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Shark consumption in India: An exploratory study on trends and awareness

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Abstract

The domestic consumption of sharks in maritime states of India and consumer perception were examined to assess the utility of such studies in conservation planning. The study surveyed 309 respondents in person, across the coastal states of India during 2018. The respondents covered were fish consumers and had highest monthly food expenditure on fish. The study found low consumption of sharks among respondents, though expenditure on fish was relatively high. Fifty-nine percent of the consumers felt that their consumption of sharks had decreased and the main reason attributed was irregular/poor supply of sharks. The study revealed that consumer awareness on shark conservation was poor with 63.2% of the respondents unaware that some shark species are protected in India or require protection. Consumer fidelity towards sharks was found to be low indicating that even if additional shark species were protected, they would be replaced by other fish in the consumer's diet. Focused efforts are essential to sensitise consumers about the vulnerability of sharks and their conservation needs. Strategies could include integrating marine conservation topics into school curricula, conducting awareness campaigns on shark conservation at retail markets and promoting consumption of sharks sourced from sustainable stocks. Additionally, the study recommends implementing minimum legal size (MLS) regulation for ensuring sustainable shark stocks in Indian waters.

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Introduction

Approaches towards shark (including sharks, rays and guitarfish) conservation are most often based on their biology, fishery and stock status by highlighting the typical life histories of this group which make them particularly vulnerable to overfishing (Worm *et al.*, 2013; Dulvy *et al.*, 2014, Zacharia *et al.*, 2017). Management advisories targeting fishers and traders are essential for implementation of regulatory measures. Some studies have also highlighted the benefits of conservation through increased returns from non-consumptive use of marine resources, such as manta ray watching (Anderson *et al.*, 2011; O'Malley *et al.*, 2013; Cagua *et al.*, 2014; Korman, 2015). Shark research and conservation campaigns in India have focused mostly on the eco-biology of the group and fishery aspects from Indian waters (Gupta *et al.*, 2022). Studies on the human dimensions of shark fisheries particularly in terms of socio-economics are limited from India (Gupta *et al.*, 2022).

Consumption patterns and consumer perception of seafood is increasingly being analysed to uncover the social drivers behind consumption which can promote conservation tools (Fabinyi and Liu, 2014; Fabinyi *et al.*, 2017). For example, Fabinyi and Liu (2014) examined consumer perceptions of seafood served at banquets in China, exploring the reasons

behind consumers' preferences for specific types of seafood. Their findings have important implications for seafood conservation policies in the country, highlighting how cultural practices and consumer choices can influence sustainable seafood management. Another study on consumption patterns of sharks and groupers caught by a small-scale fisheries in Brazil revealed that consumers often rely on local fishmongers for information about the stock status of these species (Giglio *et al.*, 2018). The authors indicated the promotion of educational campaigns to improve consumer awareness regarding conservation and sustainability. Sharks serve as important sources of nutrition and livelihood security in many parts of the world, particularly in developing countries, in diverse forms (Dent and Clarke, 2015). Shark meat consumption in India too has a long-standing history, particularly in many of the southern coastal villages; however, literature on domestic shark consumption is limited. In recent years attention has increasingly been brought on shark trade and consumption in India, *e.g.* trade of non-fin commodities of sharks and rays in India (Kizhakudan *et al*., 2024). A study by Tyabji *et al.* (2022) investigated the consumption and trade of sharks and rays from the Andaman Islands in India emphasising the perception of fishers and traders regarding shark utilisation. Karnad *et al.* (2022) studied the consumption of elasmobranchs in restaurants across India focusing on whether tourism drives elasmobranch consumption. Some literature on shark trade and consumption in India exists within the broader context of seafood marketing and consumption studies (Sathiadhas *et al.*, 2011; Shyam, 2014). Therefore, to the best of our knowledge, consumer perceptions of elasmobranchs have not been thoroughly explored in India. This gap presents an opportunity for further research, which could provide valuable insights into consumer attitudes and behaviours, ultimately informing more effective conservation and management strategies.

In this context, we conducted this study to investigate the consumption patterns of sharks in India, identify the major species consumed and explore the constraints affecting shark consumption in the country. We also attempted to assess consumer's awareness on shark conservation in the country.

Materials and methods

Surveys of fish consumers were conducted across India during January-December 2018 in the states of Gujarat, including the Union Territories (UT) of Daman and Diu, Maharashtra, Goa, Karnataka and Kerala on the Arabian Sea coast and Tamil Nadu, including the UT of Puducherry, Andhra Pradesh, Odisha and West Bengal on the Bay of Bengal coast (Fig. 1).

A total of 309 respondents were covered under this study. Respondents were interviewed at fishing harbours, fish landing centres and fish markets across the survey locations. Respondents were selected randomly and responses recorded from those willing to take part in the interview. Questions were based on a semi-structured interview schedule. The questionnaire included four sections *viz.*, General details, Family details, Monthly expenditure details and Shark (the term 'shark' here refers to sharks, rays and guitarfish) consumption details including frequency, species preferences, average monthly consumption as well as constraints in improving shark consumption. Garrett ranking (Garrett and Woodsworth, 1981) was employed to rank the constraints. The respondents were also asked about their knowledge of shark conservation in the country specifically with respect to the Wildlife (Protection) Act, 1972. Basic descriptive statistical analysis and correlation analysis (of proportions) was also done. Additionally, chi-square test was used to check for independence of responses with a significance level of 5%.

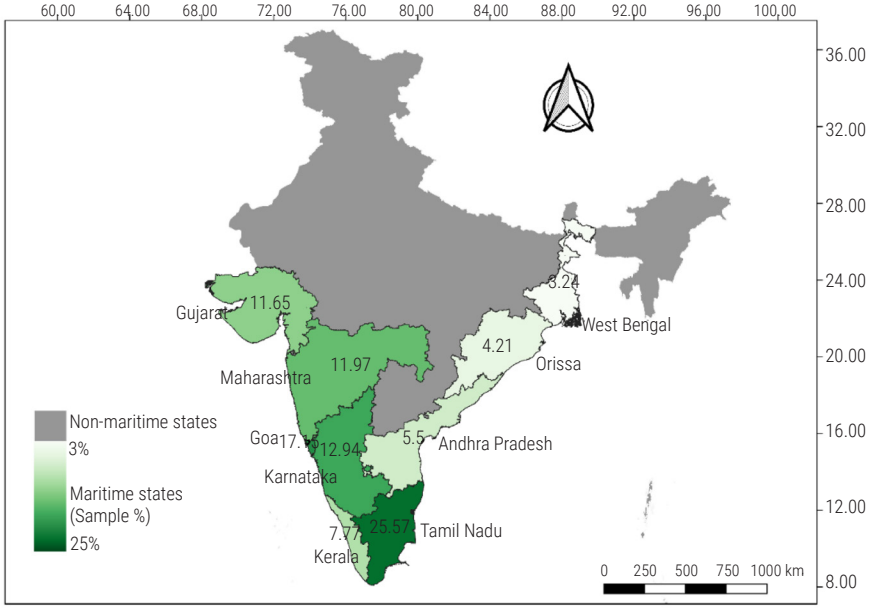

Fig. 1. Map of India illustrating the coastal states where the survey was carried out; the colour gradient mirrors the sample size, the darker the colour, the larger is the sample size

Results

General profile of respondents

Our study covered 309 respondents across all the maritime states of India (Fig. 1). Since our surveys were conducted either at fishing harbours, fish landing centres or fish markets, we focused exclusively on individuals who consume fish. The highest number of respondents were from Tamil Nadu and the lowest from West Bengal (Fig. 1). A majority of respondents were males (n = 258) while the rest were females. Female respondents who participated in the survey were primarily located in Kerala, Karnataka, Goa and Maharashtra with only one female respondent from Andhra Pradesh who was present at the survey location with her husband. In all the other states, only males agreed to participate in the survey. The age of respondents ranged between 23 and 75 with an average age of 48.6 years (The family size of respondents ranged from 1 to 8 members with an average of 3.5. Among our respondents, the largest segment consisted of individuals who had not completed matriculation, (66.3%), followed by matriculates (*i.e.* finished senior-level schooling) (11.5%), graduates (7.2%) and those who finished high school (6.6%). Respondents with the highest educational qualification (post-graduation and above) formed only 5% of the sample. Further, a small percentage of respondents (3.9%) were un-schooled.

Monthly expenditure

The highest mean monthly expenditure among respondents were on food (32.8%), shelter (30.8%) and education (8.5%) (Fig. 2). In terms of money, the average monthly expenditure was ₹ 8445/- on food, ₹7932/- on shelter and ₹2190/- on education. Among food products, the highest expenditure was on fish and fish products (24.3%, ₹1543/-), followed by meat and meat products (17.3%, ₹1100/-) and milk and dairy products (14.2%, ₹903.7/-) (Fig. 3). Expenditure on fish and fish products showed a positive correlation with spending on cereals, milk and dairy products and meat and meat products; however, none of the correlation coefficients were statistically significant. When analysing the average monthly quantity of food items used, the highest values were recorded for milk and dairy products (22.6 l), cereals (11.9 kg) and fruits and vegetables (8.7 kg). The average monthly quantity of fish and fish products was 7.6 kg while meat and meat products averaged 4.2 kg,

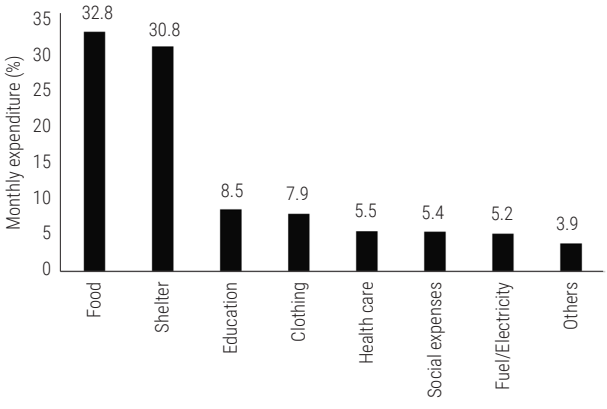

Fig. 2. Average monthly expenditure of respondents

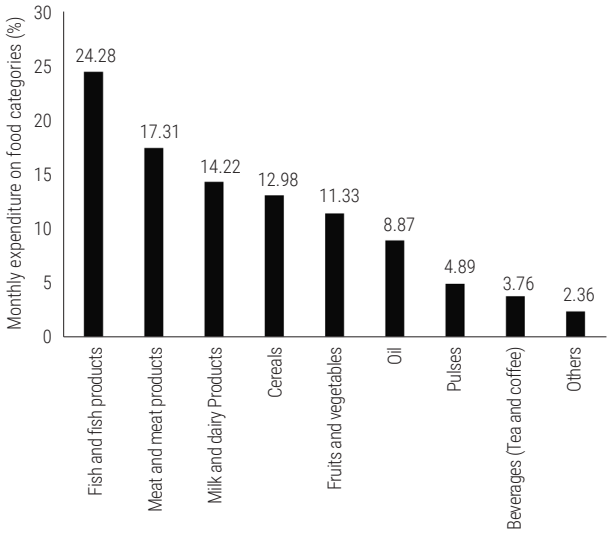

Fig. 3. Average monthly consumption expenditure on food by respondents

thereby indicating higher unit price for both these food categories compared to other food items reflecting their value in the diet.

Shark consumption

The average monthly consumption of sharks was estimated to be 2.5 kg with an average unit cost of ₹193.3 per kg of sharks. Consumption patterns indicated that sharks were primarily consumed seasonally or during festivals (25.4%), followed by weekly (22.4%) and monthly (21.4%) consumption. Chi square test indicated that the frequency of shark consumption was not independent of education level ($p = 0.023$). On the other hand, the frequency of shark consumption was independent of respondent's gender (Chi-square test; $p = 0.429$). A majority of the consumers (59%) reported a decreased consumption of sharks over the past three years, while 25% indicated an increase and 15% noted that their consumption remained constant although the varieties/species consumed had changed.

Shark species consumed

Across the country, sharks were most preferred (60.9%) followed by rays (24.1%) and guitarfishes (15.8%) (Fig. 4). Overall, the requiem sharks (*Carcharhinus* spp.), spadenose shark (*Scoliodon laticaudus*) and stingrays (*Himantura* spp.) were the most preferred sharks for consumption (Fig. 4). We mapped the most preferred shark species by state based on available responses (Fig. 5). Among the consumer responses along the north-west coast of India, 66.7% of respondents in Gujarat, 57.7% in Maharashtra and 50.0% in Goa identified the spadenose shark (*Scoliodon laticaudus*) as their most preferred species. In contrast, along the south-west coast, stingrays and leopard rays (*Himantura* spp.) were preferred in Karnataka with 66.7% of the surveyed consumers preferring them while in Kerala 58.7% favoured requiem sharks (*Carcharhinus* spp.). Along the south-east coast, consumers in Tamil Nadu preferred stingrays (*Himantura* spp.) along with leopard rays and eagle rays (*Aetobatus* spp.) (41.2% of consumer responses). In Andhra Pradesh, milk shark (*Rhizoprionodon* spp.) was the most preferred species (55.6% of consumer responses). These results indicated the diverse

preferences for shark species across different coastal regions of India. Consumption of value-added shark products was notably low, with only 17.7% of respondents indicating they consumed such products. The positive response was restricted to Karnataka and Kerala and consumption were limited to dry shark products.

Source of shark purchase

Retail markets were the most popular source of shark purchase (58.7%), followed by landing centre (25.5%) and wholesale markets (14.1%) (Fig. 6). The choice of purchase source was not independent of survey location (Chi-square test; $p<0.05$) indicating that responses varied by state. In all states, retail markets were the most preferred source of purchase; however, in Kerala and West Bengal, the landing centres were preferred instead. Freshness/ quality of product was the key criteria for choosing a particular source of purchase (40.6%), followed by affordable price (23.6%) and distance (19.3%) (Fig.7).

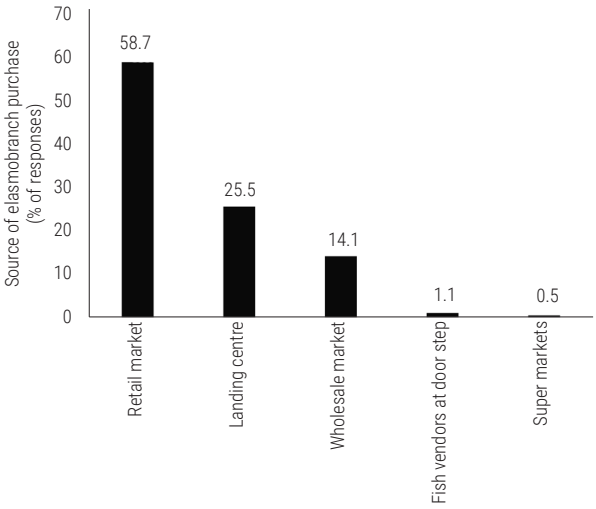

Fig. 6. Source of shark purchase

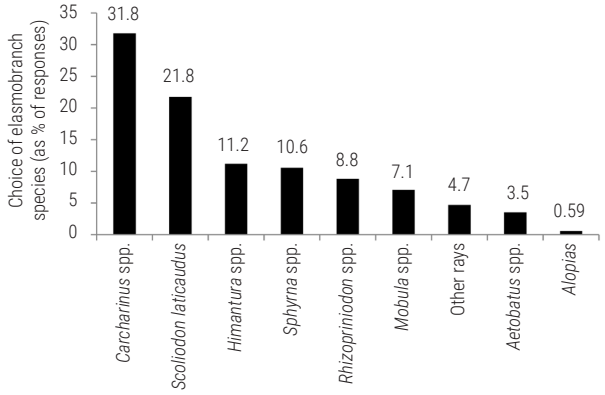

Fig. 4. Choice of shark species across all respondents

Constraints to shark consumption

The primary constraint to shark consumption was identified as irregular/poor supply of sharks followed by high price and non-availability of preferred species (Table 1). Some respondents attributed their decreased consumption to factors such as "less availability", "non-availability", "shortage", "not available", "number of sharks decreased", "more catch needed", "not available, if available then costly", "old age", "lack of hygiene, good quality fish goes to tourism sector", "increase in prices", "prefer small fish", "became vegetarian", "becoming extinct" and "eating more sharks increase body heat". Further, some respondents who reported constant consumption of sharks, indicated a change in the type of sharks they consumed.

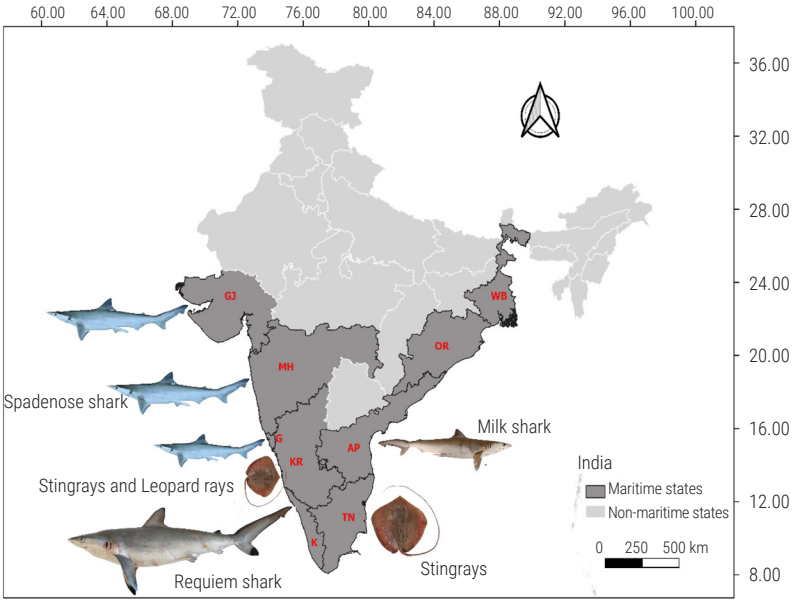

Fig. 5. Map of state-wise species preference (GJ=Gujarat, MH=Maharashtra, G=Goa, KR=Karnataka, K=Kerala, TN=Tamil Nadu, AP=Andhra Pradesh, OR=Odisha, WB=West Bengal)

Table 1. Constraints to shark purchase ranked in order of importance

Rank	Constraints
I	Irregular/poor supply
II	High price
III	Non-availability of preferred species
IV	Wide fluctuations in prices
V	Lack of fresh fish
VI	Poor access to buying
VII	Lack of hygiene at purchase sources
VIII	Tradition
IX	Restricted to social functions/events
X	Lack of awareness
XI	Legal constraints

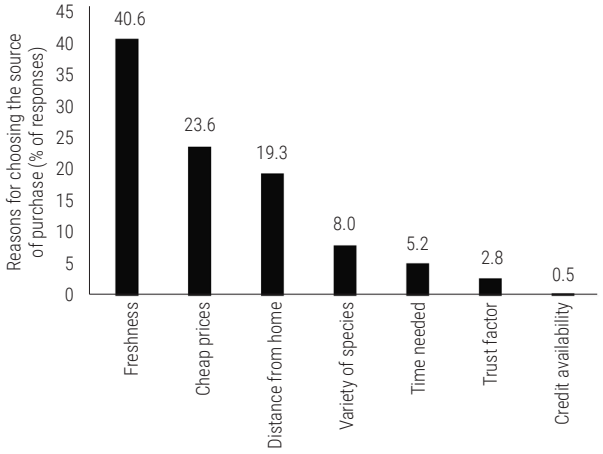

Fig. 7. Criteria for choosing a particular source of purchase

Consumer awareness on shark conservation

Majority of the respondents (63.2%) were unaware that certain shark species are protected by law under the Wildlife (Protection) Act, 1972, in the country. Further, knowledge of protected shark species was found to be independent of respondent's gender (Chi square test, p = 0.0501) indicating that awareness levels were similar among male and female respondents. However, the response regarding awareness of protected shark species were not independent of education status (Chi square test, p = 0.043). As the education levels improved, a higher percentage of affirmative responses were recorded which moved from 20.4% in the pre-matriculate group to 36.4% in the matriculate group and reaching 60% in the high school and post-graduate groups. However, a dip was seen in the degree group with only 30% responses being in the affirmative. The responses to this question were also dependent on the location (Chi square test, p <0.05). Only Maharashtra had a higher number of positive responses with 61.3% of respondents indicating awareness of protected shark species. In contrast, all the other states recorded higher negative responses (Goa - 86.5%, Andhra Pradesh – 75%, Karnataka - 71.1%, Kerala and Tamil Nadu 100%). Among the 36.7% respondents who were aware of protection, 65.6% knew about the whale shark *Rhincodon typus* while 9.4% were aware of sawfish (9.4%). A substantial portion of respondents (15.6%) mentioned hammerhead sharks as being protected, despite the fact that no hammerhead sharks were covered by domestic legislation during the study period. Additionally, some consumers expressed the belief that "all big sharks are protected" or "all big sharks, no rays are protected". Responses from Andhra Pradesh indicated that Ganges shark and Pondicherry shark were protected.

Discussion

Fish and shark consumption in India

India is the second-largest producer of fish in the world with *per capita* consumption of fish at 6.6 kg per year (FAO, 2018) and fish plays a major role in domestic nutritional profile and livelihood, particularly in the coastal regions of the country. Consumption of seafood has generally been higher at 10-12 kg per year in the coastal regions as compared to 2-3 kg per year in the non-coastal regions of the country (Ravikanth and Kumar, 2015). The popularity of fish in the diets of the coastal populace of India remains high, as evidenced in the present study, wherein the highest monthly expenditure on food products was found to be on fish and fish products. Though India is a significant fish-consuming country, the consumption of sharks is comparatively low, possibly because sharks contribute only 2-3% of India's total fish landings (Kizhakudan *et al.*, 2015).

In the sampled households, pelagic sharks along with other high value pelagic species formed only 6.1% of total fish consumption compared to 17.6% for low-value pelagic fishes such as sardines and mackerel (Kumar *et al.*, 2005). In a state-wide fish market survey in Kerala along the Arabian Sea coast, sharks did not appear among the top ten prevalent fish groups (Salim *et al.*, 2020). In our study, the average monthly consumption of sharks was estimated to be 2.5 kg which is significantly low when compared to the average consumption of low-value fish like sardines and anchovies which was 6.49 kg (Salim, 2013). Our study indicated that shark consumption was largely restricted to festivals or specific seasons with an average frequency of once a week. The comparatively low frequency indicated that consumers view sharks as "special" dish rather than "regular" fish for daily meals. This perception is supported by local customs, where sharks are considered essential menu items at weddings in certain coastal communities in Kerala, as well as in regions like Goa, Maharashtra (Malvan) and Tamil Nadu (Hanfee, 1997; Vannuccini, 1999). Moreover in certain places, sharks are considered beneficial in diets of lactating mothers due to their apparent health benefits (Raje *et al*., 2007).

Trends in shark consumption

Majority (59%) of the respondents felt that their consumption of sharks had declined in recent years which aligns with the decreasing trend seen in shark landings in India during 1961-2020 (Kizhakudan *et al.*, 2024). However, 25% of respondents indicated that shark consumption has increased while 15% reported no change, although there were changes in the varieties. In earlier years, consumption was limited to economically weaker sections and communities with a strong affinity for special cuisines. However, rising fish prices, availability issues of common low-value fishes (sardine, mackerel and clupeids) and increased export demand for many fish species, have substantially changed domestic consumption of sharks, with more species finding acceptability in the market (Karnad

et al., 2020). Thus, while shark consumption is comparatively less frequent than other fish and generally has declined in many areas, some parts of the country have seen an uptick in consumption of sharks.

It was observed that shark species were favoured over rays and guitarfishes for consumption in the country but their high value might also be a barrier to more frequent consumption as compared to other low value fishes. Sharks have also shown to be very stable in prices both at points of first sales as well as last sales (Sathiadhas *et al.*, 2011) indicating that their high prices are retained right from the landing centre to the retail markets. This high value might have contributed to the dominant consumer response in our study in which 68.3% were not willing to purchase sharks at a higher price; rather, they were agreeable to replacing them with other fish if the price of sharks increased further. This suggests a lack of consumer loyalty towards sharks. Thus, while high and stable prices of sharks are one of the major drivers for shark fishing in India even as bycatch, this trend may change in the long term.

Shark species consumed and their status

India has nearly 174 species of sharks reported from its marine waters (Akhilesh *et al.*, 2014; 2023). However, very few species were preferred by consumers. Among sharks, rays and guitarfish, sharks were the overwhelming favourite for consumption across the country. Depending on the coast, the most preferred species were either spadenose shark (*Scoliodon laticaudus*), requiem sharks (*Carcharhinus* spp.) or milk sharks (*Rhizoprionodon* spp.). As evidenced from Table 2, all the preferred shark species fall into the high risk category. Hence to ensure sustainable utilisation of these species, an urgent assessment of their stocks in Indian waters and requisite management measures based on the stock status is required.

Shark conservation - Producer and consumer awareness

Our study indicated the poor awareness among producers and consumers regarding vulnerability of sharks and their management and conservation. Majority of the respondents were not aware that certain sharks are protected in India under the Wildlife (Protection) Act 1972. Coupled with the information that consumer demand or local markets are the main local drivers for shark fishing in India (Karnad *et al.*, 2019), it is imperative to target consumers in shark conservation campaigns. In fact, consumer education has often been a recommended strategy for improving conservation of vulnerable fish species (Clarke *et al.*, 2007; Giglio *et al.*, 2018). Though not particularly aimed at sharks, some conservation initiatives to educate consumers regarding their seafood options exist in the country; examples include the "Choose Wisely" menu, a collaborative effort of ICAR-CMFRI, WWF-India and ITC Hotels (CMFRI, 2015), and "In Season Fish" initiative (Karnad *et al.*, 2021) which informs consumers on which fish to avoid during their breeding season.

Even among those who were aware of shark conservation, many were not clear about aware of the species being conserved. Some respondents in our study considered hammerhead sharks as protected in India even though at the time of this study they were not so. However, in the latest amendment of the Act in 2022, three hammerhead shark species, namely *Sphyrna mokarran*, *S. zygaena* and *Eusphyra blochii* were included under Schedule II and the first two along with *S. lewini* in Schedule IV. Considering the poor consumer fidelity towards sharks and preference for small-sized sharks, the best approach to include consumers in shark conservation would be increasing awareness on vulnerable species and popularising local cuisines for common small-sized sharks and rays that occur regularly in the fishery that are not at risk of stock depletion.

Most of the consumers sourced their sharks from retail markets which could be the key locations for public campaigns for conservation of protected and vulnerable shark species. An example to emulate is the whale shark conservation initiative in Gujarat which could successfully convert fishermen from whale shark fishers to whale shark protectors (Matwal *et al.*, 2014). As a result of extensive campaigning, awareness regarding whale shark conservation among adults of Veraval, Gujarat increased significantly from 19% in 2004 to 69% in 2007 (Matwal *et al.*, 2014). The success of whale shark conservation campaigns was evident in this study, where consumers showed a high level of awareness regarding protection of whale shark in India. A significant percentage (83%) of the respondents was males indicating that either women were numerically fewer among consumers at the surveyed sites or they were hesitant to participate in the survey. Several studies earlier have indicated that women are more mindful about sustainability and can positively influence conservation outcomes (Aggarwal, 2009; Arroyo Mina *et al.*, 2016). Hence targeting women consumers with tailored conservation strategies and campaigns could play a significant role in shifting their family's attitudes toward conservation.

In our study, the awareness of shark protection was found to increase with education level. Most of the respondents in this study were schooled with only 10 years of formal education and their poor awareness about shark conservation in the country indicated that they received very little exposure to marine life conservation both during their formal education and afterwards. Environmental

Table 2. IUCN classification and stock assessment status of preferred shark species in India

Species	IUCN status (Global)	Fishery status in India
Carcharhinus limbatus	Vulnerable (Rigby *et al.*, 2021b)	Over-exploited (Manojkumar *et al.*, 2012)
Scoliodon laticaudus	Near Threatened (Dulvy *et al.*, 2021)	Optimally exploited (Dash *et al.*, 2019)
Rhizoprionodon oligolinx	Near Threatened (Rigby *et al.*, 2021a)	Over-exploited (Purushottama *et al.*, 2017); Over-fished for the north-west region (CMFRI, 2023)
Rhizoprionodon acutus	Vulnerable (Rigby *et al.*, 2020)	Optimally exploited (Dash *et al.*, 2017)
Sphyrna lewini	Critically Endangered (Rigby *et al.*, 2019)	Non-optimal exploitation, needs regulation (Thomas *et al.*, 2021)
Rhinobatos lionotus	Critically Endangered (Dulvy *et al.*, 2021)	Over-fished for the north-east region (CMFRI, 2023)

Education (EE) has been part of India's school syllabus since early 1990s (Barthwal and Mathur, 2012) and was made a compulsory subject in 2003 (Sonowal, 2009). However, focus on marine life conservation in school syllabus is still lacking. The success of any conservation measure can be ensured effortlessly if the targeted audience is convinced about the need for conservation, in the first place. An effective means for this would be teaching children about risks to marine life and the need for the conservation of marine life as part of their school curriculum as well as involve them in conservation/awareness campaigns.

Creating awareness and effecting attitudinal change is indeed a long-term process. Until then, alternate control mechanisms for conservation of sharks should be in place. One of the most effective conservation strategies would be to establish a Minimum legal size (MLS) (Mohamed *et al.*, 2014) for commonly caught species and live release of protected species that are caught in fishing gears. Currently 10 species (5 sharks and 4 rays) have MLS in India (Mohamed *et al.*, 2014; Sivadas *et al.*, 2017; Muktha *et al.*, 2018; Thomas *et al.*, 2021); however, for the tool to be effective, their implementation needs to be strictly carried out. The MLS is an easy-to-use management tool to prevent the landing of under-sized animals by fishermen; it can be made more effective if coupled with live release of under-sized animals and protected species.

In India, sharks are consumed historically and in certain regions, they have important roles in localised customs. Despite the hype of a dominant shark fishing nation, the domestic consumption of sharks is quite less as compared to other fish species. Consumers often consider sharks as replaceable by other fish and prices play a large role in their purchasing decisions. Consumers have low awareness regarding conservation status and needs of sharks in India and addressing this knowledge gap is crucial for effective conservation. To address these challenges and promote effective conservation, the following recommendations are proposed:

(1) Create a list/database of shark species that need protection and those that can be sustainably harvested and consumed in India

(2) Encourage consumption of shark meat sourced from sustainable fisheries and of species that are not vulnerable, threatened or endangered

(3) Create awareness among stakeholders and consumers particularly women on different shark species, their conservation needs and effective strategies and

(4) Involve the younger population in conservation awareness campaigns

The conclusions drawn from this study may be of particular use in evolving participatory strategies for shark conservation in similar tropical countries with a history of shark consumption and may also be helpful in formulating region-specific conservation strategies. Even though this study was exploratory in nature, the results obtained were informative. A much more exhaustive and long-term study across all states of India including both maritime as well as inland areas as well as regions where women consumers can be covered, would provide a deeper understanding on shark consumption patterns in India.

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