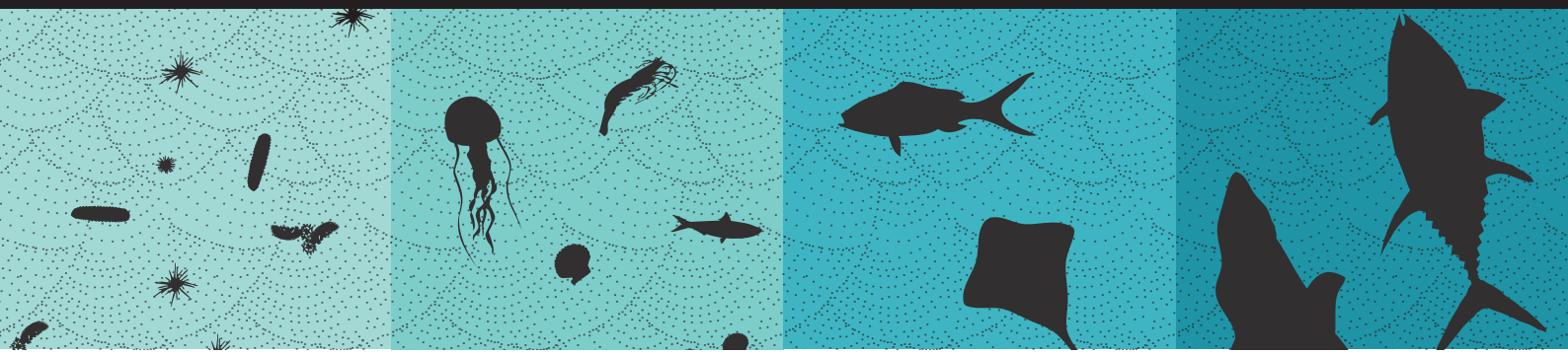

TAKING IT FROM THE TOP

MANAGING APEX PREDATOR FISHERIES IN INDIA

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In India, multispecies top predator fisheries, such as those targeting tunas, sharks, and groupers are undertaken on relatively small scales. These fisheries play an important role in sustaining livelihoods by enhancing food security, providing employment and associated economic benefits. Furthermore, the species targeted in these fisheries play a critical role in maintaining biodiversity and ecological structure thereby exerting an overarching influence on other types of fisheries and ecosystem functioning. Given their socio-ecological importance and in light of their growing global demand, adequate monitoring and appropriate management of marine apex predator fisheries is required.

Marine top predators account for the greatest biomass but also the least number of individuals. At the same time, their fisheries are highly valued across the world. These two aspects of marine top predator fisheries – low numbers and high value – make their management critical if they are to be extracted in a sustainable manner. The small stocks of top predators require management criteria and harvest limits that take into consideration social, economic, and ecological factors. Such factors include profiles of dependent fishing communities, access to resources and subsidies, markets, population trends and ecosystem dynamics. Overexploitation of top predators can lead to trophic cascades causing potential damage to other fisheries. Therefore sound fisheries management cannot afford to ignore how these specific fisheries work alongside others, in terms of gear types, spatial demarcations, temporal fishing patterns, social dimensions and ecological linkages. Majority of the tuna catch in India supports local markets, whereas sharks and groupers are mostly harvested for export purposes. Regardless, all three fisheries are rapidly moving towards over-capitalisation and this can have multiple effects on fishing communities. Social inequities arising from differential access to resources, income and subsidies may exacerbate the insecurities inherent in

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fishers' livelihoods. Specialised artisanal fishers would face great economic loss if the stocks that they depend on were to crash, potentially causing them to turn to lower value fish. Apart from the increased competition, other fishers from the community would also experience the indirect effects of predator loss through the resultant trophic cascades. Appropriate development of these fisheries would require strengthening traditional fisher rights and governance systems alongside adaptive and socio-ecologically sound management involving state and federal agencies.

This paper provides the salient features of the three top predator fisheries in India, detailing their management and socio-ecological features. Based on the available information, we have concluded with a list of recommendations pertaining to these fisheries.

COASTAL AND MARINE RESOURCES AND THE CBD

Although living marine resources sustain over 2.6 billion people across the world (http://www.cbd.int/marine/), the consequences of their removal remain poorly understood from multiple perspectives. These include impacts on the maintenance of biological diversity, long-term sustainable use for human well-being, and the changes induced by recent stressors such as global climate change. The Convention on Biological Diversity (CBD, 1992) along with global assessments such as the Millennium Ecosystem Assessment underline the need for understanding these issues further. The agenda for the 11th Conference of Parties meeting (Hyderabad 2012) further identifies key themes that relate to the maintenance of marine biodiversity and ecosystems as well as the use of these resources in a beneficial and equitable manner among various stakeholder groups.

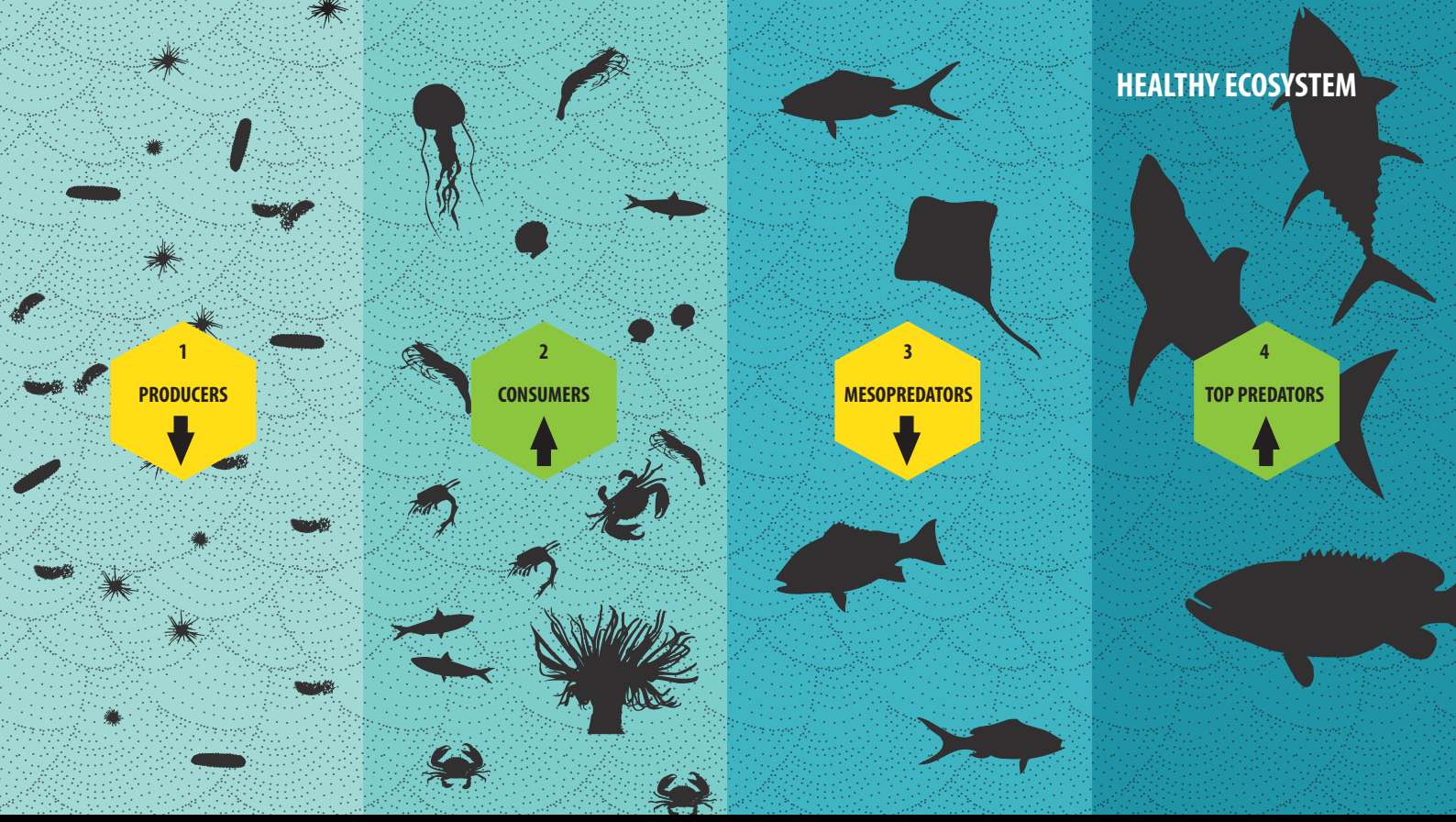
The Convention on Biological Diversity addresses a number of issues related to coastal and marine biodiversity and livelihoods and some of the general decisions of the Conference of Parties on coastal and marine biodiversity are applicable to top predator fisheries as well. Various meetings starting with COP II, encouraged the use of integrated coastal area management as the most suitable framework for addressing human impacts on marine and coastal biological diversity and sustainable use, and also encouraged parties to establish and/or strengthen institutional administrative and legislative arrangements as well as integrate these with national development plans. Signatories to the CBD are also expected to abide by the Food and Agriculture Organization of the United Nations Code of Conduct for Responsible Fisheries, and the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks. These are also related to sustainable fisheries, especially the elimination of illegal, unreported and unregulated fishery, as well as reducing bycatch and reducing discards. The adoption of an ecosystem approach and the scientific evaluation of key processes relating to the structure, function and productivity of marine ecosystems has also been highlighted by the Conference of Parties. Habitat level priorities of the COP agenda have also resulted in increased focus on coral reefs and other specific habitats. In recent meetings of the COP, the agenda has seen a distinct shift in focus towards the establishment of protected areas. While many of these recommendations were placed on specific COP agendas, they have been elaborated on during successive meetings. The social aspects of conservation as stressed by Article 8(J) and other provisions of the CBD also find mention in the agendas of various COP meetings.

MANAGEMENT CHALLENGES

Aside from landings data collected by the coastal state fisheries departments, catch data is maintained by the Central Marine Fisheries Research Institute (CMFRI) in India using a stratified random sampling method of landed fish catch since the 1950s. The Fishery Survey of India (FSI) has made assessments of oceanic stocks from exploratory surveys using longline and trawl gear. Lack of species-specific data on population size and growth rates make it difficult to accurately understand the ecosystem interaction of a predator fishery. At present fisheries are assessed based on the highly contested metric of Maximum Sustainable Yield (MSY). Even estimating MSY proves challenging given the absence of disaggregated catch data.

Outside of India's EEZ, there are a few regional fisheries organisations like the Indian Ocean Tuna Commission (IOTC), the Bay of Bengal Programme Inter-Governmental Organisation and the FAO's Bay of Bengal Large Marine Ecosystem Project (BOBLME) that work towards operationalising regional and global priorities outlined in conventions and agreements such as the UNCLOS, the Code of Conduct for Responsible Fisheries and the UN Fish Stocks Agreement. However, some of these multi-lateral agreements are of a non-binding nature and priorities outlined in these agreements are often neglected by member states[1].

Small-scale fishing fleets have always harvested top predators through multispecies fisheries in the tropics. Against a backdrop of poor design and implementation of official fisheries regulations, even traditional governance systems in these regions are unable to single-handedly control the rapid over-capitalisation in their fisheries. Such over-capitalisation in the exploitation of these commons can operate with dangerous consequences, where small-scale fishers dependent on limited top predator stocks find themselves marginalised by more affluent capital owning classes. Government policies that ignore the consequences of over-capitalisation in fisheries further exacerbate this situation of social and ecological distress.



TROPHIC CASCADES

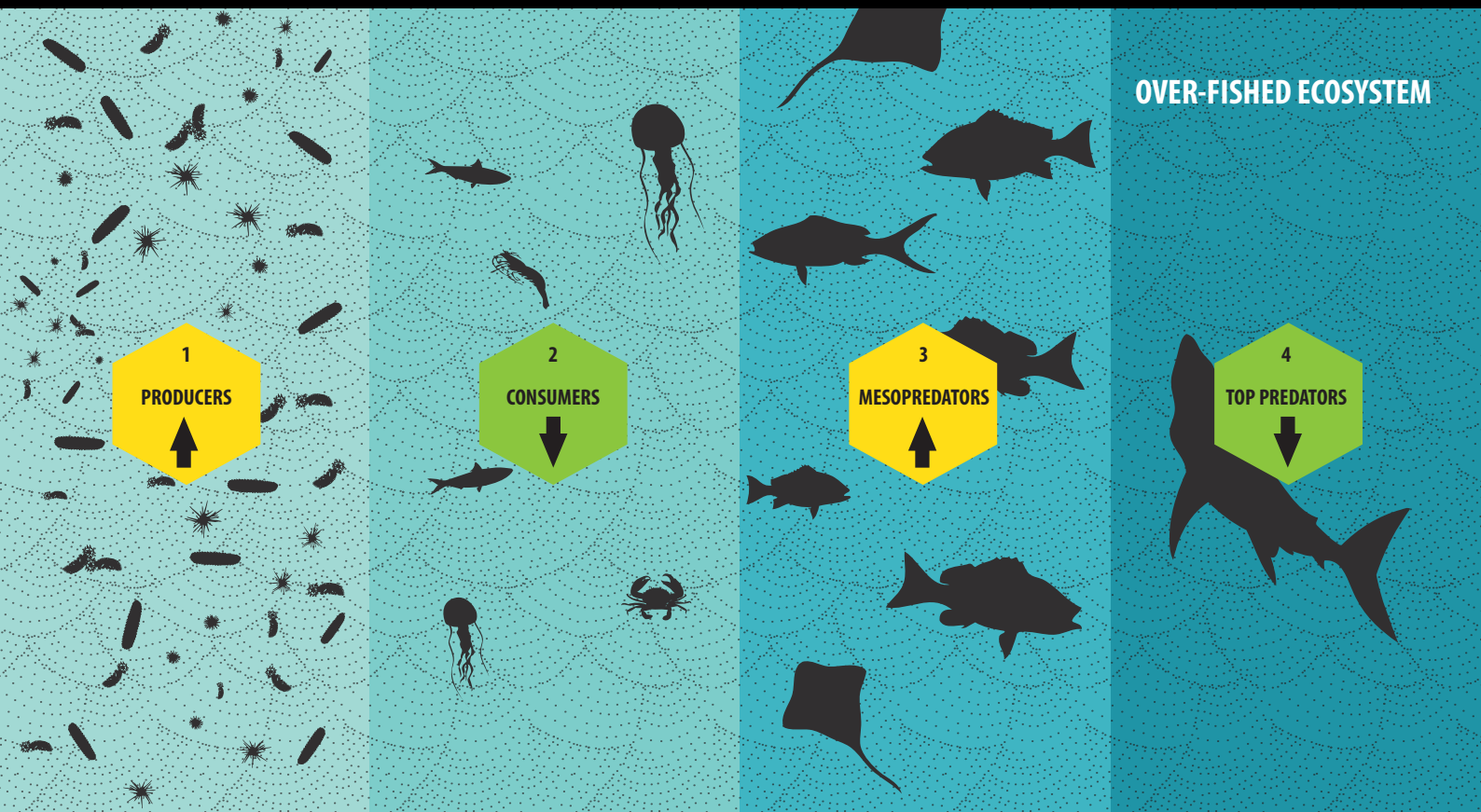
A trophic cascade is a change in the relative abundance of multiple species within a food web due to the removal of one. In particular, removal of top predators can often result in the increase of their competitors and/or prey with alternating negative and positive effects on the rest of the trophic levels.

MESOPREDATOR RELEASE

When top predators are removed this results in a sharp increase in the next lower level of species of mid-level predators, often resulting in unanticipated consequences for the entire ecosystem.

APEX OR TOP PREDATORS

Species at the top of the food chain, with few or no natural predators, capable of exerting top-down control on the ecosystem by directly keeping their prey populations in check and thus indirectly affecting multiple trophic levels. Shark, tunas and groupers are good examples of top predators.



← *A simplified representation of trophic cascades in healthy and over-fished ecosystems*

DO TOP PREDATOR FISHERIES CAUSE TROPHIC CASCADES?

Evidence of ecosystem impacts of top predator removals has been mounting in the Western Hemisphere. Take for example the sub-tropical case of the North Carolina scallop fishery that experienced a stock collapse due to increase in a mesopredator abundance, the cownose ray, that was driven by over 20 years of intensive harvest of large sharks[2]. The mesopredator populations grew unchecked in the absence of large sharks and being highly efficient at preying on scallops, clams, oysters; they were able to reduce bay scallop populations below economically viable levels leading to a closure of the scallop fishery. Over a broader scale, analysis of 50 years of Pacific longlining data has shown significant reductions in abundance and body mass of top predators like tuna, billfishes and sharks, and 10 to 100 fold increases in small bodied mesoconsumers like stingrays with uncertain consequences for open ocean ecosystems[3]. In some cases, removal of top predators have resulted in a short-term increase in the stock abundance for another fishery, as observed in the North Atlantic, where fishery induced collapse of top predatory Atlantic cod populations has led to invertebrate prey release supporting a booming American lobster industry. Unfortunately, today the American lobster industry is the sole financially feasible fishery in certain North Atlantic states, thus presenting significant risk given the instability of wild marine stocks[4]. The North Atlantic cod collapse has also lead to shifts in plankton communities, increase in smaller fish species and a general shift in dominance from fish to macroinvertebrates[3]. In the Caribbean, removal of groupers resulted in mesopredator release of smaller-carnivorous fish, such as hinds, leading to reduction in damselfish populations. Additionally, fisheries targeting parrotfish have shown to have significant top down impacts on benthic algae, leading to increased algal abundance and increased stress on coral reefs[5]. The limited understanding of trophic cascades and how they operate in the Eastern Hemisphere may be due to the lack of research, different levels of historical fishing or inherent differences in food webs that dilute the effect of top predator removals.

SCOMBRIDS: TUNA, BONITO AND SEERFISH

In India over 15 different species of high trophic level scombrids: tuna, seerfish, bonito and wahoo, are harvested on the small scale, using multispecies gear, contributing 4% to India's total marine capture production. Majority of the catch is marketed fresh and consumed locally; only a small portion is frozen, dried, salted or canned. About 23% of tuna and billfish catch fetching over 51 million USD is exported annually from India[6].

In India, over 98% of scombrid landings are from within the coastal zone that lies along the coast up to a depth of 80m. The coastal fishery uses multispecies gear such as gillnets, purse seines, hooks and line and troll line. A large portion of the coastal catch (>63%) comes from non-selective gear such as gillnets and purse seines[6]. The only species-specific target fishery exists in Lakshadweep where mechanised boats use live bait pole and line method to catch skipjack tuna. The oceanic fishery on the other had operates exclusively on longlining, it employs joint venture and Indian-owned vessels but has in the past chartered foreign vessels as well[7]. Since the 1960s there has been rapid growth of the Indian tuna industry and fishing ranges are being expanded to date without adequate monitoring or stock assessments.

Management and Regulations

Being highly migratory in nature, tuna fishery management requires the cooperation of all states and nations involved in their harvest. The Indian Ocean Tuna Commission (IOTC), formed in 1993, is an intergovernmental agency operating under FAO that is mandated to manage tuna fish stocks within the Indian Ocean - FAO statistical areas 51 and 57 (Western and Eastern Indian Ocean) and its adjacent seas. It relies on the joint action of member countries in assessing and regulating regional tuna fisheries. Resolutions adopted by the IOTC are not entirely of a binding nature and rely heavily on the governments of member states to implement various measures.

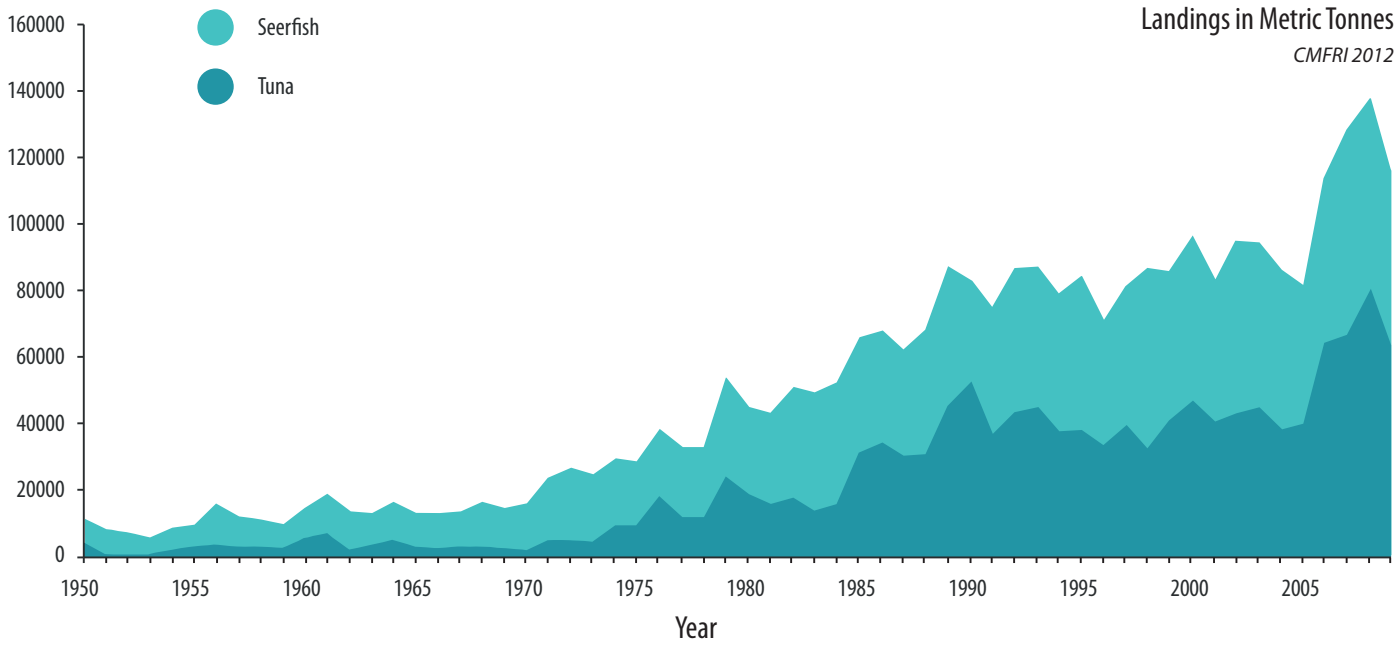
Of the species fished in the Indian Ocean, only four have been assessed, the albacore stock is subject to overfishing while the catch of yellowfin, skipjack and bigeye are believed to be maintained sustainably. However, declining catch in some areas has been a cause for concern[8]. The IUCN Red List classifies bigeye as Vulnerable and yellowfin and albacore as Near Threatened. At the same time, the current tuna yield in India is considered to be only 18% of the potential yield[9], stimulating the expansion of tuna fishing to deeper and distant waters. The Ministry of Agriculture and the Marine Products Export and Development Authority (MPEDA) are providing subsides for the conversion of existing vessels into longliners. To date 235 vessels have been converted under this scheme[10].

Currently the estimates for exploitation rates of Indian tuna are considered to be rather high[11], and without accurate population level data, the expansion of the fishery may prove to be problematic. No proper stock assessment exists for Indian tuna species, their population structure and migratory patterns. It should be noted that while searching the literature for this document, the authors found different estimates of landings of tuna and tuna-like fishes in India from FAO, CMFRI and the IOTC, these differences vary from a few 100 tonnes to over 10,000 tonnes. This may be due to difference in species designations, but regardless of the source it is difficult to identify accurate data. There is a need to improve catch reporting and monitoring as well as correct any errors that may exist in past datasets.

Livelihood Concerns

Declining tuna resources threaten fishing communities globally. Within the coastal states, though tuna and tuna-like fish do not constitute significant portions of the landings, the fishing practices used target multiple species. Any changes to harvesting methods for the conservation of tuna stocks may have strong implications for traditional livelihoods. In the Lakshadweep Islands, where tuna fishery is the primary marine product (>80% of landings), changes in fishing may result in serious socio-economic impacts[12]. Additionally, with the recent conversion of fishing boats to longliners in India, fishers may face financial downfall if fishing was to be regulated or banned.

Competition from foreign origin boats, working under the Letter Of Permit (LOP) scheme targets tuna on a large scale through industrial purse seining and longlining. Studies reveal not just a range of irregularities in the LOP operations but also caution that this scheme has resulted in large but unreported and unmonitored volumes of illegal catch[13]. Traditional tuna fisheries support small-scale fishers and provide local food security but the recent push for large-scale export-oriented

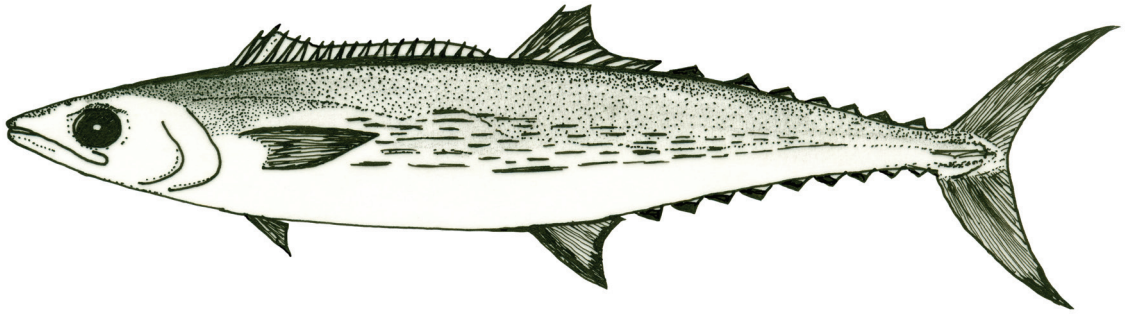


longliners may exacerbate existing inequities and power imbalances. Such government schemes should be designed only after due consultation with fisher associations given the ecological costs of such apex predator fisheries.

Ecological Considerations

There is limited ecological knowledge of the impacts of scombrid fisheries in India. In most cases multispecies fisheries using non-selective gear result in high volumes of bycatch. Purse seine fishermen identify schools by locating disturbed areas of the water surface, or by locating organisms that associate with tuna schools such as dolphins, porpoises, whales, prey species and birds thereby increasing the bycatch[14]. More recently, fisheries have started using Fish Aggregating Devices (FADs) or *payaos* to attract schools of tuna, but these devices do more than attract the targeted species, leading to higher bycatch. Longlining for tuna has high bycatch of sharks (28.3% by weight of total catch), birds, and sea turtles[15] that often goes unreported. The impact of these gears extends beyond the harvested species and thus requires evaluation. The only targeted fishery, the pole and line skipjack tuna fishery has minimal bycatch but is constrained ecologically due to the heavy use of lagoon forage fish as live bait[16]. This bottom-up impact of baitfish removal in sensitive coral reef ecosystems needs evaluation.

The ecological impacts of tuna removals in the open ocean are difficult to measure due to the high degree of spatial and temporal variability, sampling errors, as well as confounding factors such as the removal of forage fish, climatic drivers and environmental forcing. The evidence of trophic cascades, mesopredator release and prey increase is especially limited in the Indian Ocean. Impacts of Indian tuna fisheries on other fisheries such as herring, mackerel and invertebrate fisheries need further analysis.



SCOMBRIDS TUNA AND SEERFISH

102,131 tonnes
Average Annual Landings*

2%
India's Contribution to Global Landings+

Short lived
Fast growing
Early maturing

States with highest landings
Major market: Local

KEY SPECIES Narrow-Barred Seerfish, Little Tunny, Indo-Pacific Seerfish, Skipjack Tuna, Yellowfin Tuna, Longtail Tuna

GEAR SPECIFIC LANDINGS [a]

INTERNATIONAL ADVISORY BODIES
Indian Ocean Tuna Commision (IOTC), Convention on Migratory Species (CMS), IUCN Tuna and Billfish Specialist Group

ELASMOBRANCHS SHARKS

31,979 tonnes
Average Annual Landings*

9%
India's Contribution to Global Landings+

Long lived
Slow growing
Late maturing
Produce few young

States with highest landings
Major market: Foreign

KEY SPECIES Black Tip Shark, Black Reef Shark, Spottail Shark, Milk Shark, Spadenose Shark, Hammerhead Shark

GEAR SPECIFIC LANDINGS [b]

INTERNATIONAL ADVISORY BODIES
International Plan of Action (IPOA), Convention on Migratory Species (CMS), IUCN Shark Specialist Group

SERRANIDS GROUPERS

21,241 tonnes
Average Annual Landings*

?
India's Contribution to Global Landings

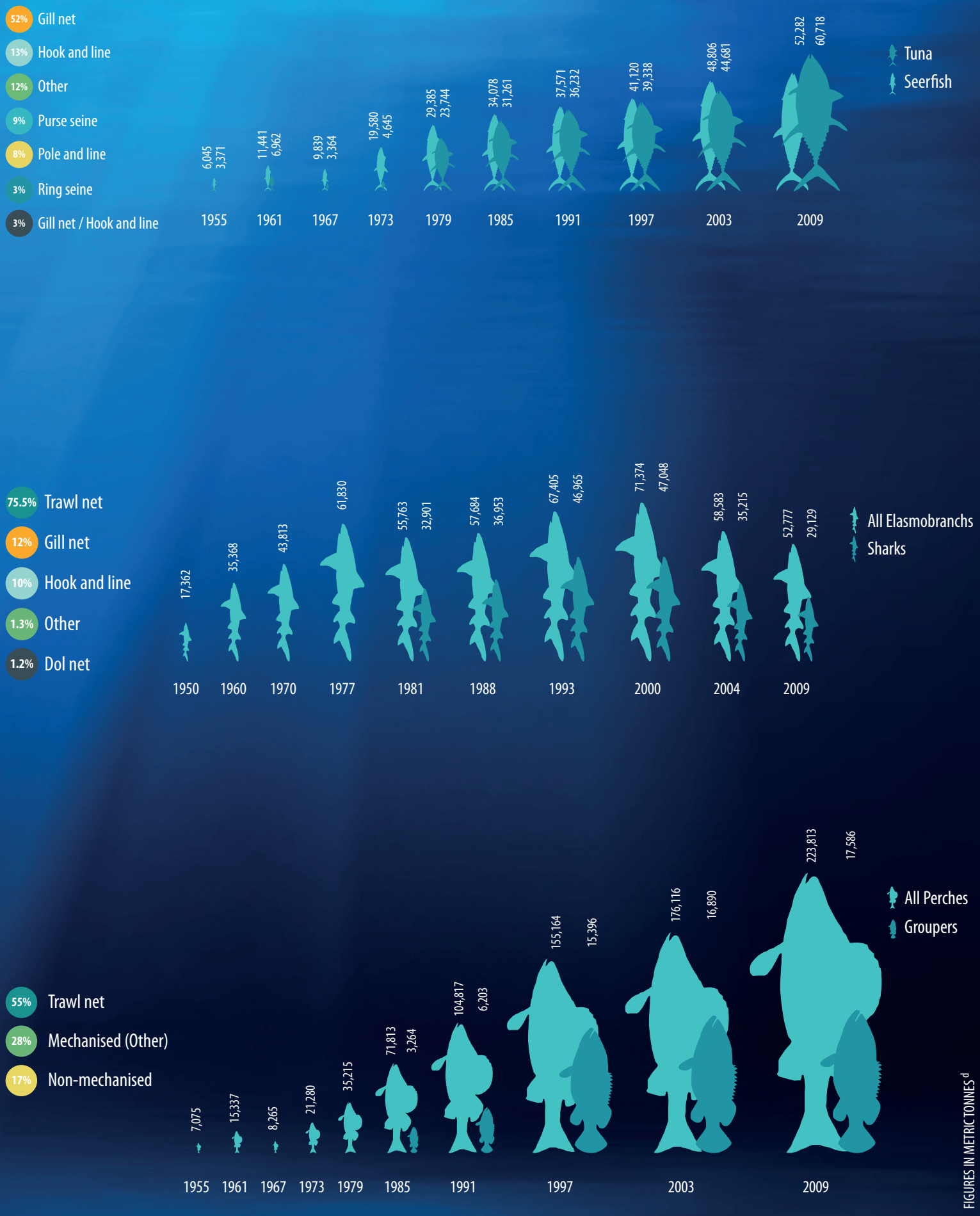
Long lived
Slow growing

States with highest landings
Major market: Foreign

KEY SPECIES Malabar Grouper, Greasy Grouper, Areolate Grouper, Spinycheek Grouper, Honeycomb Grouper, Orange-Spotted Grouper

GEAR SPECIFIC LANDINGS [c]

INTERNATIONAL ADVISORY BODY
IUCN Groupers and Wrasses Specialist Group



[+]Data: FAO [*]2000-2009. Data: CMFRI [a]Vijayakumaran & Varghese 2010 (6) [b]CMFRI Annual Report 2004-05 [c]James et al. 1994 (27) [d]Landing data: CMFRI Website, 2012

SHARKS

As apex predators that feed on a variety of organisms in marine systems, sharks are vital for ecosystem functioning and biodiversity maintenance. Sharks are targeted in India for the high returns that can be made from the export of their fins and meat. The distinctions between sharks, rays and skates in Indian elasmobranch landings were made only after 1981, but the data still lacks species-specific catch reporting.

Several types of gear are responsible for the incidental catch of sharks. Trawlers and gill nets have consistently recorded higher shark catches compared to selective gear like hook and lines[17]. Fishermen in Cochin, when faced with decreased catches in drift gill nets, switched to the more profitable hook and line fishing for large sharks and expanded their grounds beyond the 50m depth zone[18]. Traditional specialised shark fishermen also exist in India, with most hailing from the village of Thoothoor in Tamil Nadu. These fishers have migrated to major fishing centres along both coasts to catch sharks in offshore waters using set longline gear with steel leader wires attached to large hooks[19].

Trade volumes of shark and shark products originating from India are questionable owing to insubstantial record taking by MPEDA and large quantities of illegal and unreported trade continue to occur. Indian shark fin exports have been fluctuating for quite some time; however the industry has sustained itself due to the ever-increasing prices for fins that are fuelled by the high demand for shark fin soup in Southeast Asia. The export value increased from INR 13 million in 1985 to INR 70 million in 1994[17]. However, calculations of traded volumes of fins suggest that the MPEDA data are on average 5.18 times underreported[20]. Reports of smuggling of fins on airplanes from Chennai have also led to doubts about the actual volumes of trade[21]. Shark meat and liver oil have some demand in India and are also exported, but compared to the volumes and returns for shark fins, trade in these two items is minor.

Management and Regulations

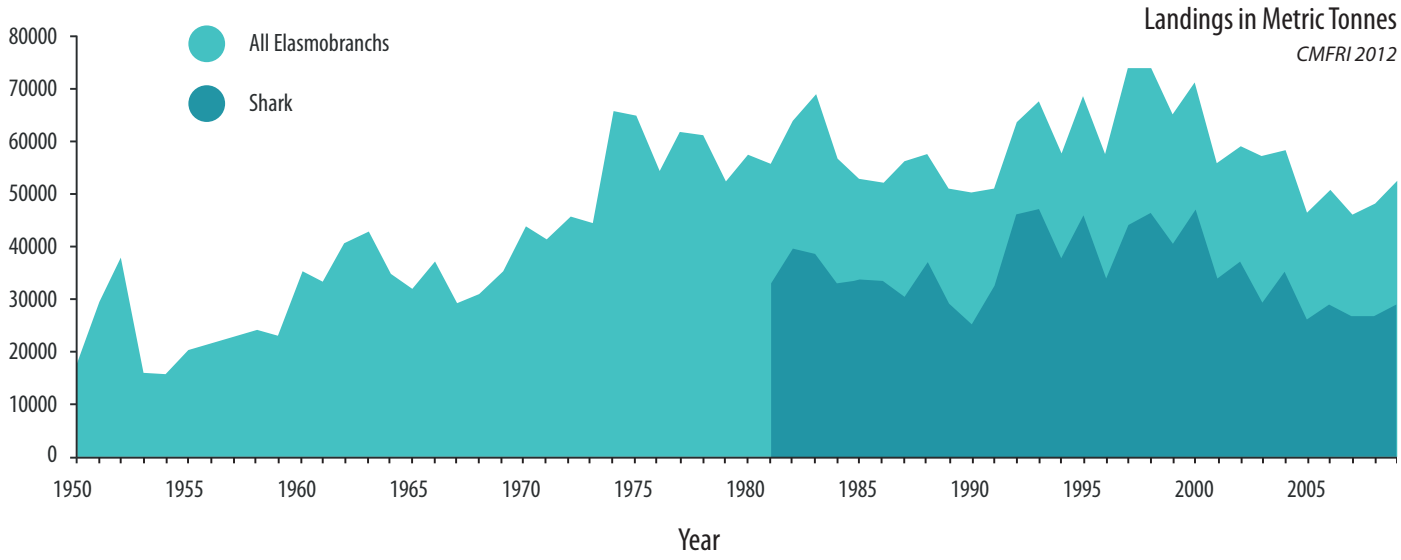
In 1999, members of the United Nations and the FAO created the International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks). Under the IPOA, member nations are expected to produce a National Plan of Action (NPOA) and Shark Assessment Reports (SARs) in order to provide a review of shark catches, management practices, policies, and status of species and stocks. India is yet to produce a SAR or a NPOA. However, India along with Sri Lanka, Bangladesh and the Maldives as part of the BOBLME is in the process of producing a NPOA and a Regional Plan of Action (RPOA). The current status of both is undetermined, but once developed; such documents may support the management of shark fisheries in the Indian Ocean.

In July of 2001, the Indian Ministry of Environment and Forests (MoEF) placed all elasmobranch species along with several other marine species under Schedule I of the Wildlife Protection Act, 1972. This resulted in a blanket ban on the capture, landing, and trade of any of these products. Prior to declaring this ban there was no consultation with fishermen groups and associated NGOs, nor was any consultation with CMFRI carried out. The ban was lifted in December 2001, by delisting all elasmobranch species with the exception of 9 non-commercial species including the whale shark. After the ban, researchers from CMFRI prepared a document describing the fishery and status of 47 species of sharks[22]. While this document made recommendations for managing certain shark species fisheries, no information on the socio-ecological dependence of fishers on them was provided. Thus, despite recommendations for regulating shark fisheries, no action has been taken to manage these vulnerable fisheries in the last decade.

Livelihood Concerns

Since a majority of sharks are caught as bycatch in Indian fisheries, it is difficult to estimate the number of individuals involved in the fishery and in allied activities. On an overall scale, it has been estimated that about 15,000-20,000 people are engaged exclusively in shark fishery in India and would have been affected by the 2001 moratorium[21].

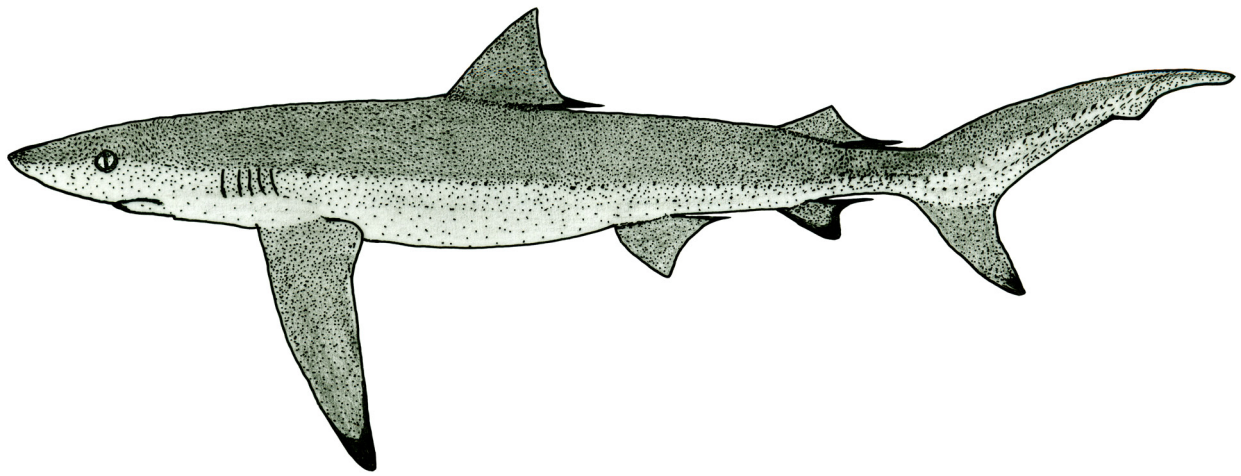
Looking at the only traditional shark fishery, the Thoothoor fleet totaled 200 boats during the peak season in the 90's, and currently consists of 500-600 boats manned by crew from Thoothoor and neighbouring villages[21]. These fishermen have invested significantly in modernising their craft and gear and have also organised themselves into associations such as the Association of Deep Sea Going Artisanal Fishermen. Faced with declining shark catches and financial instability, they



have expanded their fishing grounds and depths, making the practice of fishing for sharks all the more riskier.

Ecological Considerations

Due to the large quantities of sharks being caught as bycatch along the Indian coastline, population declines have been noticed. Using shark catch data from tuna longlining surveys conducted between 1986 and 2006, John and Varghese[23] noted sharp declines in the early 90's on both the east and west coast, with a decline in the late 90's around the relatively unfished Andaman and Nicobar Islands. Other studies along the coast have also recorded declines in shark catches over the years[24]. Combined with data of increased mesopredators landings[25] declining shark catches raise concern for ecosystem imbalances warranting conservation and management interventions. There is a need to study the ecological patterns and changes arising out of various forms and intensities of shark fishing.



GROUPERS

Groupers along with other fish families from a group called perches and are important resources in reef-based fisheries around the world, including India. Several fishing communities along India's coastline have devised indigenous fishing practices to exploit these resources. It is important to note that grouper or rock cod landings for government statistics (CMFRI data) are for the most part clubbed under perches and this is reflected in the export data from MPEDA as well. Groupers do not contribute substantially to the annual fish landings but grouper landings have been increasing steadily in the last decade.

Groupers are caught in a variety of gears including wooden traps, hook and lines, drift nets, gill nets, and trawl nets that can be operated from both mechanised and non-mechanised boats. Specialised and traditional fisheries for groupers continue to use selective gear like hook and lines in areas like Kerala and the Andaman Islands. However, large quantities of groupers, including juveniles, are increasingly being caught in trawl nets. In order to target groupers, trawl fishers in parts of the western coast have modified their fishing practices by increasing the trawled area and depths and consequently increased their effort from 274 hours in 1993 to 80,332 hours in 1996[26].

Groupers have a low economic value in local markets but fetch reasonably high prices from export. Juveniles and smaller individuals are sold at extremely low prices. It is the demand from the export markets in recent years that has resulted in the targeting of larger groupers and also altered the way in which they are sold. Groupers that would previously have been auctioned at local markets are now weighed and sold at the beach itself to merchants and middlemen at pre-fixed rates[27]. With the recently developed grouper fishery, the Andaman Islands are a site of a growing export industry of chilled and frozen perches.

Management and Regulations

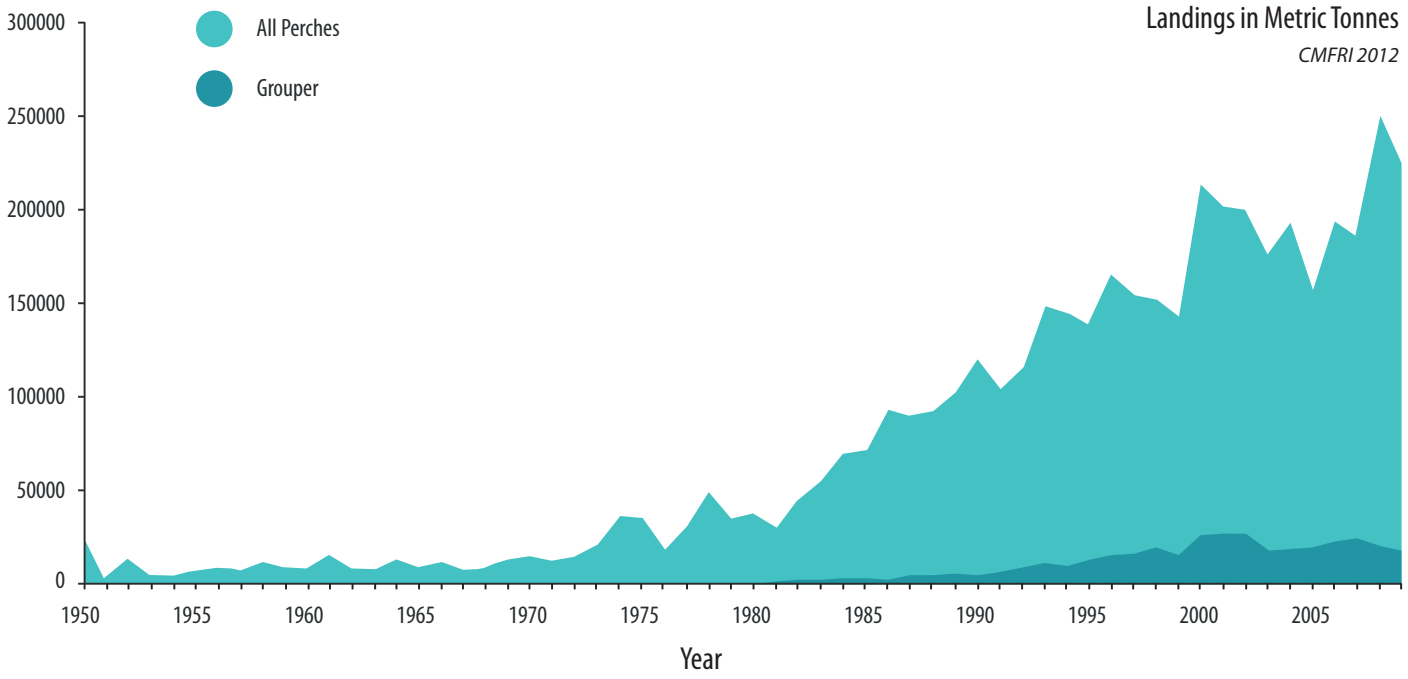
A study by the IUCN Grouper and Wrasse Specialist Group, determined that more than a quarter of grouper species face economic and ecological extinction presently due to unregulated fishing pressure and ineffective management practices[28]. Without management intervention, several grouper fisheries will not be sustainable in the future. There is limited management and regulation concerning grouper fisheries in India. It is pertinent to note that the only bony fish to be included in the Indian Wild Life Protection Act, 1972 is the giant grouper, *Epinephelus lanceolatus*. However several other species of grouper caught in India are on the IUCN Red List. *E. diacanthus*, a species endemic to the Western and Eastern Indian Ocean, is listed as Near Threatened due to the intense fishing pressure and high juvenile mortality that it faces. Without management action restricting the catches along the west coast, this species could soon be economically and ecologically extirpated[29]. Fisheries regulations in the country do not follow a system of declaring particular species protected and have not found creative means to devise management plans for important top predators either.

Livelihood Concerns

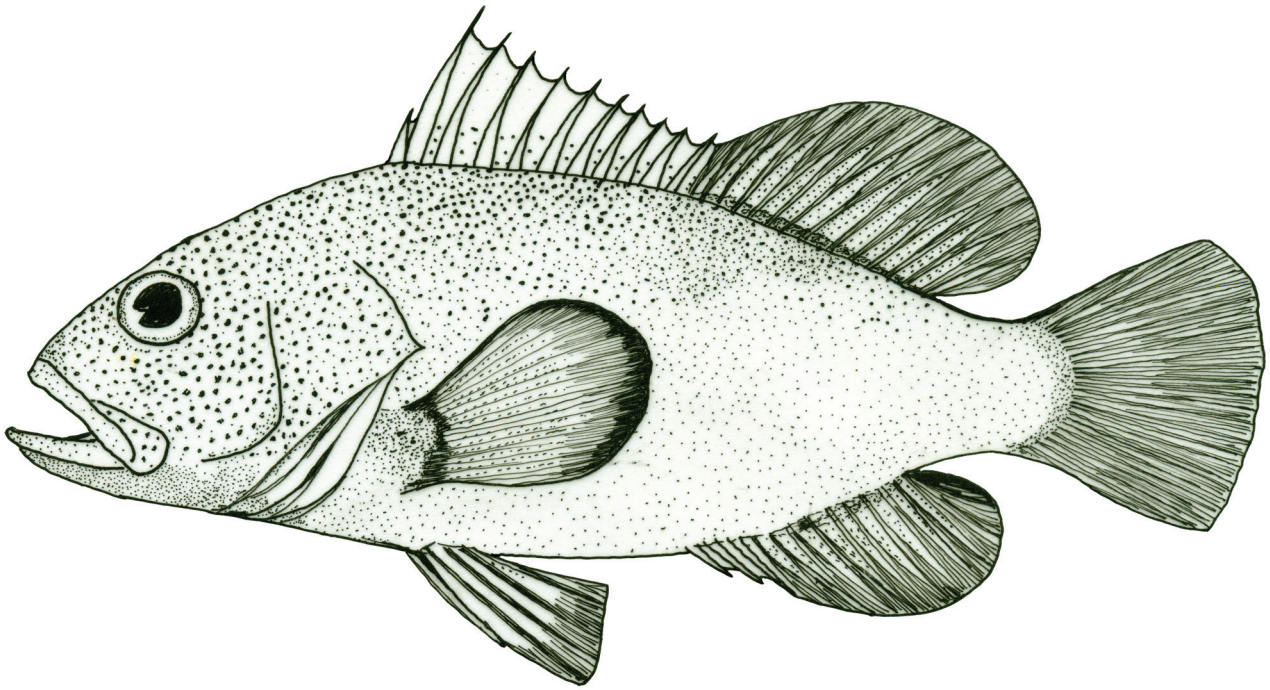
Despite the presence of a few targeted grouper fisheries scattered across the country, estimates of the number of fishermen involved in the fishery, both direct and indirect are scanty. However, groupers have played an important role in artisanal fisheries, especially in southern India, where traditional fishing grounds were named after the local name for grouper – *Kalava*. Both motorisation and mechanisation of the Indian fishing fleet have caused increasing numbers of fishers to enter the grouper fishery. However, unregulated entry of trawlers into the grouper fishery could severely affect artisanal fishers that are dependent on them. Grouper fishermen in India will be able to sustain themselves if the returns from the export sector are high and entry into the fishery is regulated amongst fishers.

Ecological Considerations

The resilience of coral reefs is intimately tied to that of marine predators such as groupers that use these systems. Sustaining healthy grouper stocks is essential in maintaining vulnerable coral reefs and reducing their susceptibility to climate change and ocean acidification. However grouper populations in Indian waters are starting to show signs of being overfished. *Epinephelus diacanthus* juveniles and adults have been caught



in high volumes in trawl gear along the south-western coast[26]. Given the increase in trawling effort and the fishing of newer grounds in recent years, some studies have recommended protecting the species[30]. Further studies on other grouper fisheries and species biology could highlight the need for management of these fisheries through sustainable solutions, while also protecting the coral reef systems that they are an integral part of.



RECOMMENDATIONS

Precautionary approach to fisheries management

In the absence of satisfactory data on top predator fisheries and the abundance of information on the effects of overexploitation of these organisms, a precautionary approach is prescribed. Such a precautionary approach could effectively manage top predator fisheries if modified to account for their life history characteristics, the nature of stock recovery and their role in ecosystems. Before future fishery regulations are implemented it is necessary to study their impacts on fisher livelihoods. The framework of this approach needs to be adaptive to accommodate new findings related to these fisheries. Such an approach could help prevent significant biodiversity loss and ensure continuation of fisher livelihoods.

Improvement in data collection and stock assessments

Improved data on landing statistics, fish stocks and trade volumes are necessary to predict the future of the fisheries and livelihoods that depend on them. Studies of top predator fisheries from around the world recommend strengthening catch records and stock assessments, given their ecologically vulnerable and often unpredictable trajectories. Obtaining information from varied sources such as fisher associations and experts in the field would also be beneficial, leading to a participatory approach to monitoring and management. Additional platforms for sharing detailed historical and current data need to be established.

Incorporating a co-management approach

Effective management of predatory fish stocks while sustaining the fisheries that depend on them might be possible in a co-management system where fishers regulate themselves within the sustainable harvest limits provided by government management agencies. Better participation in management from individuals at each level of a fishery would help identify and address the variety of issues that may result from sustainably managing predator fisheries. If anything, adopting a socially accepted management system for predatory fish stocks would be akin to using an effective yet precautionary approach to managing larger and more diverse fish stocks and their dependent fisheries at an ecosystem level.

Understanding the drivers of top predator fisheries in India

While foreign markets are significant drivers in the demand for marine top predators, there also exist within the Indian fishing community forces that are interested in greater access to returns from this fishery. Obtaining a holistic understanding of both these and other drivers is important to predict the future direction that these fisheries may be taking.

Management for the goal of social equity

When designing and implementing fisheries development and management schemes care needs to be taken to maintain equity between all sectors of the fishery and avoid the establishment of power imbalances that arise from increasing capitalisation of fisheries. It is also important to keep in mind which category of fishers benefit from the offered subsidies and whether this benefit is socio-ecologically sustainable. Certain fishery schemes and practices may have to be modified in order to achieve social goals of equity in development. Regulatory frameworks will have to be designed to target all economic stages of fisheries and all social groups involved in fisheries in a scientific, equitable and socially just manner.

REFERENCES

1. FAO. 2011. Review of the state of world marine fishery resources. FAO Fisheries and Aquaculture Technical Paper Rome No. 569. 334 pp.

2. Myers, R.A., J.K. Baum, T.D. Shepherd, S.P. Powers and C.H. Peterson. 2007. Cascading effects of the loss of apex predatory sharks from a coastal ocean. Science 315: 1846–1850.

3. Baum, J.K. and B. Worm B. 2009. Cascading top-down effects of changing oceanic predator abundances. Journal of Animal Ecology 78: 699–714.

4. Steneck, R.S., T.P. Hughes, J.E. Cinner, W.N. Adger, S.N. Arnold, F. Berkes, S.A. Boudreau et al. 2011. Creation of a gilded trap by the high economic value of the Maine lobster fishery. Conservation Biology 25(5): 904–912.

5. Mumby, P.J., R.S. Steneck, A.J. Edwards, R. Ferrari, J. Gibson, A.R. Harborne and R. Coleman. 2012. Fishing down a Caribbean food web relaxes trophic cascades. Marine Ecology Progress Series 445: 13–24.

6. Vijayakumaran, K. and S.P. Varghese. 2010. Update on the status of tuna fisheries in India. IOTC-2010-SC-Inf12. 6 p.

7. Somvanshi, V.S., N.G.K. Pillai and M.E. John. 1998. Current Status of fisheries for tunas and tuna-like fishes in India. 7th Expert Consultation on Indian Ocean Tunas, Victoria, Seychelles, 9-14 November, 1998, pp. 30–35.

8. IOTC, – SC14. 2011. Report of the Fourteenth Session of the IOTC Scientific Committee. Mahé, Seychelles, 12–17 December 2011. IOTC–2011–SC14–R[E]: 259 pp.

9. Ganga, U. and N.G.K. Pillai. 2006. Tuna resources of India - their potential and exploitation. In: Sustain Fish, School of Industrial Fisheries, CUSAT (eds. Kurup, B.M. and K. Ravindran). pp. 411–420.

10. John, M.E. and N.G.K. Pillai. 2009. Current Status of tuna fisheries in India. IOTC–2009–SC–INF05. 10 p.

11. Pillai, P.P. and G. Gopakumar. 2003. Tunas. In: Status of exploited marine fishery resources of India. (eds. Joseph, M.M. and A.A. Jayaprakash). pp. 51–59. CMFRI, Kochi, India.

12. Zacharia, S. 2007. Fisheries of Lakshadweep with special reference to livelihood issues. Technical Digest 10: 16–19.

13. Greenpeace. 2012. Licensed to loot: A Greenpeace India investigation on the letter of permit scheme. Greenpeace Report. 22 p.

14. Silas, E.G. and P.P. Pillai. 1982. Resources of tunas and related species and their fisheries in the Indian Ocean. CMFRI Bulletin 32. 190 p.

15. Vijayakumaran, K. and S.P. Varghese. 2011. India's national report to the scientific committee of the Indian Ocean Tuna Commission, 2011. IOTC-2011-SC14-NR09. 13 p.

16. Nasser, A.K., M. Sivadas, G. Gopakumar and P.P. Pillai. 2002. Tuna live-bait fishes – their exploitation, conservation and management in Lakshadweep. In: Management of Scombroid Fisheries. (eds: Pillai, N.G.K., N.G. Menon, P.P. Pillai and U. Ganga). CMFRI, Kochi, India. 148–154.

17. Devadoss, P., E. Vivekanandan, S.G. Raje, G. Mathew and S. Chandrasekar. 2000. Elasmobranch resources of India. In: Marine Fisheries Research and Management. V. Pillai and N.G. Menon (eds.). CMFRI, Kochi. pp 563–578.

18. Jayaprakash, A.A., N.G.K. Pillai and M.N.K. Elayathu. 2002. Drift gill net fishery for large pelagics at Cochin – A case study on by-catch of pelagic sharks. In: Management of Scombroid Fisheries. N.G.K. Pillai, N.G. Menon, P.P. Pillai and U. Ganga (eds). CMFRI, Kochi. pp 155–164.

19. Joel, J.J. and I.P. Ebenezer. 1993. Long-lining, specifically for sharks practised at Thoothoor. Marine Fisheries Information Service, Technical and Extension Series, 121. pp 5–8.

20. Hausfather, Z. 2004. India's shark trade: An analysis of Indian shark landings based on shark fin exports. Marine Studies (MAST) 3(1): 25–39.

21. Vivekanandan, V. 2001. An Ill-Thought Ban. Samudra 30: 3–9.

22. Raje, S.G., S. Sivakami, G. Mohanraj, P.P. Manoj Kumar, A. Raju and K.K. Joshi. 2007. An Atlas on the Elasmobranch Fishery resources of India. CMFRI, Spl. Publ. No.95. 253 p.

23. John, M.E. and B.C. Varghese. 2009. Decline in CPUE of Oceanic Sharks in the Indian EEZ: Urgent Need for Precautionary Approach. In: IOTC Working Party on Ecosystems and Bycatch; 12-14 October 2009; Mombasa, Kenya. IOTC-2009-WPEB-17. 10 p.

24. Hanfee, F. 1999. Management of shark fisheries in two Indian coastal states: Tamil Nadu and Kerala. In: Case studies of the management of elasmobranch fisheries. Shotton R. (ed). FAO Fisheries Technical Paper No. 378, Part 1. FAO, Rome, Italy. pp 316–338.

25. Mohanraj, G., S. Rajapackiam, S. Mohan, Hameed Batcha and S. Gomathy. 2009. Status of Elasmobranch Fishery in Chennai, India. Asian Fisheries Science 22: 607–615.

26. Zacharia P.U., H.S. Mahadevaswamy, S. Kemparaju and G. Sampathkumar. 1997. High abundance of large sized rock cods (*Epinephelus* spp.) off Karnataka coast during the postmonsoon month of September. Marine Fisheries Information Service, Technical and Extension Series, 147. pp 10–12.

27. James, P.S.B.R., S. Lazarus and G. Arumugham. 1994. Present status of 'major perch' fisheries in India. Bulletin of Central Marine Fisheries Research Institute 47: 1–10.

28. Sadovy de Mitcheson, Y., M.T. Craig, A.A. Bertoncini, K.E. Carpenter, W.W.L. Cheung, J.H. Choat, A.S. Cornish et al. 2012. Fishing groupers towards extinction: a global assessment of threats and extinction risks in a billion dollar fishery. Fish and Fisheries 448: 93–104.

29. Jayasankar, P., J. Jayasankar, C. Anand and S.K. Augustine. 2007. Information on *Epinephelus diacanthus* from Indian seas. Newsletter of the Groupers and Wrasses Specialist Group, 10: 9–11.

30. Manojkumar, P.P. 2005. Fishery of the spinycheek grouper, *Epinephelus diacanthus* (Valenciennes) off Calicut along the Malabar Coast. Journal Marine Biological Association of India 47(1): 63–69.

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