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By-Catch and discards: An Overview

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Abstract

Bycatch and discards non-target species caught and often discarded—pose serious threats to global fisheries, especially shrimp trawling, which alone contributes about 27% of global discards. Gear like trawls, gillnets, and longlines capture fish, turtles, seabirds, and marine mammals, disrupting ecosystems, damaging habitats, and threatening biodiversity. In India, despite high bycatch, data and mitigation efforts remain weak. While technologies such as Turtle Excluder Devices (TEDs) and Bycatch Reduction Devices (BRDs) exist, poor enforcement and awareness hinder their use. Urgent ecosystem-based management and stricter adoption of bycatch-reducing tools are vital for sustainable fisheries and ocean biodiversity conservation.

Introduction:

Bycatch and discards, long-standing issues in fishing, have become one of the most critical challenges in modern fisheries. Discards threaten endangered species, waste resources, increase fishing costs, damage habitats, and disrupt food webs (Hall et al., 2000). They are now central to fisheries management debates from both economic and ecological perspectives (Alverson & Hughes, 1996; Alverson, 1997; Kelleher, 2005; Catchpole & Gray, 2010). Shrimp trawling alone contributes about 27.3% of global discards (Kelleher, 2005). Globally, annual average discards from marine capture fisheries between 2010–2014 reached 9.1 million tonnes, nearly half from bottom trawling, including shrimp trawls (Pérez Roda et al., 2019).

Discards, defined as the portion of catch returned to the sea dead or alive (Feekings et al., 2012; Viana et al., 2013), depend on fishing methods, species, sorting time, market value, storage, and fisher choice (Catchpole et al., 2014; Eliasen et al., 2014). Research since the 1980s has focused on discard estimation, bycatch-reduction technologies, and ecological consequences, reflecting global trends toward aquatic conservation. Case studies worldwide, including in developing countries, continue to highlight both fisheries species (finfish, crustaceans) and incidental catches of non-target animals like marine mammals, reptiles, and seabirds

Bycatch:

Different fishing methods produce distinct bycatch types and rates. **Bottom trawling** is highly unselective, capturing most organisms in its path. *Otter trawls* mainly catch demersal fish and epifauna,

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while *beam trawls* also impact infauna (Philippart, 1996). **Purse seines** for small pelagics have minimal bycatch, but tuna purse-seines in the eastern Pacific once caused ~100,000 dolphin deaths annually, reduced later by modified practices (Alverson et al.). **Fixed gillnets** are size-selective, yet location and season determine bycatch: Danish cod and turbot gillnets alone killed ~7,000 harbour porpoises yearly, while California sea lions showed entanglement rates up to 7.9% (Kock et al.; Dayton et al.) **Driftnets**, widely used for squid, tuna, and salmon, are notorious for high incidental catches due to their vast coverage. In 1990, Pacific squid driftnets killed 2–2.4 million elasmobranchs, mainly blue sharks (Bonfil et al.). **Longlines**, though moderately selective, often hook protected species: Spain's swordfish fleet caught at least 18,000 loggerhead turtles annually in the Mediterranean, while longlines remain the major source of shark bycatch on the high seas, exceeding 8 million fish each year (Bonfil et al.).

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Fig 1 Bycatch from Trawlers

Discards:

Discarding of fish and other organisms is widespread in global fisheries, driven by regulations (e.g., closed seasons, minimum sizes) and market economics, but fundamentally linked to the non-selective nature of fishing, which captures undersized or unwanted species. Most discarded organisms do not survive after being returned to the sea (Berghahn et al.; Van Beek et al.). Early estimates put global discard rates at 10% (6.7 million tonnes; Saila et al., 1993), later revised to ~27 million tonnes annually, about 20% of global catches and nearly one-third of reported FAO landings (Alverson et al.). The first discard estimates came from prawn trawling, with ratios of bycatch to shrimp catch ranging from 3:1 to 15:1 (Slavin, 1982; Andrew & Pepperell, 1992). Shrimp trawling remains the most wasteful, contributing over 21% of global discards (FAO, 2004). Alverson et al. documented that commercial

bottom trawling alone accounts for ~27 million tonnes of discards, exceeding half of the annual marine capture for direct consumption.

In India, reliable bycatch/discard data are scarce. The earliest CMFRI estimate (1979) reported that 79.18% (315,902 tonnes) of shrimp trawl landings were bycatch, with the highest proportions in Gujarat (92.6%), Tamil Nadu (91.0%), and Pondicherry (86.5%) (George et al.). Later CMFRI studies (1999–2000) showed target:bycatch ratios of 1:4.6 (southwest) and 1:1.26 (southeast). Kerala landings in 2000–02 recorded 2.25–2.62 lakh tonnes of discards, of which ~33–36% was edible (Kurup et al.). Despite such findings, systematic studies on bycatch and discards in Indian waters remain limited, leaving actual discard levels likely under-reported.

Impact of fishing and discards in the ecosystem:

Fishing activities and discards have far-reaching impacts on marine ecosystems, making their understanding vital for sustainable, ecosystem-based fisheries management (Borges et al., 2001). Bottom trawling, one of the most destructive gears, disturbs seabed habitats, altering benthic species composition; while some argue it may temporarily enhance productivity ("farming the sea"), others warn of long-term damage such as exposing buried organisms to predators (Jennings & Kaiser, 1998; Jenkins et al., 2004). Discards disrupt predator–prey dynamics and food webs, with consequences that remain poorly understood (Dayton et al., 1995; Hall, 1999), and may even weaken valuable fish stocks (Monteiro et al., 2001). Some seabirds have grown dependent on discards (Furness, 2003; Votier et al., 2004), although the low nutritional value of this food source can harm chick development (Grémillet et al., 2008). Similarly, scavengers like sharks and benthic organisms such as crabs, shrimps, and demersal fish consume discarded biomass, leading to short-term increases in their populations (Jennings & Kaiser, 1998; Sánchez et al., 2005). Long-term studies in the North Sea show shifts in benthic communities, with sensitive groups such as corals, sponges, starfish, and elasmobranchs declining, while opportunistic species thrive (Kröncke et al., 1998). Bycatch and discarding also pose serious threats to vulnerable species—sharks, rays, turtles, seabirds, and marine mammals—though survival varies; for instance, spotted catsharks showed a 78% survival rate in the Cantabrian Sea and skates 55% in the Bristol Channel, higher than most bony fish (Rodríguez-Cabello et al., 2005; Enever et al., 2009b).

By-catch reduction Devices:

The global expansion of shrimp trawling, driven by high economic returns, has raised serious concerns as nearly one-third of modern fisheries production is diverted to fishmeal and non-food products rather than direct human consumption, posing risks to food security in developing nations. A major problem lies in the incidental capture and discard of juveniles of commercially important species and other ecologically significant organisms, particularly in poorly studied tropical ecosystems where their removal could destabilize food webs and biodiversity. The efficiency of trawl nets, tied to seabed contact, causes extensive benthic mortality and underscores the need for gear modifications that

improve species and size selectivity. To address this, a range of By-catch Reduction Devices (BRDs) has been developed, most notably Turtle Excluder Devices (TEDs), which allow turtles and other non-target species to escape while retaining shrimp. While such technologies have proven effective globally, their implementation in India remains limited. The Central Institute of Fisheries Technology (CIFT) has designed innovative BRDs such as square-type window attachments, radial escapement devices, fish eyes, and grids with guiding funnels, along with the award-winning Juvenile Fish Excluder cum Shrimp Sorting Device, and a CIFT-TED mandated in Orissa through MPEDA. Despite legal requirements for a minimum 35 mm cod-end mesh size, trawlers in Indian waters often use 8–10 mm meshes, leading to excessive juvenile bycatch, as enforcement and surveillance remain weak. Ironically, research shows that large-meshed nets perform better along the Indian coast without significant reduction in catch (Nayak et al.; Vivekanandan et al.; Wileman et al.; Pillai et al.). Strengthening adoption and enforcement of BRDs and appropriate mesh sizes is thus essential to reduce ecological impacts and secure long-term fishery sustainability.

Conclusion:

The impacts of bycatch and discards on the marine ecosystem, although relatively well-documented in temperate waters and known to significantly affect marine biodiversity and ecosystem functioning, remain inadequately studied in tropical regions. In countries like India, the lack of baseline data regarding the quantity and composition of bycatch, limited knowledge on the biology and ecological roles of bycatch species, and methodological challenges—such as the absence of control sites or trawl-free zones pose major obstacles to developing effective bycatch mitigation strategies and policy frameworks. To ensure the long-term sustainability of oceanic resources, it is essential to adopt a precautionary approach that emphasizes the reduction of bycatch at the source, rather than focusing solely on the utilization of bycatch once it is caught.

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