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## Threats to the sustainability of marine fishery resources along the Tamil Nadu coast, India

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### Abstract

Fisheries are a critical sector in India, providing employment to millions and contributing significantly to national food security. The major challenge today is not merely increasing fish production to meet rising demand but ensuring sustainability of fishery resources. This study identifies the principal threats to the sustainability of marine fishery resources along the Thoothukudi coast of Tamil Nadu. A total of 90 fishermen, selected through random sampling from Thoothukudi North and South, were interviewed using an open-ended schedule. Key threats reported were: use of small mesh size in the cod end and bottom trawling by trawlers, intensive mechanization and increasing numbers of fishing crafts, coastal pollution, use of unsuitable fishing gears, unrestricted fish catch (including juveniles), illegal trapping of fishery resources, overfishing, absence of a fishing-activity monitoring mechanism, high price of all fish species encouraging overexploitation, and lack of effective fisheries management.

**Keywords:** Threats, marine fisheries, sustainability

### 1. Introduction

The marine fisheries sector in India has grown remarkably, with total production increasing from 5.34 lakh tonnes in 1950-51 to 44.95 lakh tonnes in 2023-24. Coastal aquaculture particularly shrimp farming has been a major driver. Shrimp production alone grew by 27%, from 3.22 lakh tonnes in 2013-14 to 11.84 lakh tonnes in 2023-24, helping seafood exports reach 17.81 lakh tonnes worth Rs. 60,523.89 crore in 2023-24. Marine fish production rose from 34.76 lakh tonnes in 2020-21 to 44.95 lakh tonnes, an 8.9% annual increase (Department of Fisheries, 2025). Yet, in 2024, marine fish landings along the Indian mainland were estimated at 3.45 million tonnes, a 2% decline from 2023. The Andaman and Nicobar Islands contributed about 16,990 tonnes, bringing the marine fisheries sector's estimated contribution to the nation's GVA to Rs. 39,525.4 crore, about 63.04% of gross revenue (ICAR-CMFRI, 2024) <sup>[4]</sup>. The data indicate that marine capture increased significantly for a period and then began to decline. To support the development of a sustainable industry, the present study was undertaken with the objective of assessing the threats affecting the marine sector, identifying the possible reasons for stock depletion, and examining changes in catch per unit area or per fishing vessel.

### 2. Methodology

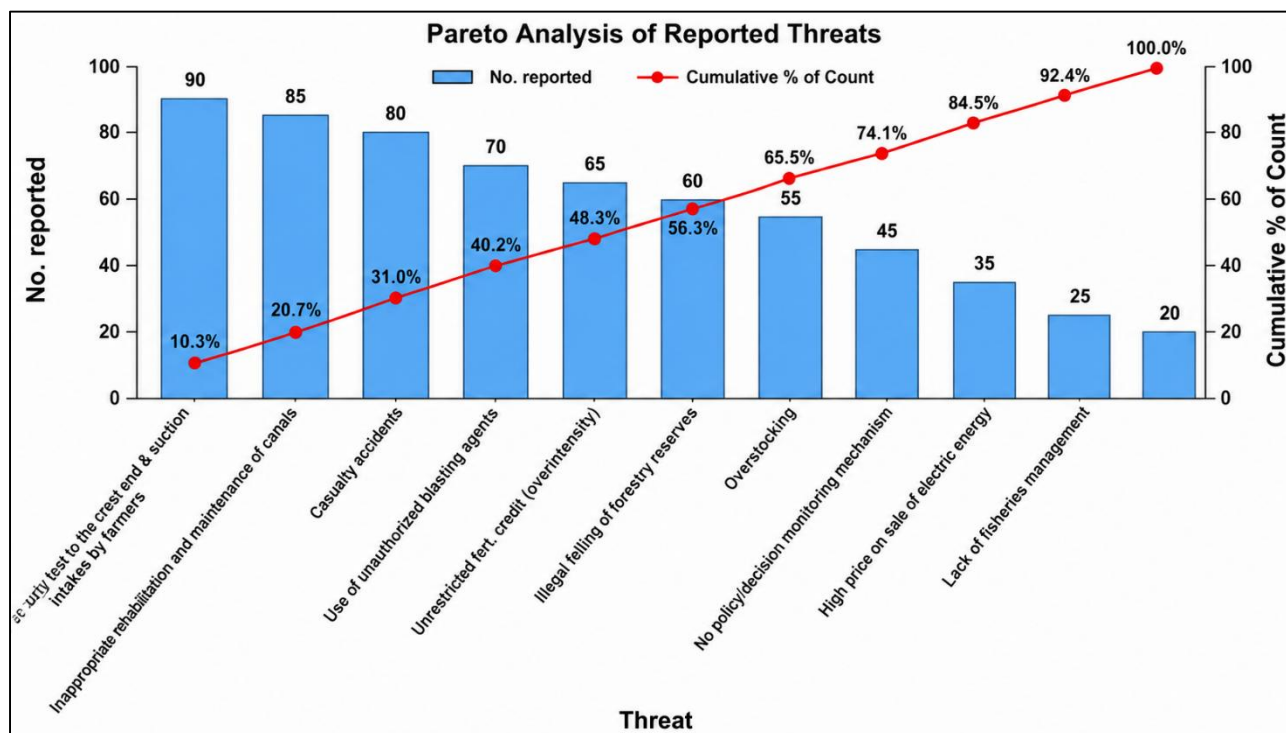
Thoothukudi district, in southern Tamil Nadu, covers 4,175 km<sup>2</sup> with a 163.5 km coastline, about 15.2% of the state's total. It is bounded by Virudhunagar and Ramanathapuram districts (north), the Gulf of Mannar (east) and Tirunelveli district (west). There are 21 coastal villages, with a fisherfolk population of 69,558 (males: 35,828; females: 33,730) (Department of Fisheries, 2020) <sup>[7]</sup>.

The data was collected using the structured open-ended interview schedule was prepared and collected from the 90 members of active fishermen (45 each from the villages of Thoothukudi North and Thoothukudi South) to identify perceived threats to marine fishery sustainability.

### 3. Results and Discussion

Major threats to sustainability of marine fisheries resources N=90

| Sl. No. | Threats identified by respondents                                   | No. reported | Percentage |
|---------|---------------------------------------------------------------------|--------------|------------|
| 1       | Use of small mesh size in the cod end & bottom trawling by trawlers | 82           | 91.11      |
| 2       | Intensive mechanization and increasing numbers of crafts            | 78           | 86.67      |
| 3       | Coastal pollution                                                   | 74           | 82.22      |
| 4       | Use of unsuitable fishing gears                                     | 69           | 76.67      |
| 5       | Unrestricted fish catch (juveniles)                                 | 66           | 73.33      |
| 6       | Illegal trapping of fishery resources                               | 59           | 65.56      |
| 7       | Overfishing                                                         | 55           | 61.11      |
| 8       | No fishing-activities monitoring mechanism                          | 53           | 58.89      |
| 9       | High price for all kinds of fishes caught                           | 47           | 52.22      |
| 10      | Lack of fisheries management                                        | 42           | 46.67      |



A Pareto chart visualizes the relative importance of factors by showing the frequency of issues or causes in a descending bar chart, overlaid with a cumulative percentage line. It helps prioritize problems by highlighting the "vital few" causes that contribute the most to a problem, a concept known as the 80/20 principle.

The Pareto chart visualizes the cumulative contribution of threats by number reported, highlighting the vital few.

The study identified a range of threats affecting coastal and marine fisheries, with respondents highlighting both environmental and anthropogenic challenges. Small mesh sizes (16-30 mm) in cod ends frequently capture juvenile fish before they can reproduce, which can cause recruitment and growth overfishing. These juveniles, often sold as trash fish, represent lost future revenue and stock replenishment, undermining sustainability. The most critical threat perceived by the majority of respondents was the use of small mesh sizes in the cod end and bottom trawling by trawlers (91.11%). Government regulation requires a 25 mm cod-end mesh, but many trawlers use 16-30 mm, capturing juvenile fish of valuable species which are then sold as low-value "trash fish." Allowing these juveniles to mature would increase future stocks and revenue. Vijayan *et al.* (2000) [28] found that 66-94% of small-trawler bycatch consisted of juveniles. Increasing mesh size enables escaping of smaller

fish, allowing them to mature and reproduce, resulting in larger future yields.

The second major concern, intensive mechanization and increasing numbers of crafts (86.67%), underscores the escalating fishing pressure on coastal ecosystems. Bottom trawling also damages benthic ecosystems. Mechanized boats now fish well beyond the earlier 5-8 km coastal range. Despite this expansion, catch per craft per day has declined, indicating excess fishing effort. Fishermen reported gear damage to traditional crafts (Venkatachalam, 2005) [27]. Studies (Hiddink *et al.*, 2019; Olsgard *et al.*, 2008) [14, 19] show that bottom trawling scrapes the seafloor, destroys coral reefs and habitats, disturbs larvae and eggs, and reduces long-lived benthic biota by up to threefold compared with shorter-lived organisms. These impacts disrupt nutrient balances and can have globally significant ecological consequences. The unchecked increase in mechanized crafts in coastal waters, often without effective regulation, leads to competition between artisanal and mechanized sectors, intensifying resource conflicts and marginalizing small-scale fishers (Bavinck *et al.*, 2018) [1]. Similar trends of stock depletion are reported globally (Sonak *et al.*, 2006) [23]. A ban on adding new fishing crafts has been suggested to curb pressure on resources.

Coastal pollution (82.22%) also emerged as a major threat followed by intensive mechanisation, reflecting the respondents' awareness of anthropogenic pressures such as industrial effluents, aquaculture discharges, and urban runoff. Coastal pollution industrial waste discharge, heavy metals, untreated sewage and port-related activities as a key threat (Eline & Schaap, 2003) <sup>[9]</sup>. Such pollution degrades marine habitats and undermines fishery sustainability. These pollutants contribute to eutrophication, habitat degradation, and contamination of fishery products (GESAMP, 2016) <sup>[12]</sup>. Similar patterns were reported by Jayasankar *et al.* (2021) <sup>[16]</sup>, who observed that nutrient enrichment and chemical contamination significantly reduced the productivity of nearshore ecosystems. Untreated sewage contributes high nutrient loads, causing eutrophication and hypoxia, adversely affecting fish survival and reproduction. Port activities introduce contaminants and disrupt habitats through dredging and ballast discharges. Such pollution degrades ecosystem health, lowering fishery productivity and threatening the livelihoods of coastal communities dependent on marine resources.

The use of unsuitable fishing gears (76.67%) and unrestricted fish catch including juveniles (73.33%) were additional issues of concern. Use of banned gears such as purse seines and shore seines leads to wasteful bycatch and destruction of eggs and juvenile fish. Enforcement of bans and strict penalties are necessary.

These findings point to a lack of enforcement of fishing regulations and poor awareness among fishers regarding sustainable gear practices. Juvenile fishing disrupts recruitment processes and reduces the resilience of fish populations (Cochrane & Garcia, 2009) <sup>[6]</sup>. At present, there is no daily maximum allowable catch per craft. Sonak *et al.* (2006) <sup>[23]</sup> similarly observed a trend of stock depletion under such conditions. Strengthening gear selectivity measures and implementing seasonal bans could help mitigate these impacts (CMFRI, 2022). Purse seines, widely used in tropical tuna fisheries, are associated with significant bycatch including juvenile tunas, sharks, rays, and turtles, with bycatch estimated at several thousand tons annually in some regions. This indiscriminate capture disrupts fish population recruitment and depletes stocks. Shore seines similarly disrupt nearshore ecosystems by catching immature fishes and eggs. Without strict enforcement and penalties, the use of these destructive gears will persist, undermining sustainability goals. Effective monitoring, gear restrictions, and compliance are crucial for protecting juvenile fish and maintaining ecosystem balance. This practice has been widely documented as a destructive fishing method that captures a high proportion of juveniles and non-target species, resulting in biodiversity loss and the depletion of fish stocks (Pauly *et al.*, 2002; FAO, 2020) <sup>[20, 11]</sup>. The findings are consistent with studies conducted along the Indian coastline, where indiscriminate trawling practices have severely affected demersal fish resources and benthic habitats (Sathianandan *et al.*, 2019) <sup>[24]</sup>.

Illegal trapping of fishery resources (65.56%) and overfishing (61.11%) indicate ongoing governance and compliance challenges. Sea cucumbers, for example, have been recommended for listing to curb their decline (Nithyanandan, 2003) <sup>[18]</sup>. Strong law enforcement is essential. Overfishing has long been recognized as a primary driver of marine resource depletion globally (Hilborn *et al.*, 2020) <sup>[15]</sup>. In India, insufficient monitoring and lack of

participatory management frameworks have exacerbated this issue (Mohanty *et al.*, 2019) <sup>[17]</sup>. Choudhury *et al.* (2007) <sup>[3]</sup> linked overfishing and destructive practices to declines in vulnerable species of the Gulf of Mannar. Moreover, the absence of fishing-activities monitoring mechanism (58.89%) highlights institutional gaps in surveillance and data collection systems. Effective fisheries management depends on robust monitoring, control, and surveillance (MCS) frameworks that ensure compliance and resource sustainability (FAO, 2018). 46.67% pointed to lack of fisheries management overall. Without effective management, technological advances and growing market demand continue to increase pressure on resources (Ramya, 2008) <sup>[22]</sup>.

The study revealed that about 73.33% of respondents cited lack of restrictions on catch size poses a significant threat to fishery sustainability.

Interestingly, high prices for all kinds of fishes caught (52.22%) were perceived as a threat, possibly indicating market-driven overexploitation, where rising demand incentivizes unsustainable fishing. Finally, lack of fisheries management (46.67%) represents an overarching institutional weakness that amplifies all other threats. Without integrated management, co-management arrangements, and stakeholder participation, fisheries sustainability remains elusive (Pomeroy & Andrew, 2011) <sup>[21]</sup>. Merchants from neighboring states pay premium prices, incentivizing fishermen to maximize catches regardless of sustainability (Vijayan *et al.*, 2000) <sup>[28]</sup>.

Overall, the discussion reveals a complex interplay between technological advancement, regulatory gaps, and ecological degradation. Addressing these threats requires a multi-stakeholder approach emphasizing ecosystem-based fisheries management (EBFM), strengthened institutional capacity, and fisher community participation to ensure long-term sustainability of marine resources.

#### 4. Conclusion

The present study underscores that unsustainable fishing practices, inadequate governance, and environmental degradation pose significant threats to the long-term sustainability of marine fishery resources along the Thoothukudi coast. To address these challenges, the following measures are urgently required:

- Enforce mesh-size regulations and prohibit destructive bottom trawling.
- Regulate the number of fishing vessels and mechanized operations.
- Mitigate coastal pollution and rigorously control the illegal exploitation of protected species.
- Establish a robust Monitoring, Control, and Surveillance (MCS) system and enhance fisheries management frameworks.
- Investigate price-regulation mechanisms to disincentivize overfishing.

The implementation of these interventions, aligned with the guidelines of the Food and Agriculture Organization (FAO), is essential for safeguarding fish stocks, sustaining coastal livelihoods, and maintaining the ecological integrity of India's marine fisheries.

## 5. Acknowledgements

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## 6. Conflicts of Interests

The authors do not have any conflicts of interest.

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