LETTER

The Allure of the Illegal: Choice Modeling of Rhino Horn Demand in Vietnam

Nick Hanley[1], Oleg Sheremet[1], Martina Bozzola[2,3], & Douglas C. MacMillan[4]

[1] School of Geography and Sustainable Development, University of St Andrews, North Street, St Andrews, Fife, Scotland
[2] Agricultural Economics and Policy Group, ETH Zurich, Switzerland
[3] Gibson Institute for Land, Food and Environment, Institute for Global Food Security, School of Biological Sciences, Queen's University Belfast, Belfast, UK
[4] DICE, School of Anthropology and Conservation, University of Kent, Canterbury, UK

Abstract

Using choice modeling, we explore willingness to pay for rhino horn among existing and potential future consumers in Vietnam. We find that wild-sourced horn, harvested humanely from the least rare species, is the most highly valued product. Furthermore, consumers are willing to pay less for rhino horn products under a scenario where international trade is legalized compared to the current situation of illegal trade. We discuss the potential implications of our findings on rhino poaching and international trade policy.

Introduction

Poaching remains a critical threat to the survival of many species worldwide, including tiger and rhino (Milliken & Shaw 2012; Saif *et al*. 2016). The global conservation community, working through international bodies such as CITES, is committing significant resources to the fight against poaching as well as demand reduction measures (CoP16; Decision 16.85, 2013). However, serious question marks remain concerning the effectiveness of current approaches and policies, as poaching rates and demand for animal parts, especially those used in traditional Asian medicine, remain stubbornly high (Challender & MacMillan 2014; Olmedo *et al*. 2017).

Crucial aspects of the demand and supply for wildlife parts used in traditional medicine (TM) remain poorly understood (Collins *et al*. 2013). In this article, we explore demand for rhino horn in Vietnam deploying a choice experiment (CE) to estimate willingness to pay (WTP) for rhino horn with different attributes. In traditional Asian medicine, rhino horn is prescribed for a variety of ailments and conditions including fever and alcohol poisoning, and is greatly valued as a gift in family and business circles in Vietnamese society (Biggs *et al*. 2013). Our sample was drawn from 857 Vietnamese citizens who have purchased or who expressed an interest in purchasing rhino horn for medicinal use, and is the largest survey conducted to date with these consumer groups.

The CE method has been used to investigate consumer demand for illegally hunted wildlife products, in the context of rural households in Tanzania for reducing consumption of bushmeat (Moro *et al*. 2015); to estimate the

Table 1 Attributes and levels used in the CE design

Attribute	Levels and description
Source	3 levels (*farmed*, *semiwild*, or *wild*)
Rarity of rhino species	3 levels (*very rare*, *rare*, and *not rare*): *very rare* – less than 100 of these species in the wild; *rare* – less than 5,000 animals of these species left in the wild; *not rare* – more than 10,000 animals of this species left in the wild
Harvesting method	2 levels (*lethal* and *nonlethal*)
Price ($US per 100 g)	8 levels (*1,200; 2,400; 3,600; 4,800; 6,000; 7,200; 8,400; 9,600*)

willingness of illegal bushmeat hunters in Tanzania to reduce time spent hunting (Moro *et al.* 2013), in the demand for bushmeat in Vietnam (Shairp *et al.* 2016); and the demand for bear bile (Dutton *et al.* 2011). CEs are particularly well-suited to investigate the demand for illegally obtained wildlife products as data on actual consumption preferences is hard to acquire because of their illegal nature and presenting hypothetical choices avoids the need to interrogate about actual use.

Methods

CEs are now applied extensively in environmental policy contexts (Johnston *et al.* 2017). The method assumes that choices about a good such as rhino horn can be described using a set of product attributes such as provenance and cost, as well as attributes that describe the individual making these choices. It is also assumed that individuals are willing to trade off having more of one desirable attribute against less of another desirable attribute; and to trade off all product attributes against the price of that product. The attributes and levels, once selected typically using focus groups of the target population, are combined into choice sets using experimental design procedures (Rose & Bliemer 2009). Each individual in the survey responds to a sequence of choices and then statistical modeling is used to infer the preferences for each attribute: importantly, these preferences can be expressed in terms of WTP using the parameter estimates for the cost attribute.

Our experimental design was based upon four attributes of rhino horn products and their associated levels (Table 1). The attributes describe three sources of rhino horn; whether rhinos are killed or not to obtain the horn; the rarity of the rhino species from which the horn is obtained; and the price to consumers in Vietnam. This design was identified following interviews with 18 TM practitioners in Vietnam and validated with 48 pilot interviews. The price range used was based on information acquired during a field visit to Vietnam, during which

contemporary price range information was collected from local experts and TM specialists and compared to prices quoted in the academic literature and local press. Price levels used in the experimental design were then finalized following the pilot study.

In the main survey, each respondent was presented with eight choice sets involving three choices (Product A, Product B, or neither) as shown in Figure 1. Sampling was targeted at current and potential rhino horn users, identified from the following question: "Is it possible that you may purchase rhino horn in the future?" Respondents could choose from five possible responses: definitely yes; probably yes; don't know; probably no, and definitely no. Those in the last category were not invited to continue to the CE section of the survey.

Respondents were equally divided into two treatments in order to explore the possible impact of legalizing trade, with every second respondent asked to consider a scenario where a regulated legal trade in rhino horn was allowed, while the other half made choices under the status quo of continuing illegal trade. Although they were given the option to opt out of the CE if they did not accept it/believe it, none of the interviewees rejected their assigned scenario. The CE was preceded by four sections: Section 1 covered general use of TMs; Section 2 explored use of rhino/pangolin TM use; Section 3 asked about purchase of rhino horn/pangolin TM. A final section covered questions about responses to various possible demand reduction interventions, and socioeconomic questions. The full survey involved face-to-face interviews during 2016 with Vietnamese citizens, and was conducted by a local company in the Vietnamese language.

Due to the sensitive nature of the subject, interviewees were recruited via 18 experts in traditional Asian medicine who acted as key informants, with subsequent interviewees identified using the snowball sampling technique (Vogt 1999; Newing *et al.* 2011). Hence, our sample was not a random draw from the (unknown) population of current purchasers of illegally sourced rhino horn products since this was not feasible, given the small percentage to rhino horn users and the sensitive nature of the survey.

Results

A total of 857 respondents completed the CE component. Excluding those respondents who always selected the "Neither A nor B" option, the sample contained 5,120 choice observations, of which Option A was selected in 38% of cases, Option B in 44%, and "Neither A nor B" in 18% of responses. As Table 2 shows, the full sample consists of predominantly young adults, as over half of

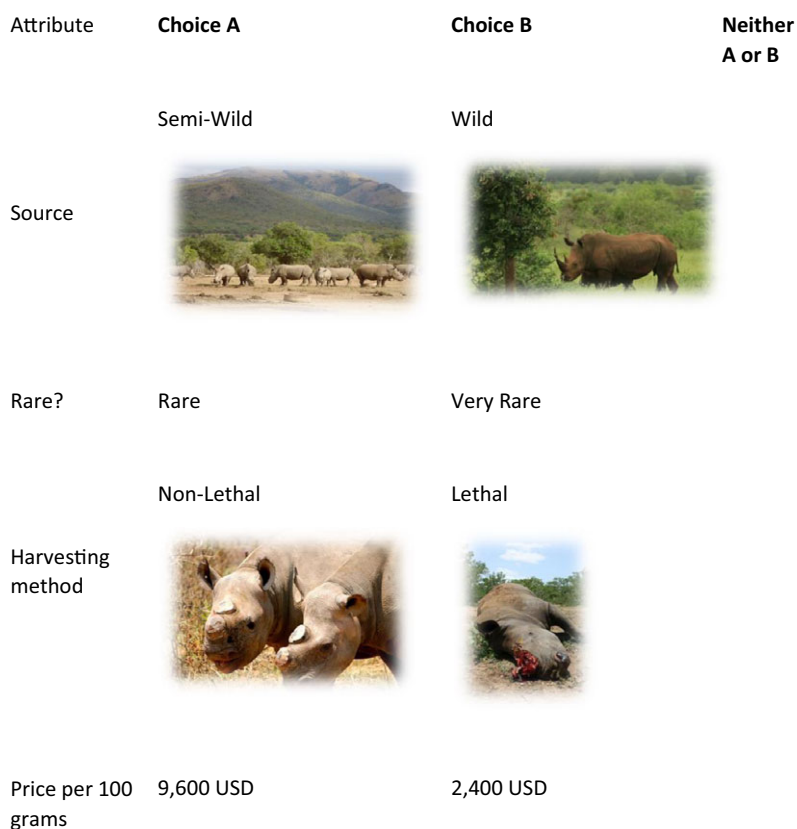| Attribute	**Choice A**	**Choice B**	**Neither A or B**
Source	Semi-Wild	Wild	
Rare?	Rare	Very Rare	
Harvesting method	Non-Lethal	Lethal	
Price per 100 grams	9,600 USD	2,400 USD	

Figure 1 Example of choice card used in the experiment.

all respondents were under the age of 29 (56%), with 72% under the age of 39. The modal age category is 18–28 and the mean within the 29–38 age category. This is similar to the Vietnamese population as a whole, where the mean is 30 years (Statistics Vietnam 2016). About half of the respondents (47%) have a university degree, with a further 8% qualified at postgraduate level. Personal income ranged from less than 3 million to over 20 million VND per year. Mean income across the whole sample was estimated at between VND 5–10 million,

Table 2 Sociodemographic characteristics of the sample

Characteristics	Sample	Illegal trade scenario subsample	Legal trade scenario subsample	Population
Number of respondents	857	440	417	
Female share	0.61	0.59	0.62	0.50
Age (years):				
Modal (range)	18–28	18–28	18–28	
Mean (range)	29–38	29–38	29–38	30.4
Share of respondents with a university degree	0.47	0.52	0.43	
Income (million VND):				
Mean (range)	5–10	5–10	5–10	2.64
Median (range)	3–5	3–5	3–5	
Shares of respondents with respect of using TM:				
Those who used animal-based TM	0.84	0.83	0.85	
Those who used or purchased rhino horn-based TM	0.28	0.26	0.31	
Those who purchased rhino horn-based TM	0.18	0.15	0.21	
Those who highly probably will buy rhino horn-based TM	0.51	0.48	0.53	

which is much higher than the average income for Vietnam (VND 2.64 million), but in line with Hanoi and Ho Chi Minh cities where most of the interviews were conducted (VND 6.7 million and VND 9.6 million). According to their statements, 719 (84%) respondents had used animal-containing TM, including 244 (28%) who had either used or purchased TM that contained rhino horn. Moreover, 433 (51%) said that it was highly probable that they would buy rhino horn-containing TM in the future. According to results of the Pearson's chi-square test for equality of proportions, the legal/illegal trade subsamples appear to be broadly similar, with only significant differences in the two groups for the percentage with a university degree (0.52 vs. 0.43, $P = 0.007$) and the percentage who had previously purchased rhino horn-based TM (0.15 vs. 0.21, $P = 0.048$). Although there was a higher overall percentage of females in our sample (61%), males formed the majority of users of TM containing rhino horn (54%).

We estimated several discrete choice models, including random parameters logit (RPL) and latent class random parameters (LCRP), with or without interactions with sociodemographic variables (Table 3). In the RPL model, respondents are modeled as having a mean preference for each attribute with an estimated standard deviation representing the variation in tastes across the sample. In the latent class model, individuals can be grouped into latent classes. Within each latent class, people have more similar preferences than they do with people who are more likely to belong to other latent classes. This latent class structure is combined with the random parameters idea in the LCRP model.

In the best fit RPL model (judged on the AIC/n criterion), with dummy variables corresponding to attribute levels, we find that the variability of attribute coefficient mean values is significantly explained by demographic variables (gender, age, education, and income); being a current buyer of TM with rhino horn; and the purchase scenario (legal/illegal trade). The rhino horn attributes that are significant for explaining choices are price (with demand declining with increases in price); rhino horn source, with respondents having a positive preference for wild rhino compared to farmed rhino; and rarity, with consumers on average preferring "nonrare" species over "very rare."

In the LCRP model, demographic variables partly determine latent class membership probabilities. For Class 1 members, who constitute about 33% of the sample and are more likely to have lower incomes, price is the only important attribute. Class 3 members, who tend to be better educated, have higher incomes, and more likely to have purchased rhino horn in the past (70% of all rhino horn product buyers are in this class), pre-

fer horn from "rare" over "very rare" species, and prefer nonlethal over lethal harvesting. They also prefer wild-sourced horn over semiwild or farmed varieties. Across all three latent classes, price was significant but compared to the RPL model, we observe more variability in size and significance of the mean attribute coefficients across classes.

WTP for different combinations of the attributes[1] under a legal or illegal trade scenario was estimated from the preference parameters and the price parameter (Table 3) from the RPL model, are reported in Table 4. These product type values represent the overall average values of survey respondents, after taking into account the variables that statistically influenced choices. We observe similar variation for different rhino horn "product types" under both legal and illegal trade scenarios. Product types 1 and 2 are equivalent to horn from poached animals, and have a lower WTP than horn with the characteristics of a supply from ranched (type 4) and farmed (type 5) horn. Horn obtained from wild animals through nonlethal harvesting (type 3) has the highest overall WTP. Importantly, across all horn types, the most consumers are willing to pay for legally traded horn is around 60–70% of their maximum WTP for an equivalent illegal horn product. These tendencies are also clearly observable in WTP calculations when only those respondents who had previously purchased rhino horn products are considered and the statistical significance of this result was confirmed by a Swait-Louviere test on the two subsamples, which rejected the null hypothesis that the preference parameters for rhino horn product attributes in the legal and illegal trade scenarios were equal.

Discussion

Our consumers tend to prefer wild horn over semiwild or farmed products, which may reflect a more general tendency in TM that associates wild-sourced products with greater power and/or effectiveness (Gratwicke *et al.* 2008). However, the finding that our sample strongly prefer horn acquired from nonlethal harvesting has not been reported previously and suggests that horn sourced humanely from living rhinos would attract a premium in the market.

Although trade bans are known to increase prices and stimulate clandestine hunting (Rivalan *et al.* 2007; MacMillan & Han 2011), our study is the first to show that legalization would reduce consumer WTP. This finding gives credence to the notion that rare and illegal wildlife products such as rhino horn and pangolin may be especially sought after by consumers because they are illegal: both consumption and gift-giving can generate

Table 3 Estimation results for RPL and LCRP models with attribute-level dummy variables and demographic variables

	RPL	LCRP		
		Class 1	Class 2	Class 3
ASC	−4.950*** (1.470)	3.412*** (0.871)	−4.473*** (0.349)	0.152 (0.286)
Semiwild	0.091 (0.143)	−0.026 (1.004)	−0.016 (0.087)	−0.410* (0.211)
Farmed	−0.303*** (0.111)	−0.166 (0.806)	−0.048 (0.120)	−0.702*** (0.204)
Rare	−0.120 (0.083)	0.868 (0.656)	−0.277** (0.122)	0.721*** (0.233)
Not rare	0.109* (0.059)	0.113 (0.856)	0.009 (0.078)	0.228 (0.185)
Nonlethal	0.120 (0.462)	0.597 (0.173)	0.096 (0.123)	1.203*** (0.209)
Price (in $US 1,000)	−0.099*** (0.017)	−0.678*** (0.173)	−0.041*** (0.016)	−0.169*** (0.032)
ASC × legal	0.160 (0.607)	−1.176 (0.848)	−1.182*** (0.351)	0.127 (0.373)
ASC × buyer	−0.227 (0.798)	−2.347*** (0.700)	4.544*** (0.462)	−6.596*** (0.842)
ASC × income	−0.213*** (0.042)			
ASC × education	0.850*** (0.266)			
Semiwild × legal	−0.141 (0.121)	−0.816 (0.937)	−0.208* (0.124)	−0.231 (0.279)
Semiwild × buyer	0.337** (0.155)	−0.224 (0.729)	0.664*** (0.174)	−0.990* (0.512)
Semiwild × age	−0.010** (0.004)			
Farmed × Legal	−0.446*** (0.155)	−1.225 (0.767)	−0.541*** (0.166)	−0.053 (0.264)
Farmed × buyer	−0.320 (0.226)	−0.121 (0.671)	0.590*** (0.213)	−1.435*** (0.433)
Rare × legal	−0.018 (0.169)	−0.619 (0.673)	0.559*** (0.181)	−0.750** (0.321)
Rare × buyer	−0.204 (0.252)	−0.122 (0.577)	−0.077 (0.244)	−1.184** (0.554)
Not rare × legal	0.034 (0.104)	1.453* (0.845)	0.025 (0.109)	−0.096 (0.239)
Not rare × buyer	−0.458*** (0.124)	−0.530 (0.671)	0.057 (0.146)	−1.977*** (0.355)
Nonlethal × legal	0.402 (0.218)	0.813 (0.616)	−0.186 (0.182)	−0.187 (0.285)
Nonlethal × buyer	0.748*** (0.283)	−1.472*** (0.557)	1.942*** (0.263)	−2.534*** (0.542)
Nonlethal × income	−0.043** (0.020)			
Nonlethal × education	0.145* (0.084)			
Price × legal	−0.081*** (0.022)	0.100 (0.164)	−0.118*** (0.024)	0.060 (0.042)
Price × BUYER	−0.070** (0.028)	0.245** (0.123)	0.015 (0.037)	−0.121** (0.053)
SD (SQ const.)	7.159*** (0.442)	0.0004 (0.098)	0.0004 (0.115)	0.0005 (0.067)
SD (Semiwild)	0.391*** (0.131)	0.0015 (0.227)	0.0005 (0 .051)	0.0003 (0.104)
SD (Farmed)	0.863*** (0.159)	0.0002 (0.188)	0.0002 (0.069)	0.0021 (0.096)
SD (Nonlethal)	1.845*** (0.145)	0.0002 (0.117)	0.0009 (0.068)	0.0004 (0.077)
SD (Price)	0.152*** (0.017)	0.0012 (0.027)	0.0001 (0.007)	0.0002 (0.011)
Pr(class)		0.327	0.496	0.178
Pr(class) × female		−0.094 (0.261)	−0.421* (0.246)	
Pr(class) × age		−0.014 (0.009)	−0.020** (0.009)	
Pr(class) × income		−0.053** (0.026)	0.004 (0.024)	
Pr(class) × education		−0.379*** (0.130)	−0.483*** (0.126)	
Nr of observations	5120		5120	
Pseudo R2	0.3759		0.3800	
LogLik	−4,700.6568		−4,669.7466	
AIC/n	1.378		1.390	

Notes: 1. The baseline attribute levels are wild, very rare, and lethal, and dummies for these are not included in the model.

2. Standard errors of the estimates are provided in parentheses.

***, **, * indicate significance at 1%, 5%, 10% level.

social esteem and status in Vietnamese society (Shairp *et al*. 2016). We note that drug enforcement efforts have had similar difficulty confronting the consumption of other banned substances such as cocaine (Chand & Califano 2007).

Our results relate solely to a legalized but regulated market. If both legal and illegal markets were to persist after trade was legalized, then the incentives for illegal hunting would depend on the relative price in legal and illegal markets. While there is a possibility that legally sourced rhino horn may encourage a significant number of Vietnamese consumers to purchase rhino horn for the first time, especially if incomes continue to rise rapidly, our results offer initial evidence that the provision of

Table 4 WTP for different rhino horn products under legal and illegal CE scenarios (per 100 g of product) estimated for whole sample and for respondents who had previously purchased rhino horn TMs

Product type	Whole sample (n = 857)			Rhino TM buyers (n = 154)		
	Illegal trade scenario	Legal trade scenario	P-values for difference	Illegal trade scenario	Legal trade scenario	P-values for difference
1: Wild, least rare, lethal (equivalent to poached white rhino)	19,890 (12,630–29,920)	11,910 (6,480–18,070)	0.044	11,610 (4,760–20,630)	8,060 (2,860–14,650)	0.125
2: Wild, very rare, lethal	19,830 (12,600–29,710)	11,690 (6,730–18,160)	0.040	13,220 (6,270–22,700)	9,120 (3,890–15,840)	0.097
3: Wild, least rare, nonlethal	24,300 (16,290–35,660)	16,900 (11,410–23,920)	0.082	17,410 (9,470–17,540)	13,900 (8,070–21,710)	0.152
4: Semiwild, least rare, nonlethal	23,100 (15,280–33,930)	15,370 (9,870–22,340)	0.066	18,200 (10,280–30,310)	13,930 (8,090–21,560)	0.111
5: Farmed, least rare, nonlethal	21,670 (13,630–33,060)	12,780 (7,350–19,560)	0.044	14,390 (6,770–25,890)	9,920 (4,080–17,120)	0.098
6: Farmed, least rare, lethal	17,250 (10,050–26,820)	7,790 (2,700–13,920)	0.021	8,590 (1,860–17,230)	4,080 (0.0–10,390)	0.070

Notes: 1. The three attribute levels specified for each product type are used to derive WTP measures from the preference parameters in Table 3, in conjunction with the parameter on the price of rhino horn.

2. The estimates are based on the RPL model with attribute level dummies and attribute–demographic variable interactions. The 95% confidence intervals provided in parentheses are calculated using the Krinsky-Robb procedure.

3. Significance of differences between mean WTP values for illegal and legal trade scenarios is tested using the Poe *et al.*, (1997, 2005) test.

an alternative legal supply humane harvesting from live animals may significantly displace poaching activity. As has been the case with crocodilians (MacGregor 2006; Moyle 2013), the introduction of a legal trade would depress prices for illegal supplies because: (1) any price premium due to its illegal nature (allure factor) would be diminished; (2) consumers prefer horn obtained humanely from live animals; and (3) the introduction of significant substitute supplies of legally sourced horn would in itself depress prices. However, we should note that any displacement effect will also depend on supply-side responses and the effectiveness of enforcement measures and any system of certification that is introduced (Biggs *et al.* 2013). We are also unsure about whether the preferences of rhino horn products in Vietnam are representative of the preferences of rhino horn consumers in other countries such as China. Further research is therefore required to explore the full economics of rhino horn production under a legalized trade scenario to establish whether a residual market in illegally hunted rhino horn products would remain, and at what scale.

The global community has focused on two measures to counter rhino horn illegal trade and to curb poaching: supply-side trade restrictions (e.g., antipoaching measures, import seizures, etc.) and demand reduction. We investigated, through additional questions in our survey, possible responses to three alternative approaches to reduce demand: the release of government-backed media campaigns; doubling existing financial penalties for purchasing rhino horn; and the risk of incurring a 6-month prison sentence. We also investigated this through in-depth interviews with 18 rhino horn suppliers, including representatives of traditional hospitals, private pharmacies, and individuals who sell rhino horn. In our responses only 3% of rhino horn TM users surveyed declared that they consumed less because of media campaign, and this low response rate was confirmed by the specialists' interviewed. In Vietnam, several organizations have already conducted information campaigns to inform citizens of rhino horn's lack of medicinal value. However, the majority of our respondents reported that stronger penalties such as imprisonment or heavy fines for purchasing rhino horn would be more of a deterrent than information campaigns alone. This result supports the conclusions of recent research highlighting the need for law enforcements to complement campaigns (Olmedo *et al.* 2017).

Although our study represents the only major study of rhino horn demand that interviews rhino horn users directly, it is important to stress that our sample was not a random draw from the (unknown) population of users and purchasers of illegally sourced rhino horn products, since that population is unidentified, and may therefore not be representative of the wider population of buyers. Moreover, we may not have adequately sampled people who do not currently purchase and/or buy rhino horn products, but who would if trade was legalized. Both of these sampling biases would need to be taken into account in any attempt to aggregate up demand effects.

As with all surveys of illegal goods there is always the possibility that some respondents may not have answered truthfully. However, the motivation for hiding consumption from the interviewer is perhaps lower than in other contexts, because there is little or no social stigma attached to consumption of TM products in Vietnam as consumers often have little to fear from laws to protect wildlife (Shairp *et al.* 2016). However, in addition to normal measures to encourage honest responses (e.g., confidential and anonymous interview guarantees), we asked a number of questions for cross-checking purposes. Furthermore, the use of the snowball sampling technique helps generate additional trust between the interviewer and interviewee as the latter has been recruited by a trusted associate or acquaintance (Newing *et al.* 2011).

We cannot exclude the possibility that some respondents behaved strategically for other reasons. For example, current buyers might want to signal a desire for lower prices in the case of the legal provision scenario (Carson and Groves 2007); or might overstate their WTP in order to impress the interviewer. For example, in Table 4, WTP estimates for current rhino horn buyers are significantly lower than the calculations for the pooled sample and it may be that current buyers considered affordability more closely than nonbuyers. We are not able to explicitly test for other possible strategic behaviours in the choice data.

Given the uncertainty about the future success of demand reduction campaigns and other enforcement efforts in Asia (Challender & MacMillan 2014), where consumption is shaped by a complex array of factors such as personal preferences, family and community tradition, and business culture (Lee 1998), we suggest that the international community should be open at least to exploring some of the issues raised by our research. Legalized, regulated trade could re-establish interest in a sustainable wildlife management models that generate significant revenues to poor rural communities in Africa. This would help to offset the costs of conserving rhinos and other species in the wild, including the costs of reducing poaching and the opportunity costs of species conservation to local people (Cooney *et al.* 2015; Di Minin *et al.* 2015).

Acknowledgment

thank two anonymous referees and the editor for very helpful comments.

Endnote

1. WTP for a particular product is measured relative to the "no purchase" option and it is calculated as a sum of the relevant marginal utilities corresponding to the model's coefficients (after accounting for all interactions).

References

Biggs, D., Courchamp, F., Martin, R. & Possingham, H.P. (2013). Legal trade of Africa's rhino horns. *Science*, **339**, 1038-1039.

Carson, R.T. & Groves, T. (2007). Incentive and informational properties of preference questions. *Environ. Resourc. Econ.*, **37**(1), 181-210.

Challender, D.W.S. & MacMillan, D.C. (2014). Poaching is more than an enforcement problem. *Conserv. Lett.*, **7**(5), 484-494.

Chand, K. & Califano, K.A. (2007). Should drugs be decriminalised? *Brit. Med. J.*, **335**(7627), 966-977.

Collins, A., Fraser, G. & Snowball, J. (2013). Rhino poaching: supply and demand uncertain. *Science*, **340**, 1167.

Cooney, M.R, Kasterine, A., MacMillan, D.C. *et al.* (2015). *The trade in wildlife - a framework to improve biodiversity and livelihood outcomes*. ITC, Geneva.

CoP16; Decision 16.85 (2013). Convention on International Trade in Endangered Species of Wild Fauna and Flora. Sixteenth Meeting of the Conference of the Parties. Bangkok, Thailand, March 03-14, 2013. https://cites.org/eng/cop/index.php. Accessed 31 May 2017.

Di Minin, E., Laitila, J., Montesino-Pouzols, F., Leader-Williams, N. & Slotow, R. (2015). Identification of policies for a sustainable legal trade in rhinoceros horn based on population projection and socioeconomic models. *Conserv. Biol.*, **29**(2), 545-555.

Dutton, A.J., Hepburn, C. & Macdonald, D.W. (2011). A stated preference investigation into the Chinese demand for farmed vs. wild bear bile. *PLoS ONE*, **6**, e21243.

Gratwicke, B., Mills, J., Dutton, A. *et al.* (2008). Attittude toward consumption and conservation of tigers in China. *PLOS ONE*, **3**, e2544.

Johnston, R.J., Boyle, K.J., Adamowicz, W. *et al.* (2017). Contemporary guidance for stated preference studies. *J. Assoc. Environ. Resourc. Econ.*, **4**(2), 319–405.

Lee, S. (1998). *Attitudes of Hong Kong Chinese towards wildlife conservation and the use of wildlife as medicine and food*. TRAFFIC East Asia, Hong Kong.

MacGregor, J. (2006). *The call of the wild: captive crocodilian production and the shaping of conservation incentives*. TRAFFIC International, Cambridge, UK.

MacMillan, D. & Han, J. (2011). Cetacean by-catch in the Korean peninsula by chance or by design? *Hum. Ecol.*, **39**, 757-768.

Milliken, T. & Shaw, J. (2012). *The South Africa – Viet Nam rhino horn trade nexus: a deadly combination of institutional lapses, corrupt wildlife industry professionals and Asian crime syndicates*. TRAFFIC, Johannesburg, South Africa.

Moro, M., Fischer, A., Czajkowski, M. *et al.* (2013). An investigation using the choice experiment method into options for reducing illegal bushmeat hunting in western Serengeti. *Conserv. Lett.*, **6**(1), 37-45.

Moro, M., Fischer, A., Milner-Gulland, E.J., Lowassa, A., Naiman, L.C. & Hanley N. (2015). An investigation of the determinants of household demand for bushmeat in the Serengeti using an open-ended choice experiment. *Anim. Conserv.*, **18**(4), 377-386.

Moyle, B. (2013). Conservation that's more than skin-deep: alligator farming. *Biodivers. Conserv.*, **22**, 1663-1677.

Newing, H., Eagle, C.M., Puri, R.K. & Watson, C.W. (2011). *Conducting research in conservation: a social science perspective*. Routledge, Abingdon, UK.

Olmedo, A., Sharif, V. & Milner-Gulland, E.J. (2017). Evaluating the Design of Behavior Change Interventions: A Case Study of Rhino Horn in Vietnam. *Conserv. Lett.*, https://doi.org/10.1111/conl.12365.

Poe G.L., Welsh, M.P., Champ, P.A. (1997). Measuring the difference in mean willingness to pay when dichotomous choice contingent valuation responses are not independent. *Land. Econ.*, **73**, 255-267.

Poe, G.L., Giraud, K.L., Loomis, J.B. (2005). Computational methods for measuring the difference of empirical distributions. *Am. J. Agr. Econ.*, **87**, 353-365.

Rivalan, P., Delmas, V., Angulo, E. *et al.* (2007). Can bans stimulate wildlife trade? *Nature*, **447**, 529-530.

Rose, J.M. & Bliemer, M.C.J. (2009). Constructing efficient stated choice experimental designs. *Transport Rev.*, **29**, 587-617.

Saif, S., Rahman, H.M.T. & MacMillan, D.C. (2016). Who is killing the tiger (Panthera tigris) and why? *Oryx*, 1-9. https://doi.org/10.1017/S0030605316000491.

Shairp, R., Veríssimo, D., Fraser, I., Challender, D. & MacMillan, D. (2016). Understanding urban demand for wild meat in Vietnam: implications for conservation actions. *PLoS ONE*, **11**(1), e0134787.

Statistics Vietnam (2016). Data by the General Statistics Office of Viet Nam. https://www.gso.gov.vn/Default_en.aspx?tabid=491. Accessed 31 May 2017.

Vogt, W.P. (1999). *Dictionary of statistics and methodology—a nontechnical guide for the social sciences*. London, Sage.