LETTER

# An investigation using the choice experiment method into options for reducing illegal bushmeat hunting in western Serengeti

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**Keywords**
Bushmeat; choice experiments; illegal hunting; livelihoods; Serengeti.

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**Received**
6 May 2012
**Accepted**
14 July 2012

**Editor**
Amy Ando

doi: 10.1111/j.1755-263X.2012.00284.x

## Abstract

Bushmeat hunting is perceived as a serious threat to the conservation status of many species in Africa. We use a novel livelihood choice experiment method to investigate the role of illegal hunting within livelihood strategies in the western Serengeti, and to identify potential trade-offs between illegal hunting and other income sources. We find that increasing access to microcredit, higher wages, increases in number of cows, weeks hunting and increased access to market all contribute to well-being. We are able to quantify the trade-offs between weeks spent illegal hunting and increases in cattle, wage income, access to markets, and access to microcredit. However, important differences emerge in response to these variables between different wealth groups which shape how we should design conservation and development interventions.

## Introduction

Hunting of wildlife is believed to be a key driver of serious population declines and local species extinctions in many parts of the world (Hofer *et al*. 1996). Hunting for bushmeat is particularly critical in Africa, and the link between the decline of wildlife populations and hunting has been studied extensively (Wilkie & Carpenter 1999; Robinson & Bennett 2000; Brashares *et al*. 2001). In this article, we investigate the alternative contributions to well-being that can replace returns from illegal hunting, and quantify the changes in these factors which would be needed to reduce hunting activity while maintaining livelihoods.

Previous studies have expressed concern about the scale of illegal hunting in protected areas such as the Serengeti National Park in Tanzania. Estimates of the number of wildebeest killed illegally annually in the Serengeti vary from 40,000 (Mduma 1996) to 118,000 animals (Campbell & Hofer 1995), and concerns have been raised about the sustainability of illegal hunting practices and about impacts on nontarget species (Arcese *et al*. 1995). Previous studies have recognized the need to investigate and understand the determinants of hunting and bushmeat consumption as an essential step in devising more effective policies to reduce unsustainable illegal hunting of wildlife (Campbell *et al*. 2001; Johannesen 2005).

Evidence suggests that the majority of hunting in the Serengeti National Park is carried out by local young males and is primarily motivated by poverty and the desire for cash income and food. Participation in illegal hunting is thought to decrease as the numbers of

  

livestock owned increase, and as access to alternative means of generating income or acquiring protein increase (Campbell *et al*. 2001; Loibooki *et al*. 2002; Holmern *et al*. 2007, though also see Mfunda & Røskaft 2001). Nielsen (2006, 2011) found that illegal hunting is linked to wealth, larger family size, and lower levels of education. Knapp (2007) found that no households engaged in poaching reported having members in full-time employment compared to 20% employment in nonpoaching households.

However, the extent and determinants of illegal hunting are still unclear (Knapp *et al*. 2010). Studies assessing levels of poaching are usually based on four methods: self-assessment of illegal hunting activity; arrest records from anti-poaching units; dietary records to measure the demand for bushmeat; and market data on bushmeat sales (Crookes *et al*. 2005). Each one of these methods has problems. Dietary surveys do not reveal who is hunting or why. The use of arrest records to determine the poaching level may tell most about the quality and extent of antipoaching activity. Market data captures only part of bushmeat supply, and it may be hard to correctly identify demand- and supply-side shifts. Finally, self-reported levels of poaching coming from household surveys suffer from under-reporting due to fear of repercussions (St. John *et al*. 2011).

This article investigates potential trade-offs between illegal hunting activity and other sources of household income using the choice experiment method. Based on focus group work with local households, a number of 'household livelihood attributes' were identified and used in an experimental design which combines alternative levels of these attributes in choice tasks. The attributes include time spent illegally hunting and the probability of being arrested on a hunting trip. Therefore, our choice experiment attenuated the reluctance of households to answer questions regarding their illegal activity, as, crucially, households were not directly questioned about the sensitive issue of whether members were engaged in illegal hunting. Time spent hunting was just one of the activities/attributes, the levels of which had to be traded-off when choosing among alternative livelihoods. By estimating an econometric model of choice determinants, it was then possible to quantify trade-off rates between livelihood attributes, keeping constant the level of household well-being, to investigate how significant these attributes were in choosing one livelihood over another, and what changes in cattle and wages, for example, would compensate households for a reduction in weeks spent in illegal hunting. As far as the authors are aware, this is the first time that the choice experiment method has been used in this way.

## Methods

### Sampling procedure and area of study

We conducted our survey in six villages in western Serengeti, located adjacent to the Serengeti National Park and Lake Victoria, along the border of the Grumeti Game Reserve. Bushmeat hunting is an illegal but widespread practice in this area. Members of approximately 32 households per village were interviewed by two local enumerators in each village, leading to an overall sample size of 200 households. All twelve enumerators were thoroughly trained in the administration of the choice experiments. The main survey was undertaken between December 2010 and February 2011.

### Choice experiment design

Choice experiments are a survey-based method for investigating preferences and demand (Hanley & Barbier 2009). Respondents are presented with a series of choice alternatives, differing in terms of characteristics (attributes) and their levels, and asked to choose their most preferred. A full outline of this approach is provided in the Supplementary Information. In this survey, we asked respondents to select their most preferred "livelihood options" among a range of alternatives presented to them. Each livelihood option consisted of six attributes, two of which related to illegal bushmeat hunting: the amount of time (weeks) spent hunting and the chance of arrest while hunting illegally. All attributes were chosen after a series of focus groups with local communities and were informed by the existing literature on likely drivers of participation in illegal bushmeat hunting in Africa. The six attributes were:

(1) *Number of cows owned by the household*. Cattle are a means of accumulating wealth in western Serengeti. The hypothesis is that more cows are preferred to fewer cows, and that increases in cattle numbers would increase household utility. The attribute has four levels: no cows, 1 cow, 15 cows, and 30 cows.
(2) *Wage rate*. The respondent was asked to imagine that one household member had a full-time job. The hypothesis is that higher wages are preferred to lower wages, and that an increase in wages increases the utility associated with a livelihood option. There are four wage levels: no job, 80,000 TZS (Tanzanian Shilling) per month, 200,000 TZS per month, or 600,000 TZS per month (1,000 TZS = 0.5 EUR or 0.64 USD). At the time of writing, 600,000 TZS was equivalent to the salary of a senior primary school

 

| | A | B | C |
|---|---|---|---|
| **Number of cows** | 0 | 30 | 1 |
| **Wage per month** | 600,000 TSh | No job | 80,000 TSh |
| **Access to microcredit** | Yes | Yes | No |
| **Access to markets** | Yes | No | Yes |
| **Likelihood of being arrested** | 0 | 2/10 | 4/10 |
| **Time spent hunting per year** | **1 week** | **2 months** | **6 months** |
| **Which one would you choose?** | [ ] | [ ] | [ ] |

**Figure 1** Example of a choice experiment card used in the survey.

teacher—one of the few employment opportunities available in the area.

(3) *Access to microcredit*. Microcredit groups are a reality in some of the villages in our study area, and many respondents were familiar with these programs. We asked respondents to imagine that there could be such a microcredit group in their village that their households could obtain money from for small business start-ups.

(4) *Road to village centre accessible by lorry*. Respondents were asked to consider the existence of a good road between the nearest town and the center of his or her village, so as to facilitate access to markets.

(5) *Time spent hunting per year*. The respondent was told the following "Imagine that you or somebody else in your household considered going bushmeat hunting to sell the meat (not to eat it at home). We are going to show you different options, for example, you (or another person in your household) could go hunting for 6 months altogether in one year, or 1 week, or not at all. The time we mention here includes all the trips made in one year, whether it's one-night trips or big trips." This attribute had four levels: no hunting, 1 week, 2 months, and 6 months.

(6) *Likelihood of being arrested per trip*. Previous studies have identified the perceived likelihood of arrest as a determinant of hunting participation (Knapp *et al*. 2010). Enumerators read the following text to each respondent "Imagine you or somebody else in your household might be going for a bushmeat hunting trip this year in a group of 10. You or somebody of your group might get arrested. We will show you different likelihoods of being caught (per trip). For example, of the 10 people in this group on your trip, two might be caught, or four." The four levels used in the experimental design were: nobody gets caught, and one, two, or four individuals out of a group of ten get caught. Because this attribute is only meaningful given the decision to hunt, we interact it with the hunting trip attribute described above in the models estimated.

Every respondent was shown six livelihood choice cards (Figure 1). Further description of the survey design is contained in the Supplementary Information.

  

**Table 1** Multinomial logit model (MNL) results. The coefficients show the effects on utility of changes in each attribute level on the average respondent relative to the baselines of no cattle owned, no job, no access to microcredit, no road access to market, no hunting and no risk of arrest

| Attribute | Coefficient | Standard error |
|---|---|---|
| Number of cows = 1 | 0.3369[b] | 0.1591 |
| Number of cows = 15 | 0.9098[a] | 0.1918 |
| Number of cows = 30 | 1.2443[a] | 0.1450 |
| Wage from job = 8,000 TZS | 0.7952[a] | 0.1838 |
| Wage from job = 20,000 TZS | 1.0219[a] | 0.2236 |
| Wage from job = 60,000 TZS | 1.7628[a] | 0.2033 |
| Access to microcredit | 0.5482[a] | 0.1022 |
| Access to market | 0.5462[a] | 0.1162 |
| Weeks spent hunting = 1 | 0.5667[a] | 0.2029 |
| Weeks spent hunting = 8 | 0.5516[c] | 0.2960 |
| Weeks spent hunting = 24 | 0.2582[c] | 0.1499 |
| Risk associated with a hunting trip | −0.8178[a] | 0.1768 |
| Model properties | | |
| Log-likelihood | −696.78738 | |
| McFadden's pseudo $R^2$ | 0.1997 | |
| AIC/*n* | 1.774 | |
| *n* (observations) | 799 | |
| *k* (parameters) | 12 | |

[a,b,c]Significance at 1%, 5%, 10% levels.

## Results

We started the analysis with a simple multinomial logit model (MNL) presented in Table 1. All attribute levels were dummy-coded to allow for variable marginal utilities associated with each. Preliminary examination of the data showed that irrespective of model specification, respondents were generally insensitive to increasing in the likelihood of being caught. By this, we mean that higher probabilities of being caught did not result in progressively lower probabilities of a livelihood option being chosen, so long as this probability was at least as high as the lowest level in the design, namely, one individual in ten being caught on a hunting trip. For this reason, this attribute is modeled as a single dummy variable, signifying a nonzero risk of being arrested when on a hunting trip.

As may be seen from Table 1, having more cattle, a higher wage income, access to microcredit, and road access to markets all appear to significantly increase the average respondents' utility, and so increases the probability of choosing a livelihood alternative which corresponds to better levels of these attributes. The risk associated with hunting trips is evaluated as negative and highly significant in explaining variation in choices. Because the risk of being arrested is controlled for statistically, the variables associated with 1, 8, and 24 weeks spent hunting represent the benefit of hunting when there is no risk of being caught. All of these coefficients are positive, showing that the benefits associated with illegal hunting are judged to be greater than the costs of time and effort by respondents. We observe that the longer the hunting trip is, the less preferred it is compared to shorter trips. Since longer trips require more time (i.e., are more costly in terms of other opportunities foregone) and effort, and imply a higher risk of getting injured by wild animals, the net benefit of a hunting trip can decrease with length if the value of meat caught does not increase proportionately faster. This may explain the pattern observed in the choice data.

Based on the MNL model results presented in Table 1, we are able to calculate respondents' trade-off rates between different attributes, such as the amount of each attribute the respondents would be willing to trade for the benefits of 1 week of riskless hunting, maintaining their utility (here, well-being) at the same level. These trade-off rates are presented in column 2 of Table 4. The utility from one week of hunting is equal to the economic benefits from owning an additional 1.47 cows, or having an additional 36,000 TZS per month income from a job.[1] This implies that increasing cattle by more than 1.47 cows, or wages by more than 36,000 TZS would suffice to offset the benefits from one week of illegal hunting for the average respondent. Having access to microcredit appears just as good as 0.85 hunting weeks per year, and nearly as valuable as having road access to a market.

Finally, we note that the absolute value of the coefficient associated with the risk of being arrested is higher than the coefficient associated with even a 1-week hunting trip. This result means that if the average respondent had a choice, he would rather not go on even a 1-week hunting trip as long as there is a positive probability of being arrested. This observation is obviously not supported by continued occurrence of poaching in western Serengeti. The reason for this is that in the MNL model, we estimate coefficients of the utility function of an average respondent. It is likely, however, that respondents vary considerably in their perception of benefits of hunting. For this reason, it is important to take preference heterogeneity and variations in people's socio-economic situations into account. We do this in the two modeling approaches that follow.

Table 2 presents the results of random parameters logit model (RPL), a technique described in full in the Supplementary Information. The RPL model allows us to take both observed and unobserved potential determinants of preference heterogeneity (variability) into account. Because we were interested in how preferences for poaching change with respondents' wealth level, we included covariates which represent potential indicators of household wealth: the number of cattle currently owned, and

 

**Table 2** Random parameters logit model (RPL) results. Mean effects show the effects on utility for discrete changes in each attribute for the average respondent away from the same baselines used in Table 1. Standard deviation parameters show the spread in preferences around this mean effect for each attribute and level change. Interaction terms show how socio-economic characteristics "number of cattle owned" and "jobs in household" co-determine the utility associated with different numbers of weeks spent hunting

| | Mean effect estimates | | Standard deviation estimates | |
|---|---|---|---|---|
| Attribute | Coefficient | Std. error | Coefficient | Std. error |
| Number of cows = 1 | 0.2624 | 0.2281 | 0.6126 | 0.5037 |
| Number of cows = 15 | 1.4826[a] | 0.3201 | 0.0240 | 0.4927 |
| Number of cows = 30 | 1.7851[a] | 0.2781 | 1.2828[a] | 0.3437 |
| Wage from job = 8,000 TZS | 0.9861[a] | 0.2999 | 0.9440[b] | 0.4330 |
| Wage from job = 20,000 TZS | 1.1712[a] | 0.3912 | 1.5725[a] | 0.5597 |
| Wage from job = 60,000 TZS | 2.4982[a] | 0.4081 | 1.2871[a] | 0.3590 |
| Access to microcredit | 0.8103[a] | 0.1937 | 1.2905[a] | 0.2804 |
| Access to market | 0.8357[a] | 0.2008 | 1.0897[a] | 0.2808 |
| Weeks spent hunting = 1 | 0.9932[a] | 0.3763 | 0.9204[b] | 0.3753 |
| Interaction with Cattle owned | −0.0244[c] | 0.0142 | – | – |
| Interaction with Jobs in household | −3.0083 | 3.7474 | – | – |
| Weeks spent hunting = 8 | 0.9039[c] | 0.5104 | 0.0191 | 0.3244 |
| Interaction with Cattle owned | −0.0259[c] | 0.0156 | – | – |
| Interaction with Jobs in household | −8.3303 | 5.2968 | – | – |
| Weeks spent hunting = 24 | 0.7045[b] | 0.2876 | 0.4834 | 0.4238 |
| Interaction with Cattle owned | −0.0348[b] | 0.0137 | – | – |
| Interaction with Jobs in household | −1.2696 | 2.7841 | – | – |
| Risk associated with a hunting trip | −1.1015[a] | 0.3165 | 0.8873[b] | 0.3868 |
| Model properties | | | | |
| Log-likelihood | −670.6538 | | | |
| McFadden's pseudo $R^2$ | 0.2360 | | | |
| AIC/*n* | 1.7540 | | | |
| *n* (observations) | 799 | | | |
| *k* (parameters) | 30 | | | |

[a,b,c]Significance at 1%, 5%, 10% levels.

the number of people within a respondent's household that currently have a job. Of these, only the number of cattle proved to have power in explaining preference differences in a statistically significant way—the more cattle a respondent owned, the less beneficial were additional weeks spent hunting. Results show that as respondents become wealthier (in terms of number of cattle owned), the share of those who would find hunting worth their while decreases.

As in the case of MNL, we are able to derive trade-off rates between different attributes for the random parameters model (Table 4, column 3). One week of hunting for respondents who currently do not own cattle and have no job income was equal to owning an additional 2.70 cows, or having about 50,000 TZS in additional job income. Increases in cattle owned above 2.70 cows would decrease time spent hunting by one week for respondents who currently do not own cattle and with no job income. Having access to microcredit was equivalent of 0.71 hunting week, whereas having road access to a market was close to 0.74 of a week spent hunting.

To investigate the issue of preference heterogeneity further, we estimated a latent class model (LC). This technique allows for the identification of a number of latent classes of respondents with distinct preferences for hunting weeks and the risk associated with being arrested while hunting (Table 3). Again, see the Supplementary Information for more detail. We used the same indicators of wealth as in the random parameters model as variables potentially explaining membership in one of two LCes. Households with more cattle were more likely to belong to LC one. The first LC of respondents (86% of the sample) considered hunting trips less beneficial than the second class (14% of the sample), whereas 24-week hunting trips even had a negative effect on utility for the former group. Members of the second LC were much more concerned with the risk of being arrested. Finally, in the case of members of class 2, one- and 8-week hunting trips appeared more beneficial than the risk associated with them, indicating that there would be a net benefit to such individuals of hunting illegally. Implied trade-off rates are presented in columns 4 and 5 of Table 4. The

  

**Table 3** Latent class model (LC) results. Membership of individual households in either class is probabilistically determined by cattle owned and jobs in household ("Explanatory variables of class probability"). For each latent class, the coefficient value shows the contribution to utility of each attribute level. Due to sample size considerations, utility parameters for number of cows, wages, access to micro-credit and road access to market are constrained to be equal for both classes

| | Latent class 1 (86% of respondents) | | Latent class 2 (14% of respondents) | |
|---|---|---|---|---|
| Attribute | Coefficient | Std. error | Coefficient | Std. error |
| Number of cows = 1 | 0.3021[c] | 0.1644 | 0.3021[c] | 0.1644 |
| Number of cows = 15 | 0.9268[a] | 0.2028 | 0.9268[a] | 0.2028 |
| Number of cows = 30 | 1.2879[a] | 0.1541 | 1.2879[a] | 0.1541 |
| Wage from job = 8,000 TZS | 0.8119[a] | 0.2040 | 0.8119[a] | 0.2040 |
| Wage from job = 20,000 TZS | 1.0238[a] | 0.2400 | 1.0238[a] | 0.2400 |
| Wage from job = 60,000 TZS | 1.8417[a] | 0.2319 | 1.8417[a] | 0.2319 |
| Access to microcredit | 0.6113[a] | 0.1165 | 0.6113[a] | 0.1165 |
| Access to market | 0.6018[a] | 0.1269 | 0.6018[a] | 0.1269 |
| Weeks spent hunting = 1 | 0.1773 | 0.2475 | 3.3775[b] | 1.6098 |
| Weeks spent hunting = 8 | 0.1152 | 0.3328 | 3.8162[b] | 1.8210 |
| Weeks spent hunting = 24 | −0.0464 | 0.1922 | 2.0434[b] | 1.0309 |
| Risk associated with a hunting trip | −0.3021[a] | 0.1644 | −2.6780[b] | 1.1680 |
| | Explanatory variables of class probability | | | |
| | Coefficient | | Std. error | |
| Constant | 0.7341 | | 0.8955 | |
| Cattle owned | 0.2420[c] | | 0.1393 | |
| Jobs in household | 0.3330 | | 0.9839 | |
| | Model properties | | | |
| Log-likelihood | −688.8595 | | | |
| McFadden's pseudo $R^2$ | 0.2152 | | | |
| AIC/*n* | 1.772 | | | |
| *n* (observations) | 799 | | | |
| *k* (parameters) | 19 | | | |

[a,b,c] Significance at 1%, 5%, 10% levels.

lower value associated with hunting trips by the members of class 1 is reflected in the trade-offs they are willing to make in comparison with the members of class 2. The implication is that increases in cattle or wage-earning options will only be effective in deterring illegal hunting activity for households who are more likely to belong to LC two.

## Discussion

Taken at face value, our findings suggest that, particularly increases in cattle or wages, but also improved access to markets or microcredit, would all reduce illegal hunting, in that households could reduce hunting activity with no decrease in well-being (utility) levels if these changes in other livelihood sources took place. However, the rates of trade-off between illegal hunting (in terms of the net benefit from this activity to individuals) and other sources of household livelihood support varied significantly across households and livelihood options. This variation was partly explained by the number of cattle owned by the household. We can quantify these trade-off rates, and show what increases in cattle or wages would compensate for a given reduction in illegal hunting activity. We also find that evaluations of the risk of being arrested while hunting illegally vary across households (Table 3), and that increase in this risk do not decrease utility once risk rises above a rather low threshold.

Current policies on reducing illegal bushmeat hunting in the Serengeti include a wide range of approaches, such as improved law enforcement, support for alternative income sources through microcredit schemes, the establishment of wildlife management areas, improving the availability of alternative protein sources such as chicken and fish, conservation awareness campaigns, and the provision of benefits to communities by the national park authority such as schools and health dispensaries. Our

 

**Table 4** Trade-off rates for livelihood attributes relative to number of weeks spent illegal hunting. Values are derived from Tables 1–3 as the ratio of the utility parameter for number of cows, job income, access to microcredit and access to market to the utility parameter for 1 week of hunting per year

| | MNL | RPL[a] | LC (class 1) | LC (class 2) |
|---|---|---|---|---|
| No. of cows for 1 hunting week | 1.4725 | 2.6987 | 0.4665 | 9.6819 |
| Job income (in thousands of TZS) for 1 hunting week | 3.5939 | 5.0815 | 1.0352 | 21.4825 |
| Hunting weeks for access to microcredit | 0.8480 | 0.7136 | 3.2204 | 0.1552 |
| Hunting weeks for access to market | 0.8450 | 0.7360 | 3.1702 | 0.1528 |

[a]For respondents who currently do not own cattle or job income.

results suggest that this range of options should be extended by measures which boost livestock numbers owned by households and wage earning opportunities. However, the effectiveness of these options will vary across households. Whilst the trade-offs between time spent hunting and other livelihood attributes were computed based on hypothetical choices, they give important pointers for conservation policies and projects.

For most respondents, stricter law enforcement does seem to act as a deterrent—however, as the persistence of bushmeat hunting shows, this effect is obviously not strong enough to prevent hunting across the entire population of western Serengeti. Although wealthier households tend to attribute less utility to hunting than less well-off households, they also seem to be less concerned about the risk of being caught. This means that policies that increase wealth, for example, through microcredits and the creation of job opportunities, can help to reduce hunting. However, at the same time, a specialization of well-off hunters who commercially harvest large amounts of bushmeat and who have the financial means to cope with the risk of being arrested needs to be prevented.

The heterogeneity in utility derived from hunting suggests that if bushmeat hunting is to be reduced, interventions are required that combine the creation of alternative income sources with stricter law enforcement that cannot be circumvented by financial means. In addition, qualitative research in the same study site points at the strong role of women in encouraging bushmeat hunting, as they highly value the access to meat and cash provided by hunters (Lowassa *et al.*). This suggests that alternative income sources have to be sufficiently attractive to compete with the opportunities provided by hunting. Our finding that, on average, our respondents would trade-off one week of hunting for an additional 50,000 TZS of wages per month (Table 4, RPL) suggests that substantial changes in job availability would have to happen in the region: only 15% of the households in our sample had one or more members with regular jobs, whereas a waitress in a small café in the district town currently earns only 20–25,000 TZS. In addition, economic development in western Serengeti (as elsewhere) implies that demand for cash will likely rise in the near future (Lowassa *et al.*). Policy instruments will thus have to address not only the status quo, but also accommodate future increases in income and well-being, in addition to the overall sustainability of alternative income sources such as intensified livestock husbandry or cash crop cultivation, an aspect that our study did not address.

Our study adds to the existing quantitative research into bushmeat hunting as it investigates hunting in its livelihood context rather than as an isolated activity, and conceptualizes hunting as part of a package of livelihood strategies. Although our representation of livelihood options in western Serengeti was by no means complete, our approach allowed us to explore the trade-offs made by households in greater depth than conventional household surveys. One of the major problems in studying illegal activities is the lack of reliable market and survey data and the reluctance of households in answering direct questions about poaching (e.g., St. John *et al.* 2011). Our choice experiment is an attempt to go around this problem, by including time spent hunting—the sensitive variable—as one of the attributes whose level had to be traded-off by respondents when choosing their combinations of attributes levels which maximize their utility. In addition, the use of choice experiments as a stated preference technique enabled us to examine behavioral intentions of a random sample of the population rather than explaining hunting ex-post, as, for example, interviews of arrested hunters do. Using choice experiments in the manner employed here avoided asking respondents directly about their participation in illegal activities, as hunting was embedded as just one option across a range of livelihood strategies. However, respondents may still have chosen options with high levels of illegal hunting less often than they would in reality if they were worried about signaling actual participation to the researchers, although pre- and pilot tests did not give any indication that this might have been the case.

Finally, although our results point to the desirability of policies towards reducing illegal hunting being

  

differentiated according to household wealth levels, we were not able to quantify the additional costs of implementing policy options differentiated in this way relative to simpler, undifferentiated policies.

## Acknowledgments

We thank Nils Bunnefield, E.J. Milner-Gulland, Anne Borge Johannesen, Maurus Msuha, Rodolfo Nayga, Martin Nielsen, Ana Nuno, Deborah Randall, Dennis Rentsch, and two anonymous reviewers for useful comments, and the Tanzania Wildlife Research Institute and Tanzania Commission for Science and Technology (COSTECH) for the permission to conduct this research. This work was carried out as part of the project "HUNT-Hunting for Sustainability" (http://fp7hunt.net/) and supported by the European Commission under the 7th Framework Programme for Research and Technological Development.

## Supplementary Material

The following supplementary material is available for this article:

**S1.** The Choice experiment method

**S2.** Outline of Random Parameters Logit Approach

**S3.** Notes on Latent Class (LC) Models

**S4.** Note on properties of experimental design used here

**S5.** Note on estimation procedure.

**S6.** Additional modeling results: effects of having current access to microcredit and currently having road access to local markets within an RPL model.

This material is available as part of the online article from: http://www.blackwell-synergy.com/doi/10.1111/j.1755-263X.2012.00284.x

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## Endnote

[1]We remind the reader that since the attribute in the utility function is number of weeks spent hunting per year, every reference to week(s) spent hunting are relative to a given year.

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