Global Ecology and Conservation 25 (2021) e01390

Contents lists available at ScienceDirect

Global Ecology and Conservation

journal homepage: http://www.elsevier.com/locate/gecco

Original Research Article

Effects of legalization and wildlife farming on conservation

Jessica Bell Rizzolo

Department of Fisheries and Wildlife, Michigan State University, 480 Wilson Road, East Lansing, MI, 48824, USA

ARTICLE INFO

Article history:
Received 16 July 2020
Received in revised form 20 November 2020
Accepted 27 November 2020

Keywords:
Wildlife farming
Legalization
Wildlife products
Tiger
Bear
Turtle
Snake
Demand

ABSTRACT

Many wildlife species are impacted by unsustainable consumption. Wildlife is consumed for such diverse purposes as food, medicine, ornamentation, entertainment, and social status. However, it is still debated whether legalization and wildlife farming can saturate demand and thus reduce poaching, or if these policies increase demand, and subsequently poaching of vulnerable wildlife. This paper used an experimental vignette survey in Mainland China (N = 1002) to explore empirically how legalization, wildlife farming, and possible changes in consumptive acceptability affect demand for wildlife products. Each respondent read a vignette about the consumption of a wildlife product from one of four species (bears, tigers, snakes, or turtles), for one of two uses (medicinal or non-medicinal), in one of three legal situations (product is illegal, product is legal and from farmed animal, or product is legal and from wild animal). All respondents were asked about the acceptability of wildlife consumption, the social stigma around consumption, and the perceived legal consequences of consumption for eight products: bear bile, bear paws, tiger bone, tiger skin, snake bile, snake leather, turtle shells, and turtle meat. Data was analyzed using linear regression models that included interaction effects and controlled for age, gender, education, income, and attitudes towards specific species, towards wildlife consumption, and towards Traditional Chinese Medicine. Wildlife product bans decreased the acceptability and social approval of wildlife consumption and increased estimations of legal punishments. The type of ban that produced these effects depended upon the wildlife product and the measurement of wildlife consumption. The effects of wildlife farming on demand for wildlife products were particularly prominent for mammals. Bear farming increased the acceptability and perceived social approval of bear bile; it also decreased perceived legal sanctions for bear consumption. Tiger farming diminished perceived legal sanctions for tiger consumption and farming tigers for medicinal use increased the acceptability of tiger consumption. Overall, these results indicate that bans on wildlife consumption and decreased wildlife farming of mammals can have conservation benefits.

1. Introduction

The illegal wildlife trade is one of the largest global criminal enterprises and encompasses the poaching, trafficking, and consumption of live animals and animal parts for food, medicine, ornamentation, and entertainment (Rosen and Smith 2010). This trade perpetuates widespread animal suffering and threatens numerous species with extinction (Nellemann et al., 2014; Baker et al., 2013). Scholars and policy-makers distinguish between the illegal and legal wildlife trade both in the context of

E-mail address: jessica.b.rizzolo@gmail.com.

https://doi.org/10.1016/j.gecco.2020.e01390

agreements such as CITES (The Convention on International Trade in Endangered Species of Flora and Fauna) and in the wildlife trade literature (Reeve 2006; Warchol 2007; Biggs et al., 2016). However, the line between the legal and illegal wildlife trades is often blurred and complicated by laundering, corruption, and inadequate enforcement resources (Bennett 2015; Lyons and Natusch 2011). Further, legal trade or consumption is not necessarily sustainable, and can threaten species with extinction both within and outside the borders of the region where it is legalized (Zang et al., 2008; Livingstone and Shepherd 2011). For example, there is evidence that the legalization of bear bile in China has led to the expansion of bear farms, and pressure on bear populations, in Laos to supply this market (Livingstone and Shepherd 2011; Foley et al., 2011).

At the same time, there are two ongoing debates in the conservation community about the dynamics of demand for wildlife products. The first issue refers to whether the legalization of wildlife products saturates or increases demand (Harvey 2016; 't Sas-Rolfes 2016). The second and related controversy concerns the introduction of legal products from farmed wildlife: wildlife bred and/or kept in captive conditions for the purpose of consumption. It is debated whether this practice can meet demand and thus reduce poaching or if it has either a null effect or yields an increase in demand (Kirkpatrick and Emerton 2010; Phelps et al., 2014; Challender and MacMillan 2014).

Debates about demand for wildlife products have intensified alongside awareness of and impacts from zoonotic diseases such as the novel coronavirus COVID-19, which is thought to have originated in China's wildlife trade (Broad 2020). In response to this outbreak, China has (at the time of writing) banned the consumption of wildlife for food but allowed wildlife consumption for medicinal purposes to continue (Li 2020). It is also an open question as to how the health risks of wildlife farms compare to wildlife animal markets (Broad 2020). Information on demand for wildlife products, and the impact of legalization and wildlife farms on this demand, is critical for understanding and minimizing the risks, including the risk of zoonotic disease, of the illegal and legal wildlife trades (Aguirre et al., 2020; Oxford 2020; WWF 2020).

Despite the primacy of these debates in conservation circles, there is a lack of empirical evidence on how the legal trade and farming of wildlife affect demand for wildlife products. This paper uses an experimental vignette survey in Mainland China ($N = 1002$) to analyze how legalization and wildlife farms affect the acceptability of, and perceived deterrents to, wildlife consumption. Further, this paper examines how these impacts of legalization and wildlife farms on demand for wildlife products are affected by species taxon (mammal or reptile) and by type of use (use for Traditional Chinese Medicine versus non-medicinal uses such as food or ornamentation). The core objectives of this paper are to determine a) if *legalization* increases or decreases demand for wildlife products and b) if *wildlife farming* increases or decreases demand for wildlife products. This information is essential for evaluating the conservation impacts of legalization and wildlife farms.

1.1. Wildlife product legalization and demand

One enduring area of controversy in both the academic and environmental policy spheres is how legalization affects demand for wildlife products. Much of this debate focuses on the legalization of products from two endangered megafauna: elephant ivory and rhino horn (Harvey 2016; 't Sas-Rolfes 2016; Biggs et al., 2013; Crookes and Blignaut 2015). Some scholars are critical of wildlife trade bans and argue that these bans limit the supply of wildlife products, thus increasing prices and poaching (Biggs et al., 2013); this view encourages legalization as an option (Conrad 2012). The contrary position is that demand for wildlife products is subject to the social norms codified through the law. Since legalization connotes social acceptance of the practice, it is thought that legalization will reduce stigma and undermine demand reduction campaigns (Harvey 2016). This could amplify the number of wildlife consumers and thus increase demand (Kirkpatrick and Emerton 2010). Further, for some species such as rhinos, affecting the price mechanism through legalization is probably insufficient to conserve the species (Crookes and Blignaut 2015). Another issue is that legal trade often provides cover for laundered illegal wildlife products (Tensen 2016), especially in countries characterized by corruption and poor governance (Bennett 2015).

The relationship between legalization and demand depends on a variety of factors, including how demand is modeled and the assumptions of the model (Crookes and Blignaut 2015; Bulte and Damania 2005), the species in question and its rarity (Krishna et al., 2019), the relationship between international actors and local communities (McAllister et al., 2009), and the markets of neighboring countries (Lemieux and Clarke 2009). Disagreements on policies are often due to different responses to risk for an issue dominated by complexity and uncertainty ('t Sas-Rolfes 2016; Aguayo 2014).

A key aspect of this debate is whether the effects of legalization on stigma undermine its potential economic or conservation benefits; this is known as the stigma effect (Abbott and Van Kooten 2011). However, analyses of the stigma effect have relied on economic modeling (Abbott and Van Kooten 2011; Bulte and Damania 2005; Phelps et al., 2014) and have not directly measured how legalization affects attitudes towards wildlife consumption. This study uses a vignette experimental format to directly examine how altering the legal context affects demand for wildlife products. Further, it differentiates between the legalization of wild-sourced products versus the legalization of products from captive animals on wildlife farms.

1.2. Wildlife farming and demand

As with legalization more broadly, some conservationists have proposed wildlife farming, the commercial breeding and legal sale of non-domesticated species, as a mechanism for meeting the demand for wildlife products and mitigating poaching (Conrad 2012). However, in order to have conservation benefits, wildlife farming needs to meet numerous conditions that involve both biological characteristics of the species and the dynamics of demand (Phelps et al., 2014). These prerequisites include, but are not limited to, the farmed product forming a substitute for the wild product, an absence of

laundering, no restocking of the farmed population with wild-caught animals, farming being more cost-efficient than poaching, and demand remaining stable (Tensen 2016).

It is rare for all these criteria to be met (Tensen 2016; Challender et al., 2019). Although the relationship between wild and farmed markets is complex (Hinsley and 't Sas-Rolfes 2020), parallel markets can develop for wild-caught and farmed products (Phelps et al., 2014) as, for some wildlife products, consumers prefer and are willing to pay a premium for wild-sourced products (Hanley et al., 2018; Davis et al., 2016; Gratwicke et al., 2008). Furthermore, legal farms can provide cover for the laundering of illegally-sourced animals (Lyons and Natusch 2011). Especially for species that don't breed well in captivity, wildlife farms are often stocked either partially or fully with wild-caught individuals (Livingstone and Shepherd 2014; Crudge et al., 2018). For many high-value wildlife species, poaching continues to be profitable relative to the perceived risks of enforcement, which can undercut products from legal trade (Gratwicke et al., 2008); this continued poaching places extreme pressure on wildlife populations already at risk (Gray et al., 2018).

Further, wildlife farms can affect demand for wildlife products through numerous mechanisms, which includes the increased availability of wildlife products as well as consumer preferences and market dynamics (Davis et al., 2019; Dutton et al., 2011; Dang and Nielson 2018; Rizzolo 2020). As the dynamics of demand depend upon species, social norms, geographic context, and motivations for consumption (Rizzolo 2020), there is still much uncertainty about how legal wildlife farming affects demand for wildlife products and wildlife consumer behavior (Challender et al., 2019). An important area of research on this front is direct measurement of consumer attitudes in response to different variables that impact the consumption choice. For example, Hanley et al. (2018) examined how price, harvesting method, rarity, and product source impacted the willingness to pay for rhino horn. However, much of this work focuses on characterizing demand for a singular product or species. One exception is Coals et al. (2020), which analyzed the intersection of consumer preferences for lion and tiger products in China and Vietnam and provided important quantitative data on the dynamics (and limitations) of wildlife product substitutability both across species and across the farmed/wild nexus. This work indicated that the wild/farmed distinction has a strong impact on consumer preferences, as most consumers demonstrated fidelity to their choice of farmed or wild-sourced products. This paper builds upon this important work; it broadens the species considered (to include both mammals and non-mammals) and includes varied products and types of use (Coals et al., 2020 focused on tiger and lion bone wine). It uses an experimental vignette design to examine how differences in species and type of use intersect with issues of source (wild versus farmed) and legality in their impact on demand for wildlife products used for medicine, food, and ornamentation.

2. Methods

2.1. Sensitive questions and vignette research

The sensitive nature of wildlife consumption can present methodological hurdles for research on its prevalence and effects (Gavin et al., 2010; Solomon et al., 2015). The experimental vignette format of this study was selected for two core reasons. First, vignettes present information in context, which has numerous advantages (Atzmüller and Steiner 2010). This makes the research topic less abstract to respondents and more accurately models how respondents would encounter and respond to information in the real world. It also allows for the simultaneous presentation of numerous variables of interest. People make environmental decisions based upon the interaction of personal norms or attitudes with various contextual variables (Stern 2000). Through combining multiple variables in a single scenario, vignettes attempt to replicate how people consider numerous variables (e.g. taxon, legal status, origin of the wildlife product, type of use) simultaneously.

Second, this method helps minimize social desirability bias and gather accurate data about a sensitive issue. Surveys that ask about sensitive topics such as taboo behaviors, unsocial attitudes, or illegal activities often generate inaccurate survey results due to social desirability bias (Krumpal 2013). Social desirability bias refers to the tendency to present oneself positively to the researcher, which can lead respondents to overestimate positive behaviors and/or underestimate negative or stigmatized behaviors. This is one of the most common sources of bias impacting the validity of survey research (Nederhof 1985). Indirect questioning is one way to reduce social desirability bias and increase the validity of survey items that deal with sensitive questions (Hughes and Huby 2004). Vignettes present information about a situation rather than ask respondents to self-reveal information, yet responses to vignettes tend to be accurate correlates of real-life behavior (Hainmueller et al., 2015). Vignettes have been successfully applied to other sensitive, complex topics such as sexual assault and drug use (Bachman et al., 1992; Hughes 1998). This paper is the first application of vignette research to wildlife consumption in particular.

2.2. Choice of wildlife species

The vignettes focused on the consumption of two mammal species (tiger and bear) and two reptile species (snake and turtle). In the survey, these species were referred to in general terms (as "snake", "turtle," "bear," or "tiger") and scientific names or subspecies were not clarified. This was meant to capture how, particularly for snakes and turtles in China, consumption of these animals tends not to differentiate between subspecies (see Zhang and Yin 2014). From these four species, eight products were selected: tiger bone, tiger skin, bear bile, bear paws, snake bile, snake leather, turtle shells, and turtle meat. These products are utilized for the most common forms of wildlife consumption in China: wildlife as medicine, food,

and ornamentation (Zhang and Yin 2014). It is important to include diverse motivations for wildlife use, as variation in motivation impacts the dynamics of demand for wildlife products (Dang Vu and Nielsen 2018).

Tigers and bears are widely farmed and consumed in China for both medicinal and non-medicinal purposes (Zhang et al., 2008; Liu et al., 2016). Tiger bones are made into medicinal wine and their pelts are ornamental status symbols (Wong 2016). Demand for tiger bone wine is high in China, and Chinese consumers indicate a strong preference for tiger bone wine over substitutes (Coals et al., 2020). In China, there are over 200 tiger farms with 6000 tigers held in poor welfare conditions; this is almost twice the number of tigers that exist in the wild worldwide (Environmental Investigation Agency 2017). Tigers are also the most heavily traded of all captive-source Asiatic big cats, comprising over 90% of the trade (Species Survival Network 2014).

Bear bile is used widely in Traditional Chinese Medicine and bear paw soup is considered a culinary delicacy (Feng et al., 2009; Sharma 2005). Over 12,000 bears are farmed in China alone, where their bile is extracted through a wound that is kept open for up to thirty years (Li 2004; Dutton et al., 2011). These extraction techniques yield severe and detrimental health consequences that persist long-term and which include both physical and psychological distress for the farmed bears (Bando et al., 2019; Loeffler et al., 2009).

Tigers are classified by the International Union for Conservation of Nature as Endangered (Goodrich et al., 2015), while bears are Vulnerable[1] (Garshelis and Steinmetz 2016), and both species are subject to international legal protections under CITES. Although China is a signatory to CITES, the Chinese government has actively promoted and legalized farming of these species, using the argument that farming bears and tigers will help conserve them in the wild (Environmental Investigation Agency 2017; Dutton et al., 2011; Haikui and Zhi 2007; Nowell 2010). This decision has implications for trade and use of these species both within and outside China. There have been reports of illegal tiger trade at government-sanctioned tiger farms (Nowell 2010). For bears, there is evidence that, in Lao PDR and Myanmar, the majority of bear farms are owned by Chinese or Vietnamese individuals; further Lao PDR has been identified as a source of bear cubs for Chinese bear bile farms (Foley et al., 2011; Livingstone and Shepherd 2014). Therefore, the debates over legalization and wildlife farming have immediate and real-world consequences for these species.

Similar to tigers and bears, snakes and turtles are extensively consumed and farmed in China (Zhang et al., 2008). Snakes are among the most commonly eaten wildlife species in China (Yang et al., 2007; Aust et al., 2017) and demand for their meat and skins, which are made into ornamental leather, continues to increase (Zhou and Jiang 2004). Despite the presence of snake farming in China, legal and illegal imports of snakes and snake products remain high, and demand threatens numerous snake species with extinction (Zhou and Jiang 2004; Chuanwu et al., 2019). Turtles are both eaten and used, due to their symbolism of longevity, in Traditional Chinese Medicine (Haitao et al., 2007). China has undertaken legal turtle farming on a massive scale to attempt to meet demand for turtle meat and shells (Haitao et al., 2008; Gong et al., 2018), but it has been argued that such farming is counterproductive to conservation (Haitao et al., 2007) and populations of numerous species of turtles continue to plummet (Stanford et al., 2020). As with tigers and bears, the debates over legalization and farming of turtles and snakes are timely and relevant to current environmental decision-making.

2.3. Sample

The sample (N = 1002) of adult respondents from Mainland China was recruited through the research firm Qualtrics, which has expertise in China-based sampling. Respondents were recruited through Qualtrics from their China-based panel. Qualtrics panel members are recruited from various sources, including website intercept recruitment, member referrals, targeted email lists, gaming sites, customer loyalty web portals, permission-based networks, and social media. Panel members' names, addresses, and dates of birth are typically validated via third-party verification measures prior to their joining a panel. Panelists join from a variety of sources and are compensated through various means; they may be airline customers who chose to join in reward for SkyMiles, retail customers who opt in to receive points at a retail outlet, or general consumers who participate for cash or gift cards. Panel members are sent an email invitation or prompted on the respective survey platform to proceed with a given survey. Qualtrics utilizes numerous quality control measures, such as tracking the amount of time a respondent spends on a survey, to ensure data quality.

Respondents completed the survey online through the Qualtrics platform in October 2019. The sample included a gender quota representative of China's adult population and was diverse in terms of gender, age, income, and education (Table 1). The distribution of gender, age, and income in the sample was approximately representative of China's population as a whole as measured in the 2015 census (National Bureau of Statistics in China 2016). The sample included more highly educated respondents than is representative of China as a whole. However, given the established connection between social status and wildlife consumption in China (Zhang and Yin 2014), this allowed the survey to capture a demographic relevant to the research topic. These demographic variables were drawn directly from other research on wildlife consumption in China (Meijer et al., 2017; Zhang and Yin 2014) in order to complement that scholarship. Due to constraints on survey length imposed in order to prevent survey fatigue and promote completion, demographic variables were restricted to gender, age, income, and education; income and education (rather than profession) were used as indicators of social status. Before commencement of the full survey, a pretest of 50 participants was conducted in order to evaluate data quality and survey

[1] This classification refers to the Asiatic Black Bear (*Ursus thibetanus*).

Table 1
Sample.

Gender (in %)		Monthly Personal Income (in %)	
Male	51.1%	Under RMB ¥ 4,000	14.9%
Female	48.9%	RMB ¥ 4,000-8,000	35.1%
		RMB ¥ 8,000-20,000	38.5%
		Over RMB ¥ 20,000	11.5%
Age (in %)		*Education (in %)*	
18-20	5%	Less than high school	3.3%
21-30	22.1%	High school	14.1%
31-40	19.8%	College	54.4%
41-50	23.5%	Graduate degree	28.2%
51-60	17.1%		
61-70	12.7%		

validity. The study was reviewed and determined to be exempt by Michigan's State University's Institutional Review Board (study number 00002048).

2.4. Vignettes and variables

Respondents were randomly assigned one of 24 different vignettes (Table 2). Since Qualtrics excludes unfinished surveys from the sample, the number of respondents per vignette ranged from 37 to 44. Whereas demographic variables were not used to assign respondents to different vignettes (assignment was random), the distribution of these variables across vignettes was roughly similar. This design was chosen to prevent the confounding of main effects and interaction effects with vignette condition (Steiner et al., 2016; Steiner personal communication). Each vignette described the consumption of a wildlife product from one of four species (bears, tigers, snakes, or turtles), for one of two uses (medicinal or non-medicinal), in one of three legal situations (product is illegal, product is legal and from farmed animal, or product is legal and from wild animal). The choice to divide consumption into medicinal and non-medicinal use was made in order to model recent developments that have granted TCM-related wildlife use particular prestige or legal exemptions. This includes the addition of TCM to the latest (11th) version of the World Health Organization's *International Statistical Classification of Diseases and Related Health* Problems (Lam et al., 2019); China's 2018 temporary reversal on its ban on rhino and tiger parts for medicinal use (Hernández 2018); and the exclusion of medicinal wildlife use from China's 2020 emergency measures to mitigate the spread of COVID-19 (White 2020).

These variables were combined and presented in a paragraph form that mimics how these respondents would be presented with this information in a real-world context (Table 3 and 4).

Table 2
Vignettes.

Vignette	Species	Origin	Consumption status	Product
1. Farming of tigers for medicinal product	Tiger	Farmed	Legal	Tiger bone [medicinal]
2. Farming of tigers for non-medicinal product	Tiger	Farmed	Legal	Tiger skin [ornament]
3. Harvesting of tigers for medicinal product	Tiger	Wild	Legal	Tiger bone [medicinal]
4. Harvesting of tigers for non-medicinal product	Tiger	Wild	Legal	Tiger skin [ornament]
5. Poaching of tigers for medicinal product	Tiger	Wild	Illegal	Tiger bone [medicinal]
6. Poaching of tigers for non-medicinal product	Tiger	Wild	Illegal	Tiger skin [ornament]
7. Farming of bears for medicinal product	Bear	Farmed	Legal	Bear bile [medicinal]
8. Farming of bears for non-medicinal product	Bear	Farmed	Legal	Bear paws [food]
9. Harvesting of bears for medicinal product	Bear	Wild	Legal	Bear bile [medicinal]
10. Harvesting of bears for non-medicinal product	Bear	Wild	Legal	Bear paws [food]
11. Poaching of bears for medicinal product	Bear	Wild	Illegal	Bear bile [medicinal]
12. Poaching of bears for non-medicinal product	Bear	Wild	Illegal	Bear paws [food]
13. Farming of snakes for medicinal product	Snake	Farmed	Legal	Snake bile [medicinal]
14. Farming of snakes for non-medicinal product	Snake	Farmed	Legal	Snake leather [ornament]
15. Harvesting of snakes for medicinal product	Snake	Wild	Legal	Snake bile [medicinal]
16. Harvesting of snakes for non-medicinal product	Snake	Wild	Legal	Snake leather [ornament]
17. Poaching of snakes for medicinal product	Snake	Wild	Illegal	Snake bile [medicinal]
18. Poaching of snakes for non-medicinal product	Snake	Wild	Illegal	Snake leather [ornament]
19. Farming of turtles for medicinal product	Turtle	Farmed	Legal	Turtle shells [medicinal]
20. Farming of turtles for non-medicinal product	Turtle	Farmed	Legal	Turtle meat [food]
21. Harvesting of turtles for medicinal product	Turtle	Wild	Legal	Turtle shells [medicinal]
22. Harvesting of turtles for non-medicinal product	Turtle	Wild	Legal	Turtle meat [food]
23. Poaching of turtles for medicinal product	Turtle	Wild	Illegal	Turtle shells [medicinal]
24. Poaching of turtles for non-medicinal product	Turtle	Wild	Illegal	Turtle meat [food]

Table 3
Example vignette (English version).

The State Council has issued an order that allows for the legal and controlled use of tiger bone for medicinal use in China. Regulation on the sales and use of tiger bone for medicinal use will be strengthened and the trade volume will be strictly controlled. Tiger bone used in medical research or in healing will be reported to and approved by authorities. Tiger bone can only be used in qualified hospitals by qualified doctors recognized by the State Administration of Traditional Chinese Medicine. Tiger bone used in medical research or in healing can only be obtained from farmed tigers. Like agricultural animals, farmed tigers are captive-bred for the purpose of consumption. According to the State Council, tiger farming protects wild tiger populations and provides economic development. The State Council encourages and supports tiger farming

The survey was originally written in English and underwent multiple rounds of translation and back-translation, as recommended for cross-cultural surveys (Cha et al., 2007). Vignettes were presented to the respondents in Simplified Chinese and were modeled from real press releases and laws issued by the Chinese Government. These source materials were China's 2017 ivory trade ban (Wildlife Conservation Society 2017), China's 2017 Wildlife Protection Law (People's Republic of China 2017), and China's 2018 temporary reversal on its ban on rhino and tiger parts in medicine (People's Republic of China 2018).

After reading the vignette, the respondent answered questions, presented on a Likert scale, about the acceptability of wildlife consumption, the social approval of wildlife consumption, and the legal repercussions for all eight wildlife products examined in the study.[2] These outcome variables are drawn from the criminological literature on perceptual deterrence (Zimmerman 2008). They include measurement of both formal and informal sanctions. Formal control uses the legal system to promote compliance, whereas informal control operates through social institutions and interactions. In prior work on Chinese respondents, researchers have identified the combination of formal and informal control as important for crime deterrence (Jiang et al., 2010).

In addition to these vignette-specific questions, all respondents completed a demographic questionnaire and two attitudinal questionnaires (available in the supplementary material). For each attitudinal questionnaire, respondents were randomly assigned to receive the questionnaire at either the beginning or end of the survey. The order of the questions within each questionnaire were randomized as well. The first questionnaire measured respondents' attitudes towards the four species included in the vignettes and the second questionnaire, adapted from Zhang et al. (2008), measured their overall attitudes towards wildlife consumption. This included questions characteristic of three different orientations towards wildlife consumption: pure protection (wildlife is not for human use), conditional utilization (wildlife can be used under certain conditions), and pure utilization (wildlife is for human consumption). These questions were combined into a matrix (see the cognitive orientation matrix in the supplementary materials) that allowed each question to be analyzed as a separate variable, in order to capture respondents who bridged multiple categories. The data was analyzed using SPSS version 25 (IBM Corp. 2017).

As each respondent viewed a single vignette (e.g. there were not multiple measurements across individuals), multivariate linear regression models were appropriate for analysis of the results (Montgomery et al., 2012). The first set of models included all main effects and 2-way interaction effects. The second set of models incorporated all main effects, 2-way interaction effects, and 3-way (higher-order) interaction effects. Every model controlled for perceptions of the four species of interest, respondents' cognitive orientation towards wildlife consumption, and demographic variables (gender, education, income and age).

Species, legal context, education, income, and age were included as effect-coded categorical variables (Mayhew and Simonoff 2015; Alkharusi 2012). Like dummy coding, this method excludes one group from the regression models. The excluded groups were turtles (for species), harvested (for legal context), less than high school completed (for education), less than RMB ¥ 4000 (for personal monthly income), and 18–20 years old (for age). However, whereas dummy coding uses the excluded category as a reference group, effect codes are interpreted based on the unweighted average of the group means. This method is useful for variables without a logical reference group, such as species (Mayhew and Simonoff 2015); it is appropriate when it makes theoretical sense to compare each group with the entire set of groups rather than a reference or control group (Alkharusi 2012).

3. Results

Models were conducted for the acceptability of wildlife consumption (Table 5), expectations of the severity of legal punishment for wildlife consumption (Table 6), and perceived social approval of wildlife consumption (Table 7). Each model included species, legal context, type of use, and 2-way interaction effects between all of these main variables. In addition, each model controlled for perceptions of the four species of interest, cognitive orientation, and demographic variables (the regression coefficients for demographic indicators are reported in the supplementary material).

[2] These products are tiger bone, tiger skin, bear bile, bear paws, snake bile, snake leather, turtle shells, and turtle meat. The order of questions was randomized.

Table 4
Example vignette (Chinese version)

在回答以下问题之前，请仔细阅读本段内容。 中国国务院已发布命令，允许在中国将虎骨合法及合理入药。政府将加强对销售和使用药用虎骨的监管，并严格控制交易量。将虎骨用于医学研究或治疗须向有关部门申报并获得批准。虎骨仅限国家中医药管理局认可的有资质医生在有资质的医院使用。用于医学研究或治疗的虎骨必须来自人工繁育的老虎。和牲畜一样，人工繁育老虎的制品可供使用。据中国国务院表示，人工繁育老虎可以保护野生老虎种群并促进经济发展。国务院鼓励并支持人工繁育老虎。

3.1. Wildlife farming

The results indicate that wildlife farming increases the acceptability and lowers the stigma (e.g. increases the perceived social approval) of wildlife consumption. Further, wildlife farming lowers expectations of legal punishment. These effects were particularly strong for mammals. Bear farming amplifies the acceptability and perceived social approval of bear bile (Tables 5 and 7); it also decreases perceived legal punishment for both bear bile and bear paw consumption (Table 6). Tiger farming diminishes perceived legal sanctions for both tiger bone and tiger skin (Table 6).

For reptiles, wildlife farming has some effects on demand for wildlife products, but these are less pronounced than those for mammals. Snake farming decreases perceived legal sanctions for snake leather (Table 6) and medicinal farming boosts the acceptability of turtle shell consumption (Table 5).

For mammals, there are significant interaction effects between species, wildlife farming and the type of consumption (medicinal or non-medicinal). Farming tigers specifically for medicinal use strongly increases the acceptability of tiger bone and tiger skin consumption, and also amplifies the social approval of tiger skin. In models that contain three-way interaction effects, bear farming increases acceptability, amplifies social approval, and lowers perceived punishment for bear paw consumption. This is congruent with the effects of bear farming on bear bile consumption (Tables 5, 6, and 7). However, in those same models, farming bears *only for medicinal use* has the opposite effect on bear paw consumption: it lowers the acceptability and social approval of bear paws.

For tigers, the effects of farming tigers for medicinal use extend to non-medicinal products (namely, tiger skin). This is not true for bears. Bear farming overall (not for medicinal use in particular) is what increases the acceptability, lowers the social stigma, and decreases the perceived legal consequences of bear consumption.

3.2. Wildlife product bans

The results demonstrate that wildlife product bans decrease the acceptability and social approval of wildlife consumption and increase estimations of legal punishments. The type of ban that produces these effects differs depending upon the wildlife product and the measurement of wildlife consumption (acceptability, social approval, or legal punishment). For tigers, the form of ban that decreases acceptability is contingent upon the product. A ban on all tiger products decreases the acceptability of tiger skin, whereas a ban on medicinal wildlife products lowers the acceptability of tiger bone (Table 5). A ban on tiger products does lower the perceived social approval, if not the personal acceptability, of tiger bone consumption (Table 7). A ban on tiger products also increases the expected severity of legal sanctions for both tiger bone and tiger skin (Table 6). However, when the ban is for medicinal products only, it lowers the perceived legal punishment for tiger skin (a non-medicinal product). This indicates that the type of ban most effective for dampening tiger consumption depends upon the type of tiger product. Medicinal wildlife bans are more effective for reducing demand for tiger bone (which is used for medicine), whereas bans on tiger consumption are more useful for decreasing demand for tiger skin (an ornamental product).

For bears, a ban on medicinal wildlife products decreases the social approval of bear bile (Table 7). However, for bear paws, it is a ban on bear products that lowers the acceptability and social approval of consumption (Tables 5 and 7). For bear paws, bans on the medicinal use of bears actually increase social approval. Thus, as with tigers, the type of ban most useful for

Table 5
Acceptability of Wildlife Consumption

	Tiger Bone	Tiger Skin	Bear Bile	Bear Paws	Snake Bile	Snake Leather	Turtle Shells	Turtle Meat
Species of Vignette								
Turtle (excluded)								
Tiger	.007	.015	-.053	.001	-.151	-.086	-.116	-.087
Bear	-.031	-.027	.001	.023	.179	.047	.048	-.002
Snake	-.017	-.041	-.104	-.088	-.016	.039	.031	.029
Legal Context of Vignette								
Harvested (excluded)								
Farmed	.009	.103	-.020	-.015	.047	.049	-.050	.046
Banned	.083	-.057	.055	-.029	-.134	-.125	-.069	-.126
Type of Use of Vignette								
Medicinal	.079	.063	.028	-.026	.077	.056	.109	.019
Interactions								
Farmed * tiger	.099	.109	.008	.004	.030	.009	.017	-.015
Farmed * bear	.108	.073	**.270****	.145	.041	.046	-.044	-.065
Farmed * snake	-.076	-.017	-.137	-.026	.145	.104	.062	.119
Banned * tiger	-.118	**-.153***	-.093	-.122	.006	-.003	.093	.070
Banned * bear	.004	.026	-.149	-.111	.058	-.026	-.045	.055
Banned * snake	.122	.129	**.204***	**.170***	-.158	-.072	.065	.022
Medicinal * tiger	.186	.103	.056	.085	.100	.034	.066	.125
Medicinal * bear	.060	-.007	**.249***	-.056	.038	.078	.077	.043
Medicinal * snake	-.156	-.053	.019	.012	-.224	-.169	-.028	.022
Farmed * medicinal	.158	.041	.063	.085	.0008	-.052	**.258****	.044
Banned * medicinal	**-.196***	-.072	-.156	-.056	.021	.119	-.106	.047
Perceptions of Species								
Perception of tigers	-.033	-.041	.037	.017	**.120****	.073	.057	-.008
Perception of bears	-.086	**-.098***	**-.206****	**-.125****	-.086*	**-.101***	-.036	-.023
Perception of snakes	.037	.049	**.076***	**.139****	-.086	-.015	-.031	.018
Perception of turtles	.075	**.091***	.076	-.017	.010	.061	.024	-.026
Cognitive Orientation								
All wildlife is for consumption	**.241****	**.266****	**.247****	**.258****	**.089***	**.123****	**.137****	**.161****
No wildlife is for consumption	**-.060***	-.034	**-.097****	**-.070***	**-.130****	**-.107****	-.043	-.017
Consumption for TCM is allowable	**.135****	**.129****	**.154****	**.118****	**.135****	**.147****	**.135****	**.127****
Only products from captive-bred wildlife are allowable	.039	-.019	**.088****	.010	**.203****	**.202****	**.130****	**.089***
Only products from wild-caught wildlife are allowable	**.139****	**.111****	**.123****	**.148****	.006	.008	.024	.064
Constant	.998	1,044	.964	.984	2.090	1.784	1.742	1.787
Adjusted R-squared	.185	.198	.249	.235	.141	.142	.098	.094

Note: Higher values indicate greater acceptability of wildlife consumption.
*Significant at p<.05
**Significant at p<.01

reducing bear consumption differs by type of use. Medicinal bans are salient for bear bile consumption (a medicinal product), whereas a species-level ban on bear products is more potent for bear paw consumption (a food product).

For reptiles, bans have a more uniform effect across type of use. A ban on snake consumption increases the stigma (decreases the perceived social approval) of snake bile (Table 7). However, most of the effects of bans on snake consumption are seen in perceptions of legal punishment. These impacts are similar across medicinal (snake bile) and non-medicinal (snake leather) products. A ban on snake products amplifies expected legal punishment for both products (Table 6). In models that incorporate higher-order (3-way) effects, both overall bans (on all wildlife products) and bans on the medicinal use of snakes raise estimations of legal punishment for snake products. This applies to both snake bile and snake leather. For turtles, an overall ban on wildlife products lowers social approval of turtle meat and raises perceived legal sanctions for both turtle meat and turtle shells (Tables 6 and 7).

3.3. Higher-order interaction effects

These models were then run with the additional inclusion of higher-order (3-way) interaction effects (see supplemental material for full models). For snakes, there were significant three-way interactions between legal context, species, and type of

Table 6
Perceived Legal Sanctions for Wildlife Consumption

	Tiger Bone	Tiger Skin	Bear Bile	Bear Paws	Snake Bile	Snake Leather	Turtle Shells	Turtle Meat
Species of Vignette								
Turtle								
Tiger	.032	-.021	.145	.152	.103	.020	.020	.096
Bear	-.046	.047	-.039	-.048	.007	.037	.018	-.011
Snake	-.028	-.003	-.144	**-.180***	-.175	-.152	-.177	**-.230***
Legal Context of Vignette								
Harvested								
Farmed	-.036	-.124	-.051	-.083	.001	-.012	-.098	-.109
Banned	.086	**.191****	.058	.093	**.160***	**.193***	**.208****	**.161***
Type of Use of Vignette								
Medicinal	-.013	-.012	0.010	.035	-.066	**-.193****	-.015	.034
Interactions								
Farmed * tiger	**-.202***	**-.177***	-.002	-.018	.079	.104	.173	.086
Farmed * bear	.070	.069	**-.232****	**-.189***	.056	.062	.134	**.225***
Farmed * snake	.072	.037	.081	.085	-.131	**-.210***	-.065	-.123
Banned * tiger	**.220****	**.187***	.000	.020	-.053	-.088	-.085	-.046
Banned * bear	-.100	-.085	.131	.108	-.159	-.087	-.061	-.103
Banned * snake	-.094	-.078	-.031	-.111	**.313****	**.298****	-.053	.018
Medicinal * tiger	-.168	-.076	-.216	**-.261***	.054	.106	.114	-.083
Medicinal * bear	.065	-.010	-.146	-.084	-.106	-.128	.008	.079
Medicinal * snake	.131	.093	.237	**.300****	**.372****	**.372****	.078	.141
Farmed * medicinal	-.031	.156	-.033	.044	-.013	.035	.020	.150
Banned * medicinal	-.035	**-.192***	.078	-.070	.122	-.007	-.046	-.092
Perceptions of Species								
Perception of tigers	**.137****	**.227****	.039	.069	**-.161****	-.054	**-.145***	-.083
Perception of bears	**.156****	.069	**.244****	**.186****	**.190****	.071	**.146****	.112
Perception of snakes	-.064	**-.092****	-.030	**-.070***	**.191****	**.160****	**.159****	**.114****
Perception of turtles	.002	.046	-.010	.029	**.108***	**.109***	**.102***	**.108***
Cognitive Orientation								
All wildlife is for consumption	**-.092***	**-.116****	-.022	**-.096***	**.167****	**.173****	**.156****	**.111***
No wildlife is for consumption	**.154****	**.123****	**.146****	**.156****	**.132****	**.108****	**.092****	**.101****
Consumption for TCM is allowable	**-.087***	-.062	**-.141****	-.065	-.069	-.058	**-.105***	-.051
Only products from captive-bred wildlife are allowable	.058	**.072***	-.023	.048	**-.208****	**-.196****	**-.138****	**-.191****
Only products from wild-caught wildlife are allowable	-.066	**-.087***	-.058	**-.137****	**.090***	.061	.018	.011
Constant	2.755	2.735	3.004	2.973	1.379	1.638	1.834	1.997
Adjusted R-squared	.123	.154	.119	.138	.174	.143	.122	.102

Note: Higher values indicate more severe perceived legal sanctions.
*Significant at p<.05
**Significant at p<.01

use, but this only affected perceived legal sanctions. Bans on the medicinal use of snakes increased the perceived legal sanctions for both snake bile ($\beta = 0.622$, $p < .01$) and snake leather ($\beta = 484$, $p < .01$).[3]

For bears, there were also significant three-way interaction effects between legal context, species, and type of use. Farming bears for medicinal use lowered the acceptability ($\beta = -0.357$, $p < .05$) and social approval ($\beta = -0.302$, $p < .05$) of bear paws (a non-medicinal product) and a ban on medicinal bear products increased the social approval of bear paws ($\beta = 0.394$, $p < .01$). This suggests that medicinal-focused interventions for bears do not extend to (and in fact have the opposite effect for) non-medicinal bear products.

Three-way interaction effects between legal context, species, and type of use also emerged for tigers. Farming tigers specifically for medicinal use was associated with increased acceptability of tiger bone ($\beta = 0.520$, $p < .01$), a medicinal product, but it also amplified the acceptability ($\beta = 0.370$, $p < .05$) and social approval ($\beta = 0.319$, $p < .05$) of tiger skin, a non-medicinal product. Thus, unlike bears, medicinal-focused tiger farms have similar effects on demand for medicinal and non-medicinal tiger products.

[3] The three-way interaction models for turtles are reported in the supplemental material. However, as turtles were the excluded species in the regression models, the interaction effects are based on tigers, bears, and snakes.

Table 7
Perceived Social Approval of Wildlife Consumption

	Tiger Bone	Tiger Skin	Bear Bile	Bear Paws	Snake Bile	Snake Leather	Turtle Shells	Turtle Meat
Species of Vignette								
Turtle								
Tiger	-.109	-.058	-.106	-.013	0.133	-.110	-.135	-.095
Bear	.060	-.017	-.505	.065	.139	.077	.070	-.001
Snake	-.018	-.028	.013	-.035	-.012	.000	.060	.115
Legal Context of Vignette								
Harvested								
Farmed	.008	.033	.033	.045	.030	.030	.069	.099
Banned	.047	.006	.085	.052	-.082	-.089	-.112	**-.152***
Type of Use of Vignette								
Medicinal	-.051	-.025	.042	.009	.099	**.205****	.002	-.003
Interactions								
Farmed * tiger	.125	.128	.004	-.008	-.072	-.106	-.044	-.047
Farmed * bear	.035	.038	**.181***	.127	.096	.130	-.010	-.118
Farmed * snake	-.085	-.069	-.055	.004	.113	.120	-.010	.146
Banned * tiger	**-.183***	-.145	-.043	-.103	.060	.050	-.022	.013
Banned * bear	.033	.085	-.139	-.130	.039	-.046	.026	.063
Banned * snake	**.170***	.127	.073	.134	**-.176***	-.103	.095	.028
Medicinal * tiger	**.317****	.189	.123	.052	.113	.077	.181	.203
Medicinal * bear	-.047	.025	**.343****	.158	.038	.098	-.028	.015
Medicinal * snake	**-.261***	-.143	-.150	-.053	-.192	-.207	-.108	-.151
Farmed * medicinal	.120	.020	.062	.089	.067	.063	.092	-.007
Banned * medicinal	-.134	-.005	**-.203***	-.136	-.099	-.030	-.021	.128
Perceptions of Species								
Perception of tigers	-.060	-.052	.011	-.042	.131	.078	.077	.078
Perception of bears	-.050	-.068	**-.133****	-.055	-.089	-.062	-.077	**-.117***
Perception of snakes	.053	**.103***	**.077***	**.103****	**-.123****	-.060	-.005	.004
Perception of turtles	.028	.041	.006	.034	.028	.040	-.018	-.044
Cognitive Orientation								
All wildlife is for consumption	**.236****	**.289****	**.229****	**.292****	**.132****	**.132****	**.148****	**.170****
No wildlife is for consumption	-.055	-.045	-.055	-.038*	-.050	**-.057***	-.043	-.026
Consumption for TCM is allowable	**.107****	.061	**.123****	**.078***	**.105****	**.111****	**.108****	**.100****
Only products from captive-bred wildlife are allowable	.014	-.038	.029	-.009	**.167****	**.149****	**.114****	**.088****
Only products from wild-caught wildlife are allowable	**.150****	**.144****	**.131****	**.155****	.008	.026	.024	.053
Constant	1.142	1.039	1.158	.846	1.993	1.781	1.927	1.956
Adjusted R-squared	.187	.216	.205	.221	.119	.123	.098	.103

Note: Higher values indicate more perceived social approval of wildlife consumption.
*Significant at p<.05
**Significant at p<.01

3.4. Attitudinal variables

Overall, a pure protection attitude (measured as agreement with the statement “no wildlife is for consumption”) was associated with decreased acceptability of consumption, lowered social approval of consumption, and increased perceptions of legal punishment. A pure utilization attitude (“all wildlife is for consumption”) had opposite effects. The pure protection attitude had a particularly strong effect for perceived legal sanctions; it increased expected legal punishment for all wildlife products (Table 6). The pure utilization attitude, on the other hand, was especially salient for personal and social approval of wildlife consumption; it was associated with increased acceptability and social approval for all wildlife products (Tables 5 and 7). The significance of attitudes towards captive-bred and wild-caught animals (both measurements of conditional utilization) depended upon other factors such as species. Increased agreement with the statement “only consumption from captive-bred animals is allowable” was correlated with more acceptability and social approval of reptile consumption. In contrast, more agreement with the notion that “only consumption from wild-caught animals is allowable” was associated with higher acceptability and social approval of mammal consumption. As discussed below, this indicates foundational differences in the social perceptions of mammals and reptiles. Finally, increased agreement with the statement “consumption of wildlife for

Traditional Chinese Medicine is allowable" was correlated with higher acceptability and social approval of *both* medicinal and non-medicinal products. However, one's attitude towards TCM was only associated with lower perceived legal sanctions for medicinal products (it had no effect on perceived legal sanctions for non-medicinal products).

4. Discussion

This paper provides empirical evidence for the stigma effect in wildlife consumption. Prior analyses of the stigma effect have utilized economic modeling (Abbott and Van Kooten 2011; Bulte and Damania, 2005) and have not directly measured how legalization affects attitudes towards wildlife consumption. The results provide strong evidence that the legal context affects not only perceptions of legal punishment, but also the level of acceptability and the social approval granted wildlife consumption. While acceptability is not equivalent to behavior, it is a powerful motivator that influences wildlife use (Thomas-Walters et al., 2019). Knowledge of how motivations respond to different levers (such as legalization or bans) provide indicators of how consumer motivations can change and therefore impact actual wildlife consumption (Zhang et al., 2008; Bachmann et al., 2019; Davis et al., 2016).

In numerous cases, bans *decrease* the acceptability and social approval of wildlife consumption and legalized wildlife farms *increase* acceptability and social approval. This indicates that levers of demand (acceptability and social approval) are fluid in response to legal change. This challenges the notion that demand can be saturated through products from legal or farmed wildlife products. Models of supply-side conservation need to take into account how lowered stigma can increase demand.

Interestingly, the results suggest that illegality has a more uniform effect across species than legality. For all species studied (bear, tiger, snake, and turtle), bans effectively lowered acceptability and social approval, and increased perceptions of legal punishment. That is, bans increased the stigma of wildlife consumption for varied products across species. Legal wildlife farming demonstrated more variability across species; the effects of legal wildlife farming were most substantial for mammals. This indicates that legalization and wildlife farming are related but unique policy contexts.

Species differences in the attitudinal correlates of consumption may be due to social perceptions of mammals and reptiles. For mammals, a respondent's attitude towards wild animals was a strong correlate of attitudes towards consumption. For reptiles, one's attitude towards captive-bred wildlife was a salient correlate. It's possible that there is a baseline level of acceptance towards the use of captive snakes and turtles. For mammals, wildlife farms may present a more substantial escalation of commodification and thus has a stronger effect on acceptability, social approval, and perceived legal punishment. Another option is that the preference for wild-sourced products is stronger for mammal products than for reptile products, and thus attitudes towards wild animals exert a larger influence for mammals. While both of these interpretations require further investigation, qualitative work on wildlife farms has identified species, and the distinction between mammals and non-mammals in particular, as a significant factor in whether or not wildlife farms are stigmatized or accepted (Rizzolo 2020).

The results also indicate that the effects of wildlife farming and wildlife bans can impact the consumption of non-target species, or species that are not the focus of that particular ban or form of farming. These effects seem to take two main forms: displacement or extension. Displacement is when the consumer finds an alternative product due to a change to the accessibility of the original product. For example, a ban on snake consumption is correlated with increased acceptability of bear products (Table 5) and heightened social approval of tiger bone (Table 7). This suggests that there may be overlap between consumers of these species; if snake products are not available (banned), there may be more willingness to consume bear or tiger. However, extension can also occur; this is when the consequence for the target species expands to other species. For example, the effects of bear farming on reducing the stigma of wildlife consumption extend to tigers. Bear farming is associated with increased acceptability of tiger bone and tiger skin. Interestingly, whether extension or displacement occurs can also depend upon type of use. For example, while bear farming is associated with more pro-consumption attitudes towards tiger consumption, when it is specified that bear farming is for medicinal purposes only, this decreases the acceptability of tiger skin, a non-medicinal product. When it is specified that a ban on bear products just applies to medicinal uses, this increases the acceptability of tiger skin. This indicates that the level of specificity assigned to wildlife farming or wildlife bans influence how these policies impact non-target species.

This paper also demonstrates the nuances of how Traditional Chinese Medicine (TCM) exerts a substantial impact on wildlife consumption. Agreement with the use of wildlife for TCM was correlated with higher acceptability and social approval of *both* medicinal and non-medicinal products. Further, there were numerous significant interaction effects between medicinal use and legal context. For example, for bears and tigers, medicinal bans (but not species-level bans) reduced the acceptability or social approval of medicinal uses of these species. As mentioned, TCM-based wildlife consumption in China is often granted particular privileges or legal exemptions not granted to other types of wildlife use. These results suggest that this can be problematic to conservation for two reasons. First, a pro-TCM orientation can generalize to and increase non-TCM wildlife uses. Second, it seems that the reduction of demand for medicinal products (such as bear bile) often requires policies that specifically target medicinal use; generalized interventions towards that species may not be sufficient. Increased agreement with the statement "consumption of wildlife for Traditional Chinese Medicine is allowable" was correlated with higher acceptability and social approval of *both* medicinal and non-medicinal products. However, this attitude was only associated with lower perceived legal sanctions for medicinal products (it had no effect on perceived legal sanctions for non-medicinal products). Thus, while one's attitude towards TCM affects attitudes towards non-medicinal consumption, it does so in the personal and social (rather than legal) realms.

There are several limitations of this work that could be expanded upon in future research. While the structured quantitative format of the survey allowed for an experimental design, it did not provide qualitative data on respondent motivations. While qualitative research on wildlife farms has been conducted with key informants from academia (Rizzolo 2020), further qualitative research with Chinese respondents/consumers would be useful for the interpretation of results such as taxa differences and for the inclusion of additional demographic variables (such as profession). Second, it is important to acknowledge that the stigma effect is one of several factors that influence the acceptability of wildlife consumption. For example, the availability of wildlife products can also increase the acceptability of consumption and wildlife farms can simultaneously influence both availability and stigma (Rizzolo 2020; Davis et al., 2016).

Despite these constraints, this paper offers important insights into how legalization and wildlife farms affect both the acceptability of wildlife consumption and conservation debates more broadly. These issues are particularly relevant given the global COVID-19 pandemic and its likely links to wildlife consumption (Broad 2020). The results have several implications for conservation policymakers and practitioners. First, much of the discourse on COVID-19 and wildlife consumption has been focused on wildlife wet markets (WWF 2020). However, based on this research and other scholarship, it appears that (at least for some species) wildlife farms are not effective substitutes for wet markets. Wildlife farms can also be reservoirs for zoonotic disease (Green et al., 2020). In addition, the results presented in this paper indicate that wildlife farming (of bears and tigers in particular) can increase the acceptability of wildlife consumption and thus can increase rather than tamper demand. The results can also inform the debate over wildlife bans in the context of COVID-19. The data indicates that bans can be effective but need to be tailored to the species, product, and type of use. For mammals (bears and tigers), the distinction between species-based bans and use-based bans was important. A general ban on tiger consumption was useful for decreasing demand for tiger skin (an ornamental product), whereas a medicinal wildlife ban was more effective for reducing demand for tiger bone (which is used for medicine). As with tigers, the type of ban most useful for reducing bear consumption differed by type of use. Medicinal bans were salient for bear bile consumption (a medicinal product), whereas a species-level ban on bear products was more effective for bear paw consumption (a food product). Thus, it appears that a reduction in demand for mammal-based medicinal products (such as bear bile or tiger bone) might require a ban that specifically targets medicinal use. While species-level consumption bans could be effective in reducing demand for products such as bear paws and tiger skin (food and ornamental products, respectively), it is important to consider bans on medicinal use to fully address the markets for these species. Although, thus far, China has focused its wildlife bans on consumption for food, medicinal-based consumption requires policy intervention (across countries) as well. In contrast, for reptiles in this study, bans had a more uniform effect across type of use (medicinal versus non-medicinal). Overall, the data demonstrates that bans can be an effective tool but should take into account both taxa differences and type of consumption.

5. Conclusion

This paper has illustrated how legalization and wildlife farms affect the dynamics of demand for wildlife products. Wildlife consumption bans and wildlife farms influence demand for target species and can also impact other wildlife through extension or displacement. It is also important to examine how these policies intersect with other variables such as type of use. For example, for both tigers and bears, different types of bans were effective at dampening demand for medicinal versus non-medicinal products.

For both mammals and reptiles, the legal context significantly impacts the acceptability of consumption, the level of social stigma surrounding consumption, and the perceived legal deterrents to consumption. This provides empirical evidence of the stigma effect, or the manner in which legality increases, and illegality decreases, the acceptability of wildlife products. Across species, wildlife product bans (of various forms) help lower the acceptability, and increase the stigma, of wildlife consumption. For bears and tigers, wildlife farming amplifies the acceptability (and reduces the stigma) of consumption of these species. This suggests that bans on wildlife consumption and decreased wildlife farming of mammals can have conservation benefits.

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.

Acknowledgments

This research was funded in part by the UCLA Animal Law and Policy program. I am grateful to Dr. Peter Steiner, Dr. Henry Kim, Dr. Benjamin Nyblade, and Dr. Meredith Gore for their input on this research.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.gecco.2020.e01390.

References

Abbott, B., Van Kooten, G.C., 2011. Can domestication of wildlife lead to conservation? The economics of tiger farming in China. Ecol. Econ. 70 (4), 721–728.
Aguayo, F., 2014. Rhino Horn and the Economics of Wildlife Trade: Risks and Uncertainties. *Assessing The Risks of Rhino Horn Trade*. South Africa.
Aguirre, A.A., Catherina, R., Frye, H., Shelley, L., 2020. Illicit Wildlife Trade, Wet Markets and COVID-19: Preventing Future Pandemics. World Medical & Health Policy. https://doi.org/10.1002/wmh3.348.
Alkharusi, H., 2012. Categorical variables in regression analysis: a comparison of dummy and effect coding. Int. J. Educ. 4 (2), 202.
Atzmüller, C., Steiner, P.M., 2010. Experimental vignette studies in survey research. Methodology 6 (3), 128–138.
Aust, P.W., Van Tri, N., Natusch, D.J., Alexander, G.J., 2017. Asian snake farms: conservation curse or sustainable enterprise? Oryx 51 (3), 498–505.
Bachmann, M.E., Junker, J., Mundry, R., Nielsen, M.R., Haase, D., Cohen, H., Kühl, H.S., 2019. Disentangling economic, cultural, and nutritional motives to identify entry points for regulating a wildlife commodity chain. Biol. Conserv. 238, 108177.
Bachman, R., Paternoster, R., Ward, S., 1992. The rationality of sexual offending: testing a deterrence/rational choice conception of sexual assault. Law Soc. Rev. 26, 343–372.
Baker, S.E., Cain, R., Van Kesteren, F., Zommers, Z.A., D'cruze, N., Macdonald, D.W., 2013. Rough trade: animal welfare in the global wildlife trade. Bioscience 63 (12), 928–938.
Bando, M.K.H., Nelson, O.L., Kogan, C., Sellon, R., Wiest, M., Bacon, H.J., Komatsu, T., 2019. Metabolic derangements and reduced survival of bile-extracted Asiatic black bears (Ursus thibetanus). BMC Vet. Res. 15 (1), 263.
Bennett, E.L., 2015. Legal ivory trade in a corrupt world and its impact on African elephant populations. Conserv. Biol. 29 (1), 54–60.
Biggs, D., Cooney, R., Roe, D., Dublin, H.T., Allan, J.R., Challender, D.W., Skinner, D., 2017. Developing a theory of change for a community-based response to illegal wildlife trade. Conserv. Biol. 31 (1), 5–12.
Biggs, D., Courchamp, F., Martin, R., Possingham, H.P., 2013. Legal trade of Africa's rhino horns. Science 339 (6123), 1038–1039.
Broad, S., 2020. Wildlife Trade, COVID-19, and Zoonotic Disease Risks. TRAFFIC, Cambridge, UK.
Bulte, E.H., Damania, R., 2005. An economic assessment of wildlife farming and conservation. Conserv. Biol. 19 (4), 1222–1233.
Cha, E.S., Kim, K.H., Erlen, J.A., 2007. Translation of scales in cross-cultural research: issues and techniques. J. Adv. Nurs. 58 (4), 386–395.
Challender, D.W., Ades, G.W., Chin, J.S., Sun, N.C.M., lian Chong, J., Connelly, E., et al., 2019. Evaluating the feasibility of pangolin farming and its potential conservation impact. Global Ecology and Conservation 20, e00714.
Challender, D.W., Harrop, S.R., MacMillan, D.C., 2015. Towards informed and multi-faceted wildlife trade interventions. Global Ecology and Conservation 3, 129–148.
Chuanwu, C., Yanfu, Q., Xianfeng, Z., Yanping, W., 2019. Human overexploitation and extinction risk correlates of Chinese snakes. Ecography 42 (10), 1777–1788.
Coals, P., Moorhouse, T.P., D'Cruze, N.C., Macdonald, D.W., Loveridge, A.J., 2020. Preferences for lion and tiger bone wines amongst the urban public in China and Vietnam. J. Nat. Conserv. 57, 125874.
Conrad, K., 2012. Trade bans: a perfect storm for poaching? Tropical Conservation Science 5 (3), 245–254.
Crudge, B., Nguyen, T., Cao, T.T., 2018. The Challenges and Conservation Implications of Bear Bile Farming in Viet Nam, pp. 1–8. *d*,.
Crookes, D.J., Blignaut, J.N., 2015. Debunking the myth that a legal trade will solve the rhino horn crisis: a system dynamics model for market demand. J. Nat. Conserv. 28, 11–18.
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., 2019. Consumer demand and traditional medicine prescription of bear products in Vietnam. Biol. Conserv. 235, 119–127.
Davis, E.O., O'Connor, D., Crudge, B., Carignan, A., Glikman, J.A., Browne-Nuñez, C., Hunt, M., 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. 203, 282–289.
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 (7), e21243.
Environmental Investigation Agency, 2017. Cultivating Demand: the Growing Threat of Tiger Farms. London, UK.
Feng, Y., Siu, K., Wang, N., Ng, K.M., Tsao, S.W., Nagamatsu, T., Tong, Y., 2009. Bear bile: dilemma of traditional medicinal use and animal protection. J. Ethnobiol. Ethnomed. 5 (1), 2.
Foley, K.E., Stengel, C.J., Shepherd, C.R., 2011. Pills, Powders, Vials and Flakes: the Bear Bile Trade in Asia. TRAFFIC Southeast Asia, Petaling Jaya, Malaysia.
Garshelis, D., Steinmetz, R., 2016. Ursus thibetanus. *The IUCN Red List of Threatened Species* 2016, e.T22824A114252336. https://doi.org/10.2305/IUCN.UK.2016-3.RLTS.T22824A45034242.en (errata version published in 2017).
Gavin, M.C., Solomon, J.N., Blank, S.G., 2010. Measuring and monitoring illegal use of natural resources. Conserv. Biol. 24 (1), 89–100.
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.
Gong, S., Vamberger, M., Auer, M., Praschag, P., Fritz, U., 2018. Millennium-old farm breeding of Chinese softshell turtles (pelodiscus spp.) results in massive erosion of biodiversity. Sci. Nat. 105 (5–6), 34.
Gratwicke, B., Mills, J., Dutton, A., Gabriel, G., Long, B., Seidensticker, J., Zhang, L., 2008. Attitudes toward consumption and conservation of tigers in China. PloS One 3 (7), e2544.
Gray, T.N., Hughes, A.C., Laurance, W.F., Long, B., Lynam, A.J., O'Kelly, H., et al., 2018. The wildlife snaring crisis: an insidious and pervasive threat to biodiversity in Southeast Asia. Biodivers. Conserv. 27 (4), 1031–1037.
Green, J., Jakins, C., Asfaw, E., Bruschi, N., Parker, A., de Waal, L., D'Cruze, N., 2020. African lions and zoonotic diseases: implications for commercial lion farms in South Africa. Animals 10 (9), 1692.
Haikui, H., Zhi, L., 2007. Bear farming and bear conservation in China. In: Proceedings of the 4th International Symposium on the Trade in Bear Parts. TRAFFIC East Asia–Japan, pp. 37–49.
Hainmueller, J., Hangartner, D., Yamamoto, T., 2015. Validating vignette and conjoint survey experiments against real-world behavior. Proc. Natl. Acad. Sci. Unit. States Am. 112 (8), 2395–2400.
Haitao, S., Parham, J.F., Lau, M., Tien-Hsi, C., 2007. Farming endangered turtles to extinction in China. Conserv. Biol. 21 (1), 5–6.
Haitao, S., Parham, J.F., Zhiyong, F., Meiling, H., Feng, Y., 2008. Evidence for the massive scale of turtle farming in China. Oryx 42 (1), 147–150.
Hanley, N., Sheremet, O., Bozzola, M., MacMillan, D.C., 2018. The allure of the illegal: choice modeling of rhino horn demand in Vietnam. Conservation Letters 11 (3), e12417.
Hernández, J.C., 2018. China Reverses Ban on Rhino and Tiger Parts in Medicine, Worrying Activists. The New York Times.
Hinsley, A., 't Sas-Rolfes, M., 2020. Wild assumptions? Questioning simplistic narratives about consumer preferences for wildlife products. People and Nature.
Harvey, R., 2016. Risks and fallacies associated with promoting a legalised trade in Ivory. Politik 43 (2), 215–229.
Hughes, R., 1998. Considering the vignette technique and its application to a study of drug injecting and HIV risk and safer behaviour. Sociol. Health Illness 20 (3), 381–400.
Hughes, R., Huby, M., 2004. The construction and interpretation of vignettes in social research. Soc. Work. Soc. Sci. Rev. 11 (1), 36–51.
IBM Corp, 2017. IBM SPSS Statistics for Macintosh. Version 25.0. Released. IBM Corp, Armonk, NY.
Jiang, S., Lambert, E., Jenkins, M., 2010. East meets west: Chinese and US college students' views on formal and informal crime control. Int. J. Offender Ther. Comp. Criminol. 54 (2), 264–284.

Kirkpatrick, R.C., Emerton, L., 2010. Killing tigers to save them: fallacies of the farming argument. Conserv. Biol. 24 (3), 655–659.
Krishna, V.V., Darras, K., Grass, I., Mulyani, Y.A., Prawiradilaga, D.M., Tscharntke, T., Qaim, M., 2019. Wildlife Trade and Consumer Preference for Species Rarity: an Examination of Caged-Bird Markets in Sumatra. Environment and Development Economics, pp. 1–22.
Krumpal, I., 2013. Determinants of social desirability bias in sensitive surveys: a literature review. Qual. Quantity 47 (4), 2025–2047.
Lam, W.C., Lyu, A., Bian, Z., 2019. ICD-11: impact on traditional Chinese medicine and world healthcare systems. Pharmaceut. Med. 33 (5), 373–377.
Lemieux, A.M., Clarke, R.V., 2009. The international ban on ivory sales and its effects on elephant poaching in Africa. Br. J. Criminol. 49 (4), 451–471.
Li, P.J., 2004. China's bear farming and long-term solutions. J. Appl. Anim. Welfare Sci. 7 (1), 71–81.
Li, Y., 2020. China's Announcement on Wildlife Trade: What's New and what Does it Mean? Interdisciplinary Centre for Conservation Science. Oxford University. Available from: https://www.iccs.org.uk/blog/chinas-announcement-wildlife-trade-whats-new-and-what-does-it-mean.
Liu, Z., Jiang, Z., Fang, H., Li, C., Mi, A., Chen, J., et al., 2016. Perception, price and preference: consumption and protection of wild animals used in traditional medicine. PloS One 11 (3), e0145901.
Livingstone, E., Shepherd, C.R., 2016. Bear farms in Lao PDR expand illegally and fail to conserve wild bears. Oryx 50 (1), 176–184.
Loeffler, I.K., Robinson, J., Cochrane, G., 2009. Compromised health and welfare of bears farmed for bile in China. Anim. Welf. 18 (3), 225–235.
Lyons, J.A., Natusch, D.J., 2011. Wildlife laundering through breeding farms: illegal harvest, population declines and a means of regulating the trade of green pythons (*Morelia viridis*) from Indonesia. Biol. Conserv. 144 (12), 3073–3081.
Mayhew, M.J., Simonoff, J.S., 2015. Non-White, no more: effect coding as an alternative to dummy coding with implications for higher education researchers. J. Coll. Student Dev. 56 (2), 170–175.
McAllister, R.R., McNeill, D., Gordon, I.J., 2009. Legalizing markets and the consequences for poaching of wildlife species: the vicuña as a case study. J. Environ. Manag. 90 (1), 120–130.
Meijer, W., Scheer, S., Whan, E., Wu, D., Yang, C., Kritski, E., 2017. Demand under the Ban – China Ivory Consumption Research. TRAFFIC and WWF, Beijing, China.
Montgomery, D.C., Peck, E.A., Vining, G.G., 2012. Introduction to Linear Regression Analysis. John Wiley & Sons.
National Bureau of Statistics in China, 2016. China statistical yearbook. Available from: http://www.stats.gov.cn/tjsj/ndsj/2016/indexeh.htm.
Nellemann, C., Henreiksen, R., Raxter, P., Ash, N., Mrema, E., 2014. The Environmental Crisis-Threats to Sustainable Development from Illegal Exploitation and Trade in Wildlife and Forest Resources. United Nations Environment Programme.
Nederhof, A.J., 1985. Methods of coping with social desirability bias: a review. Eur. J. Soc. Psychol. 15 (3), 263–280.
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.
Oxford Martin Programme on the Illegal Wildlife Trade and Interdisciplinary Centre for Conservation Science, 2020. Position Statement: Managing Wildlife Trade in the Context of COVID-19 and Future Zoonotic Pandemics. University of Oxford. https://doi.org/10.31219/osf.io/r5w46.
People's Republic of China, 2017. Wildlife protection law. Available from: https://www.legal-atlas.net/Wildlife_Trade/Legal_Framework/China/Wildlife_Law.
People's Republic of China, 2018. China to control trade in rhino and tiger products. Available from: http://english.www.gov.cn/policies/latest_releases/2018/10/29/content_281476367121088.htm.
Phelps, J., Carrasco, L.R., Webb, E.L., 2014. A framework for assessing supply-side wildlife conservation. Conserv. Biol. 28 (1), 244–257.
Reeve, R., 2006. Wildlife trade, sanctions and compliance: lessons from the CITES regime. Int. Aff. 82 (5), 881–897.
Rizzolo, J.B., 2020. Wildlife farms, stigma and harm. Animals 10 (10), 1783.
Rosen, G.E., Smith, K.F., 2010. Summarizing the evidence on the international trade in illegal wildlife. EcoHealth 7 (1), 24–32.
Sharma, C., 2005. Chinese endangered species at the brink of extinction: a critical look at the current law and policy in China. Anim. Law 11, 215.
Solomon, J.N., Gavin, M.C., Gore, M.L., 2015. Detecting and understanding non-compliance with conservation rules. Biol. Conserv. 189, 1–4.
Species Survival Network, 2014. In: Caged Assets: Tiger Farming and Trade. Education for Nature, Vietnam.
Stanford, C.B., Iverson, J.B., Rhodin, A.G., van Dijk, P.P., Mittermeier, R.A., Kuchling, G., Buhlmann, K.A., 2020. Turtles and tortoises are in trouble. Curr. Biol. 30 (12), R721–R735.
Stern, P.C., 2000. Toward a coherent theory of environmentally significant behaviour. J. Soc. Issues 56 (3), 407–424.
Steiner, P.M., Atzmüller, C., Su, D., 2016. Designing valid and reliable vignette experiments for survey research: a case study on the fair gender income gap. Journal of Methods and Measurement in the Social Sciences 7 (2), 52–94.
Tensen, L., 2016. Under what circumstances can wildlife farming benefit species conservation? Global Ecology and Conservation 6, 286–298.
Thomas-Walters, L., Hinsley, A., Bergin, D., Doughty, H., Eppel, S., MacFarlane, D., et al., 2019. Motivations for the Use and Consumption of Wildlife Products. https://doi.org/10.1111/cobi.13578.
't Sas-Rolfes, M., 2016. A rebuttal to Harvey, R. (2016).'risks and fallacies associated with promoting a legalized trade in ivory'in Politikon 43 (2): 215–229. Politik 43 (3), 451–458.
Warchol, G.L., 2004. The transnational illegal wildlife trade. Crim. Justice Stud. Crit. J. Crime Law Soc. 17 (1), 57–73.
White, A., 2020. China's wildlife policy: what has changed since COVID 19? *Global Initiative Against Transnational Organized Crime*. Available from: https://globalinitiative.net/analysis/china-wildlife-covid/.
Wildlife Conservation Society, 2017. China's announcement of domestic ivory ban in 2017-English translation. Available from: https://newsroom.wcs.org/News-Releases/articleType/ArticleView/articleId/9578/China-Announcement-of-Domestic-Ivory-Ban-in-2017–English-Translation.aspx.
Wong, R.W., 2016. The organization of the illegal tiger parts trade in China. Br. J. Criminol. 56 (5), 995–1013.
WWF, 2020. Opinion Survey on COVID-19 and Wildlife Trade in 5 Asian Markets.
Yang, D., Dai, X., Deng, Y., Lu, W., Jiang, Z., 2007. Changes in attitudes toward wildlife and wildlife meats in Hunan Province, central China, before and after the severe acute respiratory syndrome outbreak. Integr. Zool. 2 (1), 19–25.
Zhang, L., Hua, N., Sun, S., 2008. Wildlife trade, consumption and conservation awareness in southwest China. Biodivers. Conserv. 17 (6), 1493–1516.
Zhang, L., Yin, F., 2014. Wildlife consumption and conservation awareness in China: a long way to go. Biodivers. Conserv. 23 (9), 2371–2381.
Zhou, Z., Jiang, Z., 2004. International trade status and crisis for snake species in China. Conserv. Biol. 18 (5), 1386–1394.
Zimmerman, G.M., 2008. Beyond legal sanctions: the correlates of self-imposed and socially imposed extralegal risk perceptions. Deviant Behav. 29 (2), 157–190.