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# Guidance on
# National Plan of Action for
# SHARKS IN INDIA

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Indian Council of Agricultural Research
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# FOREWORD

India is one of the major shark fishing nations of the world, contributing to about 9% of the global catch of sharks during 2000-2009 with an average annual production of 54,614 t. Sustainable shark fishing was practised in India by artisanal fishermen before the introduction of mechanised fishing, which led to sharks being landed as by-catch. Later, in the 1990s, targeted shark fishing began when the demand for sharks increased in international markets. Although there was increase in shark catches initially there has been a consistent decline in the last one decade which has raised serious concern on this resource.

In 2001, India joined other nations in conserving sharks by protecting ten species under Schedule I of the Indian Wildlife (Protection) Act, 1972. India is also a signatory party to the recent CITES Appendix II listing of 5 species of sharks (of which 4 species are commonly found in Indian waters) and 2 species of manta rays, thereby initiating regulation of fin and gill plate trade in these species. Shark finning and export/import of shark fins are also prohibited in India. However, strategies to avoid protected or trade-regulated species from capture in directed as well as multispecies fisheries do not exist.

The Central Marine Fisheries Research Institute has served as a pioneering research institute in India working on fishery dependent data analysis for resource assessment of sharks along the Indian coast. Being a major shark fishing nation, it is important that India should evolve a National Plan of Action for sharks (NPOA-Sharks) and participate actively in their conservation and management. This book entitled **"Guidance on National Plan of Action for Sharks in India"** is prepared in line with the International Plan of Action for conservation and management of sharks (IPOA-Sharks) developed by FAO. It is intended as a guidance to the NPOA-Sharks. Development and implementation of the NPOA-Sharks calls for integrated research and discussion between R&D organisations, Government agencies, NGO's and stakeholders including fishermen, traders and exporters.

This document presents an overview of the shark fishery in India, current management measures, knowledge gaps to be addressed and suggested action plan for shark fishery management. In pursuit of ensuring sustainable fisheries of sharks, CMFRI will continue its research focusing on the judicious exploitation of sharks from Indian waters. This document assumes importance in the light of the attention shark resources are gaining worldwide and the increasing awareness of the need to ensure their sustainable exploitation and conservation.

Kochi, India
11 June 2015

**A. GOPALAKRISHNAN**
Director

# CONTENTS

# EXECUTIVE SUMMARY

India is one of the major shark fishing nations in the world and currently stands at the second position, next only to Indonesia. According to FAO statistics, India's contribution to the global catch of sharks during 2006-2009 was 9%. Targeted shark* fishing in India started when market demand for this commodity increased in recent years. Today, an increase in the number and efficiency of fishing boats, directed fishing and expansion of fishing areas, and multi-day, deep water shark fishing have become a prevalent practice in Indian waters. An initial rise in shark catches along the coast, followed by a subsequent consistent decline in catch and catch rate in the last one decade has raised serious concern over the resource and the long-term viability of its fishery.

Sharks are among the highly valued fishes that invite both domestic and international demand. Utilisation of sharks in India is mostly in the form of shark meat, with a good domestic market for fresh meat in the coastal states and in dried form in the southern states. The gross value of sharks landed in the Indian maritime states in 2010 stood at ₹ 278 crores. Shark fins are one of the commodities in great demand in international markets. The shark fins find their way to East Asia to meet the demands of an expanding international shark fin market. Hong Kong, China and Singapore are the major demand centres for shark fins. India's export of shark fins in 2011 was about 195 t, valued at US $ 14.99 million.

India's first move towards shark conservation was in 2001 when 10 species of elasmobranchs were included under Schedule I of the Indian Wildlife (Protection) Act, 1972. This was the result of rampant whale shark hunting along the north-west coast of India, particularly in Gujarat during the latter half of the 1990 s. In 2013, India went on to promote the "fin-on" policy, i.e. landing of the entire shark. Subsequently India supported the trade regulations on species listed under CITES Appendix II in 2014. In

February 2015, the Department of Commerce of the Ministry of Commerce, Government of India issued an order prohibiting the export and import of shark fins in India.

Sharks are characterised by slow growth, large size and longevity, slow turnover of generations, late maturation and production of few (but well-developed) off-springs. Low biological productivity makes them vulnerable to fishing, with limited chance for recovery. Given the wide-ranging distribution of sharks, including in the high seas, and long-distance migration of many species, it is increasingly important to have international cooperation for shark management plans. Food and Agriculture Organization with appropriate international expert consultation developed an International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks), which was adopted in 1999. The guidelines for the IPOA-Sharks state that nations contributing to fishing mortality of shark stocks should participate in their conservation and management, that shark resources be used in a sustainable way, and that wastes and discards be minimised. Developing NPOA-Sharks following FAO guidelines on IPOA-sharks with action plans that can be reviewed and revised at periodic intervals, can be a powerful tool for sustainably managing shark populations. Implementing national action plans that adhere to international guidelines and also build on experiences drawn from other fisheries can help save endangered shark species from extinction. Being a major shark fishing nation (India is presently the second largest shark producing nation in the world, although sharks form a mere 1.2% of India's marine fish production), it is important that India should evolve a National Plan of Action for sharks (NPOA-Sharks) and participate actively in their conservation and management. Development and implementation of the NPOA-Sharks calls for integrated research and discussion between R&D organisations, Government agencies, NGO's and stakeholders including fishermen, traders and exporters.

This document entitled "Guidance on National Plan of Action for Sharks in India" is intended as a guidance to the NPOA-Sharks, and seeks to (1) present an overview of the current status of India's shark fishery, (2) assess the current management measures and their effectiveness, (3) identify the knowledge gaps that need to be addressed in NPOA-Sharks and (4) suggest a theme-based action plan for NPOA-Sharks.

*The term "sharks" used in this document includes sharks, rays and skates. Wherever necessary, the three have been delineated.

Chapter-1

# STATUS OF **SHARK FISHERY & TRADE IN INDIA**

## BACKGROUND

India is one of the major shark fishing nations in the world and currently stands at the second position, next only to Indonesia. Shark landings include catches of true sharks, rays and guitarfishes. According to FAO statistics, India's contribution to the annual average global catch of sharks during 2000-2009 was 9%.

Artisanal fishermen in India have been conducting shark fishing in a sustainable way, in the form of a sustenance fishery. Shark landings by the mechanised sector were mainly in the form of by-catch from inshore fisheries. Targeted shark fishing started when market demand for this commodity set in. In recent years however, increase in demand for sharks in international markets, especially for the fins, has increased the number and efficiency of fishing boats, directed fishing and expansion of fishing areas, and multi-day, deep water shark fishing became a prevalent practice in Indian waters. This led to increase in fishing effort and, thereby, yield of shark catches initially. However, consistent decline in catch and catch rate in the last one decade has raised serious concern over the resource and the long-term viability of its fishery.

In the year 2001, India joined other nations in conserving sharks by including ten species in Schedule I of the Indian Wildlife (Protection) Act, 1972. India is also a signatory party to the recent CITES Appendix II listing of 5 species of sharks (of which 4 species are commonly found in Indian waters) and 2 species of manta rays, thereby initiating regulation in fin and gill plate trade in these species. However, strategies to avoid protected or trade-regulated species from capture in directed as well as multispecies fishery do not exist. Other plans for multispecies management include seasonal and spatial closure of mechanised fishing, declaration of Marine Protected Areas and minimum cod-end mesh size of trawls. These measures can help reduce shark by-catches, nevertheless there is no assessment on this.

Sharks are characterised by slow growth, large size and longevity, slow turnover of generations, late maturation and production of few (but well-developed) offsprings.

Shark landings at Cochin fisheries harbour

Low biological productivity makes them vulnerable to fishing, with limited chance for recovery. The current state of knowledge of sharks and the practices employed in shark fisheries cause problems in the conservation and management of sharks due to limited information on biological characteristics of many species and their identification at species level. Time-series and spatial data on catch, effort, landings and trade are available, but there is scope for improvement. The combined effect of these limited information deludes reliable stock estimates. In order to improve knowledge on the state of shark stocks and facilitate collection of necessary information, adequate funds are required for research and management. It is necessary to manage directed shark

fishery, and certain multispecies fisheries in which sharks constitute a significant by-catch, on a precautionary approach without waiting for flow of scientific data. In some cases the need for management may be urgent.

Given the wide-ranging distribution of sharks, including in the high seas, and long distance migration of many species, it is increasingly important to have international cooperation on shark management plans. Food and Agriculture Organization (FAO) with appropriate international expert consultation developed an International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks), which was adopted in 1999. The guidelines for the IPOA-Sharks state that nations contributing to fishing mortality of shark stocks should participate in their conservation and management, that shark resources be used in a sustainable way, and that wastes and discards be minimised. Developing NPOA-Sharks which follows FAO guidelines on IPOA-sharks with action plans that can be reviewed and revised at periodic intervals, can be a powerful tool for sustainably managing shark populations. Implementing national action plans, that adhere to international guidelines and also build on experiences drawn from other fisheries, can help save endangered shark species from extinction. Being a major shark

Landing of carcharhinid sharks *Carcharhinus limbatus* and *C. brevipinna* at Thoothoor

fishing nation (India is presently the second largest shark producing nation in the world, although sharks form a mere 1.2% of India's marine fish production), it is important that India should evolve a National Plan of Action for sharks (NPOA-Sharks) and participate actively in their conservation and management.

A major limiting factor in the formulation and implementation of adequate management measures to regulate or preserve shark fishing at sustainable levels in India is the lack of coherent information spread over a sufficiently large time period that should form the basis for proper status assessment of the stock. The NPOA-Sharks requires to be drawn upon data which are essentially a combination of "fishery dependant" (based on the actual commercial catch landed and information recorded in the logbooks of fishing vessels) or "fishery independent" (based on experimental surveys and fishing operations) data. Primary data should include data on catch, effort, geographic abundance, species diversity and market value. Add-ons to this data are biological, environmental and socio-economic data.

Trends in shark fisheries and assessment of species-specific stock parameters require a good representation of data spread over a sufficiently long time period with well-defined extreme limits of measures. Catch and effort data should be representative of a continuous and sufficiently long duration, say a minimum of five years for single species stock assessment using prediction models and twenty years or more for holistic models. Similarly, biological data on a species must be representative of the entire length range of both sexes of the species which contribute even minimally to the fishery, and should be indicative of trends and changes that recur on a seasonal basis. Representative samples for size composition of a species in the fishery must include a wide range of sizes, from newborn young to adults close to the maximum reported lengths.

The Central Marine Fisheries Research Institute (CMFRI) and Fishery Survey of India (FSI) should serve as the nodal agencies for assimilation of fishery dependant and fishery independent data, the former through its extensive programme of fisheries resource assessment directly from landing centres along the Indian coast and the latter through its exploratory trawl surveys in the Indian EEZ. Development and implementation of the NPOA-Sharks calls for integrated research and discussion between R&D organisations, Government agencies, NGO's and stakeholders including fishermen, traders and exporters.

## The objectives of this document are:

- Present an overview of the currents status of India's shark fishery.
- Assess the current management measures and their effectiveness for shark conservation.

- Identify the knowledge gaps that need to be addressed to evolve the NPOA-Sharks.
- Suggest a theme-based action plan for the NPOA-Sharks.

## Key issues which need to be addressed for managing shark fisheries:

1. Taxonomic issues need to be resolved before effective management can be achieved.
2. Available catch and effort data for sharks and shark-like fishes are inadequate in most fisheries.
3. Biological parameters of growth and reproduction have been estimated for some species, but other fundamental data such as fishing effort and species/sex/ length/age composition of the catch required for stock assessment are not available for most species.
4. The conservation status of most species is not known, particularly on a regional flatform. There is also a large gap in knowledge with respect to Biological Reference Points (BRP) and limit points for exploitation of even species that are of common occurance in the fishery.
5. Many species of sharks have low stock recruitment due to late sexual maturity and low fecundity.
6. They exhibit complex spatial structures (size and sex related aggregation; and seasonal breeding migrations).
7. Widespread multispecies fisheries take a variety of species, all with different potential for sustainable use.
8. There is a general lack of knowledge about critical habitats for most of the species.
9. There is little coordination to collect information on trans-boundary species due to lack of responsibility for these stocks, particularly in international waters.

*Manta birostris* landed at Cochin

# THE FISHERY

The annual landing of sharks in India during the period 1961-2013 fluctuated between 29,000 t and 75,000 t (Fig. 1), with the annual average being 52,640 t. Although the trend appears to be increasing, the landings during the 1960 s and early 1970 s were mostly by the artisanal sector. The effect of mechanised fishing operations is noticed from the mid 1970 s, with the landings showing an initial increase.

The annual landing of sharks in India in 2013 was 46,471 t (CMFRI, 2014) constituting 5% of the demersal and 1.23% of the total marine fish production in the country. Of the exploited shark resources, sharks constitute 44%, rays, 52% and skates, 4% . While annual shark landings have hovered within the range of 50-70 thousand tonnes over the last 29 years, the share of sharks in total fish landings has declined by more than 64% from 1985 to 2013. Peak landing was observed in the year 1998, when it almost touched 75 thousand tonnes. Mohanraj *et al.* (2009) mention an increasing trend in elasmobranch catches in India, from 27.4 thousand tonnes in 1961 to 49 thousand

tonnes in 2006. However, the trend from 1985 to 2013 has been fluctuating with landings peaking to >70,000 tonnes in 1997, 1998 and 2000. The increase in shark landings during 1997-2000 (Fig.1) is the result of intentional whale shark hunting, in high intensity, along the north-west coast of India. However, the contribution of sharks to the total marine fish production in the country had already slipped from 3.43% in 1985 to 2.81% in 1998 and stood lowest at 1.23% in 2013, indicating a disproportionate growth between total marine fish landings and shark landings (Fig. 2). While sharks formed only sustenance fisheries in some parts of the country or were taken as by-catch in coastal fisheries during the 1980 s and early 1990 s, targeted fishing, particularly for sharks was initiated from the late 1990 s with increase in demand for shark products in international markets.

Among sharks, skates and rays, the contribution of sharks to the annual shark landings in India has shown a decline from 64% in 1985 to 44% in 2013 (Fig. 3), while that of rays has increased from 30 to 55%.

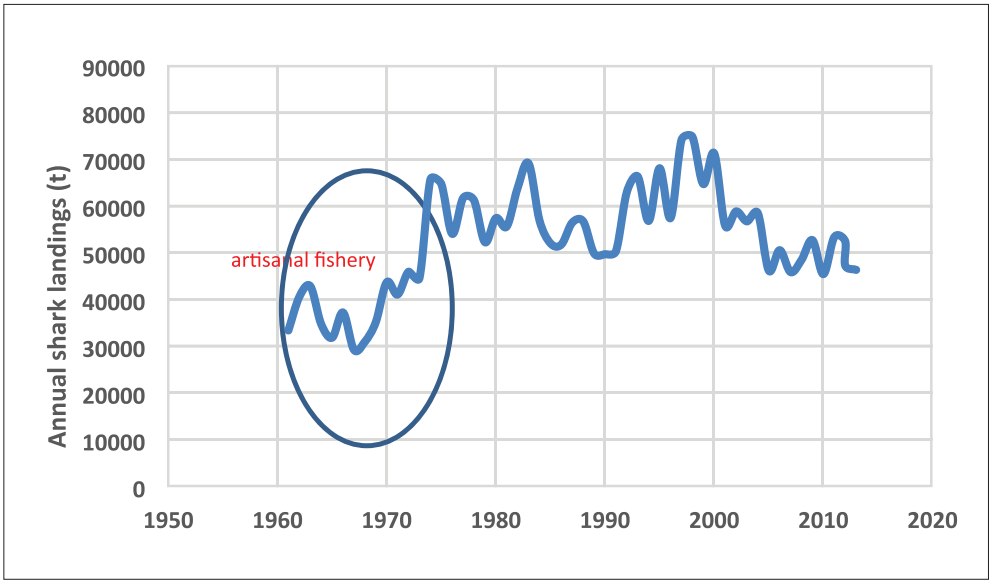



Fig.1. All-India landings of sharks (1961-2013).

Sharks were the largest contributors to the landings during 1985-2011 forming >50% of the landings (average 59.9%). During 2012 and 2013 however, their contribution fell to under 50% (average 44.2%). Shark landings showed a fluctuating yet increasing trend from 33,112 t in 1985 to 47,207 t in 1998 followed by a sharp decline to 21,138 t in 2013. Falling shark landings is a matter of concern since it would take a number of years for depleted shark stocks to recover.

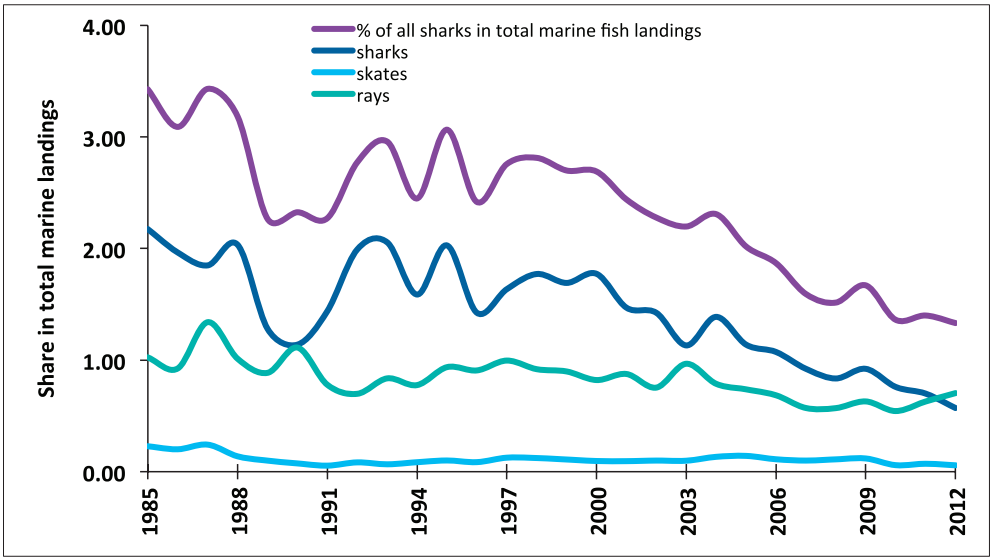



Fig.2. Trend in contribution of sharks to India's marine fish production.

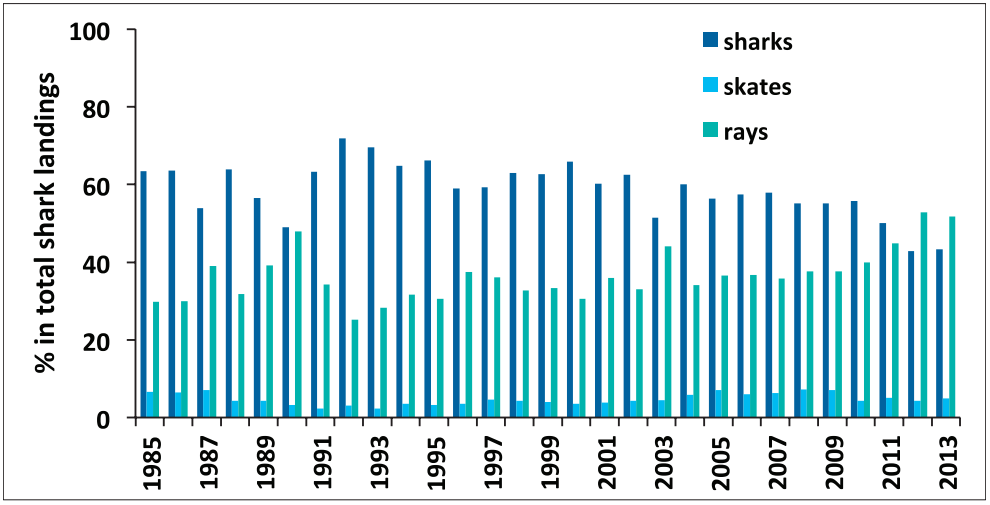



Fig.3. Percentage contribution of sharks, skates and rays to India's shark production.

Ray landings ranged from 15,569 t in 1985 to a maximum of 27,802 t in 2012. The south-east zone contributed 65.5% of ray landings, followed by the north-west zone 17.8%. The major gear contributing to ray landings is the mechanised trawl nets which landed 60% of rays. Skate landings ranged from 3473 t in 1985 to 2,263 t in 2012 with a peak of 3,749 t in 2009. The north-west zone contributed the highest to skate landings (52.6%), followed by the south-east zone (29.05%). Mechanised trawls

contributed 71.98% of skate landings in the country.

The potential yield of sharks was estimated to be 65,000 metric tonnes within 50 m depth zone and 1,03,000 metric tonnes beyond 50 m depth zone (Mathew *et al.*, 1996). Later, potential yield of true sharks in the continental shelf of the Indian EEZ was estimated to be 45,064 t, and that of pelagic sharks beyond the continental shelf, 26,200 t (Anon, 2001). These estimates were further revised in 2011 as 85,882 t for sharks and 48,721 t for true sharks in the Indian EEZ up to 100 m depth. Landing data assimilated by the CMFRI indicate that the potential yield estimated for sharks from beyond 50 m depth zone has not been reached. Instead, it appears that the 50 m zone has been fished heavily and with falling landings, there is a high probability of depletion of coastal species of sharks from these areas. Surveys to mark the distribution and abundance of sharks in the Indian EEZ have recorded high catch rates off Kutchh in the north-west zone with a good mixture of true sharks and rays in the area (Mathew *et al.*, 1996). The catch rate of rays during the survey near Veraval in the north-west zone was to the tune of 100-150 kg/h. Hence historically the north-west zone is the richest in terms of shark production. The south-west zone (Wadge Bank) also had very high catch rates of rays at 625kg/h during earlier surveys. Ray fishing grounds off Cochin in the south-west zone showed catch rates of 120-145 kg/h. In the south-east zone

Leopard whipray *Himantura undulata*

Madras and Cuddalore had high density pockets with catch rates of 264kg/h and 130 kg/h. The north-east zone had much higher concentration of sharks in shallow waters. Surveys recorded catch rates of 89-123 kg/h off Kakinada, Machlipatnam and Paradeep in the north-east zone. The survey also indicated a ground rich in skate resources in the north-east zone with catch rates of 50-110 kg/h. The survey indicated that west coast resources are deeper whereas most of the east coast resources are shallower.

At present, Gujarat and Maharashtra on the west coast and Tamil Nadu, Puducherry and Andhra Pradesh on the east coast contribute to the fishery. However, with the poor production of skates and decline in shark catches, there is an urgent need to reassess the potential for elasmobranch fishery in Indian waters.

The west coast of India has remained more productive than the east coast, contributing, on an average, 68% of the annual landings of true sharks and 66% of the annual skate landings in the country (Table 1). The east coast on the other hand has remained the higher contributor of ray landings with annual average contribution of 72% (Table 1). A five-yearly profile (Fig. 4) of coast-wise contribution to the landing of sharks indicates an increase in the contribution of the west coast from 66.7% in 1985-'90 to 74.1% in 2010-'13. In the case of skates there has been a decline from 72.7% in 1985-'90 to 62% in 2010-'13. The contribution of the east coast to the landing of rays has shown an increase from 66.1% in 1985-'89 to 79.7% in 2010-'13.

Table 1. Coast-wise landing of sharks, skates and rays in India during 1985-2013

| **Annual average landing (t)** | **Sharks** | **Skates** | **Rays** |
|---|---|---|---|
| India | 33982 | 2633 | 20234 |
| West coast | 23264 | 1722 | 5498 |
| % in all-India average | 68 | 66 | 28 |
| East coast | 10718 | 912 | 14736 |
| % in all-India average | 32 | 34 | 72 |

The states of Gujarat and Maharashtra on the north-west coast have remained the major players in this arena, followed by Kerala on the south-west coast. The north-west coast (Gujarat, Daman & Diu and Maharashtra) contributes 57% of the shark landings, while the south-east coast (Tamil Nadu& Puducherry and Andhra Pradesh) contributes 21%. The south-west (Goa, Karnataka and Kerala) and the north-east (Orissa and West Bengal) contribute 12 and 10 % respectively. In an earlier study, Vivekanandan and Sivaraj (2008) also reported that the north-west coast contributed 57% of the shark landings in the country. The contribution from the south-east coast reported by them was higher at 25 % when compared to the current average of 21%.

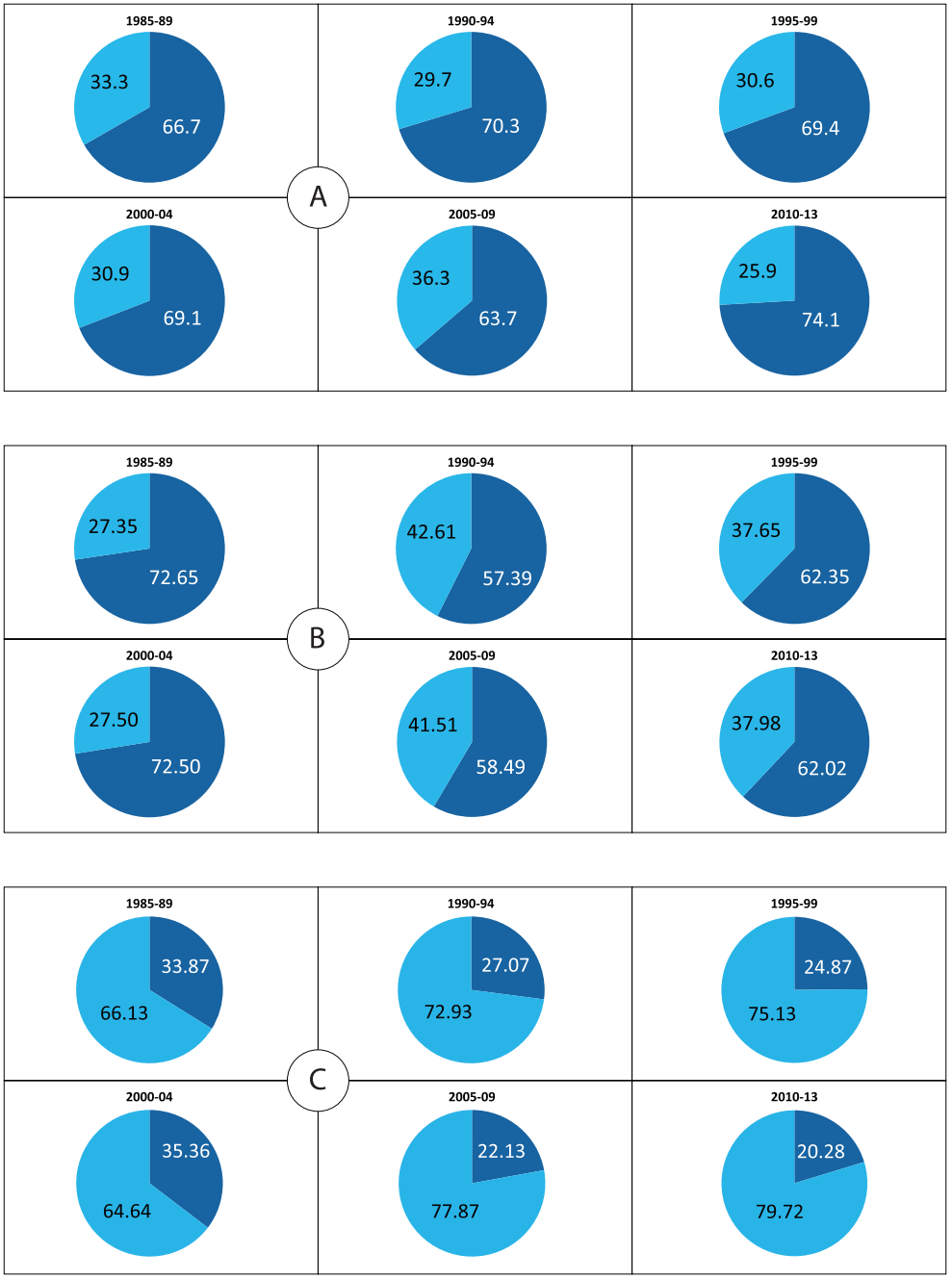



Fig. 4. Contribution (in %) of west (WC) and east (EC) coasts of India to shark landings in the country: a 5-year periodic analysis for 1985-2013 A. Sharks B. Skates C. Rays

Guitarfishes *Glaucostegus variegatus* and *Rhinobatos punctifer* landed at Colachel

However, the nature of shark fishing and landings along the Indian coast is such that sharks caught from one part of the coast are often landed elsewhere (confirmed through discussions with active shark fishermen and traders). Hence a delineation of landings as caught from west or east coasts may often be misleading. Viewed from this aspect, it may be better concluded that the contribution from the two coasts has not changed significantly over the years, in terms of catch. Changes in landing patterns may be influenced by market demand, especially for export.

Stripenose guitarfish *Glaucostegus variegatus* landed at Thoothukudi

Rapid Stock Assessment of sharks based on data for the period 1985-2013 and following the classification criteria suggested by Mohamed *et al*. (2010) indicates the delicate status of sharks in Indian waters. Sharks were either "less abundant" or "declining" along the Indian coast, except Tamil Nadu & Puducherry, where, the 3-year average being only 7.6% of the historic maximum, they could be classified as "depleted" (Table 2).

Table 2. Results of the Rapid Stock Assessment (RSA) of sharks, skates and rays along the Indian coast.

| Resource | Coast | HMC (t) | 3YA (T) | % of HMC | Status |
|---|---|---|---|---|---|
| | Gujarat | 27985 | 11069 | 39.6 | DC |
| | Maharashtra | 12929 | 4034 | 31.2 | DC |
| | Karnataka & Goa | 2829 | 749 | 26.5 | DC |
| SHARKS | Kerala | 5151 | 2328 | 45.2 | DC |
| | Tamil Nadu & Puducherry | 10934 | 827 | 7.6 | DP |
| | Andhra Pradesh | 6871 | 1572 | 22.9 | DC |
| | Orissa | 3077 | 1128 | 36.6 | DC |
| | West Bengal | 5482 | 3196 | 58.3 | LA |
| | Gujarat | 1412 | 1132 | 80.2 | A |
| | Maharashtra | 1927 | 131 | 6.8 | DP |
| SKATES | Karnataka & Goa | 307 | 229 | 74.6 | A |
| | Kerala | 875 | 257 | 29.4 | DC |
| | Tamil Nadu & Puducherry | 1613 | 426 | 26.4 | DC |
| | Andhra Pradesh | 685 | 119 | 17.4 | DC |
| | Orissa | 351 | 6 | 1.6 | C |
| | West Bengal | 601 | 57 | 9.4 | DP |
| | Gujarat | 7012 | 2446 | 34.9 | DC |
| | Maharashtra | 2660 | 498 | 18.7 | DC |
| RAYS | Karnataka & Goa | 2398 | 345 | 14.4 | DC |
| | Kerala | 4070 | 1082 | 26.6 | DC |
| | Tamil Nadu & Puducherry | 16429 | 10487 | 63.8 | LA |
| | Andhra Pradesh | 9971 | 6746 | 67.7 | LA |
| | Orissa | 1971 | 906 | 45.9 | DC |
| | West Bengal | 2059 | 831 | 40.4 | DC |

HMC - Historic Maximum Catch (1985-2013); 3YA - 3-year average (2011-13)

A-Abundant LA-Less abundant; DC-Declining; DP-Depleted; C-Collapsed

Table 3. Percentage contribution of different gears to annual shark landings in Indian states (1985-2013).

| State | Trawl net | Gill net | Line gear | Seines | Bag nets | Others |
|---|---|---|---|---|---|---|
| Gujarat& Daman-Diu | 47.7 | 40.8 | 4.7 | 0.0 | 6.8 | 0.0 |
| Maharashtra | 41.8 | 48.9 | 0.0 | 3.1 | 6.2 | 0.0 |
| Karnataka & Goa | 56.2 | 39.7 | 0.0 | 4.1 | 0.0 | 0.0 |
| Kerala | 41.0 | 27.4 | 11.9 | 2.5 | 0.0 | 17.1* |
| Tamil Nadu & Puducherry | 60.4 | 36.6 | 1.1 | 0.0 | 0.0 | 1.9 |
| Andhra Pradesh | 52.8 | 32.4 | 14.6 | 0.0 | 0.0 | 0.2 |
| Orissa | 51.0 | 6.8 | 42.2 | 0.0 | 0.0 | 0.0 |
| West Bengal | 19.4 | 51.4 | 29.2 | 0.0 | 0.0 | 0.0 |

*combination of mechanised gill net and hook & line

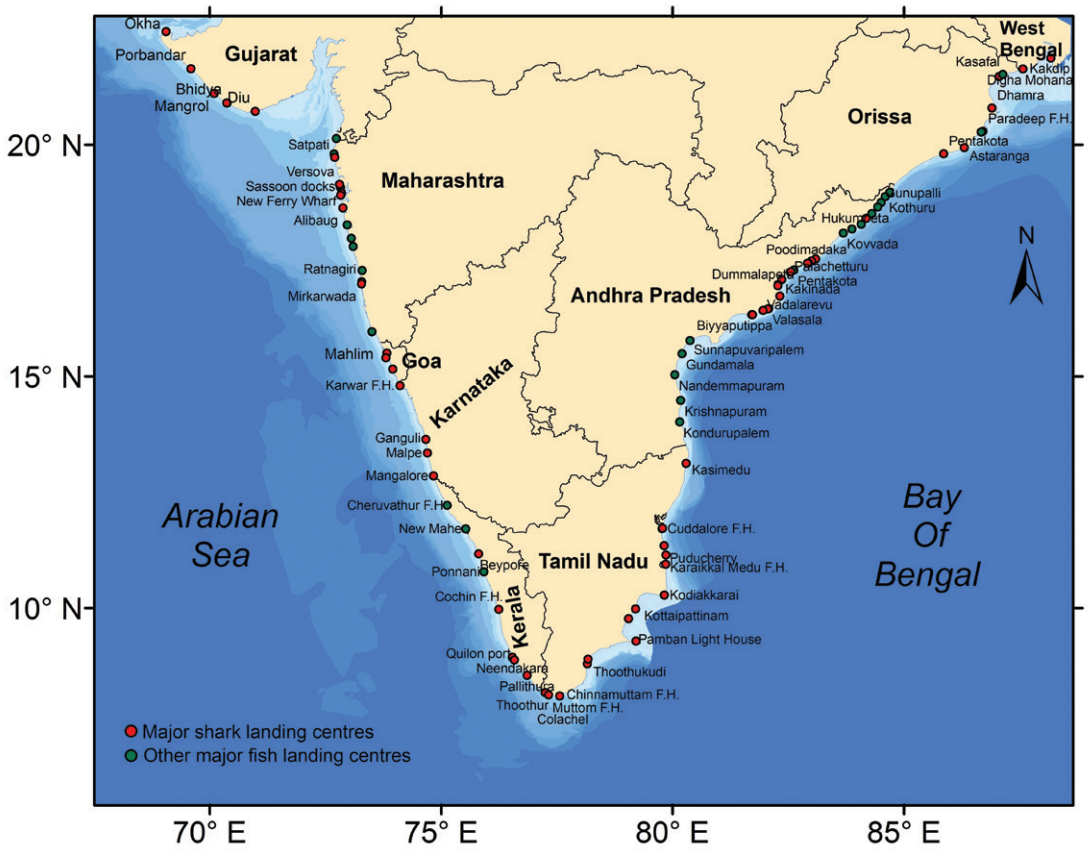
Sharks kept for transportation

# FISHING SECTORS

India's marine fishery is typically multi-species, multi-gear and multi-ground. Different gears are often operated from the same boat, alternately or simultaneously, depending on the fishing season and resource availability. Fishing boundaries between states are non-existent and catch from different grounds are often landed together at a particular landing centre, making it difficult to assess the actual area of catch. Enquiry based information is the only way. Log book maintenance by small scale commercial fishers is not a mandatorily observed practice, and access to logbooks, if maintained, is often difficult. There is no system of log book recording in artisanal fisheries. Information on shark fishing grounds is difficult to obtain and collate since directed fisheries on a relatively large scale is mostly restricted to the shark fishing fleet of Thoothoor, which lands most of the

catch in Cochin Fisheries Harbour and some other ports, even if the fishing ground is far away.

Historically, sharks have always figured significantly in India's artisanal fishery. A lucrative fishery for sharks existed along the north Malabar coast before mechanisation set in, where sharks formed the mainstay of the marine landings. However, technological advancements in fishing craft, gear and methods have improved the efficiency and extent of shark fishing operations. At present, sharks are taken by a combination of different types of crafts and gears. Based on this, the fishery can be classified into three major sectors - mechanised (large boats with inboard engines), motorised (boats with outboard motor) and non-motorised. Trawl fishing, offshore large gill net operations




Map prepared using the geo-referenced data of fish landing centres collected along the Indian Coast for the in-house project "GIS Based resource mapping of distribution and abundance of finfishes and shell fishes off Indian coast" Courtesy : Dr. A.P. Dineshbabu, Principal Investigator and all Co-investigators of the project.

and longlining are mechanised sector fishing. Most of the small scale coastal fishing operations using gill nets are done by the motorised sector. Hook & line operations, cast nets, small gill nets and traps are operated by the non-motorised sector in the inshore waters.

During 1985-2013, the mechanised sector contributed major share (71%) to the sharks landed, the motorised sector accounted for 22% and the non-motorised sector, 7%. A five-yearly analysis (Fig. 5) of the sector-wise contribution to shark landings (four years in the last period) indicates a nominal increase from 70% in 1985-89 to 80% in 2010-13 in the mechanised sector landings. The contribution from the motorised sector however, increased from 6% in 1985-89 to 31% in 2000-04 and decreased to 20% in 2010-13. The non-mechanised sector (artisanal fishery) which contributed about 24% of the shark landings in 1985-89 has now been relegated to the background, with the contribution being under 0.5%.

Pelagic longline fisheries are a significant source of catch for many species of sharks. Pelagic longlines consist of a mainline that can stretch for tens of kilometres, suspended

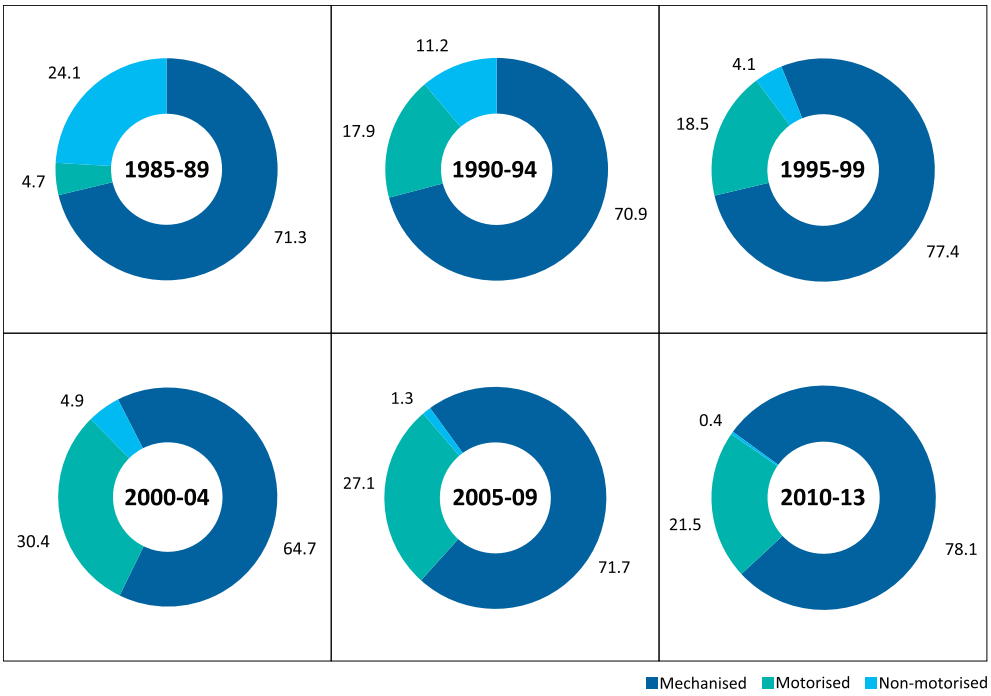



Fig. 5. Five-yearly profile of contribution of fishing sectors to average annual shark landings in India (1985-2013).

by floats with branch lines, which are vertical lines attached to the mainline by a clip or swivel with a hook suspended below.

Drift gill net is a type of fishing gear designed to entangle or ensnare fish by keeping

Shark landing at Thoothoor

the net near or at the surface with floats and allowing it to freely drift with the currents. Bottom or mid-water gill nets, which are weighted so that they fish at or near the bottom and are generally anchored to prevent drifting, can also catch a variety of shark species. Studies on gill nets report high mortality rates, especially among certain species of the requiem and hammerhead sharks.

Gill nets and longlines cause species-specific mortality and are used selectively depending on the availability of sharks in different seasons and areas. Generally long soak times (the length of time a fish is kept on fishing gear before being brought up) in bottom longline fisheries have also been linked to higher mortality rates among some shark species.

Trawls are funnnel-shaped nets that also catch sharks as by-catch. These nets have two wings of varying lengths that extend the net opening horizontally, and they can be pulled along the bottom. The trawl-nets used in India are of high-opening type, capable

Eagle ray landed at Thoothukudi

of taking catches from any level in the mid-water, including the surface water.

Exclusive shark fishing as a practice exists only to a limited extent in India, and often sharks are caught as by-catch from trawl, gill net, hook & line and longline operations. Even in directed line fishing, the target species is changed between sharks and tunas by using different types of hooks.

Directed and by-catch fisheries for sharks by different gear types require fundamentally different management approaches depending on the respective management objectives. Fishing gear and biological characteristics affect a species' catchability. Pelagic and semi-pelagic species that swim actively in the water column are more likely to encounter a gill net or hooks and therefore have a higher catchability than demersal species. Demersal species on the other hand are more vulnerable to demersal trawling. Management approaches therefore, must be developed cautiously, taking into account the type of fishery, the fishing sector and gear involved and the characteristics of the species exploited.

Another important aspect that needs to be considered while evolving management plans for a fishery is the socio-economic factor. Regulation of a fishery calls for an assessment of the extent of loss suffered by the artisanal sector and possibilities for alternate livelihood. Vivekanandan (2001) listed seven groups of fishers who exploit sharks along the Indian coast -

i. Traditional catamaran fishers of Kanyakumari who conduct seasonal shark fishing along the east coast

ii. Motorised canoe (nava) operating fishers of Kakinada who use bottom set gill nets and hooks & lines

iii. Motorised wooden and FRP catamaran fishers of Andhra Pradesh who conduct seasonal shark fishing between Visakhapatnam and Puri

iv. Traditional long-line fishers of north Kerala

v. Trawl operators who bring in sharks as by-catch

vi. Fishermen of Thoothoor in Tamil Nadu who operate a specialised shark fishing mechanised fleet all along the Indian coast

vii. Fishermen of Gujarat who employ gill nets, hooks & lines and trawls for shark fishing.

Thoothoor is a small coastal village in Kanyakumari district in the state of Tamil Nadu, located about 45 km west of Nagercoil and 40 km south-east of Thiruvananthapuram. It is almost exclusively a fishing village with a total population of about 6000. The fishermen of Thoothoor have been traditionally carrying out shark fishing in the coastal waters and have over the years, evolved into a major shark fishing fleet exploiting almost the entire length of the Indian coastline, moving up to Porbander on the north-west coast and Paradeep on the north-east coast. Using mechanised boats for long-line operations, they target sharks and tunas. They also operate gill nets for other deep sea fishes. About 600 boats from this village are known to be engaged in shark fishing. An association called the Association of Deep-Sea Going Artisanal Fishermen (ADSGAF), established in 1992, functions from this village for the welfare of the deep sea fishermen of Thoothoor. Unlike most commercial fishing operators, the fishermen of Thoothoor show serious concern for conservation of the resource. They have been actively involved in promoting the movement for shark fishery management in India towards sustainable fishing and conservation of sharks. National Mission on Conservation of Sharks-India (NMCSI) is a voluntary mission initiated by the ADSGAF for the protection and conservation of sharks in India. The mission meetings seek to integrate consultative thinking between fishermen, traders, researchers, NGO's and policy makers.

# SPECIES DIVERSITY

The diversity of sharks in Indian waters has been a subject of vast study. Day (1889) reported 69 species of chondrichthyans, while Misra (1952) reported 52 and Talwar and Kacker (1984) reported 76, including 41 species of sharks. Compagno (1984) reaffirmed the existence of 41 shark species. Later, Raje *et al.* (2002) reported 114 species of elasmobranchs while Venkataraman *et al.* (2003) included 72 species in a field identification handbook on sharks. Froese and Pauly (2015) lists 119 species in Indian waters.

Vivekanandan and Sivaraj (2008) reported changing species composition in the fishery and indicated richness of deep water species. Akhilesh *et al.* (2013) reported the existence of at least 157 valid species of sharks in Indian waters. From published information and available data collected by CMFRI, a consolidated list of 160 species of

sharks known to occur in India's commercial fishing zone has been listed in Appendix 2. Of this, 88 species are sharks belonging to 44 genera from 21 families, 53 species are rays belonging to 19 genera from 10 families and 19 species are skates belonging to 10 genera from 4 families (Table 4). Of these, 18 species are predominant in the fishery and 27 are of common occurrence in the landings along the coast (Fig. 6).

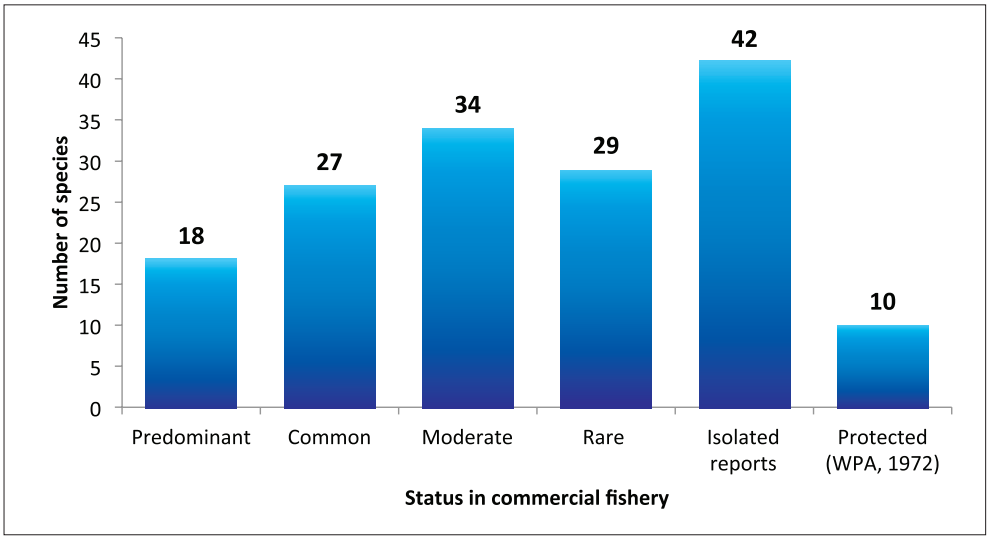



Fig. 6. Dispersion of shark species (in numbers) in Indian waters based on occurrence status in India's commercial fishery.

Sharks of the family Carcharhinidae (requiem sharks), Sphyrnidae (hammer-head sharks), Alopiidae (thresher sharks), Lamnidae (mackerel sharks), Hemiscyllidae (bamboo sharks) and Triakidae (hound sharks) are the major contributors to the commercial fishery. Landings of rays are dominated by species of the families Dasyatidae, Mobulidae,

Scalloped hammerhead shark *Sphyrna lewini*

Milk shark *Rhizoprionodon acutus*

Myliobatidae, Gymnuridae and Rhinopteridae with Dasyatidae constituting about 75.8% of the rays landed during 2007-2013. The guitarfish fishery in India is dominated by members of the family Rhinobatidae.

Carcharhinidae formed 84.6% of the true sharks landed during 2007-2013 in the country. Out of about 31 species of requiem sharks occurring in Indian waters, at least 21 species are regularly fished. Shark landings along the north-west coast of the country are dominated by the milk sharks *Rhizoprionodon oligolinx* and *R. acutus* and the spade-nose shark *Scoliodon laticaudus*. Landings along the south-west and south-east coast however, are dominated by requiem sharks of the genus *Carcharhinus*. Landing of thresher and mackerel sharks and the oceanic white tip shark

Bowmouth guitarfish *Rhina ancylostoma*

*Carcharhinus longimanus* has been found to be increasing in recent years, with increased operations in oceanic waters.

Vivekanandan and Sivaraj (2008) noted a shift in the shark fishery from an artisanal coastal fishery towards an oceanic fishery employing drift gillnets and hooks & lines operated from mechanised craft. Maximum exploitation of large sized sharks beyond near shore coastal fishing zones is done mostly by the shark fishing fleet of Thoothoor. However, the falling trend in both, contribution of sharks to the total marine fish landings and the share of true sharks in the total shark landings indicate that despite extension of fishing grounds, exploitation of oceanic waters and increase in the species diversity in shark landings, the quantum of catch appears to be stagnating. Landings of several high-value carcharhinid sharks have also notably dwindled at some of the major fish landing centres like Chennai in the recent years. On the other hand, there is a spurt in shark landings and diversity at Cochin, primarily because it has become one of the major landing sites for sharks caught from different zones along the Indian coast. In 2013, true sharks constituted almost 50% of the total shark landings at Cochin while at Chennai they formed only 5.9%.

Although reports indicate an increase in number of shark species in Indian waters, new additions to the list are mostly deepwater forms, very few of which are commercially exploited. Members of the family Carcharhinidae and Sphyrnidae remain major contributors to India's commercial shark fishery, with very little change in species composition in the last two decades.

The distribution of Indian sharks classified under IUCN categories (Fig. 7) indicates that 24% of the species in Indian waters (listed in Appendix 2) are "Near Threatened" and

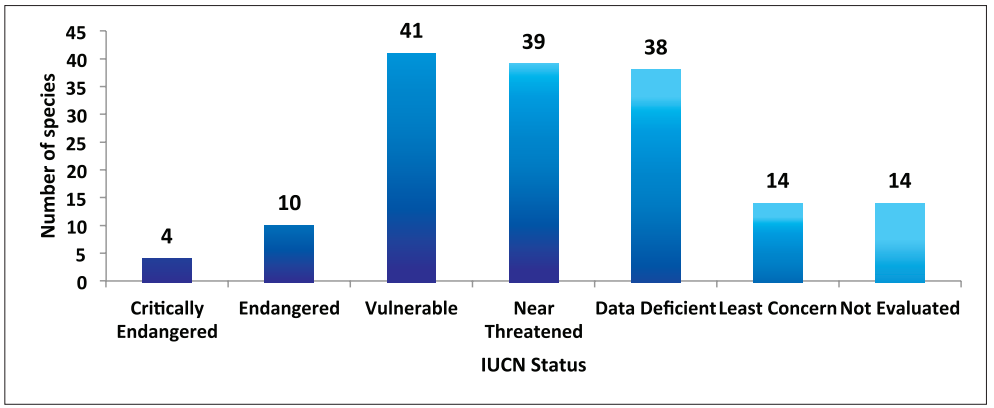
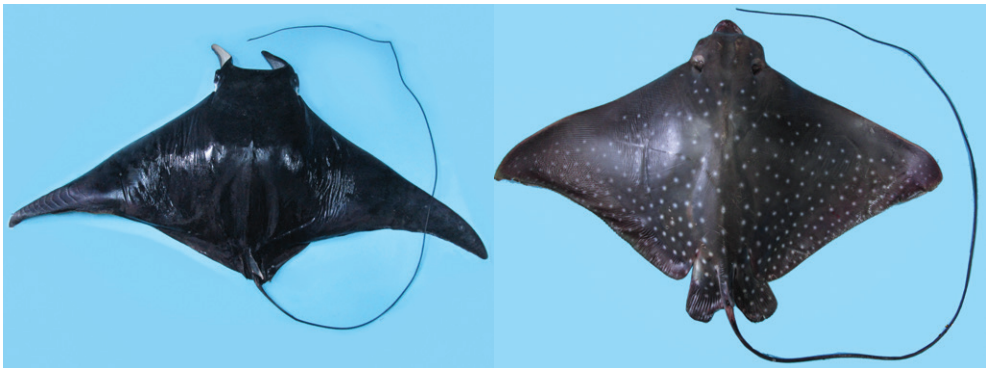



Fig. 7. IUCN category-wise abundance of sharks in Indian waters.

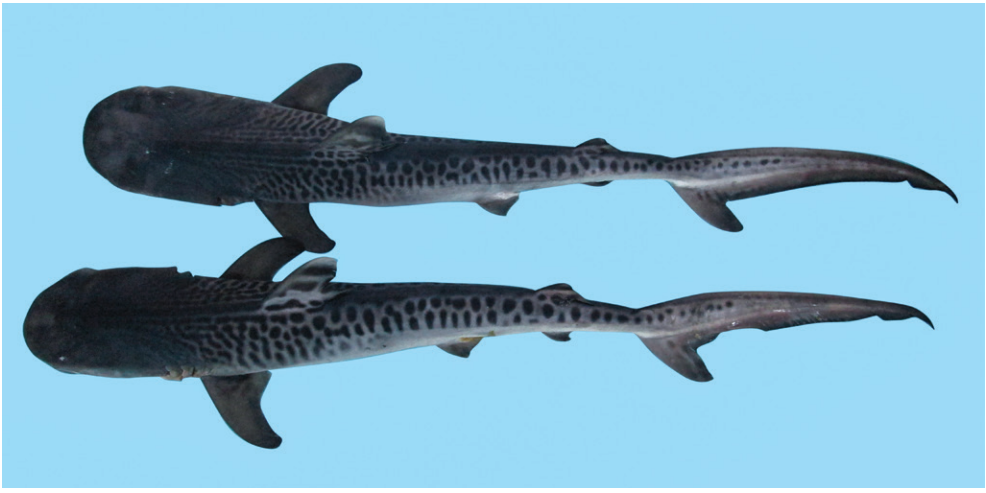


Spine tail devilray *Mobula japanica*

Spotted eagle ray *Aetobatus ocellatus*

26% are "Vulnerable." About 24% are listed as "Data Deficient", 9% as "Not Evaluated", 3% as Critically Endangered".

Among the hammerheads *Sphyrna lewini, Sphyrna mokarran* and *Sphyrna zygaena*, all three of which have been included in the CITES Appendix II listing which came into effect in September 2014, *S.lewini* and *S. mokarran* are classified as "Endangered" and *S. zygaena* is classfied as "Vulnerable". The milk shark *Rhizoprionodon acutus* and the grey sharpnose shark *Rhizoprionodon oligolinx* which contribute to the major share of commercial shark landings in India, particularly from the north-west coast, are species of "Least Concern". However, IUCN classification is based on an assessment of the global stock status of each species, and need not necessarily reflect the stock status in Indian waters.



Juveniles of the tiger shark *Galeocerdo cuvier*

Of the 160 species listed in Appendix 2, fishery information is available for 141 species. Maximum exploitation is done by mechanised trawl net, gill net and line gear operations (Fig. 8).

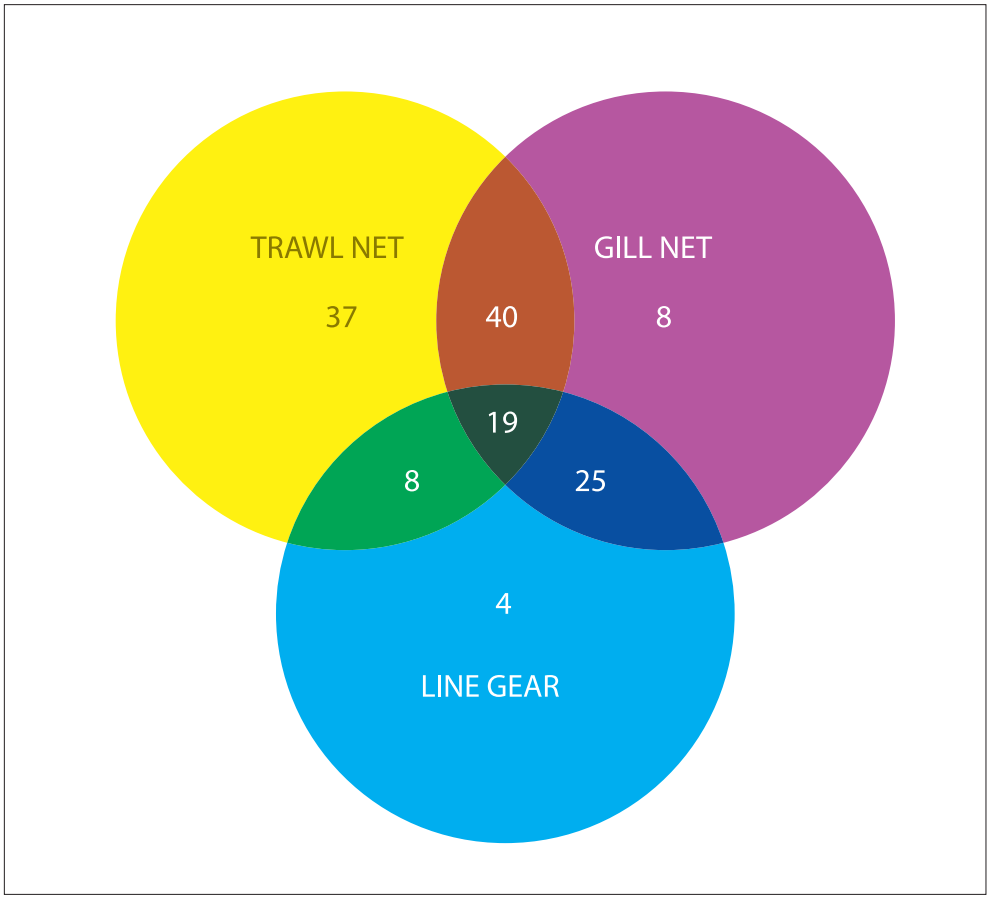



Fig.8 Gear-wise exploitation status of shark species in Indian waters

The complex nature of India's shark diversity and fishery makes management criteria more difficult to derive. Evolving regional, gear-based packages for different groups of species, based on their level of occurrence would probably prove better than a uniform management plan for the country. The advantage of separate packages would be that specific regional and sector-based issues can be addressed through collaboration between the planning & implementing government agency, research organisations, state fisheries departments, local fishing communities and other stakeholders and NGO's actively involved in the specific region.

Table 4. Number of shark species occurring in India's commercial fishing zone

| | Order | Family | Genus | Species |
|---|---|---|---|---|
| SHARKS | Hexanchiformes | Hexanchidae | 2 | 2 |
| | Squaliformes | Centrophoridae | 2 | 6 |
| | | Echinorhinidae | 1 | 2 |
| | | Etmopteridae | 1 | 2 |
| | | Somniosidae | 2 | 2 |
| | | Squalidae | 1 | 2 |
| | Orectolobiformes | Hemiscyllidae | 1 | 5 |
| | | Ginglymostomatidae | 1 | 1 |
| | | Rhincodontidae | 1 | 1 |
| | | Stegostomatidae | 1 | 1 |
| | Lamniformes | Alopiidae | 1 | 3 |
| | | Lamnidae | 1 | 2 |
| | | Odontaspididae | 2 | 3 |
| | | Pseudocarcharhiidae | 1 | 1 |
| | Carcharhiniformes | Carcharhinidae | 10 | 31 |
| | | Hemigaleidae | 4 | 4 |
| | | Proscyllidae | 2 | 2 |
| | | Scyliorhinidae | 4 | 4 |
| | | Sphyrnidae | 2 | 5 |
| | | Triakidae | 2 | 5 |
| | Pristiformes | Pristidae | 2 | 4 |
| | TOTAL | | 44 | 88 |
| RAYS | Torpediniformes | Narcinidae | 2 | 4 |
| | | Narkidae | 1 | 1 |
| | | Torpedinidae | 1 | 4 |
| | Myliobatiformes | Hexatrygonidae | 1 | 1 |
| | | Plesiobatidae | 1 | 1 |
| | | Dasyatidae | 7 | 23 |
| | | Gymnuridae | 1 | 4 |
| | | Myliobatidae | 2 | 6 |
| | | Mobulidae | 2 | 7 |
| | | Rhinopteridae | 1 | 2 |
| | TOTAL | | 19 | 53 |
| SKATES | Rajiformes | Rajidae | 6 | 7 |
| | | Rhinidae | 1 | 1 |
| | | Rhinobatidae | 2 | 8 |
| | | Rhynchobatidae | 1 | 3 |
| | TOTAL | | 10 | 19 |
| | **TOTAL** | | **73** | **160** |

# TRADE

Sharks are among the highly valued fishes that invite both domestic and international demand. Utilisation of sharks in India is mostly in the form of shark meat, with a good domestic market for fresh meat in the coastal states and in dried form in the southern coastal states. The gross value of sharks landed in the Indian maritime states in 2010 stood at ₹278 crores (Table 5). Gujarat showed maximum earnings from trade in fresh sharks while Tamil Nadu had maximum earnings from trade in rays. The landing centre price was highest for sharks in Kerala and rays in Odisha in 2014 (Table 6).

Shark products and by-products that find their way into the export fray include dried shark fins, fin rays, shark cartilage, shark liver oil and shark skin. Shark fins and rays are used for shark fin soup, considered a delicacy in south-east Asian countries. Shark skin is used for manufacturing leather products. Shark cartilage is marketed in capsule or

tablet form, and finds use in the pharmaceutical industry on account of several curative properties attributed to it. "Chondroitin", a constituent of shark cartilage is considered particularly useful in the cure of arthritis. Shark liver oils also find a wide global market and are used as components in medicines, cosmetics and lubricants. Shark teeth and jaws are sold as artefacts. Fresh shark meat is priced at ₹ 160-230 per kg while dried meat is sold at ₹ 400-500 per kg.The price of shark fins depends on the species and type of fin, and can range between ₹ 4000 and 5000 per kg. Shark teeth can also be priced up to ₹ 4000 per jaw set, depending on the species and quality of the teeth (Fig. 9).

The utilisation pattern in India has always been that of a complete one, with all sharks caught being brought to shore and the entire shark being used, largely for local consumption in fresh or dried form, and to an extent for by-products and artefacts. On- board "shark finning", is not practised in India. Shark poaching by foreign fleets and shark finning was earlier reported in the Andaman & Nicobar Islands, where no local market for shark meat existed and where ships would not accept dried shark meat for transport to the mainland (Vivekanandan, 2001; Srivastava, 2002). However, following the ban on shark finning announced in August 2013, there have been no reports of the practice in any part of the country.

Table 5. Estimate of gross value ( ₹ in lakhs) of sharks landed in Indian states (2000-2010).

| State | Resource | Value (lakh rupees) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 |
| | Sharks | 174.69 | 273 | 577.92 | 756.36 | 740 | 1450.46 | 122.92 | 1202.47 | 2274.38 | 2850.12 | 2968.16 |
| West Bengal | Rays | 63.96 | 86.4 | 78.2 | 106.02 | 50.16 | 55.1 | 37.62 | 63.16 | 148.45 | 556.21 | 232.94 |
| | Skates | 7.56 | 8.16 | 7.48 | 11.34 | 19.26 | 27.17 | 95.51 | 212.27 | 414.47 | 114.48 | 25.79 |
| | Sharks | 308.61 | 632.2 | 264.24 | 349.2 | 393.31 | 428.64 | 282.9 | 393.7 | 678.05 | 736.95 | 755.51 |
| Orissa | Rays | 175.67 | 256.88 | 142.2 | 82.16 | 67.45 | 103.55 | 0 | 22.42 | 0 | 267.5 | 244.56 |
| | Skates | 2021 | 1.65 | 5.78 | 0.17 | 0 | 0 | 105.83 | 287.42 | 201 | 3.75 | 0 |
| | Sharks | 1769.04 | 1205.09 | 693.59 | 864.45 | 1035 | 871.85 | 1824.6 | 2168.66 | 1337.48 | 1752.71 | 850.99 |
| Andhra Pradesh | Rays | 377.41 | 480.6 | 396.36 | 1379.91 | 826.98 | 681.26 | 57.71 | 27.52 | 16.74 | 997.11 | 1448.69 |
| | Skates | 95.54 | 17.29 | 11 | 35.42 | 37.26 | 13.8 | 1137.58 | 559.7 | 1044.71 | 20.41 | 33.06 |
| | Sharks | 4069.01 | 3175.2 | 4055.72 | 2873.4 | 7857.6 | 1849.23 | 1916.78 | 1237.12 | 1040.09 | 2832.68 | 1330.63 |
| Tamil Nadu | Rays | 1852.32 | 1625.83 | 2095.59 | 2757.26 | 2491.82 | 1717.68 | 134.15 | 142.33 | 178.03 | 3146.93 | 2920.1 |
| | Skates | 36.2 | 35.2 | 172.27 | 100.19 | 199.5 | 299.78 | 2109.4 | 2212.12 | 2190.76 | 560.74 | 144.86 |
| | Sharks | 173.24 | 60 | 22.96 | 48.72 | 66.3 | 21.5 | 14.91 | 29.53 | 57.5 | 65.74 | 16.17 |
| Puducherry | Rays | 52.53 | 22.24 | 42.63 | 60.28 | 33.12 | 55.5 | 1.28 | 0 | 0 | 20.48 | 68.46 |
| | Skates | 0 | 0 | 6.21 | 0 | 0 | 0.75 | 30.09 | 46.04 | 50.14 | 0 | 1.03 |
| | Sharks | 1020.52 | 1268.19 | 1365.7 | 2387.73 | 1849.09 | 1084.5 | 1502.46 | 1282.03 | 1953.15 | 2731.37 | 2176.14 |
| Kerala | Rays | 213.15 | 381.11 | 424.58 | 344.96 | 227.4 | 411.84 | 138.72 | 74.58 | 115.12 | 628.12 | 423.8 |
| | Skates | 34.2 | 201.25 | 73.92 | 67.86 | 112.96 | 79.1 | 319.16 | 323.36 | 466.14 | 157.18 | 76.3 |
| | Sharks | 365.85 | 650.08 | 971.7 | 427.68 | 509.2 | 622.88 | 332.23 | 309.87 | 495.75 | 1025.66 | 555.43 |
| Karnataka | Rays | 42.5 | 38.88 | 30.43 | 25.33 | 18.8 | 21.63 | 16.28 | 28.18 | 31.65 | 52.46 | 86.9 |
| | Skates | 0.76 | 17.48 | 12.6 | 5.72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sharks | 13.2 | 187.62 | 261.36 | 319.44 | 296.81 | 569.16 | 502.17 | 198.8 | 21.65 | 42.7 | 17.43 |
| Goa | Rays | 0.68 | 2.2 | 31.79 | 31.79 | 182 | 384.51 | 0 | 1.97 | 0.89 | 1.15 | 0 |
| | Skates | 0.57 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Sharks | 3858.53 | 4867.5 | 9231.31 | 5087.96 | 4456.08 | 4369.78 | 6404.73 | 6799.51 | 4968.96 | 4403.31 | 3978.2 |
| Maharashtra | Rays | 210.38 | 269.6 | 196.68 | 231.22 | 305.76 | 230 | 339.9 | 350.4 | 366.28 | 228.64 | 209.41 |
| | Skates | 69.08 | 57.04 | 141.93 | 155.6 | 208.72 | 179.4 | 181.83 | 271.44 | 258.18 | 55.28 | 63.39 |
| | Sharks | 13908.66 | 6705 | 6944.62 | 5573 | 6348.51 | 5567.25 | 5426.66 | 4749.37 | 6271.36 | 7643.66 | 8525.39 |
| Gujarat | Rays | 264.23 | 191.28 | 153.6 | 164 | 224.56 | 286.2 | 181.21 | 120.6 | 201.94 | 402.7 | 417.68 |
| | Skates | 135.52 | 83.07 | 95.94 | 140.28 | 208.62 | 198.2 | 170.75 | 244.08 | 327.73 | 301.94 | 239.25 |

Source: Sathiadas et al,(2012)

Table 6. Average price of sharks (₹/kg) landed along Indian states (2010-2014).

| | | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| WestBengal | Sharks | 120 | 90 | 180 | 160 | 180 |
| | Rays | 70 | 50 | 120 | 130 | 135 |
| | Skates | 85 | 70 | NA | 100 | 120 |
| Odisha | Sharks | 65 | 149.5 | 85 | 190 | 200 |
| | Rays | 28 | 64 | 45 | 198 | 208 |
| | Skates | NA | NA | 30 | NA | NA |
| Andhra Pradesh | Sharks | 67 | 90 | 90 | 100 | 100 |
| | Rays | 33 | 40 | 45 | 40 | 48 |
| | Skates | 33 | 60 | 70 | 90 | 75 |
| Tamil Nadu | Sharks | 116 | 105 | 110 | 95 | NA |
| | Rays | 34 | 58 | 50 | 80 | NA |
| | Skates | 37 | 60 | 60 | 65 | NA |
| Kerala | Sharks | 107 | 153 | 175 | 245 | 220 |
| | Rays | 46 | 50 | 59 | 85 | 90 |
| | Skates | 50 | 70 | 95 | 120 | 170 |
| Karnataka | Sharks | 97 | 120 | 130 | 140 | 145 |
| | Rays | 30 | 75 | 80 | 160 | 175 |
| | Skates | 80 | 95 | 100 | 120 | 130 |
| Goa | Sharks | 97 | 120 | 150 | 140 | 125 |
| | Rays | 30 | 85 | 80 | 160 | 80 |
| | Skates | NA | NA | NA | NA | NA |
| Gujarat | Sharks | 70 | 75 | 75 | 90 | NA |
| | Rays | 60 | 60 | 60 | 75 | NA |
| | Skates | 25 | 25 | 25 | 35 | NA |

Source: Shyam Salim, CMFRI, 2015- Personal communication. NA - Not Available

Today, while India ranks a global second in shark production, shark fin trade from the country is not a matter of alarming priority. FAO statistics indicate that while India's shark production is about 9% of the global production, the country's shark fin exports form 6% of the global figures. India's export and import statistics for the period 2006-2011 (Source: FAO-Fishstat) indicates that shark products formed <0.1% of the total marine fishery exports from the country. Imports were only in the form of shark fillet which was about 0.3% of the total marine fishery imports into the country. Shark fins are one of the commodities in great demand in international markets. The shark fins find their way to East Asia to meet the demands of an expanding international shark fin market. Hong Kong, China and Singapore are the major demand centres for shark fins. As per MPEDA statistics, India exported 195 tonnes of shark fins worth US $ 14.99

million in 2011 against 960 tonnes worth $2.74 million in 1998. The quantum of shark fins exported from India in 2013-14 stood at about 122 tonnes (Table 7). Mumbai and Chennai have been the major centres for collection, processing and export of shark fins and fin rays. The trend in recent years however, indicate an initial increase from 2008-09 to 2010-11, followed by a considerable decline in 2013-14 (Table 8). Quality and price of the fins are decided based on the species from which the fins are sourced. FAO lists at least 21 species of sharks favoured for shark fins (Table 9).

Table 7. Country-wise export details of shark fins from India.

| | | Japan | U S A | China | Southeast Asia | Middle East | Others | Total |
|---|---|---|---|---|---|---|---|---|
| | Quantity (t) | 0 | 0 | 92 | 19 | 2 | 0 | 113 |
| 2009-10 | Value (₹) | 0 | 0 | 4334.42 | 911.63 | 294.11 | 0 | 5540.2 |
| | Value (US$) | 0 | 0 | 9.17 | 1.94 | 0.6 | 0 | 11.71 |
| | Quantity (t) | 11 | 0 | 101 | 22 | 61 | 0 | 195 |
| 2010-11 | Value (₹) | 62.87 | 0 | 4959.75 | 1059.57 | 669 | 0 | 6751.2 |
| | Value (US$) | 0.14 | 0 | 11.03 | 2.34 | 1.49 | 0 | 14.99 |
| | Quantity (t) | 0 | 2 | 82 | 33 | 31 | 0 | 147 |
| 2011-12 | Value (₹) | 0 | 2.27 | 3060.1 | 1341.64 | 582.06 | 0.08 | 4986.2 |
| | Value (US$) | 0 | 0 | 6.55 | 2.85 | 1.25 | 0 | 10.66 |
| | Quantity (t) | 0 | 0 | 76 | 14 | 0 | 2 | 91 |
| 2012-13 | Value (₹) | 0 | 3.87 | 2644.43 | 724.06 | 0 | 67.01 | 3439.4 |
| | Value (US$) | 0 | 0.01 | 4.9 | 1.35 | 0 | 0.12 | 6.37 |
| | Quantity (t) | 0 | 0 | 78 | 43 | 1 | 0 | 122 |
| 2013-14 | Value (₹) | 0 | 0 | 3371.58 | 477.22 | 8.39 | 0 | 3857.2 |
| | Value (US$) | 0 | 0 | 5.75 | 0.81 | 0.01 | 0 | 6.57 |

*Quantity in tonnes, value in lakh rupees/million USD Source: MPEDA

Table 8. Export details of shark fins and shark fin rays from Chennai.

| Year | Shark fins | | Shark fin rays | |
|---|---|---|---|---|
| | Quantity (tonnes) | Value (crore ₹) | Quantity (tonnes) | Value (crore ₹) |
| 2008-09 | 24.02 | 5.41 | 4.09 | 1.75 |
| 2009-10 | 34.74 | 15.14 | 13.72 | 4.51 |
| 2010-11 | 84.75 | 32.86 | 9.06 | 1.74 |
| 2011-12 | 70.32 | 28.07 | 3.29 | 1.69 |
| 2012-13 | 64.28 | 20.16 | 1.82 | 1.19 |
| 2013-14 | 44.6 | 15.29 | 1.44 | 1.11 |

Source: MPEDA

Of late, trade in devil and manta ray gill plates has seen an upward trend at Chennai. The rays are auctioned at the rate of ₹ 30-40/kg. The flesh is salted, sun-dried and sold in the dry fish market. The gill plates are removed carefully, cleaned in seawater and dried at room temperature for about 4-5 days. Processed gill plates are sold at prices ranging between ₹ 2,500 and 10,000/kg, depending on the size of the ray and the

species. The gill rakers of *Mobula tarapacana*, commonly called "white" is being sold by traders from Kochi to buyers in Chennai, at high prices of ₹ 9,000/kg dry weight, and the meat at ₹ 200/kg wet weight. The gill plates of *M. japanica*, locally called "black" fetch only ₹ 4,000/kg dry weight. The gill plates are exported from Chennai to foreign countries for soup and medicine preparation.

Market studies (Sathiadas *et al.*, 2012) indicated that processed shark teeth fetch a price of ₹ 1400/kg in the export market and shark skin (for leather market) is sold @ ₹ 320/kg. Shark liver oil is a thriving small scale industry in many states and is sold at ₹ 25/kg in the domestic market. Major limiting factors in trade control include lack of control over 'at-sea' transfers and lack of identification procedures for shark species from unprocessed or processed by-products. Visual identification of species from dried fins and dried gill rakers have proved useful in regulating trade in restricted species in many countries. Some of the available resources applied globally to this effect include -

1. "ishark Fin" software (FAO)

2. Field Identification Guide of the Prebranchial Appendages (Gill Plates) of Mobulid Rays for Law Enforcement and Trade Monitoring Applications (Manta Ray Trust)

3. Field-based guide for visual identification of fins from the new CITES-listed sharks (Pew Charitable Trust)

Dried gill plate of *Manta birostris*

Dried gill plate of *Mobula tarapacana*

Molecular identification techniques play a vital role today in solving problems related to species identification and this should be included as an inherent part of India's NPOA-Sharks as a means to regulate trade in protected species. Even after inclusion of the whale shark *Rhincodon typus* under Schedule I of the Indian Wildlife (Protection) Act, 1972, illegal fishing and trade continued for some time in India. To curb the illegal trade and marketing of fishery products from whale shark and for strict law enforcement with the help of accurate and reliable species identification methods using molecular tools, the National Bureau of Fish Genetic Resources (NBFGR) and CMFRI generated a species-specific partial sequence data of the mitochondrial genome of properly identified stranded whale shark samples, covering the 16S rRNA (546 bp), Cyt b (541bp), COI (600bp) genes as the reference genetic profile helping in accurate identification of any body parts of the species.

In the year 2008, flesh suspected as that of the whale shark was seized from fishermen by the Forest Range Officer (Govt. of Kerala), Kannur, Kerala, India and was brought before the Judicial First Class Magistrate, Thalassery, Kannur, Kerala, India. The detailed sample analysis and confirmation of species was carried out at NBFGR Cochin Unit (R.P.330/08, dt 29. 09. 2008). Based on DNA sequencing of 16S rRNA(525bp) and

COI (600bp) Cyt b(541bp) genes and comparing with the sequences earlier generated by NBFGR (FJ375724, FJ375725, FJ375726, FJ456921, FJ456922, and FJ456923), the suspected sample was identified as that of endangered whale shark and the result was communicated to the court. This was the first criminal case in India in which scientific evidence was sought in forensic identification of the meat of an aquatic organism enlisted in the Wildlife Protection Act of India and the DNA markers reiterated their ability to reliably identify product/meat sample of a species, thus helping in curtailing illegal trade of the endangered organism (Sajeela *et al.*, 2010) .

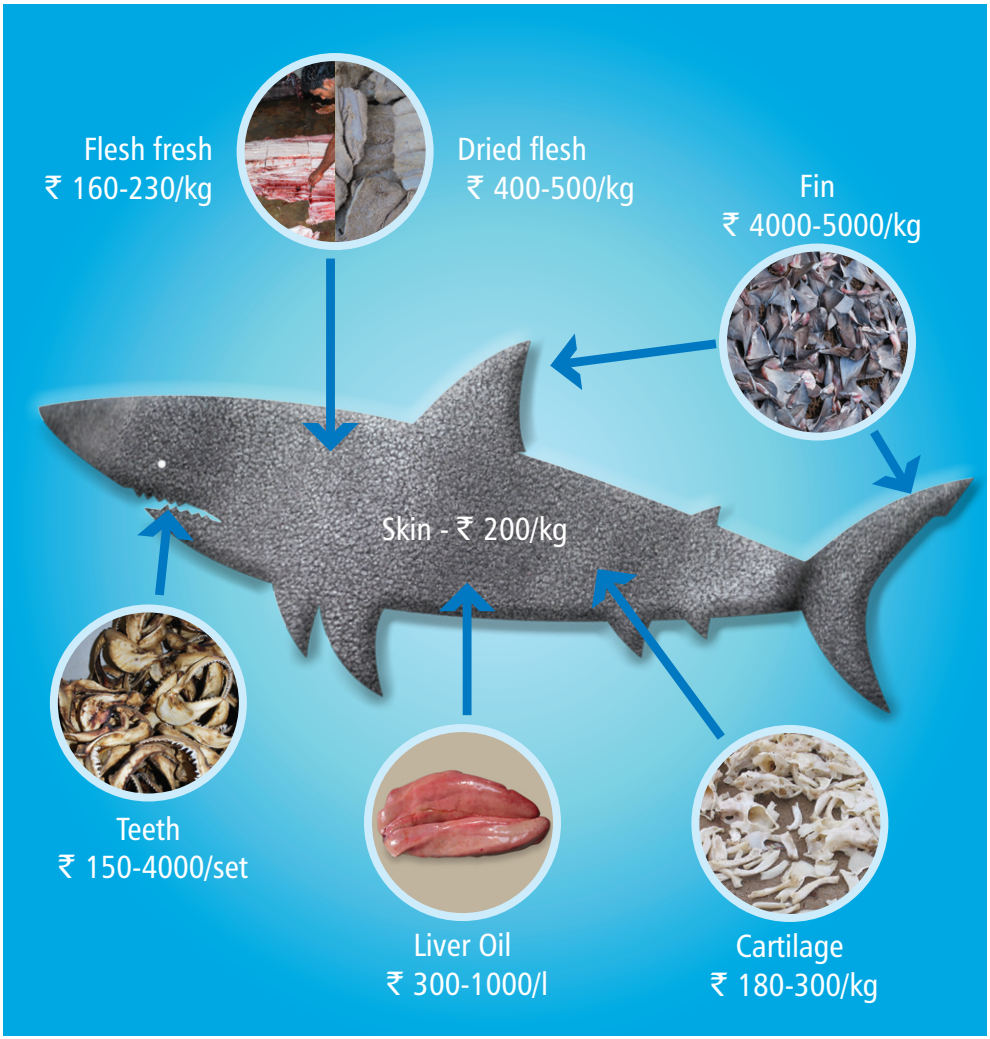



Fig. 9. Price structure of shark by-products in India.

Table 9. Popular choice of shark species for shark fins.

| First choice | Second choice | Third choice |
|---|---|---|
| Blue shark | Blacktip reef shark | Basking shark |
| Dusky shark | Blacktip shark | Piked dogfish |
| Hammerhead | Great white shark | Whale shark |
| Mako shark | Lemon shark | |
| Oceanic whitetip shark | Requiem sharks | |
| Sandbar shark | Smalltooth sandtiger shark | |
| | Spadenose shark | |
| | Thresher shark | |
| | Tiger shark | |
| | Tope shark | |
| | Scalloped hammerhead | |

(Source: FAO)

Chapter-2

# VULNERABILITY, CONSERVATION & MANAGEMENT

## WHY ARE SHARKS VULNERABLE?

Sharks are predatory cartilaginous fishes that have evolved in marine ecosystems 450 million years ago; most modern sharks appeared around 100 million years ago. They are long living apex predators with biological characteristics typified by slow growth, delayed maturation, long reproductive cycle, low fecundity and long life span. These biological characteristics make them vulnerable especially to overexploitation. Over the years, sharks have evolved through several morphological and biological modifications that have helped them to survive mass extinction events that wiped away many other primitive forms of life. However, they have not been able to withstand the effects of unplanned and indiscriminate fishing by man in recent years, leading to an unprecedented fall in shark populations in global waters.

A proper understanding of shark biology and life history patterns is necessary for evolving species-specific fishery management plans that can be successfully implemented within spatio-temporal boundaries. The great diversity of taxa within this group renders such studies a trifle difficult. A wide range of variation is exhibited

Juvenile silky sharks

between shark species and genera in most of the biological characteristics. The smallest sharks known, the squalid and proscyllids, grow to a maximum length of about 20 cm while the largest known shark, the whale shark *Rhincodon typus*, grows to a maximum length of about 2000 cm (Hoenig and Gruber, 1990; Froese and Pauly, 2015). Most of the commercially exploited sharks landed along the Indian coast grow to maximum lengths of 75-300 cm. A general trend seen among sharks is that females are often larger than the males. Slow growth rate is a characteristic feature of most sharks, and growth continuously decreases with ageing. Large sizes and slow growth accord the sharks with high longevity. In line with this, the reproductive processes in sharks are also delayed, with most sharks attaining sexual maturity at sizes which are roughly 50% or more of their maximum size. Sharks are iteroparous and produce well-developed young which are better adapted to survive when compared to the early larvae of teleost fishes. Reproductive patterns include oviparity (deposition of eggs, enclosed in a capsule, outside the maternal body), viviparity (retention of internally fertilised ova in the uterus until completion of embryonic development with umbilical connection),

ovoviviparity (retention and hatching of fertilised eggs inside the maternal body and development of embryo without umbilical connection) and even oophagy (subsistence of developing young on unfertilised eggs within the maternal body). Fetal development is slow and female sharks usually produce limited number of offspring once a year, with reproductive cycles extending to almost a year. However, large sharks can produce higher number of offspring – blue shark *Prionace glauca* and tiger shark *Galeocerdo cuvier* have been known to produce more than 80 young at one time (Bigelow and Schroeder, 1948; Pratt, 1979). Even so, the fecundity of sharks is far less than the fecundity of teleosts. The size of the young shark determines the size of the litter – an adult female shark can either produce few numbers of large young sharks or more number of small young ones. Survival of the young sharks is largely dependent on their chances of avoiding predators since their own predatory behavior ensures that food is seldom a limiting factor. Most newborn sharks are susceptible to predation from their own kind and other large fishes (Branstetter, 1990). The stock-recruitment relationship in sharks is direct – the number of recruits is dependent on the number of adults in the stock, which in turn is influenced by the survival of the young recruits and their development to sexually mature adults. Since sharks are biologically armed to withstand natural selection and extinction events, fishery-related impacts play a great role at this phase of a shark's life history. Uncontrolled fishing of young sharks which have not yet attained maturity is a major risk factor pushing shark populations towards decline.

Juvenile hammerhead sharks

Most of the sharks landed along the Indian coast, particularly the commercially important carcharhinid sharks, are in the length range below the size at maturity (Table 10). This is a cause for concern since it implies that there will be a considerable reduction in the number of sexually mature adults in a stock on an advancing time scale.

Table 10. Biological indices of some species of sharks of common occurrence in India's shark landings.

| Species | Length range in fishery(cm) | Mean length in fishery (cm) | Maximum length Lmax(cm) | Lm50 (cm) | Number of young ones | Gestation period (months) | Estimated Longevity (y) |
|---|---|---|---|---|---|---|---|
| *Scoliodon laticaudus* | 21-52 | 27 | 100 | 35 | 1-14 | 4 | 6 |
| *Rhizoprionodon acutus* | 49-93 | 79 | 120 | 69 | 2-8 | 9-12 | 8 |
| *R. oligolinx* | 34-93 | 66 | 120 | 54 | 3-5 | 9-12 | 8 |
| *Carcharhinus limbatus* | 90-210 | 150 | 275 | 165 | 1-10 | 12 | 12 |
| *C. longimanus* | 150-300 | 270 | 396 | 184 | 1-15 | 12 | 22 |
| *C. falciformis* | 109-175 | 140 | 350 | 228 | 2-16 | 12 | 25 |
| *C. sorrah* | 50-235 | 150 | 360 | 220 | 1-8 | 10 | 8 |
| *C. leucas* | 224-327 | 260 | 360 | 193 | 1-13 | 10-11 | 32 |
| *Sphyrna lewini* | 120-150 | 135 | 430 | 210 | 12-41 | 9-10 | 35 |
| *Iago omanensis* | 36-73 | 48 | 75 | 40.3 | 2-20 | 10-12 | 10 |
| *Mustelus mosis* | 28-85 | 54 | 115 | 39 | 6-25 | 10-12 | 25 |

Most sharks are predators with trophic level >4. Predators are much more vulnerable to environmental changes. They are also vulnerable to decrease in relative abundance of prey. Ontogenetic changes in diet have been reported in sharks; studies indicate that juveniles have a restricted diet associated with a particular habitat such as a nursery ground. Most sharks are opportunistic feeders while some like the sandbar shark are

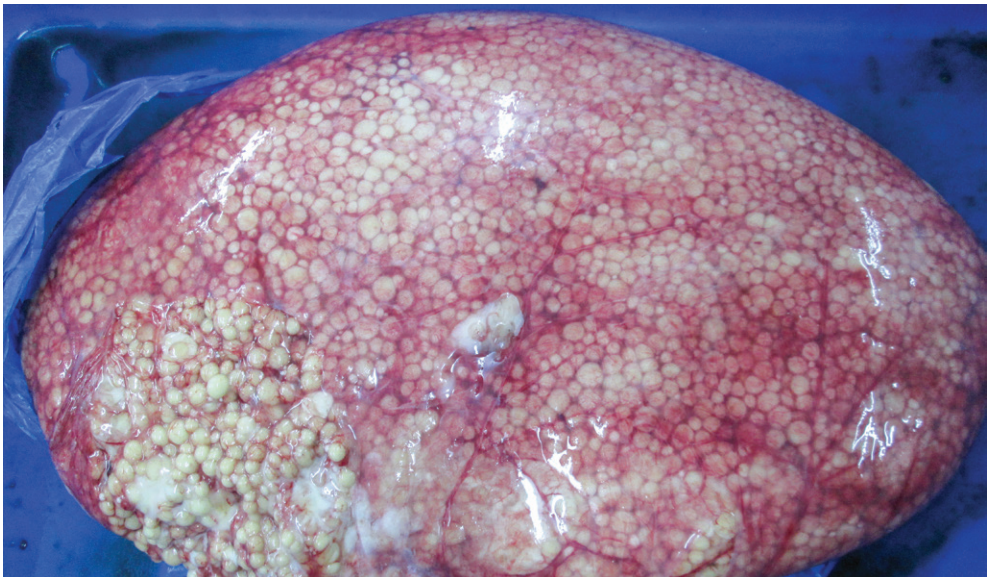
Milkshark embryos

Deep sea shark with embryos

selective feeders. Many sharks turn out to be opportunistically-selective feeders – when food is abundant, they may select a specific item and when food is less plentiful, they may feed on almost any prey which is available (Wetherbee *et al.*, 1990).

Understanding the migratory behavior of sharks is crucial in evolving fishery management plans. Sharks, particularly large ones like the whale shark, are known to undertake extensive migrations spanning one or more seas. Management of such stocks would call for joint ventures between nations along the migratory route. Most sharks are also known to undertake short-term coastal migration for breeding and nursery grounds. Usually, the individuals caught by commercial coastal fisheries would be young sharks

Guitarfish embryos, with attached yolk, collected from the uterus of the mother



Egg sac of pelagic thresher shark

which have not yet returned to oceanic waters for the adult phase of their life. The oceanic white tip shark, *Carcharhinus longimanus*, which is an offshore species, exhibits this migratory pattern and the landings of this shark in India comprise young sharks below the size of maturity (Table 5). This shark has a litter size of 12-16, with the size at birth being as small as 65 cm, which is only about 16.3% of the maximum reported length of this species. The small size places the young at the risk of predation, mostly by other sharks. Thus this species becomes easily prone to population decline with the added effects of natural predation and human interference through fishing.

Similarly, the giant manta rays are highly vulnerable to stock depletion through indiscriminate fishing. Their reproductive traits are characterised by long gestation period of more than 12 months and very low fecundity (one young per cycle). These rays, in spite of their huge sizes, are not predators. They are filter feeders like the whale shark. They are often fished at sizes below their size at maturity, leaving very little chance for propagation.

In such cases, the role of Marine Protected Areas and closed fishing seasons based on availability of young ones and breeding adults assume great importance in shark resource management. Although shark fishery in India is a multispecies one and sharks as a group are extremely susceptible to overfishing (Holden, 1977), a single management plan for sharks as a group, though desirable, may not be successful, owing to the variations in life history patterns exhibited by different species.

# CURRENT MANAGEMENT MEASURES IN INDIA

Wildlife Authority of India is the national body governing conservation of endangered species in India through enforcement of the Indian Wild Life (Protection) Act, 1972. In 2001, four species of sharks, two species of rays, one species of guitar fish and three species of sawfishes were declared protected under Schedule I of the WPA, 1972, by the Ministry of Environment and Forests vide Order No.1-2/2001 WL1 dated 28.05.2001 (Table 11). Exploitation and trade of these species have been banned and declared as punishable offences.

In August 2013, the Ministry of Environment and Forests (Wildlife Division) approved a policy advisory on shark finning (vide F. No4-36/2013WL, 21 August 2013), prohibiting the removal of shark fins on board a vessel in the sea, and advocates landing of the whole shark.

Table 11. Elasmobranchs protected under Schedule I of (Indian) Wildlife (Protection) Act, 1972.

| Scientific name | Common name | Family/Order |
|---|---|---|
| **Sharks** | | |
| *Rhincodon typus* | Whale shark | Rhincodontidae/Orectolobiformes |
| *Carcharhinus hemiodon* | Pondicherry shark | Carcharhinidae/Carcharhiniformes |
| *Glyphis gangeticus* | Ganges river shark | Carcharhinidae/Carcharhiniformes |
| *Glyphis glyphis* | Speartooth shark | Carcharhinidae/Carcharhiniformes |
| **Rays** | | |
| *Himantura fluviatilis* | Ganges sting ray | Dasyatidae/Rajiformes |
| *Urogymnus asperrimus* | Porcupine ray | Dasyatidae/Rajiformes |
| **Guitarfishes** | | |
| *Rhynchobatus djiddensis* | Giant guitarfish | Rhinobatidae/Rajiformes |
| **Sawfishes** | | |
| *Anoxypritis cuspidata* | Pointed sawfish | Pristidae/Pristiformes |
| *Pristis microdon* | Largetooth sawfish | Pristidae/Pristiformes |
| *Pristis zijsron* | Longcomb sawfish | Pristidae/Pristiformes |

India is a signatory party to IOTC Resolution 13/06/2013 which states that Oceanic whitetips are not to be retained and are to be released unharmed, to the extent practicable, when caught in association to IOTC regulated fisheries. Following the inclusion of five species of sharks and two species of manta rays in Appendix II of CITES in September 2014, India, being a signatory party to the same, steps have been initiated by the MoEF & CC to consider conservatory measures for fishing and trade of four of the five shark species (oceanic white tip reef shark *Carcharhinus longimanus* and the hammer-head sharks *Sphyrna lewini*, *S. mokarran* and *S. zygaena*) and both the manta rays which are currently being commercially exploited from Indian waters. The measures to be taken would be based on a "Non-detriment Finding document" (NDF) which will be prepared by CMFRI. Until then, it was decided at the Regional Capacity-building Workshop on CITES Appendix II listing of sharks and manta rays, held at Chennai in August 2014, that trade regulations would be effected by introducing a "minimum fin size" for legal export, subject to the "no finning" policy of the Government.

On February 6, 2015, the Department of Commerce of the Ministry of Commerce and Industry, Govt of India, through Notification No.110/(RE-2013)/2009-2014 inserted a new entry at Sl. No 31A in Chapter 3 of Schedule 2 of ITC (HS) (Classification of Export

& Import Items), prohibiting the export of shark fins of all species of sharks covered under EXIM Code 0305 71 00, and through Notification No.111/(RE-2013)/2009-2014 amended the import policy conditions of Shark fins under ITC (HS) 0305 71 00 of Chapter 03 of ITC (HS), 2012 – Schedule – 1 (Import Policy), to the effect that import policy of the item 'Shark fins' covered under EXIM Code 0305 71 00 is changed from 'free' to 'prohibited'. Most of these management measures have been complied with (Table 12).

The successful forensic identification of whale shark meat consignment in 2008 using genetic markers (Sajeela, *et al.*, 2010) has proved beyond doubt that such tools will go a long way in regulating trade of protected and listed species. With such mechanisms of easily identifying species from body parts, the current ban on trade in fins of all species of sharks needs to be reconsidered. On-board shark finning is not practised in India and complete utilisation of all parts of the landed shark must be encouraged. There is no domestic market for shark fins in India. Regulation of shark fin therefore may be restricted to protected and listed species.

Largetooth sawfish *Pristis microdon*

In addition to these specific measures, India has also regulated fishing practices through demarcation of about 31 Marine Protected Areas, fixing Minimum Legal Size (MLS) for capture of common species, gear-specific mesh size regulations, restrictions on operation of certain gears like ring seines, purse seines and pair trawling, introduction of by-catch reduction devices and seasonal ban on fishing (particularly trawling) activities from 15 June to 31 July along the west coast and 15 April to 31 May along the east coast. In recent years, there has also been an increase in participatory management

measures practised by fishermen communities within their native zones of operation.

Recovery plans to revive sharks stocks which have been assessed as "Collapsed", "Depleted" or "Declining" (Chapter 1, Table 2) need to be drafted and implemented at the earliest. Restrictions on fishing of juveniles and breeding sharks and release of pregnant sharks, unharmed, may be effective to an extent in coastal fisheries. Demarcation of breeding/pupping grounds and seasons can be done with proper evaluation of spatio-temporal abundance of shark stocks at different stages of their life history. Tagging studies can be initiated, particularly for large sharks, to trace their migratory route and pattern. CMFRI is in the process of deriving the MLS for different species of sharks commercially exploited in India. The MLS recommended for capture of four species are – 53 cm TL for the grey sharpnose shark *Rhizoprionodon oligolinx*, 14 cm DW for the scaly whipray *Himantura imbricata*, 61 cm DW for the pointed nose stingray and 29 cm DW for the long-tailed butterfly ray *Gymnura poecilura* (Mohamed *et al.,* 2014).

Whale shark *Rhincodon typus*

The history of shark fishery management in India began with the awareness creation that followed a spate of whale shark hunting in Indian waters, particularly along the Gujarat coast during the 1990 s.

The combined effort of TRAFFIC and WWF in India to stop the brutal killing and trade of these "gentle giants of the sea" (Hanfee, 1997, 2001) and the landmark documentary "Shores of Silence" (Mike Pandey, 2000) succeeded in putting into motion a mass public campaign against whale shark exploitation. With the awareness generated among fishermen, this campaign gathered momentum and resulted in the inclusion of the whale shark in Schedule 1 of the Indian WPA, 1972 in the year 2001. In the subsequent year, the species was also included in CITES Appendix I

Table 12. Compliance status in India for implemented shark management measures.

| Management Measure | Compliance Status | Remarks |
|---|---|---|
| Protection of 10 species under Schedule 1 of the Indian WPA, 1972 since 2001 | Complied | No intentional fishery; however, incidental catches may occur. |
| IOTC resolution (2013) promoting release of oceanic whitetip caught in IOTC regulated fisheries | Compliance status not known | Fishery status in Indian waters is being studied |
| Prohibition of on-board finning of sharks vide MoEF (Wildlife Division) policy (2013) | Complied | Finning of sharks on board is not practised by Indian fishermen and sharks caught are landed whole. |
| Regulation of trade of fins and gill plates of sharks and manta rays listed under CITES Appendix II (2014) | Complied | Shark fin trade in India is being regulated. The available molecular tools to identify shark species from processed fins will be of use in regulating shark fin trade of CITES listed species till such time NDF studies are completed. |
| Prohibition of shark fin export and import by the Department of Commerce, Ministry of Commerce (2015) | Complied but needs re-consideration | Shark fin trade in India is being regulated. Since Indian fishermen do not practise onboard shark finning, complete prohibition of trade in shark fins may be re-evaluated and restricted to prohibition of trade in protected and listed species. |


CMFRI scientists interact with ADSGAF representatives

Shark fishery management demands species-specific and gear-specific approaches. While formulating management or regulatory options, the spatio-temporal distribution of exploited shark populations need to be taken into consideration. Targeted species or those that dominate in the commercial fishery will have to be managed differently from stocks which are of moderate or rare occurrence and are more prevalent in deeper or oceanic waters. From the frequency of occurrence of sharks in different gears along the Indian coast, it is clear that pelagic longlines and gill nets (drift and bottom set) require management strategies to restrict the capture of undersized and threatened or vulnerable species. Trawl nets on the other hand, which are currently exploiting smaller species of least concern like *Rhizoprionodon* spp. and the near threatened species *Scoliodon laticaudus*, will require to be addressed based on fishing zone and cod-end mesh size.

Rays landed at Colachel

Chapter-3

# NATIONAL PLAN OF ACTION - **SHARKS**

## MODEL FOR NATIONAL PLAN OF ACTION

### Nature and Scope

1. The NPOA-Sharks must follow FAO's technical guidelines for the conservation and management of sharks (FAO, 2000), which identify four elements of the IPOA-Sharks:

- species conservation;
- biodiversity maintenance;
- habitat protection; and
- management for sustainable use.

2. In the NPOA-Sharks, the term 'shark' must be taken to include sharks, skates and rays.

3. The term 'shark catch' or 'shark landings' would refer to shark that is caught and landed, either from directed or non-directed multispecies fisheries by commercial fishing fleet. It would include byproduct (retained for sale) and by-catch (considered as low-value by-catch or LVB, due to very small size or poor quality, but traded). In specific cases, the term would also refer to shark that is caught by exploratory survey vessels.

## Guiding principles

1. The Government of India and all maritime states have to participate in shark management with support from research institutions, stakeholders and NGOs.

2. Management and conservation strategies should aim to keep fishing mortality for each stock within sustainable levels by applying precautionary approach. Standing stock biomass estimates and potential yield estimates have to be revalidated for all shark species in Indian waters and limit points have to be set for sustainable exploitation.

3. Management and conservation objectives and strategies should recognize that shark catches are a traditional and important source of food, employment and income. Such catches should be managed on a sustainable basis to provide a continued source of food, employment and income to local communities. Where management is directed towards ban on fishing of certain species, strategies should be evolved to develop alternate source of livelihood for artisanal fishermen who are directly impacted by a loss of income due to the ban.

## Objectives & Aims

The objective of the NPOA-Sharks would be to ensure conservation and management of sharks and their long-term sustainable use through active stakeholder support and participation.

The aims of the NPOA-Sharks would be those identified in the IPOA-Sharks, the same being:

1. To ensure that shark catches from target and non-target fisheries are sustainable;

2. To assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use;

3. To identify and provide special attention, in particular, to vulnerable or threatened sharks;

4. To improve and develop frameworks for establishing and coordinating effective consultation involving all stakeholders in research, management and educational initiatives within and between maritime states;

5. To minimise incidental catches of sharks;

6. To contribute to the protection of biodiversity and ecosystem structure and function with emphasis on identification and protection of critical habitats for shark aggregation and breeding;

7. To minimise waste and discards from shark catches;

8. To encourage full use of dead sharks;

9. To facilitate improved species-specific catch and landings data and monitoring of shark catches; and

10. To facilitate identification and reporting of species-specific biological and trade data.

## Issues in the conservation and management of sharks

Assessment of the current status of fishery, trade and management of sharks in India has identified the following conservation and management issues:

1. The need for coordination of shark research;

2. The need to improve identification of shark species by all stakeholders and fishery managers;

3. The need for secure, accessible and validated data sets at species level that record all catch and are consistent over space and time with inputs from research institutions, fisheries departments and stakeholders;

4. The need for developing a species resource atlas on spatio-temporal distribution and abundance;

5. The need to identify shark breeding areas/seasons to conserve breeding populations;

6. The need to ensure full utilisation of dead sharks and an improved understanding of marketing channels and trade in shark products;

7. The need to reduce fishing mortality of shark species;

8. The need for continued effort to maintain and improve the methods of stock assessment for target shark species in directed shark fisheries;

9. The need for reliable assessment of shark by-catch and byproducts from shark species in multispecies fisheries;

10. The need to reduce or, where necessary, eliminate shark by-catch;

11. The need for periodic Shark Assessement Reports which will help in evolving effective shark management options;

12. The need for continuous monitoring and evaluation of the adequacy of management strategies for all shark species;

13. The need for an assessment of shark handling practices for conservation and management;

14. The need for a better understanding and, where necessary, recognition in management arrangements, of shark fishing by fishermen and other stakeholders;

15. The need for risk assessments for all shark species from impacts such as natural and anthropogenic effects (fishing, pollution and climate change);

16. The need to develop strategies for the recovery of shark species and populations; and

17. The need to evolve, where necessary, alternate means of livelihood for shark fishing communities and other stakeholders relying to a great measure, on shark fisheries for their sustenance.

## Themes

The issues mentioned above can be classified into five broad themes to evolve the NPOA-Sharks:

1. Strengthen database on fishery, abundance and biology of sharks, utilisation, marketchannels and trade and socio-economics of stakeholder groups;

2. Undertake coordinated, need-specific research and development;

3. Initiate focused education/awareness programs towards capacity building for efficientparticipatory management;

4. Improve coordination and consultation between management, research and stakeholder groups;

5. Review and improve existing conservation and management measures.

# Suggested Action Plan

1. **Strengthening of database** - data sets have to be created and updated regularly. The sets of data thus collected should be well-managed in databases for easy retrieval and analysis, and be subjected to frequent internal verification and validation checks.

**1 THEME**

***Strengthen database on fishery, abundance and biology of sharks, utilisation, market channels and trade and socio-economics of stakeholder groups.***

## A. Data on fishery, abundance and biology of sharks

I. Identify gaps in existing monitoring and data collection programs for commercial fisheries and exploratory surveys - CMFRI conducts strategic research programmes to continuously monitor shark fishery along the Indian coast and assimilate shark landing data. The Association of Deep Sea Going Artisanal Fishermen (ADSGAF) has agreed to supplement CMFRI's species-wise catch data with details on fishing areas. Data on shark abundance and catch rates from exploratory surveys of the FSI needs to be added to the exhaustive landing data being collected by CMFRI in order to obtain a holistic picture of resource abundance and distribution. CMFRI is also initiating a questionnaire-based survey to collate information on shark landings in directed and non-directed fisheries across major and minor landing centres along the coast. Validation of shark catch data will also be done by employing observers on board commercial fishing vessels operating from major centres at periodic intervals, with the help of State Fisheries departments and by cross verification with information collated by NGOs active in the respective areas.

II. Ensure collection of data necessary for risk assessment of shark species such as availability, catchability, productivity and distribution - CMFRI already has a well-streamlined methodology for data assimilation and analysis for stock assessment. Data requirements pertaining to all necessary input parameter for the same will be met in the data collection programs. Such data will include information on area-wise, gear-wise, species-wise catch & effort, size composition, sex composition, reproductive indices and diet composition.

III. Ensure that, where a species is taken in two or more fisheries within a jurisdiction or in two or more jurisdictions: (a) processes are in place to collect/report data from all fisheries and jurisdictions involved in the management of that species uniformly, and, (b) where transboundary stocks are involved, when data became available, from stock assessments or risk assessments conducted for that species, the countries involved should work towards evolving and implementing complementary management advisories for that species - interaction between the BOBP member countries will play a major role in co-management of shark species within the Bay of Bengal Large Marine Ecosystem (BOBLME) region. Similarly transboundary issues within the Arabian Sea will have to be addressed.

## B. Data on utilisation, marketing channels and trade of sharks and shark products

I. Collection of information on postharvest processing, including facilities at landing centres, existing channels for at-sea and onshore disposal of catch, market chains (domestic and export), trade in shark products - CMFRI is well equipped to collect enquiry-based data on post-harvest utilisation, market channels and trade, and has well defined research programmes to collate information on price structure and utilisation pattern of sharks in all the Indian maritime states. Data will be validated through cross-verification with information from MPEDA. Export data (form, quantity and earnings) is already being tabulated by MPEDA.

II. Collection of information on import of sharks/shark products - MPEDA maintains records of all imports pertaining to sharks/shark products and this data will be utilised for evolving and implementing the NPOA.

## C. Data on socio-economics of stakeholder groups

I. Collection of socio-economic information on fishing communities involved in directed & non-directed shark fishing and local marketing and extent of their interest

and dependence on the same.

II. Collection of socio-economic information on stakeholders in shark processing & trade.

CMFRI can collect detailed socio-economic information on fishing communities and other stakeholders directly or indirectly associated with shark fishing, processing and trade. Data collection will be done through questionnaire-based survey at identified landing and trade centres in the country. Validation of data will be done through interaction with State Fisheries departments and NGOs.

**2. Sharing of data** - Protocols for easy but secure sharing of data between relevant agencies have to be developed.

## 2 THEME — *Undertake coordinated, need-specific research and development*

1. Resolve issues related to taxonomic ambiguities, develop DNA sequences of all species and establish DNA referral library;

2. Develop a comprehensive shark atlas and user-friendly field identification guides;

3. Develop a national shark museum where all shark species, shark products and shark fishing methods and conservation strategies are exhibited;

4. Evaluate methodologies for risk assessment and adopt a single national risk assessment framework, consistent across species and fisheries; however implementation of compact measures must be envisaged through a regional approach suitable for India's complex fishery. This can be done in alliance with TRAFFIC's *M-risk*; a novel method to quantify the risk posed by over-exploitation of shark stocks to identify the species/stocks of sharks of potential concern and their relative level of concern, thus allowing prioritisation of those species/stocks where management measures are critical and also identifying those stocks where improvement to management measures are needed;

5. Strengthen research on shark biology and develop appropriate methods for modeling the population dynamics of sharks in the ecosystem and develop a basis for distinguishing between natural variation and trends in the system so as to assist in understanding population status, rates of recovery, population structure and distribution;

6. Revalidate species listing under different vulnerability categories; and revise the status, if necessary, to prepare a Regional Red List;

7. Recommend Minimum Legal Size for capture of major exploited species;

8. Develop molecular markers for all species to help regulation of trade in shark products;

9. Increase opportunities for better utilisation and value addition of shark products from currently harvested species and encourage commercial fisheries to use these opportunities subject to the long-term ecologically sustainable harvest of shark species;

10. Develop harvesting strategies consistent with the principal of biological sustainability and rational long-term economic use, based on derived Biological Reference Points with methods or devices to effectively reduce the number of sharks in by-catch;

11. Develop a methodology to assess the impact of shark management and conservation measures on ecosystem structure and function with periodical evaluation of the efficiency of the methodology;

12. Formulate recovery plans to improve declining coastal shark stocks;

13. Develop a quantitative framework to assess the recovery of listed threatened species;

14. Quantify and delineate the impact of natural and anthropogenic impact (pollution and climate change) on the stocks, their migration and after abundance;

15. Prepare a document on indigenous shark fishing highlighting the traditional, cultural and spiritual significance of sharks to local people so as to accommodate these issues in the development of management arrangements.

## 3 THEME

***Initiate focused education/awareness programmes towards capacity building for efficient participatory management.***

1. Introduce a community education strategy aimed at the general public, commercial, and indigenous fishermen and raise national awareness of the vulnerability of sharks and in particular their role in the marine ecosystem, current threats and status;

2. Educate resource users about the rationale for and use of recorded shark catch data;

3. Develop awareness amongst all resource users of the protected and threatened species, provisions, reporting requirements and penalties;

4. Encourage use of techniques to improve shark species identification (for example, use of photos, retention of rare species for confirmation of species identification), by user groups; and

5. Encourage horizontal dissemination of awareness ideals through stakeholder initiatives.

## 4 THEME

***Improve coordination and consultation between management, research and stakeholder groups.***

1. Form a shark research consultative forum to facilitate coordination and collaboration on shark research and develop a strategic plan that responds to the research needs identified in the Shark-plan - the forum will consist of nominated representatives from the MOE,F&CC, DAHD&F, CMFRI, FSI, MPEDA, State Fisheries Departments, BOBP, ADSGAF and shark traders. The forum will be responsible for evolving and reviewing shark management decision-making processes. The outcomes of the forum discussions will be shared with other organisations involved in shark conservations and fishing & trade regulation like CITES , IUCN, the Convention on Migratory Species (CMS), TRAFFIC and the WWF.

2. Promote implementation of Shark Plan and improved regional management of shark stocks, particularly shared stocks, and protection of threatened species in relevant regional fisheries management organisations and under other relevant international conventions, for example, CITES and the CMS.

3. Initiate discussions with countries in the region in relation to complementary and collaborative management of straddling shark stocks. These discussions should include identification and implementation of collaborative measures to mutually enhance the capacity of these countries to collect, analyze and share data on straddling shark stocks; and evolve a comprehensive management plan.

## 5 THEME

***Review existing conservation and management measures and implement improved strategies***

1. Develop strategies to ensure filtration of conservation and management initiatives to all categories of managers and stakeholders;

2. Ensure that, where a species is taken in two or more fisheries within a jurisdiction or in two or more jurisdictions, effective communication and consultation mechanisms between all stakeholders are in place, and management measures are complementary;

3. Initiate action to identify habitat critical to the survival of shark species and where identified as necessary take action to protect, and minimise threats, to these habitats;

4. Develop trade regulation guidelines based on a precautionary approach to avoid non-judicious targeted shark fishing based on market demand;

5. Develop mechanism for certification of products to avoid illegal trade on protected species as well as to facilitate genuine trade in domestic and export markets;

6. Implement conservation and management strategies;

7. Assess current management arrangements for sharks against the objectives of this shark-plan and the issues that this shark-plan seeks to address; in particular, assess whether these arrangements are consistent with ecological sustainability of sharks and a precautionary approach, and are enforceable;

8. Assess current management arrangements for listed, protected and threatened shark species against the requirements of recovery plans for those species;

9. Assess the effectiveness of current by-catch reduction measures in reducing shark mortality; encourage the adoption of effective shark by-catch reduction measures ;

10. Assess the relevance of generic management measures for sustaining shark resources from non-directed fisheries and

11. Investigate the potential for promoting shark tourisum in select locales along the Indian coast, as an encouragement towards shark conservation and an alternate sourse of livelihood for shark fishers.

# IMPLEMENTATION

1. In India, maritime state governments are responsible for implementing coastal fisheries management measures through state specific Marine Fishing Regulation Act (MFRA). Suggested contents of the NPOA-Sharks may form the basis of a management programme for sharks.

2. The offshore component of NPOA-Sharks would have to be addressed by Government of India. As shark management deals with migratory stocks between one maritime state to another, Government of India may have to coordinate implementation of coastal shark management.

3. The Government of India will ensure international collaboration on data collection and data sharing systems for stock assessments of transboundary, straddling, highly migratory and high-seas shark stocks, in collaboration with inter-governmental agencies like the BOBP and the IOTC.

4. Research institutions such as CMFRI and FSI have to extend their support by way of consistent collection of data, including inter alia commercial and exploratory survey data, improved species identification, and ultimately the establishment of abundance indices. Data thus collected, should be made available to, and discussed with the state governments and Government of India.

5. The MPEDA will play a major role in formulating and implementing guidelines for regulation of trade in species identified as threatened or vulnerable.

6. Management measures developed will be a comprehensive package derived from advisories developed by the identified research institutions, inputs from fishermen and other stakeholders and status of trade in domestic and international markets. Further, periodical evaluation of implemented measures and their efficacy in conservation and regulation of shark fishing and trade will be done to allow suitable moulding and recasting of the management plan as the situation demands.

# SUGGESTED TIMELINE

| WHAT? | WHO? | WHEN? | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
| Preparation of NPOA-Sharks | DAHD&F with inputs from CMFRI and other research institutions | ✓ | ✓ | | | | |
| Implementation of NPOA-Sharks | DAHD&F, State Fisheries Departments, MoEF&CC | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Strengthen database on fishery biology of sharks | CMFRI | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| stock abundance | CMFRI & FSI | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| utilization | MPEDA, CIFT, CMFRI | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| market channels & trade | MPEDA, MoEF&CC, CMFRI & traders associations | ✓ | | ✓ | ✓ | | ✓ |
| socio-economics of stakeholder groups | ADSGAF, NGO's & CMFRI | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Undertake coordinated, need-specific research and development towards shark fishery assessment & management | CMFRI | ✓ | | ✓ | | ✓ | |
| shark resource survey | FSI | ✓ | ✓ | ✓ | ✓ | ✓ | |
| reduction of shark by-catch | CIFT | ✓ | ✓ | ✓ | ✓ | | |
| conservation status, shark taxonomy & biology for validation of conservation status | CMFRI | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Initiate focused education/awareness programs towards capacity building for efficient participatory management | State Fisheries departments, MoEF&CC | ✓ | ✓ | ✓ | ✓ | | |
| | BOBP-IGO, NGOs | ✓ | ✓ | ✓ | ✓ | | |
| Improve coordination and consultation between management, research and stakeholder groups | State Fisheries departments | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | CMFRI | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| | MPEDA | ✓ | ✓ | ✓ | | | |
| | BOBP-IGO | ✓ | ✓ | ✓ | | | |
| | ADSGAF, Other stakeholders & NGOs | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Review existing conservation and management measures | DAHD&F, State Fisheries departments, CMFRI | | ✓ | ✓ | ✓ | ✓ | |
| Implement improved strategies | MPEDA, Stakeholders, NGOs | | | ✓ | ✓ | ✓ | ✓ |
| Review impact of implementing NPOA-Sharks on status of shark stocks and fishery in Indian waters, particularly of protected /endangered species | CMFRI, | | | ✓ | ✓ | ✓ | ✓ |
| | FSI | | | ✓ | ✓ | ✓ | ✓ |
| | WWF | | | ✓ | ✓ | ✓ | ✓ |
| trade in shark & shark by-products | MPEDA, MoEF&CC, shark traders associations TRAFFIC, HSI | ✓ | | ✓ | | ✓ | |
| implications on the stakeholders | CMFRI, ADSGAF, NFWF, ICSF, SIFFS, HSI | | | ✓ | ✓ | ✓ | ✓ |
| status of transboundary stocks and regional assessment of shark populations | DAHD&F | ✓ | | ✓ | | ✓ | |
| | BOBP-IGO | ✓ | | ✓ | | ✓ | |
| | CMFRI | ✓ | | ✓ | | | ✓ |

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# CMFRI Pamphlets

# CMFRI POSTERS ON **SHARKS**



# APPENDIX -1

## Annual shark landing in India (1961-2013) and their contribution (in %) to the annual marine fish landing

| Year | Shark landing (t) | Total marine landing (t) | % of sharks in total marine landing |
|---|---|---|---|
| 1961 | 33527 | 682626 | 4.91 |
| 1962 | 40730 | 643913 | 6.33 |
| 1963 | 42983 | 654736 | 6.56 |
| 1964 | 34858 | 859353 | 4.06 |
| 1965 | 31973 | 832082 | 3.84 |
| 1966 | 37348 | 889321 | 4.20 |
| 1967 | 29384 | 862586 | 3.41 |
| 1968 | 31101 | 903674 | 3.44 |
| 1969 | 35287 | 912025 | 3.87 |
| 1970 | 43813 | 1083942 | 4.04 |
| 1971 | 41206 | 1159630 | 3.55 |
| 1972 | 46062 | 978189 | 4.71 |
| 1973 | 44713 | 1217533 | 3.67 |
| 1974 | 65774 | 1214645 | 5.42 |
| 1975 | 64857 | 1418658 | 4.57 |
| 1976 | 54179 | 1348949 | 4.02 |
| 1977 | 61830 | 1256035 | 4.92 |
| 1978 | 61334 | 1393750 | 4.40 |
| 1979 | 52391 | 1365973 | 3.84 |
| 1980 | 57522 | 1242881 | 4.63 |
| 1981 | 55763 | 1373295 | 4.06 |
| 1982 | 64038 | 1412664 | 4.53 |
| 1983 | 69217 | 1535987 | 4.51 |
| 1984 | 57015 | 1616104 | 3.53 |
| 1985 | 52154 | 1522517 | 3.43 |
| 1986 | 51897 | 1679373 | 3.09 |
| 1987 | 56584 | 1649165 | 3.43 |
| 1988 | 56846 | 1785549 | 3.18 |

| | | | |
|---|---|---|---|
| 1989 | 49979 | 2205598 | 2.27 |
| 1990 | 49820 | 2142713 | 2.33 |
| 1991 | 50478 | 2222111 | 2.27 |
| 1992 | 63131 | 2277008 | 2.77 |
| 1993 | 66420 | 2245124 | 2.96 |
| 1994 | 56938 | 2325146 | 2.45 |
| 1995 | 68198 | 2225028 | 3.07 |
| 1996 | 57558 | 2380847 | 2.42 |
| 1997 | 74226 | 2692426 | 2.76 |
| 1998 | 74943 | 2664549 | 2.81 |
| 1999 | 64826 | 2401706 | 2.70 |
| 2000 | 71374 | 2652928 | 2.69 |
| 2001 | 55941 | 2292703 | 2.44 |
| 2002 | 58972 | 2589645 | 2.28 |
| 2003 | 56843 | 2587095 | 2.20 |
| 2004 | 58583 | 2538105 | 2.31 |
| 2005 | 46328 | 2295490 | 2.02 |
| 2006 | 50678 | 2710988 | 1.87 |
| 2007 | 45994 | 2888461 | 1.59 |
| 2008 | 48600 | 3207205 | 1.52 |
| 2009 | 52827 | 3163314 | 1.67 |
| 2010 | 45569 | 3346658 | 1.36 |
| 2011 | 53470 | 3820207 | 1.40 |
| 2012 | 52602 | 3948938 | 1.33 |
| 2013 | 46471 | 3781868 | 1.23 |

# APPENDIX -2

## Abundance in fishery,, areas of occurrence and gears used for exploitation of 160 species of sharks occurring in India's commercial fishing zones

| Family | Genus+species | Common name | Abundance in fishery | Areas of occurrence | Gears used for exploitation | IUCN status |
|---|---|---|---|---|---|---|
| Alopiidae | *Alopias pelagicus* | pelagic thresher shark | **** | marine, pelagic-oceanic, EC & WC | longlines and drift gill nets | VU |
| | *Alopias superciliosus* | big-eye thresher shark | **** | marine, pelagic-oceanic, EC & WC | longlines and drift gill nets | VU |
| | *Alopias vulpinus* | thresher shark | *** | marine, pelagic-oceanic, EC & WC | longlines and drift gill nets | VU |
| Carcharhinidae | *carcharhinus albimarginatus* | silvertip shark | *** | marine, benthopelagic, reef associated, EC & WC | longlines and gill nets | NT |
| | *Carcharhinus altimus* | bignose shark | * | marine, demersal, reef associated, EC & WC | bottom trawl, longlines and gill nets | DD |
| | *Carcharhinus amblyrhynchoides* | graceful shark | **** | marine, coastal-pelagic, EC & WC | gill nets and longlines | NT |
| | *Carcharhinus amblyrhynchos* | blacktail reef shark | *** | marine, coastal-pelagic, reef associated, EC & WC | longlines | NT |
| | *Carcharhinus amboinensis* | pigeye shark | * | marine/brackish, reef associated, demersal, EC & WC | longlines | DD |
| | *Carcharhinus brachyurus* | copper shark | * | marine, reef associated, meso-pelagic, WC | bottom trawl and longlines | NT |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Carcharhinus brevipinna* | spinner shark | **** | marine, reef associated, pelagic, EC & WC | longlines, bottomset gill nets and hook & line | NT |
| | *Carcharhinus dussumieri* | whitecheek shark | **** | marine, reef associated, mesopelagic, EC & WC | trawl and bottom set gill nets | NT |
| | *Carcharhinus falciformis* | silky shark | ***** | marine, reef associated, epipelagic, EC & WC | longlines and bottom set gill nets | NT |
| | *Carcharhinus galapagensis* | galapagos shark | * | marine, reef associated, pelagic, WC | longlines and bottom set gill nets | NT |
| | *Carcharhinus hemiodon* | pondicherry shark | ! | marine/brackish, demersal, EC & WC | hook & line, bottom set gill nets and bottom trawl | CR |
| | *Carcharhinus leucas* | bull shark | **** | marine/brackish/freshwater, demersal, EC & WC | longlines and hook & line | NT |
| | *Carcharhinus limbatus* | blacktip shark | ***** | marine/brackish, reef associated, pelagic, EC & WC | longlines, hook & line, bottom set gill nets and bottom trawl | NT |
| | *Carcharhinus longimanus* | oceanic whitetip shark | **** | marine, pelagic-oceanic, EC & WC | longlines | VU |
| | *Carcharhinus macloti* | hardnose shark | **** | marine, demersal, EC & WC | gill nets and longlines | NT |
| | *Carcharhinus melanopterus* | blacktip reef shark | ***** | marine/brackish, reef associated, demersal, EC & WC | gill nets and longlines | NT |
| | *Carcharhinus obscurus* | dusky shark | **** | marine/brackish, reef associated, pelagic, EC & WC | longlines, hook & line and bottom set gill nets | VU |
| | *Carcharhinus plumbeus* | sandbar shark | * | marine/brackish, benthopelagic, EC & WC | longlines, bottomset gill nets and hook & line | VU |
| | *Carcharhinus sealei* | blackspot shark | * | marine, reef associated, shallow water, EC & WC | gill nets and hook & line | NT |
| | *Carcharhinus sorrah* | spot-tail shark | ***** | marine, reef associated, coastal, EC & WC | gill nets and longlines | NT |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Galeocerdo cuvier* | tiger shark | ***** | marine/brackish, benthopelagic, EC & WC | longlines, hook & line, bottom set gill nets and bottom trawl | NT |
| | *Glyphis gangeticus* | ganges shark | ! | marine/brackish/freshwater, demersal, EC | no information | CR |
| | *Glyphis glyphis* | speartooth shark | ! | marine/brackish/freshwater | no information | EN |
| | *Lamiopsis temminckii* | broadfin shark | ** | marine/brackish, demersal, EC & WC | gill nets and longlines | EN |
| | *Loxodon macrorhinus* | sliteye shark | *** | marine, demersal, EC & WC | gill nets and longlines | LC |
| | *Negaprion acutidens* | sicklefin lemon shark | ** | marine/brackish, reef associated, demersal, EC & WC | gill nets and longlines | VU |
| | *Prionace glauca* | blue shark | ** | marine, pelagic-oceanic, EC & WC | longlines, hook & line, pelagic & bottom trawls | NT |
| | *Rhizoprionodon acutus* | milk shark | ***** | marine/freshwater/brackish, benthopelagic, EC & WC | bottom trawl, gill nets, longlines, hook & line, | LC |
| | *Rhizoprionodon oligolinx* | grey sharpnose shark | ***** | marine, reef associated, demersal, EC & WC | bottom trawl, gill nets, longlines, hook & line, | LC |
| | *Scoliodon laticaudus* | spadenose shark | ***** | marine/brackish, demersal, EC & WC | longlines, hook & line, gill nets, traps and bottom trawl | NT |
| | *Triaenodon obesus* | whitetip reef shark | **** | marine, reef associated, demersal, EC & WC | gill nets and longlines | NT |
| Lamnidae | *Isurus oxyrinchus* | shortfinmako shark | **** | marine, pelagic-oceanic, EC & WC | gill nets, longlines and hook & line | VU |
| | *Isurus paucus* | longfin mako | ** | marine, pelagic-oceanic, EC & WC | gill nets, longlines and hook & line | VU |
| Rhincodontidae | *Rhincodon typus* | whale shark | ! | marine, pelagic-oceanic, EC & WC | gill net | VU |
| Stego-stomatidae | *Stegostoma fasciatum* | zebra shark | *** | marine/brackish, reef associated, demersal, EC & WC | drift gill net | VU |

| | | | | | | |
|---|---|---|---|---|---|---|
| Squalidae | *Squalus acanthias* | piked dogfish | ** | marine/brackish, benthopelagic, EC & WC | trawl net | VU |
| | *Squalus mitsukurii* | shortspine spurdog | *** | marine, benthopelagic, EC & WC | trawl net | DD |
| Hemigaleidae | *Chaenogaleus macrostoma* | hooktooth shark | **** | marine, demersal, EC & WC | gill nets and longlines | VU |
| | *Hemigaleus microstoma* | sicklefin weasel shark | *** | marine, demersal, EC & WC | gill nets and longlines | VU |
| | *Paragaleus randalli* | slender weasel shark | ** | marine, demersal, EC & WC | trawl net | NT |
| | *Hemipristis elongata* | snaggletooth shark | *** | marine, demersal, EC & WC | gill nets, bottom trawl and longlines | VU |
| Traikidae | *Iago omanensis* | bigeye houndshark | **** | marine, bathydemersal, WC | trawl and gill net | LC |
| | *Iago mangalorensis* | mangalore houndshark | **** | marine, pelagic-oceanic, WC | trawl | NE |
| | *Iago* sp. | | **** | marine, bathydemersal, EC | trawl and gill net | NE |
| | *Mustelus mosis* | arabian smooth-hound shark | ***** | marine, demersal, EC & WC | trawl and gillnet | DD |
| | *Mustelus* sp. | | ***** | marine, demersal, EC | trawl | NE |
| Sphyrnidae | *Eusphyra blochii* | winghead shark | ** | marine/brackish, benthopelagic, EC & WC | gill nets, stake nets, seines, longlines and hook & lines | NT |
| | *Sphyrna lewini* | scalloped hammerhead | ***** | marine/brackish, pelagic-oceanic, EC & WC | longlines, hook & line, gill nets and trawl nets | EN |
| | *Sphyrna mokarran* | great hammerhead | **** | marine/brackish, pelagic-oceanic, EC & WC | longlines, hook & line, gill nets and trawl nets | EN |
| | *Sphyrna tudes* | smalleye hammerhead | * | marine, benthopelagic, WC | no information | VU |
| | *Sphyrna zygaena* | smooth hammerhead | **** | marine/brackish, pelagic-oceanic, EC & WC | longlines, hook & line, gill nets and trawl nets | VU |

| | | | | | | |
|---|---|---|---|---|---|---|
| Proscyllidae | *Eridacnis radcliffei* | pygmy ribbontail catshark | ** | marine, bathydemersal, EC & WC | bottom trawls | LC |
| | *Proscyllium magnificum* | magnificent catshark | * | marine, bathydemersal, EC | bottom trawls | NE |
| Echinorhinidae | *Echinorhinus brucus* | bramble shark | **** | marine, bathydemersal, EC & WC | bottom trawls & longlines | DD |
| | *Echinorhinus cookei* | prickly shark | * | marine, benthopelagic, EC | gillnet, bottom trawls & longlines | NT |
| Hexanchidae | *Heptranchias perlo* | sharpnose sevengill shark | ** | marine, bathydemersal, EC & WC | bottom trawls and longlines | NT |
| | *Hexanchus griseus* | bluntnose sixgill shark | ** | marine, bathydemersal, WC | gillnet, longline, traps, pelagic and bottom trawls | NT |
| Hemiscyllidae | *Chiloscyllium arabicum* | arabian carpetshark | **** | marine, demersal, WC | no information | NT |
| | *Chiloscyllium griseum* | grey bambooshark | **** | marine/ brackish, reef-associated, EC & WC | gillnet & hook and line | NT |
| | *Chiloscyllium indicum* | slender bambooshark | *** | marine/ freshwater/ brackish, demersal, EC & WC | gillnet & hook and line | NT |
| | *Chiloscyllium plagiosum* | whitespotted bambooshark | *** | marine, reef-associated, EC & WC | gillnet & bottom trawl | NT |
| | *Chiloscyllium punctatum* | brownbanded bambooshark | *** | marine, reef-associated, EC | gillnet,bottom trawls, beach seine and hook and line | VU |
| Ginglymosto-matidae | *Nebrius ferrugineus* | tawny nurse shark | *** | marine, reef-associated, EC & WC | longlines, gillnets, fixed bottom nets and bottom trawls | VU |
| Pseudo-carcharhiidae | *Pseudocarcharhias kamoharai* | crocodile shark | * | marine, pelagic-oceanic, WC | pelagic & tuna longlines | NT |
| Odontaspididae | *Carcharias taurus* | sand tiger shark | * | marine, reef-associated, EC & WC | bottom and pelagic trawls, fixed bottom nets and longline | VU |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Odontaspis ferox* | small-tooth sand tiger shark | * | marine, demersal | fixed bottom nets and longline | VU |
| | *Odontaspis noronhai* | bigeye sand tigershark | * | marine, demersal | fixed bottom nets and longline | DD |
| Scyliorhinidae | *Apristurus investigatoris* | broadnose cat shark | * | marine, bathydemersal, andaman sea | trawl net | DD |
| | *Bythaelurus hispidus* | bristly catshark | * | marine,bathydemersal | trawl net | NT |
| | *Cephaloscyllium silasi* | indian swellshark | * | marine, bathydemersal, WC | trawl net | DD |
| | *Halaelurus quagga* | quagga catshark | * | marine, demersal | trawl net | DD |
| Somniosidae | *Centroscymnus crepidator* | longnose velvet dogfish | ** | marine, bathydemersal, WC | bottom trawls | NT |
| | *Zameus squamulosus* | velvet dogfish | * | marine, benthopelagic, WC | bottom trawls, longlines | DD |
| Etmopteridae | *Etmopterus lucifer* | blackbelly lanternshark | * | marine, benthopelagic | bottom trawls | DD |
| | *Etmopterus pusillus* | smooth lanternshark | * | marine, benthopelagic wc | bottom trawls, fixed bottom nets and line gear | LC |
| Centrophoridae | *Centrophorus atromarginatus* | dwarf gulper shark | *** | marine, benthopelagic WC & EC | bottom trawls, fixed bottom nets and line gear | DD |
| | *Centrophorus granulosus* | gulper shark | *** | marine, bathydemersal, EC & WC | bottom trawls, pelagic trawls and hook & line | LC |
| | *Centrophorus moluccensis* | smallfin gulper shark | *** | marine, bathydemersal, | bottom trawls | VU |
| | *Centrophorus squamosus* | leafscale gulper shark | *** | marine, bathydemersal, WC | bottom trawls, fixed bottom nets and line gear | DD |
| | *Centrophorus uyato* | little gulper shark | * | marine, bathydemersal, EC & WC | bottom trawls, fixed bottom nets and line gear | VU |
| | *Deania profundorum* | arrowhead dogfish | * | marine, bathydemersal, WC | bottom trawls, fixed bottom nets and line gear | NE |
| Myliobatidae | *Aetobatus flagellum* | longheated eagle ray | ** | marine/ brackish, benthopelagic, EC & WC | bottom trawl and inshore bottom set gill nets | EN |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Aetobatus ocellatus* | spotted eagle ray | ***** | marine/brackish, reef associated, WC & EC | bottom trawl and inshore bottom set gill nets | NT |
| | *Aetomylaeus maculatus* | mottled eagle ray | * | marine/brackish, reef associated, WC & EC | bottom trawl and inshore bottom set gill nets | EN |
| | *Aetomylaeus milvus* | brown eagle ray | * | marine, benthopelagic, WC & EC | bottom trawl | NE |
| | *Aetomylaeus nichofii* | nieuhof's eagle ray | *** | marine/brackish, demersal, WC & EC | bottom trawl and inshore bottom set gill nets | VU |
| | *Aetomylaeus vespertilio* | ornate eagle ray | ** | marine, benthoopelagic, WC & EC | bottom trawl, inshore bottom set gill nets and traps | EN |
| Rhinopteridae | *Rhinoptera javanica* | flapnose ray | ***** | marine/brackish, reef associated, WC & EC | bottom trawl and inshore bottom set gill nets | VU |
| | *Rhinoptera jayakari* | oman cownose ray | * | marine, benthopelagic | trawl and inshore bottom set gill nets | NE |
| Mobulidae | *Manta birostris* | giant manta ray | ** | | gill net | VU |
| | *Manta alfredi* | reef manta ray | * | marine, reef associated/ benthopelagic, WC & EC | no information | VU |
| | *Mobula thurstoni* | smoothtailmobula | ** | marine, pelagic-oceanic, WC & EC | gill net | NT |
| | *Mobula japanica* | spinetailmobula | *** | marine, reef associated, WC & EC | gill net | NT |
| | *Mobula tarapacana* | chilean devil ray | *** | marine, reef associated, oceanodromous, WC & EC | gill net | DD |
| | *Mobula kuhlii* | shortfin devil ray | *** | marine, pelagic-oceanic, WC & EC | gill net | DD |
| | *Mobula eregoodonteke* | longhornedmobula | ** | marine, pelagic-oceanic, WC & EC | gill net | NT |
| Dasyatidae | *Dasyatis centroura (?)* | roughtail sting ray | *** | marine/ brackish, demersal WC & EC | bottom trawl | LC |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Dasyatis microps* | smalleye sting rays | * | marine / brackish, demersal/ deepwater, EC | bottom trawl | DD |
| | *Dasyatis zugei* | pale edged sting ray | *** | marine/brackish, demersal, WC & EC | bottom trawl | NT |
| | *Himantura fai* | pink whipray | *** | marine, reef associated, WC & EC | bottom trawl and longline | LC |
| | *Himantura fluviatilis (?)* | cowtail stingray | ! | marine, reef associated, WC & EC | bottom trawl and longline | |
| | *Himantura gerrardi* | white spotted whip ray | ***** | marine/brackish, demersal, EC | bottom trawl and gill net | VU |
| | *Himantura granulata* | mangrove whipray | ** | marine / brackish, reef associated, WC & EC | bottom trawl | NT |
| | *Himantura imbricata* | scaly whip ray | ***** | marine/brackish/ fresh, demersal, WC & EC | bottom trawl and gill net | DD |
| | *Himantura jenkinsii* | jenkin's whipray | ***** | marine/brackish, demersal, WC & EC | bottom trawl, gill net and line gear | LC |
| | *Himantura leoparda* | | *** | marine, benthopelagic, WC & EC | bottom trawl and gill net | VU |
| | *Himantura marginata* | blackedge whip ray | ** | marine/brackish, demersal, | bottom trawl and gill net | DD |
| | *Himantura pastinacoides* | round whipray | ** | marine, demersal, EC | bottom trawl | VU |
| | *Himantura uarnacoides* | whitenosewhipray | **** | marine, demersal, EC | bottom trawl | VU |
| | *Himantura uarnak* | honeycompwhipray | ***** | marine/brackish, reef associated, WC & EC | bottom trawl | VU |
| | *Himantura undulata* | leopard whipray | **** | marine, demersal, WC & EC | bottom trawl and longlines | VU |
| | *Himantura walga* | dwarf whipray | * | marine, demersal | bottom trawl | NT |
| | *Neotrygon kuhlii* | blue spotted stingray | **** | marine, reef associated, WC & EC | bottom trawl | DD |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Neotrygon* cf. *trigonoides* | mask ray | *** | marine, reef associated, WC | bottom trawl | NE |
| | *Pastinachus sephen* | cowtail stingray | ***** | marine/brackish/ fresh, reef associated, WC & EC | bottom trawl and hook & line | DD |
| | *Pteroplatytrygon violacea* | pelagic sting ray | *** | marine / pleagic, oceanic WC & EC | bottom trawl, gill net and longlines | LC |
| | *Taeniura lymma* | blue spotted fan tail ray | *** | marine reef associated, WC & EC | bottom trawl, gill net and longlines | NT |
| | *Taeniura meyeni* | blotched fantail ray | *** | marine, reef associated, EC | bottom trawl, gill net and longlines | VU |
| | *Urogymnus asperrimus* | porcupine ray | ! | marine/brackish, reef associated, WC & EC | bottom trawl and gill net | VU |
| Plesiobatidae | *Plesiobatis daviesi* | deepwater stingray | ** | marine, bathydemersal, WC & EC | bottom trawl, | LC |
| Gymnuridae | *Gymnura japonica* | japanese butterfly ray | ** | marine, demersal, EC | bottom trawl, gill net and trammel net | DD |
| | *Gymnura micrura* | smooth butterfly ray | *** | marine/ brackish, demersal WC & EC | bottom trawl | DD |
| | *Gymnura poecilura* | long tailed butterfly ray | **** | marine, demersal, WC & EC | bottom trawl and trammel net | NT |
| | *Gymnura zonura* | zonetail butterfly ray | **** | marine, reef associated, WC & EC | bottom trawl, gill net and trammel net | VU |
| Narcinidae | *Benthobatis moresbyi* | dark blind ray | * | marine, bathydemersal, WC | bottom trawl | DD |
| | *Narcine brunnea* | blind ray | * | marine, demersal, WC & EC | bottom trawl | NE |
| | *Narcine prodorsalis* | tonkin numbfish | * | marine demersal, EC | bottom trawl | DD |
| | *Narcine timlei* | spotted numbfish | ** | marine, demersal, WC & EC | bottom trawl | DD |
| Narkidae | *Narke dipterygia* | numb ray | ** | marine, inshore and offshore continental waters, WC & EC | bottom trawl | DD |

| | | | | | | |
|---|---|---|---|---|---|---|
| Torpedinidae | *Torpedo fuscomaculata* | black spotted torpedo | ** | marine, brackish, reef associated, WC & EC | bottom trawl | DD |
| | *Torpedo marmorata* | marbled electric ray | ** | marine/brackish, reef associated, WC & EC | bottom trawl | DD |
| | *Torpedo sinuspersici* | mottled electric ray | *** | marine/ reef associated, WC & EC | bottom trawl | DD |
| | *Torpedo zugmayeri* | electric ray | * | marine/ wc | bottom trawl | NE |
| Hexatrygonidae | *Hexatrygon bickelli* | sixgill stingray | * | marine/bathydemersal, WC | bottom trawl | LC |
| Pristidae | *Anoxypristis cuspidata* | pointed saw fish | ! | marine/freshwater/brackish, benthopelagic, WC & EC | bottom trawl and gillnet | EN |
| | *Pristis microdon* | largetooth saw fish | ! | marine/freshwater/brackish, demersal, WC & EC | bottom trawl and gillnet | NE |
| | *Pristis pristis* | common sawfish | * | marine/freshwater/brackish, demersal, WC & EC | bottom trawl and gillnet | CR |
| | *Pristis zijsron* | longcomp saw fish | ! | marine/freshwater/brackish, demersal, WC & EC | bottom trawl and gillnet | CR |
| Rhinidae | *Rhina ancylostoma* | bowmouth guitarfish | ** | marine/ reef associated, WC & EC | bottom trawl and gillnet | VU |
| Rhinobatidae | *Glaucostegus granulatus* | granulated guitar fish | **** | marine/demersal, WC & EC | bottom trawl and gillnet | VU |
| | *Glaucostegus thouin* | clubnose guitarfish | ** | marine/demersal, WC & EC | bottom trawl and gillnet | VU |
| | *Glaucostegus variegatus* | stripenose guitarfish | *** | marine/demersal, WC & EC | bottom trawl and gillnet | DD |
| | *Rhinobatos annandalei* | annandale's guitarfish | *** | marine/brackish/ demersal, WC | bottom trawl and gillnet | DD |
| | *Rhinobatos lionatus* | smoothback guitarfish | * | marine/brackish/, EC | bottom trawl and gillnet | DD |
| | *Rhinobatos obtusus* | widenose guitar fish | ** | marine/demersal, WC & EC | bottom trawl and gillnet | VU |
| | *Rhinobatos punctifer* | spotted guitarfish | *** | | bottom trawl and gillnet | DD |

| | | | | | | |
|---|---|---|---|---|---|---|
| | *Rhinobatos schlegelii* | brown guitarfish | **** | marine/demersal, EC | bottom trawl and gillnet | DD |
| Rhyncho-batidae | *Rhynchobatus australiae* | white spotted guitarfish | *** | marine; coastal, reef-associated; | bottom trawl and gillnet | VU |
| | *Rhynchobatus djiddensis* | giant guitarfish | ! | marine; brackish; reef-associated; | bottom trawl and gillnet | VU |
| | *Rhynchobatus palpebratus* | eyebrow wedge fish | * | marine; coastal; reef-associated; | bottom trawl and gillnet | NE |
| Rajidae | *Cruriraja andamanica* | andaman leg skate | * | marine; bathydemersal, EC | bottom trawl and gillnet | DD |
| | *Dipturus johannisdavisi* | travancore skates | * | marine; bathydemersal, WC | bottom trawl and gillnet | DD |
| | *Dipturus* sp. | | ** | marine; bathydemersal, WC | bottom trawl and gillnet | NE |
| | *Fenestraja mammillidens* | prickly skate | * | marine; bathydemersal, WC | bottom trawl and gillnet | DD |
| | *Okamejei powelli* | indian ringed skates | * | marine; demersal, WC | bottom trawl and gillnet | DD |
| | *Raja miraletus* (?) | brown ray | * | marine; demersal, WC | bottom trawl and gillnet | LC |
| | *Rostroraja alba* (?) | white skate | * | marine; demersal, WC | bottom trawl and gillnet | EN |

| | |
|---|---|
| ***** | Predominant in commercial shark landings |
| **** | Common occurrence |
| *** | Moderate occurrence |
| ** | Rare occurrence |
| * | Isolated reports only |
| ! | Protected under WPA, 1972 |
| (?) | Needs confirmation |

| | |
|---|---|
| EC East Coast | CR Critically Endangered |
| WC West Coast | EN Endangered |
| | VU Vulnerable |
| | NT Near Threatened |
| | DD Data Deficient |
| | LC Least Concern |

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# ACRONYMS

| | |
|---|---|
| ADSGAF | Association of Deep Sea Going Artisanal Fishermen |
| BOBLME | Bay of Bengal Large Marine Ecosystem |
| BOBP-IGO | Bay of Bengal Programme Inter-Governmental Organisation |
| CMFRI | Central Marine Fisheries Research Institute |
| CMS | Convention on Migratory Species |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| DAHD&F | Department of Animal Husbandry, Dairying and Fisheries |
| EEZ | Exclusive Economic Zone |
| FAO | Food and Agriculture Organisation |
| FSI | Fishery Survey of India |
| HSI | Humane Society International |
| ICAR | Indian Council of Agricultural Research |
| ICSF | International Collective in Support of Fish workers |
| IPOA | International Plan of Action |
| IUCN | International Union for Conservation of Nature |
| MLS | Minimum Legal Size |
| MPEDA | Marine Products Export Development Authority |
| MOE,F&CC | Ministry of Environment, Forests & Climate Change |
| NBFGR | National Bureau of Fish Genetic Resources |
| NGO | Non-Governmental Organisation |
| NFWF | National Fish Workers Forum |
| NPOA | National Plan of Action |
| TRAFFIC | Joint programme of WWF & IUCN for wildlife trade monitoring |
| RSA | Rapid Stock Assessment |
| SIFFS | South Indian Federation of Fishermen Societies |
| WPA,1972 | Indian Wildlife (Protection) Act, 1972 |
| WWF | World Wide Fund for Nature |

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