50 years and counting: Indian Wildlife Protection Act through the lens of marine fishers

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Abstract

Fishers' awareness and attitudes towards conservation policies may vary, but can serve as important pointers towards assessing their on-ground implementation and success. We conducted a questionnaire survey across six coastal states and two island territories of India, with an aim to critically evaluate the socio-demographic factors that influence knowledge, perception and conservation attitudes of fishers towards protected marine species. Using gorgonians, seahorses and pipefishes as proxies, we assessed the differences in the fishers' awareness and conservation attitudes towards marine taxa protected through the Wildlife (Protection) Act (WLPA) 1972. Our observations revealed divergent perceptions among respondents (fishers) with greater awareness towards seahorses, followed by gorgonians and pipefishes, respectively. The low level of awareness on legal status of the focal taxa among the fishers is also a direct indication of how key stakeholders are largely misinformed on WLPA. Nevertheless, our results also showed that a better awareness on the focal taxa tends to influence the positive conservation attitudes of fishers. Based on fishers' perceptions and conservation attitudes, we constructed a priority matrix to identify priority areas that could help strengthen the implementation and enforcement of existing conservation policies. Despite existing conservation and management strategies such as Marine Protected Areas (MPAs) and the WLPA, all locations along the coast of Tamil Nadu and Odisha were identified as priority areas. Thus, we contend on the importance of improving stakeholder awareness on management policies for better compliance and conservation engagement. Also, we advocate for holistic management strategies that should look beyond the currently-known legal framework (WLPA) that appears to be largely ineffective for several protected marine taxa in India.

1. Introduction

International conventions and policy interventions play an important role in the conservation of Earth's biodiversity [1]. For instance, article 194 (5) of the United Nations Convention for the Law of the Sea (UNCLOS) and article 8 of the Convention of Biological Diversity (CBD) emphasise *in situ* biodiversity conservation and marine habitat protection that is consistent with the rights and obligations of its contracting parties [2, 3]. Similarly, multilateral agreements such as the Convention on International Trade in Endangered Species (CITES), effectively restrict global trade of rare and threatened species [4]. Additional guidelines and tools on species and ecosystem assessments by the International Union for Conservation of Nature (IUCN) deliver standardised and comprehensive resources for setting conservation priorities at regional and global scales [5]. However, these international agreements and processes have shortfalls and limitations, which can only be resolved through the effective implementation and enforcement of management and laws at the regional and/or local level [6, 7].

In compliance with international commitments and guidelines, the Government of India has enacted several national policies and laws to protect its rich biodiversity, one of which is the 'Indian Wildlife (Protection) Act, 1972' (hereafter WLPA). The fundamental objective of WLPA is the protection of India's wild flora and fauna, and their habitats, to ensure ecological and environmental security [8]. Species included in WLPA are categorised into various schedules (I to VI), with those listed in schedule I receiving the highest level of legal protection [9]. In essence, the WLPA protect wildlife through a two-pronged statutory framework, of prohibiting its hunting, trade, and protection of habitat and penalising the perpetrators [10]. In the marine realm, the WLPA has been extremely effective for protecting large mammals such as dugong [11] and turtles [12, 13], but their effectiveness has been unclear with regard to other marine taxa, such as invertebrates and fishes [14, 15]. Since WLPA's inception in 1972, several marine taxa were included in the various schedules from I to VI through subsequent amendments and notifications [16]. However, studies have shown that protected marine species in India continue to be exploited and traded, both in domestic and international markets [15, 17, 18]. For instance, syngnathids (seahorse and pipefish) and gorgonians (sea fan or sea whips) were listed under schedule I of WLPA (Part IIA and IVA, respectively) in 2001 [8], but their clandestine trade including through incidental bycatch continues to be a significant concern [19, 20].

Due to the unique characteristic of coastal and marine social-ecological systems (CM-SESs) [21], the fishery sector is prone to stakeholder conflicts (both institutional and individual) which can hamper conservation efforts at local scales [22, 23]. Socio-economic factors (e.g., per capita income, wealth, alternate livelihoods), culture, and ecology (e.g., foraging behaviour of the target species) shape the perceptions and attitudes of fishers towards wildlife conservation [24–26]. In a maritime nation like India, with a high dependency on marine capture fishery [27], stakeholder perception and compliance play a major role in species conservation [28, 29]. However, the changing dynamics of demographic, socio-economic and political structure of India's marine

fishery sector can invariably affect fishers' compliance to management systems [30–32]. Also, the level of awareness on management policies (e.g., WLPA) is not always uniform among the stakeholders (fishers, middlemen and traders) in India [33]. Nonetheless, improved awareness of policies among stakeholders need not always guarantee protection for vulnerable species, as exemplified in the seahorse trade in India [34, 35].

Based on this assertion, we tested the level of knowledge, attitude and perceptions of fishers, towards marine species protected under the WLPA, and their conservation. Using syngnathids and gorgonians as 'focal taxa', we sought to gain insights into the effectiveness of WLPA as a legal framework in protecting marine biodiversity. We specifically, (1) examine the knowledge among fishers on the catch, use and legal status of the focal taxa; and (2) analyse the fishers' perception towards conserving these 'taxa' with respect to socio-demographic and fishery characteristics; (3) prioritize areas for administrative and institutional intervention based on fishers' perceptions and attitudes; and (4) critically analyse the effectiveness of WLPA on schedule I marine taxa.

2. Materials And Methods

2.1. Study area

A questionnaire survey was carried out from July 2018 to June 2019 across fishing villages and fish landing centres on both the eastern and western coasts of India, including the Lakshadweep archipelago and the Andaman and Nicobar group of islands (Fig. 1). All surveyed areas are under the jurisdiction of the Government of India, and were carefully selected based on any one or combination of the following information on the focal taxa (gorgonians, seahorses and pipefishes): a) previous studies or reports of occurrence, b) ongoing targeted or incidental exploitation, c) local knowledge of fishers, and d) insights from marine biodiversity researchers and the authors' field experience. The coastline of the Indian subcontinent (~ 8000km) is distinct in its physical, biological and demographic characteristics [36] and covering this entire length was beyond the scope of the present study. However, the regions we surveyed are representative of the coastal states of India (six of the nine coastal states and two island territories).

2.2. Study design

We started by selecting three taxonomic groups; seahorses, gorgonians and pipefishes (hereafter focal taxon/taxa); all of which are protected under the WLPA, and the latter two are poorly known in terms of their diversity and legal status. Keeping these groups as proxies, a questionnaire survey was developed to assess the knowledge, attitudes and perception of fishers towards marine protected species. Throughout the surveys, we collected information on demographics (gender, nativity and education); knowledge on focal taxa (habitat, spatio-temporal trends in catches, and use value), as well as conservation and management strategies (opinion on species protection, awareness on WLPA status and its implementation) (Table 1). Coloured photos (both live and dead) of the focal taxa were presented to the fishers at the beginning of every interview, for identification. Only data from those fishers who correctly identified any one, or any combination of two, or all three species, were used for further analysis. Systematic sampling methods such as snowball techniques and chain referral were administered to identify potential respondents/fishers [37]. To gather information and triangulate results, semi-structured questionnaire including open-ended questions were used. All questions were delivered face-to-face directly by the authors, or with the help of local translators wherever necessary. The interview time on average, lasted between 5 to 12 minutes. The survey also recorded information exclusive to the questionnaire (e.g., local names of the species).

2.3. Data analysis

Pearson's chi-square test was used to determine the association between fishers' socio-demographic characteristics and their responses. To measure the effective size among categorical variables, phi (φ) coefficient was calculated for the binary variables and Cramer's (V) for the variables having more than two categories [38]. Comparison of subgroups within each factor was calculated using Kruskal-Wallis and Mann-Whitney test (non-parametric tests) for independent samples. An awareness score was computed from the fisher's responses (score ranges from minimum 1 to maximum 10) for gorgonians, seahorses and pipefishes. We used a generalized linear model (GLM) to identify the effect of socio-demographic factors and fishing practices on the awareness regarding the focal taxa. All data were analysed using IBM SPSS Statistics version 15 (Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC).

2.4. Prioritization matrix – fishers' perceptions and conservation attitude

A prioritization matrix was constructed to identify areas to be prioritised for legal and strategic administrative intervention so as to ensure long-term protection of the focal taxa. We adopted and modified the methodology used for prioritising actions for coastal management [39, 40]. The following responses of fishers from all survey locations were used as criteria/parameters for the matrix: (1) perceptions on population decline; i.e., whether fishers perceived a declining trend in the population of at least one of the focal taxa; (2) conservation attitude towards the focal taxa; i.e., whether fishers in the survey location were apprehensive on conserving at least one of the focal taxa; (3) awareness on legal status; i.e., whether fishers in the survey location were unaware of the legal status of at least one of the focal taxa; and (4) focal taxa landed as bycatch/targeted fishery; i.e., whether at least one of the focal taxa were landed as bycatch/targeted fishery. We omitted responses of fishers from Munambam (Kerala) due to low sample size. The rows in the matrix comprise all locations surveyed (coded A-O), while columns contain parameters (as mentioned above). We then provided the highest weightage to parameters (4) and (3) as they are directly linked to WLPA and its implementation, followed by (2) and (1) which indicates species perceptions and conservation attitudes of fishers. Since the number of respondents varied between survey locations, we used the percentage of total respondents at each location before assigning response ratings. Each of the parameters were then rated from 0 to 4, against the percentage of fishers' response to each parameter (Table 3). Finally, we calculated the weighted score (WS) to identify the areas to be prioritised for strategic management actions, i.e., highest priority area scored the highest.

3. Results

3.1. Demographic and socio-economic profile of fishers

A total of 311 fishers were interviewed, with almost equal representation from the east (Goa, Lakshadweep, Kerala, Maharashtra, n = 158) and west (Andaman, Odisha, Tamil Nadu, West Bengal, n = 153) coast of India (see Table 1). All fishers were males (n = 311), which is justifiable as the major part of fishing operations (e.g., gear and craft operation, manual and mechanised fishing/harvest, transport etc.) in the surveyed areas were carried out by men while women's roles are mostly restricted to post-harvest processes (e.g., processing and selling). Responses from fishers operating traditional (n = 34), motorised (n = 171) and mechanised (n = 106) crafts were recorded to improve inclusiveness and diversity of opinions. The region of fishing operation of almost 87% (n = 271) of fishers was in non-protected 'open-access' areas, and the remaining 13% (n = 40) within marine protected areas (MPAs) (e.g., Gulf of Mannar Marine National Park and Malvan Marine Sanctuary). The literacy level of fishers varied drastically between surveyed locations along the east and west coasts. For instance, most fishers (91.77%, n = 145) along the west coast have basic (1st to 8th grade) to higher education (9th grade and above), while 57.5% of respondents (n = 88) along the east coast were illiterate. The most preferred fishing gear were gillnets (53.4%) followed by trawl nets (27.3%), hook and line (11.3%), and seine nets (8%). While 50.8% of fishers preferred non-selective fishing operations, 32.8% harvested 'specific' fishes (e.g., mackerel, tuna) and 16.4% targeted and collected economically-important crustaceans (e.g., crab, lobster, shrimp).

3.2 Awareness towards the 'focal taxa'

Analyses of awareness score of the three focal taxa revealed that fishers tend to have higher general awareness (identification of species observed in their catch, change in population size, legal status) towards seahorses (M = 6.13 ± 2.3, N = 311), followed by gorgonians (M = 5.26 ± 2.6, N = 311) and pipefishes (M = 4.14 ± 3.3, N = 311) respectively. Generalized linear model (GLM) showed that fishers' awareness on seahorses were influenced by factors such as marine protected area ($p < 0.001$), nativity ($p < 0.001$), years of experience ($p = 0.003$), target fisheries ($p = 0.004$), and education ($p = 0.037$). On the other hand, awareness on gorgonians was mainly influenced by target fisheries ($p < 0.001$), years of fishing experience ($p < 0.001$), marine protected area ($p < 0.001$) and depth of fishing operation ($p = 0.027$); and geography ($p < 0.001$), gear of operation ($p < 0.001$), depth of fishing operation ($p < 0.001$), craft used ($p = 0.004$), and years of fishing experience ($p = 0.007$) in the case of pipefishes. Further, awareness also varies significantly with different socio-demographic variables which is discussed in detail in the subsequent sections.

3.2.1. Demography and social profile

Of the 311 fishers, 92.9% (n = 289) correctly identified seahorses, 86% (n = 268) identified gorgonians and 65.3% (n = 203) identified pipefishes. Geography (east and west coast) tends to significantly influence the fishers' ability to identify gorgonians (χ^2 = 16.83, df = 1, p < 0.001; ϕ = 0.23) and pipefishes (χ^2 = 27.3, df = 1, p < 0.001; ϕ = 0.30), but not seahorses (χ^2 = 0.03, df = 1, p < 0.861; ϕ = 0.01). While seahorses were identified by almost all fishers from both the coasts - east (n = 144) and west (n = 145) (p = 0.42), gorgonians and pipefishes were accurately identified (p < 0.001) by more fishers from the east coast (93.6% and 78.8%) than along the west (77.2% and 50.6%). Fishers' education significantly influenced accurate identification of gorgonians (χ^2 = 12.38, df = 2, p = 0.002; V = 0.20). About 96% of fishers with no education (n = 97), 83.5% of fishers with basic education (n = 96) and 78.95% of fishers with higher education (n = 75) were able to correctly identify gorgonians (H = 13.07, df = 2, p = 0.001). Fishing experience (in years) also significant influenced fishers' ability to identify gorgonians (χ^2 = 30.610, df = 4, p < 0.001; V = 0.312), seahorses (χ^2 = 16.54, df = 4, p = 0.002; ϕ = 0.23) and pipefishes (χ^2 = 29.02, df = 4, p < 0.001; V = 0.30). As the years of fishing experience increased, the more likely is the chance of fishers accurately identifying the focal taxa. We found that more fishers with 11–20 years (n = 88) of fishing experience correctly identified gorgonians (93.2%) and pipefishes (84.1%), and > 40 years (n = 16) in the case of seahorses (100%) (p < 0.05). When asked about the changes in population size of the focal taxa over the past five years, fishers with 21–30 and 11–20 years of fishing experience revealed as having observed a decreasing trend in gorgonians (44. 9%, n = 40) and seahorses (50%, n = 39) (p < 0.05).

Fishery characteristics such as the nature of craft and gear also influenced fishers' ability to identify the focal taxa. For instance, type of fishing craft used significantly influenced the fishers' ability to identify pipefish (χ^2 = 7.73, df = 2, p = 0.02; V = 0.16). Our results also suggested that more fishers using mechanised boats identified pipefish accurately (74.5%, n = 79, p = 0.02) than those operating motorised or traditional boats. All fishers operating traditional (n = 29) and motorised boats (n = 124) tend to have observed a gorgonian (p < 0.001) in their catch more frequently than those operating mechanised boats. When asked about the change in population size of the focal taxa over the past five years, most traditional fishers revealed as having observed a decreasing trend in the case of gorgonians (76.7%, n = 23, p < 0.001), seahorses (71.9%, n = 23, p < 0.001) and pipefishes (82.4%, n = 14, p = 0.002), compared to those operating mechanised and motorised boats. Similar to fishing crafts, the type of gears operated significant influenced the ability of fishers to identify gorgonians (χ^2 = 6.303, df = 4, p < 0.98; V = 0.14) and pipefishes (χ^2 = 40.56, p < 0.001, V = 0.36). Also, fishers operating gears such as seine nets, gill nets, hook and line and those who were engaged in dive collection (100%, n = 169, p < 0.001) tend to have observed gorgonians in their catch. Whereas in the case of pipefish, it was fishers operating seine net, and those involved in dive collection or using hook and line who have observed (100%, n = 14, p = 0.01) the animals in their catch followed by those operating gillnets (97.5%, n = 77) and trawls (80.6%, n = 25). To our question on the changes in population size of focal taxa during the past five-years, gillnet-operating fishers revealed as having observed a decreasing trend for gorgonians (49.3%, n = 69, p < 0.001) and pipefishes (48.5%, n = 48, p < 0.001). Whereas a decreasing trend in seahorse populations were observed by fishers operating gillnets and trawl nets (45.5%, n = 70 and 45.6%, n = 36, p < 0.001) respectively.

3.2.2. Awareness of fishers towards legal status of focal taxa and WLPA

Our analyses showed that awareness of the legal status of focal taxa was considerably low among the fishers, which is a direct pointer regarding how the WLPA remains uninformed among key stakeholders. For example, on the east coast, only 22.6% of fishers were aware of the legal status of gorgonians (p < 0.001), and 61.1% (n = 88) in the case of seahorses (p = 0.04). Similarly, on the west coast, this was 33.6% (n = 41) and 23.4% (n = 34), respectively, in the case of gorgonians and seahorses. There was no significant difference in the awareness among fishers between the two coasts in the case of pipefish (p = 0.37), and only 44.3% (n = 90) recognised its legal status. Other responses to our question on the legal status of the focal taxa include 'no' (i.e., focal taxa not legally protected; gorgonians – 42.9%, seahorses – 20.8% and pipefishes – 34.5%) and 'don't know' (i.e., unaware of the existence of any sort of legal mechanisms such as WLPA; gorgonians – 29%, seahorses – 37% and pipefishes – 21.2%). While comparing fishers' education with the awareness on the legal status of focal taxa, there was a significant difference in responses on seahorses (p < 0.001), where illiterate fishers (67.3%, n = 66) recognized its legal status better than those who are literate (basic education 31.4%, n = 32, and those possessing higher education 27%, n = 24). Whereas for gorgonians (p < 0.001), literate fishers (either with basic education 30.2%, n = 29, or higher education 29.3%, n = 22) recognized its legal status better than illiterates (23.7%, n = 23). To our question on penalties or penalization records for fishing and/or trading of scheduled marine species including the three focal taxa covered in our study, only 9.8% fishers (n = 13) from east coast responded about the 'crime' or its

associated legal proceedings, whereas along the west coast all fishers' (n = 141) responses were recorded as 'no' (i.e., no penalty or crimes recorded).

3.3 Attitude of fishers towards conservation

Our results showed that positive conservation attitude of fishers was influenced by increasing level of awareness on the focal taxa (Fig. 2). For instance, fishers showed a positive attitude towards conservation of the three 'focal' taxa along both coasts ($p < 0.05$). However, fishers from the west coast showed better conservation attitudes ($\bar{\chi}$ = 4.26 ± 0.9 gorgonian, $\bar{\chi}$ = 4.20 ± 1 seahorse and $\bar{\chi}$ = 4.18 ± 1 pipefish) than those on the east ($\bar{\chi}$ = 3.33 ± 1.4 gorgonian, $\bar{\chi}$ = 3.73 ± 1 seahorse and $\bar{\chi}$ = 3.62 ± 1.1 pipefish, scale 0–5). Also, while assessing fishers' attitude towards conservation of the focal taxa with respect to education ($p < 0.001$), there was an increase in positive attitude with the increasing level of education of the fishers, from no education ($\bar{\chi}$ = 2.84 ± 1.4 gorgonian, $\bar{\chi}$ = 3.44 ± 0.9 seahorse and $\bar{\chi}$ = 3.32 ± 1.1 pipefish) to basic education ($\bar{\chi}$ = 3.95 ± 1.1, $\bar{\chi}$ = 4.03 ± 1 and $\bar{\chi}$ = 3.95 ± 1) and higher education ($\bar{\chi}$ =4.54 ± 0.7, $\bar{\chi}$ = 4.44 ± 0.8 and $\bar{\chi}$ = 4.41 ± 0.8) respectively. In the case of fishing experience ($p < 0.05$), most fishers in the categories '1–10 years' to > 40 years of fishing experience showed positive attitude towards conservation of gorgonians ($\bar{\chi}$ = 3.11–4.09 ± 1.1–1.5), seahorses ($\bar{\chi}$ = 3.71–4.18 ± 0.9–1.2) and pipefishes ($\bar{\chi}$ = 3.52–4.07 ± 0.9–1.1). Comparing the fishers' attitude towards conservation with respect to fishing craft ($p < 0.05$), fishers operating motorised boats showed more positive attitudes towards conservation of gorgonians ($\bar{\chi}$ = 3.76±1.5) and seahorses ($\bar{\chi}$ = 4.03±1), than fishers operating mechanised and traditional boats.

3.4. Prioritization of areas

Of the 15 survey locations, the top three priority areas for legal and strategic administrative intervention were identified as Gopalpur (WS = 40), Paradeep (= 38) and Puri (= 38); all in the state of Odisha; followed by two locations in Maharashtra (Worli = 34, Dandi = 31) and three locations in Tamil Nadu (Thondi = 34, Chennai = 32, and Mandapam = 31), of which Mandapam is a fishing village within the expanse of the Gulf of Mannar Biosphere Reserve. Rest of the locations scored relatively less than the top six (see Table 3). The areas of least priority were found to be the islands; i.e., Andaman and Nicobar Islands (South Andaman = 19) and Lakshadweep (Kavaratti = 11, Agatti = 15). While addressing individual parameters, the lower level of awareness on the legal status of the focal taxa among the fishers at each location is indicated by higher scores. Thus, fishers at nine locations which scored the highest (WS = 12; i.e., > 90%) were unaware of the legal status of at least one of the focal taxa. Only Neendakara (Kerala) scored the lowest indicating a better level of awareness among the fishers (WS = 3). At almost all locations except Kavaratti (Lakshadweep islands), more than 61% of fishers observed catches of at least one of the focal taxa at their respective landing centres. Similarly, higher weightage scores on conservation attitude towards the focal taxa was observed in Puri (WS = 8), followed by Gopalpur, Paradeep, Thondi and Worli (WS = 6). The higher scores indicate a negative conservation attitude towards the focal taxa at these locations. Locations such as Agatti, Digha, Goa, Kavaratti, Mandapam and South Andaman received the lowest scores (WS = 0) where almost all fishers expressed a positive conservation attitude. Similarly, higher scores for perceptions on population decline in at least one of the focal taxa were observed at Gopalpur, Paradeep, and Puri (WS = 4). Kavaratti, Agatti and Worli received the lowest scores (WS = 0), where fishers perceived a stable population of at least one of the focal taxa.

4. Discussion

4.1. Awareness towards the focal taxon – sociodemographic and fishery characteristics

One of the key highlights of this study is the difference in the level of fishers' general awareness towards three legally protected focal taxa. Though most fishers had a good level of general awareness of seahorses, it was comparatively low for gorgonians, followed by pipefishes. A higher level of knowledge on seahorses is justifiable on several grounds. Firstly, the clandestine trade of seahorses is a source of income for fishers in India [41, 42]. Secondly, there is always a high chance of encountering seahorses in both incidental (bycatch) as well as in targeted catch, particularly in the study area [17, 35]. Thirdly, seahorses are icons of global marine conservation efforts [43] and their discoveries, research efforts, illegal trade and confiscations are popular stories covered by media. The long history of using seahorses as traditional medicine would also have resulted in a better perception, about their value and relevance [44]. On the contrary, gorgonians are sedentary organisms that are usually found on the rocky substrates, reefs slopes and island shelves [45]. Our interactions with fishers revealed that these are some of the areas where nets (except bottom-

set gillnets) are seldom laid. Therefore, there is a lower chance of encountering gorgonians compared to seahorses in their catches. Though gorgonians were exploited till the early 2000s [46], the trade gradually ceased to exist as there were no significant monetary benefits to the fishers. Similarly, pipefishes are lesser-known members of a diverse group of fishes in the family Syngnathidae [47]. When compared to seahorses in India, pipefishes fetch a very low market value [33], and most fishers (except in Tamil Nadu) were unaware of the trade value. Besides, many fishers have comparatively poor knowledge on this taxon, often confusing pipefishes to *Fistularia* sp. and other similar species resulting in misidentifications. Though in lower numbers when compared to seahorses, pipefishes are also exploited for trade in some parts of India [33]. Previous studies from India and elsewhere have also suggested that several species, including invertebrates (corals, gorgonians, cowries) and fishes (elasmobranchs, syngnathids, groupers), are very poorly known among the relevant stakeholders [33, 48].

Fishers' awareness on the focal taxa can be influenced by the individual's socio-demographic factors such as coastal regions, education, fishing experience, and the fishery characteristics such as craft and gears used. For instance, most fishers on both coasts were able to identify seahorses, but there was a significant difference in the response towards correctly identifying gorgonians and pipefishes. Further, the number of fishers identifying gorgonians and pipefishes were greater on the east compared to the west coast. A significant variation in the ability of fishers to identify the focal taxa based on the fishing crafts used was obvious only in the case of pipefishes, with most fishers operating mechanised boats (e.g., trawlers) being able to identify these fish, compared to those operating motorised and traditional boats. However, based on our results, the chances of encountering the focal taxa in the catch tends to be higher among fishers operating traditional boats, an observation that has been previously documented from India [see 34, 42]. The education status of fishers influenced the awareness of the focal taxa, but significant variation in responses related to identifying the taxa can only be seen in the case of gorgonians. Interestingly, most fishers with lower education seem to have identified gorgonians, than those with higher education. This may be due to differences in fishing experience, as our study showed that fishing experience is directly proportional to the ability to correctly identify the focal taxa. The older generation are comparatively less educated than the youngsters [see 31], but may have more years of experience at sea, and therefore better with their traditional knowledge. Only a small proportion of fishers with between 21–30 years (< 45%) of fishing experience perceived a decreasing trend in population status of gorgonians, while those possessing 11–20 years (50%) of experience perceived a decreasing trend in seahorses. This could be because the focal taxa, except for seahorses in some parts of Tamil Nadu [17], does not form a major part of the actual catch leaving little chance for fishers to perceive any trends in population status.

Based on the responses, we observed that the presence of the focal taxa in the catch was greater in seine nets, gillnets, dive collection or hook and line in the case of gorgonians; seine nets, dive collection or hook and line for pipefishes; and all gears for seahorses. Excluding the minimal percentage difference in responses towards 'seen in catch', fishers operating gillnets landed the focal taxa more frequently than other gears. This observation is partially supported by our results that fishers operating gillnets perceived a decreasing trend in the population status of the three focal taxa. Our results also indirectly support the findings of previous studies that highlight mesh size regulation, and the deleterious effect of different types of gill nets on fish populations and marine benthic fauna [49–51].

4.2. Awareness on the legal status, conservation attitudes and WLPA

Understanding stakeholder awareness and conservation attitudes are imperative to assess the effectiveness of national legislations aimed at conserving marine biodiversity [52, 53]. However, knowledge, perception and attitude towards conservation policies may differ between different fishing communities [54]. This study reaffirms the fact that key national legislations such as the WLPA remains misinformed among key stakeholders – in this case, fishers. Further, while land-based PA networks in India often involve local communities in the process of creating awareness among stakeholders (e.g., the Periyar National Park [55]), such efforts of grassroot level stakeholder education are seldom undertaken for marine species and MPAs. For instance, more than 61% of fishers (n = 88) were aware of the legal status of seahorses on the east coast, which is twice the number of fishers surveyed on the west. The significant difference in this awareness might be because some of the surveyed areas covered on the east coast (e.g., Tamil Nadu) are protected as MPAs where law enforcement and its interventions are comparatively more effective (e.g., monitoring and trade seizures) [35]. However, the awareness on the legal status of gorgonians and pipefishes among the fishers were very low. A similar observation was documented in a study from the Andaman and Nicobar Islands, where low awareness on the legal status of protected marine species such as seahorses and gorgonians were observed [33]. Also, our question related to

penalisation or law enforcement on illegal landings of the focal taxa received very few responses (< 10%), perhaps due to fishers' apprehension on being exposed to illegal activity, or because there was no visible legal enforcement from the authorities, or the fishers were genuinely unaware of any such legal actions except for seahorses [35].

An overall increase in the awareness of the focal taxa tends to influence fishers' positive conservation attitudes, hence underlining the pivotal role of awareness initiatives among the stakeholders in the success of species conservation [28, 29]. Fishers on both east and west coast showed a positive attitude towards conserving the three focal taxa, though this attitude was much more pronounced among fishers on the west coast. There was also an increase in positive attitude towards conservation of the three focal taxa with an increasing level of education. Throughout the survey, we observed that most fishers who identified the taxa correctly show a positive attitude towards its conservation. However, there is a lack of awareness on pipefishes compared to seahorses and gorgonians, among fishers. We observed that fishers perceived commercial (trade) and personal values (aesthetic and medicinal) for seahorses as reported in previous studies from India [17]. We also observed that gorgonians were regarded by some fishers as ecosystem builders that sustains other marine life. A prevalent belief among fishers in some surveyed areas (e.g., in Odisha) deems gorgonians to be bringing good omen. Also, some traditional fishers in Goa (west coast) find seahorses in their catch as a sign of bad omen, that they usually layoff their fishing activity for the next day.

Our survey results suggest that there is inconsistency in the fishers conservation values, and awareness on the legal status of focal taxa. We understand that fisher's knowledge is only one type of information that provides insight into observations of social impact and conservation outcome, governance, and social acceptability of management plans [56]. There is also a need for further research to ensure the accuracy of fisher's knowledge and incorporating them into extinction risk and conservation assessments [57]. However, understanding stakeholder perception and knowledge can help develop models for community compliance on long-term management strategies and sustainability [29, 58]. Also, successful marine conservation and management policies demands regulatory and institutional coordination and the involvement of key stakeholders at different levels for effective planning and execution [52, 59]. Based on the fishers' response, it is understood that the focal taxa are being landed as bycatch in both selective and non-selective gears, operated by various fishing crafts. Though our data is not sufficient to reveal the utilization of the focal taxa in bycatch, several studies suggest a flourishing illegal trade of the protected focal taxa that questions the efficacy of WLPA and its enforcement [15, 28, 35]. Since responses to the question on WLPA enforcement was very low among fishers, we cannot conclusively suggest whether administrative execution was ensued, or not. However, incidental landings coupled with the lack of awareness on legal status of the focal taxa contravenes the primary objective of WLPA, i.e., protection of wild species and their habitats (Fig. 3). Also, the lack of a concrete interdepartmental coordination in both awareness and conservation action, in this case between the forest department who enacts and enforces the law, and fisheries department which considers all these focal taxa as a 'resource'. The absence of effective management plans to reduce the fishing capacity and bycatch, is yet another impediment in achieving the set targets of WLPA [42]. Hence, we argue for a management strategy that must transcend beyond WLPA, as mere 'hunting and trade ban' policies might foster several socio-economic and conservation impediments such as illegal wildlife trade and associated criminal activities [60]. Thus, we argue that WLPA is ineffective for the conservation of India's marine fauna (Table 2).

4.3. Priority areas – a way forward

As discussed above, a statutory ban on hunting and trade of marine species may not always be effective unless primary stakeholders are aware and willing to endorse such policies [e.g., 33, 35]. Our prioritization matrix suggests that administrative and management efforts at regional levels play a crucial role in realising the objectives of a national policy such as the WLPA. For instance, one of the top five priority areas among the survey locations that we identified is Mandapam (Tamil Nadu) – a fishing village located within the boundaries of the Gulf of Mannar Biosphere Reserve [40]. Here, more than 60% of fishers were unaware of the legal status of at least one the focal taxa. This ignorance to WLPA is further reflected in their responses that more than 91% of fishers have observed at least one of the focal taxa in the landings as either target, or as bycatch. In terms of WLPA, this is a 'crime committed' and violates the basic foundations on which this policy is framed [8]. Also, it is not surprising that all three survey locations from Tamil Nadu were identified as priority areas for conservation, as several studies consider this region as a marine faunal 'trade hub' especially in the case of syngnathids [17, 35, 40]. However, the top three priority locations we identified are located in the state of Odisha. Despite a prevalence of traditional fishers among the respondents in Odisha, observance of bycatch or targeted landings, negative conservation attitude, and lack of awareness on the legal status of the focal taxa tends to

be very prominent, and hence the higher score. Other than the authoritative incompetence, socio-political factors might have also influenced the negative conservation attitude and lack of awareness among fishers in Odisha [32]. On the contrary, survey locations in Andaman and Nicobar Islands and Lakshadweep Islands, emerged as the areas of least priority. Despite scoring very high on the lack of awareness on WLPA, positive conservation attitudes and comparatively lower observance of landings are good signs for the focal taxa in the islands. Also, the use of sustainable fishing practices such as hook and line in Lakshadweep with minimal effect on bycatch could be yet another reason why the focal taxa are not severely impacted in these regions [61].

Our prioritization matrix further underpins the fact that level of awareness on the legal status of the focal taxa among the fishers is extremely poor at almost all locations, with an exception of Neendakara. Also, more than 91% of fishers at almost 11 survey locations observed at least one of the focal taxa in their catches, which is an impending concern for long-term management actions in these areas. In regions such as in Tamil Nadu, the exploitation and trade of protected species like seahorses occurs at the behest of fishers who are well-informed about the national ban – i.e., the WLPA [35]. Thus, identifying socio-political factors, and local drivers that result in such unlawful activities will better equip strategic and successful implementation of national policies such as WLPA at regional levels, through initiating dialogues and cooperation among primary stakeholders [28, 29, 32]. Our priority areas will serve as a basis for authorities and managers to identify breakpoints at which an existing conservation policy fails to meet its true objective.

5. Conclusion

Knowledge, perception and attitude towards conservation policies may differ between fishing communities [20]. Though debatable for compliance with international policies (e.g., CITES), WLPA has no doubt been an effective tool in protecting India's wildlife by curbing illegal hunting and trade [9, 11]. Our study provides an overview of the sociodemographic profile of fishers, and its influence on their level of awareness and attitudes towards the conservation of three legally protected marine taxa by keeping them as proxies. It is clear from our results that the WLPA is largely ineffective in protecting 'threatened' marine taxa, particularly with little efforts to reduce over capacity of fishing vessels and bycatch [42], lack of coordination between stakeholder departments, and failure of including stakeholder perception in conservation planning and policy making. We found that the level of awareness among fishers was inconsistent between focal taxa, i.e., higher awareness score for seahorses, followed by gorgonians and lowest for pipefishes. Socio-demographic factors such as coastal areas, years of experience, education, and type of craft and gear in operation tend to affect the fishers' knowledge, perception and conservation attitude towards the focal taxa. Fishers' awareness of the legal status of the focal taxa was also very low, which highlights the need for a bottom-up approach in a participatory democracy to inform key stakeholders on such policies for their better acceptance and compliance [27].

Nevertheless, the top-down approach suits best for guiding law enforcement to curb illegal fishing activities and trade [21]. We also favour the timely appraisal and updation of WLPA to resolve inaccuracies, confusion and objectivity as suggested previously [5–10]. We have also identified priority areas based on the fishers' perceptions and attitudes that could serve as pointers to strengthen the implementation and enforcement of existing conservation policies such as the WLPA. For long-term conservation of the focal taxa, we recommend viable management strategies such as 1) improving fishers' awareness on WLPA and protected species to ensure better compliance; 2) grassroots level participatory awareness campaigns specifically focused at marine taxa; 3) expanding the spatial extent of MPAs; 4) spatio-temporal restrictions in the use of destructive gears such as trawls and gill nets; 5) overall reduction in fishing capacity and effective reduction of bycatch, and 6) refining existing policies including WLPA, with inclusion of marine species in various schedules, incorporating fishers perspectives and promoting better coordination between stakeholder departments.

Declarations

Declaration of competing interest

The authors of this manuscript entitled '50 years and counting: Indian Wildlife Protection Act through the lens of marine fishers' declare no competing or conflicting interest.

Ethical statement

This research involving human communities adhered to all standard ethical norms and we followed guideline set by an EU code of ethics for socio-economic research. (http://www.respectproject.org/ethics/412ethics.pdf). The questionnaire and survey methodology were pre-tested and approved by the ethics committee of our institution (KUFOS/SOST/04/2018). Before each interview, we read out the ethical statement and ensured that the personal responses and identity of the interviewee was kept confidential. All interviews were voluntary and participants were given the option to withdraw or remove their responses from the study. All the data collected were solely for the purpose of research and no such information (raw data) were shared with either respondents or any other agencies/institutions.

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References

1. P.F. Donald, F.J. Sanderson, I.J. Burfield, S.M. Bierman, R.D. Gregory, Z. Waliczky, International conservation policy delivers benefits for birds in Europe, Science 317 (2007) 810–813. https://10.1126/science.1146002.
2. United Nations Convention on the law of the sea, in: Multilateral Treaties Deposited with the Secretary-General, New York, 1982, pp. 1–192.
3. The Secretariat of the Convention on Biological Diversity, Handbook of the convention on biological diversity including its Cartagena protocol on biosafety, third ed., Friesen Press, Montreal, 2005.
4. P. Doukakis, E.K. Pikitch, A. Rothschild, R. DeSalle, G. Amato, S. Kolokotronis, 2012. Testing the Effectiveness of an International Conservation Agreement: Marketplace Forensics and CITES Caviar Trade Regulation. PLoS One 7, e40907. https://dx.doi.org/10.1371%2Fjournal.pone.0040907.
5. A.S.L. Rodrigues, J.D. Pilgrim, J.F. Lamoreux, M. Hoffmann, T.M. Brooks, The value of the IUCN Red List for conservation, Trends Ecol. Evol. 21 (2006) 71–76. https://doi.org/10.1016/j.tree.2005.10.010.
6. J.A. Seminoff, K. Shanker, Marine turtles and IUCN Red Listing: A review of the process, the pitfalls, and novel assessment approaches, J. Exp. Mar. Biol. Ecol. 356 (2008) 52–68. https://doi.org/10.1016/j.jembe.2007.12.007.
7. B.N. Tissot, B.A. Best, E.H. Borneman, A.W. Bruckner, C.H. Cooper, et al., How U.S. Ocean policy and market power can reform the coral reef wildlife trade, Mar. Policy 34 (2010) 1385–1388. https://doi.org/10.1016/j.marpol.2010.06.002.
8. Anonymous, The Wildlife (Protection) Act, 1972, as amended up to 2002, Ministry of Law and Justice, Government of India, 2003.
9. P. Mohanraj, K. Veenakumari, Nomenclature, Classification and the basis of the schedules in the Indian Wildlife (Protection) Act, 1972, Curr. Sci. 70 (1996) 428–432.
10. S.S. Bist, A Critical Review of the Schedules of the Wildlife (Protection) Act, 1972 and their Amendments, Indian Forester. 125 (1999) 943–962.
11. K. Sivakumar, Status and Conservation of *Dugong dugon* in India: Strategies for Species Recovery, In: K. Venkataraman, C. Sivaperuman, C. Raghunathan (Eds.), Ecology and Conservation of Tropical Marine Faunal Communities, Springer, Berlin, Heidelberg, 2013. https://doi.org/10.1007/978-3-642-38200-0_27.
12. K. Shanker, N.J. Pilcher, Marine turtle conservation in South and Southeast Asia: hopeless cause or cause for hope, Marine Turtle Newsletter 100 (2003) 43–51.
13. M. Gangal, A.B. Gafoor, E. D'Souza, N. Kelkar, R. Karkarey, N. Marbà, R. Arthur, T. Alcoverro, 2021. Sequential overgrazing by green turtles causes archipelago-wide functional extinctions of seagrass meadows. Biol. Conserv. 260, 109195. https://doi.org/10.1016/j.biocon.2021.109195.
14. Z. Tyabji, T. Wagh, V. Patankar, R.W. Jabado, D. Sutaria, 2020. Catch composition and life history characteristics of sharks and rays (Elasmobranchii) landed in the Andaman and Nicobar Islands, India. PloS One 15, e0231069. https://doi.org/10.1371/journal.pone.0231069.

15. J. Sajan, B.M.P. Kumar, K. Sivakumar, B.C. Choudhury, An assessment of marine fauna of Wildlife (Protection) Act, 1972 in curio trade in India: A market study, in: K. Venkataraman, C. Sivaperuman, C. Raghunathan (Eds.), Ecology and Conservation of Tropical Marine Faunal Communities, Springer, Berlin, 2013, pp. 451–461. https://doi.org/10.1007/978-3-642-38200-0_29.
16. P.T. Rajan, Conservation status of marine faunal diversity in India: An analysis of the Indian Wildlife (Protection Act) and IUCN threatened species, in: K. Venkataraman, C. Sivaperuman (Eds.), Marine faunal diversity in India taxonomy, ecology and conservation, Academic Press, USA, 2015, pp. 461–471. https://doi.org/10.1016/B978-0-12-801948-1.00027-6.
17. K.R. Salin, T.M Yohannan, C.M. Nair, Fisheries and trade of seahorses, *Hippocampus* spp., in southern India, Fisheries Manag. Ecol. 12 (2005) 269–273. https://doi.org/10.1111/j.1365-2400.2005.00450.x.
18. S. Prakash, T.T.A. Kumar, R. Raghavan, A. Rhyned, M.F. Tlusty, T. Subramoniam, Marine aquarium trade in India: Challenges and opportunities for conservation and policy, Mar. Policy 77 (2017) 120–129. https://doi.org/10.1016/j.marpol.2016.12.020.
19. S.J. Foster, T. Kuo, A.K.Y. Yan, A.C.J. Vincent, Global seahorse trade defies export bans under CITES action and national legislation, Mar. Policy 103 (2019) 33–41. https://doi.org/10.1016/j.marpol.2019.01.014.
20. U. Bhagirathan, S.K. Panda, V.R. Madhu, B. Meenakumari, Occurrence of live octocorals in the trawling grounds of Veraval coast of Gujarat, Arabian Sea, Turk. J. Fish. Aquat. Sc. 8 (2008) 369–372.
21. D. Ferrol-Schulte, M. Wolff, S. Ferse, M. Glaser, Sustainable livelihoods approach in tropical coastal and marine social–ecological systems: A review, Mar. Policy 42 (2013) 253–258. http://dx.doi.org/10.1016/j.marpol.2013.03.007.
22. R. Chuenpagdee, J.J. Pascual-Fernández, E. Szeliánszky, J.L. Alegret, et al., Marine protected areas: Re-thinking their inception. Mar. Policy 39 (2013) 234–240. https://doi.org/10.1016/j.marpol.2012.10.016.
23. A.S. Afonso, L.L. Fidelis, P.L. Roque, R. Galindo, et al., 2019. Public support for conservation may decay with increasing residence time in suboptimal marine protected areas, Mar. Policy 108, 103665. https://doi.org/10.1016/j.marpol.2019.103665.
24. J.E. Cinner, T. Daw, T.R. McClanahan, Socioeconomic Factors that affect artisanal fishers' readiness to exit a declining fishery, Conserv. Biol. 23 (2009) 124–130. https://doi.org/10.1111/j.1523-1739.2008.01041.x.
25. C. D'Lima, H. Marsh, M. Hamann, A. Sinha, R. Arthur, Positive interactions between Irrawaddy dolphins and artisanal fishers in the Chilika lagoon of eastern India are driven by ecology, socioeconomics, and culture, Ambio 43 (5) (2014) 614–624. https://doi.org/10.1007/s13280-013-0440-4.
26. P.F.M. Lopes, E.M. Rosa, S. Salyvonchyk, V. Nora, A. Begossi, Suggestions for fixing top-down coastal fisheries management through participatory approaches, Mar. Policy 40 (2013) 100–110. http://dx.doi.org/10.1016/j.marpol.2012.12.033.
27. FAO, The State of World Fisheries and Aquaculture 2020 (SOFIA), Sustainability in action, Food and Agriculture Organization, Rome, Italy, 2018, pp. xii + 205. https://doi.org/10.4060/ca9229en.
28. D. Karnad, D. Sutaria, R.W. Jabado. Local drivers of declining shark fisheries in India, Ambio 49 (2020) 616–627. https://doi.org/10.1007/s13280-019-01203-z.
29. D. Karnad, M. Gangal, K.K. Karanth, Perceptions matter: how fishermen's perceptions affect trends of sustainability in Indian fisheries, Oryx 48 (2014) 218–227. https://doi.org/10.1017/S0030605312001251.
30. V. Patankar, E. D'Souza, T. Alcoverro, R. Arthur, Erosion of traditional marine management systems in the face of disturbances in the Nicobar Archipelago, Hum. Ecol. 43 (2015) 697–707. https://doi.org/10.1007/s10745-015-9781-x.
31. G.S. Rao, T.V Sathianandan, S. Kuriakose, K.G. Mini, T.M. Najmudeen, J. Jayasankar, W.T. Mathew, Demographic and socio-economic changes in the coastal fishing community of India, Indian J. Fish. 63 (2016) 1–9. https://doi.org/10.21077/ijf.2016.63.4.44288-01.
32. V. Chhotray, Justice at Sea: Fishers' politics and marine conservation in coastal Odisha, India, Marit. Stud. 15, 4 (2016). https://doi.org/10.1186/s40152-016-0043-3.
33. V.J. Patankar, 2019. Attitude, perception and awareness of stakeholders towards the protected marine species in the Andaman Islands, Ocean. Coast. Manag. 179, 104830. https://doi.org/10.1016/j.ocecoaman.2019.104830.
34. A.L. Perry, T. Vaidyanathan, B.G. Giles, M.A. Moreau, C.M. Picco, A.C.J. Vincent, The catch and trade of seahorses in India pre-ban, Fish. Cent. Res. Rep. 28 (2020) 1–55.
35. T. Vaidyanathan, A.C. Vincent, State of seahorse fisheries in India, nearly two decades after they were banned, Biodivers. Conserv. 30 (2021) 2223–2253. https://doi.org/10.1007/s10531-021-02188-6.

36. K. Venkataraman, M.V.M. Wafar, Coastal and marine biodiversity of India, Indian J. Mar. Sci. 34 (2005) 57–75.
37. H. Newing, Conducting research in conservation: Social science methods and practice, Routledge, London, 2010.
38. P. A. Pebsworth, R. Gawde, M. Bardi, B.V. Vijayan, S. Radhakrishna, To kill or not to kill?: Factors related to people's support of lethal and non-lethal strategies for managing monkeys in India, Hum. Dimens. Wildl. (2020) 1–18. https://doi.org/10.1080/10871209.2020.1856453.
39. M. Scherer, J. Andrade, E.G. Emerim, A. Felix, T.C.R. Oliveira, H.B. Mondl, F.V. Lima, Prioritizing actions for coastal management: A methodological proposal, Ocean Coast. Manag. 91 (2014)17–22. https://doi.org/10.1016/j.ocecoaman.2014.01.012.
40. K. Uiterwyk, J.P. Kritzer, A. Novelly, S.L. Smith, K. Starbuck, J. Wiggin, Municipal policy priorities in three coastal communities in the Northeastern United States recognize effects of global climate change, Ocean Coast. Manag. 168 (2019) 177–184. https://doi.org/10.1016/j.ocecoaman.2018.10.028.
41. R.A. Sreepada, U. M. Desai, S. Naik, The plight of Indian sea horses: Need for conservation and management, Curr. Sci. 82 (2020) 377–378.
42. T. Vaidyanathan, X. Zhang, R. Balakrishnan, A. Vincent, Catch and trade bans for seahorses can be negated by non-selective fisheries, Aquat. Conserv.: Mar. Freshw. Ecosyst. 31 (2021) 43–59. https://doi.org/10.1002/aqc.3419.
43. M. Yasué, A. Nellas, A.C.Vincent, Seahorses helped drive creation of marine protected areas, so what did these protected areas do for the seahorses?, Environ. Conserv. 39 (2012) 183–93. https://doi.org/10.1017/S0376892911000622.
44. N. Gopal, M.V. Neelima, K. Harsha, V.K. Sajesh, A. Ashok, J. Bindu, S. Sreejith, S. Velloth, N.G.K. Pillai, A. Jayakumar, Traditional Knowledge in Marine Fisheries of Kerala, ICAR-Central Institute of Fisheries Technology, Kochi, 2018.
45. K. Fabricius, P. Alderslade, Soft Corals and Sea Fans: A comprehensive guide to the tropical shallow-water genera of the Central-West Pacific, the Indian Ocean and the Red Sea, Australian Institute of Marine Science, Townsville, 2001.
46. Anonymous, Statistics of marine products exports 2001, MPEDA, Kochi, 2003.
47. R.H. Kuiter, Seahorses, Pipefishes and their Relatives: A Comprehensive Guide to Syngnathiformes. TMC Publishing, Chorleywood, U.K, 2000.
48. R.L. Jefferson, I. Bailey, D. d'A. Laffoley, J.P. Richards, M.J. Attrill, Public perceptions of the UK marine environment, Mar. Policy 43 (2014) 327–337. https://doi.org/10.1016/j.marpol.2013.07.004.
49. G. Luther, Y. Appanasastry, Occurrence of spawners, juveniles and young fish in relation to the fishery seasons of some major fishery resources of India—a preliminary study, Mar. Fish. Infor. Sew. Technical and Extension Series 122 (1993) 1–8.
50. A.J. Temple, N. Wambiji, C.N.S. Poonian, N. Jiddawi, S.M. Stead, J.J. Kiszka, P. Berggren, Marine megafauna catch in southwestern Indian Ocean small-scale fisheries from landings data, Biol. Conserv. 230 (2019) 113–121. https://doi.org/10.1016/j.biocon.2018.12.024.
51. G.G. Shester, F. Micheli, Conservation challenges for small-scale fisheries: Bycatch and habitat impacts of traps and gillnets, Biol. Conserv. 144 (2011) 1673–1681. http://dx.doi.org/10.1016/j.biocon.2011.02.023.
52. I. Kusumawati, H. Huang, Key factors for successful management of marine protected areas: A comparison of stakeholders perception of two MPAs in Weh island, Sabang, Aceh, Indonesia, Mar. Policy 51 (2015) 465–475. https://doi.org/10.1016/j.marpol.2014.09.029.
53. C.L. Martin, S. Momtaz, A. Jordan, N.A. Moltschaniwskyj, Exploring recreational fishers' perceptions, attitudes, and support towards a multiple-use marine protected area six years after implementation, Mar. Policy 73 (2016) 138–145. http://dx.doi.org/10.1016/j.marpol.2016.08.002.
54. K.B. Kincaid, G. Rose, H. Mahudi, Fishers' perception of a multiple-use marine protected area: Why communities and gear users differ at Mafia Island, Tanzania, Mar. Policy 43 (2014) 226–235. https://doi.org/10.1016/j.marpol.2013.06.005.
55. S.P. Thampi, Ecotourism in Kerala: Lessons from the eco-development project in Periyar Tiger Reserve, E-Paper Series 13, pp. 1–10. http://ecoclub.com/library/epapers/13.pdf, 2005 (accessed 08 September 2021).
56. N.J. Bennett, Using perceptions as evidence to improve conservation and environmental management, Conserv. Biol. 30 (2016) 582–592. https://doi.org/10.1111/cobi.12681.
57. K.P. O'Donnell, M.G. Pajaro, A.C.J. Vincent, How does the accuracy of fisher knowledge affect seahorse conservation status?, Anim. Conserv. 13 (2010) 526–533. https://doi.org/10.1111/j.1469-1795.2010.00377.x.

58. S. Bose, A. Crees-Morris, Stakeholder's views on fisheries compliance: An Australian case study, Mar. Policy 33 (2009) 248–253. https://doi.org/10.1016/j.marpol.2008.07.004.
59. J. van Leeuwen, J. Raakjaer, L. van Hoof, J. van Tatenhove, R. Long, K. Ounanian, Implementing the Marine Strategy Framework Directive: A policy perspective on regulatory, institutional and stakeholder impediments to effective implementation, Mar. Policy 50 (2014) 325–330. https://doi.org/10.1016/j.marpol.2014.03.004.
60. D. Roe, A. Dickman, R. Kock, E.J. Milner-Gulland, E. Rihoy, M. Sas-Rolfes, 2020. Beyond banning wildlife trade: COVID-19, conservation and development, World Dev. 136, 105121. https://doi.org/10.1016/j.worlddev.2020.105121.
61. K.V. Aneesh Kumar, S.K. Paresh, P. Pravin, V.R. Madhu, and B. Meenakumari, Effect of hook design on longline catches in Lakshadweep Sea, India, Indian J. Fish. 60 (2013) 21–27.
62. K.A. Shaji, Lakshadweep unveils world's first sea cucumber conservation research, Mongabay (India). https://india.mongabay.com/2020/05/lakshadweepunveils-worlds-first-sea-cucumber-conservation-reserve/, 2020 (accessed 17 August 2021).

Tables

Table 1. Description of respondent characteristics and definitions used in the paper

Respondent characteristic	Description and grouping
Station	The location of survey. Grouped here as Kerala, Goa, Maharashtra, West Bengal, Odisha, Tamil Nadu, Andaman and Nicobar Islands and Lakshadweep (All being either States, or Union Territories of India)
Stakeholder group	Fishers; grouped as artisanal, mechanised and motorised based on the type of fishing craft used
Education and	Highest level of education attained: no education, primary level (1st to 8th standard), secondary level above (9th standard and above)
Nativity	The place of origin of the respondent. Grouped here as native and non-native fishers based on the station of survey and native state ('state' unless not specified means federal states of the Indian Union). Natives are fishers born, residing and fishing along the waters of the surveyed station or state. Non-natives are usually migrants/non-residents fishing along the waters of the surveyed station or state seasonally, based on the availability of fish and market demand.
Fishing experience	Respondent's fishing experience in years
Region of operation	Respondent's area or region of regular fishing within the arbitrary state boundary of the surveyed station or beyond
Crafts in operation	Type of craft used for regular fishing (mechanised, motorised and artisanal)
Gear used	Type of gear used for regular fishing (trawl net, seines, gillnet, direct capture and hook and line)
Classification of crafts/boats	(i) mechanized boats are larger boats with inboard motors (ii) motorized boats are smaller boats with outboard motors (iii) non-motorized traditional boats (e.g., catamarans).
'Seen in catch'	Observance of focal taxa in respondent's daily quota of incident or targeted catch

Table 2. Schedule I marine taxa listed in WLPA and its outcome

Schedule I taxa (WLPA)	Threats	Effectiveness of WLPA	References
PART I: Mammals			
Dugong (*Dugong dugon*)	No visible harvest or trade	Effective	[11]
PART II: Amphibians and Reptiles			
Turtles	No visible harvest or trade	Effective	[12], [13]
PART IIA: Fishes			
Sharks and Rays	Illegal harvest and trade	Ineffective	[14], [28]
Seahorse (all syngnathids)	Illegal harvest and trade	Ineffective	[35], this study
PART IVA: Coelenterates			
Hard corals	Illegal harvest and trade	Ineffective	[15], [18]
Sea fan (all gorgonians)	Destructive fishing	Ineffective	This study
PART IVB: Mollusca	Illegal harvest and trade	Ineffective	[15]
PART IVC: Echinodermata			
Sea cucumber (all holothurians)	Illegal harvest and trade	Ineffective	[62]

Table 3. Priority matrix to identify priority areas among surveyed locations. A – Neendakara, B – Ponnani, C – Worli, D – Dandi, E – Goa, F – Kavaratti, G – Agatti, H – Digha, I – Chennai, J – Thondi, K – Mandapam, L – Puri, M – Gopalpur, N –Paradeep, O – South Andaman

Criteria	Weightage	Scoring values	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Perceptions on population decline in focal taxa	1	0: Fishers observed no decline / steady state of the focal taxa	3	0	0	1	1	0	0	1	2	3	3	4	4	4	1
		1: 1-30% fishers observed a decline in any of the focal taxa															
		2:31-60% fishers observed a decline in any of the focal taxa															
		3: 61-91% fishers observed a decline in any of the focal taxa															
		4: > 90% fishers observed a decline in any of the focal taxa															
Conservation attitude fishers on the focal taxa	2	0: All the fishers show positive/neutral conservation attitude towards all focal taxa	2	2	6	2	0	0	0	0	2	6	0	6	8	6	0
		1: 1-30% fishers' show negative conservation attitude towards at least one of the focal taxa															
		2:31-60% fishers' show negative conservation attitude towards at least one of the focal taxa															
		3: 61-91% fishers' show negative conservation attitude towards at least one of the focal taxa															
		4: > 90% fishers' show negative conservation attitude towards at															

		least one of the focal taxa															
Awareness on legal status	3	0: All the fishers are aware about the legal status of all the focal taxa	3	12	12	12	9	12	9	9	12	9	12	12	12	12	9
		1: 1-30% fishers don't know or not aware about the legal status of at least one of the focal taxa															
		2: 31-60% fishers don't know or not aware about the legal status of at least one of the focal taxa															
		3: 61-90% fishers don't know or not aware about the legal status of at least one of the focal taxa															
		4: > 91% fishers don't know or not aware about the legal status of at least one of the focal taxa															
Focal taxa landed as bycatch/targeted fishery	4	0: Fishers observed no landing of any of the focal taxa	16	12	16	16	16	4	12	16	16	16	16	16	16	16	12
		1: 1-30% fishers observed landing of at least one of the focal taxa															
		2:31-60% fishers observed landing of at least one of the focal taxa															
		3: 61-91% fishers observed landing of at least one of the focal taxa															
		4: > 90% fishers observed landing of at least one of the focal taxa															
Total Score			24	26	34	31	26	16	21	26	32	34	31	38	40	38	22

A. Gopalpur (I)	B. Paradeep (II)	C. Puri (II)	D. Thondi (III)	E. Worli (III)	F. Chennai (IV)	G. Mandapam (V)	H. Dandi (V)
I. Goa (VI)	J. Digha (VI)	K. Ponnani (VI)	L. Neendakara (VII)	M. South Andaman (VIII)	N. Agatti (IX)	O. Kavaratti (X)	

Figures

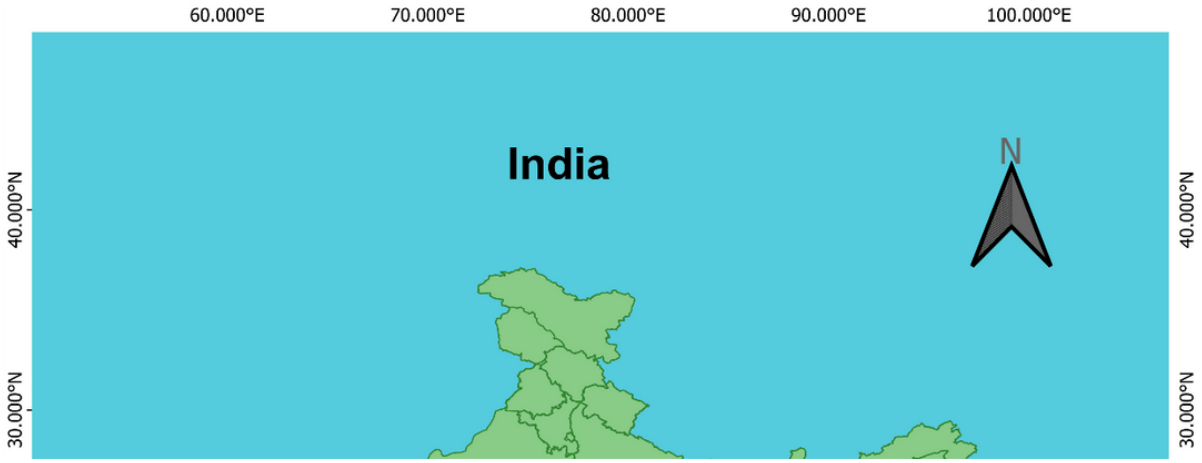

Figure 1

Map of India showing the states and Union Territories from east (Goa, Lakshadweep, Kerala, Maharashtra, n = 158) and west (Andaman and Nicobar Islands, Odisha, Tamil Nadu, West Bengal, n = 156) coast of India, where surveys were undertaken

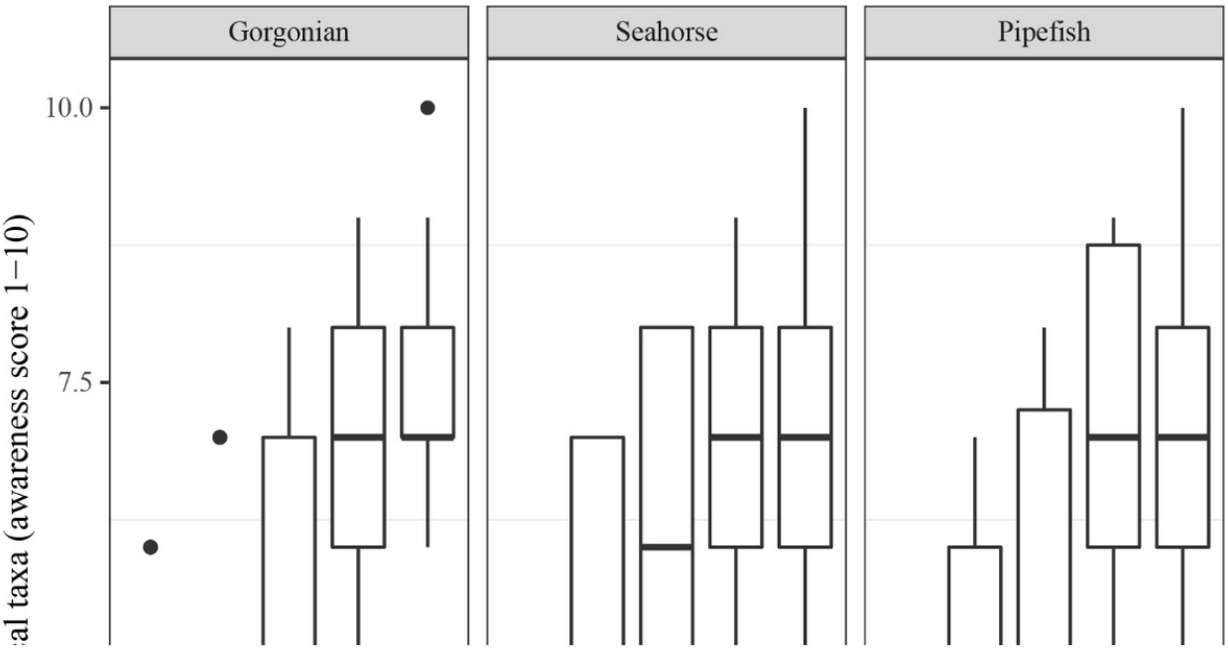

Figure 2

Dependency relationship of marine fishers' conservation attitude with level of awareness on the focal taxa (seahorses, gorgonians and pipefishes) in India. SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree

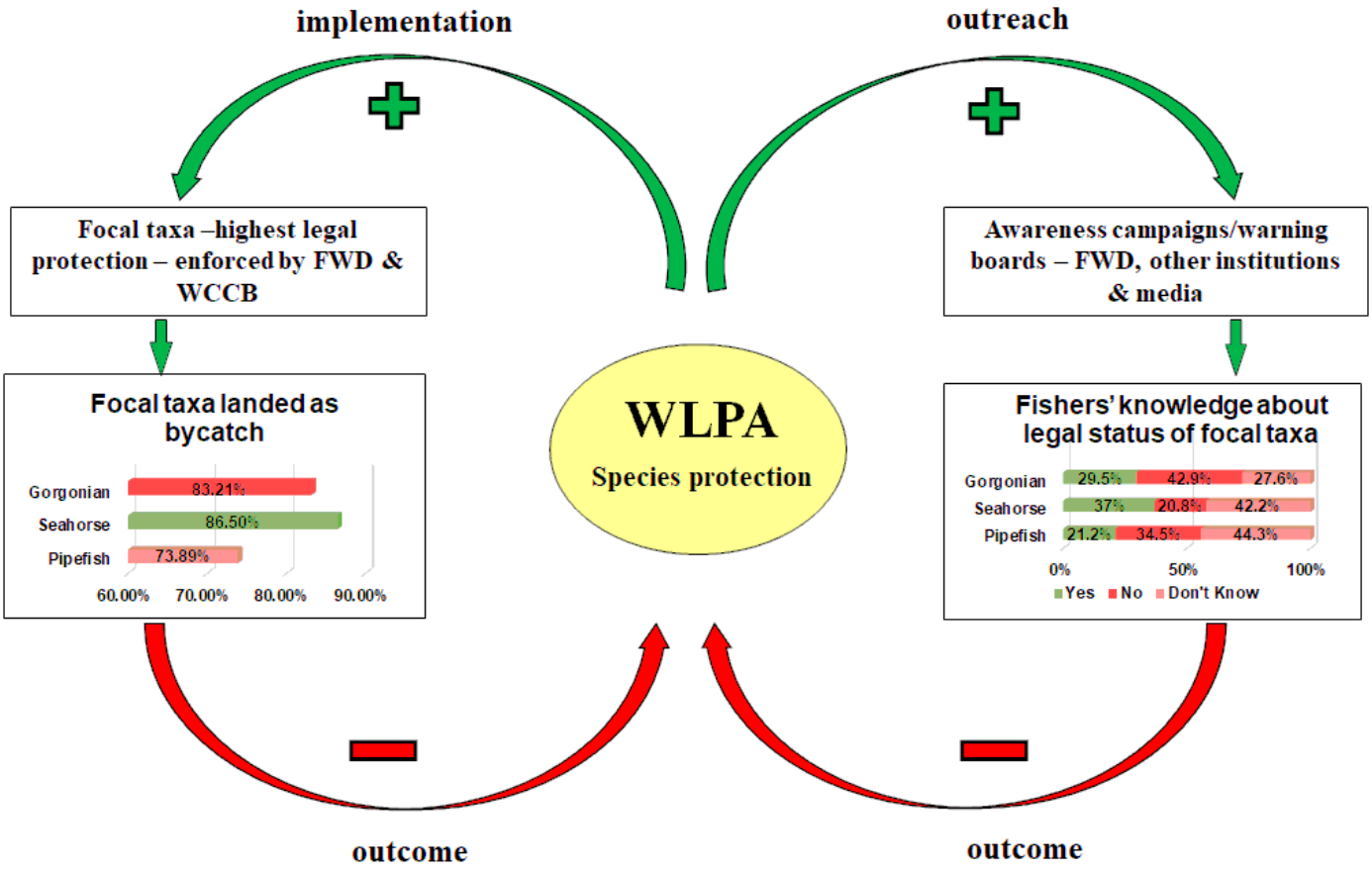

Figure 3

Policy-stakeholder (in this case 'fisher') feedback loop for species protection. The green and red arrow indicates the positive and negative impact on species protection (here focal taxa) respectively. FWD – Forest and Wildlife Department, WCCB – Wildlife Crime Control Bureau

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- AppendixABCMarPol.docx