Conservation and livelihood implications of trawler bycatch: Towards improved management

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Abstract

Mechanised fishing such as trawling was introduced in India in the 1950s to target high-value catch, driven by foreign interests. Trawling changed the face of Indian fisheries; while it caused an immense growth in marine production, it also brought about several environmental impacts. Bycatch, which is the incidental capture of non-target species, is one such consequence. Bycatch-related mortality is a major threat to marine wildlife such as turtles, cetaceans and sharks. In addition, juvenile fish and non-commercial species constitute a significant portion of bycatch in Indian fisheries. Although once discarded, these are increasingly sold to meet the rising demand for seafood and other products, as well as to offset the declining catches of high-value species. Trawling is increasingly shifting towards a biomass-driven fishery, with bycatch playing a significant role in the industry today.

Fisheries management in India has long focused on production and maximising catch, with conservation and sustainability as secondary concerns. Few regulations exist to mitigate and manage bycatch, with limited enforcement of the same. With the growing economic value of bycatch, fishers have little incentive to comply with these regulations. Management is further affected by a governance system that spans the Fisheries Department, under the Ministry of Agriculture and Farmers' Welfare, which aims to maximise production, and the Forest Department, under the Ministry of Environment, Forest and Climate Change which focuses on wildlife conservation.

This bycatch-driven fishery is not only a threat to marine biodiversity but is also unsustainable in the long-term, endangering the livelihood and food security of millions in the fishing community. A holistic approach that looks at the supply-demand drivers of bycatch can be key in regulating the fisheries sector. We also emphasise the scope and need for improvement in management, starting with appropriate policy reforms that account for the present bycatch economics in the country. While trawl fishing is the root of these problems, attempts to directly manage, reduce or even ban trawling have been met with little success.

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Addressing bycatch will not only alleviate some of these threats but may also be a means of better managing the trawl industry itself.

Keywords

Bycatch, Trawling, Conservation, Management, Livelihoods.

Background

The mechanisation of fisheries sector India in the early 1950s represented a turning point for the industry in the country. First introduced as part of the erstwhile Indo-Norwegian project (Gerhardsen 1958; Mathews 2005), trawl fishing aimed to increase food production and protein availability, as well as to target high-value catch such as shrimp, cephalopods and certain finfish (Jayasankar *et al.* 2000). High returns facilitated the spread of trawling across the coastline over the subsequent decades. Concurrently, as the economic gains from trawling became more evident, the focus of these fisheries gradually shifted from food production to foreign exchange, with shrimp especially exported in large quantities (Bhathal 2005).

Along with other advancements such as improved engine efficiency and boat capacity, trawling brought about an enormous growth in marine fish production (Somvanshi 2001) from 0.5 million tonne in the 1950s to 3.9 million tonne in 2012 (Dineshbabu 2013). This was a strong contrast to the subsistence-based fisheries in the country pre-1950. Mechanised crafts (trawlers and purse seiners) currently number 54,073 and account for about 75 per cent of the total marine fisheries production, which is a significant fraction considering that they constitute only 24 per cent of the total marine vessels in the country. The remaining 25 per cent of production is shared between 1,67,377 motorised and traditional fishing crafts, constituting 76 per cent of Indian marine fishing vessels (CMFRI 2015; Department of Animal Husbandry 2015).

While mechanised fisheries contributed to increased economic growth (Sathiadhas 2005), it introduced a host of ecological impacts in Indian waters. Trawling has led to the destruction of benthic communities and habitats like seagrass beds and coral reefs (Dayton *et al.* 1995; Kumar and Deepthi 2006). Trawl fishing has also been linked with depletions and collapses of fish populations globally (Myers *et al.* 1997) as well as in India (Mohamed *et al.* 2010). There is no dearth of evidence for the ill-effects of trawling, yet it remains one of the most widespread forms of fishing. Given the scale, economics and complex socio-political issues around trawling, any attempts to regulate or reduce this fishery have met with little success, calling for a more ancillary approach to the problem.

Bycatch is a central issue in trawling today. Traditionally defined as the non-targeted portion of the catch incidentally captured in fishing gear, bycatch is an inevitable component of the non-selective trawl nets (Alverson *et al.* 1994). It includes a diverse range of marine wildlife, from megafauna such as cetaceans, turtles and sharks, to invertebrates like crustaceans and molluscs. Fisheries bycatch constitutes one of the biggest threats to sea turtles (WWF 2017), with high mortality rates reported from different fisheries globally, including Odisha (Gopi *et al.* 2006; Pandav *et al.* 1997) and other states on the mainland coast of India (Shanker and Choudhury 2006). Many species of sharks and other elasmobranchs are declining due to fishing pressure (Dulvy *et al.* 2008), with half the global landings attributed to bycatch (Stevens *et al.* 2000). Over half the species in the Arabian Sea have been assessed as threatened (Jabado *et al.* 2018). These charismatic species have become flagships for marine conservation and bycatch management.

In tropical developing nations like India, trawlers apply nets with very small cod-end mesh sizes to maximise catch (Davies *et al.* 2009; Kumar and Deepthi 2006). This results in the capture of a large volume of juveniles as bycatch, particularly in shrimp

Figure 1: Distribution of crafts and marine fisheries production between mechanised and non-mechanised fishing vessels in India. Data from Central Marine Fisheries Research Institute (2015) and Department of Animal Husbandry, Dairy and Fisheries (2015).

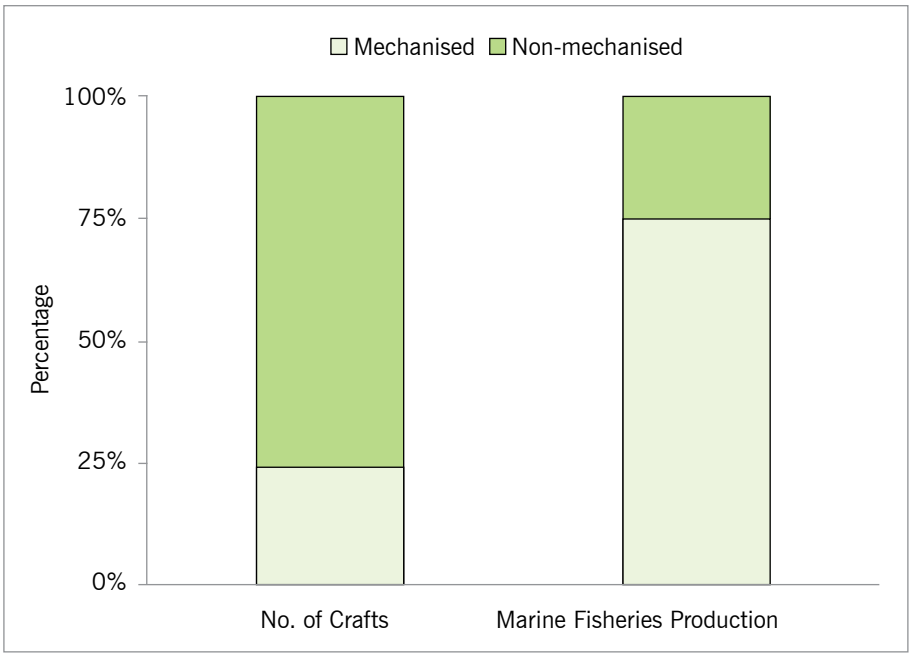
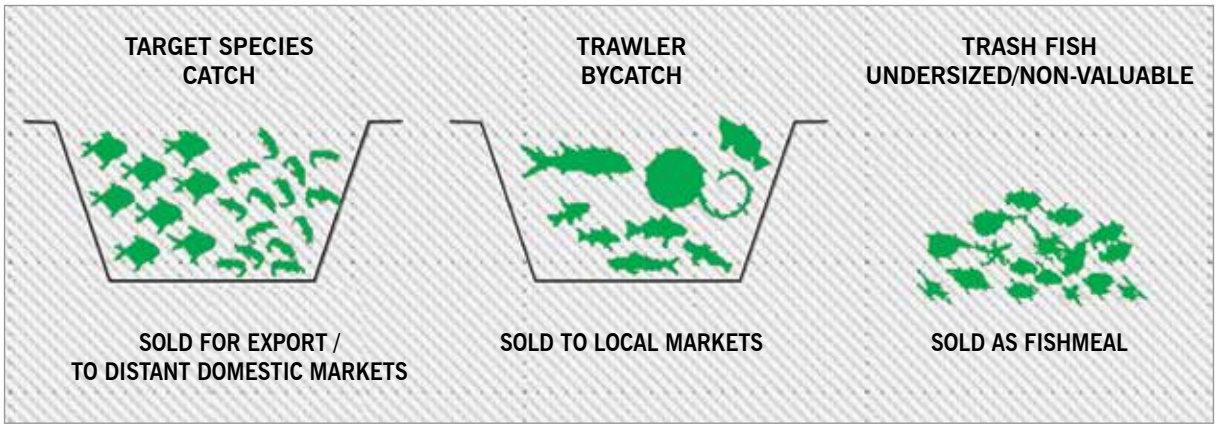


Figure 2: Different types of trawler catch. Adapted from Lobo (2012).



trawlers as exploitable quantities of shrimp occur in the same habitats used by juvenile fish (Bhathal 2005). This growth overfishing, i.e. capturing fish before they can grow, can potentially compromise the recruitment, and hence population growth, of the species (Funge-Smith *et al.* 2005). Trawler bycatch comprises 56–93 per cent of the total catch across the different maritime states in India (Kumar and Deepthi 2006). It is ever-present, irrespective of the presence and abundance of the target species. Increasing fishing pressure in India has resulted in overfishing and fishing down the food web (Bhathal and Pauly 2008), depleting inshore resources and increasing bycatch (Sathiadhas 2005).

Bycatch has emerged as a major conservation issue globally. Not only is it in need of immediate and serious action but tackling the bycatch problem may be a means of better managing the trawl industry itself. In this article, we broadly define bycatch as the entire range of non-target organisms, from megafauna to juvenile fish. We

Figure 3: Catch of one haul of a trawler

provide a brief account of the transformation of the trawl fisheries in India which has made bycatch a critical issue. We subsequently discuss limitations in the current fisheries management and provide recommendations for ameliorating management of bycatch, which can be beneficial for both coastal and marine biodiversity, as well as for the sustenance of local livelihoods.

Transformation of trawl fisheries

Due to minimal regulation, the early period of trawling was characterised by unchecked exploitation of marine ecosystems and large volumes of catch (Devaraj and Vivekanandan 1999). The huge quantities of inevitable bycatch were largely discarded due to a lack of commercial value (Alverson *et al.* 1994). The initial high supply, coupled with a rising human population, urbanisation and changes in macroeconomics of the country, increased consumption of and hence the demand for seafood (Aswathy *et al.* 2012; Salagrama 1998). At the same time, the export market for fish increased, with India's marine export rising from 0.3 million tonne in 1995 to 1.4 million tonne in 2017 (MPEDA, 2018). Trawl fisheries underwent major developments in the 1990s in response to this demand and high competition, with new areas of growth such as deep-sea fishing, expansion of target species with the introduction of the pelagic trawl and immense capital investments (Dineshbabu 2013; Salagrama 1998).

Perhaps one of the most notable transformations is reflected in the utilisation of bycatch. Quantum of discards have reportedly lowered over the past few decades, both globally and in the country (Dineshbabu *et al.* 2014; Kelleher 2005). This is because new markets for previously non-commercial or under-utilised species opened up. Hence numerous bycatch species started being commercially sold, either fresh or dried, to cater to these markets (Aswathy *et al.* 2012).

However, it was the industrial demand that spurred the growing utilisation of bycatch (Clucas 1997; Dineshbabu *et al.* 2014). Juveniles and small non-commercial bycatch species found an application as 'trash fish'. This refers to a mix of fish and invertebrates that have little to no direct commercial value and are sold primarily for fishmeal preparation,

used as aquaculture and livestock feed (Funge-Smith *et al.* 2005). India has seen massive growth in the poultry and aquaculture industries over the past two decades, greatly fuelling the demand for trash fish and bycatch, particularly from the mechanised fishing sector (Lobo *et al.* 2010). Trash fish landings were more than 50,000 tonne on the north-west coast of India in 2011, comprising an average of 33 per cent of a trawler's landed catch (Dineshbabu 2013). Trash fish links fisheries with poultry and numerous other industries, making bycatch a multi-sectoral issue. What started as a supply-driven industry now appears to be largely driven by demand from a rapidly growing market.

However, the ocean is far from an unlimited resource. Given the initial, unrestricted phase of trawling, many nearshore fishing grounds at present are either overexploited or rapidly reaching that state (Devaraj and Vivekanandan 1999). Indian waters presently support far more fishers and vessels than capacity, leading to declines in many high-value species and increasing effort per fishing boat (Devaraj and Vivekanandan 1999; Salim *et al.* 2014). While trawling in India was always a multi-species fishery, it has gradually transformed into one that targets, captures and utilises everything in its path, driven by quantity rather than quality. Bycatch is playing an increasingly significant role in this scenario and may presently be sustaining an otherwise declining trawling industry (Lobo *et al.* 2010).

Implications of a bycatch-driven fishery

Overexploitation of fisheries has serious impacts on marine ecosystems and hence local livelihoods. With bycatch supporting the prolongation of trawling, this practice may continue beyond the point of collapse of the target species, with little chance of recovery (Lobo *et al.* 2010). Declines of high-value species have been documented along the coastline, such as silver pomfret and whitefish along the south-west coast of India (Mohamed *et al.* 2010). Commercial bycatch is predominantly composed of small-sized species (Lobo 2012), which tend to be more productive and relatively resistant to fishing (Jacobsen *et al.* 2013). However, prolonged unchecked harvesting may be detrimental to their populations as well. Furthermore, trawling continues to pose a threat to vulnerable marine biodiversity such as turtles and sea snakes. For instance, high mortalities from trawling and subsequent declines in certain sea snake species have been documented on the west coast (Rao *et al.* 2017).

Impacts of this overexploitation are not restricted to trawl fishers. There are 4 million fisherfolk in the country and millions more employed in allied activities (Department of Dairy, Animal Husbandry and Fisheries 2015). 61 per cent of Indian fishers are below the poverty line (Ghosh and Lobo 2017). Declining fish populations put the long-term livelihood of this entire community at risk, particularly small-scale fishers who are highly dependent on inshore fish resources for their livelihood and food security.

Bio-economic management strategy

Economics and technology, rather than ecological principles, have largely determined how the marine ecosystem has been exploited (Hall *et al.* 2000). This stems from a long-held view by managers of marine life as 'produce' rather than wildlife (Sridhar and Namboothri 2012). Marine fisheries management across the globe has therefore been geared towards production and maximum yield, with conservation matters such as bycatch as a secondary concern.

Maximum sustainable yield, known commonly as MSY, has long been one of the guiding principles of fisheries management globally. MSY is the maximum level at which a resource can be safely and routinely exploited without long-term depletion (Maunder 2008). However, MSY has faced multiple critiques (Larkin 1977; Ramesh and Namboothri 2018), some of these being its disregard for natural fluxes in fish populations,

and its treatment of complex ecological systems as simple economic problems to maximise profit, resulting in poor management strategies. In spite of these and many other criticisms, MSY remains a key paradigm in fisheries management globally, including India. This profit-based strategy has allowed the growth and dominance of mechanised fishing in the country. There is a limited scope for the effective management of bycatch, sustainability, equitable distribution and other environmental and social matters in this framework.

Regulations of bycatch

With this bio-economic view, the main focus of Indian fisheries policy has long been to promote development, generate food and foreign exchange and reduce conflicts among sectors. Regulation and control of fishing effort and bycatch are relatively recent concerns. (Bhathal 2005). Multiple legislations, as well as technological innovations, have been developed in this regard. Mechanised fishing is prohibited within 5-10 km from the shore by the Marine Fisheries Regulation Acts of the different maritime states (Datta 2013). A minimum mesh size of 35 mm for the cod end (40 mm in Gujarat) is stipulated for trawler nets (Mohamed 2015). The state of Kerala has also legally specified minimum landing sizes for many commercial species (Basheer 2017). While these policies deal with the bycatch of juveniles and under-sized individuals, regulations such as seasonal and spatial closures aim to control the overall scale and intensity of fisheries (Datta 2013).

Bycatch reduction devices (BRDs) are structures inserted in fishing gear to reduce capture or enable the escape of non-target species from fishing nets (FAO 2002). Various BRDs such as the Turtle Excluder Device (TED) have been developed across the world for trawler nets to mitigate bycatch. In India, the Central Institute of Fisheries Technology (CIFT) has developed and tested BRDs such as the Juvenile Fish Excluder and Shrimp Sorting Device (JFE-SSD), focusing on reducing bycatch with minimal impacts on the catch of the high-value species (Pravin *et al.* 2013). Several states such as Odisha and Andhra Pradesh have policies mandating the use of BRDs (TEDs in particular), due to high rates of sea turtle mortality (Boopendranath *et al.* 2008).

With these seemingly comprehensive regulatory measures, commonly used across the globe in fisheries management, why is the bycatch problem still persistent? Implementation and enforcement of these regulations in Indian fisheries are inadequate, hindered by shortage of staff, poor monitoring and motivation (Johnson 2010). Most regulations are plagued with low compliance, with trawlers using nets with the cod ends as small as 8 mm, and frequently fishing illegally in shallow inshore waters despite prohibition (Kumar and Deepthi 2006). While most threatened megafauna (sea turtles, marine mammals and some species of elasmobranchs) are protected under the Wildlife (Protection) Act (Ministry of Environment and Forests 1972), there are few strategies in place to reduce their incidental capture. On-ground application of BRDs is nearly negligible; for instance, although mandated by law, trawlers in Odisha hardly use TEDS due to concerns of its potential impact on the catch (Rao 2011).

However, enforcement may well be a secondary issue. The source of this problem is that the existing regulations are not very relevant in the present fishing scenario. With the current biomass-based fisheries, there is little incentive for fishers to minimize bycatch. It is therefore not surprising that bycatch reduction measures are met with little success. We emphasize the necessity for a revision of the entire approach to bycatch management. With the lines between catch and bycatch becoming increasingly blurred, these traditional categories of target catch and bycatch are no longer applicable, particularly for trawl fisheries (Lobo 2012). The entire spectrum of the catch should be adequately

monitored, and regulations applied across all species, not just the high-value or charismatic ones. Furthermore, management approaches need to account for the economic role of bycatch and align the conservation of marine ecosystems with the interests and livelihoods of the fishing community.

We suggest that a comprehensive understanding of the present supply-demand dynamics in fisheries may be crucial in designing informed and effective strategies. Present regulations on fishing effort and gear impose a single standard across a range of fisheries. Bycatch rates, species and utilisation varies greatly with region, fishery, gear and local social and cultural norms. A 'one size fits all' approach may therefore not be the most effective at managing bycatch (Squires and Garcia 2018). Detailed research on the supply side of fisheries can provide a better understanding of these nuances and variations, and aid in framing more appropriate, case-specific regulations for bycatch management rather than broad legislation. Secondly, further investigation on the demand side is vital, focusing on the industrial drivers of fishing. Stronger controls on these driving forces paired with regulations on the supply end of the chain may be more efficient in tackling the fisheries problem in the country. For example, transparency and regulations on the use of fishmeal as feed in aquaculture can help better manage this portion of the catch (Huntington and Hasan 2009).

Integrated governance

Governance of fisheries and related aspects is shared between the Fisheries Department of the Ministry of Agriculture and the Forest Department of the Ministry of Environment, Forest and Climate Change (Lobo 2012; Project Seahorse 2017). The former aims to maximise production, with its primary tasks including fisheries development, production and welfare of the fisher community (Bhathal 2005). The Forest Department, in contrast, focuses on biodiversity and wildlife conservation. In the marine context, the department is responsible for the preservation of endangered species and vulnerable habitats such as turtles, corals reefs and mangroves, guided by the Wildlife Protection Act (Ministry of Environment and Forests 2006). Fisheries impacts such as bycatch span the duties of both departments.

Furthermore, fisheries monitoring and management within the Ministry of Agriculture and Farmers Welfare occurs across two centre-run institutes – The Central Marine Fisheries Research Institute (CMFRI) and the Fishery Survey of India (FSI) – as well as the state fisheries departments. While each of these bodies has a set of specific responsibilities, there is overlap in certain tasks such as catch data collection. Improved coordination across agencies and departments can facilitate the greater allocation of effort and resources towards bycatch (Bhathal 2005; Hornby *et al.* 2015; Sridhar and Namboothri 2012).

The way forward

Trawl fishing is one of the biggest marine threats across the globe. While there have been attempts at bringing about an outright ban on this form of fishing, this seems to be an unrealistic option given the sheer scale, ubiquity and complexity of trawling. The best practical solution is a policy intervention for immediate and effective regulation to curb trawling and mitigate its various impacts. Bycatch is one of the major consequences of trawling and is now emerging as one of its driving forces as well. Successful bycatch regulation can result in better management of trawl fisheries. In this article, we assessed the mechanised fisheries and bycatch scenario in India and detailed their negative impacts on biodiversity and livelihoods.

We suggest that a more holistic and interdisciplinary approach to bycatch management is urgently needed, starting with a larger focus on bycatch and conservation within fisheries management in the country. Trawling is increasingly shifting to a biomass-based, demand-driven fishery, and

policies need to be reformed to address this. Better research on the supply-chain drivers of trawling can lead to improved and more relevant bycatch measures over the entire fisheries chain and related industries. Greater cohesion and structure within and between governing bodies responsible for fisheries is also essential in strengthening bycatch management efforts. These measures can be instrumental in tackling the bycatch problem and alleviate the threat to marine ecosystems as well as the livelihood and food security of millions in the country.

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