Assessment of bycatch and discard rates in trawl fisheries: A case study.

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Introduction

Bycatch and discards are among the most pressing challenges facing global fisheries, particularly in trawl fisheries, which are notorious for their lack of selectivity. The assessment of bycatch and discard rates in trawl fisheries provides critical insights into the ecological and economic sustainability of fishing operations. Bycatch refers to the unintentional capture of non-target species, including fish, invertebrates, and sometimes endangered species such as sea turtles or marine mammals. Discards are the portion of the catch that is returned to the sea, either dead or alive, due to regulatory restrictions, low market value, or poor quality. Understanding the scale and composition of bycatch and discards is essential for improving fisheries management, reducing waste, and minimizing ecosystem impacts [1].

Trawl fisheries operate by towing a large net through the water column or along the seabed, targeting species such as shrimp, demersal fish, or pelagic schooling fish. While efficient in harvesting large quantities of target species, trawling often captures a wide range of organisms indiscriminately. The design of the trawl gear, the location and depth of fishing, and the behavior of the target species all influence the extent of bycatch. In many tropical and subtropical shrimp trawl fisheries, for instance, bycatch can exceed the target catch by weight, sometimes reaching ratios as high as 10:1. Such high bycatch rates are ecologically damaging and economically inefficient, leading to the loss of juvenile fish, habitat damage, and trophic imbalances [2].

To assess bycatch and discard rates, a case study was conducted in a demersal trawl fishery along a continental shelf region where both industrial and artisanal fleets operate. Observers were deployed aboard commercial trawlers to record catch composition, measure the weights and numbers of retained and discarded species, and note the reasons for discarding. Sampling was conducted over multiple seasons to capture variability in species composition and fishing effort. Additional data were obtained from logbooks, port sampling, and interviews with fishers and stakeholders [3].

The findings of the case study revealed a complex and dynamic picture. Bycatch comprised more than 40% of the total catch by weight, with substantial variation across seasons and fishing grounds. The bulk of bycatch consisted of juvenile fish species, non-commercial invertebrates, and low-value fish that lacked market demand. Some species, such as small rays and sea snakes, were consistently discarded due to gear damage risk or unmarketability. A significant portion of discards included juveniles of commercially valuable species, indicating a threat to future stock recruitment [4].

Discards were primarily motivated by economic and regulatory factors. Fishers discarded undersized individuals to comply with minimum size regulations and avoid penalties. Species with little or no market value were also discarded due to limited onboard storage capacity and the prioritization of more valuable species. Some discards occurred due to high-grading practices, where lower-quality fish were thrown back in favor of higher-quality specimens when space was limited. Mortality rates among discarded organisms were found to be high, particularly for bottom-dwelling species exposed to barotrauma and prolonged air exposure during sorting [5].

Gear selectivity emerged as a major determinant of bycatch rates. Traditional trawl nets used in the fishery lacked effective bycatch reduction devices (BRDs) or turtle excluder devices (TEDs). As a result, non-target species and endangered fauna were frequently caught. The use of small mesh sizes in codends exacerbated the capture of juveniles and small-bodied species. When modified gear configurations were tested, including larger mesh sizes, square mesh panels, and sorting grids, significant reductions in bycatch were observed. These modifications allowed smaller or non-target species to escape while retaining target-sized individuals, demonstrating the potential of technical solutions to mitigate bycatch [6].

Habitat type and depth also influenced bycatch composition. Trawling on muddy and sandy bottoms resulted in higher capture rates of benthic invertebrates, while operations near reef structures or seagrass beds led to greater bycatch of reef-associated fish and juveniles. Seasonal variations in water temperature, salinity, and fish migrations contributed to temporal changes in bycatch patterns. For instance, spawning aggregations of certain species during monsoon transitions led to increased capture of reproductive individuals, raising concerns about long-term impacts on population sustainability [7].

The socio-economic implications of bycatch were multifaceted. For artisanal fishers, bycatch represented both a challenge and an opportunity. While some low-value bycatch was used for subsistence or sold in local markets, large volumes of discards still occurred due to market saturation or poor post-harvest infrastructure. Women and youth were often engaged in

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sorting and processing bycatch, highlighting gendered aspects of fisheries labor. Discards also imposed costs on fishers in terms of time, fuel, and gear damage, undermining profitability and operational efficiency [8].

From a conservation standpoint, the high bycatch rates raised concerns about biodiversity loss and ecosystem degradation. The removal of non-target species, many of which play important ecological roles as predators, prey, or habitat engineers, can alter food web dynamics and reduce ecosystem resilience. The incidental capture of threatened species such as sea turtles, sharks, and rays further underlines the need for urgent bycatch mitigation. The mortality of juvenile fish before reaching maturity impairs stock replenishment and can result in recruitment overfishing [9].

Management responses to the bycatch issue have been varied. In the case study region, regulatory frameworks existed for gear specifications, closed seasons, and bycatch reporting, but enforcement was inconsistent. Observer coverage was limited, and data quality suffered from underreporting and misidentification of species. Stakeholder engagement was uneven, with limited participation of small-scale fishers in decision-making processes. Despite these challenges, several promising initiatives were underway, including community-based monitoring programs, capacity-building workshops, and pilot projects on selective gear adoption.

Recommendations from the case study emphasized the need for a multi-pronged approach to reduce bycatch and discards in trawl fisheries. First, promoting the widespread adoption of selective fishing gear through subsidies, training, and regulatory incentives can significantly improve gear performance. Second, establishing bycatch reduction targets and monitoring frameworks can enhance accountability and transparency. Third, developing markets for currently discarded species through value addition, product development, and improved cold-chain logistics can transform waste into economic opportunities. Fourth, implementing spatial and temporal closures to protect vulnerable habitats and life stages can reduce the incidental capture of sensitive species [10].

Conclusion

In conclusion, the assessment of bycatch and discard rates in trawl fisheries offers valuable insights into the sustainability of fishing practices and the health of marine ecosystems. The case study underscores the scale and complexity of the bycatch problem, driven by technological, ecological, economic, and social factors. It also demonstrates that practical solutions exist, ranging from gear innovations to market development and community engagement. Reducing bycatch is not only an environmental imperative but also an economic and ethical one. By aligning policy, science, and stakeholder participation, trawl fisheries can move towards a more responsible and sustainable future.

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