Bycatch Reduction Device: Technology for Sustainable Fisheries

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Abstract

The global fishing industry stands at a crossroads where the demand for seafood must be balanced against the urgent need for marine conservation. A primary obstacle to this balance is bycatch, the incidental harvesting of sharks, turtles, and juvenile fish. Excessive bycatch not only threatens marine biodiversity but also affects long-term fishery sustainability and economic efficiency. Bycatch Reduction Devices (BRDs) have emerged as an effective technological intervention to address this issue. These devices are designed to improve gear selectivity by allowing non-target species to escape while retaining commercially valuable shrimp. Various BRD designs, including rigid grids, fisheye escape openings, and square mesh panels, have demonstrated significant reductions in bycatch without substantially affecting shrimp catch rates. In addition to ecological benefits, BRDs enhance operational efficiency by reducing sorting time, minimizing catch damage, and lowering fuel consumption due to reduced net drag. As fisheries move toward sustainability, BRDs stand out as a simple yet powerful technological tool for balancing conservation goals with economic returns in shrimp trawl operations.

Keywords: Bycatch, Incidental harvesting, Sustainability, Non-target species, Marine biodiversity

Introduction

India is the second largest fish producing country in the world, contributing about 8% to the global fish production (Press Information Bureau, 2025). The trawlers, which have historically played a vital role in the marine fishery production of the state, recorded the highest landings in the mechanized sector, with a total of 4.29 lakh tonnes (CMFRI, 2024). The Marine Fisheries Census 2016 (CMFRI-FSI-DoF, 2020) reported that approximately 30,486

trawlers were operational across the country. While trawl nets are the most widely used fishing equipment in marine fisheries both worldwide and in India, their lack of selectivity and the significant amount of bycatch they produce make them highly detrimental to marine ecosystems. Bycatch is a pivotal problem in modern trawling.

Alverson et al. (1994) defined it as the untargeted portion of the catch that is incidentally caught in fishing gear, with bycatch being an unavoidable element of nonselective trawl nets. Alongside the significant and diverse catch, trawler landing also comprising by-catch that consists of juvenile quality fish, small-sized prawns, crabs, squilla (Pravin and Manohardoss, 1996) and diverse range of megafauna such as turtles, sharks, cetaceans and molluscs. Between 2017 and 2019, low-value bycatch (LVB) constituted 30-60% of trawl catches in India, with most of it being utilized for fishmeal production (Dineshbabu et al., 2022).

Table 1 Records of diverse range of bycatch capture along various region of world

Region	Bycatch Composition	References
Orissa coast, India	5282 dead olive ridley turtles were counted in fishing nets along coastline	Pandal et al., 1997
Orissa Coast, India	Mortality of 26 Olive ridley turtles captured in trawl	Gopi et al., 2006
Adriatic Sea, Italy	Annually 3141 hauls for bottom trawler were monitored, comprising 863 turtles, 5436 Sharks, 5414 Rays with bottlenose dolphins in low numbers.	Fortuna et al., 2010
Northeast Atlantic region	Recorded unsustainable levels of by catch comprising 2200 porpoises per year from Celtic Sea and around 8000 porpoises from North Sea in bottom-set gill net fisheries	Isaac and Wdcs, 2021
Northern Peru	Reported 65 species of molluscs from 277 species caught as by catch in 300 hauls of shrimp trawl.	Mendo et al., 2022
Northern South China Sea	Reported 7464 bycatch events in Trawl net, gill nets and seine net comprising 33.6 % sea turtles, Whale sharks 12.4 %, Indo-Pacific	Lin et al., 2023

	finless porpoises 12.4 % and Indo-Pacific humpback dolphin- 8.5%	
Moroccan Mediterranean Sea	Total of 5792 questionnaire were performed in 2203 days of sea observations, sharks and Rays -93%, Common dolphins 0.03%,	El Arraf et al., 2024

Reducing fish bycatch is crucial for conserving marine biodiversity and maintaining sustainable fisheries. Various gear modifications, such as increasing mesh size or using grids in trawls, have proven effective in selectively reducing unwanted catches while maintaining target species harvests (Swimmer et al., 2020; Kennelly and Broadhurst, 2021).

Under the National Policy on Marine Fisheries (2017), sustainable management of marine biodiversity is prioritized, particularly through the adoption of bycatch reduction strategies. The policy calls for effective governance systems and adherence to international frameworks, notably the FAO's Code of Conduct for Responsible Fisheries (CMFRI, 2012; 2017). Bycatch reduction devices (BRDs) represent an innovative approach to selectively reduce unwanted catch in fisheries while retaining target species, improving both ecological and economic outcomes.

Bycatch Reduction Devices (BRDs)

Bycatch reduction devices (BRDs) are essential tools designed to minimize the incidental capture of non-target species including marine mammals, fish, and invertebrates, while maintaining target catch in various fisheries. This device can minimize the capture of unwanted bycatch in shrimp trawls and lessen the effects of trawling on non-target marine resources. They lead to a decrease in damage to shrimp caused by the absence of large animals in the cod end, a reduction in sorting time, extended tow durations, and decreased fuel expenses due to lower net drag. Reports indicate that the impact of BRD installation on the overall drag of the trawl system, and consequently on fuel consumption, is minimal (Pravin et al., 2013). Various forms of BRDs have been created and implemented in the global fishing industries.

The Juvenile Fish Excluder cum Shrimp Sorting Device (JFE-SSD), which has received the Smart Gear (WWF) award was created by the Central Institute of Fisheries Technology (CIFT). It effectively minimizes the bycatch of juvenile and smaller non-target species during commercial shrimp trawling. At the same time, it facilitates the harvesting and retention of larger, economically significant finfish and shrimp species by fishermen (Pravin et al., 2013).

Table 2 Types of BRDs (Source: Sabu et al., 2011, Gibinkumar, 2012., Boopendranath, 2010, Jung et al., 2025)

Type of BRD	Description	Examples	Use/Status in India
Hard BRDs	Rigid metallic grids or rods	Nordmore grid, Blubber-chute	Developed for small mechanized trawlers off Cochin; effective bycatch exclusion
Soft BRDs	Netting modifications (mesh windows, ropes)	Square mesh window, Bigeye BRD, Rope BRD	Bigeye BRD tested experimentally off Cochin
Combination BRDs	Mix of hard and soft materials	Various combinations	Not specifically detailed but part of Indian research
Marine Mammal Guide Nets	Inclined net panels to exclude mammals	Inclined net (BRD-type guide nets) panel with 30◦ and 45◦ tilt angles	Tested in South Korea, not reported for India

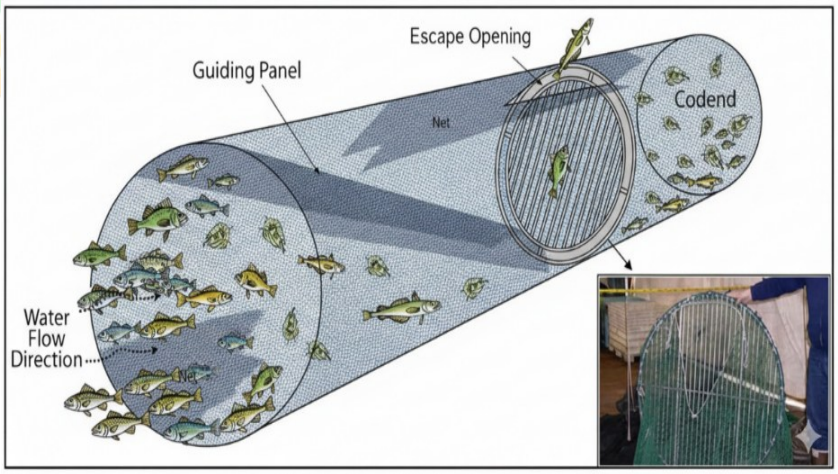

Fig. 1 Diagram of a typical rigid-grate (Hard BRDs) excluder showing shrimp passing through the device, while larger fish are blocked by the grate and escape through the opening (Source: Frimodig, 2008)

Limitations of Bycatch Reduction Devices (BRDs)

Bycatch Reduction Devices (BRDs) face several limitations that affect their overall effectiveness and adoption. Physical issues like clogging of grids with debris or vegetation can

reduce BRD functionality in certain habitats. In trawl fisheries, BRD performance can be influenced by environmental conditions and fishing practices, such as weather and haulback timing, which affect bycatch exclusion efficiency and target species retention (Broadhurst et al., 2011).

Additionally, some BRDs cause unintended catch losses of target species or smaller commercially valuable fish, complicating their acceptance by fishers (Silveira et al., 2024; Palder et al., 2023). Welfare issues are also raised for animals that manage to escape through BRDs; for example, small cetaceans could endure injuries or stress while attempting to escape, and the knowledge of their survival rates post-release is not well established (Dolman et al., 2022).

Conclusion

Bycatch Reduction Devices are essential tools that bridge the gap between profitable fishing and responsible stewardship of the sea. They offer a practical way to protect marine life without halting industry operations. For these devices to truly transform the industry, we must support the fishers who use them and continue improving the technology. Embracing these innovations is the only way to ensure our oceans stay healthy and productive in the long run.

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