Leveraging shark-fin consumer preferences to deliver sustainable fisheries

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Abstract
At least one third of sharks and their cartilaginous relatives (Class Chondrichthyes) meet the IUCN Red List Criteria for being threatened with extinction. Overfishing is the primary threat, with less than 4% of the world’s shark catches managed for sustainability. The high-value shark-fin trade has gained the greatest attention as a conservation issue, yet there has been little research on shark-fin consumer preferences, and how these might be leveraged to deliver sustainability goals. We used an online discrete choice experiment to explore preferences for price, quality, rarity, and finning among 2914 shark-fin soup consumers in China. Overall, consumers prefer higher priced and rare shark-fins, obtained without finning, yet we found three distinct groups with substantial heterogeneity between them. Our results provide evidence for the conspicuous consumption nature of shark-fin use, but also suggest these preferences could be leveraged to incentivize responsible shark fishing. In addition, messaging for future unsustainable demand reduction should focus on shark-finning and animal welfare as opposed species rarity and extinction.

Keywords
blue sharks, consumer, market, short-fin mako, silky sharks, sustainability

1 | INTRODUCTION

Overexploitation threatens many species, particularly those with conservative life histories and high economic value (Maxwell et al., 2016; McClenachan et al., 2016). Interventions to reduce these threats and promote sustainability need to consider the economic realities of wildlife markets (‘t Sas-Rolfes et al., 2019). This requires understanding people and the choices they make to identify leverage points for changing unsustainable behaviors (Veríssimo et al., 2012, 2020). Some wildlife products, such as rhino horn and shark-fin, are consumed as high-value luxury goods, motivated by status-seeking and tradition (Thomas-Walters et al., 2020). Markets for such goods are often characterized by relatively price-inelastic demand, which suggests that intervention measures that lead to higher market prices may have little or no impact on rates of consumption (Chen & ‘t Sas-Rolfes, 2021). In such cases, nuanced policy- and market-based interventions may be more effective in achieving sustainability goals.

Of the 994 species of cartilaginous fish (Class Chondrichthyes, which includes shark, rays, and chimera) assessed against the Red List criteria, 36% were allocated to threatened categories (IUCN, 2021). Overfishing, the
primary direct threat, has many complex drivers. Bycatch is the primary source of shark fishing mortality globally, which interacts with direct demand for a range of shark-derived products (e.g., meat, liver oil, cartilage, fins), driving targeted shark fisheries and retention of incidentally caught sharks as valuable secondary catch (Booth et al., 2019; Dulvy et al., 2017). Though it is technically and biologically possible to achieve sustainable shark fisheries, less than 4% of the world’s shark catches are managed for sustainability (Simpfendorfer & Dulvy, 2017). Indeed, most shark fisheries lack any form of science-based management, in part due to their relatively low economic and political prioritization, for example, relative to other high-value targeted fisheries, such as tuna and bill fish, or other charismatic marine mega fauna with widespread public appeal, such as marine mammals. As such, many shark populations continue to decline, with a need for new regulatory and market-based reforms to deliver conservation and sustainability objectives (MacNeil et al., 2020; Pacoureau et al., 2021).

The shark-fin trade has generated strong concern as a conservation and sustainability issue. The fin trade is driven primarily by demand for high-value shark-fin soup, particularly in China and Singapore (Dent & Clarke, 2014; Wu, 2016), where it is consumed as a luxury food item, traditionally served as a token of respect and signal of power in Chinese folk custom (Fabinyi, 2012). It was typically served at high-level banquets, which play a role in professional and social advancement, wherein relationships and social capital (guanxi) are formalized through the shared experience of eating together, whereas luxury “gives face” (mianzi) (i.e., honor, dignity) to guests (Fabinyi & Liu, 2014; Szto, 2015). Shark-fins are graded and priced based on shark species (Dent & Clarke, 2014; Wu, 2016). Though it is difficult to ascertain the proportion of global shark fishing mortality that can be directly attributed to the fin trade, it creates economic incentives for fisheries to retain, target, and in some cases “fin” (defined as removing shark-fins on board vessels and discarding carcasses at sea [Fowler et al., 2010]) certain high-value species. These incentives also interact with other socioeconomic drivers—such as food security and the meat trade, and the resulting fishing practices are rarely managed for sustainability (Booth et al., 2019; Simpfendorfer & Dulvy, 2017).

China is the world’s largest shark-fin consumer, due to its large population and folk custom related to this product. However, volumes and prices of fins in trade have declined during the past decade (Dent & Clarke, 2014; Mingzhe, 2019). While there have been several mass-media demand-reduction campaigns in China (Heller, 2015; Jefferys, 2016). As well new international trade regulations for 46 Chondrichthyes species of the Convention on the International Trade of Endangered Species (CITES) have been made (UNEP-WCMC, 2019). These trends likely relate to the removal of shark-fin soup from official government receptions (General Office of the Central Committee of the Communist Party of China, 2013). Within this context, we conducted a choice experiment with shark-fin consumers in China. We aimed to build a detailed understanding of shark-fin consumer preferences, to better inform consumer-focused interventions that could drive more sustainable fisheries.

2 | METHODS

2.1 | Survey design

We used a questionnaire consisting of four parts. The first was a brief introduction to management of shark fisheries in China and globally (see the Supporting Information). The second focused on respondent demographics including age, gender, city of residence, education, occupation, and household income. The third focused on respondent psychographics relating to purchase and consumption, past and future, of shark-fin (see Table S1). The fourth and last section consisted of a discrete choice experiment focused on four key shark-fin attributes (Table 1). Beyond price, which is a key part in choice experiments focused on consumer preferences, our rational for selecting these attributes focused on the documented importance of rarity in the context of luxury sea food consumption in China; the importance of different levels of product quality given the luxury status of shark-fin soup; and finally the use of finning as an issue that has gained much traction in shark fishery management circles (Carpenter & Song, 2016; Fabinyi, 2016; Fabinyi & Liu, 2014; Fowler et al., 2010).

Based on Table 1, we designed a Discrete Choice Experiment using an orthogonal design generated in IBM SPSS 22.0 with the initial choice alternatives being paired using a “shifted technique” (Louviere et al., 2000) into 24 dichotomous choices. As shown in Figure 1, we included an optout option in the form of a neither (Choice [c]). We aimed to keep the Discrete Choice Experiment design simple, to limit cognitive burden, and so assigned only eight choices per respondent.

2.2 | Data collection

We used WeChat (www.wechat.com)—a popular multi-purpose messaging, social media, and mobile payment app in China—to collect the data. The survey was implemented through the free version of the Wenjuanxing (www.wjx.cn) online survey platform, between November 2017 and February 2018. The study was conducted in
TABLE 1 Attributes and levels of a discrete choice experiment on shark-fin soup consumption in China

| Attribute       | Levels | Description                                                                 |
|-----------------|--------|-----------------------------------------------------------------------------|
| Rarity          | Yes    | Whether the shark species from which the fin is obtained is rare or not.    |
|                 | No     |                                                                             |
| Harvesting      | Fining | Whether the shark-fin soup is made of was obtained from a fishery that uses shark fining |
| Method          | Without fining |
|                 |        |                                                                             |
| Quality         | Top-grade | Whether fin cartilages are unbroken in the bowl after cooking (top-grade), somewhat fragmented (middle-grade) or very fragmented (low-grade) |
|                 | Middle-grade |
|                 | Low-grade |
| Price           | 20     | Cost in Yuan per bowl                                                      |
|                 | 80     |                                                                             |
|                 | 140    |                                                                             |
|                 | 200    |                                                                             |
|                 | 260    |                                                                             |
|                 | 320    |                                                                             |

FIGURE 1 Sample choice card used for a discrete choice experiment on shark-fin soup consumption in China (shark-fin soup [Choice a]: rarity, not shark fining, low-end soup, 20 Yuan/bowl; shark-fin soup [Choice b]: not rarity, shark fining, top-grade soup, 320 Yuan/bowl; [Choice c]: choose neither)

accordance with the Declaration of Helsinki (World Medical Association, 2013) and ‘National Statement on Ethical Review Method for Biomedical Research Involving People’ (2016) and was approved by the Ethics Committee of Northeast Forestry University (Project identification code: 2021006).

As shark-fin soup is a niche luxury product, it is generally difficult to find consumers. Thus, the dissemination of the survey was done through the China Aquatic Products Processing and Marketing Alliance (http://www.cappma.org), a nonprofit organization under the Chinese Ministry of Agriculture that brings together seafood producers, processors, distributors, suppliers, and institutions for fisheries-related research and education. Only respondents who had consumed shark-fin soup in the last 5 years were considered.

In this paper, the respondents are divided into two regions: Eastern China and the remainder of the country. Eastern China included three municipalities and seven provinces: Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, and Hainan (Table S2). The East of China was considered
TABLE 2 Multinomial logit (MNL) and latent class model (LCM) estimates of utility function for each attribute, including standard errors. Significance levels: *P < 0.05, **P < 0.01. McFadden Pseudo R-squared = 0.248. Attribute reference levels: “Not rare,” “No Fining,” “Low-end fin soup,” “Female,” “Not east China,” and “Will not buy shark-fin again”

|                      | MNL          | LCM 1 (66.1%) | LCM 2 (18.4%) | LCM 3 (15.4%) |
|----------------------|--------------|---------------|---------------|---------------|
| Alternative specific constant | −0.412**(0.027) | −3.162*** (0.107) | 0.154 (0.095) | 3.437*** (0.275) |
| Rarity               | 0.082** (0.015) | 0.082** (0.017) | 0.01** (0.048) | −0.163 (0.195) |
| Fining               | −0.044** (0.015) | −0.032* (0.017) | −0.084* (0.045) | −0.526*** (0.187) |
| Top-grade            | 0.018 (0.018) | −0.014 (0.021) | 0.168*** (0.055) | 0.562** (0.227) |
| Mid-grade            | 0.006 (0.034) | −0.148 (0.148) | 0.071 (0.082) | 0.377 (0.248) |
| Price\(^a\)          | 0.047** (0.007) | 0.073*** (0.008) | 0.09*** (0.023) | 0.142 (0.094) |
| Gender               | −0.297** (0.122) | −0.094 (0.145) |               |               |
| Age\(^b\)            | 0.138* (0.075) | −0.01270 (0.089) |               |               |
| Location\(^c\)       | −0.032** (0.013) | 0.001 (0.015) |               |               |
| Will you buy shark-fin in the future?\(^d\) | 1.433*** (0.076) | 0.691*** (0.089) |               |               |
| Household income\(^e\) | −0.078* (0.041) | −0.174*** (0.05) |               |               |

\(^a\)Unit used: ¥100.
\(^b\)Categorized as “<21” = 1, “21–30” = 2, “31–40” = 3, “41–50” = 4, “51–60” = 5, “>60” = 6.
\(^c\)East China defined as including three municipalities and seven provinces: Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, and Hainan.
\(^d\)Categorized as Yes = 1; Not sure = 0; No = −1.
\(^e\)Categorized as: <50,000 Yuan/Year = 1; 50,000–99,999 = 2; 100,000–149,999 = 3; 150,000–199,999 = 4; 200,000–249,999 = 5; 250,000–299,999 = 6; ≥300,000 = 7.

separately because it has a more developed economy (National Bureau of Statistics of China, 2017).

2.3 Data analysis

We first assessed the aggregate preferences of respondents using a Multinomial Logit (MNL), although this assumes homogeneous preferences among respondents, which is unlikely in issues such as wildlife consumption where consumer motivations are diverse (Thomas-Walters et al., 2020). To explore potential heterogeneity in preferences, we used latent class model (LCM) (Boxall & Adamowicz, 2002). LCMs are considered to be the best approach to partition the sampled population into more homogeneous classes (Boxall & Adamowicz, 2002). Analyzed using LIMDEPNLOGIT 4.0, the optimal numbers of latent classes were decided based on a balanced assessment of statistics including Akaike information criteria (AIC) and Bayesian information criteria (BIC). We included an alternative specific constant (ASC) to account for the “neither” responses. In all our analysis, ASC took a value of 1 when “neither” choice was opted, reflecting the utility derived from not choosing any of the offered choice options.

3 RESULTS

From November 2017 to February 2018, a total of 3450 respondents who had consumed shark-fin in the previous 5 years responded to the survey, of which 84.5% completed the survey. We obtained 23,312 choice cards from 2914 respondents from 32 provincial-level administrative divisions of China (see Table S2). As we use WeChat to conduct the investigation, we do not know how many people saw the questionnaire and did not respond. We investigated a number of model specifications related to both respondent demographics and psychographics. LCM with three respondent segments was selected as the most relevant as it was considered the most parsimonious by all three statistical criteria in our analysis (Table S3). We also calculated willingness to pay (WTP) for different attributes (see Table S4). Overall, respondents favored higher priced fins from rare species of shark obtained without finning (Table 2). Product quality was not considered important overall. Also securing sustainable supply among consumer segments regarding the importance of fin quality, price, or rarity, there was also agreement regarding the desirability of shark-fins obtained from fins-attached fisheries.

The LCM3 segment contained around 15% of respondents, who were strongly opposed to finning while having a strong preference for top-grade shark-fin and not being sensitive to price. Consumers in this segment had higher household income and were less likely to intend to buy shark-fin in the future, when compared to the other two consumer segments. The LCM2 segment encompassed just under 20% of respondents, and its members favored higher priced, top-grade shark-fins from rare species, obtained without finning. Compared to LCM3, which was the segment of reference, consumers in LCM2 were more likely
to intend to buy shark-fin in the future and have relatively lower income. The LCM1 segment included about two thirds of respondents, and its members followed the overall trend of preferring higher priced fins from rare shark species, obtained without finning. When compared to the LCM3, the reference segment, LCM1 was more likely to include older female consumers based outside East China, intending to consume shark-fin in the future but having a relatively lower household income.

4 | DISCUSSION

4.1 | Interpreting consumer preferences

Overall, and across most segments, consumers favored higher priced shark-fins. Although it may seem counterintuitive, this preference for higher priced products has previously been documented in the context of luxury seafood consumption in China, and indeed other luxury goods (Jin et al., 2015; Shairp et al., 2016; Veblen, 2005). This provides further empirical evidence that shark-fin consumption is a form of “conspicuous consumption” (Fabinyi, 2012). Our results also align with the social function of shark-fin consumption, that is, for guanxi and mianzi, as a fundamental part of cultivating one’s social status in business and personal life (Fabinyi et al., 2016). Luxury seafood has long been a prominent feature in situations where guanxi is cultivated, which helps to explain these price preferences (Fabinyi, 2012).

Rarity was an important attribute for more than three quarters of respondents, which aligns with past research describing rarity as a proxy for exclusivity for high-value wildlife products (Courchamp et al., 2006). Without further management, these findings open the door to an “anthropogenic Allee effect,” which predicts increasing exploitation of species, even if supply costs increase (Courchamp et al., 2006). This may impact species such as dusky sharks (Carcharhinus obscurus), which are threatened species, with fins that are differentiated in consumer markets and known for their high price and quality (Clarke et al., 2006; Wu, 2016). Future research could focus on better understanding the aspects of rarity that drive consumer preferences.

There is evidence that China’s shark-fin sales and prices have declined sharply since 2013 (Mingzhe, 2019). Our findings corroborate previous studies suggesting that many remaining Chinese shark-fin consumers have limited concern for conservation and fisheries sustainability, and do not support the notion that these declines are due to increasing conservation concerns from consumers (Fabinyi & Liu, 2014; Fabinyi et al., 2016). Although this may seem surprising given the investments in high-profile demand-reduction campaigns over the past decade, it is consistent with recent studies on the limitations of celebrity-endorsed behavior change interventions, which may have a large reach but for which there is limited evidence of impact on behavior (Olmedo et al., 2020).

In contrast, negative preferences for shark-finning across all segments suggest that remaining Chinese shark-fin consumers have animal welfare concerns, a result that parallels findings around rhino horn in Vietnam (Hanley et al., 2018). However, two thirds of respondents had a higher WTP for rarity than for avoiding finning (see Table S4), suggesting that conspicuous consumption preferences would override animal welfare concerns. Nonetheless, 18% of respondents did have a higher WTP for avoiding finning than for rarity, suggesting there is a niche market for shark-fins that are obtained from fins-attached fisheries for abundant species. This consumer segment (LCM2) also put a price premium on higher quality fins. That said quality was not an overall key consideration for the majority of respondents, in particular older female consumers based outside East China who are more likely to be part of the LCM1 segment. This result contradicts the wider findings of Fabinyi et al. (2016), which suggested shark-fin consumers have differentiated profiles from those of luxury seafood more broadly. Finally, it should be noted that the preference for more expensive products, a hallmark of conspicuous consumption, was seen in the consumer segments with lowest income (Table 2), potentially signaling the greater willingness of these groups to advance socially.

4.2 | Leveraging preferences to deliver sustainability

The recent indications that demand for shark fin is decreasing in China open the door to a broader use of consumer behavioral insights to achieve sustainability in shark fisheries and prevent extinctions. There remains a gap in leveraging and directly linking individual consumer decision-making to sustainability outcomes (Fabinyi, 2016). Our research provides insights for two types of future interventions that could leverage Chinese consumer preferences to achieve shark conservation and sustainability objectives: (1) market-based mechanisms, which are directly linked to sustainable fisheries; (2) unsustainable demand-reduction efforts, to ensure that market demand remains within the limits of sustainable supply.

This may be practically challenging in the current context, because only 4% of global shark catch is managed for sustainability and most of the species classified as such are not suitable for the fin trade (Simpfendorfer & Dulvy, 2017).
However, appropriate markets and incentives could drive wider adoption of best-practice sustainability measures for more stocks. Supplying this niche market would require careful selection of species and stocks. Possible candidate species include blue sharks (*Prionace glauca*), short-fin mako sharks (*Isurus oxyrinchus*), and silky sharks (*Carcharhinus falciformis*), which are valued in the fin trade, have fast enough growth rates to withstand some fishing pressure, and in some places are already being sustainably fished (Simpfendorfer & Dulvy, 2017; Wu, 2016). However, we caution that many populations of these species are already severely depleted, and reiterate that appropriate population selection, science-based management plans, precautionary catch limits, and robust monitoring would be essential.

Also securing sustainable supply, several other practical challenges also remain. First, certification schemes could face major hurdles given that most Chinese seafood consumers believe seafood sustainability is up to the government, not the individual consumer (Fabinyi & Liu, 2014; Fabinyi et al., 2016). In terms of a high-end brand-based approach, although these could more easily leverage the *mianzi* function of shark-fin consumption, appropriate branding would be required, because the premiums consumers are willing to pay for sustainability alone are low (Wang et al., 2009). Any market-based approaches may therefore have to focus on quality control (e.g., supply chain traceability), animal welfare (i.e., no finning), and food safety, as key issues for Chinese seafood consumers, with fisheries sustainability and species conservation built in as side benefits. Second, complex supply chains and limited traceability make it difficult to determine the source of shark-fins, and seafood in general, which could hinder reliable certification and compliance (Xiong et al., 2016). However, recent advances in monitoring and traceability technology—such as at-vessel video monitoring, environmental DNA for forensic catch reconstruction, real-time PCR for species and stock identification, and block chain for chain of custody—could all support transparent and responsible sourcing in the future (Cardeñosa et al., 2018; Esmail et al., 2020).

Because many shark populations are declining, and are not currently managed for sustainability, further unsustainable demand reduction may also be needed to ensure demand can be met by sustainable supply. Based on our results, demand-reduction initiatives could focus primarily on LCM1 consumers, who place more value on rarity and less value on quality, and may therefore have a larger impact on endangered species. However, campaigns that focus on shark endangerment may be counterproductive for this segment. Rather, messaging could focus on finning, for which consumers exhibit a negative preference. To a lesser extent, messaging around the possibility of counterfeit products (Fabinyi & Liu, 2014) could also deter consumers in LCM2, who value the highest quality shark-fins. In addition, although we were not able to test this explicitly in our choice experiment, due to limitations on the number of attributes that respondents can meaningfully trade-off between, consumers in China identify food safety as a key area of interest. As such, messaging focused on the health risks of shark-fin consumption, for example, due to possible high heavy metal content (Bosch et al., 2016), could be a deterrent for all consumer groups, and particularly LCM2 consumers, who value high quality. Finally, we recognize that further research is needed to understand how consumer demand for shark-fin in a major fishing nation such as China is linked to shark fishing mortality and sustainability of shark fisheries at the global scale (Davidson et al., 2016), given the complex supply chains and the many actors involved in the trade.

Moving forward, any market-based interventions should be evidence based and carefully piloted and evaluated. This will ensure it is fulfilling a niche demand, which can incentivize sustainable practices.

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**CONFLICT OF INTEREST**

The authors declare no conflict of interest.

**AUTHOR CONTRIBUTIONS**

XZ: conceptualization, methodology, writing-original draft preparation, writing-reviewing and editing, funding acquisition. HB: methodology, writing-reviewing and editing. ML: methodology, formal analysis, investigation. ZS: formal analysis, data curation. DCM: methodology, writing-reviewing and editing. WZ: conceptualization, methodology, supervision, validation, project administration, writing-reviewing and editing. QW: conceptualization, methodology, formal analysis, investigation, writing-reviewing and editing. DV: methodology, writing-reviewing and editing.

**ETHICS STATEMENT**

The Northeast Forestry University Ethics Committee provided ethics approval for this research (2021006).

**DATA AVAILABILITY STATEMENT**

Data available from corresponding authors upon reasonable request.
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Additional supporting information may be found in the online version of the article at the publisher’s website.

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