

Assessing awareness and perceptions of shark fishing regulations for improved fisheries management[‡]

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Abstract Global demand for shark products has contributed to increased levels of illegal shark fishing, posing a significant threat to marine ecosystem health and the sustainability of related livelihoods. Despite increased management and policy attention, including bans on shark finning and harvesting of certain species, compliance is not universal, and unsustainable practices persist. In this study, we focus on illegal shark fishing by Sri Lanka's semi-industrial fleet, aiming to explore fishers' awareness, perceptions of, and compliance with measures introduced to curb unsustainable shark fishing. During January–June 2023, 254 questionnaire-based interviews and six focus group discussions were conducted at three harbours associated with previous illegal shark landings to explore awareness of regulations and potential drivers of non-compliance. Our findings suggest that only 9% of respondents were aware of all banned shark species, 12% landed banned sharks that were caught incidentally and 47% reported that illegal shark landings occur. Thematic analysis identified key drivers of non-compliance, including the economic importance of sharks, reluctance to discard sharks, lack of awareness of regulations and perceived corruption amongst management authorities. These findings underscore the need to incorporate human dimensions into policymaking and fisheries management to address the global issue of illegal shark fishing effectively. Additionally, we identify that local support is critical for the success and sustainability of shark conservation and management efforts.

Abstract මෝර මසුන් නීති විරෝධී ලෙස ඇල්ලීමේ මට්ටම ඉහළ යාමට මෝර මත්ස්‍ය නිෂ්පාදනය සඳහා ඇති ගෝලීය ඉල්ලුම දායක වී ඇති අතර, සමුද්‍ර පරිසර පද්ධති වල නිරසාරභාවයට සහ ඒ ආශ්‍රිත ජීවනෝපායන්ට මෙය

සැලකිය යුතු තර්ජනයක් එල්ල කරයි. මෝර මසුන් දඩයම් කිරීම සහ ඇතුම් විශේෂ වල අස්වැන්න තහනම් කිරීම ඇතුළුව කළමනාකරණ සහ ප්‍රතිපත්තිමය වශයෙන් ඉහළ අවධානයක් මේ සඳහා ලැබුණත්, නීතිරීති වලට අවනත වීම සාක්ෂාත් වී නොමැති අතර නිරසාර නොවන භාවිතයන් පවතී. මෙම අධ්‍යයනයේදී, ශ්‍රී ලංකාවේ බහුදින ධීවර යාත්‍රා විසින් තහනම් මෝරුන් ඇල්ලීම පිළිබඳව අපි අවධානය යොමු කරන අතර, නිරසාර නොවන ලෙස මෝර මසුන් ඇල්ලීම මැඩපැවැත්වීම සඳහා හඳුන්වා දී ඇති ක්‍රියාමාර්ග පිළිබඳ ධීවරයින්ගේ දැනුවත්භාවය, සංජානනය සහ ඒවාට අනුකූල වීම ගවේෂණය කරමු. පවත්නා නීතිරීති හා ඒවාට අනුකූල නොවීමට මෙහෙයවන සාධක පිළිබඳ දැනුවත්භාවය ගවේෂණය කිරීම සඳහා පෙර නීති විරෝධී මෝරු ගොඩබෑම හා සම්බන්ධ වරායන් තුනකදී 2023 ජනවාරි සිට ජුනි දක්වා ප්‍රශ්නාවලින් ($n = 254$) සහ කේන්ද්‍රගත කණ්ඩායම් සාකච්ඡා ($n = 6$) පවත්වන ලදී. අපගේ සොයාගැනීම් වලින් පෙනීයන්නේ ප්‍රතිවාර දැක්වූවන්ගෙන් 9% ක් පමණක් සියළුම තහනම් මෝරු විශේෂ පිළිබඳව දැනසිටි බවත්, 12% ක් අහම්බෙන් අල්ලන ලද තහනම් මෝරුන් ගොඩ බෑ බවත්, 47% ක් නීති විරෝධී මෝරුන් ගොඩබෑම සිදුවන බවත් වාර්තා කර ඇති බවයි. නීතිරීති හා අනුකූල නොවීම කෙරෙහි මෙහෙයවන ප්‍රධාන සාධක ලෙස මෝරුන්ගේ ඇති ආර්ථික වැදගත්කම, මෝරුන් ඉවත දැමීමට ඇති අකමැත්ත, නීතිරීති පිළිබඳ දැනුවත්භාවය නොමැතිකම සහ කළමනාකරණ බලධාරීන් අතර පවතින දූෂණ අක්‍රමිකතා තේමාත්මක විශ්ලේෂණය මගින් හඳුනාගෙන ඇත. තහනම් මෝර මසුන් ඇල්ලීමේ ගෝලීය ගැටළුව එලදායි ලෙස විසඳීම සඳහා ප්‍රතිපත්ති සම්පාදනය සහ ධීවර කළමනාකරණයට මානව මානයන් ඇතුළත් කිරීමේ අවශ්‍යතාවය මෙම සොයාගැනීම් මගින් අවධාරණය කරයි. මීට අමතරව මෝර මසුන් සංරක්ෂණය සහ කළමනාකරණ ප්‍රයත්නවල සාර්ථකත්වය සහ නිරසාරභාවය සඳහා දේශීය සහයෝගය ඉතා වැදගත් බව අපි හඳුනා ගනිමු.

Keywords Elasmobranchs, Sri Lanka, enforcement, illegal fishing, Indian Ocean, non-compliance, regulations, sharks

මූල පද Elasmobranchs, Sri Lanka, බලාත්මක කිරීම, නීති විරෝධී ලෙස මසුන් ඇල්ලීම, ඉන්දියන් සාගරය, අනුකූල නොවීම, මෝරුන්

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Introduction

Illegal fishing, the act of contravening a state's fisheries laws and regulations, has detrimental effects on coastal and marine species, ecosystems and associated services (Temple et al., 2022). It is increasingly recognized as a widespread phenomenon threatening not only ecological balance but also food security, maritime livelihoods and the sustainability of fisheries worldwide (Mackay et al., 2020). Illegal fishing is estimated to account for 20% of the world's fish catch, resulting in substantial economic losses and hindering scientific stock assessments, which then contributes to poor management (Agnew et al., 2009; Sumaila et al., 2020). Certain taxa, such as sharks and rays, are particularly vulnerable to illegal fishing because of their low fecundity and slow growth rate (Nijman, 2023). Globally, they also face heightened pressure as a result of high demand for shark-derived products, including fins, meat, liver oil and cartilage (Zhou et al., 2021).

Over the past 5 decades, overfishing of sharks and rays has compromised the stability of their populations (Davidson et al., 2016; MacNeil et al., 2020). For example, the global abundance of oceanic sharks and rays has declined by 71% since 1971 (Pacoureau et al., 2021) and 31% of shark species are currently at risk of extinction (Dulvy et al., 2021). To manage and conserve sharks better, various policies and regulations have been implemented at national, regional and international scales. These policies can be broadly categorized into target-based policies for sustainable use (e.g. fisheries quotas) and limit-based policies that completely ban specific aspects of exploitation to promote healthy shark populations without a species-specific focus (e.g. marine reserves; Shiffman & Hammerschlag, 2016). For example, shark-fin bans are widespread, making possessing, selling, trading and distributing shark fins illegal (Ward-Paige & Worm, 2017). The application of shark trade regulations through CITES also puts into place a general ban on commercial international trade or introduces trade monitoring and regulation on a species-specific basis (Friedman et al., 2018). However, the efficacy of many of these measures is often limited by challenges to their implementation (Cardenosa et al., 2018).

Limited monitoring and surveillance capacity in many countries is a major barrier to robust implementation of shark-related policies (Doumbouya et al., 2017), and understanding the social drivers of non-compliance is also a critical but often neglected consideration for policy success (Arias et al., 2015; Collins et al., 2020). Shark fins and meat often provide substantial economic benefits (Peiris et al., 2021; Collins et al., 2023), and shark fisheries

contribute to nutritional needs (Glaus et al., 2019). Policies and regulations aimed at controlling shark fisheries may thus impose multiple types of costs on fishing communities (Booth et al., 2019; Mizrahi et al., 2019), leading to substantial social consequences, particularly for communities that are socio-economically vulnerable (Robinson & Sauer, 2013). Effective shark conservation therefore depends on understanding the wider social context of fisheries, to enable robust policy implementation (Alabsi & Komatsu, 2014; Collins et al., 2020).

Historically, various theories have been proposed to explain non-compliance (Oyanedel et al., 2020). For instance, the theory of compliance suggests that individuals are rational decision-makers who seek to maximize their utility, breaking rules only when the benefits outweigh the cost (Becker, 1968); derived from classical economic theory, this concept forms the foundation of the deterrence model. This model postulates that illegal fishing should be managed through rigorous monitoring, enforcement, prosecution and the imposition of severe penalties so that the costs outweigh the benefits (Sumaila et al., 2006). However, the successful application of the deterrence model to reduce illegal fishing can be affected by its inability to integrate and account for wider factors such as detection rates, corruption, unsuitable sanctions and high enforcement costs (Sumaila et al., 2006; Nunan et al., 2018). An alternative theoretical approach, the compliance framework (Ramcilovic-Suominen & Epstein, 2012), also incorporates context-specific economic, social, cultural and institutional variables that may influence individual motivations. For example, this approach integrates legitimacy and norms to better understand what motivates compliance (Nielsen, 2003).

Using illegal shark fishing by the semi-industrial fleet in Sri Lanka as a case study, we aimed to explore the social aspects of fisheries non-compliance and understand potential challenges to the success of policies designed to curb unsustainable fishing practices. Despite national and international efforts, Sri Lankan vessels have frequently been apprehended for illegal fishing in foreign waters, including the Seychelles and India, with targeting of sharks identified as a key driver of these behaviours in the Chagos Archipelago Marine Protected Area (Tickler et al., 2019; Collins et al., 2021). We first characterized key fishing practices and then assessed fishers' self-reported behaviours and awareness of national shark fishing management regulations. Finally, we identified broader social aspects potentially hindering the success of these regulations.

Methods

Survey design and development

We conducted this study at three sites along the south-west, west and north-east coasts of Sri Lanka (Fig. 1) that have

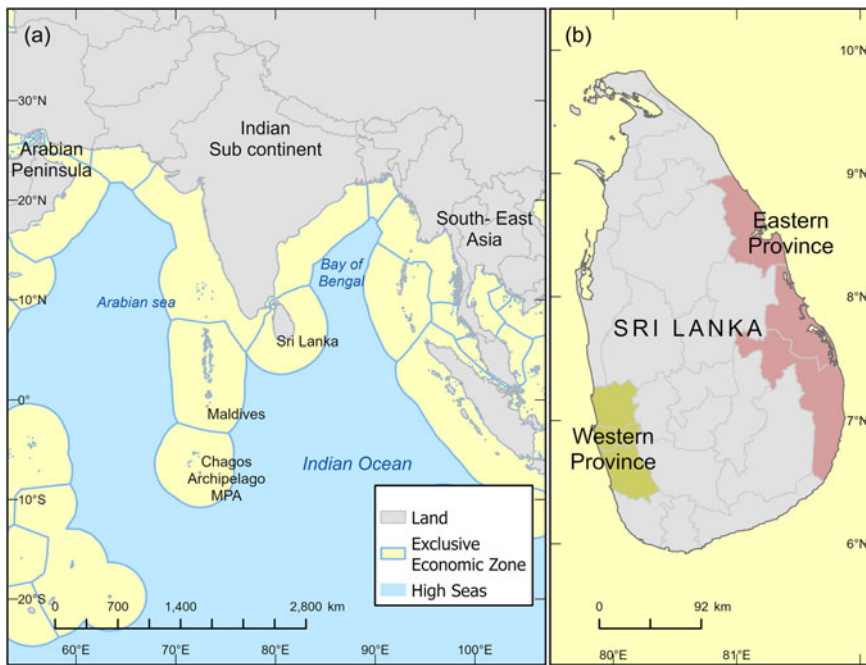


FIG. 1 (a) The location of Sri Lanka, its exclusive economic zone and those of neighbouring countries, (b) the provinces in Sri Lanka where the study sites were located. Precise locations of fisheries are not disclosed, to protect the anonymity of respondents.

been associated with violations of shark fishing management regulations and illegal fishing of sharks in foreign waters, notably the Chagos Archipelago Marine Protected Area (Martin et al., 2013; Collins et al., 2021; Fernando & Stewart, 2021). In particular, we focused on the national Shark Fishing Management Regulations, 2015, which stipulate that no individual engaged in fishing operations within Sri Lankan waters shall catch any of the following species of sharks: common thresher shark *Alopias vulpinus*, bigeye thresher shark *Alopias superciliosus*, pelagic thresher shark *Alopias pelagicus*, oceanic whitetip shark *Carcharhinus longimanus* and whale shark *Rhincodon typus*. It also states that no person shall remove, retain on board, tranship or land fins of any shark unless such fins are naturally attached to the body of the shark (DFAR, 2015).

During a preliminary investigative phase, author LGG conducted 10 site visits to engage with fishing communities informally through discussions about fishing activities, to observe shark landings and to validate study site selection. We chose to survey inboard multi-day vessels (Plate 1), which are medium-sized vessels (9–17 m) operated by a crew of 5–10 that primarily target high-value pelagic species such as tuna, sharks and billfish using gillnets and/or longlines (Collins et al., 2020). Overall, 35% of the nationally registered inboard multi-day vessels land at the three selected sites (Ministry of Fisheries, 2020). Site names are anonymized here because of the sensitive data collected.

We used questionnaire-based interviews and focus group discussions to collect data. We designed these instruments using evidence on potential factors related to fishers' non-compliance (e.g. Gelcich et al., 2005; McClanahan et al., 2005; Pita et al., 2010; Karnad et al.,



PLATE 1 Medium-sized fishing vessel locally referred to as an inboard multi-day vessel.

2014; de Andrade & de Oliveira Soares, 2017; Maynou et al., 2018) and factors identified during preliminary field visits (Table 1). We included the following sections in the questionnaire: fishers' socio-economic characteristics (e.g. years of fishing experience, main occupation), spatial data (e.g. fishing area), vessel characteristics (e.g. licence category, vessel length), awareness of shark fishing regulations (including also the perceived purpose of these regulations), compliance with regulations (including self-reported compliance, perceived level of compliance by others, consequences for non-compliance), and perceived effectiveness of the regulations on shark fishing (Supplementary Tables 1 and 2).

TABLE 1 Variables obtained from the questionnaire responses to characterize behaviours and perceptions regarding national regulations on shark fishing management among fishers, skippers and boat owners.

Variable	Data type	Description (supporting references)
Socio-economic characteristics		
Occupation	Categorical	Specified by respondents, used to describe how fishery occupations influence awareness of regulations & their perceived effectiveness (stakeholder attitudes can differ depending on their livelihoods; Gelcich et al., 2005)
Fish landing site	Categorical	Reported landing site of respondents
Experience in fishery	Categorical	Number of years respondents have worked & gained experience in fisheries, to determine whether level of experience affects awareness of fisheries regulations (experience working in fisheries has a significant effect on the perceptions of fishers; Pita et al., 2010, Karnad et al., 2014, de Andrade & de Oliveira Soares, 2017, Maynou et al., 2018)
Education level	Categorical	Highest grade to which respondents were educated, to examine effect of level of education on awareness of fisheries regulations (there can be a significant effect of level of education on resource users' perception of marine protected area management; McClanahan et al., 2005)
Membership of fisheries cooperative or association	Binary	Whether respondents belong to any fisheries association or similar
Fishing area	Categorical	Spatial scope of respondents' fishing activities
Vessel characteristics		
Type of fishery licence	Categorical	Type of fishery licence(s) under which vessel operates, to determine whether fisheries licence category affects perceptions of fisheries regulations
Vessel length	Categorical	Length of fishing vessel on which respondents work, to examine whether type of vessel affects awareness of regulations (fishers' perceptions of the EU discard ban showed that vessel length had a significant effect on how they perceive landing obligations; Maynou et al., 2018)
Type of fishing gear	Categorical	Types of fishing gear used by respondents
Psychological characteristics		
Awareness of Shark Fishing Management Regulations	Categorical	Respondents' awareness of banned species of sharks & reasons for ban (categorized as high awareness, intermediate awareness, low awareness & no awareness based on number of species they correctly identified as banned species; i.e. 3, 2, 1, 0, respectively)
Own compliance with regulations	Open	What action respondents took when they accidentally caught banned shark species
Perceived level of compliance by others	Categorical	Respondents' perception of action that others take when they accidentally catch banned shark species
Implications for non-compliant behaviours	Open	Self-reported sanctions for non-compliance
Perceived likelihood of being caught when landing banned sharks (Fishers' perceived effectiveness of shark fishing regulations)	Categorical	Respondents' perceived likelihood of being caught when landing banned sharks, expressed as per cent

We used focus group discussions to collect broader qualitative data around the issues we discussed amongst respondents. Focus group discussion guidelines comprised 26 open-ended questions and related prompts to understand fishing practices, awareness of national shark fishing management regulations and perceived effectiveness in terms of compliance and protecting shark populations (Supplementary Tables 3 & 4). We also designed interactive activities such as asking fishers to sort sharks

according to their protection status, to stimulate and generate discussion.

Data collection

Target respondents (fishers, skippers or boat owners) were recruited using convenience (where respondents are approached randomly at suitable sites) and snowball sampling (where respondents are asked to recommend suitable

additional respondents; Newing, 2010). A pilot study was conducted with 27 fishers across different sites, primarily to identify potential methodological improvements. Face-to-face questionnaire-based interviews were conducted during February–June 2023 by LGG, and OD and DB, who were trained on-site for > 1 month prior to data collection. We also conducted a pilot focus group at one of the study sites to determine any changes needed in the focus group discussion guidelines. Based on this, more prompt questions were added to encourage discussion.

At the start of interviews and focus group discussions, we explained the purpose of the research, highlighting anonymity and data confidentiality and emphasizing that respondents could skip questions or end their participation at any time. We collected the data only after obtaining their verbal consent to participate and be audio recorded. We conducted all data collection in Sinhalese, audio-recorded our interactions with respondent permission, and then transcribed the responses and translated them into English.

Data analysis

We summarized responses to closed questions as frequencies. Some response categories had limited counts and were grouped for more robust distinctions (Table 2). We used Pearson χ^2 test of independence and Fisher's exact test (if any of the categories had ≤ 5 counts) to explore potential differences in socio-economic and vessel characteristics amongst landing sites. Statistical analyses were conducted in R 4.3.2 (R Core Team, 2023), with significance at $P < 0.05$.

Answers to open questions in the questionnaires and focus group discussion transcripts were imported into NVivo 14 (NVivo, 2023) and analysed together. We used a hybrid approach of both inductive and deductive reasoning to conduct a thematic framework analysis (Fereday & Muir-Cochrane, 2006). Firstly, we created a thematic analysis framework (Table 3) based on a targeted literature review and data familiarization. Key literature focused on the potential impacts of fishers' perceptions, knowledge of management policies and perception of their effectiveness on compliance (e.g. Gallic & Cox, 2006; Le Page & Radomski, 2006; Dimech et al., 2009; St John et al., 2013; Karnad et al., 2014; Thomas et al., 2016; Bennett, 2019). Secondly, data were coded against the thematic analysis framework in an iterative manner, where new codes were added or modified as needed, and existing ones were deleted to ensure they matched the data (Bryman, 2016). We arranged codes in a hierarchical structure, with codes and sub-codes rearranged during the iterative coding process. Within the Results, illustrative quotes are used to further explain the codes.

Results

Characteristics of the study population and their fishing practices

For the questionnaire-based survey, we approached 273 individuals of whom 19 (7%) declined to participate because of limited available time or concerns about discussing illegal fishing activities. Overall, 254 people participated (84, 84 and 86 from site 1, 2 and 3, respectively) in surveys that took, on average, 17 min. Respondents were primarily skippers (149, 59%), followed by fishers (83, 33%) and boat owners (22, 8%). Skippers were perceived to have more knowledge about fishing practices and were frequently identified by others as suitable respondents for the survey. Although boat owners typically have ultimate authority and are responsible for managing fishers and skippers, they may not always be aware of what happens on board. As a result, boat owners directed us to skippers for data collection, recognizing their key role in managing fishing operations and their detailed understanding of practices at sea. Overall, 97 (38%) of survey respondents had > 20 years of experience in fisheries. A summary of the main characteristics of respondents, fishing vessels and practices is presented in Table 2.

Vessel length averaged $12.8 \pm \text{SD } 1.7$ m (range 8.5–18.0) and the majority (172, 68%) of vessels had a high-seas operation licence. Most (79%) of the smaller vessels (< 10.7 m long) only held local-water operation licences, whereas larger vessels (≥ 10.7 m) mostly (75%) had a high-seas operation licence. Overall, 80 (32%) of respondents reported they operated only on the high seas, and 95 (37%) operated on both high seas and in local waters, with the remaining 79 (31%) fishing only in local waters. Based on self-reported fishing areas and licences, six (2%) vessels fished non-compliantly on the high seas without a high-seas operation licence.

Most respondents used more than one type of fishing gear, with longline being the most common (142, 56%), followed by gill net (110, 43%), purse seine (66, 19%) and other types of gear (33, 9%), including flying fish nets.

The following socio-demographic and vessel characteristic variables differed significantly between sites: education level, licence type, vessel length, types of fishing gear and fishing area (high seas, local waters; see Supplementary Table 5 for statistics). For example, the majority of the respondents from one of the sites had larger vessels and high-seas operation licences, in contrast to the other two sites.

A total of 34 respondents, including fishers and skippers, participated in the six focus group discussions conducted across three sites. On average, each focus group discussion lasted 25 minutes.

TABLE 2 Summary of the key characteristics (Table 1) of the 254 questionnaire respondents, their fishing vessels, practices and perceptions.

Variable	Categories	Number of respondents (%)
Occupation	Skipper	149 (59)
	Fisher	83 (33)
	Boat owner	22 (8)
Experience in fishery (years)	< 10	52 (21)
	10–19	105 (41)
	20–29	58 (23)
	≥ 30	39 (15)
Education level	Primary level or lower	32 (13)
	Junior secondary level	57 (22)
	Senior secondary level or higher	165 (65)
Membership of fisheries cooperative or association	Yes	98 (38)
	No	154 (61)
	Prefer not to answer	2 (1)
Fishing area	High seas	80 (32)
	Local waters	79 (31)
	Both	95 (37)
Type of fishery licence	High seas	172 (68)
	Local water	80 (31)
	Prefer not to answer	2 (1)
Vessel length (m)	< 10.70	29 (11)
	10.70–12.19	92 (36)
	12.20–13.69	75 (30)
	≥ 13.70	57 (22)
	Unknown	1 (0.4)
Type of fishing gear (multiple options allowed)	Longline	142 (41)
	Gill net	110 (31)
	Purse seine	66 (19)
	Others	33 (9)
	Unknown	1 (0.4)
Awareness of Shark Fishing Management Regulations (see Table 1)	High awareness	23 (9)
	Intermediate awareness	139 (55)
	Low awareness	83 (33)
	No awareness	9 (3)
Perceived levels of compliance by others	Unknown	49 (19)
	Relatively high (≥ 40%)	28 (11)
	Intermediate (10–39%)	46 (18)
	Relatively low (< 10%)	46 (18)
	Not landing banned shark species	85 (34)
Perceived likelihood of being caught landing banned sharks	Unknown	75 (30)
	Relatively high (≥ 60%)	49 (19)
	Intermediate (10–59%)	39 (15)
	Relatively low (< 10%)	43 (17)
	No likelihood	48 (19)

Awareness about regulations, and self-reported behaviours

To assess awareness about shark fishing management regulations, survey respondents were asked to identify banned shark species: thresher sharks (all three thresher shark species collectively), oceanic whitetip sharks and whale sharks. Overall, 245 (97 %) named ≥ 1 banned species but only 23 (9%) identified all banned species and had relatively high awareness levels (Table 2). The most common perceived reasons for the bans were extinction threat

for sharks (141, 56%), low reproduction rates (54, 21%), and ensuring their functional roles within the wider ecosystem such as protecting coral reefs and cleaning the ocean (26, 10%). Fifty respondents (22%) did not know why these bans were in place. Awareness of regulations and associated punishments were reported to come primarily from social networks, especially from people who had previously faced consequences for landing sharks illegally.

Most respondents (221, 87%) reported they release banned sharks caught incidentally. However, 30 (12%) reported retaining them and either landing them as whole carcasses

TABLE 3 Thematic analysis framework used to code qualitative data to describe perceptions of the fishing community in Sri Lanka of national shark fisheries management regulations and aspects of compliance. Quotes are taken from discussions held with focus groups (Supplementary Table 3).

Codes	Sub-codes	Description	Quotes
Awareness of regulations	Communication & engagement mechanisms by policymakers	Any descriptions of communication & engagement mechanisms used by policymakers in the dissemination of information; e.g. posters, banners & word of mouth. Any detail as to how effective these strategies have been in making fishers aware of regulations.	If we violate that regulation again, we have to pay a fine of LKR 5,000,000–6,000,000 . . . About that is pasted on the wall of fisheries harbour office to read.
	Social transmission of policy information	Relating to how information about policies & related management (e.g. enforcement) has been transmitted through social networks.	We all adhere to the same set of rules and regulations. I brought those species & received a fine, & I also informed others about the rules.
	Exposure to regulations	Descriptions of how participants' previous exposure to regulations (& resulting sanctions/enforcement) affected their awareness of regulations, nature of sanctions & how this may have caused a change in behaviour.	Unknowingly, I brought a baby oceanic whitetip shark to the land. They filed a court case against me, & I had to pay a fine of LKR 50,000.
	Nature of awareness	Fishers' level of awareness, any misconceptions or incorrect interpretations of the regulations & enforcement. For example, there is a misbelief held by some fishers that the hammerhead sharks (<i>Sphyrna</i> spp.) fall under the category of prohibited species, contrary to national regulations.	There is no prohibition to catch whale sharks. There is no value of that animal.
Fishing strategies		Description of influence of type of fishing gear, target species, fishing seasons & fishing locations on fishers' compliance with regulations.	Usually, we use purse seine & banned sharks don't get caught in our nets. It's more likely for those banned sharks to be caught by fishers who use longlines.
Legitimacy of regulations	Environmental justification	Description of how regulations will improve fisheries sustainability & wider environmental benefits, along with participants' perceptions of their relevance & necessity.	The government never informed fishers about why sharks like threshers and the oceanic whitetip sharks are banned from catching. They didn't make us aware of what would eventually happen if we kept catching those sharks. They only implemented regulations to prohibit the catching of these sharks without providing any explanation or awareness to us fishermen.
	International influence	Participants' perceptions of how Sri Lanka's agreements with international organizations have influenced development of national shark fishing management regulations & whether these regulations are fair & justified.	NARA ¹ imposed this ban as an international requirement. Photographs of the dead sharks were taken & released internationally. News has spread that Sri Lankan fishers were catching those shark species without any limits. As a result, we are now unable to bring those species here.
	Perception of corruption	Participants' beliefs about dishonesty or corruption of governing institutions may influence non-compliance, according to previous studies.	No one gets caught when landing banned fish because everyone bribes the officers. If we give money to the Navy, no punishment is imposed.
	Perceived fairness of regulations	Explanation of how participants perceive regulations & their implementation in terms of fairness, validity & acceptability.	In Sri Lanka, we do not catch them, but they are caught by other countries & sent here as dried fish. Is it fair?
	Perception of complexity of regulations	How individuals perceive level of complexity when navigating & comprehending the diverse rules, requirements & procedures outlined within the regulatory system.	They asked us to dry the shark fish as a whole. Have you ever seen a 50 kg weight shark dried whole? It is not possible to do.

(Continued)

TABLE 3 (Continued)

Codes	Sub-codes	Description	Quotes
Perceived effectiveness of regulations		Description of respondents' varied perceptions about success or effectiveness of regulations in controlling illegal shark fishing.	There's not any decrease in catching fish. Earlier also, if there were 50 boats, 10 boats went for sharks. Now also, the same happens. Now 25–30 boats go. They catch all species of sharks. No change in catching.
Sanctions	Perceived severity of sanctions	Participants' perceived severity of sanctions levied for non-compliant behaviour.	No matter how severe the punishment is, it is not a problem for us. The sea & the prison are the same for us.
Perceived probability of capture (likelihood of being caught)	Probability of capture	All descriptions of participants' perception of likelihood of being caught for illegal shark fishing, & frequency of capture.	Rarely one or two boats might get caught. If someone passes the news to the Navy, they will come to check.
Economic importance		Description of economic drivers of non-compliance, including potential gains from selling banned sharks, financial consequences of compliance & current socio-economic pressures, such as the financial crisis.	Most of the time, people bring those banned sharks to land to cover at least the cost of the boat. Normally, the cost spent on the boat is around LKR 20 lakhs [lakh refers to LKR 100,000]. So, if we bring in 10 lakhs worth fish, it is not enough ¹ .
Social-cultural drivers	Socio-cultural impacts	Perception held by fishers that the regulations are ignoring their culture or traditional rights & practices.	They [coast guard officers] check every corner. Even though we argue with them to not damage our nets during their search, it still happens. It's their job to conduct checks & other procedures, but it's also our job to fish.
	Influence of social norms	Any descriptions of the influence of social norms on the behaviour of respondents, including influence of injunctive norms (e.g. perceptions of approved or disapproved behaviours) & descriptive norms (e.g. perceptions of others' behaviours).	Mostly no one brings them because they know the banned & endangered shark species.

¹National Aquatic Resources Research and Development Agency.

(12), dried fish (11) or using them for food (7). When asked about the behaviour of other fishers, 168 respondents (66%) said their friends always released banned sharks, 42 (17%) said friends either consume them onboard or land banned sharks as whole carcasses or dried fish, and the remaining said they did not know what other fishers did with sharks. In addition, 120 (47%) said they think other fishers at their harbour (not their friends) land banned sharks and 28 (11%) said that the prevalence of illegal shark landings was relatively high (> 40% of other fishers engaging in this behaviour; [Table 2](#)).

Drivers and deterrents of illegal shark fishing

Economic importance of shark fishing

Respondents cited economic reasons (122, 48%) and the role of sharks as a food source both whilst on board and on land (17, 7%) as the main reasons for landing banned shark species. Thematic analysis supported this, indicating that the perceived high income from shark fishing, relative to other occupations, was a substantial driver of non-compliance. Respondents indicated that shark fishing was their only viable means of economically supporting their families, particularly given the rising cost of living. They also cited the need to cover the high operating costs of their fishing vessels, such as fuel and food, driven by the country's economic crisis. One fisher stated: 'Most of the time, people bring those sharks to land to cover only the cost of the boat . . . [which] is around LKR 20 lakhs [USD 6,500–7,000; lakh refers to LKR 100,000]. So, though we bring in LKR 10 lakhs worth of fish, it is not enough'.

Respondents said strong demand and high prices for sharks, particularly shark fins and dried shark, which have stable prices compared to other fish, was driving non-compliance. For example, the price of shark fins remained consistently high over the study period at USD 12–40/kg (LKR 7,000–12,000). One fisher stated: 'We are also going for sharks the next trip. Those fish prices don't fluctuate like in yellow fin tuna. They have a good market'. Prohibited oceanic whitetip sharks were mentioned as the most expensive fish sold in harbours, mainly because of the high value of their notably long fins.

Fishers believe there is a higher availability of shark species in offshore foreign waters than in traditional local fishing grounds as a result of overfishing, which reportedly encourages illegally crossing borders of other countries' waters. One fisher explained: 'No fish in our seas now; we have to go to other borders to catch them'.

Consequences of non-compliance

When asked about perceived punishments for landing banned shark species, 194 respondents (76%) mentioned fines (estimates were LKR 25,000–100,000; USD 76–305), and 97 (38%) said skipper licences are revoked (for 3, 6 or

12 months). Some respondents thought that fines were relative to the weight of illegal landings, and others said half the fine was payable by the vessel owner and the other half by the crew.

Other consequences reported were: court cases (81, 32%), custodial sentences (21, 8%), boat confiscation (9, 4%) and fishing bans (6, 2%). Fishers mentioned that specific sanctions vary depending on the nature of the illegal activity. Respondents reported that repeated regulation violations incur severe penalties, including fines of LKR 5,000,000–6,000,000 (USD 16,000–20,000), boat confiscation, extended jail time and a fishing ban if a skipper's licence is revoked three times. However, when asked to score the perceived level of punishments, four (2%) replied that there were no punishments, with one fisher stating, 'No matter how severe the punishments are, they are not enforced'. For the remaining 250 (98%) who perceived there were some punishments, these were generally perceived to be 'relatively strong or severe' by 62% and 'weak or moderate' by 23%.

Perceptions of the likelihood of capture and corruption

Perceptions regarding the likelihood of being caught landing a banned shark varied widely, ranging from 0 to 100%. Overall, 48 (19%) respondents believed there was no chance of being caught, and 49 (19%) perceived a relatively high likelihood (> 60%), most of whom (45) felt there was a 100% chance of being caught ([Table 2](#)). The likelihood of being caught varied depending on information leaks or someone informing the coastguard about the presence of banned sharks. As a result, fishers typically sold banned sharks directly to the same shark seller to prevent information reaching the coastguard through third parties. One stated, 'Let's say we bring a banned shark and promise to sell it to one person for LKR 1,000. Another person comes and offers to buy it for LKR 1,200. We cannot sell it to the second person . . . if we do so, the first person gives a hint to some officer and betrays us. That's why we give those sharks to the same person as agreed upon'.

It was noted by fishers that the coastguard faces challenges with the taxonomic identification of sharks as well as the feasibility of inspecting cold rooms filled with ice, leading to increased opportunity for non-compliance and a decreased likelihood of being caught. They explained that individuals landing banned sharks typically remove the gut, head and fins, making identification difficult. Respondents stated that banned sharks are unloaded daily by at least 2–3 vessels at different locations, without getting caught. One fisher said, 'To get caught, Navy officers should be there when we unload these sharks. They only inspect us just after we return to the harbour. Furthermore, those officers lack the knowledge and are unable to distinguish between banned and non-banned shark species'.

A perceived key reason behind non-compliance is bribery, with officers accepting monetary bribes or a share of the fish catch, and favouring fishers with personal connections, leading to distrust in law enforcement. Fishers explained that vessels they perceived as poorer are more frequently punished for non-compliance, while wealthier vessels, particularly those owned by individuals with multiple vessels, often evade any consequences for illegal shark landings, creating an unfair situation. One fisher said, 'Normally, fishers don't get caught unless someone provides a hint. However, if we do get caught, there are ways to escape. For instance, if I contact a specific officer or offer bribes, I can be safe. There are rules and regulations in Sri Lanka, but they are not implemented'.

Wider drivers of non-compliance

Some fishers (66, 26%) believe discarding banned shark catches is wasteful. For example, one fisher stated: 'If a banned shark gets entangled in our nets and is already dead, throwing it away into the sea is useless. It is not beneficial for us fishers or the sea.' Fishers explained they felt it was unfair to be told to release banned sharks, especially after working hard to earn a living. For example, one fisher said: 'For instance, someone might have caught only oceanic whitetip sharks but is still required to remove them because of the law'.

Other factors that led to the perceived unfairness of regulations included the inability to selectively target permitted shark species; other countries, such as India, continuing to target banned species in high-sea areas; and regulations preventing fishers from drying sharks onboard (a traditional practice). Some fishers emphasized the poor communication regarding why only some shark species are banned. Similarly, some felt that species-specific bans were the Sri Lankan government's response to international pressure to enact shark conservation. Fishing strategies and social-cultural drivers (Supplementary Table 6) were also identified as factors that affect the non-compliance behaviour of respondents.

Discussion

Social dimensions are often overlooked in shark management and policy design, undermining their effectiveness (Booth et al., 2019; MacKeracher et al., 2019). Our research provides new insights into the drivers of non-compliance in Sri Lankan shark fisheries operating inboard multi-day vessels. Our findings reveal that fishers of these vessels engage in both forms of non-compliance, landing of banned shark species and fishing in other countries' exclusive economic zones to target sharks to varying degrees, influenced by factors such as awareness of regulations, social networks and perceived penalties. These findings highlight the

importance of considering social dimensions in designing management strategies to address non-compliance.

Occurrence of non-compliant behaviour

Although asking questions about illegal behaviour is likely to generate non-response and response biases (Nuno & St John, 2015), and the estimates reported here are conservative, our data provide evidence of the occurrence of non-compliant behaviour among Sri Lankan fishers operating inboard multi-day vessels. This confirms previous studies that found banned species, including thresher sharks and oceanic whitetip sharks, at markets in Sri Lanka (Collins et al., 2021; Peiris et al., 2021). In addition to reporting illegal shark landings by themselves and their friends, respondents also mentioned vessels entering other countries' exclusive economic zones to target sharks. Respondents reported that declines in sharks in local waters are prompting them to venture into high seas and areas where, according to their perception, shark populations are higher. This supports other studies that suggested fishers tend to fish in foreign waters when sharks in traditional, local waters are heavily exploited (Schiller et al., 2018; Collins et al., 2021). Our findings also indicate ongoing instances of landing prohibited species of sharks, primarily from bycatch in tuna fisheries (Balawardhana et al., 2018), with a few vessels directly targeting sharks. This contradicts previous claims (Hasarangi et al., 2012) that Sri Lankan fishers no longer target sharks.

Drivers of non-compliance

Economic incentives have been widely identified as a key driver of non-compliance in other studies (Sumaila et al., 2006; Agnew et al., 2009), a finding supported by our research. Although the international market for shark fins in East Asia has traditionally been identified as the primary driver of shark harvests (Clarke et al., 2007; Cardenosa et al., 2018), our data highlight the importance of strong demand and high, stable prices for shark meat and dried fish within the domestic market. Our data suggest some fishers were driven to illegal behaviours by the economic crisis in Sri Lanka, which accelerated in 2022 as a result of the country's depletion of foreign reserves, and led to shortages of food, fuel, medication and other essential goods (George et al., 2022; Sharma et al., 2022). This is supported by other studies that show how socio-ecological shocks, such as an economic crisis, can have negative effects on compliance (Quimbayo et al., 2022). Nevertheless, our findings indicate these fishers target sharks primarily to obtain additional income, underscoring that while poverty may drive some resource users to engage in shark fishing for basic needs, it is not the sole economic motivation resulting in non-compliance.

Enforcement is crucial for ensuring compliance, with weak enforcement often linked to low compliance (Alabsi & Komatsu, 2014). However, several studies have indicated that the perceived impact of sanctions may differ based on various factors, including social context (Collins et al., 2020) and prior experience such as previous interactions with enforcement personnel or processes (Battista et al., 2018). Similarly, respondents in our study reported instances of corruption, such as monetary bribes or sharing catches with monitoring officers, with these behaviours reportedly more commonplace amongst individuals of better economic standing, leading to negative perceptions of sanctions among other fishers. Booth et al. (2024) discuss this issue in the context of distributive justice, highlighting how the unequal distribution of costs can result in poor social and biodiversity outcomes, thereby fostering non-compliance. Additionally, some respondents believed that punishments are insufficient compared to the gains from illegal shark fishing, further supporting the economic rationale for engaging in this behaviour.

Other social drivers of non-compliance were identified, including legitimacy. We found that fishers perceived unfairness in regulations, particularly the requirement to discard banned sharks and also the lack of consequences for Indian fishers who, according to respondents, face no punishments under their own country's regulations for illegally fishing for sharks in the same fishing grounds (e.g. Chagos Archipelago Marine Protected Area). Additionally, as some fishers perceived that regulations were created to comply with international guidelines rather than for genuine ecological or conservation reasons, this led to reduced perceptions of legitimacy regarding regulations. This is likely to jeopardize the current measures given that natural resource users are more likely to feel obliged to comply if they perceive regulations as fair and legitimate, even when non-compliance could benefit them personally (Nielsen, 2003; Turner et al., 2016). Relatedly, we found that both fishers and monitoring officers lacked sufficient knowledge of the regulations and their ecological justification. Lack of knowledge regarding the environmental justification for regulations has also been identified as a driver of non-compliance (Jagers et al., 2012).

Previous studies have suggested that social networks influence the perceived acceptability of non-compliance (Arias & Sutton, 2013). Similarly, we found some evidence of the importance of social networks in both facilitating the transmission of information regarding non-compliance and influencing perceived social norms around the acceptability of it. Given that compliance can be determined by the extent to which rule-breaking is negatively perceived by peers and the fishing community (Jagers et al., 2012), the relatively high perceived rates of non-compliance among friends of study respondents may

contribute to rule-breaking becoming normalized, particularly within specific networks, leading to increased non-compliance.

Wider fisheries management implications

Effective fisheries management typically requires a policy framework with clear objectives, a set of laws and regulations to govern resource users' behaviour, and robust enforcement mechanisms to ensure compliance (Alabsi & Komatsu, 2014). Non-compliance is framed in previous studies as an interaction between motivated actors and opportunities (Clarke, 1980; Oyanedel et al., 2020); addressing it thus requires a robust understanding of drivers. Our findings emphasize the role of various drivers in affecting compliance (e.g. economic factors, legitimacy and perceived fairness) and, although their importance may vary, these should be carefully considered when planning the design of potential incentive programmes. For example, financial incentives for compliance with shark regulations can be more effective than traditional regulatory methods with penalties (Booth et al., 2023). When monetary value is not the sole determinant of fisher behaviour, financial incentives can be integrated with community-led initiatives, such as cooperative management systems, where traditional practices and social norms are recognized and reinforced alongside monetary benefits to enhance intrinsic motivations for compliance (Grillos et al., 2019). However, such incentive programmes need to be tailored to specific local conditions, considering ecological, socio-economic and institutional factors (Börner et al., 2017; Booth et al., 2023). This approach could be trialled in Sri Lanka, although financial constraints may pose a barrier, requiring additional funding sources.

Fishers in our study mentioned that some monitoring officers (although not all) cannot distinguish prohibited species from other shark species, which undermines management of shark conservation. Similar to other areas (Wosnick et al., 2019), evisceration, decapitation and finning prior to landing can be particularly problematic for proper monitoring, impairing the correct identification of species. However, improving monitoring is costly for developing countries (Doubouya et al., 2017), requiring more cost-effective collaborative approaches (Iwane et al., 2021). Peer monitoring, or placing the burden of proof on fishers, can be an effective strategy. Although a reward-based approach such as incentives for live shark releases can encourage compliance (Wosnick et al., 2023), implementing these incentive-based tools may have financial implications for Sri Lankan authorities. Their suitability is also uncertain for an offshore fleet where incidental capture of sharks is frequent, which may lead to high numbers of claims and increased administrative burden. Partnering with NGOs to pilot schemes could decrease the financial

burden and support transitioning to community-driven management. Furthermore, ensuring fair enforcement of regulations for all fishers, regardless of economic status, can foster distributive justice and uphold the shared responsibilities of compliance.

Fishers also reported instances of corruption among monitoring officers, potentially driven by personal motivation, which undermines enforcement efforts and requires urgent attention. As suggested by Moreto et al. (2015), strategies such as building internal organizational capacity, enhancing leadership integrity, establishing internal affairs units, and strengthening supervisory oversight can help to mitigate corruption. However, the Sri Lankan context needs to be further researched to identify the root causes of corruption and to tailor interventions to address underlying motivations effectively.

Ensuring that fishers are sufficiently aware of regulations is essential for the success of regulatory efforts (Islam et al., 2017). Efforts to enhance access to information and conduct targeted campaigns for fishers, aimed at addressing relevant perceptions and improving regulatory knowledge, have been shown to motivate behaviour change (Butler et al., 2013; Battista et al., 2018). Moreover, the social networks used by fishers play a crucial role in motivating their participation in conservation projects (Iwane et al., 2021). In Sri Lanka, social networks and key community actors could be more effective in improving awareness of regulations amongst fishers and securing their support in managing shark fishing. Future research could seek to assess monitoring and the awareness of enforcing officers, perceptions of the effectiveness of national shark fishing management regulations and challenges in implementing the regulations.

Finally, our results highlight the persistent non-compliance of shark fisheries in Sri Lanka, which undermines conservation efforts. This underscores the importance of understanding social dimensions and integrating them into policy frameworks to manage non-compliance effectively. Furthermore, we advocate adoption of a collaborative and inclusive fisheries management approach that could achieve sustainable outcomes for both shark populations and reliant communities (Angel et al., 2019). This would ensure a holistic strategy in which conservation objectives are integrated with socio-economic considerations, balancing conservation goals with fisheries' socio-economic needs (Booth et al., 2019; Mizrahi et al., 2019).

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Conflicts of interest None.

Ethical standards This research was reviewed and approved by the Zoological Society of London (Reference: ZSLHEC-003) and abided by the *Oryx* guidelines on ethical standards.

Data availability The data collected in this study are strictly confidential, to protect the anonymity of the research participants. Requests to access the fully anonymized datasets should be directed to the corresponding author, LGG.

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