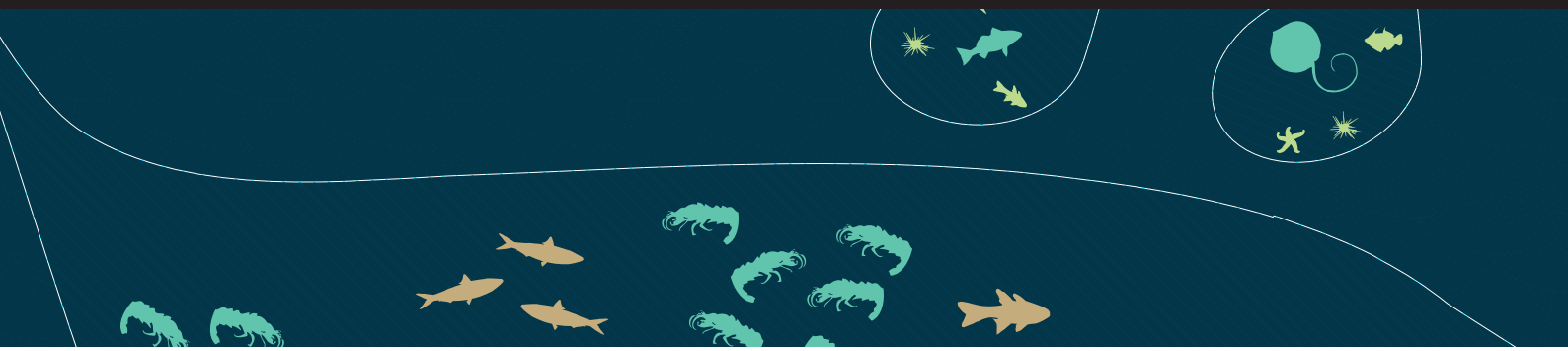

MANAGING FISHERIES IN AN OCEAN OF BYCATCH

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Understanding bycatch

The problem of 'bycatch' is recognised as one of the most pressing conservation challenges associated with the world's fisheries today, and one for which there are still no clear solutions. Bycatch commonly refers to the total catch of non-target animals that takes place in fisheries which set out to capture a particular species (e.g., shrimp) or a group of species. However, there has been considerable confusion pertaining to its definition. These definitional difficulties reflect the changes in our understanding of the composition of fish catch, the changing values in catch, evolving fisheries economies, and concepts such as 'target catch', 'trash fish', and high- and low-value species. These definitions are also influenced by an ecological understanding of marine species, and their order and interactions at various scales and trophic levels.

For example, the term 'discards' (the portion of the catch that is discarded at sea) is commonly regarded as being synonymous with bycatch in some countries and is conceptually considered to be a subset of the term bycatch (the total non-targeted catch landed on board a vessel). The term 'trash fish' is often also used synonymously with discards or bycatch but generally refers to very low-value fish (usually caught in trawl fisheries). All these definitions are highly dependent on ecological, economic, legal, and social influences, and this paper highlights the importance in recognising these shifts in definition while addressing the issue of bycatch.

CONVENTION ON BIOLOGICAL DIVERSITY (CBD) AND BYCATCH

The Aichi Biodiversity Targets of the CBD that are part of the Strategic Plan for biodiversity 2011-2020 articulate broad commitments for marine and coastal areas. Two of the Aichi Targets which pertain to bycatch are Target 6 and Target 7.

Target 6 on the sustainable management of fish and other marine organisms states: "By 2020, all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits."

Target 7 on sustainable aquaculture states:
"By 2020, areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity."

BYCATCH AND BIODIVERSITY

Bycatch is a major threat to marine biodiversity. An estimate (derived primarily from trawl fisheries) suggests that bycatch constitutes approximately 40.4% of the estimated annual global marine catch of 95 million tonnes (Davies et al. 2009). However, bycatch biomass estimates by themselves underplay the real magnitude of this problem. A diversity of species encountered as bycatch are differentially affected by the fisheries that capture them.

Bycatch related mortality is also among the main causes of declines of threatened marine megafauna including sea turtles, cetaceans, and sea birds (Lewison et al. 2004). Even seemingly resilient species can be threatened as bycatch, e.g., juvenile fish constitute a major proportion of the catch in tropical shrimp trawlers (Foster and Vincent 2010). This continuous removal of large quantities of juveniles as bycatch can impede the recovery of both target and bycatch stocks.

Bycatch also has a strong moral dimension to it since it has long been associated with discarding large quantities of useful fish protein (Kelleher 2005). Interestingly what was considered bycatch by the industrial fisheries sector was the commercially important targeted catch of the small-scale fisheries sector. In tropical countries like India with a diversity of fisheries and social groups, the problem of bycatch is certainly a normative one, raising questions about its implications for equity and justice in fisheries.

Considering that the small-scale fisheries sector contributes food to local domestic markets, the problem of bycatch is seen as the depletion of this food source for local consumption and therefore a threat to livelihoods and food security in general.

BYCATCH IN INDIA

In India, as in most tropical developing countries, the concept of bycatch is relatively new in management lexicon, and is often equated with the definition of bycatch adopted by developed nations which are characterised by highly mechanised and industrialised fisheries (Pauly 1996). In India, the term bycatch gained usage as a consequence of the gradual mechanisation of fisheries that took place after its independence, primarily characterised by the introduction of trawl fisheries. Up until the 1950s, the fisheries seascape in the country was one dominated by artisanal fishers, who fished primarily for subsistence and local markets (Kurien 1978). Their operations were basic and characterised by lack of engine power, limited storage facilities, and use of primarily passive gear which included stationary nets and lines.

The introduction of trawlers marked a paradigm shift in fishing behaviour. In contrast to artisanal fishers, trawlers were mainly driven by demands from export markets. They primarily targeted shrimp which they caught by dragging their non-selective gear (bottom trawl nets with small mesh sized cod ends) on nearshore fishing grounds. This resulted in the capture of a large number of non-target (bycatch) species which constituted a major portion of the catch. However, limited demand for bycatch, coupled with factors such as the limited storage space (primarily reserved for export quality catch) and the effort involved in sorting the highly mixed and diverse non-target catch led fishers to discard it altogether. Therefore, trawlers had high levels of discards in their early years.

Catch rates of threatened/charismatic species caught as bycatch in various fisheries in India

Taxa	Annual Catch	Region	Comment	Source
Sea turtles	~2574 individuals/year (Mean calculated for years 1997-1999)	Countrywide estimate	This estimate excludes the Gahirmatha coast of Orissa	Rajagopalan et al. 2006
	~9000 individuals/year (atleast 90,000 individuals were recorded between 1994 and 2004)	Orissa coast	Primarily based on counts of dead turtles washed ashore	Shanker et al. 2004
Cetaceans	9000-10000 individuals/year	Countrywide statistic	Estimate primarily restricted to gillnet bycatch	Yousuf et al. 2009
Sea horses	9.75 tonnes of dried sea horse/year	Countrywide estimate (based primarily on data collected from the three major sea horse landing centres, namely, Gulf of Mannar, Palk Bay, and Kerala)	Estimate based on bycatch landed from trawl fisheries as well as targeted harvests	Salin et al. 2005

In essence, bycatch could be looked at as a product of the marriage between technology and the market. A lot of what constituted the trawlers' bycatch was often important commercial catch of the artisanal fishers. Thus the term bycatch (if defined as comprising non-target species) is itself a misnomer in that it does not constitute non-target species across all fisheries. At the same time, new values are emerging for what was once considered 'trash fish' or 'discards'. This confusion in comprehensively defining bycatch has impeded efforts to estimate and officially manage it (Davies et al. 2009).

It was the capture and mortality of threatened species that brought the problems associated with bycatch to prominence across the world. In India, some of the charismatic threatened species encountered as fisheries bycatch include cetaceans, seabirds, sea turtles, and threatened species of fish including elasmobranchs (sharks, rays, and sawfish). For example, approximately 100,000 dead olive ridleys sea turtles were recorded as bycatch in fisheries off the coast of Orissa between 1994 and 2004 (Shanker et al. 2004). Many of these species have certain life-history characteristics that make them particularly vulnerable to fishing. For instance, many of them are air breathers, e.g., sea turtles, sea snakes, cetaceans, and sea birds, are generally long-lived, grow slowly, and are late to mature sexually, making it difficult for populations of these species to recover once depleted.

CONCERNS REGARDING BYCATCH

Fisheries development and bycatch

In order to adapt to depleting fish resources from nearshore waters, marine fisheries is now expanding to newer and relatively unexploited areas. The areas covered by fleets fishing in the continental shelf region expanded four times between 1970 and 2000 (Bhathal and Pauly, 2008). There has also been an expansion of pelagic fisheries for species such as tuna into the waters of the exclusive economic zone (EEZ), the introduction of deep-sea trawl fisheries, and an increase in trawler effort of the relatively underexploited seas off the two main island groups - the Andaman & Nicobar and the Lakshadweep, which have been prospected and declared as tuna rich waters. Most of the fishing gear that is promoted in these development programmes can potentially result in high levels of bycatch. Tuna longlining is known to result in the bycatch of sharks, billfish, sea turtles, and sea birds, and deep sea trawling targetting Solenocerid shrimp results in high levels of deepwater shark bycatch.

Small-scale fisheries and bycatch

The small-scale fisheries sector is another sector deficient in bycatch data. Although the small-scale sector has often been generalised as being a sustainable sector, in India this sector is large and currently represents a high diversity of crafts and gear. Over the years and through various incentive schemes, this sector has gone through rapid economic and technological transformations in its operations. This includes the widespread motorisation of crafts, the use of modern fishing gear, and the provisioning of storage facilities such as iceboxes. In fact some small-scale fisheries practices can be of particular concern to biodiversity. The small-scale gillnet fleets targeting tuna in India and Sri Lanka are responsible for high levels of bycatch which include dolphins, sea turtles, manta, and devil rays.

Commercialisation of bycatch

Although the practice of discarding bycatch continues, usually for protected species and to a certain extent in trawl fisheries, there is an increasing trend of bycatch commercialisation. In India, this trend can be attributed to several causes. These include:

1. Declining profits from target catch: The nearshore waters in

TRAWLER TARGET CATCH → Sold to export / distant domestic markets

CRUSTACEANS

Lobster
(*Palinurus spp., Thenus orientalis*)

Penaeid shrimp
(*Penaeus monodon, Penaeus simisulcatus, Fenneropenaeus indicus*)

Swimming crab
(*Portunus spp.*)

CEPHALOPODS

Squid (*Loligo spp.*)

Cuttlefish (*Sepia spp.*)

Octopus (*Octopus spp.*)

FISH

Pomphret (*Pampus argenteus*)

Sea perch (*Lates calcarifer*)

Snapper (*Lutjanus spp.*)

Emperor (*Lethrinus spp.*)

Barracuda (*Sphyraena spp.*)

Grouper (Epinephelus *spp., Cephalophis spp.*)

Threadfin bream (*Nemipterus spp.*)

Anchovy (Stolephorus *spp.*)

TRAWLER BYCATCH

COMMERCIAL BYCATCH → Sold to local markets as fresh or dried fish

MEDIUM SIZED FISH

Croaker (*Johnius spp., Panna spp.*)

Small carangids (*Decapterus russelli, Carangoides spp., Caranx spp.*)

Lizardfish (*Saurida spp.*)

Goatfish (*Upeneus spp.*)

Bigeye (*Priacanthus spp.*)

Spiny flathead (Platycephalidae)

Wolf herring (*Chirocentrus dorab*)

Batoid elasmobranchs (*Himantura spp., Dasyatis spp., Torpedo spp., Narcine spp., Narke spp., Rhinobatos spp.*)

TRAWLER TRASH FISH → Sold as fishmeal

SMALL UNDERSIZED FISH

Silverbellies (*Leiognathus spp., Secutor spp.*)

Sardine (*Sardinella spp.*)

Lizardfish (*Trachinocephalus myops, Saurida spp.*)

Cardinal fish (Apogonidae)

Leatherjacket (Monocanthidae)

Triggerfish (Ballistidae)

Puffer (Tetraodontidae)

UNEDIBLE CRUSTACEANS

Crab (*Calappa spp., Matuta spp.*)

Mantis shrimp (*Squilla spp.*)

ECHINODERMS

Sand dollars, urchins, starfish

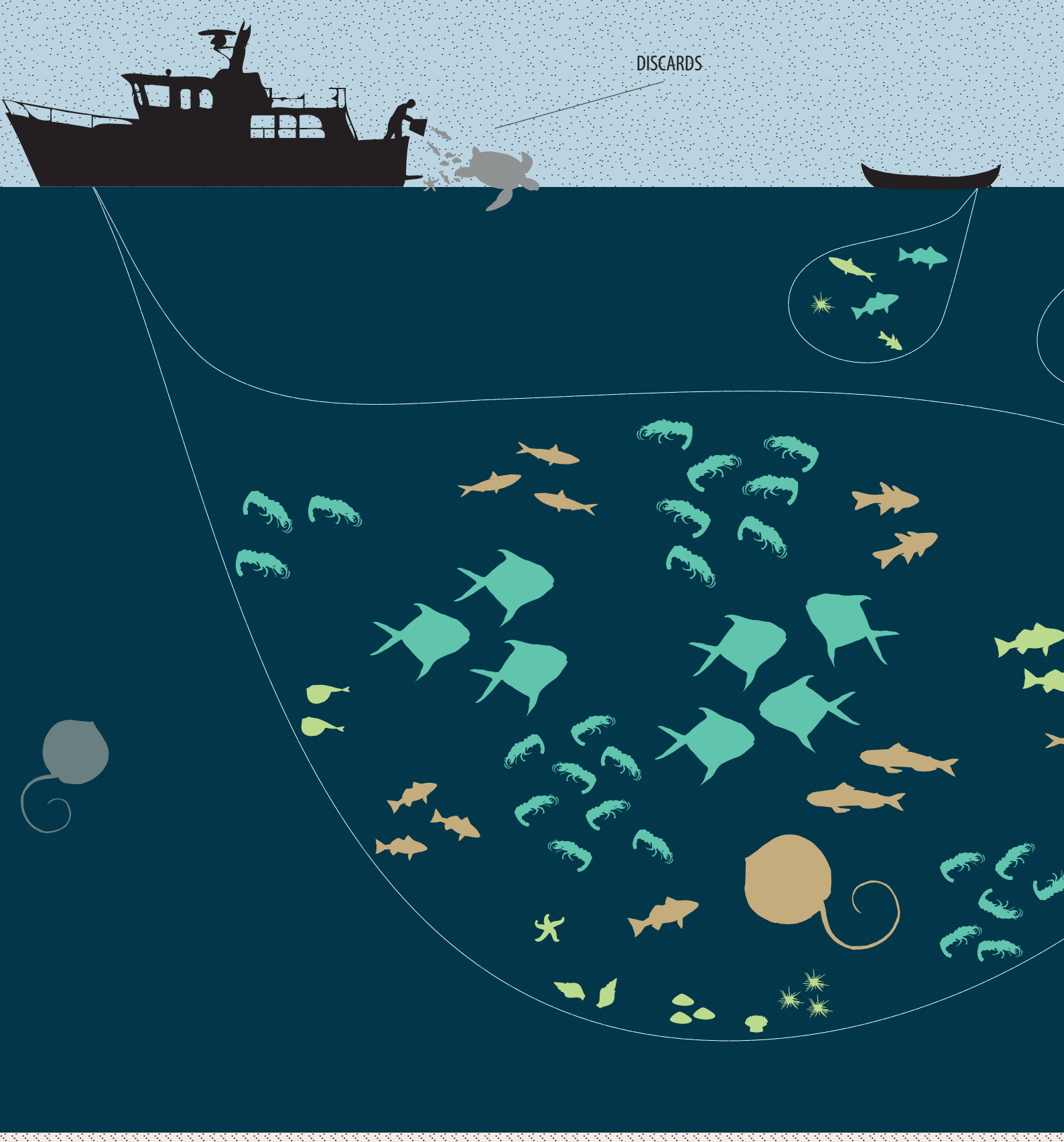
MOLLUSCS

Gastropods and Bivalves

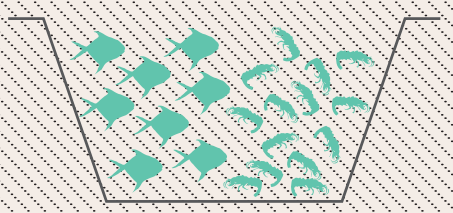
JUVENILES OF TARGET CATCH AND BYCATCH

LOW VALUE TRASH FISH CONSTITUTES **DISCARDS**

Data source: Lobo et al. 2010

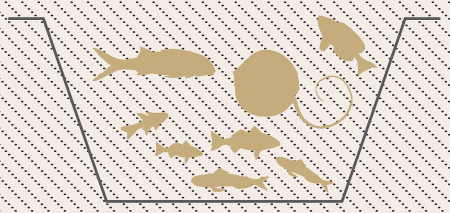


TARGET SPECIES
CATCH



SOLD FOR EXPORT /
TO DISTANT DOMESTIC MARKETS

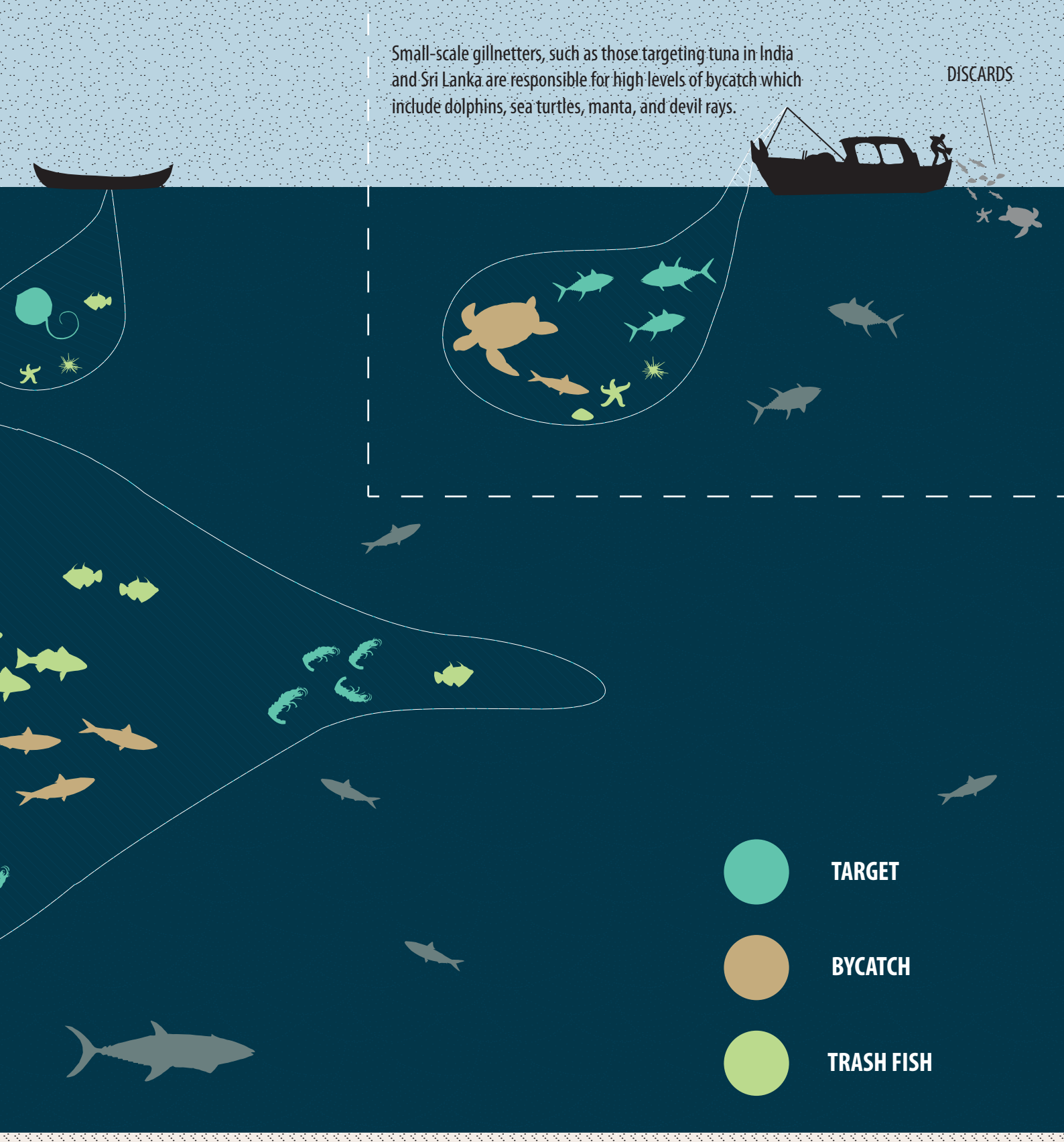
TRAWLER
BYCATCH



SOLD TO LOCAL MARKETS

TRASH FISH
UNDERSIZED / NON-VALUABLE

SOLD AS FISHMEAL



ONE MAN'S BYCATCH IS ANOTHER'S CATCH

India have been overfished and target stocks have depleted, which reflects on profit margins. This is especially true in fisheries such as trawl fishery, and has made fishers increasingly reliant on profits they make from the sale of bycatch which was earlier discarded.

2. New markets for bycatch species or products: There has been an increase in the demand and consumption of seafood in India. This has led to the generation of new markets for low-value species (formally considered 'non-target species') which were earlier not exported.

3. Fishmeal as feed in the poultry and aquaculture industries: Trash fish (very low-value fish) landed by trawlers were previously largely discarded at sea. However, trawlers are now landing trash fish in most parts of the country. This component of bycatch is dried and sold as low-value fishmeal to the poultry industry.

4. Considering most of the trawlers' bycatch have some economic value, the introduction of Bycatch Reduction Devices (BRDs) such as Turtle Excluder Devices (TED) have usually been met with high levels of resistance. Even along the coast of Orissa which harbours the largest nesting population of olive ridley turtles, trawler owners have strongly objected to the use of TEDs, because it brings about the loss of other valuable fish.

The commercialisation of bycatch may help sustain profits of a fishery that can no longer survive solely on the revenue from traditionally targeted stocks (Lobo et al. 2010). While this may appear positive, it is very likely that the bycatch stocks will be overfished as well, and the fishery will fish itself out of business. While this is a livelihood and social equity concern, it is also a pertinent ecological threat. Sustained by profits of low-value bycatch, exploitation of the higher value (traditionally targeted but now depleted) species can continue, thereby pushing them to extinction. This further facilitates the degradation of marine benthic habitats.

Schizophrenic policy approach

Another common pathology that plagues marine species conservation in the country has to do with the fractured orientation of policies. In India, while the State Forest Departments and the central Ministry of Environment and Forests shoulder the mandate of restricting and banning the harvest of certain marine animals, the State Fisheries Departments and the Ministry of Agriculture aim at maximising fisheries production. These appear as conflicting objectives and confuse management approaches. Contrary to the national claim of pursuing sustainable development, the maximisation of resource exploitation alone been achieved although inequitably and singularly through the industrialisation of fisheries (development of the trawling sector). The irony of this development trajectory is evident in declining fish catches.

POULTRY AND BYCATCH

The poultry industry: an invisible driver of overfishing?

The poultry industry is a growing driver for fishmeal in the country. Most of the trash fish bycatch landed by trawlers along the east coast of India is dried and transported to two of India's major poultry centres, namely, Chitoor and Namakkal. Fishmeal constitutes a cheap source of protein and is also an important source of crucial micronutrients, not easily available in other protein alternatives such as soyabean. Although fishmeal makes up only a small proportion of the chicken's diet, the poultry industry has seen a major growth in the country and can potentially result in the overfishing of nearshore marine resources.

RECOMMENDATIONS

1. Defining bycatch

In an attempt to sharpen the scope of management efforts to focus on bycatch issues, a recent paper defined bycatch as the catch that is either unused or unmanaged (Davies et al. 2009). While it could be argued that much of the fisheries of the world is not well-managed, and indeed much of trash fish itself has new markets and values, Davies et al's definition offers new possibilities. It accounts for discards and trash fish being subsets of bycatch but importantly recognises the dynamic nature of use and value in fisheries. It also suggests a strong normative approach by categorising products of unmanaged fisheries as bycatch. Such ideas should be tested within the context of tropical developing nations which themselves call for a re-orientation of ideas about bycatch.

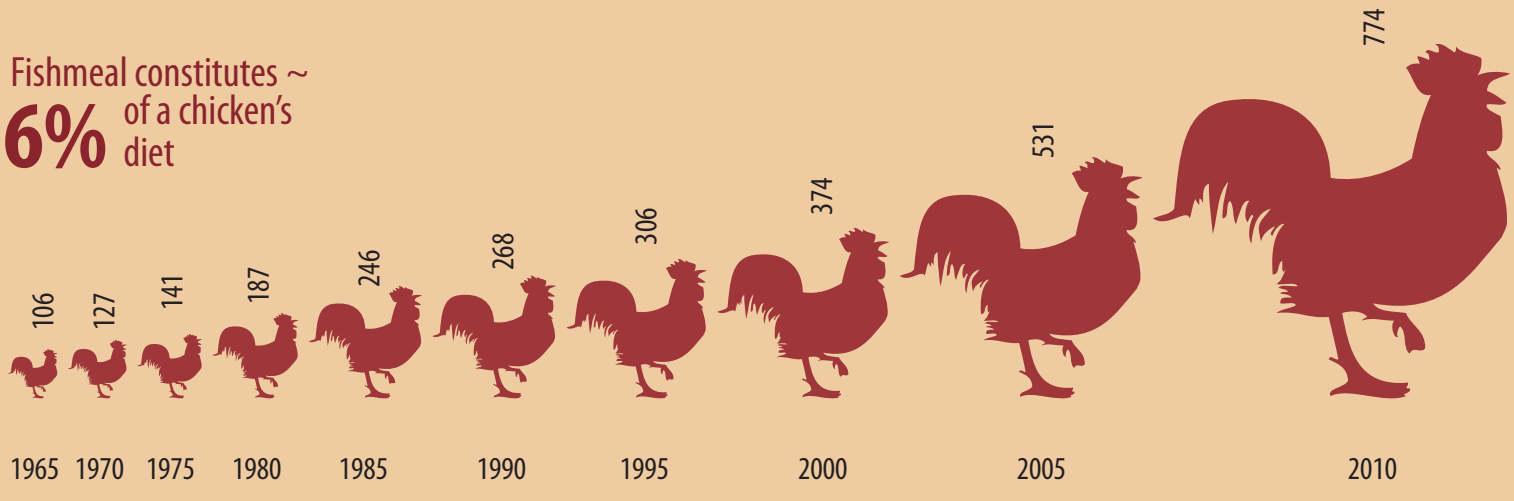
2. Reducing bycatch by reducing trawler effort

It has been well-documented that tropical trawl fisheries (especially bottom shrimp trawling) besides being a major ecological catastrophe are also a significant livelihood threat for small-scale fisheries. Analysed through its impacts on bycatch, this type of fishery needs to be brought under the scanner. Rules pertaining to the use of particular fishing gear via mesh size regulations, and restrictions on particular fishing methods such as paired trawling must be strictly enforced. Efforts should be made to reduce fishing effort through buyback schemes of vessels and fishing licenses. This can be an effective management strategy to address overexploitation of fish stocks and distributional issues. Buyback schemes can help restructure relations among fishers and create positive incentives that reinforce conservation and management objectives. Considering that the Indian nearshore trawling sector is on the decline because of rising costs and dipping profits, it is an opportune moment to experiment with such economic incentives especially in over-fished waters/ impoverished trawler harbours.

3. Research and Monitoring

- Mapping the bycatch seascape of the Indian Ocean for threatened species can help in demarcating spatial areas/ zones which need priority intervention in terms of bycatch of threatened species or magnitude of threat. Besides this, an assessment and categorisation of bycatch rates across the range of crafts and gear is required. Such an exercise should include a mapping of both threatened commercial fish species as well as other species including mammals,

The growth of the poultry sector in India expressed as the average number of live chickens (in millions)



Data source: Food and Agriculture Organization. http://faostat3.fao.org/home/index.html#VISUALIZE

reptiles, and birds.

- Bycatch (including discards, trash fish, non-target commercial fish, etc.) should be included in fisheries monitoring systems, to ensure that it is represented in fisheries statistics.

- There should be provisions to include trained onboard observers aboard vessels in areas or fisheries that are attributed to have particularly high levels of bycatch. This will help to obtain catch rates of endangered bycatch species and also to quantify discards in these fisheries.

- In continuation with the above, fisheries management needs to pay adequate attention to the small-scale sector to ensure that growing social inequalities and unsustainable practices do not go unaddressed in fisheries policy and implementation.

- Development of a database of life history traits of marine species encountered in fisheries in the Indian Ocean. This data will be crucial in understanding the underlying mechanisms that govern diversity and abundance of species and their vulnerability to different fisheries. This can then be used to conduct meta-analyses to identify and help prioritise areas that warrant further research. This can facilitate the development of a monitoring programme based on an indicator species approach, i.e., species that are affected differentially by fishing pressure. This can be particularly useful in the case of multi-species fisheries such as shrimp trawls.

4. Regional co-operation

There is a need for a regional approach rather than one based on political delineations, when it comes to the management of fisheries, marine species and ecosystems. This is pertinent, especially in the case of threatened and highly migratory species such as sea turtles, cetaceans, and other non-target species that are caught as bycatch. A good illustration of this issue is the problem of conservation of olive ridley sea turtles which nest along the east coast of India and which mass nest along the beaches in Orissa. These turtles migrate beyond the coast of Sri Lanka to reach distant foraging grounds. These turtles interact with a range of fisheries and are thus threatened as bycatch along the entire eastern and southern coasts of India (Pandav et al. 1998). The conservation of this important population of olive ridleys highlights the need not just for inter-state co-operation between the three coastal states of Orissa, Andhra Pradesh, and Tamil Nadu, but also one that calls for international co-operation and a integrated approach towards the management of turtle bycatch in common waters.

5. Fisheries certification

It is important to recognise and reward good fishing practices in the market place. Among the most popular seafood certification organisations is the Marine Stewardship Council. The Council certifies fisheries based on the sustainability of fish stocks, the level of environmental impact (one of the parameters is that the fisheries should have negligible/low levels of bycatch), and whether the fishery is being effectively managed. A fishery that comes close to meeting these criteria of sustainability is the pole and line skipjack tuna fishery in the Lakshadweep. However, it is important to recognise the dynamic nature of what constitutes bycatch and evolve incentive systems which recognise the moral, social, and economic implications of bycatch along with its ecological impacts.

It is equally important to understand that certification alone is not likely to bring about major improvements in the conservation of bycatch species. So far certification has primarily been effective in raising awareness among consumers (Ward, 2008). Its shortcomings are that it is seen primarily to market opportunities, and has rarely, if ever, helped the recovery of depleted species (Jacquet et al. 2009; Jacquet et al. 2010).

6. Horizon scanning

Recognising the positive correlation between greater fisheries development and increased bycatch, it is important to identify future issues pertaining to marine fisheries management in the country. This should be a collaborative process involving a range of stakeholders including researchers, fisher groups, and policy makers. Some of these key issues could include:

New fishing grounds and resources:

Identification of geographical areas and planning management strategies for fisheries that target new grounds is imperative. For example, a management plan for longline tuna fleets, which are presently encouraged to exploit resources in the

island groups of the Andaman and Nicobar and Lakshadweep, as well as the northern Bay of Bengal region and its exclusive economic zone could be developed.

New market-based drivers:

It is necessary to identify and predict the growth of new market-based drivers for marine resource extraction,—e.g., the fishmeal industry which relies greatly on trawl fishery bycatch to further feed poultry and aquaculture industries—and develop strategies to regulate these markets.

7. Synergistic policy

There is an urgent need for a comprehensive fisheries management policy that addresses the implications of technological changes in fisheries, and their potential impacts. Such an integrated view must develop regulatory mechanisms for markets which fuel unsustainable fisheries. India's experience with bycatch demands a well-considered and context-specific approach in devising legal definitions, tangible incentives and disincentives to minimise the negative social, ethical, and ecological impacts of bycatch.

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The views expressed in this paper are of the author and do not necessarily reflect the positions of his organisation.

Citation: Lobo, A.S. 2012. Managing fisheries in an ocean of bycatch. *Position Paper for CBD-COP 11*. Dakshin Foundation, Bengaluru and Foundation for Ecological Security, Anand.

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Design and layout: Seema Shenoy