconomic characteristics. The magnitude of fines and patrolling frequency had a significant but very low negative effect on the probability of choosing to engage in hunting or trading bushmeat compared with the salary of an alternative occupation. Donation of livestock and the price of substitute meats in the local market both affected the choice significantly in a negative and a positive direction, respectively. The wealthier a household was the more likely the respondent was to choose to continue hunting or trading bushmeat. On the margin, our results suggest that given current conditions in the Kilombero Valley on any given day 90% of the respondents would choose salary work at US\$3.37/day over their activities in the bushmeat trade, all else equal.*

Keywords: choice experiment, poaching, wildlife management

Factores que Determinan la Elección de Cazar y Vender Carne de Caza en el Valle Kilombero, Tanzania

Resumen: *La regulación de la venta de carne de caza ilegal es un gran obstáculo para la conservación en África. Investigamos cuáles factores son más probables de inducir a los participantes de la venta de carne de caza para cambiar a una ocupación alternativa al conducir un experimento con 325 participantes de la caza en el Valle Kilombero, Tanzania. Específicamente, pedimos a los participantes elegir entre cazar o intercambiar carne de caza y un trabajo alternativo con un salario pagado. Esto en un juego de escenarios hipotéticos donde los atributos de estas alternativas variaron e incluyeron medidas de comando y control, precio de la carne sustituta, salario diario en la opción de trabajo y si las vacas fueron donadas o no al participante. Modelamos la elección contingente en características socioeconómicas. La magnitud de las multas y la frecuencia del patrullaje tuvieron un efecto significativo muy bajo sobre la probabilidad de elegir participar en la caza o intercambiar carne de caza comparado con el salario de la ocupación alternativa. La donación de ganado y el precio de la carne sustituta en el mercado local afectaron las elecciones significativamente tanto en una forma negativa como positiva respectivamente. El hogar más acaudalado fue el que tuvo la mayor probabilidad de que el participante eligiera continuar cazando o intercambiando carne de caza. En el margen, nuestros resultados sugieren que dadas las condiciones actuales en el Valle Kilomber, en un día cualquiera el 90% de los participantes elegirían el trabajo con salario de US\$3.37 al día sobre sus actividades en la venta de carne caza ilegal, siendo todo lo demás igual.*

Palabras Clave: Caza furtiva, experimento de elección, manejo de vida silvestre

Introduction

Despite high levels of de jure protection, wildlife populations in most parks in the tropics are negatively affected by hunting (Craigie et al. 2010; Laurence et al. 2012; Geldmann et al. 2013), and conservation efforts have hence been considered to fail in relation to protected area management and regulating trade in wildlife products (Bennett 2011; Harrison 2011). This has prompted calls for the use of market-based instruments and other economic incentives to promote more efficient environmental regulation (Damiania & Hatch 2005). However, insufficient information is available on what determines illegal hunting effort (Wilkie et al. 2005) and on what factors may induce actors to shift to an alternative occupation. Attempts to explicitly examine the sensitive choice to engage in illegal hunting and trading bushmeat have rarely been made. But choice experiments, a stated preference method which has more than 20 years use in developing countries (Whittington 2010), may allow us to elicit comparable measures of preferences across factors and attributes of the choice to hunt or trade bushmeat relative to alternative options and reduce the sensitivity of the issue through the use of hypothetical scenarios. Although stated preference methods are vulnerable to hypothetical bias they are the only way to capture preferences ex ante of a change (Bateman et al. 2002). Careful attention to design reduces such bias; yet, it has to be considered in interpretation of results.

Using choice experiments, Moro et al. (2013) recently undertook an inspiring attempt to determine what would most efficiently reduce bushmeat hunting in Serengeti. Their focus was on the trade-off between hunting effort and other livelihood strategies, and their sample consisted of regular community members asked to imagine and answer as if they were hunters. Although the subject of the illegal bushmeat trade may be less sensitive to regular community members this sample may not well represent groups actively involved in the bushmeat trade. Several valuation studies show that familiarity with goods changes the stated value, improves preference estimation (List 2005; Christie et al. 2006), and decreases uncertainty associated with making the trade-offs (Olsen et al. 2011). The decision to undertake an activity such as hunting and trading bushmeat where it is illegal is not just a question of expected income and economic rationality. It also depends on subjective norms and the specific attitude toward the behavior (St. John et al. 2010). These aspects affect the individual's utility (the total level of satisfaction they derive from a choice) and hence the likelihood of engaging in a given activity. Combined with the many studies revealing distinct socioeconomic and demographic characteristics of hunting households (e.g., Loibooki et al. 2002; Coad et al. 2010; Mfunda & Røskaft 2010), the influence of norms and attitudes suggests that preferences and trade-offs of nonhunters are likely to be different from those involved in hunting and trading bushmeat. Like Moro et al. (2013), we also focused on the choice between hunting or trading bushmeat and alternative occupations, but our sample consisted of 325 individuals currently active in the bushmeat trade in the Kilombero Valley of Tanzania. Hence this study as far as we know constitutes the first choice experiment with actors in a bushmeat commodity chain. In addition to providing results on actual as opposed to potential hunter preferences and trade-offs (i.e., Moro et al. 2013), focusing on individuals involved in the trade enabled us to differentiate between actors with distinctly different roles in the bushmeat trade and hence to assess the necessity of differentiated policies and management strategies.

We asked respondents to choose between a day of hunting or trading bushmeat and a day of salary-based work under varying conditions of law enforcement patrol frequency and magnitudes of fines for hunting and trading bushmeat, different salaries in the alternative work option and various prices of substitute domestic animal meat, and the donation of a number of cows to the household common for both alternatives. We further modeled the choice contingent upon socioeconomic characteristics.

Methods

Study Area

The study was conducted in the Kilombero Valley, which is one of Africa's largest wetlands, spans more than 6550 km^2, and is a component of the greater Selous-Niassa ecosystem centered on the World Heritage site Selous Game Reserve to the south (Fig. 1). To the north the valley borders the Udzungwa Mountains, a component of the Eastern Afro Montane Biodiversity Hotspot, and to the east the Mikumi National Park. The standard of material well-being in the area is extremely low (Starkey et al. 2002). The study focused on three anonymous villages located on the northern edge of the valley of which the central part is designated as the Kilombero Game Controlled Area (KGCA), below the Udzungwa Scarp Forest Reserve (USFR). The villages are known for unlicensed commercially oriented bushmeat hunting and trade that has resulted in marked declines of several species, including the near endemic puku (*Kubus vardoni*) (TAWIRI 2009).

Data Collection

A focus group discussion in each village, conducted in June 2011, with five to seven key informers involved in the bushmeat trade was used to assist our identification of factors likely to affect individuals' choice
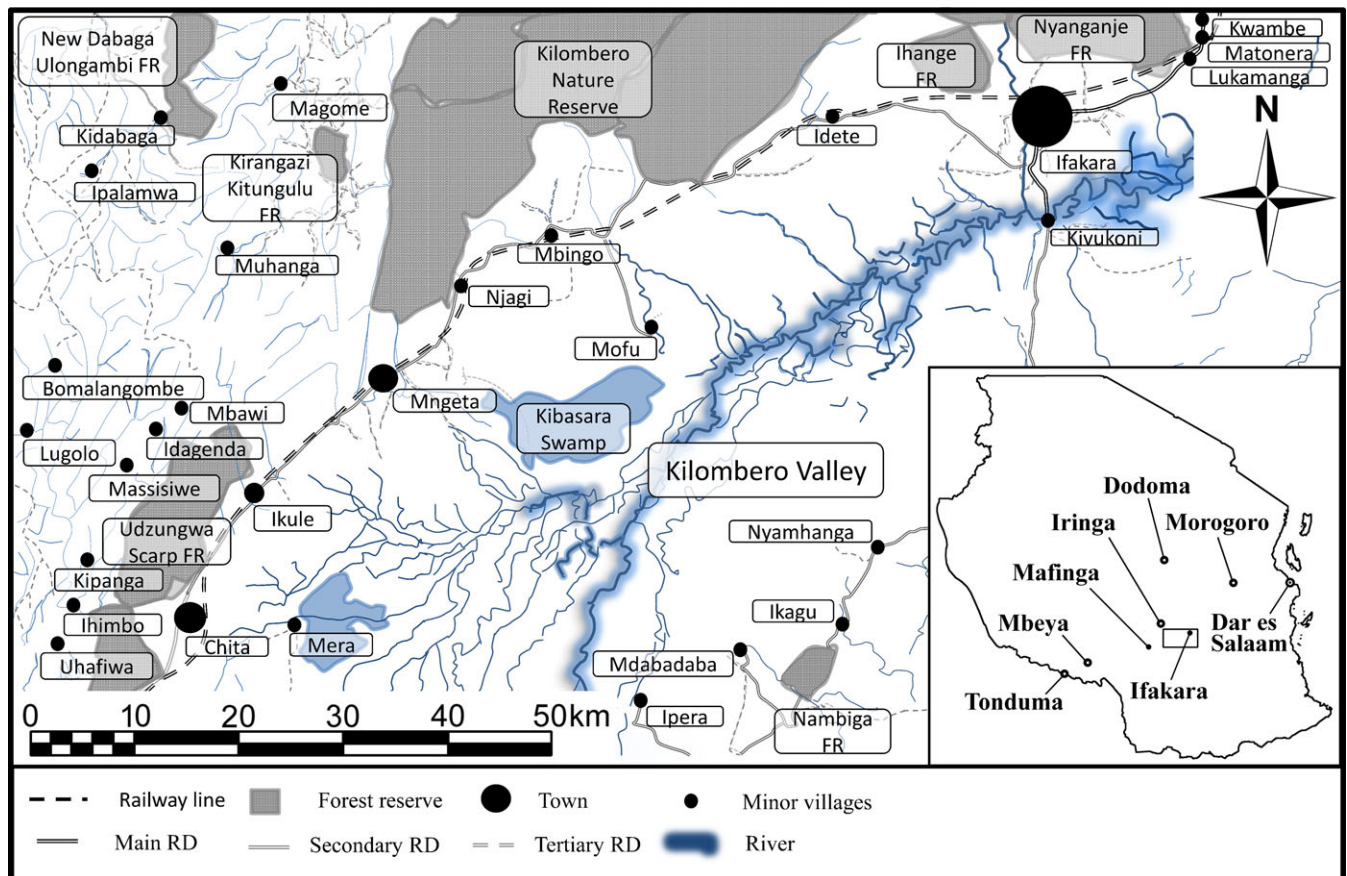
Figure 1. Kilombero Valley, Tanzania, modified from maps SC-37-1 and SC-36-4 (scale 1:250.000, Series Y 503, edition 1 TSD 1961) published by the Survey Division, Ministry of Lands, Forests and Wildlife.

between hunting and trading bushmeat and alternative occupations. Participants were identified over the course of a 1 year study of the bushmeat trade in 2008 and 2009 (MRN unpublished data). The survey was undertaken in October and November 2011 in Swahili with the aid of two research assistants. A snowball sampling strategy (Patton 1990), based on the local knowledge of collaborating actors, was applied to attempt to identify and interview all individuals in the three villages engaged in the bushmeat trade. The long-term relations with the actors in the bushmeat trade in the area, and the local insight of research assistants, enabled us to obtain all identified actors' confidence and to ensure their collaboration and open discussion on the subject. A structured questionnaire was used to collect demographic and socioeconomic household information on income and selected productive and nonproductive assets owned (land, domestic animals, and household assets) (Supporting Information). Income was converted to adult equivalent units (AEUs) following Cavendish (2002). Detailed information on each respondent's function in the bushmeat commodity chain was collected through an open-ended question. Respondents were placed in three main actor groups based on their own description

of activities undertaken. There were 80 hunters, 169 traders, and 76 local retailers. Hunters undertook the killing and initial processing (chopping into lager parts); traders transported meat to villages, cut meat into smaller pieces, and sold meat to an established clientele of customers or hired retailers, who sold the meat in the streets (number of actors per villages is in Supporting Information). After the initial questions, respondents were presented with the choice experiment.

Choice Experiment Design

Relevant attributes of the choice between hunting/ trading bushmeat and alternative occupations were selected on the basis of what was considered important by participants in the focus group discussions, the first author's experience in the area, and relevant economic theory and the literature on drivers of the bushmeat trade. The five selected attributes included donation of dairy cows to respondents' households (a commonly suggested and pursued extension strategy [e.g., Mockrin et al. 2005]), the price of domestic animal meat, daily salary in an unspecified but available alternative occupation of similar strenuousness, patrolling frequency by law

Table 1. Attributes, their levels, and hypotheses on their effects on the choice between hunting or trading bushmeat and acceptance of a salaried job.

Notation	Attribute[a]	Level	Hypothesis[b]
Cd	cows donated	0 and 4	Higher number of cows reduces the inclination to choose to hunt or trade bushmeat illegally because it supplies meat and products for own use and income generation.
Dp	price of domestic animal meat in general	1000, 3000, 4000, and 6000 (TZS/kg)	Higher price provide incentives to hunt or trade bushmeat in order to cover own protein needs and profit from potential positive spillover to the price of bushmeat.
S	daily salary in an alternative occupation of similar strenuousness and risk	1000, 2000, 3000, 4000, 5000, and 7000 (TZS/day)	Higher wages reduce the propensity to choose the hunting or trading bushmeat option.
Interaction = PF	patrolling frequency by law enforcement staff × magnitude of the fine	Once per year, twice per year, once every month, and once every week 30,000, 50,000, 100,000 and 300,000 (TZS/arrest)	The product of patrolling frequency and magnitude of fine is the expected costs of enforcement. Therefore higher frequency and higher fines reduce the utility of hunting or trading bushmeat.

[a]*The following continuous socioeconomic variables were also included: Av, value of selected household assets per adult equivalent unit (AEU); Lc, area of land cultivated per AEU; I, total annual household income per AEU.*
[b]*Hypotheses were largely based on bio-economic equilibrium theory as outlined in Milner-Gulland (2001) (Supporting Information).*

enforcement staff, and magnitude of the fine if caught (Table 1). The underlying hypotheses were based on standard economic theory and empirical evidence indicating: that people are less likely to engage in hunting or trading bushmeat illegally if they have more domestic animals producing meat and dairy products for subsistence use and income generation (Mockrin et al. 2005); that a higher price for domestic animal meat encourages hunting both for subsistence and for satisfying the derived demand for bushmeat (e.g., Wilkie & Godoy 2001; Brashares et al. 2004; Wilkie et al. 2005); that higher wages increase the utility of choosing a salary job and hence reduce the propensity to choose the hunting or trading bushmeat option (Síren et al. 2006; Gill et al. 2012; Sayer et al. 2012); and that increased expected cost, in terms of the product of frequency of patrolling and fines, reduces the inclination to choose the hunting or trading bushmeat option (Milner-Gulland & Clayton 2002; Damania et al. 2005).

Combining all attribute levels resulted in 768 alternatives. However, it is common practice to apply a fractional factorial design in which a subset of all possible combinations is selected, but the ability to estimate main effects and some second-order effects is maintained. The design software Ngene version 1.1.1. was used to generate such a design consisting of 12 scenarios (see example in Supporting Information) optimized for d-efficiency. Scenarios were then grouped into three blocks each consisting of four choice sets. Each respondent was first randomly presented with one block. Subsequently, they were presented with a random block of the two remaining blocks, where the scenarios in addition included the donation of four dairy cows (i.e., regardless of choice). The experiment and the scenarios were further described as a hypothetical game to reduce incentives for strategic answers (Supporting Information). Individual preferences were uncovered by asking respondents to choose between the salary work option or continue hunting or trading bushmeat in these eight different scenarios.

The choice experiment was followed by a direct open-ended contingent valuation (i.e., willingness to accept [WTA]) question on the daily income respondents would require from an alternative occupation in order to cease hunting or trading bushmeat. The question included a provision point mechanism. This consisted of describing a scenario where a donor would compensate people for not hunting or trading bushmeat but subject to a budget restraint forcing the donor to abandon the project if the combined demanded amount exceeded an undisclosed amount (Supporting Information). The purpose is to reduce incentives for strategic answers.

Analysis of Choice Experiment Data

Because the choice experiment has only two outcomes (hunt or trade bushmeat or conduct salary work), we used a random effects logit model with a respondent identification number set as a group variable. The model included main effects of donated cows, price of domestic animal meat and salary, and an interaction term for the fine and patrol frequency attributes (henceforth referred

to as the patrol–fine interaction). The two individual attributes had to be dropped because the marginal effect of neither can be validly estimated without consideration of the other. We included a number of socioeconomic and demographic variables to examine the influence of wealth and other household characteristics. Hence the resulting model is a binary logit random effects model according to which the likelihood of choosing hunting or trading bushmeat ($s = 1$) over salary work ($s = 0$) is given by

$$\ln \frac{p_{(s=1)}}{1 - p_{(s=1)}} = \beta_{1,v}Cd + \beta_{2,v}Dp + \beta_{3,v}S + \beta_{4,v}PF$$
$$+ \beta_{5,v}Av + \beta_{6,v}Lc + \beta_{7,v}I + \alpha_v$$
$$s = 1 \text{ or } 0 \text{ and } v = 1 \dots 325, \qquad (1)$$

where v is the individual index and α_v is a panel effect that captures the individual-specific variance. The notation for the attributes and socioeconomic variables is described in Table 1.

We tested for learning and fatigue effects across the choice experiment and for scale differences (scale is the inverse of the variance) between market actors and applied scale parameters where significant (Supporting Information). Marginal effects of one unit change, averaged over observations in other variables in the models, were calculated using the EFFECTS command. Finally, a model including interaction between actor groups and the various attributes and socioeconomic variables was estimated to test for significant differences between actor groups. The analysis was conducted in Nlogit 5/Limdep 10 and STATA version 12.1.

Results

All attributes and socioeconomic variables were significant with the expected signs (Table 2). McFaddens pseudo-R^2 was relatively high at 0.56, which suggests the covariates significantly improved choice prediction. The model predicted accurately 81% of actual choices made. Data were adjusted for scale differences between the first and last four choice sets and between actor groups (Supporting Information).

Donation of cows, higher daily salary in an alternative available occupation, a higher patrol–fine interaction, and cultivation of more land significantly reduced the likelihood that the average person in the sample would choose to hunt or trade bushmeat (Table 2). A higher price for domestic animal meat, higher investment in selected assets per AEU (on the 0.1 level), and earning higher total annual household income per AEU was associated with significantly higher likelihood of choosing to continue hunting or trading bushmeat. Marginal effects of one unit change, averaged over the levels of other variables in the model, revealed that an additional salary of 1000 TZS per work day reduced by approximately

11% the likelihood that the average person in the sample would choose to hunt or trade bushmeat (Table 2). The effect of donation of four cows and additional 0.40 ha of cultivated land per AEU reduced the likelihood by 9% and 4%, respectively. A 10,000 unit increase in the patrol–fine interaction, however, had negligible but still significant negative marginal effect. A 1000 TZS increase in the price of 1 kg domestic animal meat had limited but still significant positive effect. For each additional million TZS household assets owned and each million TZS higher annual household income, the likelihood of choosing hunting or trading bushmeat increased by almost 28% and 12%, respectively.

The model incorporating interactions between actor groups and the attributes and socioeconomic variables indicated there were significant differences between actors in some effects (Table 3). This included a significantly lower effect of cows donated that was almost cancelled ($-1.64 +1.22$) for hunters while remaining negative for traders and retailers (the reference group). There was no significant difference between actors in the effect of price of domestic animal meat, salary, or fine–patrol interaction. However, the effect of land cultivated was significantly more negative and the effect of total income was significantly more positive for hunters and traders relative to retailers.

Answers to the contingent valuation-format WTA question on how much income from an alternative source would be required for the respondent to cease hunting or trading bushmeat indicated an average salary of 7,649 TZS/day (840 95% CI) for the combined sample, 10,016 (1,100 95% CI) for hunters, 7,022 (771 95% CI) for traders, and 6,553 (720 95% CI) for retailers. Differences were significant only between hunters and retailers ($F = 13$; $P < 0.01$). The assessed current daily salary rate for casual work in the area is around 3000 TZS/day. The required amount may thus reflect a higher expected return from hunting or trading bushmeat. It may, however, also be somewhat inflated by strategic or hypothetical bias.

Discussion

Effect of Fines and Patrol Frequency

The results reveal that traditional conservation approaches based on patrolling and fines have very low influence on the choice to hunt or trade bushmeat. This applied although the ranges were extended beyond the frequencies and fines currently used in the Kilombero Valley. Moro et al. (2013) found a much larger effect of enforcement in terms of the likelihood of apprehension, but this was based on a sample of the general population in the area. Therefore, in addition to the basic difference between the relevant attributes (Supporting Information) this may be explained by the currently very low patrol effort in KGCA and the fact that our sample

Table 2. Regression coefficients of random effect binary logistical regression on the choice between hunting or trading bushmeat and doing salary work (base group) and marginal effects for the logistic probability function averaged over observations.

Attribute or variable[a]	Logit model	(SE)	p	Marginal effect	(SE)	p
Donated cows	−0.94474	(0.16881)	0.000	−0.09168	(0.01542)	0.000
Price of domestic animal meat (1000 TZS/kg)	0.12150	(0.03401)	0.000	0.01179	(0.00316)	0.000
Salary (1000 TZS/day)	−1.15293	(0.03900)	0.000	−0.11188	(0.00189)	0.000
Patrol–fine interaction (10,000)	−0.00045	(0.00018)	0.011	−0.00004	(0.00002)	0.018
Household assets value (1,000,000 TZS/AEU)	2.83627	(1.45153)	0.051	0.27524	(0.14008)	0.051
Land cultivated (acre/AEU)	−0.39948	(0.16221)	0.014	−0.03877	(0.01571)	0.017
Total income (1,000,000 year/AEU)	1.22790	(0.34971)	0.000	0.11916	(0.03354)	0.002
Constant	3.58091	(0.28996)	0.000			
Sigma	2.40894	(0.14065)	0.000			

[a]*Abbreviation: AEU, adult equivalent unit.*
Model properties: observations, 2593; groups (i.e., individuals), 325; log likelihood, −942.81755; McFaden's pseudo-R^2, 0.5590; Akaike's information criterion, 0.734.

Table 3. Regression coefficients of the random effect binary logistical regression on the choice between hunting or trading bushmeat and doing salary work (base group) with interactions with actor groups.

Attribute or variable[a]	Logit model	(SE)	p
Donated cows	−1.63934	(0.33907)	0.000
Donated cows × hunter	1.22359	(0.46955)	0.009
Donated cows × trader	0.65751	(0.41990)	0.115
Price of domestic animal meat (1000 TZS /kg)	0.14813	(0.05802)	0.011
Price of domestic animal meat × hunter	−0.00793	(0.08515)	0.926
Price of domestic animal meat × trader	−0.01856	(0.07283)	0.799
Salary (1000 TZS/day)	−1.19758	(0.09930)	0.000
Salary × hunter	0.17490	(0.11276)	0.121
Salary × trader	−0.06747	(0.10303)	0.513
Patrol–fine interaction (10,000)	−0.00093	(0.00038)	0.014
Patrol–fine interaction × hunter	0.00051	(0. 00051)	0.314
Patrol–fine interaction × trader	0.00072	(0.00044)	0.103
Household assets value (1,000,000 TZS/AEU)	5.14175	(5.40045)	0.341
Household assets value × hunter	−3.55845	(5.59533)	0.525
Household assets value × trader	0. 94900	(6.03015)	0.875
Land cultivated (acre/AEU)	0.30757	(0.28909)	0.287
Land cultivated × hunter	−1.01517	(0.46696)	0.030
Land cultivated × trader	−1.03919	(0.37803)	0.006
Total income (1,000,000 year/AEU)	−0.40373	(0.85974)	0.639
Total income × hunter	2.42498	(1.17844)	0.040
Total income × trader	1.89691	(1.09309)	0.083
Constant	3.56330	(0.36609)	0.000
Sigma	2.40127	(0.18414)	0.000

[a]*Abbreviation: AEU, adult equivalent units.*
Model properties: observations, 2593; groups (i.e., individuals), 325; log likelihood, −925.77892; McFaden's pseudo-R^2, 0.4337; Akaike's information criterion, 0.732.

consisted of individuals actually involved in hunting or trading bushmeat who are likely to be fundamentally less averse to these specific risks than individuals not involved in these illegal activities (Milner-Gulland 2001). In addition, most cases where actors had been apprehended were settled through payment of a bribe (66% of cases) rather than a formal fine (19% of cases), and bribes were as expected significantly lower than fines (MRN unpublished data). Other studies have, however, showed that bushmeat hunting has declined as a result of increased law enforcement (Milner-Gulland & Clayton 2002; Jachmann 2008).

Salary in an Available Alternative Occupation

The most important attribute affecting the choice was the daily salary in the alternative occupation, which represented the opportunity cost of continuing hunting

or trading bushmeat relative to taking salary work. Nonlinear prediction (i.e., estimating the conditional mean) at the approximate current level of other attributes (3,000 TZS/kg domestic animal meat; patrol frequency of once per month; fine of 50,000 TZS) indicated the likelihood that the average individual would choose hunting or trading bushmeat could be reduced to 10% (arbitrarily selected level as a complete stop is probably unrealistic) if a job opportunity providing a salary of 5400 TZS/day were available, all else equal. Such an outcome would likely have positive effects on wildlife populations. Consistent with this result, in Equatorial Guinea the bushmeat trade declined following the outmigration of hunters to seek employment in the construction industry in a period of rapid economic growth (Gill et al. 2012).

We measured the salary attribute in terms of daily salary rather than monthly wage. This means we could not make direct inference as to whether respondents would make the same choice confronted with an opportunity for a longer term employment with a monthly salary. However, it is likely that greater job security would be associated with WTA a lower salary per day.

Donation of Livestock and Price of Domestic Animal Meat

The second most important attribute of the choice was donation of livestock; it had the same direction of effect as observed by Moro et al. (2013). Nonlinear predictions at the current level of other attributes and assuming no available salary work indicated that the likelihood that the average individual would choose hunting could be reduced to less than 20% through donation of four cows. Just as any alternative economic activity that directly absorbs labor and raises the opportunity cost, increased focus on livestock production may reduce the bushmeat trade directly by affecting individuals' cost–benefit considerations. Specifically, livestock production may provide income through offspring, dairy products, and meat and may provide a substitute for bushmeat for the household.

An increase in availability of domestic animal meat at the aggregated level following a massive donation of livestock could furthermore potentially reduce the price of domestic animal meat sufficiently to affect the relative demand for and price of bushmeat. But hard evidence that demand for bushmeat would lessen if livestock was more available is limited (Wilkie et al. 2005). Furthermore, although the marginal effect at an individual level is significant, implementation of such a policy at the aggregate level (particularly if scaled up to include other relevant villages) raises other concerns. Studies for instance indicate that competition and spread of diseases from livestock to wildlife already has adverse effects on wildlife populations in the Kilombero Valley (Bonnington et al. 2007). Thus donation of livestock does not easily

suggest itself as a panacea for reducing bushmeat hunting, though it could be part of a combined policy.

The price of domestic animal meat had very limited effect on the choice, and nonlinear prediction revealed that the likelihood of choosing to hunt or trade bushmeat can be reduced to only 30% even if the price of domestic animal meat were reduced to a third of the current level when salary work is unavailable (i.e., adjusting the scenario described earlier). This may reflect the significant difference in price between domestic animal meat and bushmeat and respondents expectations of continued shortage of meat. Fresh bushmeat (all species combined) is sold in packages weighing about 2 kg (but varying depending on demand) and on average costing 2609 TZS (33 95% CI), whereas beef on average costs 4392 TZS/kg (27 95% CI).

Socioeconomic Factors

Respondents' preferences, and hence choices, may vary systematically with socioeconomic and demographic factors. Wealthier households, in terms of income (particularly hunters and traders) and value of assets, were more likely to choose to continue hunting or trading bushmeat. This result is consistent with their reluctance to relinquish what they know generates high profit (Supporting Information) and perhaps that they are more productive than others because they are less credit constrained or subject to less risk in terms of enforcement. Our focus was exclusively on individuals involved in the bushmeat trade, but this result is consistent with recent studies indicating that within rural communities the middle or even higher income groups harvest most bushmeat (de Merode et al. 2004; Starkey 2004; Kümpel et al. 2010). Similarly the negative effect of area of agricultural land cultivated suggests that people (particularly hunters and traders) with more land more readily abort trading bushmeat perhaps in expectation of sufficient agricultural income and as a result of higher opportunity costs of labor on land. This result is consistent with the findings of Johannesen (2005), which indicate people cultivating less land in the Serengeti ecosystem are more likely to be involved in hunting.

Hypothetical and Strategic Bias

As with all stated preference studies, ours is subject to hypothetical bias and particularly strategic bias. This could be further exacerbated by insecure institutions, low education level, and lack of trust prevalent in developing countries such as Tanzania (Whittington 2010). In particular one could expect that attributes related to negative incentives such as patrolling frequency and fines could be underestimated compared with attributes representing positive incentives. We could not exclude the occurrence of strategic answers. But on the basis of the coefficient of the patrol–fine interaction, it was evident that

it was so low that even a severe downward strategic or hypothetical bias would not change the result that very high patrol frequencies or fines would be needed to seriously affect the choice. Similarly, the estimated required salary to accept an alternative occupation (and the stated WTA income required to cease hunting or trading bushmeat), although higher than payments from available casual labor, was within the same order of magnitude. Another common reason for hypothetical bias relates to unfamiliar contexts (List 2005; Christie et al. 2006). However, we sampled individuals currently involved in hunting or trading bushmeat and selected attributes based on their relevance according to focus group discussions and interviews with similar individuals, so this aspect is unlikely to be a significant source of bias compared with Moro et al. (2013).

Recommendations and Future Directions

Our findings and those of Moro et al. (2013) illustrate that choice experiments have a potential to provide specific and relevant information for policy development and selection of management strategies on the sensitive subject of the bushmeat trade. Despite a fairly modest sample size, we are able to obtain significant estimates and make valid inferences on variables, and our models predicted observed choices well. Although the use of hypothetical scenarios likely contributed to making the process of elicitation of preferences less sensitive, the previously established long-term relations with these actors in the bushmeat market may also have contributed. Future studies applying this approach should identify, target, and elicit preferences from people who are actually involved in the bushmeat trade, rather than approximating these by asking a broader sample of community members to respond as if they were hunters (as in Moro et al. 2013). Because people self-select into these activities and those involved may be distinctly different from other community members, analyses should be based on the specific group that is the focus of the policy. This also enables stronger conclusions because information on preferences and trade-offs is based in the relevant socioeconomic and demographic characteristics and social psychological profiles (St. John et al. 2010). Most notably the likely higher risk aversion among a population consisting mainly of nonhunters (i.e., Moro et al. 2013) may explain the marked difference in the effect of command and control measures relative to this study.

We found that realistic ranges of fines and patrolling frequencies had very low potential to influence the choice of hunting or trading bushmeat compared to the opportunity costs in terms of daily salary in an alternative available occupation, the potential in owning livestock, and the price of substitute meats. The models suggest that particularly the salary in an available alternative occupation would have the highest effect on an actor's decision to exit the bushmeat trade. Specifically, we found that if a job was available paying the equivalent of US$3.37/day, then hunting and trading of bushmeat could be reduced to 10% of the current level. This is consistent with other recent studies indicating that hunting rarely is a preferred activity. Rather, it is a means of obtaining regular income when paid employment is unavailable (Coad et al. 2010; Kümpel et al. 2010) that escalates during periods of economic recession and high unemployment (Endamana et al. 2010; Wittemyer 2011). Hence, although our assessment only reflects the choices of individuals at the margin, it appears that facilitating actors in the bushmeat trade to move into alternative occupations is more likely to enable wildlife populations in the Kilombero Valley to rebound than relying solely on enforcement. Relying solely on enforcement would require a patrolling effort that is unattainable considering staff and funding available in most protected areas in Tanzania (Caro et al. 2000), which has resulted in significant declines of buffalo (*Syncerus caffer*), hippopotamus (*Hippopotamus amphibious*), and warthog (*Phacochoerus africanus*) and substantial declines of puku and elephant (*Loxodonta africana*) populations in the Kilombero Valley from 1991 to 2009 (TAWIRI 2009). This suggests that perhaps antipoaching policies should be directed more at increasing the opportunity cost of poaching by creating better alternative economic opportunities (Poudyal et al. 2009; Gill et al. 2012; Sayer et al. 2012). At the same time, the redirection of work effort would produce compensating production values in the new occupations. These efforts should be complemented by interventions targeted at increasing the availability of domestic animals, reducing the price of domestic animal meat, addressing corruption of enforcement staff, limiting the availability of firearms, and involving local communities in the area's management through decentralization of management rights and responsibilities, which has been shown to be important aspects in explaining wildlife trends in adjacent areas (Nielsen 2011; Nielsen & Treue 2012; Nielsen & Meilby 2013). Regardless of which combination of these management recommendations are selected, the outcome needs to be monitored because large-scale implementation of policies will have equilibrium effects not accounted for in studies such as this.

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Supporting Information

The questionnaire used (Appendix 1), description of the choice experiment design and contingent valuation question (Appendix 2), analysis of the choice experiment (Appendix 3), and details of the comparison between the results of the choice experiment and the contingent valuation WTA question (Appendix 4) are available online. The authors are solely responsible for the content of this material. Queries (other than absence of the material) should be directed to the corresponding author.

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