Original Research Article

An updated analysis of the consumption of tiger products in urban Vietnam

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ARTICLE INFO

ABSTRACT

Tigers are indisputably in danger of extinction due to habitat loss and demand for their parts. Tigers are extirpated in the wild from every country bar one in mainland East and Southeast Asia. Although consumption of tiger products is known to be established in China, less is known about demand for tiger products in Southeast Asia. In this study, we investigate tiger product demand in Vietnam, a major illegal wildlife consumer country. There has been little research into consumption, in particular the level of use, the products being consumed, variation in use of products between areas, and the motivations of consuming tiger products. Through a quantitative survey of 1120 individuals, we show that use of tiger products could be as high as ~11% of the sample in both urban centers of Vietnam, Hanoi and Ho Chi Minh City. Tiger bone glue is the predominant product used, for medicinal purposes. In Hanoi, it is generally purchased by the individual for self-use, while in Ho Chi Minh City it is generally purchased as a gift. In both cities, individuals were generally highly satisfied with the product, indicating entrenched belief in efficacy among consumers. Ultimately, our results show that tiger product use is relatively pervasive. We suggest that conservation organizations should focus on behavior change campaigns that are informed by the results here, and that are specific to each area and to the specific use of tiger product glue for medicine. By reducing demand, beleaguered tiger populations will have a greater chance of stabilization and eventual growth.

1. Introduction

Vietnam has become a significant wildlife consumer country, in part due to increasing overall wealth (e.g. Dang Vu and Nielsen, 2018 and Olmedo et al., 2018). Although wildlife does continue to be exported out of the country, the scale of wildlife consumption in Vietnam points to a wide and sufficiently affluent internal market (e.g. Cao and Wyatt, 2012, Davis et al., 2019a, Nguyen et al., 2010, and Sandalj et al., 2016). The scale of consumption within Vietnam in turn has spurred

significant focus on Vietnam by researchers and practitioners in illegal wildlife trade (IWT). A significant focus of IWT researchers working in and/or "on" Vietnam has been on rhino horn, with a slew of recent studies investigating characteristics of consumption (Dang Vu and Nielsen, 2018), possible methods of consumption mitigation (e.g. Hanley et al., 2018), and evaluations of rhino horn demand reduction campaigns in the country (e.g. Olmedo et al., 2018). Wild meat consumption has also been a significant focus (e.g. Drury, 2009, 2011; Shairp et al., 2016), as has the rapid and alarming decline in pangolins, mostly to fuel wild meat consumption and medicine (e.g. Aisher, 2016; Harrington et al., 2018; Heinrich et al., 2016; Shairp et al., 2016). Vietnam has also been a large focus of bear conservation due to the rapid decline in bear populations (Crudge et al., 2016; 2018), with levels of bear bile consumption still at alarmingly high levels (Davis et al., 2019a). Cataloguing all of the wildlife in Vietnam that is threatened and ensnared in IWT is beyond the scope of this article; consequently, this article is focused on the understudied consumer dynamics of tiger part consumption.

Wild tiger populations have declined by about 50% globally over the past twenty years (Goodrich et al., 2015). This decline has been partially driven by the illegal wildlife trade (IWT) of tiger parts, which are internationally traded and consumed, with both China and Vietnam identified as major consumer countries (Goodrich et al., 2015; Nowell, 2010; Stoner et al., 2016; Wong, 2015), so much so that tigers are "gravely imperilled by black market demand" (Goodrich et al., 2015). Border countries like Lao PDR (hereafter Laos) and Myanmar have been identified as wildlife 'supply' areas for the Chinese market (Krishnasamy et al., 2018; Nijman and Shepherd, 2015), although less is known about trade from and within Vietnam. Due to widespread illegal and legal hunting in Vietnam, tigers are likely extirpated from the wild (Goodrich et al., 2015), as they probably are in the neighboring countries of China and Cambodia (Stoner et al., 2016). In Lao PDR, a beleaguered 'population' of two tigers was detected in 2013, but it is highly probable that intensive poaching pressure has caused their extirpation (Rasphone et al., 2019). More generally, there is continued extirpation of tigers across the Southeast Asian region and uncertain futures for tigers throughout other areas of South Asia, such as India and Bangladesh (e.g. Aziz et al., 2017 and Kolipaka et al., 2018).

Tigers are largely consumed for medicinal purposes in both China and Vietnam (Drury, 2011; Nowell, 2010), although their skins are also a desirable commodity (Stoner et al., 2016). China is known to have a preference for tiger bone glue, which is a medicinal product made from boiled tiger bones, with the boiling process turning the bones into a sticky, thick "glue" (Nowell, 2010). This product is also consumed in Vietnam (Drury, 2011; Stoner et al., 2016), although to date there have been no estimates of the prevalence of use there. Fake tiger bone glue (which is bone glue made from other animals besides tigers) are known to be widespread in the tiger part medicine trade in China (Nowell, 2010), although the prevalence of fakes in the Vietnamese market is largely unknown. Stoner et al. (2016) argue that Russian tigers are a major supply for Vietnam, although they note that lion bones, likely from South Africa (e.g. Coals et al., 2019) have been found in Vietnam as substitutes for genuine tiger bone. Jaguar bone glue is also beginning to be found in China (e.g. Lemieux and Bruschi, 2019), and it could be filtering into Vietnam as well.

Greater enforcement is needed to effectively conserve the remaining wild tiger populations; however, even increased enforcement measures can fail when confronted with the ubiquity of poaching and snaring throughout Southeast Asia (Gray et al., 2018; Rasphone et al., 2019). This has been unfortunately exemplified by the plight of the remaining tigers in Nam Et Phou Louey National Protected Area (NEPL). They were made the focus of the conservation measures, specifically greater enforcement and patrolling, enacted by the park management. Nonetheless, it is likely they were poached (Rasphone et al., 2019), and it is strongly probable that their bodies and subsequently their parts were funnelled either up to China or over to Vietnam through Lao PDR's porous border (e.g. Environmental Investigation Agency (EIA), 2015).

Demand for tiger parts, therefore, is overcoming the capabilities of many parks and conservation organizations working to enforce protections of the remaining tigers in the wild. The fate of the tigers in NEPL strongly indicates that demand reduction initiatives must be implemented in high consumption countries such as China and Vietnam. Effective demand reduction initiatives necessitate an understanding of the extent of the consumptive behavior in question, the motivations behind the behavior, and what individuals are likely to be performing the behavior (Kanagavel et al., 2014; Veríssimo et al., 2012; Veríssimo, 2013). Without such an understanding of the consumers, demand reduction initiatives can be ineffective (Olmedo et al., 2018 and Dang Vu and Nielsen, 2018). At the same time, obtaining such an understanding is challenging when the product in question is illegal. Specialized questioning techniques (SQTs), for example, are increasingly being used to obtain accurate understandings of wildlife consumption behaviors (e.g. Davis et al., 2019b and Ibbett et al., 2017), by overcoming biases from respondent deceit. In this study, we employ the SQT of Unmatched Count Technique (Olmedo Castro et al., 2019 and Nuno and St. John, 2015) to attempt to gain an accurate picture of tiger product use in urban Vietnam.

Beyond obtaining simple prevalence estimates, it can also be challenging to gain a complete understanding of motivations for consuming wildlife products. Respondents themselves may not know, or be able to articulate, exactly what compels them to use a product. For example, in Laos bear bile may be taken in social settings with friends, which is maintained by the powerful motivator of social approval; yet, the respondents themselves may state rather vague medicinal motivations of "fatigue" mitigation (Davis et al. forthcoming). Beyond such underlying motivations, a plethora of motivations may also work together. Dang Vu and Nielsen (2018) show this in their study on Vietnamese use of rhino horn, where respondents would mention a combination of motivations including familial obligations, psychological peace of mind, and practicality.

Despite these challenges, there is a great need for reducing the demand for illegal wildlife products. Across the Southeast Asian region many animal populations are in continued decline (e.g. Brook et al., 2014; Gray et al., 2018; Harrison et al., 2016),

despite decades of work by conservation organizations and government agencies. A variety of factors have contributed to a lack of overall success, including lack of governmental buy-in and/or corruption (e.g. Wyatt et al., 2018), as well as a lack of research, and a lack of robust evaluation of "awareness-raising"/behavior change campaigns (e.g. Milner-Gulland et al., 2018; Greenfield and Veríssimo, 2019). Although it is not within the bounds of this paper to address corruption or evaluate the success of conservation initiatives, we do attempt here to provide a clear view of tiger product use in Vietnam, which can in turn provide clarity on tiger conservation priorities within the country.

In this study, we focus on the two urban centers of Vietnam, Hanoi (in the north) and Ho Chi Minh City (in the south). Both cities continue to have high documented high wildlife consumption (Davis et al., 2019a; Shairp et al., 2016), despite decades of work by conservationists to reduce demand for wildlife products (e.g. ENV, 2015). With the recognition that effective behavior change will not be possible without a full understanding of consumer characteristics, this study's aims are to provide an analysis of the motivations and behaviors of consumers of tiger products, which can be used to inform well-designed and evaluated demand reduction initiatives around the consumption of tiger products in urban Vietnam.

2. Methods

2.1. Study area and survey protocol

This study was conducted in Hanoi and Ho Chi Minh City (HCMC). These were chosen as study sites as they are the two largest cities in Vietnam, with documented high wildlife consumption. Surveys were conducted between March 2017 and April 2017. The sampling method was a combination of cluster random sampling method and semi-random sampling strategy, with a total of 1120 individuals surveyed. This number was determined according to a formula designed by TRAFFIC that incorporated insights from prior research (Appendix I). The target sampling size was over the calculated number of 1101 both for greater ease in dividing between administrative districts, and to ensure that broad patterns could be identified, and to ensure a 'buffer' of additional data in case of missing and/or incomplete data. Due to the difference in the urban population, fewer structured-interviews were conducted in Hanoi (n = 360) than HCMC (n = 760). Two wards in each district were randomly selected, with 20 households in each ward randomly selected, to ensure a proportional, random sample was obtained. Specifically, we used a three-step sampling process: first, purposive sampling was employed to target only adults (older than 18) in urban districts of Hanoi (nine districts in total) and HCMC (19 districts in total); second, cluster random sampling was used, where the study population was divided into two clusters, including primary sampling units (districts) and secondary sampling units (wards), with 2 wards in each district selected using probability proportional to size approach; and finally random sampling was used in the field where surveyors selected 20 households in each ward using the random walk method. Cluster sampling specifically was used due to the geography of both cities. Hanoi and HCMC both have distinct character clines (e.g. Kim, 2015; Labbé et al., 2010; Vind and Fold, 2010; Waibel, 2004), and cluster sampling is an appropriate way to ensure that the diversity of demographics, occupations, and other human population attributes are captured. In addition, cluster sampling is useful for places with large populations (Newing, 2011), as both Hanoi and HCMC are.

We surveyed only one person per household. The interviewers were instructed to select respondents based on their gender and age range in order to draw a representative sample. For example, if the interviewers surveyed a man in the first household, they then interviewed a woman in the second household and alternated throughout the day. If they interviewed an older woman at one house, they sought to interview a younger man at the next house. If there were other people in the same place, the interviewers were instructed to find a private place to talk to the chosen person. The surveys were conducted by Vietnamese interviewers employed and trained in administration of face-to-face interviews by TRAFFIC.

2.2. Survey instrument

A quantitative questionnaire was used to conduct structured-interviews with potential consumers in Hanoi and HCMC. The following methods were used to pre-test and evaluate quality while finalizing the questionnaire:

- Expert opinion method: Six staff members of the international NGO TRAFFIC, who have many years of experience in developing and implementing demand reduction initiatives in Vietnam were consulted about the appropriateness, feasibility and usefulness of survey questions within the context of Vietnam;
- 'Role play interviews' by enumerators: During the training workshops, nine enumerators who had previously conducted a number of social-economic surveys tested the questionnaire to identify inconsistencies and ambiguities in terms of logic and translation, and interviewed 18 people;
- Pilot survey: The researchers conducted a small pilot survey (n = 20) on randomly selected pedestrians in a public venue in Hanoi, Vietnam to identify any remaining issues with the questions and answer values.

The instrument was designed using questions tested and used in similar studies in the region and known to be effective at eliciting information in the Southeast Asian context (Davis et al., 2016 and Davis et al., 2019a). The information was collected

according to conservation social marketing and behavior change theory, which emphasizes, in brief, the investigation of consumer characteristics, motivations, social networks, and the uncovering of "actionable insights" that can directly influence behavior change campaigns (e.g. Greenfield and Veríssimo, 2019).

The final quantitative questionnaire used in this study was divided into several sections (the full instrument can be found in Appendix II). Respondents were asked for demographic information about themselves (e.g. gender, place of residence), as demographic characteristics are known to be important in determining which audiences to target in behavior change initiatives, particularly those influenced by conservation marketing (Kanagavel et al., 2014). as well as the types of medicine that they had used. As some individuals in Vietnam are known to practice medical pluralism (i.e. utilizing multiple medicinal systems) (Wahlberg, 2006), respondents could choose whether they had used only Western, traditional, other, or some combination.

Individuals who had consumed tiger products were then asked about their consumption. They were asked directly whether they had consumed tiger products (yes/no) and were asked through a specialized questioning technique (SQT), unmatched count technique (UCT), whether they had used tiger products. UCT is part of a suite of methods that are designed to reduce bias in estimates of sensitive behaviors (Nuno and St. John, 2015). As the use of illegal wildlife products can be sensitive and subject to respondent bias (Davis et al., 2019b), we determined that using UCT could be useful for eliciting more truthful responses from our respondents.

UCT is also called a "list experiment", because respondents are given a list of behaviors and asked to state the number of these behaviors they have done. One group is the control and given a list of non-sensitive behaviors, while another group is the treatment group, and given the same list of non-sensitive behaviors, plus the sensitive behavior of interest (e.g. Olmedo Castro et al., 2019). In our study, the behaviors were medicinally-related, since prior research has indicated that tiger products tend to be used for medicinal purposes in Vietnam (Stoner et al., 2016) (Table 1). The non-sensitive behaviors in this study were used in a similar consumption investigation in Cambodia (Davis et al., 2019b).

As is the case for many SQTs, UCT is vulnerable to error. The addition of the sensitive item on the list can affect individuals' responses to the list and thereby introduce bias, an effect known as "design effect" (Blair and Imai, 2010). Moreover, UCT is vulnerable to high rates of standard error, which generally necessitates large sample sizes (e.g. Coutts and Jann, 2011).

They were also asked a variety of questions around the consumption of the product; for example, why they had consumed the product, with provided responses of 'medicine', 'gift', 'protection' etc. This information can help with designing the message and identifying the target audience for a future behavioral change campaign (e.g. Bennett et al., 2017; Phelps et al., 2016). Respondents were always given an 'other' option, in case the given responses did not accurately reflect their consumption. They were also asked about the time frame of when they had used the product, with response categories of 'within the last year', 'in the last 1−5 years', '5−10 years', etc.

Individuals who had purchased tiger products were then asked a set of questions related to purchasing, for example, who the product was purchased for, if not for themselves (with categories of 'close family', 'extended family', 'close friends', and so on), as well as their level of satisfaction with the product, measured through a standard 5-point Likert-type scale (e.g. Glikman et al., 2019) that ranged from 1 'not at all satisfied' to 5 'very satisfied'. Using a Likert-type scale, they were also asked whether they would be likely to purchase the product again in the next twelve months, with categories ranging from 1 'Not at all likely'" to 5 'Very likely'. All structured-interviews were written in/conducted in Vietnamese. The instrument was anonymous. Ethical approval was obtained from Miami University Ohio IRB for Human Subject Research, Protocol Number FWA00023676.

2.3. Statistical analysis

We accepted quantitative questionnaires for analysis if they had the demographics section completed, but respondents may not have answered every question. As such, each question analyzed has differing sample sizes depending on the number of responses to that question. We tested data for normality and homogeneity of variances using both the Shapiro-Wilk and Bartlett's Tests (Bartlett, 1937; Srivastava and Hui, 1987). We found the data to be non-normal. Transformations were not attempted on the data, as survey data are often non-normal (Vaske, 2008). Thus, we used standard non-parametric unpaired two-sample Wilcoxon tests for comparisons between two groups, while the chi-squared test and Kruskal-Wallis non-parametric test were used for comparisons between multiple groups (Kruskal and Wallis, 1952). We considered results significant with 95% confidence intervals (p-value < 0.05). All statistical analyses were performed in R (R Core Team, 2019), and all figures were created using ggplot2 (Wickham, 2016). We used the standard UCT formula for obtaining the average UCT prevalence estimate (as in Davis et al., 2019b and Olmedo Castro et al., 2019). Obtaining confidence intervals from the formula necessitated the use of the "list" package and its functions (Blair and Imai, 2010). Specifically, we found the maximum likelihood

Table 1
The behaviors that were asked in the unmatched count technique (UCT).

Control	Treatment
Taken painkillers	Taken painkillers
Seen a medical practitioner	Seen a medical practitioner
Broken a bone in your arm	Broken a bone in your arm
Had heart surgery	Had heart surgery
	Purchased tiger products

estimates (MLE) for each city and for both cities together and generated predicted prevalence estimates and corresponding confidence interval estimates from the MLE regression model (Blair and Imai, 2010).

3. Results

3.1. Participant characteristics

In both cities the individuals sampled were approximately 37 years old, Kinh ethnic group (the dominant ethnic group in Vietnam), did not practice a religion, and made between 0 and 10 million dong (432 USD) a month. The sample was split along the gender ratio of Vietnam, with women slightly more dominant.

The majority (80%) of individuals had used Western medicine in the past twelve months in both cities, while 20% of respondents had used mostly traditional medicine (Appendix III). There were no apparent differences in what medicine was primarily used between the entire sample and users of tiger products.

Both participants in the entire sample and respondents who had used tiger products stated that they were most influenced by their close family, followed by close friends. In the full sample, participants were third most influenced by their extended family, while in the smaller group of tiger product consumers, the third most influential group was extended family and colleagues (Appendix III).

3.2. Prevalence of use

The prevalence estimate for unmatched count technique (UCT), when directly calculated using the UCT formula, was 11.3% in both cities, and 7.2% in Hanoi (n = 360) and 13.6% in Ho Chi Minh City (HCMC) (n = 760). Using "list" (Blair and Imai, 2010), the predicted prevalence estimate for the use of tiger products in both cities was 6% (CI: −7.1, 19) (total n = 1120). In Hanoi the predicted prevalence was 6.1% (CI: −10.48, 22.66), while in HCMC the predicted prevalence was 3.5% (CI: −16.64, 23.65). Using the "list" package (Blair and Imai, 2010) there was found to be no design effect acting in the experiment. For direct
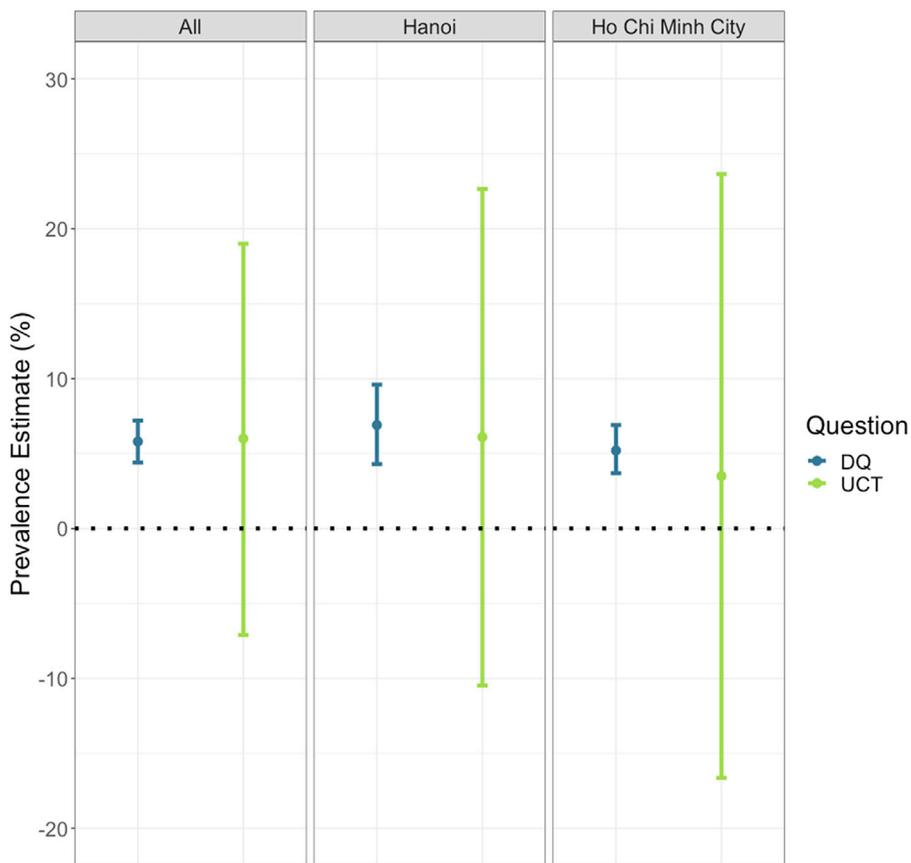

Fig. 1. Prevalence estimates and 95% confidence intervals, compared between DQ and the predicted estimates of UCT calculated using the "list" package (Blair and Imai, 2010). Estimates were calculated between the entire sample (n = 1120) and Hanoi (n = 360) and Ho Chi Minh City (n = 760). DQ and UCT overlap in all sites.
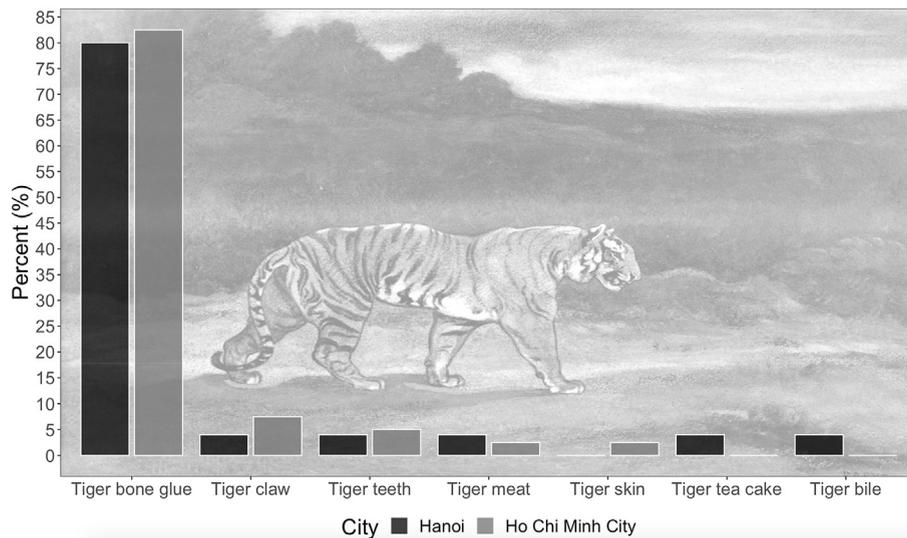
Fig. 2. Products directly stated to have been used most frequently by tiger part consumers in both cities surveyed (Hanoi: n = 23, Ho Chi Minh City: n = 40). Tiger bone glue is the most popular product. (*Background image is by Antoine-Louis Barye, "Tiger Walking". Image from Wikimedia Commons*).

questioning (DQ), there was an overall 5.8% (CI: 4.4, 7.2) direct admittance of tiger part use in both cities, with 6.9% (CI: 4.3, 9.6) of participants in Hanoi directly admitting to use, and 5.2% (CI: 3.7, 6.9) in HCMC (Fig. 2).

The predicted UCT is higher than DQ for all sites compared but is lower than DQ for the two cities individually (Fig. 1). However, the UCT prevalence estimate obtained when calculated using the standard formula is higher than the DQ estimates.

3.3. Models of consumer characteristics on UCT and DQ estimates

3.3.1. UCT

Using the list package, models were run with a number of independent variables (Appendix IV, Table 1) on the dependent variable of the stated number of UCT behaviors (0—4 for the control group, 0—5 for the treatment group).

Due to the relatively low sample size for UCT estimation (e.g. Hinsley et al., 2017), the model did not generate sensible estimates and by extension, did not show any strong characteristic specific to tiger part consumers (full model presented in Appendix IV).

3.3.2. DQ

We ran several generalized linear models on the direct question (DQ) data. In the full model we found significance for four variables: age, education, income, and an individuals' social network (Table 2 for the significant variables and their corresponding estimates, standard error, z-value, and p-value, Appendix V for the full model). Individuals who were older were more likely to have used tiger products, as well as individuals who had only achieved a secondary school education, and individuals whose stated monthly income was "over 10—32 million Vietnamese dong" (approximately 431 USD to 1381 USD). Individuals who knew of no one who had used tiger products previously or who would use in the future were significantly less likely to use products themselves (see Table 2)

When we reduced the models to each variable, we found that a very slight association could be found between age group and whether individuals had used tiger products, i.e. individuals 45+ were slightly more likely to use tiger products. When broken down for education, however, we found no actual effect on tiger product use, when the educational categories were compared against each other. This was also true when income was also the only variable in the model, and for the variables about tiger product consumers within the individuals' social group. All of these models can be found in Appendix V.

Table 2
Significant variables in the generalized linear model (GLM) of direct admittance to tiger product use and the effect of demographic and social factors.

Variable	Estimate	Std. Error	z-value	p-value
Age Group	1.001	0.020	5.115	3.13e-07 ***
Education:: Secondary School	1.817	0.076	2.387	0.017 *
Income:: Over 10—18 million VND	1.353	0.053	2.573	0.010 *
Income:: Over 18—32 million VND	2.019	0.073	2.775	0.006 **
Number of friends and family who have used previously:: None	−2.100	0.035	−6.003	1.93e-09 ***
Number of friends and family who will use in the next year:: None	−1.088	0.052	−2.081	0.037 *

Following this full sample comparison, we explored the nature of consumption among the sub-sample of direct admittance tiger part consumers (n = 65 for both cities, n = 25 for Hanoi and n = 40 for Ho Chi Minh City). This is presented below.

3.4. Products used

For both cities, respondents who directly admitted that they used tiger products were most likely to consume tiger bone glue (Fig. 2). Tiger claw, teeth, meat, and skin were all consumed by less than 10% of the self-stated consumers. Two women from Hanoi stated that they had used "other" for a tiger product. One woman elaborated that she had used tiger bile, and another had used "tiger tea cake".

3.5. Why tiger consumers use the products

In Hanoi, consumers stated that they only used tiger products for medicine or to protect themselves or others. Individuals in (HCMC) also stated these reasons, as well as multiple other reasons for using tiger products that Hanoians did not, e.g. using the products to show others (Table 3).

3.6. How individuals received tiger products

Overall most participants stated that they either purchased themselves or received tiger products as a gift (Fig. 3). A chi-squared test between cities did not find a statistically significant difference in how tiger products were obtained ($\chi^2 = 2.3459$, df = 4, p = 0.6724). However, in HCMC a greater percentage of individuals were given tiger products as a gift, while in Hanoi individuals were more likely to have purchased it for themselves.

3.7. Individuals' satisfaction with the product

In Hanoi, no individuals were dissatisfied with the tiger product they used; whereas some individuals did express dissatisfaction in HCMC (Fig. 4). Generally, our results show tiger part consumers in urban Vietnam as satisfied with tiger products.

3.8. Last time tiger products were purchased

Consumption of tiger products continues in urban Vietnam, as evidenced by our results of when consumers had last purchased tiger products (n = 65). Consumers were more likely to have bought the products within the last year, versus the other time frames asked.

3.9. Who products were purchased for

Tiger part consumers generally bought the products for themselves (59%, n = 13/22). Two of the consumers bought for themselves and their close family (9%), and 50% (n = 11/22) of the consumers stated that they had bought the tiger product for their close family.

3.10. Likelihood of purchasing products again in the next twelve months

Tiger part consumers mostly stated that they were 'not at all likely' to purchase tiger products in the next twelve months (49%, n = 32/65), although 13% of consumers did state that they were 'somewhat likely' to do so (n = 9/65).

None of the tiger product consumers stated a reason not to purchase the products. In terms of tiger product origin influencing use, 72% (n = 47/65) of the consumers stated that they cared where the product came from, with the majority (89%, n = 42/47) preferring wild tiger products over farmed.

Table 3
Self-stated reasons tiger consumers used tiger products. Medicine was the predominant reason individuals used tiger products, in both cities (Hanoi consumers n = 25; HCMC consumers n = 40). In HCMC individuals had more diverse reasons for consuming tiger products.

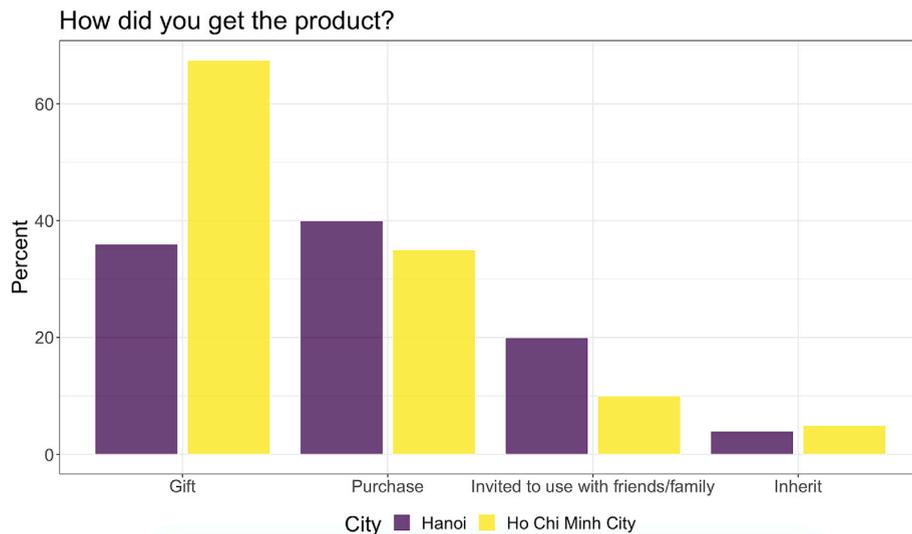|	Hanoi	Ho Chi Minh City
Medicine	76% (n = 19)	67.5% (n = 27)
Protect self and/or others	8% (n = 6)	5% (n = 2)
Show to others	0%	5% (n = 2)
Gift	0%	5% (n = 2)
Tradition	0%	2.5% (n = 1)
Keep for future use	0%	0%
Investment	0%	0%

How did you get the product?

Fig. 3. How individuals in Hanoi (n = 25) and Ho Chi Minh City (n = 40) obtained tiger products, according to direct questioning. In Ho Chi Minh City tiger products were primarily given as a gift, while in Hanoi individuals directly purchased the products.
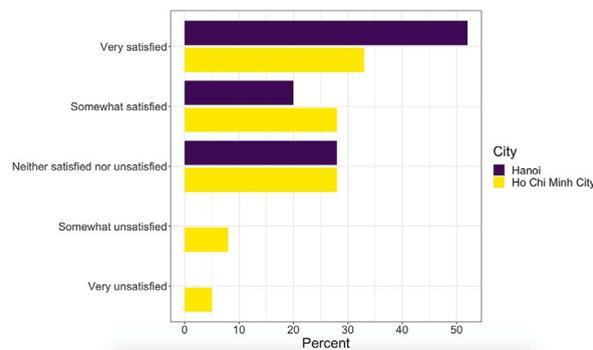

Fig. 4. Level of satisfaction tiger product consumers directly admitted they had with the product they used (Hanoi n = 25; Ho Chi Minh City n = 40).

3.11. Factors influencing the decision to purchase tiger products again

Tiger part consumers were asked what factors were most likely to influence their decisions to purchase tiger products. Quality was the biggest concern for buyers of tiger products, closely in tandem with whether the product was genuine or not (Table 4). Price was the third most influential factor, and the overall least influential variable was "place to buy".

4. Discussion

Little has been previously known about consumer demand for tiger products in Southeast Asia. Vietnam is involved in the farming and trade of tigers (as well as the farming and trade in lions as tiger substitutes) (Williams et al., 2017), but peer-

Table 4
Factors influencing tiger consumers when purchasing tiger products. Quality was the predominant influencer, in both cities (Hanoi consumers n = 25; HCMC consumers n = 40). In HCMC individuals were more evenly split in which factors they found most influential, compared to Hanoi. Note: percentages are greater than 100% because individuals were asked to choose up to three influential factors.

	Hanoi	Ho Chi Minh City	Total
Genuine	52%	32.5%	41.5%
Quality	68%	32.5%	46.2%
Price	24%	25%	24.6%
Place to buy	8%	10%	9.2%
Reputation of sellers	16%	20%	18.5%
Other	4%	25%	16.9%

reviewed studies on consumer demand have been lacking. This study is one of few and represents an essential first step in filling these key information gaps. Using a specialized questioning technique, unmatched count technique (UCT) to overcome deceit, we found the calculated prevalence to be that approximately 10% of the people in our sample were using tiger products. However, the relatively low sample sizes for each city resulted in lower predicted prevalence and wide confidence intervals, when predicted by the maximum likelihood estimation (MLE) model. Theoretically, the "true" prevalence of use could be as high as 23% of the sample (in Ho Chi Minh City (HCMC)), or as low as 0%. However, we suspect that the "true" prevalence is more akin to the predictions calculated from the direct UCT formula, which were (in order of "all", "Hanoi" and "HCMC") 11.3%, 7.2%, and 13.6%. Considering the variability in the data, the "true" prevalence is unlikely to be as high, but we do not believe that it is a stretch to infer that the prevalence is greater than the ~6% calculated through DQ.

Nonetheless, the similarity between our UCT and DQ responses (Fig. 1) indicates that consuming tiger products may not be a very sensitive behavior to admit to in Vietnam. The reasons for this are unclear. It could be that urban Vietnamese are unaware that it is illegal to sell, or advertise tiger, or perhaps the consumption of tiger products is relatively accepted in urban Vietnam. Future research is needed that employs qualitative methods, to gain a better understanding of why individuals may be comfortable admitting to tiger product use.

We found that tiger bone glue was by far the most prevalent tiger product consumed in urban Vietnam (Fig. 2). Ten years ago, Drury (2009) argued that use of tiger bone glue was 'sufficiently rare' in Vietnam and thus 'retained symbolic value'. As tiger bone glue consumption was not a focus of her study, it is possible that either its prevalence was under-estimated in Hanoi at the time, or that consumption has grown in the ensuing thirteen years since that data collection. A few years later other researchers claimed that tiger bone glue was part of an "emerging sub-culture" in Vietnam (Stoner et al., 2016); however, the report the claim was based on was unresearched speculation of use as something 'risky' and therefore enticing for the 'mystique'. Ultimately, there is little consensus on whether tiger bone glue is a recent trend in Vietnam, or whether it has been used for decades, under-recorded by conservation researchers as their research methods focused on surveying product availability rather than consumers.

It is also worth noting that without employing comprehensive DNA testing, it is impossible to know how much of this consumption is of lion bone or other fakes, e.g. 'tiger bone glue' that does not contain any discernible level of tiger bone. There is precedence for this mixing of felid parts, as a report by Stoner et al. (2016) in Vietnam found that in a spate of tiger product seizures, lion bones had been found along with tiger bones. There is also a new trend in China of use of jaguar bone glue (Lemieux and Bruschi, 2019), which could potentially further 'muddy the waters', if traders to Vietnam market jaguar bone glue as tiger bone glue, and/or if Vietnamese tiger part consumers try and begin to desire jaguar bone glue as well. Un-published data from Bolivia indicates that the jaguar is being marketed in China as "the tiger of South America", and such marketing may resonate for the Vietnamese tiger part consumers identified here as well (M. Arias, pers. comm.).

The GLM analyses that explored respondent characteristics failed for UCT results, possibly as a result of the relatively low sample size, as well as the comparatively low level of tiger part consumption generally, which has been seen to affect UCT estimations (e.g. Ibbett et al., 2017). When a full model was applied on the direct questioning (DQ), we found that there is slight evidence for tiger product consumption to be more likely when the individual was 45+, in medium-low income brackets, and possessing secondary school education as their highest level of education. Although these effects were insignificant when the model was reduced to solely those variables, the full model results challenge assumptions that tiger products are only available to the wealthy, and confirm that older individuals are the most likely users. However, we caution that these results are solely based on DQ for reporting income and for use. Individuals with higher incomes may have lied about their income, and/or higher income individuals may not have been accessed (e.g. Vyas and Kumaranayake, 2006).

Importantly, the full model results also indicate to the significance of one's peers in influencing use; if individuals did not know others who had used tiger products, they were significantly less likely to do so themselves. This points to trends seen elsewhere in another wildlife product, bear bile, where growing evidence indicates that users tend to be embedded in networks of other uses (Davis, 2019 and Davis et al., 2019a). Altogether, tiger product demand reduction campaigns should focus primarily on individuals who are 45+, mid to low income, and who know other individuals who use tiger products.

Generally, tiger product users had few distinguishing characteristics. Like non-tiger product consumers, they were more likely to use Western medicine, rather than traditional medicine, and they were aligned demographically in predominantly having no religion, mostly being Kinh, and primarily stating that they make 0−10 million dong (roughly 0−430 USD) a month (Appendix VI). The primary difference between tiger product consumers and all other participants in this study was that tiger product consumers tended to be older than the rest of the sample. As tiger products were stated as being primarily consumed for medicinal purposes, this makes logical sense. Generally, older individuals will be both more likely to have health ailments, and to have treated those over time (e.g. Ross and Wu, 1996). There is also evidence that older individuals may be more likely to turn to traditional medicine (both herbal and wildlife) compared to younger individuals (Doughty et al., 2019); however, age variations in medical pluralism has not, to our knowledge, been formally tested in Vietnam. Another possibility related to the differences in age that we noted is that younger, urban Vietnamese who have used tiger products were reluctant to directly admit to having used, considering the increasing amount of pro-conservation awareness enacted by NGOs and the Vietnamese government, particularly in urban areas (e.g. Nguyen et al., 2016).

Consumers of tiger products were generally satisfied with the product they had been given or purchased, although there were a few confirmed users in HCMC who were not satisfied (n = 5). These individuals had all purchased tiger bone glue (rather than being given it); however, the consumers were not asked why they had felt dissatisfied with their purchase of tiger bone glue. This is an important void, as finding and using motivating factor(s) barring the use of wildlife products can be

powerful in enacting effective demand reduction. Nonetheless, our respondents' satisfaction with the glue made from the bones of large, vulnerable big cats is alarming, in light of recent research that has highlighted Chinese demand for jaguar bone glue (Lemieux and Bruschi, 2019). The tiger product consumers identified in this study are a potential user group for consuming these types of products as well, considering the perceived lack of barriers against consumption.

Tiger products were primarily bought for consumers' personal use, although two individuals stated that they would share with their close family as well, and 50% stated that they bought the product solely for their close family. Consequently, we found that between cities there was an observable difference in how individuals obtained the products they used. In HCMC, tiger products were generally given as gifts, compared to Hanoi, where individuals were more likely to purchase the product directly. A chi-squared test did not find significance between the cities and how they obtained tiger products; nonetheless, these results are important for what they indicate about the disparity in how use of tiger products (and other wildlife products) may occur between the two major cities of Vietnam.

The most important qualities that tiger part consumers stated determined their purchase were whether the product was genuine, and whether it was of good quality. Price was the third most influential factor, but was overall only stated as being important by a quarter of the tiger part consumers surveyed. Although we did not directly ask what price tiger parts were, we can infer that tiger products are not exorbitantly priced, considering our additional findings about consumers' being categorized as low-to-middle income. The price of illicit products such as tiger parts depends on a plurality of factors, including the risk involved in trading the product (Wong, 2015), as well as the availability of the product (e.g. South and Wyatt, 2011). The persistence of tiger farms in Vietnam and relatively low levels of wildlife enforcement in Vietnam (EIA, 2019) could be facilitating achievable prices for the "average" urban Vietnamese. However, there are likely also a sufficient amount of fakes circulating, as the respondents' themselves indicate through their concerns over the quality and legitimacy of the products.

Tiger farms are persistent across Southeast Asia and China, with an overall increase in tiger trade across the region and in the captive bred population (EIA, 2013, 2019; Stoner et al., 2016). This is increasing the available supply of tiger products, which may increase consumer use. Increase in availability arguably facilitates use for potential users who may otherwise be put off by the expense, time, or effort necessary in obtaining the product. In the same vein, we note and are concerned by the similarities of tiger product demand to the demand for bear-bile. Although bears are one of the few remaining large carnivore species in Vietnam, they are unfortunately well-established as a farmed animal, just like tigers, and their bile is ubiquitous as a medicinal product (Crudge et al., 2018; Davis et al., 2019a). The farming of bears for their bile is illegal in Vietnam (since 2005) and bear farms are indeed declining across the country; however, "deficiencies" in enforcement have maintained the presence of bear farms to date (Crudge et al., 2018). The number of tiger farms, meanwhile, appears to be increasing, with 17 farms holding a total of 199 tigers reported in 2019 (EIA, 2019), double the number reported by Brunner (2012). There are "untold other [tiger farms]" in Nghe An province (EIA, 2019), thought of as the epicenter of bear bile farming (Crudge et al., 2018). At a broader scale, tigers are increasingly (and illegally) being farmed across Southeast Asia and China, which likely increases the overall market availability of tiger products, considering the relatively porous borders in the region (e.g. Contreras, 2016). Although bear farming and tiger farming are at distinctly different stages, they share important similarities in their current trajectory and in the overall regional context; one important similarity is that China legalizes both types of farming. Generally, the examples from bear farming shows that there is every possibility that tiger farming will continue to grow in the region, with this increasing availability ensuring tiger products become as pervasive and accepted as bear bile.

4.1. Limitations and future research

The estimates of UCT that were generated directly from the formula were higher than the DQ estimates, which indicated that there was some bias in answering. However, the predicted UCT estimates were lower than the DQ estimates in both cities. In addition, the UCT estimates had the very high standard errors that distinguish UCT in practice (Hinsley et al., 2017). As we discuss above, our UCT data was limited by the relatively small total sample size (and particularly each cities sample size), which made the identification of important characteristics difficult. Sample sizes generally need to be very large to fully encapsulate meaningful patterns (e.g. Hinsley et al., 2017).

It is possible that the variability in the predicted estimates was a result of the non-sensitive behaviors not being sufficiently high and/or medium prevalence in the sample, e.g. not enough individuals sampled were likely to have taken painkillers or seen a medical practitioner. It is recommended that future studies employing UCT in Vietnam enact more extensive piloting of UCT behaviors, to ensure an even spread of behaviors and minimization of potential error. UCT has also been criticized for its limited ability to tease out other factors that are significant in understanding consumption, such as the characteristics of the individuals who are more likely to lie, and why. It is possible that individuals who lie are those who are aware that they are being "tricked" in some way (e.g. Davis et al., 2019b), and not necessarily those individuals who use the product more. As we discuss in other sections of this manuscript, this can be addressed through the application of qualitative techniques such as interviews, although interviews are themselves not without possibilities for bias (e.g. Drury, 2009).

Another limitation of this research is the lack of data on income. Although the income question was designed to reduce some of the biases associated by keeping the categories relatively vague, individuals may still have lied about their true income. Future studies that include more focus on income, price of tiger products, and their interplay could benefit from using techniques such as choice experiment (CE), which has been successfully used to understand prices' role in determining consumption of rhino horn (Hanley et al., 2018), turtle meat (Nuno et al., 2018), and general "bushmeat" (Moro et al., 2013). Our study seems to indicate that tiger product consumption is more affordable than rhino horn, which is price inelastic due to

the high demand of the wealthy for whom price is not a factor (e.g. Dang Vu and Nielsen, 2018); however, this was not fully explored, and could therefore be only a small piece of the tiger consumption picture.

In conjunction with the above, another limitation of this study was the lack of qualitative data that could be used to more deeply explain some of the key points noted here. For example, qualitative data could have elucidated why some individuals in HCMC were dissatisfied with tiger bone glue, as well as why individuals in HCMC may be more compelled to give (and receive) tiger products as a gift. We suggest that further research be undertaken in both major cities of Vietnam, to build on these results and offer greater insights that can be used to build effective targeted behavior change initiatives.

An avenue of further research in tiger product consumption is the possibility of herbal alternatives being promoted in place of tiger bone glue. Encouraging the consumption of bear bile leaf or safflower rather than bear bile has been a focus of behavior change campaigns in Vietnam; however, there is evidence that individuals believe the medicinal efficacy of the wildlife product is higher than the herbal alternative (Davis et al., 2019a), and therefore these individuals will be unlikely to adopt herbal consumption in lieu of bear bile. Despite this challenge, future studies into tiger product consumption should interrogate this aspect and assess whether campaigns around herbal alternatives in lieu of tiger products will have efficacy in shifting behaviors.

Finally, we were unable to answer the question of whether consumption of tiger bone glue is a modern trend, or a behavior with a long history. Although our instrument did ask about the time frame of when tiger product consumers last purchased the product, only a few of the self-identified users answered that question, in either city. We therefore feel unable to speculate on any possible trends in use. However, traditional research can assume consumption of wildlife products over time through their market availability rather than surveying the population directly. It is of critical importance that both types of research continue to take place to be able to deliver and evaluate the impact demand reduction programs and other efforts to tackle illegal wildlife trade have on the expected conservation outcomes.

5. Conclusion

Our results are intended to feed directly into evaluated, targeted behavior change initiatives around halting the consumption of tiger products in Vietnam. In this study, we could not find any strong identifying characteristics of consumers of tiger products, apart from the slightly older ages of the consumers. By extension, tiger part consumers could potentially be any individual in urban Vietnam. Importantly, we have found different motivations for consuming tiger parts between Hanoi and Ho Chi Minh City (HCMC), with Hanoians more likely to purchase the product for their own use, and individuals in HCMC more likely to gift it. Behavior change (BC) campaigns in Hanoi, therefore, could encourage consultation with Western doctors, over purchasing something 'untested', while BC campaigns in HCMC could discourage the gifting of endangered wildlife products, which subsequently forces others into obligations. We have also shown that tiger product use is sensitive to admit to in both Hanoi and HCMC. It is therefore essential to incorporate specialized questioning techniques into the evaluation of any BC campaigns that are implemented, to ensure that tiger product consumption prevalence is accurately assessed.

Tigers are one of the world's most vulnerable charismatic species, and even the relatively 'minor' amount of demand identified here can have significant and devastating effects on the fragmented, beleaguered tiger populations left. This is the case even for populations in relatively stable range countries; previous studies of tiger demand have noted that tigers traded into Vietnam has come from as far away as Russia (Stoner et al., 2016). Published research such as this is essential for providing evidence into the plural aspects of illegal wildlife trade, e.g. market availability and consumer demand, particularly for a species that is as yet under-researched in IWT, compared to other megafauna such as rhinos. Ultimately, the alarming state of tiger populations worldwide demands that all actions to reduce the threats to the species must be made a priority. Evidence, and collaborative and effective actions are all necessary to tackle the complex social issues surrounding illegal wildlife trade, and to ultimately prevent the extinction of tigers.

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.

Acknowledgements

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gecco.2020.e00960.

References

Education for Nature − Vietnam, 2015. Analysis of Change in Bear Bile Use 2015. Online publication. https://www.env4wildlife.org/images/News_Resources/Publication/Analysis-of-change-in-bear-bile-use-2015.pdf.

Aisher, A., 2016. Scarcity, alterity and value: decline of the pangolin, the world's most trafficked mammal. Conserv. Soc. 14 (4), 317−329.

Aziz, M.A., Tollington, S., Barlow, A., Goodrich, J., Shamsuddoha, M., Islam, M.A., Groombridge, J.J., 2017. Investigating patterns of tiger and prey poaching in the Bangladesh Sundarbans: implications for improved management. Global Ecology and Conservation 9, 70−81.

Bartlett, M., 1937. Properties of sufficiency and statistical tests. *Proceedings of the Royal Society of London*, Ser. A 160, 268−282.

Bennett, N.J., Roth, R., Klain, S.C., Chan, K., Christie, P., Clark, D.A., Cullman, G., Curran, D., Durbin, T.J., Epstein, G., Greenberg, A., 2017. Conservation social science: understanding and integrating human dimensions to improve conservation. Biol. Conserv. 205, p93−p108.

Blair, G., Imai, K., 2010. List: statistical methods for the item count technique and list experiment. available at: The Comprehensive R Archive Network (CRAN). URL. https://CRAN.R-project.org/package=list.

Brook, S.M., Dudley, N., Mahood, S.P., Polet, G., Williams, A.C., Duckworth, J.W., Van Ngoc, T., Long, B., 2014. Lessons learned from the loss of a flagship: the extinction of the Javan rhinoceros Rhinoceros sondaicus annamiticus from Vietnam. Biol. Conserv. 174, 21−29.

Brunner, J., 2012. Biodiversity Conservation in Vietnam: A Perfect Storm.

Cao, A., Wyatt, T., 2012. A Green criminological exploration of illegal Wildlife Trade in Vietnam. Asian J. Criminol. https://doi.org/10.1007/s11417-012-9154-y.

Coals, P., Burnham, D., Loveridge, A., Macdonald, D.W., Sas-Rolfes, M.T., Williams, V.L., Vucetich, J.A., 2019. The ethics of human−animal relationships and public discourse: a case study of lions bred for their bones. Animals 9 (2), 52.

Contreras, A.P., 2016. Transboundary environmental politics in Southeast Asia: issues, responses and challenges. In: Routledge Handbook of the Environment in Southeast Asia. Routledge, pp. 165−174.

Coutts, E., Jann, B., 2011. Sensitive questions in online surveys: experimental results for the randomized response technique (RRT) and the unmatched count technique (UCT). Socio. Methods Res. 40 (1), 169−193.

Crudge, B., et al., 2016. Status & Distribution of Bears in Vietnam, 2016. Bear Specialist Group Research.

Crudge, B., Nguyen, T., Cao, T.T., 2018. The Challenges and Conservation Implications of Bear Bile Farming in Viet Nam. *Oryx*, pp. 1−8.

Dang Vu, H.N., Nielsen, M.R., 2018. Understanding utilitarian and hedonic values determining the demand for rhino horn in Vietnam. Hum. Dimens. Wildl. 23 (5), 417−432.

Davis, E.O., Glikman, J.A., Crudge, B., Dang, V., Willemsen, M., Nguyen, T., O'Connor, D., Bendixsen, T., 2019a. Consumer demand and traditional medicine prescription of bear products in Vietnam. Biol. Conserv. 235, 119−127.

Davis, E., et al., 2016. Understanding public perceptions and motivations around bear part use: A study in northern Laos of attitudes of Chinese tourists and Lao PDR nationals. Biol. Conserv. https://doi.org/10.1016/j.biocon.2016.09.009.

Davis, E., 2019. Understanding Use of Bear Products in Southeast Asia: Human- Oriented Perspectives from Cambodia and Laos. Unpublished PhD Dissertation.

Davis, E.O., Crudge, B., Lim, T., O'Connor, D., Roth, V., Hunt, M., Glikman, J.A., 2019b. Understanding the prevalence of bear part consumption in Cambodia: a comparison of specialised questioning techniques. PloS One 14 (2), e0211544.

Doughty, H., Veríssimo, D., Tan, R.C.Q., Lee, J.S.H., Carrasco, L.R., Oliver, K., Milner-Gulland, E.J., 2019. Saiga horn user characteristics, motivations, and purchasing behaviour in Singapore. PloS One 14 (9).

Drury, R., 2009. Identifying and Understanding Consumers of Wild Animal Products in Hanoi, Vietnam: Implications for Conservation Management. Doctoral dissertation, UCL (University College London).

Drury, R., 2011. Hungry for success: urban consumer demand for wild animal products in Vietnam. Conserv. Soc. 9 (3), 247−257.

Environmental Investigation Agency (EIA), 2013. Hidden in Plain Sight: China's Clandestine Tiger Trade.

Environmental Investigation Agency (EIA), 2015. SIN CITY Illegal Wildlife Trade in Laos' Golden Triangle Special Economic Zone.

Environmental Investigation Agency (EIA), 2019. Running Out of Time: Wildlife Crime Justice Failures in Vietnam.

Glikman, J.A., Ciucci, P., Marino, A., Davis, E.O., Bath, A.J., Boitani, L., 2019. Local attitudes toward Apennine brown bears: insights for conservation issues. Conservation Science and Practice 1 (5), e25.

Goodrich, J., Lynam, A., Miquelle, D., Wibisono, H., Kawanishi, K., Pattanavibool, A., Htun, S., Tempa, T., Karki, J., Jhala, Y., Karanth, U., 2015. Panthera tigris. The IUCN Red List of Threatened Species 2015: e.T15955A50659951. https://doi.org/10.2305/IUCN.UK.2015-2.RLTS.T15955A50659951.en. Downloaded on 15 August 2019.

Gray, T.N., Hughes, A.C., Laurance, W.F., Long, B., Lynam, A.J., O'Kelly, H., Ripple, W.J., Seng, T., Scotson, L., Wilkinson, N.M., 2018. The wildlife snaring crisis: an insidious and pervasive threat to biodiversity in Southeast Asia. Biodivers. Conserv. 27 (4), 1031−1037.

Greenfield, S., Veríssimo, D., 2019. To what extent is social marketing used in demand reduction campaigns for illegal wildlife products? Insights from elephant ivory and rhino horn. Soc. Market. Q. 25 (1), 40−54.

Hanley, et al., 2018. The allure of the illegal: Choice modeling of Rhino Horn demand in Vietnam. Conservation Letters. https://doi.org/10.1111/conl.12417.

Harrington, L.A., D'Cruze, N., Macdonald, D., 2018. Rise to fame: events, media activity and public interest in pangolins and pangolin trade, 2005−2016. Nat. Conserv. 30, 107.

Harrison, R.D., Sreekar, R., Brodie, J.F., Brook, S., Luskin, M., O'Kelly, H., Rao, M., Scheffers, B., Velho, N., 2016. Impacts of hunting on tropical forests in Southeast Asia. Conserv. Biol. 30 (5), 972−981.

Heinrich, S., Wittmann, T.A., Prowse, T.A., Ross, J.V., Delean, S., Shepherd, C.R., Cassey, P., 2016. Where did all the pangolins go? International CITES trade in pangolin species. Global Ecology and Conservation 8, 241−253.

Hinsley, A., Nuno, A., Ridout, M., John, F.A.S., Roberts, D.L., 2017. Estimating the extent of CITES noncompliance among traders and end-consumers; lessons from the global orchid trade. Conservation Letters 10 (5), 602−609.

Ibbett, H., Lay, C., Phlai, P., Song, D., Hong, C., Mahood, S.P., Milner-Gulland, E.J., 20172017. Conserving a globally threatened species in a semi-natural, agrarian landscape. Oryx 53 (1), 81−191.

Kanagavel, A., Raghavan, R., Veríssimo, D., 2014. Beyond the "general public": implications of audience characteristics for promoting species conservation in the Western Ghats hotspot, India. Ambio 43 (2), 138−148.

Kim, A.M., 2015. Sidewalk City: Remapping Public Space in Ho Chi Minh City. University of Chicago Press.

Kolipaka, S.S., Tamis, W.L.M., van't Zelfde, M., Persoon, G.A., De Iongh, H.H., 2018. New insights into the factors influencing movements and spatial distribution of reintroduced Bengal tigers (Panthera tigris tigris) in the human-dominated buffer zone of Panna Tiger Reserve, India. Mammalia 82 (3), 207−217.

Krishnasamy, K., Shepherd, C.R., Or, O.C., 2018. Observations of illegal wildlife trade in Boten, a Chinese border town within a Specific Economic Zone in northern Lao PDR. Global ecology and conservation 14, e00390.

Kruskal, W., Wallis, W.A., 1952. Use of ranks in one-criterion variance analysis. J. Am. Stat. Assoc. https://doi.org/10.1080/01621459.1952.10483441.

Labbé, D., Collin, J.P., Boudreau, J.A., 2010. Facing the urban transition in Hanoi: recent urban planning issues and initiatives. INRS Centre-Urbanisation Culture Société. http://espace.inrs.ca/id/eprint/4986.

Lemieux, A.M., Bruschi, N., 2019. The production of jaguar paste in Suriname: a product-based crime script. Crime Science 8 (1), 6.

Milner-Gulland, E.J., Cugniere, L., Hinsley, A., Phelps, J., Veríssimo, D., 2018. Evidence to Action: Research to Address Illegal Wildlife Trade.

Moro, M., Fischer, A., Czajkowski, M., Brennan, D., Lowassa, A., Naiman, L.C., Hanley, N., 2013. An investigation using the choice experiment method into options for reducing illegal bushmeat hunting in western Serengeti. Conservation Letters 6 (1), 37−45.

Newing, H., 2011. Conducting Research in Conservation, vol. 631. Routledge, London and New York, NY.

Nguyen, M.H., Van Ngoc, T., Thai Minh, B., Vu Ngoc, T., 2010. Survey and Assessment of Illegal Wildlife Trade in Thua Thien Hue Province, Vietnam. Trade Status and Recommendation for Management. WWF, Hue, Vietnam. Technical Report No.1.

Nguyen, T.N., Lobo, A., Nguyen, H.L., Phan, T.T.H., Cao, T.K., 2016. Determinants influencing conservation behaviour: perceptions of Vietnamese consumers. J. Consum. Behav. 15 (6), 560–570.

Nijman, V., Shepherd, C.R., 2015. Trade in tigers and other wild cats in Mong La and Tachilek, Myanmar—A tale of two border towns. Biol. Conserv. 182, 1–7.

Nowell, K., 2010. Tiger farms and pharmacies: the central importance of China's trade policy for tiger conservation. In: Tigers of the World. William Andrew Publishing, pp. 463–475.

Nuno, A., Blumenthal, J.M., Austin, T.J., Bothwell, J., Ebanks-Petrie, G., Godley, B.J., Broderick, A.C., 2018. Understanding implications of consumer behavior for wildlife farming and sustainable wildlife trade. Conserv. Biol. 32 (2), 390–400.

Nuno, A., John, F.A.St, 2015. How to ask sensitive questions in conservation: a review of specialized questioning techniques. Biol. Conserv. 189, 5–15.

Olmedo Castro, A., Davis, E., Hinsley, A., 2019. Asking Sensitive Questions in Conservation Using the Unmatched Count Technique. Tools and Guidance. Oxford Martin Programme on the Illegal Wildlife Trade, University of Oxford. https://doi.org/10.31235/osf.io/rcdbk.

Olmedo, A., Sharif, V., Milner-Gulland, E.J., 2018. Evaluating the design of behavior change interventions: a case study of rhino horn in Vietnam. Conservation Letters 11 (1), e12365.

Phelps, J., Biggs, D., Webb, E.L., 2016. Tools and terms for understanding illegal wildlife trade. Front. Ecol. Environ. 14 (9), 479–489.

R Core Team, 2019. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Rasphone, A., Kéry, M., Kamler, J.F., Macdonald, D.W., 2019. Documenting the demise of tiger and leopard, and the status of other carnivores and prey, in Lao PDR's most prized protected area: Nam Et-Phou Louey. Global Ecology and Conservation 20, e00766.

Ross, C.E., Wu, C.L., 1996. Education, age, and the cumulative advantage in health. J. Health Soc. Behav. 104–120.

Sandalj, M., Treydte, A.C., Ziegler, S., 2016. Is wild meat luxury? Quantifying wild meat demand and availability in Hue, Vietnam. Biol. Conserv. 194, 105–112.

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.

South, N., Wyatt, T., 2011. Comparing illicit trades in wildlife and drugs: an exploratory study. Deviant Behav. 32 (6), 538–561.

Srivastava, M.S., Hui, T.K., 1987. On assessing multivariate normality based on Shapiro-Wilk W statistic. Stat. Probab. Lett. 5 (1), 15–18.

Stoner, S., Krishnasamy, K., Wittmann, T., Delean, S., Cassey, P., 2016. Reduced to skin and bones re-examined: full analysis. TRAFFIC Report.

Vaske, J., 2008. Levels of measurement: once over again. In: Survey Research and Analysis: Applications in Parks, Recreation, and Human Dimensions. Venture Publishing, Inc., State College, PA, pp. 79–94 (Chapter 5).

Veríssimo, D., 2013. Influencing human behaviour: an underutilised tool for biodiversity management. Conservation Evidence 10 (1), 29–31.

Veríssimo, D., Challender, D.W., Nijman, V., 2012. Wildlife trade in Asia: start with the consumer. Asian Journal of Conservation Biology 1 (2), 49–50.

Vind, I., Fold, N., 2010. City networks and commodity chains: identifying global flows and local connections in Ho Chi Minh City. Global Network 10 (1), 54–74.

Vyas, S., Kumaranayake, L., 2006. Constructing socio-economic status indices: how to use principal components analysis. Health Pol. Plann. 21 (6), 459–468.

Wahlberg, A., 2006. Bio-politics and the promotion of traditional herbal medicine in Vietnam. Health 10 (2), 123–147.

Waibel, M., 2004. The Ancient Quarter of Hanoi—a reflection of urban transition processes. Asien 92 (Summer), 30–48.

Wickham, H., 2016. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag, New York.

Williams, V.L., Loveridge, A.J., Newton, D.J., Macdonald, D.W., 2017. A roaring trade? The legal trade in Panthera leo bones from Africa to East-Southeast Asia. PloS One 12 (10), e0185996.

Wong, R.W., 2015. The organization of the illegal tiger parts trade in China. Br. J. Criminol. 56 (5), 995–1013.

Wyatt, T., Johnson, K., Hunter, L., George, R., Gunter, R., 2018. Corruption and wildlife trafficking: three case studies involving Asia. Asian Journal of Criminology 13 (1), 35–55.