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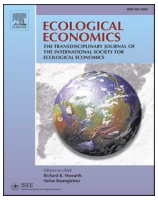

Surveys

Policies to reduce local participation in illegal hunting: The case of Kafue National Park in Zambia

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ABSTRACT

Using data collected from 217 respondents living near the Kafue National Park in Zambia, we assess how households value alternative policy interventions aimed at minimizing poaching. Building on the current debate on community-based wildlife conservation policy, we presented households with different combinations of agro-inputs packs donation, access to a micro-credit facility and donation of dairy cows for milking. These were proposed as alternative policy interventions to compliment the traditional command and control policy framework, implemented through a rise in frequency of game patrols and increase in minimum jail sentences for poaching offenses. We use a discrete choice experiment to estimate policy preferences and potential trade-offs between poaching and proposed alternative policy instruments. Our findings show that increase in each of the proposed interventions could significantly contribute to the well-being of respondents, potentially reducing the number of hunting trips a poacher would make per month. Similarly, a rise in the deterrent interventions have significant, but weak effect on respondents' choice to poach. The above carrot and stick instruments could be deferentially applied based on cost and effectiveness of each combination to achieve desired goals.

1. Introduction

Effective policy responses to poaching is a problem of growing concern for many public agencies responsible for wildlife management (Travers et al., 2019; Lindsey et al., 2017; Nyirenda et al., 2015). In this paper, poaching refers to being in possession of or killing of wild animals without relevant permits. Although real causes and severity of poaching are unclear, due to lack of accurate data (Travers et al., 2019), extant literature broadly attribute the drivers to many sources. These include material and non-material losses to communities following establishment of wildlife protected areas (PAs), inadequate compensation for providing conservation services, lack of alternative livelihood sources for communities neighbouring PAs, nuisance wildlife damage, and loss of commercial source of revenue (Mbanze et al., 2021; Travers et al., 2019). These are exacerbated by inadequate devolution of user-rights over wildlife to communities living near PAs, coupled with poor law enforcement due to poor funding towards conservation (Ntuli et al., 2020).

Poaching has been associated with declining wildlife populations (Lindsey et al., 2016; Nielsen and Meilby, 2014; Simasiku et al., 2008). Other impacts are increasing edge effects or shrinking size of a protected area (Hofer et al., 1996), loss of dry season grazing, and ecotourism income losses (Lindsey and Bento, 2012; Lindsey et al., 2011; Jambiya et al., 2007). Poachers also use fire to lure[1] wild animals to venture outside PAs in search of grazing due to dry-season graze losses (Lindsey and Bento, 2012). Poaching using snares has a significant impact in that snares are not only easy to acquire but are also difficult to detect and non-selective with regards to animal size, leading to huge collateral damage (Hofer et al., 1996). Lindsey and Bento (2012) report poaching-related income losses from ecotourism investments amounting to 92.3% in Mozambique, 66.6% in Namibia, 44.4% in Zimbabwe, 18.8% in Tanzania and 66.6% in Zambia. The Save Valley of Zimbabwe

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[1] Burning the bush leads to shooting of green grass that attracts wild animals thereby bringing them in close proximity with poachers

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records yearly revenue losses of at least US$1.1 million from trophy hunting and legal meat sales (Lindsey et al., 2011). Revenue losses from ecotourism are also reported in Makuleke Concession of Kruger National Park (Lindsey et al., 2011), Burigi and Biharamulo game reserves of Tanzania (Jambiya et al., 2007).

In this paper, we follow Sterner and Coria (2013) to distinguish between command-and-control, incentive based, and market-based policies. Command and control policies involve more effective law enforcement as in Zimbabwe's CAMPFIRE and Zambia's ADMADE programs, where part of the revenue from hunting fees and Safari concessions was used to recruit local game scouts to support regular patrols (Virtanen, 2003). Incentive based policies use a variety of nudges to encourage communities to support conservation. Communal Conservancies in Namibia are trusts created to support management of community-driven wildlife conservation efforts (Barnes et al., 2002), given legal autonomy to manage wildlife sustainably as an incentive. South Africa's strong institutions and adequate funding support communities to co-manage ecotourism ventures (Krueter et al., 2010). Under Zambia's community-based conservation policy, Zambia Wildlife Authority (ZAWA) compensates communities providing conservation services through community-based developmental projects (Simasiku et al., 2008; Wainwright and Wehrmeyer, 1998). Other policies incentivise communities to develop alternative livelihoods, through agricultural projects seen as having significant potential given the relationship between poaching, meat consumption and food security (Milner-Gulland and Bennett, 2003). These are part of Integrated Conservation Development Programs (ICDPs) (Johannesen and Skonhoft, 2004) implemented in Kenya, Tanzania, Cameroun (Van Vliet, 2011) and Mozambique (Lindsey et al., 2011). Market-based policies facilitate bargaining between parties through payments for environmental services (Mashayekhi et al., 2016). Ecotourism consumers are charged to raise funds used to compensate environmental services (ES) providers and provide institutional support.

However, despite having these policies in place, poaching has remained difficult to address in most Sub-Sahara Africa countries (Nisson et al., 2016). In general, public policy offers no incentive to improve quality of environment management beyond set standards. Secondly, public policy is often inflexible, imposing same standards, and conservation-control technology to all, drawing no distinctions between providers of ES that find it easy and inexpensive to provide services and those who find it difficult and costly to do so. Finally, public policies are subject to compromise in the political process and implementation. Although South Africa and Namibia report successful stories following their strong institutions and adequate funding towards conservation, their models resist replication to other counties with different settings. Community Markets for Conservation (COMACO) an NGO operating near Luangwa National Park in Zambia, provides alternative livelihood skills to communities living near PAs. This is done through training of former poachers and small-scale farmers in climate-smart, sustainable agricultural practices using small-household loans and provision of market to improve their incomes. *However, COMACO's approach to conservation is largely supply driven, and fails to establish what beneficiaries consider adequate benefits from conservation. Poachers can therefore accept "inadequate benefits" and still go back to poach. Furthermore, no empirical analysis has been done to evaluate its effectiveness in reducing poaching. Given that conservation impose an opportunity cost on communities providing environmental services, there is need to estimate the opportunity cost imposed in order to provide equivalent or higher compensation to spar sustainable conservation. Our study compliments COMACO's strategy, by experimentally estimating what poachers consider adequate alternative livelihoods to trade-off with poaching. Further, our study site which is far from COMACO's operational areas provides useful information to COMACO and other stakeholders engaged in wildlife conservation.*

Wildlife conservation is an economic activity impacting livelihoods of over 8% of the country's population (GRZ, 2019). Zambia's tourism sector classified by the World Bank as "nature-based" contributed over US$1.1 billion (7.1%) to GDP in addition to creating over 319,000 direct jobs in 2018 (GRZ, 2019). Despite implementing community-based wildlife conservation policy from early 1980s (Wainwright and Wehrmeyer, 1998), several studies separately commissioned to evaluate its performance report dismal results. Continued declining performance of the sector points to the need to look elsewhere for effective conservation interventions, which leads one to ask how the current wildlife conservation policy can be enhanced to address the existing challenges.

We use a Discrete Choice Experiment (DCE) to investigate how households living next to the Kafue National Park in Zambia would trade-off poaching that supports subsistence living, for proposed alternative livelihoods. Giving up poaching requires some sacrifices, i.e., reduced food or income, and the DCE attempts to explore what compensations would be needed for poachers to give up the vice. As such, the method adopted for the study will help estimate the private losses related to the required change of activities but not the change in the value of the public good (restored biodiversity, increased eco-tourism potential, etc.).

Our study draws motivation from governance theories (Stoker, 1998) about maintaining public-sector resources under some degree of political control and developing strategies to sustain government's capacity to act in the face of management tools that replace highly centralized and hierarchical structures. This is done by designing decentralized management environments where decisions on resource management, allocation and service delivery are made closer to the point of delivery. We also draw on interactions between state institutions and society and how this influences the defining of mutual rights and obligations of state and society (Jagers et al., 2021; Benequista, 2010), including negotiating public resources allocated and establishment of different modes of accountability. Related to governance structures is the importance of collective action based on social capital, represented by metrics of trust, reciprocity, and community involvement, identified as an important determinant of the success of collaborative institutional engagements (Jagers et al., 2021; Wagner et al., 2010; Benequista, 2010; Ostrom, 2000). Finally, DCEs are theoretically in line with behavioural change theoretical models, which infer that intentions to performance behaviors of different kinds can be predicted with accuracy from attitudes towards the behaviour, subjective norms, and perceived behavioural control (Ajzen, 1991).

To differentiate this study from previous work, we focus on poaching using snares/bow and arrow rather than firearms, given growing evidence pointing to poaching using above weapons, as having an inestimable impact on large mammals alike (Damania et al., 2005). Hunting with snares/bows and arrows make it difficult to trace poachers compared to use of firearms. The use of these weapons is prominent in the study area. Thus, in exchange for reducing the number of hunting trips, we presented respondents with: agro-inputs packs, cows for milking, access to a community micro-credit facility, increase in frequency of game patrols and a rise in minimum jail sentence for poaching offenders. Study findings show that increase in quantities of proposed interventions would significantly contribute to community welfare, potentially reducing poaching.

2. Methodology

2.1. Study area

The study was hosted in Mumbwa Game Management Area (GMA), situated adjacent to Kafue national park in Mumbwa district of the central province of Zambia (Fig. 1). Kafue National Park is the third-largest park in Africa and Zambia's oldest and largest wildlife protected area. Mumbwa GMA makes for an appropriate context for this study in that the size and composition of communities in the GMA is not only large, but representative of populations in other GMAs in Zambia. Over 56% of the population is male, while adults (16 years and above) make up about 49%. Mumbwa GMA hosts three Chiefdoms

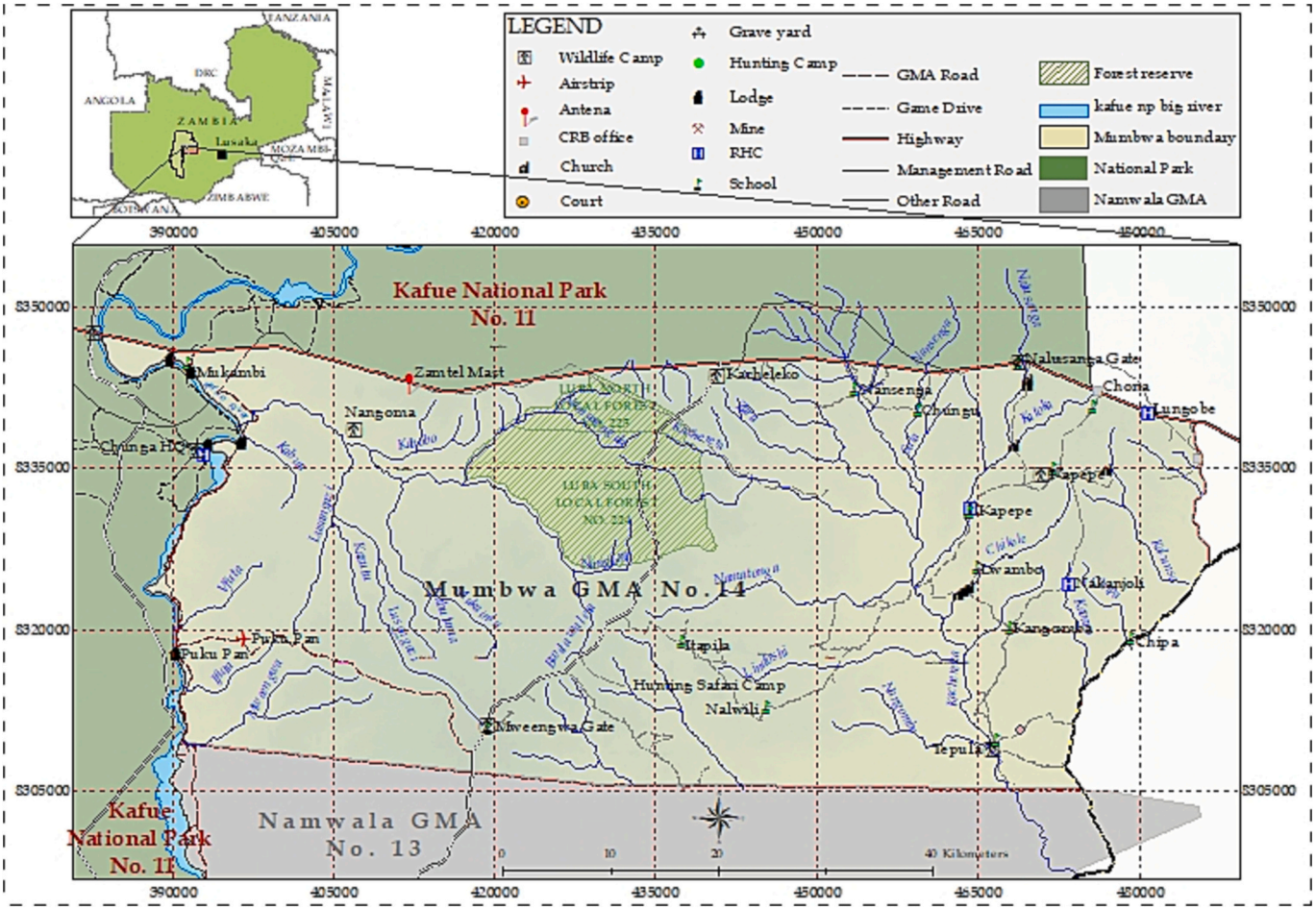

Fig. 1. Map of Mumbwa Game Management Area.

(Kabulwebulwe, Chibuluma and Mulendema), whose traditional leaders are designated as patrons of Community Resources Boards in each chiefdom. Locally elected Community Resource Boards (CRBs) are grass root institutions providing policy guidance, extension support (Simasiku et al., 2008) and platforms for development partners wishing to improve local community welfare. They also ensure equitable distribution and use of compensation to communities for conservation services provided.

According to ZAWA, the GMA hosts a diversity of wildlife including 19 species of large herbivores like elephant (*Loxodonta africana*), sable (*Hippotragus niger*), antelope (*Kobus leche kafuensis*), buffalo (*Syncerus caffer*), hippopotamus (*Hippopotamus amphibius*), waterbuck (*Kobus ellipsiprymnus*), and impala (*Aepyceros melampus*). It has 13 species of carnivores including lion (*Panthera leo*), leopard (*Panthera pardus*), wild dog (*Lycaon pictus*), hyena (*Crocuta crocuta*), serval (*Leptailurus serval*), jackal (*Canis aureus*) and cheetah (*Acinonyx jubatus*). It has seven species of omnivores including porcupines (*Erethizon dorsatum*), squirrel (*Paraxerus cepapi*) and has four species of primates like Chacma baboons, Kinda baboons (*Papio ursinus*), Vervet monkeys (Cercopithecoidea) and Bush baby (Galagidae).

2.2. Designing the choice experiment

2.2.1. Selection of policy attributes

We used a discrete choice experiment where attributes are the proposed interventions presented as alternative forms of livelihoods to substitute poaching. To ensure that attributes are demand-driven, relevant and realistic, four iterative focus group discussions (FGDs) were held, with each subsequent FGD providing more information that helped us refine the questionnaire. Each FGD comprised of seven to nine persons, including one female participant (Chairperson of the Resources Board) and a village head, randomly selected to help us understand their knowledge on the current conservation policy, its performance and observed challenges. The last FGD included six former convicted poachers, from whom we sought to understand the extent of the poaching problem, its causes and law enforcement related issues, based on their own, and other peoples' experiences. Using FGD results and existing literature, we established a first list of attributes. The FGD findings were discussed with; selected local village scouts in the GMA, ZAWA officials, Wildlife conservation experts, officials from Ministry of Tourism, Park managers, and key-informants familiar with the study area. We also reviewed literature (e.g., Costedoat et al., 2016; Nielsen and Meilby, 2014; Piannar et al., 2014; Nielsen et al., 2013; Kaczan et al., 2013; Moro et al., 2012) which led to a final list of attributes and levels presented in Table 1.

2.2.2. Hypothetical scenarios

As an introduction to the survey, respondents were informed that donors planned to improve their welfare through introduction of new income generating opportunities. Donors would also help government improve enforcement of wildlife regulations. Respondents were informed that the survey was eliciting information for development of donor-funded alternative livelihood interventions, as an upgrade of the current wildlife conservation policy that failed to meet their expectations. Proposed alternative policy interventions are; donations of agro-input packs for two farming seasons, one-off donation of milking cows, and having access to a micro-credit facility. Deterrent measures are; increasing the frequency of game patrols per week through the hire of more scouts, and a rise in the minimum jail sentence for poaching

Table 1
Attributes, attribute levels, descriptions and their impact on households.

Attributes	Description	Levels (* = status quo)
Agro-input packs	Agro-input packs comprise 20 kg maize seeds, 100 kg of basal dressing and 100 kg of top-dressing inorganic fertilisers delivered at the beginning of a growing a season for two years (equivalent to 220 USD per year)	0*, 1, 2, 4 (number of agro-packs)
Cows for milking	One-off donation of cows, at in-calf stage, for milking and later on beef, (equivalent to 160 USD each).	0*, 2, 4, 6 (number of cows)
Community Micro-credit facility	Access to community micro-credit facility to obtain small loans of up to ZMW1000 (US$50) for business start-ups. Loans will be secured through "group lending" as a form of Collateral	YES, NO*
Hunting trips	Household's number of hunting trips per month	4*, 2, 1, 0
Frequency of game patrols per week	Increased frequency of game park patrols per week through recruitment of more game scouts	3*, 4, 5, 7
Minimum Jail term for poaching	Increased minimum jail term for convicted poaching offenders	3*,5,10, 15

offenders. The attribute dealing with the number of hunting trips per month is used as a cost attribute, to trade-off with alternative policy interventions. The proposed payment vehicle was a jointly managed hypothetical donor-supported wildlife conservation trust fund (WCTF). A payment vehicle is a critical component of DCE designs. Finally, respondents were asked a direct question about their current monthly income and willingness to accept (WTA) compensation to stop poaching. A choice set for the study is illustrated in Fig. 2.

2.3. Experimental design, sampling and survey

After holding FGDs towards the end of 2019, we conducted a pre-survey with male only 50 randomly selected respondents using an orthogonal design with seven attributes. We used the preliminary results to develop a D-efficient design with 12 choice tasks using Ngene v.1.1.2 (Rose and Bliemer, 2009). The D-error of the final experimental design was 0.048. A full design is at the supplementary material. The survey instrument was implemented in early 2020 after Free Prior Informed Consent (FPIC), ethics clearance from the University of Pretoria, the Zambia Wildlife authority and consents from respondents. We conducted 217 face-to-face interviews with households drawn from five villages; Shimbizhi, Tumbama, Lunyemu, Nalusanga and Choona, randomly selected from their respective Village Action Group (VAG) registers. We used VAG registers prepared by the local Community Resource Boards and accepted by the ZAWA to obtain a fair representation from which we could draw inferences, based on the situation on the ground.

Information from FGDs showed that poaching was an activity carried out by males above 16 years old. Consequently, we interviewed household heads for male-headed households and a male adult older than 16 years for female-headed households as these greatly influence family decision on important matters.

2.4. Data analysis

We analysed the data using a conditional logit model. In accordance with the random utility theory (McFadden, 1974), we assume that the utility of individual n from choosing alternative j in choice situation t can be represented as: $U_{njt} = \beta'.X_{njt} + \varepsilon_{njt}$, where X_{njt} is a vector of observed attributes related to alternative j of the choice situation t; β' is a vector of preference parameters explaining choices while ε_{njt} is the unobserved

Card 1		Current Situation	Alternative A	Alternative B
Number of agro-inputs Packs		0	4	1
Numbers of Cows for milk		0	8	0
Number of hunting trips per month		4 times in a month	Once in a month	4 times in a month
Access to community micro-credit facility		0	NO	YES
Frequency of game patrols		3 days a week	5 days a week	7 days a week
Minimum jail sentence for poaching		3 years	10 years	15 years
Please choose one only		( )	( )	( )

Fig. 2. An example of choice set used in the study.

error term. Some attributes might only be relevant when applied in combination, i.e., a person might only have preferences for longer sentences if engaged in poaching. Therefore, a second conditional logit model with interactions between hunting trips, jail sentences and patrol frequency were also estimated. We modelled, utility of household as:

$$U(a,h,j,p) = ASC + \beta_{ag} \times agropack + \beta_{cow} \times cows + \beta_{credit} \times credit + \beta_{hunt} \times hunt + \beta_{patrol} \times patrol + \beta_{jail} \times jail + \beta_{jh} \times jail \times hunt + \beta_{ph} \times patrol \times hunt + \beta_{pj} \times patrol \times jail$$

Using the second model, we estimated willingness to accept (WTA) compensation for agro-packs, cows and access to credit for reducing the number of hunting trips. To demonstrate the general approach to estimating WTA, we develop the calculations for the case of agro-packs. Since marginal utility of agro-packs is β_a, marginal utility of hunting trips will be:

$$\beta_h + \beta_{jh} \times jail + \beta_{ph} \times patrol$$

For a given jail sentence and number of patrols per week, we can calculate WTA for agro-packs to reduce hunting by one unit as the marginal rate of substitution between agro-packs and hunting trips as:

$$WTA_{agr} = \frac{\beta_h + \beta_{jh} \times jail + \beta_{ph} \times patrol}{\beta_a}$$

To evaluate possible policy consequences, we calculated WTA at current levels of jail sentences and patrols per weeks (3 and 3 respectively). We then evaluate the marginal effect of varying the jail terms or the patrol levels on this WTA value. For example, the marginal effect of increasing jail term by one year on WTA for agro packs is calculated as:

$$\frac{\partial WTA_{agr}}{\partial jail} = \frac{\beta_{jh}}{\beta_a}$$

The same reasoning was applied for computation of WTA for cows and access to credit. In order to estimate the variability of our results, the standard errors of these values were computed using the Delta method.

3. Results

3.1. Social-demographic characteristics

Table 2 shows that majority of respondents are married and above 40 years of age. The mean age of 43 year is consistent with local household statistic of farmers in rural parts of the country. Ngoma et al. (2021) report a mean age of farmers of 51.5 years in a similar area. Mean household family size is high, with a low mean household monthly income from non-poaching sources of just above US$70.

Majority of respondents were literate, having attended primary and secondary education. Over 50% of respondents were unemployed, implying that we addressed a population most likely to engage in poaching. The low monthly incomes of US$70.96 from non-poaching sources compared to US$94.47 (Kabika et al., 2019) for other rural communities outside GMAs, make the households susceptible to poaching. The high mean family size, in the light of higher unemployment, put these households under financial pressure to poach.

Low number of respondents who report owning cattle leads to high demand for poaching for extra income and protein needs. Although over 90% of respondents show desire to engage in agriculture, with 67% owning at least a hectare of land, lack of agricultural inputs force them to engage in poaching (96%). With regards to compensation provided for conservation, 17% report satisfaction with both the type and distribution process of compensation under the current policy, while 15% report satisfaction with the amount of compensation offered.

Table 2
Social-demographic characteristics.

Variable	Frequency		Mean	St. Dev.
	Number	%		
Age			43.2	11.965
Family size			6.9	3.670
Marital status				
Single	28	13		
Married	189	87		
Education level				
Illiterate	35	16		
Adult Education	3	1.2		
Primary	87	41		
Secondary	85	39		
College	7	2.8		
Occupation				
Unemployed	116	54		
Pensioner	10	5		
Casual laborer	18	8		
Self employed	55	25		
Employed in private sector	13	6		
Employed in public sector	5	2		
Monthly income (poaching excluded)			ZMW1348.31 (USD 70.96)	ZMW1111.99
Monthly income (rural communities outside GMAs (USD)			ZMW1,794.92 (USD 94.47)	ZMW1211.30
Monthly income from poaching (USD)			ZMW4137.44 (USD217.76)	ZMW2484.12
Monthly WTA compensation to stop hunting (USD)			ZMW2994.06 (USD157.58)	ZMW1593.07
Own at least one animal (cattle)	81	37		
Desire to engage in subsistence agriculture	199	92		
Owns at least one hectare of land	146	67		
Reported poaching as main source of income	194	89		
Reported poaching as main source of protein	190	87		
Reported poaching as the only alternative form of livelihood	216	96		
Satisfied with type of compensation for conservation services	17	7.8		
Satisfied with amount of compensation for conservation services	15	6.9		
Satisfied with distribution process of compensation	17	7.8		

Source: survey data 2020.

3.2. Results of the choice experiment

All attributes were highly significant with expected signs (Table 3). The questionnaire was translated from English to the local language called Tonga and in that process a detail on the legitimacy of the hunting trip were lost. We used the analysis to reveal how respondents had perceived this attribute; If the hunting trips were perceived legal, we would expect the coefficient sign for the number of hunting trips per month to be positive since more hunting trips would give more utilities from both food and income. However, if respondents considered all trips as illegal, we would expect that at low jail terms and number of patrols, the hunting trips would have a positive impact on their livelihood, but with higher risk of being caught and longer jail terms, this would become negative.

Therefore, we tested possible interaction effects between hunting trips attribute, jail sentence and number of patrol attributes. Table 4

Table 3
Estimates of the conditional logit model.

Variable	Coefficient	Sig.[a]	Standard error
Donated Agro-packs	0.764	***	0.040
Donated Cows	0.454	***	0.025
Access to Credit	1.001	***	0.075
Frequency of patrolling	−0.046	***	0.011
Minimum jail sentence for poaching	−0.122	***	0.008
Hunting trips per months	−0.090	***	0.008
Alternative Specific Constant (Status Quo)	−0.496	***	0.112
Observations	2604		
Log-likelihood	−1594.016		
McFadden's pseudo R^2	0.440		
AIC	3202.03		
BIC	3243.09		
Estimated parameters	7		

[a] ***, **, * indicates significance at 1%, 5%, 10% levels

Table 4
Estimates of the conditional logit model with interactions.

Variable	Coefficient	Sig.[a]	Standard error
Donated Agro-packs	0.816	***	0.047
Donated Cows	0.436	***	0.025
Access to Credit	1.292	***	0.116
Frequency of patrolling	−0.296	**	0.100
Minimum jail sentence for poaching	−0.323	***	0.065
Hunting trips per months	0.670	*	0.263
Jail sentence * hunting trips	−0.039	**	0.014
Frequency of patrols * hunting trips	−0.094	*	0.045
Frequency of patrols * Jail sentence * hunting trips	0.000		0.001
Frequency of patrols * Jail sentence	0.056	***	0.012
Alternative Specific Constant (Status Quo)	−1.859	***	0.315
Observations	2604.0		
Log-likelihood	−1584.29		
McFadden's pseudo R^2	0.442		
AIC	3190.57		
BIC	3255.09		
Estimated parameters	11.0		

[a] ***, **, * indicates significance at 1%, 5%, 10% levels.

presents results of a conditional logit model with additional three interaction terms; Jail sentence x Hunting trips, Patrolling frequency x Hunting trips, and Jail sentence x Patrolling frequency x Hunting trips. The interactions between the number of patrols and hunting trips per month and number of patrols and jail sentences were significantly different from zero indicating that respondents indeed interpreted the hunting trips as illegal. The introduction of interaction terms slightly improved overall fit of the model (Table 4). The coefficients for three incentives (agro-packs, cows and credit) are similar to those in the previous model, implying that presence of interacting terms did not influence the estimation of the marginal utility of the three incentives.

This suggests that marginal utility of households' hunting trips vary with level of risk taken, where risk is represented by a combination of probability of being caught influenced by the numbers of patrols conducted per week and increase in minimum jail term. Similarly, WTA for agro-packs, cows and credit also vary with levels of risk. We calculated WTA values under two different scenarios.

Table 5
WTA for compensations under a hypothetical riskless environment.[a]

	Estimate	Std.Err	Z value	Pr(>z)	
Agro-packs	0.821	0.305	2.691	0.821	**
Cows	1.535	0.628	2.445	1.535	**
Credit	0.518	0.196	2.648	0.518	**

[a] Riskless WTA are calculated for a situation with no patrol and no jail sentence.

First, we calculated the WTA with no patrol and jail terms. This we referred to as the riskless scenario, that can be thought of as gross value of hunting trips, which would bring meat, etc., and have no costs other than time of the poacher. WTA values are reported in Table 5. Results show that respondents would give up one trip per month if they were given 0.821 agro-packs per year. Since we know the price of the agro-packs (220 USD), the monetary equivalent would be 1440 USD/per household/2 years ($0.821 \times 220 \times 4$) to reduce hunting from four to zero trips per month, meaning one hunting trip would cost 15 USD. This value corresponds to the value of meat, net of the cost of labor time and other perceived costs. The same calculations were made for other instruments and the results are presented in Table 6. WTA at current jail and patrol levels, as well as marginal effects of additional jail term and patrol level on WTA are presented in Table 5.

In the second scenario, we calculated the same trade-offs under the current scenario, with a jail sentence of 3 years and 3 patrols per week (Table 7). Respondents would give up one hunting trip per month if they were given 0.333 agro-packs. Assuming linearity of responses, they would accept to stop hunting completely if given $4 \times 0.333 = 1.332$ agro-packs.

When translated into monetary equivalent, this would require $1.332 \times 220 \times 2 = 586$ USD per household over the two years period for agro-packs priced at 220 USD each. However, this WTA will be affected by the deterrent measures (minimum length of jail terms and frequency of patrols). The results suggest that one additional patrol per week has more impact than one additional year in jail. One additional patrol per week all else being equal would reduce the compensation to respondents by $0.115 \times 4 \times 220 \times 2 = 202$ USD per household but increase the budget required for patrols, e.g., recruiting more game scouts and buying more equipment for patrols. In the same way, an increase in prison sentence of one year, all else being equal would reduce WTA by 85 USD per household but would require additional budget for costs related to management of jail facilities. The same calculations were made for other incentives and results are presented in Table 8.

We also inferred from the coefficients additional number of years of jail sentence or additional number of patrols per week required to make marginal utility of hunting nil. This is calculated by solving the equation $\beta_h + \beta_{jh} \times jail + \beta_{ph} \times patrol = 0$, where we fix either the *patrol* or *jail* variables. Under current patrolling environment (3 days per week), we would need to increase minimum jail sentence up to 10 years to render poaching unattractive. Similarly, under current minimum jail term (3 years), we would need up to six patrols per week to render poaching unattractive, with no need for compensation.

4. Discussion

Study findings show that access to a community micro-credit facility, donation of agro-inputs packs and milking cows could potentially reduce poaching (Table 4). Compensation required to reduce poaching depends on frequency of patrols and length of jail sentence, as increasing one or both actions reduce marginal utility of hunting, and by extension, required compensations. The difference between the WTA under riskless hunting (Table 5) and the WTA with the impact of patrols and jail sentence (Table 7) give an indication of the value of residual poaching to respondent welfare.

Table 6
Yearly amount of compensation required to stop the hunting in a riskless environment.

Instrument	Agro-packs	Cows	Credit
Units to stop hunting under current hunting level[a]	3.284	6.14	2.072
Unit cost in USD for 2 a year program	440	160	100
Equivalent USD compensation for 2-year program	1440	982.4	207.2

[a] Current hunting trips per months = 4

Table 7
WTA compensations and impact of jail and patrol levels on WTA under current situation.[a]

	Estimate	Std.Err	Z value	Pr(>z)	
WTA Agropack	0.335	0.134	2.502	0.335	**
• dWTA-Agropack/dJail	−0.047	0.015	−3.105	−0.047	***
• dWTA-Agropack/dPatrol	−0.114	0.052	−2.177	−0.114	*
WTA Cows	0.626	0.273	2.290	0.626	*
• dWTA-Cows/dJail	−0.089	0.030	−2.910	−0.089	**
• dWTA-Cows/dPatrol	−0.214	0.106	−2.023	−0.214	*
WTA Credit	0.211	0.085	2.496	0.211	**
• dWTA-Credit/dJail	−0.030	0.009	−3.226	−0.030	***
• dWTA-Credit/dPatrol	−0.072	0.034	−2.117	−0.072	*

[a] WTA are calculated at the current jail sentence (3 years) and patrol intensity (3 patrols days per week).

Table 8
Amount of compensation of each instrument to stop the hunting under current setting.

Instrument[b]	Agro-packs	Cows	Credit
Units to stop hunting under current Setting[a]	1.332	2.492	0.844
Unit cost in USD for a 2 yr program	220 × 2 = 440	1 × 160	2 × 50 = 100
Equivalent USD compensation for 2 yr program	586	398.72	84.4
Impact of 1 additional year in jail on the equivalent USD compensation	−84.48	−113.92	−12
Impact of 1 additional patrol per week on the equivalent USD compensation	−202.4	−273.92	−28.8

[a] Current setting: 4 hunting trips per months / 3 patrols per weeks / jail sentence 3 years.
[b] Two-years program. Agro-pack and credit given at the beginning of each year. Cows are given only once at the beginning of the program.

4.1. Donation of agro-input packs

Utility from one hunting trip is equivalent to benefits received from 0.333 agro-packs under current jail and patrol status. This is plausible as an increase in agricultural production beyond subsistence levels improves financial position of respondents, potentially reducing the desire to poach. This was highlighted during FGDs. Kaczan et al. (2013) also report that an upfront organic fertiliser payment was statistically significant in motivating farmer participation in conservation. Johannesen and Skonhoft (2004) also conclude that likelihood of poaching decreased with increasing agricultural activities in Tanzania.

4.2. Access to micro-credit

Benefits from access to micro-credit are equivalent to 0.211 hunting trips per month under current jail and patrol levels. Lack of income to support entrepreneurial activities was the main reason reformed poachers advanced for continued poaching. Kaaya and Chapman (2017) also conclude that micro-credit is a strong complimentary strategy to other wildlife management interventions in Kenya. Assumptions in the hypothetical scenario were that loans would be secured through group lending as a form of collateral to minimize defaults.

4.3. Donation of cows

Utility from one hunting trip is equivalent to benefits received from 0.623 milking cows under current jail and patrol levels. Cows supply income and family proteins. Our results are supported by Nielsen and Meilby (2014) and Moro et al. (2012), who conclude that people would less likely engage in poaching if they had more domestic animals producing dairy and meat products for own subsistence and income generation. Loibooki et al. (2002), also conclude that participation in poaching decreased as wealth in terms of domestic animals owned increased. Their study further reveals that convicts of poaching interviewed were mainly young adult males with low incomes who had few or no livestock.

4.4. Effects of patrolling frequency

FGDs revealed that participants perceived risks of being caught as low due to low patrolling frequency. Model estimates also show decreasing utility from hunting trips when law enforcement is increased through increased patrolling frequency. One additional patrol per week could reduce household's WTA by 34.5%. Our results contrast other study findings reporting that increasing patrolling frequency was not a very strong deterrent (Moro et al.,2012). There are several reasons. First, an increase in patrolling frequencies might be an indicator of "credibility" of patrols. However, if increased probability of being caught only means the payment of "tips" to game scouts, an increase in frequency of patrols would have minimal effects. Jachmann (2008), reports that patrol efficiency vary from place to place where the number of patrols may be a poor indicator of the probability of being caught. Our results suggest that patrols are taken more seriously in the study area than in other places, as was noted during the FDGs. Second, we are likely to find some variability in the attitudes towards patrols, when related to the current wealth status of the respondents. Moro et al. (2012) observe that more well-off hunters are likely to have the financial means to cope with the risk of being arrested.

4.5. Effects of increasing the minimum jail sentence for poaching offenses

Increasing minimum jail sentence appears to decrease marginal utility of hunting, thereby decreasing attractiveness of poaching. This confirms former poaching convicts' observation during FGDs that jail sentences for poaching offenses were relatively shorter than those for other criminal offenses. Similarly, Lindsey et al. (2017) report that one of the key drivers of poaching in developing countries is perceived weak penalty system, where most gazetted punishments for poaching provide inadequate deterrents and often do not reflect the value of resources being destroyed. Increasing jail sentence by an additional year, all else being equal reduces a household's compensation by 14.4%, though at the expense of additional budget for jail management.

4.6. Willingness to accept compensation (WTA) and cost of implementing policy instruments

Table 6 presents different WTA required by respondents to stop hunting. Converting compensation units (agro-packs, cows and credit) into their equivalent USD cost, we found some very important differences ranging from 85 USD to 586 USD per household over a period of two years. This implies that 85 USD given in the form of financial credit would have the same impact as a 586 USD given in the form of agro-input packs. This means a policy based on micro-credit facility to finance non-agricultural activities would be more cost-efficient. However, this could also mean that returns from cows and agro-packs are much less attractive to households in the region. An important conclusion at this stage is that, delivery of a micro-credit services appears to be a least-cost option for reducing poaching.

4.7. Combination of incentives/deterrent mechanisms and property rights

While the current community-based conservation policy is founded on a joint ownership basis of wildlife resources between government and local communities, in principle wildlife property rights and the obligation to protect the resource primarily lies with the state (Ostrom, 2000). As such, the success of conservation largely dependent on the adequacy of perceived community benefits derived from conservation. The right combination of incentives/deterrent interventions will depend on

several considerations, including cost-efficiency, defined as the amount of budget required to obtain a reduction in poaching. Policy makers should balance between incentive/carrot mechanisms (donations, micro-credit) and repressive/stick mechanisms (jail, patrols) that will be cost-effective. The chosen balance will reflect how society perceive the property rights for wildlife resources, where a fully repressive interventions (high jail and patrol frequency) would imply community members have no property rights over wildlife, hence, require compensations to stop poaching. On the other hand, a fully compensation mechanism (with low jail and patrol frequency) would mean households have property rights over wildlife and need not to be compensated to stop poaching. Although findings of this study show that implementing a stronger "sticks" component is expected to yield desired results, its impact is likely to decrease over time, given challenges of implementing such instruments in light of vices like corruption. Therefore, implementation of "carrots" would still be required to complement that of "sticks".

4.8. Combination of incentive/deterrent mechanisms and free riding

The implementation of incentive mechanisms alone may not be sufficient to completely address the problem of poaching due to the possibility of free riding (Van Lange et al., 2013; Lewis, 2006; Stroup, 2000). Indeed, reducing poaching contributes to the creation of a public good (biodiversity, eco-tourism potential, etc.). However, in the absence of adequate control mechanisms, households may well accept the proposed compensations but continue to poach, especially if they perceive a low risk of being sanctioned, and do not perceive the potential benefits of the collective action (Hall and Buzwell, 2013; Bulte et al., 2003; Hampton, 1987). This, therefore, calls for a combination of incentive/deterrent mechanisms. In this paper we have only considered the coercive means that would be applied by the state, i.e., imprisonment. However, other strategies could be tested such as the social control among the community members (Ostrom et al., 2002; Ostrom, 1992). Yet, facilitating collective action still requires the development by communities of an enforcement framework that reduces free riding and ensures compliance with rules and regulations (Jagers et al., 2021). This supposes the ability of local communities to self-define and self-enforce rules to control poaching. Such community enforcement frameworks can in turn lean either towards coercion or towards an approach that tries to encourage compliance through cooperation, co-management, and participation (Keane et al., 2008; Sjöstedt and Linell, 2021). Finally, since traditional leaders may have high legitimacy among their subjects, they also have to be involved in these processes. For example, they may better understand the needs of the communities compared to state representatives that might have problems in being present in these areas on a more permanent basis. These chiefs may also wield significant influence over their subjects, which helps in enhancing social capital and reducing the free rider problem. However, recent literature also suggests that democratic governance within communities tend to improve collective action (Nourani et al., 2021).

Overall, although we have identified the possibility of giving private incentives to farmers to stop poaching, its success are still dependents on finding realistic enforcement mechanisms to address free riding. This is because incentives are more generic and less dependent of community structures, therefore we emphasize enforcement of regulation by the state. As such, further research is needed to determine how other mechanisms developed by the local communities themselves would be more efficient in securing community cooperation (Sjöstedt and Linell, 2021).

5. Conclusion

Our proposed policy interventions have the potential to generate long-term empowerment opportunities for households and create adequate substitution effect to shift their attention from poaching to new interventions under suitable institutional frameworks (van Velden et al., 2020). These interventions incorporate the element of normative value critical for their acceptance and provide for community heterogeneity not common with conventional - one size fits all typical of traditional wildlife conservation programs (Oyanedel et al., 2020).

Effective implementation and replication of the study findings to other contexts will largely depend on the prevalence of corruption and strength of local institutions. This would require addressing factors driving corruption including; lack of transparency and accountability mechanisms; ineffective deterrents; implementing laws and rules that are complex, ambiguous and contradictory; lack of social stigma against corruption; perceptions that some corrupt behaviors are "victimless"; low or irregular renumerations to staff and weak judicial independence (Lindsey et al., 2017; WWF, 2015). The institutional framework in the study area comprise of a relatively weak state regulatory environment due to inadequate enforcement, low levels of corruption among enforcement agencies and complimentary strong traditional/cultural structures guided by strong norms and traditional leadership, recognized by government as overseers in the implementation of conservation policy. Local traditional structures wield significant authority over their subjects with regards to accepted traditional norms and therefore could reinforce state regulation. The above factors greatly influenced how respondents made their choices.

A number of non-material individual and community level factors drive subsistence poaching (Ntuli et al., 2021). Higher incidences of human-wildlife conflicts, low trust among local community members, low respect for existing institutions, not perceiving wildlife as assets, as well as failure to consider conservation of wildlife a good thing are some of them. The impact of these and other cultural, traditional or leadership drivers of poaching in the study area is reportedly low. A unique driver in the study area include hunting to meet the demand for wild animal parts required for medicinal purposes. Although there exists the problem of labelling traditional hunting as poaching (Hitchcock, 2000), our study results reveal that it is the illegal hunting or poaching and not hunting that households are willing to give up.

Our study advances significant contribution towards community-based conservation policy prescription at two levels. First, by investigating poaching under its livelihood context of using basic tools like snares, bows and arrows, in the light of proposed policy instruments, is the first attempt at addressing the problem of poaching in Zambia using a discrete choice experiment. Secondly, by demonstrating the trade-offs in implementation of carrots and sticks, policy makers have the latitude of implementing cost-effective policy instruments in an effective and differentiated manner.

While the maximum attribute levels of 6 cows and 4 agro-packs were consistently demanded both during FGDs and questionnaire testing, given the levels of agricultural land and pastoral activities in the neighborhood, we recommend further investigations on the feasibility of managing such levels of diary animals and agro-inputs on subsistence farms. Future areas of study should also include investigating compensation options that could provide for wildlife-caused damages and the impact of institutional arrangements on the implementation of our proposed policy interventions. The observed impact of interacting terms on poachers' decision to stop poaching also reveal another perspective that require further enquiry. Additionally, research would be required to confirm circumstances under which increase in patrol frequency could reduce desire to poach.

Finally, the research provides the types and amount of compensation that could make poachers adopt new livelihood activities and abandon poaching. As such it considers only the opportunity cost of poaching in the park. However, proposed incentives could have benefits for the communities and the society that we have not accounted for. A more complex approach where poachers will have to consider the accrued public benefits into their decisions should be developed. However, such approach will need to be able to accommodate different community attitudes and compliance mechanisms.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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