MULTISPECIES FISHERY ASSESSMENT REPORT

Draft Document – Version 2.1 – Issued October 2022

Fishery/Unit of Assessment (UoA)	Goa and Maharashtra multispecies trawl fishery
Date	October 2024
Assessor	Key Traceability Ltd

Application details and summary of the assessment outcome	
Name: OMEGA fishmeal and oil private limited	
Address: G - 3, Mirjole Midc, Ratnagiri, Maharashtra	
Country: India	**Postal code:** 415639
Telephone: N/A	**Fax:**
Email address: N/A	**Applicant code:** N/A
Assessment details	
Name of assessment body: Key Traceability Ltd.	
Assessor name: Charles Horsnell, Emily Wardrop, Tom Evans, Ayoni Dutta	**Peer reviewer:** N/A (assessment is pre-assessment)
Assessment days: 15	**Initial/Surveillance/Reapproval:** N/A (assessment is pre-assessment)
Scope details	
Management authority (county/state): Goa and Maharashtra	
Main species: The main commercial species caught by trawlers in India, include perch-likes (drums and croakers, Indian mackerel, threadfins and breams), herring-likes (herrings, Indian oil sardine, sardines, etc), invertebrates (octopuses, cuttlefish, squid, etc), and, crustaceans (shrimps, crabs, etc)[1]. Additionally, key species used for fishmeal production, classified as lower-value bycatch, include smooth-backed puffer (*Lagocephalus inermis*), ponyfish (*Leiognathus spp.*), threadfin breams (*Nemipterus randalli, N. japonicus*), lizardfish (*Saurida undosquamis, S. tumbil*), sardines (*Sardinella longiceps, Dussumieria acuta*), scads (*Decapterus spp*.), anchovies, and flathead fish (*Platycephalus spp*.). Other bycatch species include largehead hairtail (*Trichiurus lepturus*), moontail bullseye (*Priacanthus hamrur*), eels, tongue soles (*Cynoglossus spp.*), cuttlefish (*Sepia spp.),* swimming crab (*Charybdis spp.*), penaeid shrimp (*Trachypenaeus sp.*), red shrimp (*Solenocera choprai*), and false trevally (*Lactarius lactarius*). These species, including juveniles of high-value species and low-demand fish, are often used in fishmeal and fish oil production.[2]	

[1] This list is generalised to all of India trawl catches based on official reported data mainly extracted from the Food and Agriculture Organization of the United Nations (FAO) FishStat database (found here: http://www.fao.org/fishery/statistics/en), and additional data from reconstructed estimates of unreported data (including major discards) via the SeaAroundUs Initiative. The data selected is for years 2005-2019 http://www.seaaroundus.org/data/#/eez/356?chart=catch-chart&dimension=taxon&measure=tonnage&limit=10

[2] Dineshbabu, A. P., Thomas, S., & Vivekanandan, E. (2014). Assessment of low value bycatch and its application for management of trawl fisheries. Central Marine Fisheries Research Institute. Received June 10, 2014, accepted June 30, 2014, published October 15, 2014.

Fishery location: State-managed waters of Goa and Maharashtra, as well as the adjacent federal waters under Indian government jurisdiction (12-200 nautical miles)
Gear type(s): Trawl (various)

Assessment process

This assessment has been produced by Key Traceability for Omega Fishmeal and Oil Private limited, who source from the multispecies trawl fishery operating in the waters of Goa and Maharashtra. The assessment adhered to the MarinTrust multispecies framework, which was determined to be more suitable than the conventional whole fish fishery assessment[3] due to the diverse species caught in the trawl fishery, with more than 247 species caught[4].

The assessment process began with a collection of information sourced from the client, supplemented by desktop research of publicly available documents. These materials included fishery regulations, scientific research papers, government reports, and other relevant websites. Specifically, the assessment team reviewed fishery management regulations and the biological status of species that interact with the fishery to assess how the fishery aligns with sustainability objectives/MarinTrust clauses. The evaluation focused on the fishery's regulatory environment, compliance with existing frameworks, and its broader ecological impact, considering species diversity and the multi-species nature of the fishery.

It is to be noted that the MarinTrust multispecies assessment template which was used for this work is still in draft format, and it currently can not be used to obtain MarinTrust certification, and its use must be approved to be included in the MarinTrust multi-species pilot project.

Summary of Section 1 results

General clause	Outcome (Pass/Gap)
M1 – Legislation, policy and plans	Gap (1.7 and 1.8)
M2 – Institutions and stakeholder engagement	Gap (2.1, 2.6, and 2.7)
M3 – Monitoring, control and surveillance	Gap (3.3 and 3.5)

For Section 1, all general clauses M1, M2 and M3 had gaps indicating these need to be included in the Fishery Action Plan. For M1, clauses 1.7 (up to date fisheries management plan) and 1.8 (goals and operational objectives related to fisheries management plan), were the identified gaps. For M2, clauses that remain as gaps include 2.1 (effective compliance and enforcement mechanisms), 2.6 (consultation process), and 2.7 (the decision-making process is transparent, with processes and results publicly available). Regarding M3, two criteria resulted in a gap – this included 3.3 (evidence of non-compliance) and 3.5 (stakeholders understanding laws and regulations).

Summary of Section 2 fishery risk ratings

	Very low (0-20)	Low (21-40)	Moderate (41-60)	High (61-80)	Very high (81-100)
Catch – Part A					
Catch – Part B					
Catch – Part C					

[3] The MarinTrust multispecies assessment criteria have been designed to meet the needs of complex fisheries, such as trawl fisheries in SE Asia, that do not fit the conventional approach to fishery assessment. Major adaptations are required for these regions and their fisheries if they are to meet expectations for the sustainable supply of fish for both direct consumption and for fishmeal and fish oil.

[4] Dineshbabu, A.P., Thomas, S., & Dinesh, A.C. (2013). Use of GIS in developing operation-based bycatch reduction interventions in trawl fisheries and the necessity for such interventions in tropical marine fisheries conservation and management.

ETPs*					
Habitats					
Ecosystems					

*ETP = endangered, threatened, and protected species

The risk ratings provided are based on publicly available information, and some uncertainties in the assessment necessitated the use of precautionary scoring. With additional investigation and data, these scores could potentially be improved. For instance, in the habitats and ecosystem sections, more detailed information on vessel locations, particularly whether they frequently overlap with sensitive marine environments such as coral reefs or seagrass beds, could result in a more favourable risk rating.

It is to be noted to the reader, as per the guidance provided in the document 'MarinTrust multi-species assessment guidance version 2.1 – issued October 2022', There is no minimum risk rating that an applicant fishery must achieve. However, to remain in the MarinTrust Improver Program (IP) a fishery must be able to demonstrate a reduction in risk rating over time. At this stage of the IP pilot, they (MarinTrust) are allowing fisheries to propose their own improvement timeline, which will ask expert peer reviewers to examine and to determine whether it represents a meaningful rate of progress. These requirements will tighten as the learnings from the pilot IP are assessed. Once the assessment is finalized and there is a determination on where responsible management of fisheries falls under the standard process, a decision on the timeline will then be made.

The mitigation value for each criterion can be used by a fishery to reduce the level of risk for any of the risk areas. This risk assessment process will allow the fishery to identify the main risks to the fishery and allow for the development of a FAP that could include strategies and measures that will further reduce the Fishery Risk Ratings over time. The MarinTrust Improver Programme aims to allow fisheries the flexibility to reduce the risk they pose through whatever actions they deem appropriate for their specific circumstances. Therefore, potential mitigation measures are not limited to those listed in the IP multi-species assessment methodology.

Characteristics of the fishery

This introductory overview provides context to the assessment of the Goa and Maharashtra trawl fishery, prepared based on information from the applicant and relevant documents. This document outlines the key aspects of the fishery, including its area of operation, history, management practices, and the current status of data availability, catch profiles, fishing areas, seasons, and gear types. Additionally, this overview touches upon the fishmeal/oil supply chain in relation to the fishery.

1. Area of operation of the UoA and jurisdiction under which it falls

The fishery under assessment operates along the west coast of India, in the coastal waters of the states of Goa and Maharashtra. This region falls under the jurisdiction of the respective state governments of Goa and Maharashtra. The fisheries departments in both states are responsible for regulating and managing the fishery, setting seasonal fishing bans, and enforcing local regulations. Additionally, the Exclusive Economic Zone (EEZ) off the coast of India is governed by national laws and regulations set by the Ministry of Fisheries, Animal Husbandry, and Dairying.

2. History of the fishery and its past management

The Goa and Maharashtra trawl fishery has a long history dating back to the 1960s when mechanized trawlers began to dominate the fishing landscape, replacing traditional artisanal fishing methods[5]. Initially, the fishery focused on shrimp as a target species; however, over the decades, the fishery diversified to include other demersal species such as croakers, ribbonfish, and threadfin bream[6]. The evolution of the fishery has been marked by fluctuations in stock levels, driven by both natural variability and fishing pressure[7].

Management of the fishery has evolved in response to increasing fishing effort and concerns about overfishing. Seasonal fishing bans, spatial management, and gear restrictions have been implemented periodically by state authorities[8]. Both states also participate in national fisheries management programs that aim to promote sustainable practices and resource conservation[9].

3. Data availability

Data availability for the trawl fishery is moderate, with both Goa and Maharashtra maintaining fisheries databases that include annual landings, catch composition (of main species or species groups), and effort data[10]. However, data gaps exist in areas such as stock assessments, species-specific information, and the socio-economic impacts of the fishery. While catch data is relatively reliable, information on discards and bycatch is limited[11].

The Central Marine Fisheries Research Institute (CMFRI) provides additional scientific support through research surveys and data collection on species distribution, abundance, and overall health of fish stocks in the region.

4. Catch and fleet profiles

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[5] Ansell, J. (2020). *India's marine fisheries*. Sea Around Us, University of British Columbia; White, T. D., Zeller, D., Palomares, M. L. D., & Pauly, D. (2020). *South Asian and Indian Ocean Islands fisheries catches (1950–2017)*. Fisheries Centre Research Reports, 28(1), Sea Around Us, University of British Columbia.

[6] CMFRI (2021). Fishery Resources Assessment in India.

[7] Ansell, J. (2020). *India's marine fisheries*. Sea Around Us, University of British Columbia

[8] Department of Fisheries, Government of Goa (2021). Fisheries Policy and Regulations; Department of Fisheries, Government of Maharashtra (2021). State Fisheries Development Plan.

[9] CMFRI (2021). Fishery Resources Assessment in India.

[10] CMFRI Annual Report (2020). Central Marine Fisheries Research Institute, Kochi.

[11] CMFRI (2018). Status of Indian Marine Fisheries.

The Goa and Maharashtra trawl fishery is characterized by a mixed species catch, with shrimp, ribbonfish, threadfin bream, and croakers being the most commonly landed species (CMFRI, 2021). Other important species include squid, cuttlefish, and various demersal finfish[12].

The fishing fleet primarily consists of mechanized trawlers, ranging in size from 9 to 24 meters in length, with

engine power ranging from 45 to 450 hp @ 2000 rpm[13], equipped with winches and power blocks[14]. These trawlers operate out of major fishing ports such as Vasco in Goa and Ratnagiri in Maharashtra, making daily or multi-day fishing trips depending on the season, target species, and vessel characteristics. The difference in catches of the single-day trawlers and multi-day trawlers is mostly due to the difference in depth of operation, distance from the shore, speed of trawling and fishing ground[15].

5. Fishing areas and seasons

The fishing grounds of the Goa and Maharashtra trawl fishery are predominantly located on the continental shelf, in waters up to 100 meters deep. The primary fishing areas extend from the northern coastline of Maharashtra to the southern tip of Goa. The fishery is largely seasonal, with peak fishing activity occurring during the post-monsoon months (October to May), coinciding with favourable weather conditions and increased abundance of target species. The vessels fish within the 0-12 nautical miles of state waters, along with fishing in the Indian EEZ waters of 12-200 nautical miles.

To promote resource regeneration, both Goa and Maharashtra enforce seasonal fishing bans on mechanised trawlers from June 1st-July 31st, which allows fish stocks to recover and reduces fishing pressure on juvenile populations. The central government also imposes fishing bans during the same period for national waters between 12-200 nautical miles.

6. Gears and operation of the fishery

The fishery predominantly uses bottom trawl nets, which are towed along the seabed to target demersal species. These nets are often equipped with otter boards that keep the net mouth open while trawling[16]. Some vessels also deploy mid-water trawls to target pelagic species during certain seasons[17]. However in India, various types of trawlers operate depending on the region, and these trawls are further classified based on the device used for mouth opening, number of panels used for fabrication, depth of operation and based on target species.

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[12] Singh, J., Jaiswar, A.K., Ahirwal, S.K., Gogoi, P., Gurjar, U.R., Samanta, R., Sarma, K., & Shenoy, L. (2023). Geo-spatial distribution and trends of trawl catch and bycatch off the south Konkan coast, Maharashtra, India. Cleaner and Circular Bioeconomy, 3, 100211

[13] Remesan M. P. (2022). Trawling: types and methods. ICAR – Central Institute of fisheries Technology, Kochi).

[14] Sawant, Nilesh and Mohite, Ashish S. (2016). Fish trawl (119 M) of Ratnagiri, Maharashtra (India). Asian J. Animal Sci., 11(2): 86-91; Kharatmol, B.R., Shenoy, L., Singh, V.V., Landge, A.T., & Mohite, A.S. (2018). Fishing characteristics of trawling off Mumbai coast of Maharashtra, India. Journal of Entomology and Zoology Studies, 6(2), 3322-3329.

[15] Sawant, V.V., & Raje, S.G. (2009). Trawl fisheries with special reference to catch composition along Mumbai coast, Maharashtra. Indian Journal of Geo-Marine Sciences, 38(1), 56-61.

[16] Food and Agriculture Organization of the United Nations (FAO). (n.d.). Gear type: Bottom trawls (OTB). Retrieved from https://www.fao.org/fishery/docs/CDrom/ARTFIMED/ArtFiWeb/descript/Gear/geartype/gt306.htm

[17] Abdul Azeez, P., Rohit, P., Mohammed Koya, K., Shenoy, L., Jaiswar, A. K., Raman, M., … Damodaran, D. (2023). Bycatch species distribution from mid-water trawlers in the north-eastern Arabian sea: a step towards the implementation of marine spatial planning. *Journal of Maps*, *19*(1). https://doi.org/10.1080/17445647.2023.2192371

These can include stern trawlers, otter trawlers, pair trawlers, shrimp trawlers, side trawlers, beam trawlers, mid-water trawlers, and multi-purpose trawlers[1819].

Bycatch reduction devices (BRDs) and turtle excluder devices (TEDs) are encouraged by authorities in certain areas to reduce the capture of non-target species and protect endangered marine life[20], however for both Goa and Maharashtra these mitigation methods are not mandated in regulation.

7. Supply chain for fishmeal/oil

There have been previous assessments such as 'An appraisal of trawl fisheries of India with special reference on the changing trends in bycatch utilisation' (CFMRI / CIFE, 2014)[21] and 'Bycatch in Indian trawl fisheries and some suggestions for trawl bycatch mitigation' (CFMRI, 2022)[22] which provide some insights into the reduction component of the trawl fisheries in India, including Goa and Maharashtra as it relates to fishmeal and oil production. The catch from trawlers can generally be classified into three categories: (i) high-value catch (HVC), which includes fish, crustaceans, and molluscs destined for direct human consumption; (ii) low-value bycatch (LVB), which includes juveniles of high-value species and small-sized adult fish that are not used for human consumption but are diverted to fishmeal and fish oil production; and (iii) discards-at-sea, which consist of non-edible biota or occasionally edible species that are discarded due to poor market demand or other quality issues[23]. While the majority of the catch is composed of high-value species with significant market demand, a portion, especially low-value bycatch and undersized juveniles of high-value species, is often sent for reduction rather than being sold in the market[24].

There are news reports that suggest that fishing practices are changing due to the demand required by the fishmeal and oil industry. As mentioned above, the fishmeal and fish oil sectors in India have created a growing demand for raw materials, which in some cases appears to be influencing fishing behaviours. According to a report by Mongabay (2020)[25], the rapid expansion of these industries has led to a situation where fishing vessels might target certain species solely for reduction purposes, rather than for human consumption. The report highlights that the fishmeal and fish oil industries are increasingly relying on low-value fish, including juveniles and bycatch that are often diverted from traditional edible markets. This shift suggests that some fishers could be prioritizing species with less immediate market value to meet the volume demands of reduction factories, contributing to overfishing and impacting the sustainability of local fish stocks.

Furthermore, the demand for these products in the aquaculture feed industry has exacerbated this trend, as fishmeal and oil are key components of feeds for farmed fish. As a result, there is concern that fisheries are being

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[18] Sijo Paul and Hezekiel, K. C. (2013). Paired and unpaired trawling at Munambam F.H. and mini harbour. Central Marine Fisheries Research Institute, Kochi

[19] Remesan M. P. (2022). Trawling: types and methods. ICAR – Central Institute of fisheries Technology, Kochi).

[20] Srinath, M., Kuriakose, S., & Mini, K.G. (2005). By-catch reduction: A case study from Indian waters. ICAR - Central Marine Fisheries Research Institute.

[21] J. Mar. Biol. Ass. India, 55 (2), 69-78, July-December (2013) https://eprints.cmfri.org.in/10057/1/Article-11.pdf

[22] Current science, vol. 123, no. 11, 10 December 2022 https://fisheryprogress.org/sites/default/files/documents_actions/Currrent%20Science_2022_Dineshbabu%20A%20P_1.pdf

[23] Dineshbabu, A.P., E.V. Radhakrisnnan, Sujitha Thomas, G. Maheswarudu, P.P. Manojkumar, A.J. Kizhakudan, S.L. Pillai, R. Chakraborty, J. Jose, P.T. Sarada, P.S. Sawant, K.K. Philipose, V.D. Deshmukh, J. Jayasankar, S. Ghosh, M. Koya, G.B. Purushottama and G. Dash, 2013. An appraisal of trawl fisheries of India with special reference on the changing trends in bycatch utilization. J. Mar. Biol. Ass. India, 52: 69-78.

[24] Dineshbabu, A. P., Thomas, S., & Vivekanandan, E. (2014). Assessment of low value bycatch and its application for management of trawl fisheries. Central Marine Fisheries Research Institute. Received June 10, 2014, accepted June 30, 2014, published October 15, 2014.

[25] Mongabay. (2020, January 14). Fish meal and fish oil industries pose threat to the fishing sector in India. Mongabay-India. https://india.mongabay.com/2020/01/fish-meal-and-fish-oil-industries-pose-threat-to-the-fishing-sector-in-india/

increasingly driven by the requirements of the fishmeal industry, potentially prioritizing volume over sustainability, and further reducing the availability of edible species for local consumption[26]. These socio-economic drivers influencing fishing activity have not been further addressed in this report, as such analysis falls outside the author's scope of expertise and the objectives of this assessment.

The study by CFMRI (2022) found that during 2017-2019, between 30 and 60 percent of trawl landing in India was constituted by LVB and is mostly used in fishmeal and oil production.

8. Objectives for the fishery:

The trawl fishery in Goa and Maharashtra, including adjacent federal waters, is guided by several key objectives related to resource sustainability, environmental protection, social responsibility, and economic viability. However, these objectives appear to be broad and loosely defined, which hinders effective management and decision-making. Recent guidelines, such as those laid out in FAO's framework on multispecies and multigear fisheries management, highlight the importance of establishing clear, measurable, and actionable objectives.

According to the FAO's Toolbox for Managing Multispecies and Multigear Fisheries, fisheries management must be built around defined objectives that are aligned with sustainability and ecosystem-based management approaches. These objectives must not only be clear but also quantifiable (through various methods), with specific indicators tied to management actions. This shift is necessary because traditional broad goals can fail to address the complexities of managing a dynamic ecosystem, leading to ineffective or unsustainable practices[27].

a. With the above in mind, the broad objectives as outlined in the National Policy on Marine Fisheries, and the relevant State level regulations, are summarised below.**Resources**

The primary objective of the fishery is to manage fish stocks sustainably to prevent overfishing and ensure long-term resource availability (Goa and Maharashtra fisheries regulations of 1980 and 1990, respectively). Key management strategies include seasonal fishing bans during monsoon periods to allow fish populations, especially juvenile species, to recover, and implementing regulations on gear use and fishing areas.

b. Environmental

The fishery management aims to minimize its environmental impact, particularly concerning bycatch and habitat destruction. While trawling has inherent risks to marine habitats, the adoption of mitigation strategies such as Bycatch Reduction Devices (BRDs) and Turtle Excluder Devices (TEDs), though not yet mandated, are encouraged.

c. Biodiversity and ecosystem

Research with institutions like the Central Marine Fisheries Research Institute (CMFRI) aims to monitor species distribution, abundance, and health of fish stocks, contributing to ecosystem conservation efforts if required.

d. Social

The National Policy on Marine Fisheries 2017[28] set the overarching objectives for all fisheries in India. These socio-economic objectives focus on enrichment of fisher communities, gender justice, and improving the overall quality of life for those dependent on the fishery. Key initiatives include:

- Fisher welfare and social security: Ensuring that fishers have access to social safety nets, institutional credit, and support programs that enhance their livelihoods. This includes implementing the provisions of the Voluntary Guidelines on Sustainable Small-scale Fisheries (VG-SSF), which promote a human rights-based approach to food security and poverty eradication.

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[26] Dineshbabu, A. P., Thomas, S., & Vivekanandan, E. (2014). Assessment of low value bycatch and its application for management of trawl fisheries. Central Marine Fisheries Research Institute. Received June 10, 2014, accepted June 30, 2014, published October 15, 2014.

[27] Leadbitter D, Fulton EA, Kulanujaree N, Noranarttragoon P, Nguyen KB, Phoonsawat R, Porobic J, Sainsbury K, Staples D, Vu VH and Ye Y (2023). Managing multispecies and multigear fisheries – a toolbox for scientists, managers and stakeholders. FAO Technical Guidelines (not yet published)

[28] National Policy on Marine Fisheries 2017. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC177473/

- Community empowerment: Encouraging participatory and co-management practices by involving local fishing communities, cooperatives, and other stakeholder groups in decision-making processes. This will help in resolving conflicts between traditional and mechanized sectors and fostering better collaboration among stakeholders.
- Gender equity: Promoting gender justice through specific support for women in fisheries, including women-friendly financial schemes, safe working conditions, and active participation in fisheries management. This objective aims to increase the engagement of women in the sector by providing equal opportunities and creating a supportive work environment.
- Climate resilience: Supporting fishers and their communities in adapting to climate change impacts through focused studies and adaptation programs, ensuring that their livelihoods remain resilient in the face of environmental challenges.

e. Economic

The economic objectives for the fishery, as outlined in the NPMF 2017, aim to balance sustainable resource utilization with economic growth, ensuring long-term profitability and value addition throughout the supply chain. These objectives include:

- Sustainable development: Ensuring the sustainable harvest of marine resources while promoting the responsible use of low-value bycatch for fishmeal and oil production. The policy stresses the importance of controlling the proliferation of fishmeal plants to prevent overfishing of species used as reduction material, while encouraging responsible utilization to maximize value.
- Enhancing market access and quality: Improving post-harvest handling and processing to reduce losses and increase the value of fish products. This includes promoting better on-board fish handling practices, maintaining cleanliness and hygiene in facilities, and improving the quality of high-value species for both domestic and international markets.
- Support for small-scale and traditional fishers: Expanding financial support to fishers for purchasing fishing implements and crafts, promoting Public-Private Partnerships (PPP), and developing entrepreneurship opportunities within the sector. Additionally, increasing access to deep-sea resources and developing infrastructure to support the integration of the seafood processing and export sectors with the fishery are key economic goals.
- Traceability and eco-labelling: Establishing robust traceability systems and promoting eco-labelling for fisheries products, enhancing the sustainability and marketability of Indian fish products. This will improve the fishery's global competitiveness and ensure compliance with international sustainability standards.

9. Current status of the fishery resources, ETPs, habitats and the ecosystem

The trawl fishery in Goa and Maharashtra primarily targets demersal species such as shrimp, ribbonfish, threadfin bream, and croakers. Stock levels for these species fluctuate due to natural variability and fishing pressure, with stock assessments ongoing for some stocks. To address this, management measures like seasonal fishing bans are in place, helping regulate fishing activity and allowing juvenile populations to recover, however no specific objectives as it relates to the trawl fishery have been defined with quantifiable specific indicators that are tied to management actions

Bycatch remains a significant concern as exact compositions of species are not known and for lesser-known species there are no formal stock assessment conducted, and thus Productivity-Susceptibility analysis are needed which may come with uncertainties. Further, while the use of Bycatch Reduction Devices (BRDs) and Turtle Excluder Devices (TEDs) are encouraged, it has not yet been made mandatory. Research and monitoring programs, in collaboration with institutions like the Central Marine Fisheries Research Institute (CMFRI), aim to assess and mitigate the fishery’s impact on ETP species.

10. Current Management Arrangements, Monitoring, and Evaluation

The trawl fishery in Goa and Maharashtra operates under a multi-tiered management framework that includes both state and national authorities. The fisheries departments of Goa and Maharashtra oversee state-managed waters (0-12 nautical miles), while the Ministry of Fisheries, Animal Husbandry, and Dairying governs federal waters (12-200 nautical miles) within India’s Exclusive Economic Zone (EEZ). These regulatory bodies implement key management measures, including seasonal fishing bans, gear restrictions, and spatial closures to ensure

sustainable fishing practices. Rights of access to the fishery are generally granted to licensed fishers operating mechanized trawlers, and traditional artisanal fishers are afforded special protections and rights within territorial waters, aligning with the National Policy on Marine Fisheries (NPMF) 2017. This framework aims to balance the rights of small-scale fishers with larger commercial operations, ensuring equitable access to resources.

Monitoring, control, and surveillance (MCS) activities are in place to enforcing fishery regulations. Both state and central governments are responsible for conducting surveillance through patrol vessels, satellite monitoring, and port inspections to ensure compliance with legal requirements. The introduction of biometric identity cards for fishers is a step towards modernizing the monitoring systems[29], while the use of logbooks[30] and movement tokens[31] enhances traceability of fishing activities. Although the use of electronic monitoring systems, such as Vessel Monitoring Systems (VMS), is growing, further investments are needed to ensure comprehensive coverage across the fleet. Enforcement of regulations includes penalties for violations such as illegal, unreported, and unregulated (IUU) fishing, with particular emphasis on protecting endangered, threatened, and protected (ETP) species and minimizing bycatch.

The effectiveness of the management system is evaluated through regular reporting and performance reviews, conducted by state and national authorities in collaboration with research institutions like the Central Marine Fisheries Research Institute (CMFRI). Data collected from fish landings, catch composition, and fishing effort are used to monitor the fishery's performance. This includes evaluating the success of measures such as seasonal bans and bycatch reduction initiatives. Reporting requirements mandate fishers to submit logbook data, which is reviewed by authorities to ensure compliance with regulations and assess the overall health of fish stocks. These reviews help inform adaptive management strategies to address emerging challenges such as stock fluctuations and environmental changes, with the aim of ensuring that the fishery continues to operate sustainably.

[29] https://maritimeindia.org/maritime-safety-and-security-in-india-fisheries-mcs-a-key-enabler/

[30] https://english.mathrubhumi.com/news/kerala/boat-owners-refuse-to-comply-with-instructions-of-maintaining-logbook-of-workers-at-sea-1.9544989. Note it is not fully illuminated from this review if logbooks pertain to environmental requirements or just records of workers and other aspects on board the vessel. The article from 2024 also mentions there is likely high non-compliance with this logbook scheme.

[31] https://www.hindustantimes.com/mumbai/maharashtra-fishermen-need-a-token-before-venturing-into-sea/story-gJu5ZOiWVML2qCeabJSxIK.html

Section 1 – Management/governance framework

This section considers the legislation, policy and planning (M1); management frameworks (M2); and monitoring, control and surveillance mechanisms (M3) in place in the fishery. The Fishery Action Plan (FAP) should include improvements which work towards meeting all of the requirements in this section.

M1	**Legislation, policy and plans**		
	M1.1	The fishery is covered by modern comprehensive legislation that includes primary legislation (law and acts) and subsidiary legislation (rules and regulations).	Pass
	M1.2	The legislation is based on relevant international law, instruments and standards.	Pass
	M1.3	The legislation and/or overarching policy documents outline the overall policy goals for the fishery (ecological, social and economic)	Pass
	M1.4	The legislation legally empowers the responsible organisations to manage the fishery, including undertaking monitoring, control and surveillance and implementing management actions.	Pass
	M1.5	The policies and plans publicly commit the fisheries management organisations to sustainable development of the fishery.	Pass
	M1.6	The legislation and national policies include arrangements for stakeholder engagement and consultation.	Pass
	M1.7	The fishery has an up-to-date fisheries management plan (or is linked to such a plan) that incorporates the main principles of the ecosystem approach to fisheries, covering the ecological, social and economic dimensions of sustainable development.	Gap
	M1.8	The fishery management plan specifies goals and operational objectives.	Gap
	M1.9	The fishery management plan outlines the roles and responsibilities of the different fishery management and partner organisations.	Pass

M1.1 –

The existence of modern comprehensive legislation, encompassing both primary legislation (laws and acts) and subsidiary legislation (rules and regulations), is important for the sustainable management and development of India's fisheries sector. Various regulations and policies that directly relate to multispecies trawl fisheries, focusing on sustainable management, conservation, and regulation of fishing practices include:

The Marine Fishing Regulation Act (MFRA) at the state level, which regulates fishing activities within territorial waters (up to 12 nautical miles). Each coastal state, including Goa and Maharashtra, enforces its

own MFRA, with provisions for vessel licensing, mesh size regulations, and fishing gear restrictions to reduce juvenile bycatch and overexploitation of resources.

The Indian Wildlife Protection Act, 1972 (with its subsequent amendments), indirectly affects trawl fisheries by prohibiting the capture of endangered species such as marine turtles, which are often caught as bycatch. This legislation mandates that fisheries management plans include measures to avoid incidental capture of protected species.

Seasonal Fishing Bans, enforced at both the state and national levels, are aimed at protecting breeding stocks during key periods, typically during the monsoon season. These bans help in rebuilding fish populations and ensuring long-term sustainability of the fisheries.

Marine Protected Areas (MPAs) and Coastal Regulation Zone (CRZ) notifications also contribute to regulating fishing practices, particularly in ecologically sensitive areas. Certain zones may restrict trawling activities to mitigate habitat destruction and conserve critical marine ecosystems.

The National Fisheries Policy (currently under draft) is expected to further integrate multispecies fishery management with ecosystem-based approaches, considering climate impacts, habitat restoration, and the promotion of co-management with coastal communities.

The National Policy on Marine Fisheries (2017) highlights the fisheries sector in India is governed by a comprehensive legal framework that integrates both primary and subsidiary legislation to address its diverse needs. The marine fisheries sector, which involves a wide variety of fishing vessels with different designs, sizes, and operational areas, is subject to laws and regulations aimed at ensuring proper registration, certification, safety, and labour conditions.

Primary legislation typically includes key laws or acts passed by the government to establish broad regulations. These laws cover essential areas such as: registration, survey, and certification of fishing vessels, mandatory identification documents and tracking equipment for vessels, penalties for violations related to safety and operational standards, and manning norms and sea safety requirements for fishing vessels.

Additionally, subsidiary legislation, such as specific rules and regulations, is continuously updated to align with international standards set by organizations like the Food and Agriculture Organization (FAO), International Maritime Organization (IMO), and International Labour Organization (ILO). These updates ensure compliance with global best practices, including labour protection standards, vessel safety, and the sustainable management of fisheries.

Moreover, the Central Government, under its mandate to regulate fisheries within the Exclusive Economic Zone (EEZ), is actively working to introduce specific legislation for the sustainable development and management of fisheries in this area (12–200 nautical miles). This comprehensive legal framework, combining primary laws and subsidiary rules could significantly contribute towards ensuring the well-being of fishers.

A revised National Fisheries Policy has been introduced in 2020 but it is not yet approved.

M1.2 –

Adherence of the National Fisheries Policy 2017 to relevant international law, instruments, and standards is crucial for sustainable fisheries management in India. The legislation governing India's marine fisheries is based on and aligned with several relevant international laws, instruments, and standards, ensuring that the sector operates within the global regulatory framework for fisheries management, labour, and environmental protection.

1. Alignment with International Agreements: India, as a signatory to key international agreements such as the 1982 United Nations Convention on the Law of the Sea (UNCLOS) and the 1995 FAO Code of Conduct for Responsible Fisheries (CCRF), is committed to updating its domestic laws to reflect international standards. For example, fisheries management regulations will be revised to prevent Illegal, Unreported, and Unregulated (IUU) fishing, in compliance with global agreements aimed at deterring such practices in the Exclusive Economic Zone (EEZ), the high seas, and other nations' EEZs.

2. Compliance with International Standards for Vessel Safety and Operation: The modernization and registration of fishing vessels, as well as manning and sea-safety norms, are governed by international standards set by agencies such as the International Maritime Organization (IMO) and the Food and Agricultural Organization (FAO). Indian legislation mandates compliance with these norms, ensuring that vessels operating in the EEZ and beyond are certified, equipped with proper safety gear, and subject to penalties for violations.

3. Labor Standards on Fishing Vessels: The Government is also working toward incorporating the provisions of ILO Convention 188, which sets standards for labour conditions on fishing vessels. This includes improving the working conditions of both domestic and migrant labourers and ensuring that Indian legislation reflects the international labour norms established by the International Labour Organization (ILO).

4. Deep Sea Fishing and High Seas Compliance: India's efforts to enhance deep sea fishing capabilities, including modernizing its fleet and expanding fishing in Areas Beyond National Jurisdiction (ABNJ), are in full compliance with international agreements governing high seas fisheries. Proper Monitoring, Control, and Surveillance (MCS) regimes are being put in place to ensure that Indian vessels adhere to the relevant rules and regulations concerning sustainable resource utilization in these areas.

5. Traceability and Global Seafood Trade Standards: Recognizing the importance of traceability and compliance with international trade standards, India is working to align its domestic seafood products with benchmarks set by international markets. This includes harmonizing the Food Safety and Standards Authority of India (FSSAI) standards with those of the Export Inspection Council (EIC), enhancing India’s ability to meet global demands for seafood safety and quality.

6. Climate Change Commitments: As part of its international obligations related to climate change, India is promoting the concept of green fisheries, aiming to reduce Greenhouse Gas (GHG) emissions from fishing activities. This initiative is aligned with global climate agreements and emphasizes sustainability in the fisheries sector.

7. Model Bill for Fisheries Management: To ensure comprehensive coverage of fisheries management, the Government is considering drafting a Model Bill for coastal States and Union Territories. This legislation will integrate international instruments like UNCLOS and the FAO CCRF, ensuring that India's Marine Fisheries Regulation Acts (MFRAs) are updated to reflect global best practices in sustainable fisheries management.

In summary, India's fisheries legislation is not only informed by international law and standards but also actively seeks to integrate these frameworks into domestic policy, ensuring that the sector remains compliant with global norms for sustainable fishing, labour conditions, and environmental conservation.

M1.3 –

The National Policy on Marine Fisheries (NPMF) 2017 sets out comprehensive ecological, social, and economic goals for sustainable marine fisheries management in India. Ecologically, the policy prioritizes preserving marine biodiversity and ecosystem health by managing fishing efforts, protecting vulnerable species and habitats, and implementing the Ecosystem Approach to Fisheries Management (EAFM). Socially, it focuses on the socio-economic upliftment of fishing communities, ensuring livelihood sustainability, capacity building, and securing the tenure rights of traditional fishers, while promoting gender justice and participatory governance. Economically, the policy aims to maximize the value of fishery products, promote sustainable mariculture, develop fisheries-related infrastructure, and optimize resource utilization within the Exclusive Economic Zone (EEZ). Overall, it balances environmental conservation with social welfare and economic growth to benefit present and future generations.

M1.4 –

The National Policy on Marine Fisheries (2017) empowers relevant organizations to effectively manage fisheries through a comprehensive legal framework, with a strong focus on Monitoring, Control, and Surveillance (MCS). The Department of Fisheries (DoF), Coastal Marine Police, and the Indian Coast Guard (ICG) are mandated to oversee vessel registration, licensing, and fishing operations, supported by technological tools such as smart registration cards, vessel monitoring systems, and biometric identity cards for fishers. The policy also mandates strengthening MCS functions through improved training for enforcement agencies and community participation. Additionally, it addresses vessel construction standards by expanding the scope of Marine Fishing Regulation Acts (MFRAs) to include vessel inspections and the registration of boatyards. Furthermore, the policy emphasizes compliance with international fishing regulations in the Exclusive Economic Zone (EEZ) and Areas Beyond National Jurisdiction (ABNJ), ensuring the sustainable use of marine resources. Through its Implementation Plan, the policy sets clear timelines, assigns responsibilities, and outlines funding for action points, ensuring effective management and regulation of fisheries. Also the national legislation legally empowers responsible organizations to manage fisheries, including undertaking monitoring, control, and surveillance, and implementing management actions. For example, measures such as the mandatory installation of Vessel Monitoring Systems (VMS) and participatory research initiatives ensure effective oversight and sustainable management of fishery resources.

M1.5 –

The National Policy on Marine Fisheries (2017) publicly commits to sustainable fisheries management by outlining a comprehensive strategy centred on seven key pillars: sustainable development, socio-economic upliftment, inter-generational equity, and the precautionary approach. It prioritizes maintaining the health of marine ecosystems while promoting sustainable harvesting practices, particularly in India's Exclusive Economic Zone (EEZ). The policy emphasizes biodiversity conservation, species-specific and area-specific management plans, and the protection of Ecologically and Biologically Significant Areas (EBSAs) and Vulnerable Marine Ecosystems (VMEs). It seeks to optimize fleet sizes, promote responsible deep-sea fishing, and balance inshore fishing at sustainable levels. The policy also encourages private investment, Public-Private Partnerships (PPP), and institutional financing to modernize the sector while ensuring equitable resource use for present and future generations. Through these commitments, it fosters the ecological, economic, and social well-being of the fishing community, aiming for a balanced and sustainable fisheries sector.

M1.6 –

The National Policy on Marine Fisheries (2017) integrates extensive stakeholder engagement through participatory governance and co-management systems, ensuring fishers, coastal States/UTs, and other key actors are actively involved in decision-making. Policies such as fleet size optimization, spatial-temporal closures, and mariculture development are formulated in consultation with fishers, research institutions, and private investors to promote both ecological sustainability and socio-economic benefits. The policy also

encourages fisher cooperatives and stakeholder-run committees for managing infrastructure like Fish Landing Centres and harbours. Additionally, international agreements are implemented through wide consultations, promoting coherence between national policies and global standards. By incorporating traditional knowledge, scientific research, and business principles, the policy fosters a holistic, inclusive approach to fisheries management.

M1.7 –

The National Policy on Marine Fisheries (2017) incorporates the ecosystem approach to fisheries, balancing ecological, social, and economic sustainability. For ecological sustainability, it emphasizes protecting the health of marine ecosystems through measures like fishing effort management, fleet size optimization, species-specific and area-specific plans, and conserving Ecologically and Biologically Significant Areas (EBSAs) and Vulnerable Marine Ecosystems (VMEs). It also promotes biodiversity conservation, protection of endangered species, and sustainable utilization of resources, alongside periodic reviews of Marine Protected Areas (MPAs).

In terms of social sustainability, the policy prioritizes the socio-economic upliftment of fishers, ensuring their tenure rights, promoting gender justice, and involving them in co-management systems. The participatory approach ensures inclusive governance, conflict resolution between traditional and mechanized sectors, and capacity-building for small-scale and artisanal fishers. It also addresses training and technological upskilling to transition to more sustainable fishing methods.

For economic sustainability, the policy focuses on optimizing the economic benefits from marine fisheries by tapping into underutilized resources such as tuna and oceanic species, promoting mariculture, and supporting post-harvest infrastructure. It encourages private investment, public-private partnerships, and better integration of seafood processing and export sectors to enhance livelihoods and national revenue.

However, there is no fishery-specific management plan that relates directly to multispecies trawl fisheries in Goa and Maharashtra. The broader national Policy may cover the main principles of the ecosystem, but there is no direct legislation related to the objectives nor management measures in place for multispecies fisheries. This element does not pass.

M1.8 –

The National Policy on Marine Fisheries (2017) sets clear goals and operational objectives for fisheries management, focusing on sustainability while ensuring social and economic benefits. Its primary goal is to balance ecological integrity with the socio-economic upliftment of fisher communities through sustainable resource utilization. Operational objectives include advancing the Blue Revolution (Neeli Kranti) by promoting sustainable practices in marine fisheries and aquatic resource management. This initiative aligns with the global Blue Growth Initiative and the Sustainable Development Goals (SDGs), aiming to improve the livelihoods of fishers while safeguarding marine biodiversity and ensuring long-term economic viability in the sector. These objectives guide fisheries management for the next ten years.

There is no fishery-specific management plan for multispecies trawl fisheries and therefore the related measures and objectives required to pass this element of the assessment are not met.

M1.9 –

The National Policy on Marine Fisheries (2017) clearly outlines the roles and responsibilities of different fishery management and partner organizations. At the core of the policy is the Department of Animal Husbandry, Dairying & Fisheries (DAHD&F), which provides guidelines for managing fisheries within the Indian EEZ, including deep-sea fishing operations. The policy also promotes a single window approach to integrate stakeholders such as private investors, governmental agencies, and public-private partnerships (PPP) to facilitate the development of deep-sea fisheries and processing industries. Coastal States and Union

Territories (UTs) work in coordination with the Union Government to implement sustainable management practices. The policy further outlines that a comprehensive Implementation Plan will define specific roles, timelines, and funding sources, with an emphasis on monitoring and evaluation to ensure effective coordination across all partners. These roles collectively aim to ensure sustainable fishery management, promote economic growth, and uplift fishing communities.

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M2	**Institutions and stakeholder engagement**		
	M2.1	The organisation identified in the initial screening has an effective management framework in place.	Gap
	M2.2	The management decision-making is based on the best scientific evidence available.	Pass
	M2.3	There is an organisation charged with the identification, management and conservation of ETPs with jurisdiction over the fishery.	Pass
	M2.4	There is an organisation responsible for the conservation and protection of fishery habitats.	Pass
	M2.5	The fishery has some form of governance arrangements in place that can be used to coordinate management between the government organisation and key stakeholders of the fishery.	Pass

	M2.6	There is a consultation process through which fishery stakeholders are engaged in all aspects of planning and decision-making.	Gap
	M2.7	The decision-making process is transparent, with processes and results publicly available.	Gap

M2.1 –

The National Policy on Marine Fisheries (2017) clearly outlines the roles and responsibilities of different fishery management and partner organizations. At the core of the policy is the Department of Animal Husbandry, Dairying & Fisheries (DAHD&F), which provides guidelines for managing fisheries within the Indian EEZ, including deep-sea fishing operations. The policy also promotes a single window approach to integrate stakeholders such as private investors, governmental agencies, and public-private partnerships (PPP) to facilitate the development of deep-sea fisheries and processing industries. Coastal States and Union Territories (UTs) work in coordination with the Union Government to implement sustainable management practices. The policy further outlines that a comprehensive Implementation Plan will define specific roles, timelines, and funding sources, with an emphasis on monitoring and evaluation to ensure effective coordination across all partners. These roles collectively aim to ensure sustainable fishery management, promote economic growth, and uplift fishing communities.

However, at this stage of the pre-assessment, there is no indication that the terms and measures within this Policy are “effective” as required by the scoring element guidelines. Likewise, as mentioned in M1.7 and M1.8, without a specific set of objectives and management measures for multispecies trawl fisheries directly, there is no way to verify that these are effective in their operations. Thus, this element cannot pass.

M2.2 –

The National Policy on Marine Fisheries (2017) emphasizes that management decision-making is firmly rooted in the best scientific evidence available. The policy outlines the use of spatial and temporal closures to sustainably manage fish stocks, with regular reviews based on scientific data to ensure effectiveness. The government collaborates with scientific institutions and stakeholders like fishers to optimize fishing practices through evidence-based measures, such as controlling fleet size, fishing days, and gear specifications, and setting limits like Maximum Sustainable Yield (MSY) and minimum legal size. Additionally, the policy incorporates a precautionary approach in managing resources, ensuring recovery plans for depleted stocks and periodic capacity appraisals. Through scientific monitoring and the introduction of modern technology in deep-sea fishing, the policy ensures that all fishing activities comply with international regulations and contribute to sustainable resource management.

M2.3 –

India has a robust organizational framework for the identification, management, and conservation of Endangered, Threatened, and Protected (ETP) species within its fisheries. The responsibility for protecting wild fauna and flora, including species such as whale sharks, and marine turtles, is shared between the Union and State Governments, as mandated by List III of the Concurrent List. This framework ensures both levels of government are accountable for coastal zone protection, marine biodiversity conservation, and pollution prevention. States are encouraged to promote research and develop techniques for the rehabilitation and enhancement of endangered species, maintaining genetic diversity through gene banks. The National Aquatic Products Council (NAPC) aligns fish trade regulations with CITES guidelines, ensuring sustainable practices. Fishermen using various fishing vessels are educated to avoid capturing ETP species, reinforcing conservation efforts.

Also, there are the following laws that govern conservation in India:

1. Wildlife (Protection) Act - 1972
2. Ratification of the CITES - 1976
3. Ratification of Bon Convention - 1981
4. Environment (Protection) Act - 1986

5. The Biological Diversity Act, 2002
6. The Wildlife Protection Amendment Act- 2002
7. The Marine Fishing Policy, 2004
8. Marine Fisheries (Regulation and Management) Bill, 2009
9. Coastal Regulation Zone Notification, 2011
10. State Fisheries Policies and Laws

M2.4 –

The National Policy on Marine Fisheries (2017) establishes a framework for the conservation and protection of fishery habitats, assigning clear responsibilities for habitat protection to relevant organizations. The policy focuses on mainstreaming biodiversity conservation through species-specific and area-specific management plans, safeguarding Ecologically and Biologically Significant Areas (EBSAs) and Vulnerable Marine Ecosystems (VMEs), and protecting endangered, threatened, and protected (ETP) species. To achieve this, the government collaborates with scientific institutions, fishers, and stakeholders to create fish refugia through consultative processes and ensures the periodic evaluation of Marine Protected Areas (MPAs) to secure both biodiversity and the tenure rights of traditional fishers.

Moreover, the policy integrates international standards such as the FAO's Code of Conduct for Responsible Fisheries (CCRF) into its activities, ensuring adherence to global conservation principles. Additionally, the government supports regional cooperation to manage shared ecosystems, especially in areas like the Gulf of Mannar, Palk Bay, and Sundarbans, to protect migratory and straddling fish stocks, promoting sustainable use and conservation across borders.

M2.5 –

The governance arrangements include a pluralistic structure, involving multiple institutions across different levels of government. Coastal State/Union Territory (UT) governments, the Central Government (through agencies like the Department of Animal Husbandry, Dairying & Fisheries, Ministry of Commerce & Industry, Indian Coast Guard, and scientific bodies all play critical roles in the management of the sector. This requires strong coordination between the Ministry of Agriculture and Farmers Welfare, coastal States/UTs, and various Union Ministries and Departments.

To enhance collaboration, the policy proposes the creation of a coordination mechanism that brings together all relevant agencies. This would also involve cooperation between coastal States/UTs to ensure that marine fisheries are sustainably harvested, promoting a unified approach across regions and institutional layers for effective fisheries governance.

M2.6 –

The National Policy on Marine Fisheries (2017) incorporates a strong consultation process, ensuring the active engagement of fishery stakeholders in all aspects of planning and decision-making. This consultative approach is evident in various strategies outlined by the policy, particularly regarding capacity management, conservation efforts, and co-management systems. For instance, when addressing the issue of overcapacity in territorial waters, the government will consult with States/Union Territories (UTs) and other stakeholders before developing strategies to reduce the fleet size. Similarly, when introducing species-specific and area-specific management plans (e.g., for Ecologically and Biologically Significant Areas (EBSAs) and Vulnerable Marine Ecosystems (VMEs)), the government will rely on consultative processes with relevant stakeholders to ensure that the measures are well-informed and aligned with community needs. Further, the policy highlights co-management in fisheries, a globally recognized participatory management system. This system encourages multi-stakeholder engagement and is crucial for resolving conflicts among different fishing groups. The government will develop norms for this system in consultation with fishers, their associations, coastal States/UTs, and fisheries research institutions. In the case of traditional fisheries and mariculture, the government will continue to protect Territorial Use Rights for Fisheries (TURFs) in consultation with user groups, while also engaging stakeholders to address the needs of emerging sectors like mariculture through spatial planning and capacity building initiatives. The policy also underscores the importance of international fisheries instruments, emphasizing that their implementation will be enhanced through wider stakeholder

consultations. This inclusive approach ensures that planning and decision-making processes are responsive to the needs and interests of the fishers and other key stakeholders across the sector.

However, the extent to which stakeholders do engage and interact with these consultation periods is unknown. Likewise, the method by which the government extends invitations for stakeholders and the public to enter the consultation is unclear. Therefore, even though the Code stipulates that these consultation periods are accessible, without evidence that they are effective at inviting and encouraging stakeholder input or disclosing the findings and outcomes from the consultation process, the applicability of this measure is largely unknown and therefore cannot be deemed as effective or "in place". Thus, this element cannot pass.

M2.7 –

"India Marine Fisheries Code: Guidance on a marine fisheries management model for India" mandates a transparent decision-making process in fisheries management, with processes and results made publicly available. States are mandated to facilitate consultation and effective participation from industry, fish-workers, environmental groups, and other stakeholders in developing laws and policies related to fisheries management, development, and international aid. This approach guarantees that decisions are timely, inclusive, and aligned with national laws and regulations, ensuring that all relevant parties are informed and engaged throughout the process.

There is no evidence of publicly available reports on the consultation process nor the decision-making process that could help to disclose the important findings and outcomes of this measure. Therefore, despite the measure being written into the Code, further information is essential to understand the extent of the applicability, and this element cannot pass.

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M3	**Monitoring, control and surveillance**		
	M3.1	The MCS organisation identified in the initial screening provides effective compliance and enforcement mechanisms that ensure management measures are complied with.	Gap
	M3.2	There are adequate sanctions for illegal activities that can be applied when rules and regulations are broken.	Pass
	M3.3	There is no substantial evidence of widespread non-compliance in the fishery, and no substantial evidence of illegal, unreported and	Gap

		regulated (IUU) fishing.	
	M3.4	Surveillance is conducted through a regime that includes a range of activities, for example, at-sea and portside inspections, observer programmes and VMS, as appropriate.	Pass
	M3.5	Stakeholders in the fishery are aware of, and understand, the laws and regulations.	Gap

M3.1 –

The National Policy on Marine Fisheries (2017) emphasizes the importance of a robust Monitoring, Control, and Surveillance (MCS) regime to ensure effective compliance with management measures in the marine fisheries sector. The policy identifies key mechanisms and strategies to enforce regulations and promote responsible fishing practices. Firstly, the Government aims to modernize the MCS framework by integrating advanced technology, such as chip-based smart registration cards for fishing vessels, which would store vital data including registration details, licensing information, and voyage logs. Additionally, Vessel Monitoring Systems (VMS) and Automatic Identification Systems (AIS) will be implemented to monitor the real-time location and activities of vessels, ensuring adherence to fishing zones and periods. Biometric cards for fishers, logbooks, and movement tokens will also be mandatory, further bolstering the control mechanisms. Colour-coding of vessels is another compliance measure to easily identify different categories of fishing vessels, aiding in the enforcement of spatial and fleet-specific regulations. The policy highlights a multi-tiered approach by engaging various entities such as the Department of Fisheries (DoF), Coastal Marine Police, and the Indian Coast Guard (ICG), all of which will play crucial roles in enforcing regulations. These bodies will receive training and equipment upgrades to improve their capacity for monitoring and enforcement. Coordination between the Central Government, State/UT governments, and local bodies is essential to ensure seamless operation of the MCS system. Moreover, the policy encourages the involvement of fishing communities in the MCS process, thereby strengthening enforcement at the local level. This participatory approach fosters a sense of ownership and accountability among fishers, helping ensure compliance with established management measures. Lastly, the infrastructure necessary to support MCS functions will be enhanced through the development of fish dressing centres, processing estates, and other harbour-based facilities, which will be created in collaboration with fisher cooperatives and through Public Private Partnerships (PPP). This infrastructure is critical not only for the value chain but also for ensuring effective monitoring and enforcement across the sector. Through these comprehensive measures, the MCS regime will be strengthened, ensuring compliance with both national and international regulations and promoting sustainable fishing practices.

However, the extent to which these objectives are “effective” is unclear at this stage. Most of the measures are described as “aims” and whether these have been applied in practice is uncertain. Therefore, despite the framework in place for these measures, this element cannot meet a passing score without evidence of their efficacy.

M3.2 –

The National Policy on Marine Fisheries (2017) provides clear sanctions against Illegal, Unreported, and Unregulated (IUU) fishing to ensure compliance with both national and international regulations. India, as a party to various global agreements, will implement strict measures at ports and at sea to prevent IUU fishing in its Exclusive Economic Zone (EEZ) and beyond. Sanctions for illegal activities include fines, confiscation of catches, and license revocations. The policy promotes the use of advanced monitoring systems like Vessel Monitoring Systems (VMS) and Automatic Identification Systems (AIS) to detect violations in real time. In addition, India will cooperate with other nations to ensure Indian vessels comply with regulations in international waters, ensuring effective deterrence and enforcement of fishing laws.

M3.3 –

Although the NFP 2017 outlines commitment of India towards international agreements to deter, prevent, and eliminate IUU fishing, and the government has established mechanisms to ensure compliance, there is a significant information gap regarding the extent of IUU fishing. The Central Marine Fisheries Research Institute

(CMFRI) report (2021) does not address IUU fishing, creating a void in the available data. Additionally, Dineshbabu et al. (2018) highlight the lack of mechanisms to accurately track bycatch discards from trawlers, with current data relying on limited sources such as participatory programs and selected trawler operators, further indicating potential gaps in monitoring and reporting compliance.

M3.4 –

The National Policy on Marine Fisheries (2017) outlines a comprehensive Monitoring, Control, and Surveillance (MCS) regime to ensure effective compliance with fishing regulations. Surveillance activities are diverse and include:

1. At-sea inspections: The Indian Coast Guard (ICG) and Coastal Marine Police are actively engaged in monitoring fishing activities at sea. This includes verifying vessel registration, ensuring safety standards, and preventing illegal fishing practices such as crossing into international waters.
2. Portside inspections: The MCS regime includes monitoring of fishing vessels at ports, ensuring that vessels comply with licensing, logbook maintenance, and other regulations.
3. Vessel Monitoring Systems (VMS) or Automatic Identification Systems (AIS): These systems are used to track vessel movements and ensure that fishing operations comply with spatial and temporal regulations. This allows for real-time surveillance and monitoring of fleet activities.

Additionally, the policy emphasizes strengthening MCS efforts by enhancing registration systems (like the ReALCraft system), smart registration cards, and color-coded vessels to improve compliance tracking. The Central Government, along with State/UT Governments, will work to further develop and implement these surveillance mechanisms to ensure sustainable fishing practices.

M3.5 –

Despite efforts to translate the Indian Marine Fisheries Code into several Indian languages and conduct awareness campaigns, significant gaps in stakeholders' understanding of fisheries laws and regulations remain. According to Varkey et al., many fisheries scientists in India are unaware of key fisheries management concepts detailed in the Code. The infrequency of awareness campaigns and assessments on implementation contributes to this gap. Article 6.16 of the Code emphasizes the need for states to promote awareness of responsible fisheries through education and training, highlighting the importance of fishers and fish farmers understanding the conservation and management of the resources they depend on. However, the report indicates a substantial lack of awareness among stakeholders. It is worth noting that this report is now 14 years old, so with further evidence of improvement in stakeholder awareness, then this clause would likely achieve a pass.

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Section 2 – Fishery risk ratings: Catch, ETPs, habitats and ecosystem

Section 2a: Catch

The first of the four Fishery Risk Ratings relates to the species caught in the fishery and is named ‘catch’. This represents the risk posed by the fishery to the populations of the stocks it exploits, including discards, and particularly the risk of overfishing. Mitigation measures involve understanding the effects of the fishery on the fished species, determining appropriate levels of catch, restricting the total fishing effort, and others. The most effective way to reduce the risk posed by the fishery is to reduce total effort and/or fishing mortality, and this is reflected in the potential mitigation scores.

The catch of the multi-species fishery is divided into three parts:

Part A: Total aggregate catch – based on a target reference point (TRP) e.g. multi-species maximum sustainable yield (MMSY).

Part B: High-risk species/species groups – based on a limit reference point (LRP) e.g. Point of recruitment impairment (PRI). Note: These species or groups of species do not include ETPs that are assessed separately below.

Part C: The reduction component of the catch – based on ensuring that the catch of this component is restored to or maintained at a safe biological level and indices of juvenile catches. This component is often called ‘low value/trash fish’ and is the source of the material used to manufacture fish meal/oil. Note that the low value/trash fish may be made up any species – even those that typically return a high market value.

Part A: Total aggregate catch

Part A: Total Mitigation Value	18
Part A: Catch Risk Value (100 minus mitigation value)	82
Part A: Catch Risk Rating	High (60-80)

A1: Management objectives and reference points	
	Mitigation score
The fishery has not developed any objectives or target reference points to ensure that the total multi-species assemblage is maintained or restored to levels capable of producing the TRP (e.g. multi-species maximum sustainable yield (MMSY) as qualified by relevant environmental and economic factors).	**0**
The fishery has informally adopted objectives and target reference points to ensure that the total multi-species assemblage is maintained or restored to levels capable of producing the TRP.	8
The fishery has formally adopted objectives and target reference points to ensure that the total multi-species assemblage multi-species assemblage is maintained or restored to levels capable of producing the TRP.	17

Rationale

Trawl fisheries in India, including those in Goa and Maharashtra, operate under a regulatory framework at both the state and federal levels. While there are various management measures in place, formal and well-enforced management plans with clear objectives, such as multi-species maximum sustainable yield (MMSY), appear to be lacking. This is particularly relevant in multi-species fisheries like those targeting shrimp, demersal fish species (such as croakers, ribbonfish, and pomfrets), and pelagic species (such as mackerel and sardines), which are commonly caught in trawl nets.

In Goa and Maharashtra, as well as the adjacent Exclusive Economic Zone (EEZ), fisheries management primarily focuses on effort controls and output controls. These include seasonal fishing bans, mesh size regulations and vessel registration and licensing to control fleet size.

In Goa, the mesh size is to be no lower than 24mm for catching fish and 20mm for catching prawns (Fisheries Department of Goa, 2023). Maharashtra has variable mesh size allowances based on zone, with no trawl gear having less than 35 mm mesh size shall be operated by any mechanized fishing vessel within territorial waters of Thane, Greater Mumbai, Raigad and Sindhudurg, and no trawl gear having less than 25 mm mesh size shall be operated by any mechanized fishing vessel within territorial waters of Ratnagiri (Rajesh, K. M. (n.d.)

While these measures are designed to control fishing effort and bycatch, formal target reference points for individual species or multi-species fisheries, such as MMSY, maximum fishing mortality thresholds, or biomass-based reference points, are not well-established or enforced. The lack of clear reference points hinders the ability to effectively assess the sustainability of the fishery, especially in a complex, multi-species context where different species have varying biological and ecological needs.

Sources

Fisheries Department of Goa. (2023, August 1). MCS reports from the Fisheries Departments of Goa [Letter Ref No. DF/GB/SOC-47/OMEGA-FIP/2180]. Available: https://www.marin-trust.com/sites/marintrust/files/2023-12/M%202.4%20-%20MCS%20reports%20dated%2001.08.2023%20from%20the%20Fisheries%20Departments%20of%20Goa%20-%20compressed.pdf

Rajesh, K. M. (n.d.). Fisheries legislation in India. Central Marine Fisheries Research Institute (CMFRI), Pelagic Fisheries Division, Mangalore Research Centre. https://eprints.cmfri.org.in/9871/1/Rajesh_8.pdf

A2: Data and information	
	Mitigation score
The fishery does not monitor any indicators relating to total catch nor collect sufficient data and information to assess the current status of the resources	0
The fishery monitors indicators relating to total catch with a low degree of precision and regularity and collects some information that could be used to estimate the status of the fishery resources through proxies.	**8**
The fishery monitors indicators relating to total catch with a high degree of precision and frequency and collects sufficient data and information to formally assess the current status of the fishery resources.	17
Rationales The fishery monitors indicators relating to total catch primarily through landing centre and government fishery reports (CFMRI). While some data is collected, the monitoring cannot be deemed highly precise or frequent enough to fully assess the status of the fishery resources. The information gathered is mainly used to estimate resource status through indirect measures like catch per unit effort (CPUE), but it lacks the detail required for comprehensive stock assessments. Although the data provides some insight, it does not reach the level of rigor needed for formal resource status evaluations. Therefore, the fishery's data and information systems reflect a low degree of precision and regularity, suitable for an 8 mitigation score.	
Sources Department of Fisheries, Government of Maharashtra. (2023, July 24). Updated information on Harvest Strategy, Monitoring, Control & Surveillance, and Protection of ETP species [Letter No. ACF/RTN/Tech-3/1949/2023-24]. Ratnagiri: Assistant Commissioner of Fisheries (Tech). Sathianandan, T. V., Pillai, N. G. K., & Nair, P. N. R. (2013). Assessment of bycatch and discards in trawl fisheries along the southwest coast of India. Indian Journal of Fisheries, 60(3), 27-31.	

A3: Fishery resource information	
	Mitigation score
There is no recent or reliable assessment of the status of the fishery resource.	0
The status of the fishery resource is based on indirect evidence from indicators or proxies of stock status.	**8**
The fishery resource status has been recently assessed using a scientifically sound methodology.	17
Rationale The status of the fishery resource is based on indirect evidence from indicators such as catch per unit effort (CPUE) and landing data collected at the state level. Within Maharashtra, the Department is collecting fish landing data on a monthly basis from major fish landing centres (Department of Fisheries, Government of Maharashtra, 2023). Although these proxies provide some insight into the status of the fishery, there is no recent or comprehensive stock assessment based on a scientifically sound methodology. The lack of formal and up-to-date assessments for multi-species assemblages means that the current understanding of resource status relies on these less precise methods. Given this reliance on indirect evidence and the absence of a recent, scientifically rigorous assessment, the appropriate mitigation score is 8.	

Sources:

CMFRI. (2019). Marine Fisheries Information Service, Technical & Extension Series. No. 240, 1-72. Central Marine Fisheries Research Institute, Cochin.

Department of Fisheries, Government of Maharashtra. (2023, July 24). Updated information on Harvest Strategy, Monitoring, Control & Surveillance, and Protection of ETP species [Letter No. ACF/RTN/Tech-3/1949/2023-24]. Ratnagiri: Assistant Commissioner of Fisheries (Tech).

A4: Status of the fishery resource

	Mitigation score
The current status of the fishery resource with respect to a target reference point is unknown.	**0**
The current status of the fishery resource with respect to a target reference point is known with a low level of certainty and is based on proxies.	8
The current fishery status with respect to a target reference point is known with a high level of certainty.	17

Rationale

The Indian trawl fisheries operating in Goa, Maharashtra, and adjacent federal waters are characterized by a multi-species fishery with complex management structures. Stock assessments, where available, are often based on indirect indicators like fishing effort and biomass proxies. However, these assessments do not typically include well-defined and scientifically validated target reference points for the majority of species caught (or at aggregate levels). As a result, the status of the fishery with respect to a TRP remains uncertain or only based on proxies.

A5: Management measures and their effectiveness

	Mitigation score
There are no management measures in place to control total catch.	0
There are management measures in place to control total catch, but they are not effective.	**8**
There are management measures in place to control total catch, which are effective.	17

Rationale

The Indian trawl fisheries operating in the waters of Goa, Maharashtra, and adjacent federal waters are subject to effort-based management measures, including seasonal closures, and gear restrictions, as outlined in the Goa and Maharashtra fisheries regulations of 1980 (amended by Goa Marine Fishing

Regulation Act, 2019) and 1990, respectively. These management measures indirectly impact total catch by limiting fishing effort during specific periods or regulating gear types. However, they are not designed to directly control total allowable catch (TAC) or impose species-specific quotas.

Despite the existence of these management measures, their effectiveness in controlling total catch is limited due to several factors:

- Weak enforcement: Enforcement of seasonal bans and gear restrictions is inconsistent, and compliance challenges exist, particularly in smaller ports or for non-target species (National Maritime Foundation, 2021)
- No direct catch limits: The fishery lacks direct controls on the total catch (such as TACs or quotas), which makes it difficult to effectively limit removals, especially in a multi-species fishery.

- Multi-species complexity: The nature of the trawl fishery, which targets a wide variety of species, complicates the implementation of effective management across all species being caught.

Specifically in Maharashtra as outlined in Letter No. ACF/RTN/Tech-3/1949/2023-24 from the Ratnagiri Assistant Commissioner of Fisheries, there are MCS measures in place whish support management measures of total catch. These include:

1. The 151 No. of fishing vessels equipped with Vessel Tracking Systems (VTS) which are going for offshore fishing. CCTV, DAT, and VTS are compulsory for 4 and 6 cylinder fishing vessels. Regarding distribution of Transponders to mechanised fishing vessels, the department has collected physical information of every registered fishing vessel presently.

2. The Department has an Enforcement Officers which are responsible for checking the compliance of Fishery Rules and Regulations in accordance with the Maharashtra Marine Fishing Regulation Act, 1981 and 2021.

3. The following are the functions of Enforcement Officers: a. Strict implementation of the Maharashtra Marine Fishing Regulation Act, 1981 and 2021. b. Implementation of Indian Fisheries Act, 1897. c. To register fishing vessels under the MS Act (The Merchant Shipping Act, 1958). d. To issue fishing licenses to the vessel owners. e. To lease fishing tanks in reserved areas. f. To conduct patrolling for preventing IUU Fishing (Department has hired only one Patrolling Vessel for the district). g. To issue QR Coded PVC Aadhar Cards presently. For security point of view it is essential for every fisherman. h. Posting of Fisheries Wardens at major landing centres for monitoring the fishing activities.

Furthermore, for Maharashtra, the following fishing regulations are also present (Rajesh, K. M. (n.d.).:

(i)) Operation of trawl net by mechanized fishing vessels is prohibited from the seashore to 5 fathoms and 10 fathoms depth zone in specified areas; Fishing vessels are banned from 1st June to 31st July (Directorate of Fisheries: Government of Goa, 2023)

(ii) Operation of trawl gear by mechanized fishing vessels is prohibited between 6 pm and 6 am.

(iii) Fishing by mechanized fishing vessels of any type with more than 6 cylinder engines is prohibited within the territorial waters of Maharashtra up to 22 km.

(iv) Purse-seine shall not be operated by any mechanized fishing vessel within the territorial water of Greater Mumbai, Thane, Raigad, Ratnagiri and Sindhudurg districts.

(v) Mechanized fishing vessels operating purse-seine gear beyond the territorial waters shall not land the catch caught by such gear in any port other than Mirkarwada (Ratnagiri Port).

(vi) No trawl gear having less than 35 mm mesh size shall be operated by any mechanized fishing vessel within territorial waters of Thane, Greater Mumbai, Raigad and Sindhudurg.

(vii) No trawl gear having less than 25 mm mesh size shall be operated by any mechanized fishing vessel within territorial waters of Ratnagiri.

For Goa, regulations that also support control of catch include (Rajesh, K. M. (n.d.):

(i) The area up to 5 km from the coastline is the specified area and mechanized fishing vessels are prohibited from fishing in the area.

(ii) Restrictions on mesh size of nets, i.e. 20 mm for prawn and 24 mm for fish.

While these management measures have shown some positive effects, such as reduced fishing pressure during closed seasons (June 1st – July 31st), they do not fully control the total catch. As a result, the fishery does not meet the standard for highly effective management measures but does have some management in place. This leads to a mitigation score of 8, reflecting that management measures are present but are not fully effective in controlling total catch.

References:

Department of Fisheries, Government of India. (2023, March 30). Fishing ban order 2023: Indian Exclusive Economic Zone (EEZ) beyond territorial waters. Government of India.

Department of Fisheries, Government of Maharashtra. (2023, July 24). Updated information on Harvest Strategy, Monitoring, Control & Surveillance, and Protection of ETP species [Letter No. ACF/RTN/Tech-3/1494/2023-24]. Ratnagiri: Assistant Commissioner of Fisheries (Tech).

Goa Marine Fishing Regulation Act, 1980. https://faolex.fao.org/docs/pdf/ind63794.pdf

Maharashtra Marine Fishing Regulation Act, 1981. https://mpeda.gov.in/wp-content/uploads/2020/07/mfra_maharashtra_1981.pdf

National Maritime Foundation. (2021, September 16). Indian responses to the challenge of IUU fishing: A first look. Maritime India. https://maritimeindia.org/indian-responses-to-the-challenge-of-iuu-fishing-a-first-look-at/

Rajesh, K. M. (n.d.). Fisheries legislation in India. Central Marine Fisheries Research Institute (CMFRI), Pelagic Fisheries Division, Mangalore Research Centre. https://eprints.cmfri.org.in/9871/1/Rajesh_8.pdf

Directorate of Fisheries: Government of Goa (2023) – email from the Directorate to the fishery explicitly outlining the details of the seasonal fishing ban between 1st June – 31st July.

A6: Management performance

	Mitigation score
The fishery has failed to achieve the objectives it has set in relation to the aggregate catch OR there are no such objectives.	**0**
The fishery is making progress to meeting the objectives it has set in relation to the aggregate catch.	8
The fishery has achieved the objectives it has set in relation to the aggregate catch.	17

Rationale

The trawl fisheries operating in Goa, Maharashtra, and adjacent federal waters are subject to various management measures, including seasonal closures, mesh size regulations, and vessel registration (Goa and Maharashtra fisheries regulations of 1980 and 1990, and their amendments). However, the fisheries management framework in these regions does not include formal aggregate catch limits or total allowable catch (TAC) objectives for the multi-species fisheries targeted by trawlers. As a result, the fishery has not fully achieved specific objectives related to aggregate catch, as such objectives are not clearly defined within the management system.

The fishery is currently working towards achieving sustainability goals through effort-based controls. For example, seasonal fishing bans help reduce overall fishing pressure, and mesh size regulations support the prevention of capturing of juvenile fish, contributing to more responsible fishing practices. These measures have had some success in managing the overall fishing effort, but without formal catch-based objectives or measures such as multi-species maximum sustainable yield targets (or other targets based off the appropriate level of CPUE, species maturity size, etc), it is difficult to measure progress toward meeting aggregate catch goals.

The current management measures aim to help reduce fishing pressure and protect fish stocks to some extent. However, these measures cannot be considered to be formal “objectives” as defined by the FAO (2023) because there are no indicators in place that will help to measure the objectives using quantitative and/or qualitative information. Therefore, it could be argued that there are no such objectives in place and thus this element meets the lowest mitigation score only. .

References:

Goa Marine Fishing Regulation Act, 1980. https://faolex.fao.org/docs/pdf/ind63794.pdf

Goa Marine Fishing Regulation (Amendment) Act, 2019. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC194998/

Leadbitter D, Fulton EA, Kulanujaree N, Noranarttragoon P, Nguyen KB, Phoonsawat R, Porobic J, Sainsbury K, Staples D, Vu VH and Ye Y (2023). Managing multispecies and multigear fisheries – a toolbox for scientists, managers and stakeholders. FAO Technical Guidelines (not yet published).

Maharashtra Marine Fishing Regulation Act, 1981. https://mpeda.gov.in/wp-content/uploads/2020/07/mfra_maharashtra_1981.pdf

Maharashtra Marine Fishing Regulation (Amendment) Ordinance, 2021. https://www.fao.org/faolex/results/details/en/c/LEX-FAOC227295

Both the original Goa and Maharashtra Marine Fishing Regulation acts have been amended in 2019 and 2021. More information can be found amendments by visiting the following hyperlinks Goa, Maharashtra.

Part B: High-risk species/species groups

The trawl fishery under assessment catches a wide array of species, including both commercially valuable species and those of less economic value. The species composition can fluctuate significantly due to various factors such as seasonality, recruitment patterns, and habitat conditions. While this fishery captures over 196 species by the trawl fishery in Goa[32] and 101 species in Maharashtra[33] - as documented in previous studies - it is impractical to assess every species individually, and the MarinTrust multispecies assessment criteria do not expect Productivity-Susceptibility Analyses (PSAs) to be conducted for every species, which is the defacto norm for other fisheries certification Standards dealing with data-limited elements. Additionally, various scientific reports demonstrate that the catch composition in trawl fisheries fluctuates significantly over temporal and spatial scales due to factors like seasonality, recruitment patterns, and habitat conditions. For instance, distinct peaks in bycatch biomass, particularly of juvenile and lower value species, were observed during pre-monsoon and post-monsoon seasons in Goa[34]. Therefore, providing a definitive list of species composition and exact percentages for these fisheries is not practical, given the high variability across studies and landing centres.

Instead, we focus on high-risk species groups that are particularly vulnerable to fishing pressure. These species groups have been identified based on their ecological characteristics (e.g., slow growth, low reproductive rates) and their importance within the ecosystem. Rather than using PSAs for all species, we have applied a precautionary approach guided by the Multispecies Maximum Sustainable Yield (MMSY) framework. This approach focuses on the species groups most at risk due to their biological and ecological traits. High-risk species are often those with slow growth rates, long lifespans, and late maturity, such as sharks, rays, and guitarfishes, or species that play important roles in ecosystem balance, such as crustaceans and certain commercially important fish.

The estimated bycatch associated with this trawl fishery is highlighted below (Table 1**Error! Reference source not found.**), and likely high risk species are in Table 2.

Part B Total Mitigation Value	0
Part B: Catch Risk Value (100 minus mitigation value)	100
Part B: Catch Risk Rating	Very high (80-100)

Table 1: Estimated bycatch species associated with this trawl fishery has been taken from official reported data mainly extracted from the Food and Agriculture Organization of the United Nations (FAO) FishStat database[35] and additional data from reconstructed estimates of unreported data (including major discards)

[32] Velip, D. T., & Rivonker, C. U. (2015). Trends and composition of trawl bycatch and its implications on tropical fishing grounds off Goa, India. Regional Studies in Marine Science, 2, 65-75. Department of Marine Sciences, Goa University, Goa, India.

[33] Prabhakar, R. P. (2011). Assessment of bycatch and discards in marine capture fisheries from Uran (Raigad), Navi Mumbai, Maharashtra. Veer Wajekar Arts, Science and Commerce College, Phunde, Navi Mumbai, Maharashtra.

[34] Ibid (31).

[35] http://www.fao.org/fishery/statistics/en

via the SeaAroundUs Initiative. The data selected is for years 2005-2019[36]. Further information can be found in both Velip, D. T., & Rivonker, C. U. (2015) and Prabhakar, R. P. (2011) for more comprehensive lists.

Category	Species	% of Total Catch
1. Perch-likes		
	Barracudas, sennets	0.87%
	Barramundi	<0.0001%
	Basses, groupers, hinds	1.05%
	Bigeyes	0.02%
	Black pomfret	0.46%
	Chinese silver pomfret	0.11%
	Doublespotted queenfish	<0.0001%
	Drums, croakers	5.27%
	Emperors, scavengers	0.41%
	False trevally	0.23%
	Flathead grey mullet	<0.0001%
	Goatfishes	0.98%
	Great barracuda	<0.0001%
	Grunters	<0.0001%
	Indian mackerel	6.78%
	Indian mackerels	0.03%
	Indo-Pacific king mackerel	0.45%
	Jacks, pompanos	2.47%
	Japanese threadfin bream	<0.0001%
	Jarbua terapon	<0.0001%
	Largehead hairtail	0.01%
	Mackerels, tunas, bonitos	0.46%
	Mullets, grey mullets	<0.0001%
	Narrow-barred Spanish mackerel	0.90%
	Queenfishes	<0.0001%
	Scads	2.58%
	Seabasses, hinds	<0.0001%
	Silver pomfrets	0.77%
	Silver sillago	<0.0001%
	Slipmouths, ponyfishes	2.55%
	Smelt-whitings	<0.01%
	Snappers	0.27%
	Streaked seerfish	<0.01%
	Threadfins	0.32%
	Threadfins, whiptail breams	4.57%
	Tigertooth croaker	<0.0001%

[36]http://www.seaaroundus.org/data/#/eez/356?chart=catchchart&dimension=taxon&measure=tonnage&limit=10

	Wahoo	<0.01%
	Yellowstripe scad	<0.01%
Category Total		**31.58%**
2. Herring-likes		
	Herrings, sardines, menhadens	2.42%
	Hilsa shad	1.35%
	Indian oil sardine	12.78%
	Wolf herrings	0.60%
Category Total		**17.15%**
3. Anchovies		
	Anchovies	4.44%
	Anchovies, round herrings	1.24%
	Garment anchovies	1.91%
	Thryssas	1.29%
Category Total		**8.88%**
4. Crustaceans		
	Commercial shrimps and prawns	5.71%
	Crabs, lobsters, shrimps	6.08%
	Acetes shrimps	<0.0001%
	Banana prawn	<0.01%
	Flathead lobster	<0.0001%
	Giant tiger prawn	<0.01%
	Green tiger prawn	<0.01%
	Indo-Pacific prawns	<0.01%
	Indo-Pacific swamp crab	<0.01%
	Marine crabs, shrimps, lobsters nei	<0.0001%
	Sergestid shrimp	<0.01%
	Tiger prawns	<0.01%
Category Total		**11.81%**
5. Other Fishes & Invertebrates		
	Bombay-duck	3.64%
	Catfishes	2.44%
	Common pencil squids	0.02%
	Cuttlefishes	2.13%
	Daggertooth pike conger	<0.01%
	Eels, morays	0.31%
	Eeltail catfishes	<0.0001%
	Filefishes	0.42%
	Giant catfish	<0.0001%
	Greater lizardfish	<0.0001%

	Halfbeaks	0.17%
	Lizardfishes	0.01%
	Lizardfishes, sauries	1.84%
	Marine fishes nei	10.85%
	Octopuses	<0.01%
	Octopuses, pikas	0.22%
	Pike congers	<0.0001%
	Sea catfishes, coblers	<0.01%
	Sepia cuttlefishes	<0.0001%
	Squids	2.25%
	Squids, cuttlefishes, octopuses	0.15%
Category Total		**28.42%**
6. Flatfishes		
	Flatfishes	<0.01%
	Indian halibut	<0.01%
	Soles	1.40%
Category Total		**1.40%**
7. Sharks & Rays		
	Batoids, skates, rays, sawfishes	0.73%
	Granulated guitarfish	<0.0001%
	Honeycomb stingray	<0.0001%
	Requiem sharks	<0.0001%
	Sharks, rays, skates	0.65%
Category Total		**1.38%**
8. Tuna & Billfishes		
	Bullet and frigate tunas	0.30%
Category Total		**0.30%**
9. Molluscs		
	Clams	0.11%
	Clams, seasnails, squids, octopuses	<0.0001%
	Granular ark	<0.0001%
	Horse mussels	<0.0001%
	Sea snails	0.06%
	Venus clams	<0.0001%
Category Total		**0.18%**
10. Scorpionfishes		
	Flatheads	0.03%
Category Total		**0.03%**

11. Cod-likes		
	Unicorn cod	0.01%
Category Total		**0.01%**
Unspecified/Other		**2.78%**
Total		**100%**

Table 2 below attempts to coarsely categorise high risk species groups that are likely impacted via the Goa and Maharashtra trawl fishery to support scoring Part B clauses. This is in no way a definitive list, and for management purposes, it is anticipated that high risk species groups would be assessed differently – for example by the use of indicator species for monitoring and management purposes. The FAO publication 'Managing multispecies and multigear fisheries – a toolbox for scientists, managers and stakeholders'37, highlights the importance of using indicator species in multispecies fisheries to simplify the management of complex ecosystems. These indicator species would reflect the vulnerability of various species to overfishing and could be monitored to inform adaptive management actions. For instance, in the case of high-risk species such as sharks, rays, and guitarfish, monitoring their population trends could serve as an early warning system for broader ecosystem health. Additionally, by focusing on indicator species, management efforts can be concentrated on the most ecologically and commercially critical species, making it more feasible to implement harvest control rules and mitigate the impacts of the trawl fishery on the entire ecosystem.

Table 2. High risk species groupings for the Goa and Maharashtra trawl fishery

Species Group	Rationale for High-Risk Classification
Sharks and rays	Vulnerable due to slow growth, late maturity, and low reproductive rates. High fishing mortality is likely to cause population declines. Various species could be caught in the trawl fishery and are particularly susceptible to overfishing. A report by the IUCN puts 11% of Indian sharks, rays and chimaeras at high risk of extinction[38].
Guitarfish *(Rhinobatidae/Rhinidae*)	Critically endangered or vulnerable species, with high susceptibility to bottom trawling due to their benthic nature. Their slow growth and low reproductive rates make them highly vulnerable to overfishing. The critically endangered granulated guitarfish[39] is one of the species in this group.
Threadfin breams	High commercial value species. Overfishing, particularly of juveniles, is a significant concern in multispecies trawl fisheries[40].
Crustaceans (Shrimps, Crabs, etc.)	Essential for ecosystem balance and commercially valuable. High fishing pressure, especially during spawning periods, makes them vulnerable to overexploitation.

[37] Leadbitter D, Fulton EA, Kulanujaree N, Noranarttragoon P, Nguyen KB, Phoonsawat R, Porobic J, Sainsbury K, Staples D, Vu VH and Ye Y (2023). Managing multispecies and multigear fisheries – a toolbox for scientists, managers and stakeholders. FAO Technical Guidelines (to be published)

[38] Pacoureau, N., Rigby, C.L., Kyne, P.M. *et al.* Half a century of global decline in oceanic sharks and rays. *Nature* 589, 567–571 (2021). https://doi.org/10.1038/s41586-020-03173-9

[39] https://www.fishbase.se/summary/Glaucostegus-granulatus

[40] Balachandran, R., Zacharia, P. U., Purushottama, G. B., Sudarsan, K. S., Shafeeque, M., Kumar, R. R., Varghese, E., Joseph, A., Rahul, R., Kishore, N., Bright, R. P., Seetha, P. K., & George, G. (2024). Assessing the Sustainability of threadfin bream fishery along South-eastern coast of the Arabian Sea: A comprehensive analysis of climate change impact and fishing frontiers. Aquaculture and Fisheries. https://doi.org/10.1016/j.rsma.2024.103418

Indian Mackerel	A high-risk species due to its importance in the local fishery. Vulnerable to overfishing, particularly as juveniles are often captured, which can disrupt population replenishment.
Indian Oil Sardine / Sardines	Vulnerable to overfishing due to high commercial demand for human consumption and fishmeal/oil production. Cyclical declines have been observed in landings, indicating vulnerability to both fishing pressure and environmental factors, requiring adaptive management.
Marine Turtles (Olive Ridley, Green, etc.)	Endangered species with high susceptibility to trawling gear. Often caught during migration and nesting periods.

B1: Management objectives and reference points	
	Mitigation score
The fishery has not identified high-risk species/species groups and has not developed any objectives or limit reference points to ensure that these species or groups of species are not being pushed past their PRI.	**0**
The fishery has identified some high-risk species/species groups and the fishery has informally adopted objectives and limit reference points for these species or groups of species.	8
The fishery has identified most of the high-risk species/species groups and the fishery has formally adopted objectives and limit reference points for all these species or groups of species.	17

Rationale:

Whilst this assessment has been able to identify very high level species groups that are considered to be "high-risk" as determined by table 2 above, there is no indication that the fishery has developed objectives or limit reference points to ensure that all these species or groups of species are not being pushed past their PRI or potential MMSY. While there are seasonal closures, gear restrictions and stock assessments conducted particularly for Indian Oil Sardine and Indian Mackerel, this does not constitute management objectives required to achieve MMSY outcomes which would be required through quantifiable specific indicators tied to management actions.

Therefore, the fishery scores the lowest mitigation score for this element.

B2: Data and information

	Mitigation score
Monitoring does not include indicators that can be used for evaluating management performance or conducting stock assessments for high-risk species/species groups.	**0**
Monitoring includes some indicators that can be used for evaluating management performance or stock assessments for some high-risk species/species groups.	8
Monitoring includes indicators that can be used for evaluating management performance and conducting stock assessments for all high-risk species/species groups.	17

Rationale:

As with B1, there are no indicators that the "high-risk" species described in table 2 above are monitored (baring IOS, Indian Mackerel and threadfin breams which have stock assessments based on fishing mortality rates, spawning stock biomass and recruitment levels, with methods including length-based assessments, and catch per unit effort), nor that appropriate quantifiable indicators are used to evaluate management performance of the species linked to fishery (trawl) specific objectives. Likewise, no formal stock assessments are found for these species (again, besides that of IOS, Indian Mackerel and Threadfin bream). It is also important to note here, that while stock assessments may have been conducted for many key commercial species, as described in detail in the FAO report 'Managing multispecies and multigear fisheries – a toolbox for scientists, managers and stakeholders'[41], that "due to the large number of species caught, and the range of gears catching them, results in too many species and gear interactions for a traditional stock assessment approach to accommodate, and these Single species assessments models also do not consider ecological interactions between species which creates a number of issues such as:

- the sum of single species MSYs is greater than the multispecies/multigear MSY, so management based on combined single species MSY can lead to overfishing of the ecosystem;
- focusing on one species often leads to overfishing or underfishing of other species, which are often not assessed and therefore cannot inform decision making for the fishery;
- single species assessment cannot evaluate the effects of increasing/reducing one species' catch on the other species; and
- fishery impacts on many species or ecosystem components are commonly ignored and so they are unable to provide information on either the impact of the fishery on the environment or the impact of the environment on the fishery resources."

Therefore, the fishery scores the lowest mitigation score for this element (0).

B3: Assessment of high-risk species/species groups

[41] Leadbitter D, Fulton EA, Kulanujaree N, Noranarttragoon P, Nguyen KB, Phoonsawat R, Porobic J, Sainsbury K, Staples D, Vu VH and Ye Y (2023). Managing multispecies and multigear fisheries – a toolbox for scientists, managers and stakeholders. FAO Technical Guidelines

	Mitigation score
There is no or unreliable assessment of the status of high-risk species/species groups.	**0**
The status of high-risk species/species groups has been recently assessed based on indirect evidence from indicators or proxies of stock status.	8
The status of high-risk species has been recently assessed using a scientifically sound methodology	17
Rationale: As with B1 and B2, it is unclear that monitoring, surveillance or assessment of the stock health for all "high-risk" species is considered. Therefore, the fishery scores the lowest mitigation score for this element.	

B4: Status of high-risk species/species groups	
	Mitigation score
The status of high-risk species/species groups with respect to the limit reference point is unknown.	**0**
The status of the high-risk species/species groups with respect to the limit reference point is known with a low level of certainty.	8
The fishery status with high-risk species/species groups with respect to the limit reference point is known with a high level of certainty.	17
Rationale: The status of most of the high-risk species/species groups is unknown, and so too are indicators that limit reference points are considered when implementing management measures. Therefore, the fishery scores the lowest mitigation score for this element.	

B5: Status of high-risk species/species groups	
	Mitigation score

There are no management measures in place aimed at preventing high-risk species/species groups falling below the PRI.	**0**
There are some management measures in place aimed at preventing specific species or groups of species, falling below the PRI.	8
There are management measures in place that are capable of achieving the objectives relating to high-risk species/species groups	17
Rationale: As there has been no PRI officially set for the "high-risk" species, there are subsequently no management measures in place that aim to prevent these species stocks from falling below it. Therefore, the fishery scores the lowest mitigation score for this element (0).	

B6: Management performance	
	Mitigation score
The fishery has failed to achieve the objectives it has set in relation to high-risk species/species groups OR there are no such objectives.	**0**
The fishery is making progress to meeting the objectives it has set in relation to high-risk species/species groups.	8
The fishery has achieved all the objectives it has set in relation to high-risk species/species groups.	17
Rationale: While this fishery may recognize some high-risk species (in terms of commercial value such as IOS, Indian Mackerel and Threadfin breams), it does not meet the more comprehensive, ecosystem-based approaches suggested for management performance/objectives for multispecies and multigear fisheries. The reliance on single-species management tools and the absence of multispecies reference points, like MMSY, indicate that objectives set in relation to high-risk species have not adopted the more holistic management needed to effectively manage high-risk species groups. As a result, there is no evidence that the fishery is making progress in managing these species sustainably, and the fishery scores the lowest mitigation score for this element (0).	

Part C: Reduction component of the catch

Part C of the catch criteria, looks at the component of the UoA fishery that supplies raw material that is reduced to fish meal/oil.

Mitigating measures include ensuring that the catch of the component is sustainable when the total UoA is fished to a defined TRP, and minimizing the catch of juvenile fish of higher-value species.

Part C: Total Mitigation Value	6
Part C: Catch Risk Value (100 minus mitigation value)	94
Part C: Catch Risk Rating	Very High (80-100)

C1: Management objectives (Catch of the reduction component)	
	Mitigation score
The fishery has not developed any objectives for the total catch (see Part A) or for the reduction component of the catch to ensure that the reduction component of the catch is maintained at levels capable of producing less than the TRP (e.g. multispecies maximum sustainable yield (MMSY) of the reduction component as qualified by relevant environmental and economic factors).	**0**
The fishery has developed objectives for the total catch (see part A) but NOT for the reduction component of the catch that indirectly results levels capable of producing less than the TRP (e.g. MMSY) of the reduction component as qualified by relevant environmental and economic factors).	6
The fishery has developed objectives for the total catch (see part A) AND for the reduction component of the catch that indirectly results levels capable of producing less than the TRP (e.g. MMSY) of the reduction component as qualified by relevant environmental and economic factors).	11
Rationale: The fishery under assessment is indiscriminate in the species that it catches and therefore, the reduction component of the fishery is largely variable depending on the catch of the day (Prabhakar, 2011). In India, bottom trawl fisheries contributed to 54% of the total number of marine fisheries in 2018 (SeaAroundUs, 2018). The main species caught in Indian waters consisted of Indian oil sardine (*Sardinella longiceps*) (4%), crustaceans (12%), Indian mackerel (*Rastrelliger kanagurta*) (8%), herring and sardines (7%) and a range of other species (SeaAroundUs, 2018). Therefore, it is estimated that these species will be frequently recurring in the catch of the fishery under assessment. Species named above are all high-value fish which are frequently used for human consumption. However, there is no fishery-specific record of what species eventually become low value bycatch (LVB) because this varies depending on the type of catch per fishing trip. However, studies in catch composition of trawl fisheries in India demonstrated that between 30-60% of total catch were low value bycatch (LVB) species (Dineshbabu, et al., 2022). This suggests that a large contribution to total catch rates from trawl fisheries could end up as the reduction component rather than for human consumption. More fishery-specific data is essential to demonstrate the species type, quantity	

(mass and number), and traceability of the LVB/reduction component species in order to improve the mitigation score provided here.

Trawl bycatch in a fishery in Goa demonstrated a contribution of 68% to the total catch composition, with 89% of that bycatch being from juveniles and trash species (Velip & Rivonker, 2015). A study conducted on the assessment of bycatch and discards in marine capture fisheries in Uran, Navi Mumbai, and Maharashtra, also identified 31 species of gastropods, 11 species of bivalves, three species of cephalopods, four species of polychaetes, and one species of sponges (Prabhakar, 2011). The study also demonstrates that trawling is one of the leading contributors to exploitation of marine resources and in particular marine species, due to the lack of selectivity.

There is little-to-no information about the species that could be considered LVB fish that would be used for fishmeal or other reduction components. Therefore, although the fishery has developed some independent measures for the total catch (part A) there is no consideration, or specific objectives in place for the reduction component. Furthermore, as described by the FAO technical guidelines (2023), operational objectives require a series of indicators that can be used to track and measure the effectiveness of the objective using quantitative or qualitative information – none of which could be found in this assessment. Further, typical MSY measures for multispecies fisheries are considered insufficient in accurately managing the different stocks associated with the catch. This is due to individual MSY measures being combined which results in a higher estimated MSY for the multispecies stock, which, as a result, leads to higher exploitation effort on that stock and could lead to detrimental losses. This therefore leads to this element meeting the lowest mitigation score.

References:

Velip, D. T. & Rivonker, C. . U., 2015. Trends and composition of trawl bycatch and its implications on tropical fishing grounds off Goa, India. *Regional Studies in Marine Science,* Volume 2, pp. 65-75.

Prabhakar, R. P., 2011. Assessment of bycatch and discards in marine capture fisheries from Uran (Raigad), Navi Mumbai, Maharashtra. *the Ecosan,* 5(3&4), pp. 105-109.

Dineshbabu, A. et al., 2022. *Bycatch in Indian trawl fisheries and some suggestions for trawl bycatch mitigation,* Kochi: Central Marine Fisheries Research Institute.

Leadbitter D, Fulton EA, Kulanujaree N, Noranarttragoon P, Nguyen KB, Phoonsawat R, Porobic J, Sainsbury K, Staples D, Vu VH and Ye Y (2023). Managing multispecies and multigear fisheries – a toolbox for scientists, managers and stakeholders. FAO Technical Guidelines.

SeaAroundUs, 2018. *SeaAroundUs: Catches by gear in the waters of India (mainland).* [Online] Available at: https://www.seaaroundus.org/data/#/eez/356?chart=catch-chart&dimension=gear&measure=tonnage&limit=10

C2: Management objectives (juvenile catch)	
	Mitigation score
The fishery has not developed any objectives relating to the catch of juvenile higher-value fish in the reduction component to ensure that the catch is having a minimal impact on total fish resource of the UoA.	**0**

The fishery has informally adopted objectives for the catch of juvenile higher-value fish in the reduction component to ensure that the catch is having a minimal impact on total fish resource of the UoA.	6
The fishery has formally adopted objectives for the catch of juvenile higher-value fish in the reduction component to ensure that the catch of juveniles is having a minimal impact on total fish resource of the UoA.	11

Rationale:

Low value bycatch (LVB) was described in the 2019 study by Mahesh et., al., as being the species caught in trawl multispecies fisheries that is mainly transported as raw material for fish meal production (Mahesh, et al., 2019). In this study, a range of juvenile finfish species were also described to be caught during the process of trawling in this fishery, including Indian mackerel (*Rastrelliger kanagurta*) and Indian scad (*Decapterus russelli*) contributing to 338 t and 1,397 t per year, respectively. As Indian mackerel also contributed 8% of the country's total fish landings in 2018 (SeaAroundUs, 2018), the impact of juvenile bycatch by trawl fisheries could eventually be detrimental to the mass of Indian mackerel that can be used for human consumption, due to a lack of recruitment to the adult population.

Likewise, the study by Prabhakar (2011), demonstrated that undersized/juvenile cepahlopods were commonly caught in marine capture fisheries in India, particularly from the cuttlefish (*Sepia officinalis*) and squid (*Loliga vulgaris*) families (Prabhakar, 2011). Juvenile crustaceans, including shrimp (*Acetes indicus*), and crabs, gastropods including sea snails, and bivalves, including clams (*Katelysia opima*) and scallop (*Chlamys singaporina*) were also commonly found to be captured in these fisheries. As described above, the impact of catching and retaining juvenile bycatch can lead to detrimental outcomes for the greater ecosystem. In a 2019 study, catch composition from a Maharashtrian trawl fishery demonstrated that of the fishery's bycatch, 52.44% were juvenile species (Ramkumar, et al., 2019).

In Goa, there is a mesh size limit that requires all mesh be no smaller than 24 mm for finfish fisheries and no smaller than 20 mm for prawn fisheries (Fisheries Department of Goa, 2023). This requirement is largely to prevent and mitigate against the bycatch of ETP species, but likewise will help to reduce the number of juvenile bycatch. In Maharashtra, there is a size limit for trawl gears being no less than 35 mm for mechanized vessels in the waters of Thank, Greater Mumbai, Raigad and Sindhudurg, and no less than 25 mm for any vessels operating in the waters of Ratnagiri (Rajesh, 2013). Likewise, the fishing bans that take place between 1st June – 31st July in Maharashtra and Goa have demonstrated to have a positive impact on the recruitment of dominant demersal species directly post-ban (Vivekanandan, et al., 2010), (Directorate of Fisheries: Government of Goa, 2023).

Therefore, there is evidence of some management measures and intentions for management in place within this fishery that aim to reduce the negative impact on juvenile species within the stock. However, these cannot be considered "objectives" as described by the FAO (2023), because there are no associated indicators that can be used to fully measure the objectives using quantitative nor qualitative information. Likewise, as there are no logbooks, dockside monitoring, or third-party observer data that could help to identify the number or mass of juvenile bycatch at this stage, the effectiveness of these management measures is largely unknown. Furthermore, as described above, there are large numbers of juvenile species bycatch associated with trawl fisheries, which will require equally high standards of management objectives to prevent overexploitation of these animals, which are currently absent. Therefore, this element scores a low mitigation score.

References:

Directorate of Fisheries: Government of Goa (2023) – email from the Directorate to the fishery explicitly outlining the details of the seasonal fishing ban between 1st June – 31st July.

Dineshbabu, A., Thomas, S. & Radhakrishnan, E., 2010. *Bycatch from trawlers with special reference to its impact on commerical fishery, off Mangalore,* s.l.: CMFRI.

Rajesh, K. M., 2013. *Fisheries Legislataion of India,* Mangalore: Central Marine Fisheries Research Institute (CMFRI).

Vivekanandan, E. et al., 2010. *Marine Fisheries Policy Brief - 2: Seasonal Fishing Ban,* Kochi: Central Marine Fisheries Research Institute.

Ramkumar, S. et al., 2019. Does the mechanised trawl target the non-targets from the commercial fishing grounds of northern Maharashtra, eastern Arabian Sea, India. *Journal of Entomology and Zoology Studies,* 7(6), pp. 1133-1140

C3: Data and information (reduction component catch)	
	Mitigation score
The fishery does not monitor any indicators relating to catch of the reduction component nor collect sufficient data and information to assess the current status of the reduction component.	**0**
The fishery monitors indicators relating to the catch of the reduction component with a low degree of certainty and frequency and collects some information that could be used to estimate the status of the reduction component through proxies.	6
The fishery monitors indicators relating to total catch with a high degree of certainty and frequency and also collects sufficient data and information to formally assess the current status of the reduction component.	11

Rationale:

This element of the pre-assessment has two components: the first being a review of the data and information that allow an assessment of the reduction component, and the second requires a review of the indicators involved in deciding management measures and harvest strategies that can be used to assess how well the target reference point is being achieved.

As mentioned in C1 and C2, there is no fishery-specific monitoring of the bycatch associated with this fishery, which is essential in understanding the composition of bycatch and the reduction component of these particular vessels within the fishery. Information is available from other research studies conducted on similar fisheries in India, and an estimate of the type of species caught by trawl fisheries in the Western coast of India is available. Catches of low value bycatch (LVB) are reported to contribute between 20-60% of the totally catch composition of trawl species (Mahesh, et al., 2019; Dineshbabu, et al., 2022). Information is, therefore, available to estimate the type of species that would be considered the reduction component for the fishery under assessment.

However, at this stage, the type of species that would become part of the reduction component varies between catches. Further, there is no information from the fishery about the current status of these resources. It is expected that during some fishing sets, some species may be considered as LVB that would not be considered as such in other sets. Therefore, explicit research and understanding about the status of the reduction component is unknown and this element is provided the lowest mitigation score.

References:

Dineshbabu, A., Thomas, S. & Radhakrishnan, E., 2010. *Bycatch from trawlers with special reference to its impact on commerical fishery, off Mangalore,* s.l.: CMFRI.

Mahesh, V. et al., 2019. Characterization of low value bycatch in trawl fisheries off Karnataka coast, India and its impact on juveniles of commercially important fish species. *Indian Journal of Geo Marine Sciences,* 48(11), pp. 1733-1742.

C4: Data and information (juvenile catch)

	Mitigation score
The fishery does not monitor any data on the catch of juvenile higher-value fish in the rection component.	**0**
The fishery monitors indicators relating to the catch of juvenile higher-value fish with a low degree of certainty and frequency.	6
The fishery regularly monitors the catch of juvenile higher-value fish with a degree of certainty	11

Rationale:

As mentioned in C1 and C2, there is no fishery-specific monitoring (independent and/or third-party data) of the bycatch associated with this fishery, which is essential in understanding the composition of bycatch, particularly of juvenile species. Previous research conducted on the catch composition of trawl fisheries operating in the Karnataka waters off the west coast of India were able to identify the types of juvenile species associated with these fisheries, including Indian mackerel and Indian scad (Mahesh, et al., 2019) - more information about species types can be found in C2. In a 2019 study, catch composition from a Maharashtrian trawl fishery demonstrated that of the fishery's bycatch, 52.44% were juvenile species (Ramkumar, et al., 2019). Information is available from other research studies conducted on similar fisheries in India, but these are for neighbouring or different coastal states that may differ in the species diversity and management measures.

The measures mentioned in C2 do not constitute "objectives" because there are no associated indicators necessary to measure the objectives. Therefore, in this pre-assessment for the fishery, a mid-level mitigation score cannot be met because the fishery does not "monitor indicators". Furthermore, there is only an estimated bycatch composition of juvenile species in trawl fisheries operating in Western India, and no fishery-specific data. therefore, this element can only meet the lowest mitigation score.

References:

Ramkumar, S. et al., 2019. Does the mechanised trawl target the non-targets from the commercial fishing grounds of northern Maharashtra, eastern Arabian Sea, India. *Journal of Entomology and Zoology Studies,* 7(6), pp. 1133-1140.

C5: Assessment and status of the resource (reduction component)

	Mitigation score
There is no recent or reliable assessment of the status of the fish resources in the reduction component of the catch.	**0**
The status of the fishery resource in the reduction component is based on indirect evidence from indicators or proxies of stock status.	6
The fishery resource status has been recently assessed using a scientifically sound methodology.	11

Rationale:

As mentioned in previous elements, the reduction component is largely unknown due to the variability in the catch composition associated with this fishery. However, estimates of the percentage composition to total catch rates conducted by Mahesh et., al., 2019 showed approximately 0.35 thousand tonnes (21%) of total trawl landings were marked as “low value bycatch” (LVB) to be used in fishmeal production (Mahesh, et al., 2019). Another study demonstrated that the catch rate of LVB species was anywhere between 30-60% (Dineshbabu, et al., 2022). Estimates of the species composition have already been disclosed in Part D of this pre-assessment, complete with productivity-susceptibility analyses (PSAs) that identified if any species were considered to be “high risk”, due to the lack of management and understanding of the stock status of these species. Therefore, it is likely that few of the species considered as the LVB species have reliable assessments of the stock status and thus this element meets the low mitigation risk score.

References:

Mahesh, V. et al., 2019. Characterization of low value bycatch in trawl fisheries off Karnataka coast, India and its impact on juveniles of commercially important fish species. *Indian Journal of Geo Marine Sciences,* 48(11), pp. 1733-1742.

Dineshbabu, A. et al., 2022. *Bycatch in Indian trawl fisheries and some suggestions for trawl bycatch mitigation,* Kochi: Central Marine Fisheries Research Institute.

C6: Assessment and status of the resource (juvenile catch)

	Mitigation score

There has been no consideration of the possible impact of the catch of juvenile higher-value fish on the status of the fishery resource of the total UoA.	0
There has been consideration of the possible impact of the catch juvenile highervalue fish, but no assessment has been made.	**6**
The impact of the catch of juvenile higher-value fish on the fishery resources in the UoA is known with a fair degree of accuracy	11

Rationale:

Previous research conducted on the catch composition of trawl fisheries operating in the Karnataka waters off the west coast of India were able to identify the types of juvenile species associated with these fisheries, including Indian mackerel and Indian scad (Mahesh, et al., 2019). Juvenile catch was also estimated to contribute to 47.5% of the catch of finfish by weight, which is a significant portion of the catch and enough to estimate that the associated risk to these species is high. The research article recommended the adoption of Juvenile Fish Excluder-Shrimp Sorting Device (JFE-SSD) be implemented in this trawl fishery, as well as a reduced fishing effort in critical fishing grounds to reduce the damages to marine ecosystems (Mahesh, et al., 2019). Another 2019 study conducted in the waters of Maharashtra in a shrimp trawl fishery further demonstrated a majority bycatch rate from juvenile species (52.44%) (Ramkumar, et al., 2019).

Therefore, there is significant information about the possible impact of the catch of juvenile higher value fish, but no true assessment has been made on the individual species contributing to the bycatch rates. Therefore, this element meets a mid-range mitigation score.

References:

Mahesh, V. et al., 2019. Characterization of low value bycatch in trawl fisheries off Karnataka coast, India and its impact on juveniles of commercially important fish species. *Indian Journal of Geo Marine Sciences,* 48(11), pp. 1733-1742.

Ramkumar, S. et al., 2019. Does the mechanised trawl target the non-targets from the commercial fishing grounds of northern Maharashtra, eastern Arabian Sea, India. *Journal of Entomology and Zoology Studies,* 7(6), pp. 1133-1140.

C7: Management measures and their effectiveness	
	Mitigation score
There are no management measures in place to control the catch of the reduction component nor the amount of juvenile higher-value fish taken.	**0**
There are management measures in place to control the catch of the reduction component and the amount of juvenile higher-value fish taken but are not effective.	6

There are management measures in place to control the catch of the reduction component and the amount of juvenile higher-value fish taken, which are effective.	11

Rationale:

As mentioned in C2, there are some measures in place to reduce the catch of juvenile species, including mesh size limits and seasonal fishing bans (Vivekanandan, et al., 2010). However, more work could be done to improve and add to the management measures and further reduce juvenile bycatch rate, including the suggestion made by Mahesh et., al., 2019 about the use of JFE_SSD and further closed areas. The estimated catch of juvenile species is approximately 50%, which is a significant portion of the total catch composition from trawl species in Karnataka (Mahesh, et al., 2019). Furthermore, the information described in the other 2019 study by Ramkumar et., al. highlighted a contribution of 52.44% of juvenile species to total bycatch in shrimp trawl fisheries operating in Maharashtra. The unselective nature of this fishing method is detrimental to species diversity and the health of the stocks that depend on the juvenile recruitment. Similarly, the measures described do not constitute as "objectives" defined by the FAO (2023) because there are no associated indicators used to measure the objective using quantitative and/or qualitative information.

For the reduction component of the fishery, the main measure used to prevent the interaction with LVB is the trawl fishing ban between June and July. However, there are no indicators used to measure the trawl fishing ban in the monsoon season, and with the varied nature of the catch composition, there is no way to fully determine the extent to which this trawl ban is effective. There has also been no data supplied at this time that can be used to draw reference to the temporal trends of bycatch rate and composition for the vessels under assessment. This would be useful to understand the impact, if any, of the trawl fishing ban.

Therefore, more information is required to evidence whether the measures in place are truly effective. Thus, this element meets the lowest mitigation score.

References:

Mahesh, V. et al., 2019. Characterization of low value bycatch in trawl fisheries off Karnataka coast, India and its impact on juveniles of commercially important fish species. *Indian Journal of Geo Marine Sciences,* 48(11), pp. 1733-1742.

Vivekanandan, E. et al., 2010. *Marine Fisheries Policy Brief - 2: Seasonal Fishing Ban,* Kochi: Central Marine Fisheries Research Institute.

C8: Management performance (reduction component)	
	Mitigation score
The fishery has failed to achieve the objectives it has set in relation to the reduction component OR there are no such objectives.	**0**
The fishery is making progress to meeting the objectives it has set in relation to the reduction component of the catch.	6

The fishery has achieved the objectives it has set in relation to the reduction component of the catch.	11

Rationale:

One of the only 'objectives' available for the reduction portion of the catch from trawl fisheries operating in west India, is the trawl fishing ban between 1st June to 31st July (Directorate of Fisheries: Government of Goa 2023). The fishing ban during this monsoon period was introduced in 1992 in an attempt to curb the rate of exploitation of commercially important species during their breeding and pre-recruitment period. A study highlighted that the decadal average marine landings during the pre-ban years was 3.91 lakh tonnes, which increased to 4.04 lakh tonnes in the post-ban period. This represents a, albeit small, increase in the landings. Whilst this cannot be solely attributed to the fishing ban, it is considered to be influenced by the period of limited ecosystem disturbance (Salim, et al., 2010). However, the most recent ban period in 2024 reported that in Goa, trawl vessels from neighbour states, allegedly Maharashtra and Karnataka, have been fishing in their waters. Whilst these infractions have been reported, the article highlights the lack of action taken on these vessels (O Heraldo, 2024).

There is no information about the measures or objectives in place within the specific fishery under assessment related to the reduction component of the catch. Whilst there is the seasonal fishing ban that relates to all trawl fisheries, this does not reduce the amount of bycatch or contribution to the reduction component in the fishery throughout the rest of the year. There is little information about the type of species caught and considered to be part of the reduction component of the fishery under assessment as this is variable depending on the fishing trip. Therefore, there is no real understanding of the contribution of the fishery under assessment to the reduction species considered to be low value bycatch (LVB) nor whether progress is being made within these objectives. Thus, this element meets the low mitigation score.

References:

Vivekanandan, E. et al., 2010. *Marine Fisheries Policy Brief - 2: Seasonal Fishing Ban,* Kochi: Central Marine Fisheries Research Institute.

Rajesh, K. M., 2013. *Fisheries Legislataion of India,* Mangalore: Central Marine Fisheries Research Institute (CMFRI).

Directorate of Fisheries: Government of Goa (2023) – email from the Directorate to the fishery explicitly outlining the details of the seasonal fishing ban between 1st June – 31st July.

O Heraldo, 2024. Intrusion of trawlers despite fishing ban alarms Goan fishermen. *O Heraldo*, 7 June.

Pandey, K., 2024. *Marine fisheries policy moving against the current of scientific recommendations,* s.l.: Mongabay.

Salim, S. S., Vijayan, H. & Sandhya, K. M., 2010. Trade-off between monsoon trawl ban and the livelihood of trawl labourers in Maharashtra. *Indian Journal of Fisheries,* 57(2), pp. 67-71.

C9: Management performance (juvenile catch)	
	Mitigation score
The fishery has failed to achieve the objectives it has set in relation to juvenile catch OR there are no such objectives.	**0**

The fishery is making progress to meeting the objectives it has set in relation to the juvenile catch.	6
The fishery has achieved the objectives it has set in relation to the juvenile catch	11

Rationale:

There is no fishery-specific data about the type of juvenile species caught by the vessels under this pre-assessment. The research articles used to demonstrate the types of juvenile species contribution to catch composition of trawl fisheries operating in the west coast of India were by Prabahakar et., al. (2011), Ramkumar et., al (2019), and Mahesh et., al. (2019). The 2011 study was conducted in Maharashtra but is outdated, whereas the 2019 studies represent a more temporally accurate estimation of the types of juvenile species consistently found in trawl bycatch. However, despite the difference in age of research, there were common findings across all. Including that the majority of juvenile species caught by trawl fisheries derived from Indian mackerel, sardines, bream, and flatfish.

However, information on the management measures in place to reduce the catch of juvenile species is limited. Mesh size restrictions and the seasonal fishing ban are the main objectives determined during this pre-assessment. As mentioned in C8, a study highlighted that the decadal average marine landings during the pre-ban years was 3.91 lakh tonnes, which increased to 4.04 lakh tonnes in the post-ban period. This represents a, albeit small, increase in the landings. Whilst this cannot be solely attributed to the fishing ban, it is considered to be influenced by the period of limited ecosystem disturbance (Salim, et al., 2010). However, this study failed to describe the type of species that was contributing to this increase in landings post-ban implementation. The research conducted by Mahesh et., al (2019) also recommended that trawl vessels adopt Juvenile Fish Excluder-Shrimp Sorting Devices (JFE-SSD) and reduce their efforts to reduce the impact on the ecosystem.

Finally, there are no such management “objectives” actually in place for this multispecies trawl fishery assessed in this pre-assesmsnet. Under the FAO (2023), management objectives require a series of indicators that can be used to measure the objectives using quantitative and/or qualitative information. No such indicators could be seen for these measures in place by the Indian fisheries management. Therefore, this element can only meet the lowest mitigation score.

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References

Mahesh, V. et al., 2019. Characterization of low value bycatch in trawl fisheries off Karnataka coast, India and its impact on juveniles of commercially important fish species. *Indian Journal of Geo Marine Sciences,* 48(11), pp. 1733-1742.

Prabhakar, R. P., 2011. Assessment of bycatch and discards in marine capture fisheries from Uran (Raigad), Navi Mumbai, Maharashtra. *the Ecosan,* 5(3&4), pp. 105-109.

Ramkumar, S. et al., 2019. Does the mechanised trawl target the non-targets from the commercial fishing grounds of northern Maharashtra, eastern Arabian Sea, India. *Journal of Entomology and Zoology Studies,* 7(6), pp. 1133-1140

Section 2b: Endangered, threatened and protected species groups

The second of the four Fishery Risk Ratings relates to the impacts of the fishery on ETP species.

ETPs, as defined by MarinTrust are Endangered, Threatened and Protected (ETP) species, are defined for the purposes of the MarinTrust assessment as those which either:

- are categorised by the IUCN as Endangered or Critically Endangered; or
- appear in the CITES appendices

Species listed in national (state/province/local) legislation as being depleted, or at increased risk of extinction and usually subject to conservation measures, are also considered as ETPs

Mitigation measures include monitoring and understanding the effects of the fishery on ETP species, minimising interactions, and mitigating other potential impacts.

Total ETP Mitigation Value	24
ETP Risk Value (100 minus mitigation value)	76
ETP Risk Rating	High (60-80)

T1: ETPs are known	
	Mitigation score
There is no list of ETPs and fishers are unaware of the existence of ETPs.	**0**
Some ETPs have been listed and fishers are familiar with these.	12
A full list of ETPs has been formally adopted and fishers are familiar with all these ETPs.	25

Rationale:

There is no specific reference to ETP species bycatch in this fishery. However, ETP species that inhabit the coastal waters of India are well researched and described.

<u>*Elasmobranchs*</u>

There are many shark and ray species that inhabit the coastal waters of India, including the whale shark (*Rhincodon typus*), tiger shark (*Galeocerdo cuvier*), hammerhead sharks (*Sphyrna* spp.), bull shark (*Carcharhinus leucas*), pigeye shark (*C. amboinensis*) (Karnad, et al., 2020), silky shark (*C. falciformis*), oceanic whitetip shark (*C. longimanus*), pointed sawfish (*Anoxypristis cuspidata*), Ganges stingray (*Himmamtura fluviatilis*), largetooth sawfish (*Pristis microdon*), longcomb sawfish (*Pristis zijsron*), giant guitarfish (*Rhynchobatus dijidensis*), porcupine ray (*Urogymus asperrimus*) (Bhagyalekshmi & Biju Kumar, 2021). All of the rays listed above are protect under the Indian Wildlife Protection Act

There is an active elasmobranch fishery in West Bengal. The landings of pelagic sharks in India during 2020 were estimated at 9,927 tonnes. The west coast (FAO Area 51) accounted for 47.85 percent, and the rest (52.15%) from the east coast (FAO Area 57).

Turtles

There are five main species of turtle that inhabit the coastal waters of India, including the Olive Ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and green turtle (*Chelonia mydas*)

The government of India has given high priority to conserve the sea turtles and all the five species are protected as they are placed in Schedule I of the Indian Wildlife (Protection) Act 1972 as per the Amendments made to the Schedule in September 1977.

Cetaceans

Cetacean species most frequently found in Indian coastal waters include the Indo-pacific humpback dolphin (Sousa chinensis), spinner dolphin (*Stenella longirostris*), long beaked common dolphin (Delphinus capensis), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), Finless Porpoise (*Neophocaena phocaenoides*), and Risso's Dolphin (Grampus griseus). The Short-finned Pilot Whale (Globicephala *macrorhynchu*) and Sperm Whale (Physeter microcephalus) are also found in these waters. However, it should be noted that the interaction between these animals and fisheries operating in overlapping waters is typically within gillnet and purse seine fisheries, rather than trawl fisheries (Joseph, et al., 2021).

Seabirds

There are thought to be no interactions between the trawl fishery and ETP seabirds.

Overall, there is sufficient information about the types of ETP species that inhabit the area in which the fishery operates. The fishery provided the assessor with a lot of the information and sources used to complete this assessment, indicating that the fishery is therefore aware of the potential interaction rate with these animals. However, there is no indication that the fishers themselves are "aware". If there was some evidence of fisher training in the identification of specific ETP species, this might help increase the score. However, in absence of this, this element cannot surpass the lowest mitigation score.

References:

India Wildlife (Protection) Act (1972): a1972-53.pdf (indiacode.nic.in)

Karnad, D., Sutaria, D. & Jabado, R., 2020. Local drivers of declining shark fisheries in India. *Kung L. Vetenskaps Akademien,* Volume 49, pp. 616-627.

Joseph, R., Dhiju, P. H. & Edwin, L., 2021. *Cetacean fishery interaction during operation of fishing systems of India,* Kerala: Fishery Technology.

Bhagyalekshmi, V. & Biju Kumar, A., 2021. Bycatch of non-commercial batoids in the trawl fishery of south India: Status and conservation prerequisites. *Regional Studies in Marine Science,* Volume 44, p. 101738.

T2: Interaction with ETPs are known	
	Mitigation score
There are no observations or records pertaining to ETPs interaction with the fishery.	0
There are ad hoc observations or records of interactions with ETPs.	**12**
There are reliable and regular records of ETP interactions.	25

Rationale:

No fishery-specific records nor observations pertaining to ETP interactions with the fishery could be identified at this stage of the assessment. Perhaps observer data, or vessel logbook data could help to understand more about the ETP bycatch and interaction rate of the fishery in the future.

Cetaceans

However, despite a lack of fishery-specific information, the expected interaction rate of trawl fisheries in India with ETP species are well researched and documented. Research conducted in 2021 observed dolphin interactions with Indian fisheries and noticed that about 15.3% of fisheries reported on dolphin bycatch across gillnet, purse seine and trawl fisheries (Joseph, et al., 2021).

Elasmobranchs

Research conducted by the Central Marine Fisheries Research Institute (CMFRI) highlighted that mechanised trawl fisheries contribute to the greatest proportion of ray and skate bycatch (60% and 72%, respectively) compared to other fishing gear (including purse seine and gillnets) (BOBP-IGO, 2021) . Furthermore, the research demonstrated that in the Maharashtra and Goa region, trawl fisheries contribute to 41.8% and 56.2%, respectively of the total shark landings against all other fishing gear types. Therefore, it is expected that the ETP interaction rate of this fishery is potentially high.

Turtles

Furthermore, as with sharks, despite there being no fishery-specific data on turtle bycatch incidents, previous research conducted on Indian fisheries' interaction with turtles demonstrates that gillnets and trawl fisheries provide the greatest threat to turtle bycatch (Prakash, et al., 2016) .

Therefore, because there are no fishery-specific reports about the ETP species interaction rate, nor information about the type of species that the fishery interacts with directly (through verified, third-party data), a high score for this element cannot be met. However, as there are detailed research reports on the ETP species bycatch incident rate across generalised Indian fisheries, a mitigation score of 12 can be met.

References:

Prakash, R. R., Boopendranath, M. R. & Vinod, M., 2016. Performance evaluation of turtle excluder device off Dhamra in Bay of Bengal. *Fishery Technology,* Volume 53, pp. 183-189.

BOBP-IGO, 2021. *National Plan of Action for Conservation and Management of Sharks in India.,* Chennai: Bay of Bengal Programme Inter-Governmental Organisation.

Joseph, R., Dhiju, P. H. & Edwin, L., 2021. *Cetacean fishery interaction during operation of fishing systems of India,* Kerala: Fishery Technology.

T3: Interaction effects	
	Mitigation score
It is unknown whether the fishery has a significant negative effect on ETPs.	**0**
There is some evidence to show that the fishery has no negative effect on ETPs	12

There is substantial evidence to show that fishery has no negative effect on ETPs.	25

Rationale:

Using the information provided via the research reports referenced in T2, including the bycatch rate of ETP elasmobranch, cetacean, and turtle species, it is estimated that the ETP species interaction rate for the fishery under assessment will be high. The nature of trawl fisheries means that the gear is highly unselective, and is also submerged in the water for extended periods of time, during which, drowning or suffocation of ETP species is likely.

In India, there have been studies conducted on the effectiveness of turtle excluder devices (TEDs) integrated into the net construction, which provides an opportunity for these animals to escape if they are incidentally caught. IA study conducted on 15 trawls, each catching one turtle during the setting, 100% of the turtles caught were able to escape the net through the TED (Prakash, et al., 2016). Therefore, if the fishery is using TEDs in the nets used during operations, there is some evidence to show that the fishery is having no effect on ETPs. However, at this stage, no information could be found that the vessels in the fishery are using TEDs.

There is no third-party observer data that records incidents of bycatch in this trawl fishery. There were also no fishery-specific logbooks or information on specific ETP bycatch rates for the vessels under assessment at this stage. Therefore, without further information on the rates of ETP catch, there is no evidence to show that the fishery has no negative effect on ETPs. Thus, this element meets the lowest mitigation score.

References:

Prakash, R. R., Boopendranath, M. R. & Vinod, M., 2016. Performance evaluation of turtle excluder device off Dhamra in Bay of Bengal. *Fishery Technology,* Volume 53, pp. 183-189.

T4: Management measures and their effectiveness	
	Mitigation score
The fishery is known to interact with ETPs AND:	
There are no strategies or measures in place to minimise mortality of ETPs.	0
There are some strategies and measures in place to protect ETP species, and to mitigate the impacts of the fishery on ETP species, but they are not effective.	**12**
There are comprehensive strategies and measures in place to protect ETP species, and mitigate the impacts of the fishery on ETPs, which are effective	25

Rationale:

<u>Cetaceans</u>

Besides the Wildlife (Protection) Act 1972, the following Indian acts and global conventions are intended to directly or indirectly protect marine mammals:

- The Indian Fisheries Act, 1857

- The Indian Forest Act, 1927
- The Wildlife (Protection) Act, 1972
- The Wildlife (Transactions and Taxidermy) Rules, 1973
- The Wildlife (Stock Declaration) Central Rules, 1973
- Terrestrial water, continental shelf, Exclusive Economic Zone and other marine zones Act, 1976
- Water (Prevention and control of pollution) Act, 1977
- Maritime Zones of India (Regulation and fishing by foreign vessels) Act, 1980
- The Wildlife (Protection) Licensing (Additional matters for consideration) Rules, 1983
- Environmental (Protection) Act, 1986
- Coastal Zone Regulation Notification, 1991
- Wildlife (Protection) Amendment Act, 1991
- The Wildlife (Protection) Rules, 1995
- National Biodiversity Act, 2002

Research conducted in 2021 observed dolphin interactions with Indian fisheries and noticed that about 15.3% of fisheries reported on dolphin bycatch across gillnet, purse seine and trawl fisheries (Joseph, et al., 2021). There are no fishery-specific measures in place to prevent or reduce the cetacean bycatch rate. Whilst the animals are protected under the aforementioned Acts, without further fishery-specific data regarding the rate of bycatch of cetaceans in these vessels, this element cannot meet a high mitigation score.

Sharks and Rays

The Guidance on National Plan of Action for Conservation and Management of Sharks (NPOA-Sharks) has been prepared by the Bay of Bengal Programme Inter-Governmental Organisation in collaboration with the Bay of Bengal Large Marine Ecosystem Project (Phase 1) (Kizhakudan, et al., 2015). In India, the following three species of marine sharks are listed under Schedule I of the Indian Wildlife (Protection) Act, 1972:

1. Whale shark
2. Pondicherry shark
3. Spear tooth shark

Further, with a view to stop the hunting of sharks and to enable the enforcement agencies to monitor the illegal hunting/poaching of the species of elasmobranchs listed in Schedule I of the Wild Life (Protection) Act, 1972, the then Ministry of Environment and Forest vide its Policy Circular No. F. No. 4-36/2013 WL dated 25th of August 2013 has prohibited the removal of shark fins on board the vessels in the sea. The policy also prohibits any possession of shark fins that are not naturally attached to the body of the shark. In addition, the Ministry of Commerce, Government of India has also notified vide its Order No. 110 (RE. -2013)/2009- 2014 dated 6 February 2015 prohibiting export of shark fins of all species of sharks. The Guidance on National Plan of Action – Sharks, India, published in (2015) outlined a series of objectives to ensure that the management of sharks in Indian waters is monitored and maintained (Kizhakudan, et al., 2015). One of the objectives was to understand more about the abundance, biology and current fishery impacts of sharks, as well as gather data on the utilisation of sharks and shark by-products.

Turtles

In 2018, the South Indian states designated a trawl ban period that overlaps with the spawning period of common fish species. The ban was proposed to span 30 days over the Southwest and 30 days over the

Northeast monsoon period. Both of these periods have demonstrated to be the spawning periods for pelagic and demersal fish species, respectively. Since then, annual total EEZ fishing bans have been implemented in the country spanning, collectively, 122 days from April 15th – June 14th (east coast), and June 1st – July 31st (west coast). These bans aim to give heavily exploited resources and ecosystems a chance to recover, ensuring long-term sustainability. These regulations, though sometimes debated in their effectiveness, provide critical respite to heavily exploited resources and ecosystems.

Therefore, there are some measures in place to protect ETP species, and to mitigate the impacts of the fishery on ETP species, but there is no evidence that they are effective. Without third-party observer data or evidence about the catch rate of ETP species within this specific fishery under assessment, this element cannot meet a high mitigation score.

References:

Kizhakudan, S. J. et al., 2015. *Guidance on National Plan of Action for Sharks in India,* Kochi: CMFRI Marine Fisheries Policy Series No. 2.

The Wild Life (Protection) Act, 1972 - Wildlife Protection Act, 1972.pdf (tribal.nic.in)

Section 2c: Habitats

The third of the four Fishery Risk Ratings relates to the impacts of the fishery on critical habitats.

ETPs, as defined by MarinTrust are Endangered, Threatened and Protected (ETP) species, are defined for the purposes of the MarinTrust assessment as those which either:

- are categorised by the IUCN as Endangered or Critically Endangered; or
- appear in the CITES appendices

A critical habitat is one that is essential to maintaining the integrity of an ecosystem, species or assemblages of species. For a species, it is the habitat that is important for the spawning and survival of juvenile fish, which if degraded, results in a decline the abundance of fish (in a tropical system these are usually mangroves, seagrasses and coral reefs).

Mitigation measures include monitoring and understanding the effects of the fishery on critical habitats, protecting critical habitats, and mitigating other potential impacts

Total Habitats Mitigation Value	32
Habitats Risk Value (100 minus mitigation value)	68
Habitats Risk Rating	High (60-80)

H1: Habitat consideration	
	Mitigation score
There is no consideration of potential critical habitat interactions in the management of the fishery.	0
There is some consideration of potential critical habitat interactions in the management of the fishery.	**16**
There is full consideration of potential critical habitat interactions in the management of the fishery	33

Rationale:

Trawl fishing has been noted as being one of the largest and most significant contributors to human-caused physical disturbances and destruction of ecosystems (Dineshbabu, et al., 2010; Thomas, et al., 2017). The 2017 study by Thomas et., al. highlighted the impact of benthic trawling on demersal ecosystems as a result of habitat destruction. For example, in areas that are highly concentrated in coral reefs, even minute impacts to the species heterogeneity as a result of destruction of more fragile organisms can lead to large implications for the ecosystem that is supported by the corals (Thomas, et al., 2017). These fishing gears are capable of making physical, biological and topographical changes to the seabed which can lead to a reduced species diversity.

In the fishery's target area, Maharashtra and Goa, there are a range of critical and sensitive marine habitats occupying the EEZs, including; mangroves, mudflats, and coral reefs (Parvez Al Usmani & Ansari, 2020; Larka, et al., 2021). Around Goa, studies conducted on the surrounding marine ecosystems and habitats

demonstrate that these areas are used as critical fish nurseries, many of which are commercially valuable to the county's fishing industry (Parvez Al Usmani & Ansari, 2020). The main component of these fish nurseries is the vast seagrass bed that occupies the Goan coastline, composed of two species (*Halophila beccarii* and *H. ovalis*). Mangroves are also widely reported across the Goan coast, contributing to 8486 ha, and whilst concentrated in a smaller area around Grande Island, 24 species of coral are also found in these waters. Therefore, there are a significant number of important and sensitive marine habitats within the coastal waters in which the vessels in this fishery operate.

The Government of India Ministry of Fisheries, Animal Husbandry, and Dairying, Department of Fisheries annually implements a uniform fishing ban on all vessels operating in the Indian exclusive economic zone (EEZ) beyond territorial waters on the East coast (including west Bengal, Odisha, Andhra Pradesh, Puducherry, Tamil Nadu, Andaman, & Nicobar Islands) and West coast (including Gujarat, Daman & Diu, Karnataka, Goa, Maharashtra, Kerala, Tamil Nadu and Lakshadweep Islands) in the following dates:

1. East coast – from 15th April, to 14Th June (both days inclusive (61 days)
2. West coast – from 1st June to 31st July (both days inclusive (61 days) (Directorate of Fisheries, 2023)

These bans aim to give heavily exploited resources and ecosystems a chance to recover, ensuring long-term sustainability. These regulations, though sometimes debated in their effectiveness, provide critical respite to heavily exploited resources and ecosystems.

Therefore, as there is well-defined research on the types of marine habitats that occupy the coastal waters of both Goa and Maharashtra, this element can meet a mid-range score for the mitigation score requirement. If there was more specific information about the actual fishing area and the habitats that the fishery encounters, via vessel monitoring systems (VMS) or tracking maps, this score may be able to increase.

References

Directorate of Fisheries: Government of Goa (2023) – email from the Directorate to the fishery explicitly outlining the details of the seasonal fishing ban between 1st June – 31st July.

Parvez Al Usmani, S. M. & Ansari, Z., 2020. Status of coastal marine biodiversity of Goa and challenges for sustainable management - An overview. *Journal of Ecophysiology and Occupational Health,* 20(3&4), pp. 222-231.

Larka, W., Ramkumar, S. & Gopalakrishnan, A., 2021. Marine fishereis and biodiversity management in Maharashtra: status, challenges, and opportunities. *Indian Journal of Animal Sciences,* 91(2), pp. 91-95.

Dineshbabu, A., Thomas, S. & Radhakrishnan, E., 2010. *Bycatch from trawlers with special reference to its impact on commerical fishery, off Mangalore,* s.l.: CMFRI.

Thomas, L. et al., 2017. An assessment on the impact of bottom trawling to the demersal fisheries and benthic diversity of Andaman Islands, India. *Regional Studies in Marine Science,* Volume 10, pp. 20-26.

H2: Information on the impact on critical habitats	
	Mitigation score
There is no information on the impacts of the fishery on the critical habitats it encounters.	0
There is limited information collected on the impacts of the fishery on the main critical habitats.	**16**

There is comprehensive information collected on the impacts of the fishery on main and critical habitat	33

Rationale:

Third-party research and information about the type of impact that benthic trawl fisheries have on the seafloor and other marine habitats has been well-documented and described in the rational for H1. However, as there is no fishery-specific information about the actual locations in which the vessels operate, via VMS or other vessel tracking data, the mitigation score can only meet a mid-range score. With more specific information about the fishery's impact on the habitats that it encounters, the mitigation score may be able to increase.

H3: Management measures	
	Mitigation score
If the fishery is known to interact with critical habitats AND:	
There are no measures in place to minimise and mitigate negative impacts.	**0**
There are some measures in place to minimise and mitigate negative impacts, but they are not effective.	16
There are comprehensive measures in place to minimise and mitigate negative impacts that are effective.	33

Rationale:

It is unknown as to whether the fishery interacts with critical habitats, therefore, this element will be scored to ensure that this assessment maintains a precautionary nature. There is no information available using the resources provided by the fishery that there are measures in place to minimise and mitigate negative impacts on marine habitats. Therefore, this element can only achieve the lowest mitigation score.

Section 2d: Ecosystems

The third of the four Fishery Risk Ratings relates to the impacts of the fishery on ecosystems. Mitigation measures include monitoring and understanding the effects of the fishery on ecosystems, protecting ecologically important species, and mitigating other potential impacts.

Total Ecosystems Mitigation Value	24
Ecosystems Risk Value (100 minus mitigation value)	76
Ecosystems Risk Rating	High (60-80)

E1: Ecosystem consideration	
	Mitigation score
The impact of the fishery on the broader ecosystem within which the fishery occurs is not considered in management.	**0**
The impact of the fishery on the broader ecosystem within which the fishery occurs is considered in a superficial way in management.	12
The impact of the fishery on the broader ecosystem within which the fishery occurs is considered fully in management.	25

Rationale:

The Government of India Ministry of Fisheries, Animal Husbandry, and Dairying, Department of Fisheries annually implements a uniform fishing ban on all vessels operating in the Indian exclusive economic zone (EEZ) beyond territorial waters on the East coast (including west Bengal, Odisha, Andhra Pradesh, Puducherry, Tamil Nadu, Andaman, & Nicobar Islands) and West coast (including Gujarat, Daman & Diu, Karnataka, Goa, Maharashtra, Kerala, Tamil Nadu and Lakshadweep Islands) in the following dates:

1. East coast – from 15th April, to 14Th June (both days inclusive (61 days)
2. West coast – from 1st June to 31st July (both days inclusive (61 days) (Directorate of Fisheries: Government of Goa, 2023)

There are similar bans that are implemented at the state level for both Goa and Maharashtra for the same time period covering the state waters up to 12 nautical miles, so in effect all trawlers under the unit of assessment would be banned from fishing for this 61 day period each year.

These bans aim to give heavily exploited resources and ecosystems a chance to recover, ensuring long-term sustainability. These regulations, though sometimes debated in their effectiveness, provide critical respite to heavily exploited resources and ecosystems.

However, there is minimal information about the specific habitats interacted with by the fishery and vessels. Therefore, the extent to which the fishing gear interacts with the sensitive habitats listed in H1, is

largely unknown. As also mentioned in H1, these sensitive habitats are critical for a range of different ecosystem functions and services, not least being available habitat for other species, including juveniles that will be recruited into the larger stock of target species. Therefore, without fishery-specific information about the operational area of the vessels, the highest mitigation score for this element cannot be met.

The Ecopath with Ecosim study of the Zuari estuary demonstrates how dynamic modelling can provide insights into how various fishing policies impact broader ecosystem recovery over time (G.B Sreekanth et al., (2021). In that study, different fishing management scenarios were simulated, revealing that ecosystem-wide measures, such as reducing fishing effort or banning indiscriminate fleets, contributed significantly to the recovery of fish stocks and ecosystem health. The model also demonstrated the importance of considering the broader ecosystem when implementing management practices, however it is not understood how these studies are incorporated into such management

While the current fishery benefits from the national and state fishing bans, the lack of fishery-specific data in terms of operational areas and direct ecosystem interactions remains a limitation, as indicated above. Implementing more sophisticated ecosystem modeling, like the Ecopath with Ecosim model, could help guide management in this fishery toward a more holistic understanding of ecosystem impacts, further informing protective measures.

Therefore, as a precautionary measure, the lowest mitigation score is provided.

References:

Directorate of Fisheries: Government of Goa (2023) – email from the Directorate to the fishery explicitly outlining the details of the seasonal fishing ban between 1st June – 31st July.

Parvez Al Usmani, S. M. & Ansari, Z., (2020). Status of coastal marine biodiversity of Goa and challenges for sustainable management - An overview. *Journal of Ecophysiology and Occupational Health,* 20(3&4), pp. 222-231.

Sreekanth, G. B., Chakraborty, S. K., Jaiswar, A. K., Zacharia, P. U., & Mohamed, K. S. (2021). Modeling the impacts of fishing regulations in a tropical Indian estuary using Ecopath with Ecosim approach. Environment, Development and Sustainability, 23, 17745–17763.

E2: Impacts on the ecosystem structure and function	
	Mitigation score
There is no information available on the ecosystem structure/biodiversity and function.	0
There is only ad-hoc information about the impact of the fishery on the ecosystem, especially with respect to structure/biodiversity and function.	**12**
The impact on the ecosystem is well known, especially with respect to structure/biodiversity and function.	25
Rationale:	

Trawl fishing is one of the most physically invasive forms of commercial fishing as a result of the heavy gear that is dragged along the seafloor (Parvez Al Usmani & Ansari, 2020; Larka, et al., 2021). Due to this fishing method, coral reefs, seagrasses and mangroves can be disturbed or even destroyed after being exploited. As mentioned in H1, the impacts of disturbing or destroying these important habitats, also regarded as ecosystem engineers, can have significant knock-on effects to the wider ecosystem, including both the flora and fauna that rely on them. Corals, seagrasses, mudflats and mangroves all provide necessary services, including shelter, protection, and food to the marine organisms that occupy the same niche and damaging or destroying part of this environment may be detrimental to the species diversity of the area.

Trawling is also a highly unselective fishing method, contributing to great levels of bycatch of non-target species, including juveniles. Research conducted on Indian marine capture fisheries has demonstrated a range of animals are caught during trawls, including cephalopods, particularly cuttlefish (*Sepia officinalis*) and squid (*Loliga vulgaris*) families (Prabhakar, 2011). Juvenile crustaceans, including shrimp (*Acetes indicus*), and crabs, gastropods including sea snails, and bivalves, including clams (*Katelysia opima*) and scallop (*Chlamys singaporina*). Removing these juveniles from the ecosystem is considered to be highly detrimental to the functionality of that ecosystem because these juveniles have not had the time to reproduce or add to the existing population (Prabhakar, 2011). Many of these species are classed as liw value bycatch.

Low value bycatch (LVB) was described in the 2019 study by Mahesh et., al., as being the species caught in trawl multispecies fisheries that is mainly transported as raw material for fish meal production (Mahesh, et al., 2019). In this study, a range of juvenile finfish species were also described to be caught during the process of trawling in this fishery, including Indian mackerel (*Rastrelliger kanagurta*) and Indian scad (*Decapterus russelli*) contributing to 338 t and 1,397 t per year, respectively. As Indian mackerel also contributed 8% of the country's total fish landings in 2018 (SeaAroundUs, 2018), the impact of juvenile bycatch by trawl fisheries could eventually be detrimental to the mass of Indian mackerel that can be used for human consumption, due to a lack of recruitment to the adult population.

Despite there being a large amount of research available to describe the potential ecosystem impacts presented by trawl fisheries, there is limited fishery-specific information about the type of habitats/ecosystems that the vessels interact with (mentioned in E1 there is the ecopath and ecosim approach by G.B Sreekanth et al., but it is not understood if this reflects the broader fishing area), and therefore specific details on the direct impact of the fishery is unknown at this stage. Therefore, it is considered that only ad-hoc information about the impact of the fishery on the ecosystem and the mid-range mitigation score is given.

References:

Mahesh, V. et al., 2019. Characterization of low value bycatch in trawl fisheries off Karnataka coast, India and its impact on juveniles of commercially important fish species. *Indian Journal of Geo Marine Sciences,* 48(11), pp. 1733-1742.

Prabhakar, R. P., 2011. Assessment of bycatch and discards in marine capture fisheries from Uran (Raigad), Navi Mumbai, Maharashtra. *the Ecosan,* 5(3&4), pp. 105-109.

Ramkumar, S. et al., 2019. Does the mechanised trawl target the non-targets from the commercial fishing grounds of northern Maharashtra, eastern Arabian Sea, India. *Journal of Entomology and Zoology Studies,* 7(6), pp. 1133-1140

SeaAroundUs, 2018. *SeaAroundUs: Catches by gear in the waters of India (mainland).* [Online] Available at: https://www.seaaroundus.org/data/#/eez/356?chart=catch-chart&dimension=gear&measure=tonnage&limit=10

E3: Impacts on key ecological species/keystone species	
	Mitigation score
There is no data or information on key ecological species in the ecosystem.	**0**
There is limited data and information that indicates that there is either no key ecological species in the ecosystem or that the impact on the fishery on these is known with a low degree of certainty.	12
There is adequate data and information that indicates that there is either no key ecological species in the ecosystem or that that the impact on the fishery on these is known with a high degree of certainty.	25

Rationale:

Research conducted on the ecosystem and habitats in Goa and Maharashtra (Parvez Al Usmani & Ansari, 2020; Larka, et al., 2021) identifies coral reefs, mangroves and seagrasses as the main habitats in these coastal waters. Whilst the vessels are known to operate in wasters up to 100 m deep, there is no specific data describing where the vessels operate, which could be essential in increasing the score for this element of the preassessment.

Furthermore, the lack of fishery-specific catch composition data from a either a fishery-dependent source or verified third-party means that there is currently no way to reliably demonstrate the potential impact on key ecological species. Estimates of the types of species encountered by this fishery can be made, and include a large range of high-risk species (see Section B for more details). Improvements in the data collection for this fishery could help to understand the impacts on key ecological species.

Tracking or VMS data could also help to identify any specific overlapping ecosystems that the fishery interacts with. Therefore, whilst there is some data available to estimate the potential ecological impact of the fishery, the mitigation score for this element is scored using the precautionary approach and a lowest score is assigned.

References:

Parvez Al Usmani, S. M. & Ansari, Z., 2020. Status of coastal marine biodiversity of Goa and challenges for sustainable management - An overview. *Journal of Ecophysiology and Occupational Health,* 20(3&4), pp. 222-231.

Larka, W., Ramkumar, S. & Gopalakrishnan, A., 2021. Marine fishereis and biodiversity management in Maharashtra: status, challenges, and opportunities. *Indian Journal of Animal Sciences,* 91(2), pp. 91-95.

E4: Management measures and strategies	
	Mitigation score

There are no measures in place for the management and conservation of ecosystem structure and function.	0
There are some plans/strategies and measures in place for the management and conservation of ecosystem structure and function.	**12**
There is a comprehensive set of plans/strategies and measures in place for the management and conservation of ecosystem structure and function.	25

Rationale:

The Government of India Ministry of Fisheries, Animal Husbandry, and Dairying, Department of Fisheries annually implements a uniform fishing ban on all vessels operating in the Indian exclusive economic zone (EEZ) beyond territorial waters on the East coast (including west Bengal, Odisha, Andhra Pradesh, Puducherry, Tamil Nadu, Andaman, & Nicobar Islands) and West coast (including Gujarat, Daman & Diu, Karnataka, Goa, Maharashtra, Kerala, Tamil Nadu and Lakshadweep Islands) in the following dates:

1. East coast – from 15th April, to 14Th June (both days inclusive (61 days)
2. West coast – from 1st June to 31st July (both days inclusive (61 days) (Directorate of Fisheries: Government of Goa, 2023)

There are similar bans that are implemented at the state level for both Goa and Maharashtra for the same time period covering the state waters up to 12 nautical miles, so in effect all trawlers under the unit of assessment would be banned from fishing for this 61 day period each year.

These bans aim to give heavily exploited resources and ecosystems a chance to recover, ensuring long-term sustainability. These regulations, though sometimes debated in their effectiveness, provide critical respite to heavily exploited resources and ecosystems.

However, there is minimal information about the specific habitats/ecosystems interacted with by the fishery and vessels. Therefore, the extent to which the fishing gear interacts with the sensitive ecosystems, is largely unknown. As mentioned in H1, sensitive habitats like coral reefs, mangroves and seagrasses are critical for a range of different ecosystem functions and services, not least being available habitat for other species, including juveniles that will be recruited into the larger stock of target species. Therefore, without fishery-specific information about the operational area of the vessels, the highest mitigation score for this element cannot be met. Therefore, as a precautionary measure, the mid-range score is provided.

References:

Directorate of Fisheries: Government of Goa (2023) – email from the Directorate to the fishery explicitly outlining the details of the seasonal fishing ban between 1st June – 31st July.

Socio-economic criteria

In addition to the areas examined above, applicants to full MarinTrust approval must commit to ensuring that vessels operating in the fishery adhere to internationally recognised guidance on human rights. They must also commit to ensuring there is no use of enforced or unpaid labour in the fleet(s) operating upon the resource.

Annex 1. Additional PSAs for species likely to interact with Goa and Maharashtra Trawl fisheries.

Table 3: PSA for Indian scad mackerel

Species name	Indian scad (*Decapterus russelli*)	
Productivity attributes	**Value**	**Score**[42]
Average age at maturity	1 year	1
Average maximum age	4 years	2
Fecundity	20,000 – 100,000	1
Average maximum size	22 cm	2
Average size at maturity	11-16 cm	2
Reproductive strategy	Broadcast spawner	1
Mean Trophic Level (MTL)	3.7	1
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.43
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Indian scad occupy similar habitats as the target species so there is considered to be high areal overlap.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Indian scad occupy similar habitats as the target species so there is considered to be high encounterability.	3
Selectivity of gear type:	a. Individuals < size at maturity are	3

[42] Indian oil sardine S.longiceps 51 57 Surv v 2.0 Nov 2018 (1).pdf

Potential of the gear to retain species	regularly caught because this species inhabits the same environment as the main species. b. Individuals < half the size at maturity are retained by the gear because the mesh traps them.	
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 4: PSA for longtail tuna

Species name	Longtail tuna (*Thunnus tongol*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	2 (Maturity Age[43])	1
Average maximum age	19	2
Fecundity	1,200,000 - 1,900,000	1
Average maximum size	150cm	2
Average size at maturity	60.7cm	2
Reproductive strategy	Broadcast spawner	1
Mean Trophic Level (MTL)	4.5	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.75
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3

[43] Thunnus tonggol | fishIDER

Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Marine; pelagic-neritic; oceanodromous. They can be found at 10m depth. They can be found near the coastal areas where chances of getting caught are higher.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. b. Individuals < half the size at maturity are retained by the gear because the mesh traps them.	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 5: PSA for blackfin sea catfish

Species name	Blackfin sea catfish (*Arius jella*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	1 year [5]	1
Average maximum age	4 years	1
Fecundity	25-120 eggs / year	3
Average maximum size	30 cm	1
Average size at maturity	14-16 cm	1
Reproductive strategy	Demersal egg layer	2
Mean Trophic Level (MTL)	3.5	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.71
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a	Species found in Indian ocean FAO	3

species concentration of the stock	areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N. High areal overlap with the fishery.	
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Found mostly in coastal marine waters, estuaries, and tidal rivers. Feeds mainly on invertebrates. Caught with stake traps, shore seines, set bag nets and on hook and line.[44] Therefore, there is low overlap with fishing gear.	1
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught. Despite being largely estuarine, indications of bycatch suggest that there is at least regular landings of these animals (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		2.5
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 6: PSA for torpedo scad

Species name	Torpedo scad (*Megalaspis cordyla*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	2.5 years	1
Average maximum age	5	1

[44] Arius jella, Blackfin sea catfish : fisheries (mnhn.fr)

[5] D-3342.pdf (egranth.ac.in)

Fecundity	146,400	1
Average maximum size	80cm	1
Average size at maturity	22-26cm	1
Reproductive strategy	Broadcast spawning	1
Mean Trophic Level (MTL)	3.9	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.29
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Found mostly in marine; brackish; reef-associated; depth range 20 - 100 m, which is within the access area of trawl vessels	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught. Despite being largely estuarine, indications of bycatch suggest that there is at least regular landings of these animals (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass

Compliance rating	N/a

Table 7: PSA for orangefin ponyfish

Species name	Orangefin ponyfish (*Photopectoralis bindus*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	1[45]	1
Average maximum age	3[46]	1
Fecundity	4,377 - 10,449	2
Average maximum size	11-14cm	1
Average size at maturity	9.3 cm[47]	1
Reproductive strategy	Broadcast spawning	1
Mean Trophic Level (MTL)	2.9	2
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.29
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Distributed across, Indo-West Pacific: Port Sudan in the Red Sea and the Persian Gulf to Japan, the Arafura Sea, and Australia. There is a overlap of the fishing effort with a species concentration of the stock.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Orangefin ponyfish are widely distributed in tropical and subtropical coastal waters, often overlapping with fishing efforts.	3
Selectivity of gear type: Potential of the gear to retain	a. Individuals < size at maturity are regularly caught because this species inhabits the same	3

[45] Photopectoralis bindus, Orangefin ponyfish : fisheries (fishbase.se)

[46] (PDF) Population characters of silverbelly Photopectoralis bindus (Valenciennes, 1835) along the Ratnagiri coast of India (researchgate.net)

[47] (PDF) Reproductive biology of the orange ponyfish, Photopectoralis bindus (Valenciennes, 1835) off Mangaluru coast, Karnataka (researchgate.net)

species	environment as the main species. Also, there is no indication about the frequency at which these animals are caught. Despite being largely estuarine, indications of bycatch suggest that there is at least regular landings of these animals (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 8: PSA for splendid ponyfish

Species name	Splendid ponyfish (*Eubleekeria splendens*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	1	1
Average maximum age	2.3 years	1
Fecundity	6,000-58,000[48]	2
Average maximum size	23cm[49]	1
Average size at maturity	9.4cm	1
Reproductive strategy	Broadcast spawner	1
Mean Trophic Level (MTL)	2.9	2
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.28
Susceptibility attributes		
Areal overlap (availability):	Distributed across: Indo-West	3

[48] (PDF) Reproductive Biology of Splendid Ponyfish Leiognathus splendens (Cuvier, 1829) in Myeik Coastal Waters, Myanmar (researchgate.net)

[49] Eubleekeria splendens, Splendid ponyfish : fisheries (fishbase.se)

Overlap of the fishing effort with a species concentration of the stock	Pacific: from India to Papua New Guinea; north to Japan; south to Australia. This indicates possibility of overlap.	
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Marine; brackish; demersal; amphidromous; depth range 10 - 100 m, a range within the potential functioning area of trawl fishing.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught. Despite being largely estuarine, indications of bycatch suggest that there is at least regular landings of these animals (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 9: PSA for Malabar tonguesole

Species name	Malabar tonguesole (*Cynoglossus macrostomus*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	1 year[50]	1
Average maximum age	1.27- 3 years[51]	1

[50] Microsoft Word - MS 3338.docx (niscpr.res.in)

[51] (PDF) Studies on growth and mortality of Malabar tongue sole, Cynoglossus macrostomus (Norman, 1928) along the Ratnagiri coast of Maharashtra India (researchgate.net)

Fecundity	5000 – 65000[52]	2
Average maximum size	17.3 cm[53]	1
Average size at maturity	97 mm	1
Reproductive strategy	Broadcast spawner	1
Mean Trophic Level (MTL)	3.3	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.42
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are marine; brackish; benthopelagic; non-migratory species. Their distribution is mostly restricted to the coast of India, which matches the location of the fishing gear in the coastal regions.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught. Despite being largely estuarine, indications of bycatch suggest that there is at least regular landings of these animals (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or	3

[52] Jayaprakash_85-95.pdf (cmfri.org.in)

[53] Cynoglossus macrostomus, Malabar tonguesole : fisheries (fishbase.se)

permitting subsequent survival	suffocation.	
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 10: PSA for goldspotted grenadier anchovy

Species name	Goldspotted grenadier anchovy (*Coilia dussumieri*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	6-7 months[54]	1
Average maximum age	20 months	1
Fecundity	1,000 - 5,000	2
Average maximum size	1cm	1
Average size at maturity	18-20 cm	1
Reproductive strategy	Broadcast spawners	1
Mean Trophic Level (MTL)	3.3	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.42
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are pelagic and found in coastal waters and have high chances of being encountered by trawl fishing vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about	3

[54] Coilia dussumieri, Goldspotted grenadier anchovy : fisheries (mnhn.fr)

	the frequency at which these animals are caught. Despite being largely estuarine, indications of bycatch suggest that there is at least regular landings of these animals (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 11: PSA for long tongue sole

Species name	Long tongue sole (*Cynoglossus lingua*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	2 years [55]	1
Average maximum age	7-11 years	2
Fecundity	360 - 35,926	2
Average maximum size	9-12.2 cm[56]	1
Average size at maturity	4.5 cm	1
Reproductive strategy	Broadcast spawners	1
Mean Trophic Level (MTL)	3.5	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.57
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a	Species found in Indian ocean FAO areas.	3

[55] downloadfile.php (asianfisheriessociety.org)

[56] Cynoglossus lingua, Long tongue sole : fisheries (fishbase.se)

species concentration of the stock	Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They live in oceans; freshwater; brackish water at the bottom; non-ovipositive retro drome . Depth of their dwellings range from upper and lower limit 10 - 961 m, reducing their chances of being caught by trawl fishing vessels.	1
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 12: PSA for Dussumier's halfbeak

Species name	Dussumier's halfbeak (*Hyporhamphus dussumieri*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary
Average maximum age	Not known	3 – precautionary
Fecundity	Not known	3 – precautionary
Average maximum size	38cm[57]	1
Average size at maturity	19cm	1

[57] Hyporhamphus dussumieri, Dussumier's halfbeak : fisheries (fishbase.se)

Reproductive strategy	Broadcast	1
Mean Trophic Level (MTL)	3.5	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		2.15
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Distributed in the Indo-Pacific: Seychelles through the East Indies, Borneo, Philippines, and New Guinea north to Hong Kong and Okinawa and eastward as far as Tuamotu Islands. However, chances of being encountered in India are less. Although they are still present in the Indo-Pacific.	2
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		2.75
PSA risk rating (from Table D(b))		**Fail**
Compliance rating		N/a

Table 13: PSA for many spotted flying fish

Species name	Manyspotted flying fish (*Cheilopogon spilopterus*)	
Productivity attributes	**Value**	**Score**

Average age at maturity	Not known	3 – precautionary
Average maximum age	5	1
Fecundity	7,196 - 23,195[58]	1
Average maximum size	25cm	1
Average size at maturity	29cm	1
Reproductive strategy	Broadcast spawners	1
Mean Trophic Level (MTL)	4.2	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.57
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are pelagic and found in coastal waters and have moderate chances of being encountered by trawl fishing (pelagic trawl)	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3

[58] Cheilopogon spilopterus, Manyspotted flyingfish : fisheries (mnhn.fr)

PSA risk rating (from Table D(b))	Pass
Compliance rating	N/a

Table 14: PSA for tadoore

Species name	Tadoore (*Opisthopterus tardoore*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary
Average maximum age	Not known	3 – precautionary
Fecundity	2,000-11,140[59]	2
Average maximum size	23cm[60]	1
Average size at maturity	Not known	3 - precautionary
Reproductive strategy	Broadcast spawner	1
Mean Trophic Level (MTL)	3.4	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		2.29
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Tardoore are pelagic and found in coastal waters, and thus have low possibility of being encountered by trawl (pelagic) fishing vessels.	1
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species.	3

[59] STUDIES ON THE BIOLOGY OF OPISTHOPTERUS TARDOORE (CVWIER) FROM RATNAGIRI | Indian Journal of Fisheries (icar.org.in)

[60] Opisthopterus tardoore, Tardoore : fisheries (mnhn.fr)

	Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		2.5
PSA risk rating (from Table D(b))		**Fail**
Compliance rating		N/a

Table 15: PSA for Smalleyed squillid mantis shrimp

Species name	Smalleyed squillid mantis shrimp (*Miyakea nepa*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary
Average maximum age	Not known	3 - precautionary
Fecundity	50,000	1
Average maximum size	16 cm[61]	1
Average size at maturity	8 cm	1
Reproductive strategy	No distinct information is available in this regard, however, they are known as a "very common shore species" that burrows in "level-bottom habitats" with a preference for "sandy-muddy bottoms" [SeaLifeBase]. This benthic lifestyle suggests they spend most of their time on the seabed, making demersal spawning (laying eggs on the bottom) more likely.	2
Mean Trophic Level (MTL)	3.27	3
Density dependence (to be used when scoring	Not known	3 - precautionary

[61] (PDF) Population dynamics of mantis shrimp (Miyakea Nepa Fabricius, 1781) in Siwa, Bone Bay, South Sulawesi, Indonesia (researchgate.net)

invertebrate species only)		
Average productivity score		2.12
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They have a benthic lifestyle. Although they have a preference for sandy muddy bottoms, but they are very common shore species as well, and this nature enhance the possibility of them being by trawl (demersal) vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		**Fail**
Compliance rating		N/a

Table 16: PSA for silver pomfret

Species name	Silver pomfret (*Pampus argenteus*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary
Average maximum age	7 years	1
Fecundity	Bay of Bengal: 40,610 - 90,460 Gujarat (2012-2013): 58,345 - 131,523	1

Average maximum size	18cm[62]	1
Average size at maturity	25.3cm	1
Reproductive strategy	Broadcast spawners	1
Mean Trophic Level (MTL)	3.3	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.57
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are pelagic and found in coastal waters, and thus have high possibility of being encountered by trawl (pelagic) fishing vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

[62] Pampus argenteus, Silver pomfret : fisheries (fishbase.se)

Table 17: PSA for Chinese silver pomfret

Species name	Chinese silver pomfret (*Pampus chinensis*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary
Average maximum age	Not known	3 - precautionary
Fecundity	57,969 – 248,520[63]	1
Average maximum size	40cm	1
Average size at maturity	22-25cm	1
Reproductive strategy	Broadcast spawners	1
Mean Trophic Level (MTL)	3.6	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.86
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are pelagic and found in coastal waters, and thus have high possibility of being encountered by trawl fishing vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3

[63] Pampus chinensis, Chinese silver pomfret : fisheries (fishbase.se)

Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		**Fail**
Compliance rating		N/a

Table 18: PSA for black pomfret

Species name	Black pomfret (*Parastromateus niger*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	1	1
Average maximum age	Not known	3 - precautionary
Fecundity	1,692 - 151,796[64]	3
Average maximum size	75cm	2
Average size at maturity	23cm	1
Reproductive strategy	Broadcast spawning	1
Mean Trophic Level (MTL)	2.9	2
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.86
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of	Black pomfrets are found in coastal areas with muddy substrate, but they exhibit a diurnal vertical migration, i.e., they spend their days near the bottom and ascend towards the surface at night. Thus, there is high	3

[64] Parastromateus niger, Black pomfret : fisheries (fishbase.se)

the gear	chance of being encountered by trawl (demersal) vessels.	
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3).	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		**Fail**
Compliance rating		N/a

Table 19: PSA for spinycheek grouper

Species name	Spinycheek grouper (*Epinephelus diacanthus*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary
Average maximum age	Not known	3 - precautionary
Fecundity	4,165 - 24,765[65]	1
Average maximum size	55cm	1
Average size at maturity	39.2cm	2
Reproductive strategy	Broadcast	1
Mean Trophic Level (MTL)	3.9	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		2

[65] Epinephelus diacanthus, Spinycheek grouper : fisheries (fishbase.se)

Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They reside over muddy sand or mud substrata and caught in depths of 63 to 100 m off the Kerala coast, which is within the access area of trawl vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		**Fail**
Compliance rating		N/a

Table 20: PSA for narrow-barred Spanish mackerel

Species name	Narrow-barred Spanish mackerel (*Scomberomorus commersoni*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	2[66]	1
Average maximum age	22	2
Fecundity	590,000 - 1,500,000	1
Average maximum size	240cm	3

[66] Scomberomorus commerson, Narrow-barred Spanish mackerel : fisheries, gamefish (fishbase.se)

Average size at maturity	75.2cm	2
Reproductive strategy	Broadcast spawning	1
Mean Trophic Level (MTL)	4.5	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.86
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Narrow-barred Spanish mackerel are pelagic and found in coastal waters where trawl (pelagic) vessels could encounter them.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		**Fail**
Compliance rating		N/a

Table 21: PSA for streaked seerfish

Species name	Streaked seerfish (*Scomberomorous lineolatus*)	
Productivity attributes	**Value**	**Score**

Average age at maturity	2 years[67]	1
Average maximum age	5 years	1
Fecundity	559,000 - 2,143,000	1
Average maximum size	94 cm [68]	1
Average size at maturity	70 cm	2
Reproductive strategy	Broadcast spawners	1
Mean Trophic Level (MTL)	4.5	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.43
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are pelagic and found in coastal waters where trawl (pelagic) vessels could encounter them.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a	Due to the nature of trawl fishing, it is highly unlikely that the species	3

[67] Maturity, spawning and fecundity of the streaked seer, Scomberomorus lineolatus (Cuvier & Valenciennes), In the Gulf of Mannar and Palk Bay - CORE Reader

[68] Scomberomorus lineolatus, Streaked seerfish : fisheries, gamefish (fishbase.se)

species would be released and that it would be in a condition permitting subsequent survival	will survive once it is removed from the water due to crushing or suffocation.	
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 22: PSA for largehead hairtail

Species name	Largehead hairtail (*Trichiurus lepturus*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	1 year[69]	1
Average maximum age	6.8 years[70]	1
Fecundity	22,533 - 186,667	1
Average maximum size	207cm	2
Average size at maturity	50 cm	1
Reproductive strategy	Broadcast spawners	1
Mean Trophic Level (MTL)	4.4	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.43
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are benthopelagic and found in coastal waters where they can be encountered by trawl vessels.	3

[69] Trichiurus lepturus, Largehead hairtail : fisheries, gamefish (fishbase.se)

[70] Indian oil sardine S.longiceps 51 57 Surv v 2.0 Nov 2018 (1).pdf

Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 23: PSA for Savalai hairtail

Species name	Savalai hairtail (*Lepturacanthus savala*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary
Average maximum age	Not known	3 - precautionary
Fecundity	9,178 - 17,347[71]	1
Average maximum size	100 cm	1
Average size at maturity	38 cm	1
Reproductive strategy	Not known	3 - precautionary
Mean Trophic Level (MTL)	4.3	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		2.14
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80°	3

[71] Lepturacanthus savala, Savalai hairtail : fisheries (fishbase.se)

	E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They inhibit in coastal waters and often come near the surface at night, and there is high possibility of them being encountered by trawl vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		**Fail**
Compliance rating		N/a

Table 24: PSA for Hilsa shar

Species name	Hilsa shar (*Tenualosa Ilisha*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	1.2 years[72]	1
Average maximum age	5 years[73]	1
Fecundity	375,000 - 1,423,000	1
Average maximum size	31.3cm	1
Average size at maturity	60cm	1
Reproductive	Broadcast spawners	1

[72] article_119368_db9790434609d8e72f425f41b2a3a138.pdf (ekb.eg)

[73] Tenualosa ilisha, Hilsa shad : fisheries, aquaculture (fishbase.se)

strategy		
Mean Trophic Level (MTL)	2.9	2
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.14
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Schooling in coastal waters and ascending rivers for as much as 1200 km and have high chances of being encountered by shallow trawl vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 25: PSA for false trevally

Species name	False trevally (*Lactarius lactarius*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary

Average maximum age	1-2 years[74]	1
Fecundity	9,000 – 79,000	2
Average maximum size	40cm	1
Average size at maturity	15cm	1
Reproductive strategy	Broadcast spawning	1
Mean Trophic Level (MTL)	4.2	3
Density dependence (to be used when scoring invertebrate species only)	N/a	N/a
Average productivity score		1.71
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are found in coastal waters down to a depth of about 100m and they have chances of getting encountered by trawl vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3

[74] Lactarius lactarius, False trevally : fisheries (fishbase.se)

PSA risk rating (from Table D(b))	Pass
Compliance rating	N/a

Table 26: PSA for banana shrimp

Species name	Banana shrimp (*Fenneropenaeus merguiensis*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	0.5 years[75]	1
Average maximum age	1.5 years [76]	1
Fecundity	100 000 - 450 000 [77]	1
Average maximum size	24cm	1
Average size at maturity	3cm	1
Reproductive strategy	Broadcast spawning	1
Mean Trophic Level (MTL)	2.5 - 3.0	2
Density dependence (to be used when scoring invertebrate species only)	Not known	3 - precautionary
Average productivity score		1.38
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are highly likely to be caught by trawl fishing due to their bottom-dwelling lifestyle and the midwater targeting of purse seines.	3
Selectivity of gear type: Potential of the gear to retain	a. Individuals < size at maturity are regularly caught because this species inhabits the same	3

[75] Prawns | Australian Fisheries Management Authority (afma.gov.au)

[76] Prawns | Australian Fisheries Management Authority (afma.gov.au)

[77] Maturation and spawning of the banana prawn Penaeus merguiensis de Man (Crustacea : Penaeidae) in the Gulf of Carpentaria, Australia - ScienceDirect

species	environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of purse seine fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 27: PSA for kiddi shrimp

Species name	Kiddi shrimp (*Parapenaeopsis stylifera*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	1	1
Average maximum age	2	1
Fecundity	39,500 - 236,000	1
Average maximum size	15cm	1
Average size at maturity	6.5-7.5 cm[78]	1
Reproductive strategy	Broadcast spawners	1
Mean Trophic Level (MTL)	2.9	2
Density dependence (to be used when scoring invertebrate species only)	Not known	3 - precautionary
Average productivity score		1.36
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N	3

[78] PROCEEDINGS OF THE WORLD SCIENTIFIC CONFERENCE ON THE BIOLOGY AND CULTURE OF SHRIMPS AND PRAWNS (fao.org)

	Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	They are found at coast to depths of 90 m, but usually down to 50 m on muddy or sandy-mud substrates. So, there are possibilities of them being encountered by trawl vessels.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of trawl fishing, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a

Table 28: PSA for Indian squid

Species name	Indian squid (*Uroteuthis duvaucelii*)	
Productivity attributes	**Value**	**Score**
Average age at maturity	Not known	3 - precautionary
Average maximum age	3	1
Fecundity	11,802 - 30,100	1
Average maximum size	40cm	1
Average size at maturity	10cm	2
Reproductive strategy	Demersal spawning	2
Mean Trophic Level (MTL)	<2.75	1
Density dependence (to be used when scoring	Not known	3 - precautionary

invertebrate species only)		
Average productivity score		1.75
Susceptibility attributes		
Areal overlap (availability): Overlap of the fishing effort with a species concentration of the stock	Species found in Indian ocean FAO areas. Indian Ocean Western: 30° E - 80° E; 45° S - 30° N Indian Ocean Eastern: 77°E - 150°E; 55°S - 24°N.	3
Encounterability: The position of the stock/ species within the water column relative to the fishing gear, and the position of the stock/species within the habitat relative to the position of the gear	Found in shallow waters, they have and the dredge vessels operate in overlapping habitats, meaning that encounterability is likely.	3
Selectivity of gear type: Potential of the gear to retain species	a. Individuals < size at maturity are regularly caught because this species inhabits the same environment as the main species. Also, there is no indication about the frequency at which these animals are caught (2). b. Individuals < half the size at maturity are retained by the gear because the mesh traps them (3)	3
Post-capture mortality (PCM): The chance that, if captured, a species would be released and that it would be in a condition permitting subsequent survival	Due to the nature of dredging, it is highly unlikely that the species will survive once it is removed from the water due to crushing or suffocation.	3
Average susceptibility score		3
PSA risk rating (from Table D(b))		Pass
Compliance rating		N/a