Non-Detriment Findings (NDF) for the export of Shark and Ray species listed in Appendix II of the CITES and harvested from Indian waters

Indian Council of Agricultural Research
Central Marine Fisheries Research Institute
P.B. NO.1603, Kochi -682018, India

Non-Detriment Findings (NDF) for the export of Shark and Ray species listed in Appendix II of the CITES and harvested from Indian waters

Scalloped hammerhead shark *Sphyrna lewini*
Great hammerhead shark *Sphyrna mokarran*
Smooth hammerhead shark *Sphyrna zygaena*
Oceanic whitetip shark *Carcharhinus longimanus*
Giant Manta ray *Manta birostris*
Alfred/Reef Manta ray *Manta alfredi*

P.U. Zacharia, Shoba Joe Kizhakudan, Sujitha Thomas, P.P. Manojkumar, Rekha J. Nair, T.M. Najmudeen, G.B. Purushottama, M. Muktha, Swathipriyanka Sen Dash, K.V. Akhilesh & L. Remya.

Indian Council of Agricultural Research
Central Marine Fisheries Research Institute
P.B. NO.1603, Kochi -682018, India

Marine Fisheries Policy Series No. 6

Non-Detriment Findings (NDF) for the export of shark and ray species listed in Appendix II of the CITES and harvested from Indian waters

Published by
Director
ICAR-Central Marine Fisheries Research Institute
Post Box No. 1603, Ernakulam North P.O.,
Kochi – 682 018, Kerala, India
www.cmfri.org.in

Email: director@cmfri.org.in
Tel: +91-484 2394 867
Fax: +91-484 2394 909

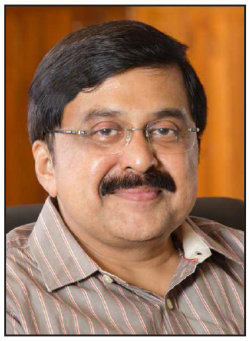
Publication, Production & Co-ordination
Library & Documentation Centre

Citation: Zacharia P.U., Shoba Joe Kizhakudan, Sujitha Thomas, P.P. Manojkumar, Rekha J. Nair, T.M. Najmudeen, G.B. Purushottama, M. Muktha, Swathipriyanka Sen Dash, K.V. Akhilesh & L. Remya, 2017. Non-Detriment Findings (NDF) for the export of Shark and Ray species listed in Appendix II of the CITES and harvested from Indian waters. Marine Fisheries Policy Series No. 6 , Central Marine Fisheries Research Institute, Kochi, India, 240 pp.

ISSN: 2394-8019

Printed at: Print Express, Ernakulam

FOREWORD



CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments, which aims at the sustainability of wild exploited fauna/flora and ensures that international trade in specimens of wild animals and plants does not threaten their survival. 183 Parties have voluntarily joined CITES in an effort to sustain its resources. Since the trade in wild animals and plants crosses borders between countries, the effort to regulate it requires international cooperation to safeguard certain species from over-exploitation. Five species of sharks and two manta rays were added to Appendix II at Bangkok (Thailand), CITES CoP16 in 2013, effective from 14 September 2014. The list includes the scalloped hammerhead shark *Sphyrna lewini*, great hammerhead shark *Sphyrna mokarran*, smooth hammerhead shark *Sphyrna zygaena*, oceanic whitetip shark *Carcharhinus longimanus*, porbeagle shark *Lamna nasus*, giant manta ray *Manta birostris* and reef manta ray *Manta alfredi*. Although CITES is legally binding on the Parties, it does not take the place of national laws; rather it provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level. Decisions on the extent of trade regulation are usually based on the recommendation of a Non-Detriment Findings study made by a competent Scientific Authority to assess the extent to which the survival of the species would be affected by the trade.

ICAR–Central Marine Fisheries Research Institute has been recognized as the Scientific Authority for CITES in India. Non Detrimental Findings (NDF) document prepared by the Scientific Authority is a prerequisite for the trade of Appendix II listed species in any country. Therefore, this NDF document has been prepared for the four species of sharks and two manta rays available in Indian waters to ascertain its exploitation status in India in a trade outlook. The recommendations of the study are intended as guidance in regulating or allowing international trade of the concerned species and its by-products, as laid down by CITES Appendix II criteria, and subject to existing regulatory laws on shark fin trade implemented by the Government of India.

I compliment the team from the Demersal Fisheries Division in bringing out this valuable document which will help to sustainably manage the population of these species in Indian seas.

(A. Gopalakrishnan)

CONTENTS

Executive Summary

Five species of sharks and two manta rays were added to Appendix II at Bangkok (Thailand), CITES CoP16 in 2013, effective from 14 September 2014. These include the scalloped hammerhead shark *Sphyrna lewini*, great hammerhead shark *Sphyrna mokarran*, smooth hammerhead shark *Sphyrna zygaena*, oceanic whitetip shark *Carcharhinus longimanus*, porbeagle shark *Lamna nasus*, giant manta ray *Manta birostris* and reef manta ray *Manta alfredi*. The giant manta ray, the reef manta ray, the oceanic whitetip shark, the porbeagle shark and the smooth hammerhead shark are listed as Vulnerable on the IUCN Red List. The scalloped and great hammerhead sharks are listed as Endangered, thereby considered to be facing a very high risk of extinction. While the porbeagle shark is not known to occur in Indian waters, all the other species listed above are relevant to India.

The inclusion of these species under Appendix II renders trade of the products from these species traceable through the CITES certification system. While the listing does not imply a ban in commercial trade it implies that trade would be regulated with transparency and accountability.

Decisions on the extent of trade regulation are usually based on the recommendation of a Non-Detriment Findings study made by a competent Scientific Authority to assess the extent to which the survival of the species would be affected by the trade. Non-detriment finding (NDF) document is part of those CITES requirements for the trade of Appendix II listed species prepared by a Scientific Authority considering their population status, distribution, population trend, harvest, trade information and other biological and ecological factors; and advising whether such export will not be detrimental to the survival of that species.

ICAR –Central Marine Fisheries Research Institute has been recognized as the Scientific Authority for NDF document preparation in India. This document has been prepared at the behest of the Ministry of Environment, Forests & Climate Change. The study and its results are based on the following –

- Real-time data on fishery trends in India
- Data collected by CMFRI on biology of the different species
- Data on shark fin trade in India
- Published information on biology and behavior of different species from different parts of the world

The procedures set out in the CITES Non-Detriment Findings Guidance for shark species (2nd revised version) by Victora Munday-Taylor et al. (2014) for BfN Federal

Agency for Nature Conservation published by TRAFFIC has been used as a guidance for preparation of this document.

The hammerheads are fished worldwide and global catch estimates show a fluctuating trend over the years. In Indian waters the hammerhead sharks show a declining trend. Trawl is the major gear by which these sharks are caught, followed by gill net and hook and line. There is no targeted fishery of hammerhead sharks and they form a by-catch in the fishery. *Sphyrna lewini* forms only 0.73 % of the total shark landings in India. Reports of species-wise landing of *S. mokarran* is limited in India since the catches are dominated mostly by *S. lewini* and it is not easy to distinguish the species when contribution to the bulk is negligible, as in the case of *S. mokarran.* The all-India average landing during 2007-2015 was only 9 t. The average landing of *S. zygaena* during 2007-2015 was 59 t. Several traits increase the susceptibility of hammerheads to capture, including increased risk due to their unique head shape, which can easily become tangled in nets. The tendency of juvenile hammerhead sharks to aggregate in nearshore and coastal waters make it more susceptible to capture. In most of the maritime states of India, juveniles of these species are landed by fishing vessels operating in coastal waters.

There is no targeted fishery of the oceanic whitetip shark in Indian waters but it is often landed as by-catch of pelagic longline and gill net fisheries. Cochin Fisheries Harbour on the south-west coast of India is the major landing centre for this shark. The landings steadily increased from 1.3 t in 2007 to 381.2 t in 2014; it has since then decreased to 283.6 t in 2015. Large size, slow growth, long lifespan, high trophic level, low fecundity and long gestation period make the oceanic whitetip shark particularly vulnerable to population depletion through unregulated fishing. However, at present there is no targeted fishing for this species in Indian waters; it is landed as by-catch of other fisheries. A major threat to the stock in Indian waters is the low mean size of 60 cm TL in the landings, which is below the size at maturity estimated for the species from different localities, including India.

The giant manta ray *Manta birostris* is known to occur in Indian waters, both in the Arabian sea and the Bay of Bengal; a good stock of this species is believed to exist in the waters between the India peninsula and Sri Lanka. This species is often encountered as by-catch in the fishery. Although the distribution range of *Manta alfredi* extends across Indian waters, this species is seldom encountered in the fishery and there is not much information on the presence of resident stocks in these waters. While the full extent of mobulid landings in India is not known, numerous published references document significant manta and mobula ray landings from the Indian coastal trawl, gillnet and longline fisheries. Given the vast size of the Indian trawl and gillnet fleets and limited fisheries insight, the landings of mobulids in these fisheries may be significantly underreported. Likewise, with well-organized harpoon fisheries for

M. birostris reported on both east and west coasts of India with no landings data available, there is again the strong possibility of significant landings going unaccounted for in the fisheries data. To properly estimate total manta and mobula ray landings in India, further investigation is required.

From the information available on the fishery and stock status of hammerhead sharks and oceanic whitetip shark in Indian waters, ICAR-CMFRI has found that at present, the fishery does not pose a serious threat to the stocks of these species, provided there is a check on the exploitation of juvenile hammerheads from the inshore waters. Positive NDFs are therefore recommended, and international trade in these sharks and their by-products can be done with CITES certification, subject to existing regulatory laws on shark fin trade implemented by the Government of India. Since the sharks are not targeted by a particular fishing fleet, gear or method, and the landings are not consistent throughout the year, it is not possible to fix recommended harvest levels.

From the information available on the fishery and stock status of manta rays in Indian waters, ICAR-CMFRI has found that at present the extent of threat posed to the stock cannot be clearly assessed. Collection and analysis of data on fishery and trade of this species must be continued for three more years. The NDF study can be taken up after three years, during which time international trade in this ray and its by-products can be done with CITES certification, subject to existing regulatory laws on elasmobranch trade implemented by the Government of India. Since the species is characterised by high biological vulnerability, a precautionary approach is recommended, which includes intensive awareness generation among stakeholders.

Introduction

India is a party to several international conventions/treaties/institutions related to wildlife conservation, viz., Convention on International Trade in Endangered Species of wild fauna and flora (CITES), International Whaling Commission (IWC), United Nations Educational, Scientific and Cultural Organization-World Heritage Committee (UNESCO-WHC), the Convention on Migratory Species (CMS) etc.

CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement between governments, which aims at the sustainability of wild exploited fauna/flora and ensures that international trade in specimens of wild animals and plants does not threaten their survival. 183 countries are party to CITES.

Wild exploitation for international trade is a major conservation challenge and CITES functions in putting certain controls over the trade of selected species to prevent over-exploitation. Today, more than 35,000 species of animals and plants are protected through CITES listing, based upon the extent of threat to their survival. Each protected species or population is included in any one of three lists, in its varying degree of protection, known as Appendices.

Appendix II includes species not necessarily threatened with extinction, but in which trade must be controlled to avoid utilization incompatible with their survival. International trade in specimens of Appendix II species is allowed only by the granting of an export permit or re-export certificate.

Sharks are keystone species and their abundance and health are critical to the balance of the marine ecosystem. Five species of sharks and all manta rays (2 species) were added to Appendix II at Bangkok (Thailand), CITES CoP16 in 2013. These include the oceanic whitetip shark, the porbeagle shark, scalloped, smooth and great hammerhead sharks, as well as the great and reef manta rays. This effective date was delayed by 18 months, i.e. until 14 September 2014. The listings of these species under Appendix II renders trade of the products from these species traceable through the CITES certification system. The listing does not imply a ban in commercial trade; but instead trade would be regulated with transparency and accountability. The giant manta ray, the reef manta ray, the oceanic whitetip shark, the porbeagle shark and the smooth hammerhead shark are listed as Vulnerable on the IUCN Red List. The scalloped and great hammerhead sharks are listed as Endangered, thereby considered to be facing a very high risk of extinction. Given that most of these shark species are highly migratory and traverse the waters of many nations, it is imperative that all such nations come together to form cohesive and structured plans for implementation of shark conservation measures.

Non-detriment finding (NDF) document is part of those CITES requirements for the trade of Appendix II listed species prepared by a Scientific Authority considering their population status, distribution, population trend, harvest trade information and other biological and ecological factors and advising whether such export will or will not be detrimental to the survival of that species, Scientific Authority shall monitor both the export permits granted by that country for specimens of species included in Appendix II and the actual exports of such specimens. Whenever a Scientific Authority determines that the export of specimens of any such species should be limited in order to maintain that species throughout its range at a level consistent with its role in the ecosystems in which it occurs and well above the level at which that species might become eligible for inclusion in Appendix I, the Scientific Authority shall advise the appropriate Management Authority of suitable measures to be taken to limit the grant of export permits for specimens of that species. The NDF is an effective advice by the CITES Scientific Authority of the exporting country on the effect of proposed trade on survival of the species. The recommendations of the NDF study can have a direct bearing on fishery regulating policies adopted by a member country as the NDF accounts for the impact of existing fishery on the stock status of the species in that region.

CMFRI has been recognized as the Scientific Authority for NDF document preparation in India. This document has been prepared at the behest of the Ministry of Environment, Forests & Climate Change. The study and its results are based on the following –

- Real-time data on fishery trends in India
- Data collected by CMFRI on biology of the different species
- Data on shark fin trade in India
- Published information on biology and behavior of different species from different parts of the world

The recommendations of the study are intended as guidance in regulating or allowing international trade of the concerned species and their by-products, as laid down by CITES Appendix II criteria, and subject to existing regulatory laws on shark fin trade implemented by the Government of India.

Hammerhead sharks

Hammerhead sharks are a small but common genus of sharks of the family Sphyrnidae. They are easily identified from their heads which have laterally expanded blades that resemble the shape of "a double-bitted axe in profile"; this unique head shape is perhaps of advantage in increasing manoeuvring capabilities and sensory capacity particularly in tracking their prey (Compagno, 1984). Hammerheads are plain grey or brown on top and white underneath. These sharks exhibit vivipary, *i.e.*, the embryos develop *in utero* and are fed by a yolk sac placenta. They are obligate ram ventilators (i.e. they need to swim to get oxygen from the water) (Compagno, 1984).

Scalloped hammerhead shark *Sphyrna lewini* (Griffith & Smith 1834)

The scalloped hammerhead shark *Sphyrna lewini* is distinguished from other hammerheads by a marked central indentation on the anterior margin of the head, along with two more indentations on each side of this central indentation, giving the head a "scalloped" appearance. It has a broadly arched mouth and the rear margin of the head is slightly swept backward. The dentition of the scalloped hammerhead consists of small, narrow, and triangular teeth with smooth edges (often slightly serrated in larger individuals), and is similar in both jaws. The front teeth are erect while subsequent teeth have oblique cusps, and the lower teeth are more erect than the upper teeth (Bester, 2011a). The body of the scalloped hammerhead is fusiform, with a large first dorsal fin and low second dorsal and pelvic fins. The first dorsal fin is moderately hooked with its origin over or slightly behind the pectoral fin insertions and the rear tip in front of the pelvic fin origins. The height of the second dorsal fin is less than the anal fin height and has a posterior margin that is approximately twice the height of the fin, with the free rear tip almost reaching the precaudal pit. The pelvic fins have relatively straight rear margins while the anal fin is deeply notched on the posterior margin (Compagno, 1984). The scalloped hammerhead generally has a uniform grey, greyish brown, bronze, or olive coloration on top of the body that shades to white on the underside with dusky or black pectoral fin tips.

Great hammerhead shark *Sphyrna mokarran* (Rüppell 1837)

The great hammerhead shark *Sphyrna mokkaran* has a very straight and square hammer head (cephalophoil) which differentiates it from the smooth and scalloped hammerheads (Bester, 2011b). The front margin of the head is gently curved in juveniles in contrast to the nearly straight margin with a shallow notch at the middle in adult great hammerheads. The body is coloured grey-brown above and light below, without fin markings (Fischer and Bianchi, 1984). Another distinguishing characteristic of the great hammerhead is the curved rear margin of the pelvic fins whereas the scalloped hammerhead has straight posterior edges (CoP16 Prop. 43). The pectoral

fin of *S. mokarran* is more falcate, much narrower and sharply pointed than in other hammerheads. The upper to lower caudal ratio and post-ventral margin ratio is larger in *S. mokarran* than in *S. lewini*. The tip of the lower caudal lobe has a small dusky black mark and the ventral tip of the pectoral fin is black in great hammerheads. Total vertebral centra are 197 to 212 (Marshall and Barone, 2016).

Smooth hammerhead shark *Sphyrna zygaena* (Linnaeus 1758)

The smooth hammerhead shark *Sphyrna zygaena* is characterised by the absence of the prominent scalloped indentation but with lateral indentations. The cephalophoil in *S. zygaena* is very wide but longitudinally short, its width being 26 to 29% of total length. The posterior margin of the head is wide and angled posterolaterally. Prenarial grooves are well-developed and situated anteromedial to the nostrils (Compagno, 1981). The rear tip of first dorsal fin is well ahead of pelvic-fin origin. The second dorsal fin is low, its height being less than that of the anal fin, and has a shallowly concave posterior margin with long inner margin about twice fin height; it ends well in front of the upper caudal origin. Pelvic fins are not falcate and have straight or slightly concave posterior margins. The posterior margin of the anal fin is deeply notched. Total vertebral centra are 193 to 206 (FAO Smartfish, 2014). The body colour is more olive-brown in *S. zygaena* and its ventral colour is stark white in contrast, whereas in *S. lewini* there is no clear difference between dorsal and ventral skin; dorsal colour is more grey in *S. lewini*. The ventral tip colour of the pectoral fin tapers distally along the posterior margin in *S. zygaena*, whereas in *S. mokarran* it is concentrated around the fin tip (Marshall and Barone, 2016).

BIOLOGY

Growth

Sphyrna lewini

This is a large shark, growing to >3m in total length (TL). The maximum size reported for the species globally was 370-420 cm (Compagno, 1984). It has a long lifespan of about 20-30 years and is a late maturing species. Studies from Indian waters are sparse; the size common in the fishery is reported to be 18-260 cm (CMFRI, 2015). The maximum size reported from India is 430 cm and the longevity is estimated as 35 years; the females are expected to mature at 210 cm TL (Kizhakudan et al., 2015). Table 1 presents a comparison of estimates of maximum size and age, and size and age at maturity from different localities. Asymptotic size also varies from region to region. *S. lewini* is reported to grow slowly in western Atlantic having smaller asymptotic size compared to eastern and western Pacific. The asymptotic length ranged from 300 cm (Brazil) to 519 cm (South Africa). In Indian waters, preliminary estimates indicate the L_{∞} to be 476.6 cm (CMFRI, 2015, unpublished).

Table 1. Measures of maximum size, age and size at maturity from different locations for male and female *S. lewini*

	Sex	Measure (TL cm)	Location	References
Max. size	F	346	N Australia	Stevens & Lyle, 1989
		260	Temperate	Harry et al., 2011
		317	Indonesia	White et al., 2008
		331	Taiwan	Chen et al., 1988, 1990
		307	South Africa	Bass et al., 1975
		295	Porto novo, India	Raje et al., 2007
		430	Kochi, India	Kizhakudan et al., 2015
	M	370-420	Global	Compagno, 1984
		290	Temperate	Harry et al., 2011
		240	Indonesia	White et al., 2008
		301	Taiwan	Chen et al., 1988, 1990
		321	SW Atlantic	Hazin et al., 2001
		301	N Australia	Stevens & Lyle, 1989
		295	South Africa	Bass et al., 1975
		252	Kochi, India	CMFRI, 2015 (unpublished)
Size at maturity	F	240	SW Atlantic	Hazin et al., 2001
		212	Global	Compagno, 1984
		250	Gulf of Mexico	Branstetter, 1987
		220-240	Indonesia	White et al., 2008
		200	N Australia	Stevens & Lyle, 1989
		210	Taiwan	Chen et al., 1988, 1990
		212	South Africa	Bass et al., 1975
		180	Port novo, India	Raje et al., 2007
		210	India	Kizhakudan et. al., 2015
	M	180-200	SW Atlantic	Hazin et al., 2001
		140-165	Global	Compagno, 1984
		180	Gulf of Mexico	Branstetter, 1987
		170-190	Indonesia	White et al., 2008
		135-161	N Australia	Stevens & Lyle, 1989
		129-199	E Australia	Harry et al., 2011
Max. age (years)	F	35	Gulf of Mexico	Branstetter, 1987
		38.5	Atlantic/Gulf of Mexico	Piercy et al., 2007
		21	E. Australia	Harry et al., 2011
	M	22-30	Gulf of Mexico	Branstetter, 1987
		26.6	Atlantic/Gulf of Mexico	Piercy et al., 2007
		15	E Australia	Harry et al., 2011
Age at maturity (years)	M	15	Gulf of Mexico	Stevens & Lyle, 1989
	F	9-10	Gulf of Mexico	Stevens & Lyle, 1989
		3-9	E Australia	Harry et al., 2011

Length-weight relationship of *S. lewini* in Indian waters

The length weight relationship was calculated as

$W=0.003533\ L^{3.07015}$ (M) ($r^2 = 0.957$)

$W= 0.005399\ L^{2.96917}$ (F) ($r^2 = 0.99$)

$W= 0.0051\ L^{2.98103}$ (pooled) ($r^2 = 0.99$)

Sphyrna mokarran

The great hammerhead shark is the largest of all hammerheads with maximum total size reported for the adult being 550 to 610 cm (Compagno, 1998; Compagno et al., 2005). Last and Stevens (2009) report that a size of 450 cm is more common for a mature adult. Great hammerheads are inherently vulnerable to overexploitation due to their long lifespan (estimated at 44 years), slow growth, prolonged reproductive cycles with an 11-month gestation period and pupping activity once in two years (Fact Sheet-CMS). The size at maturity reported for males is 225 cm and for females, 210 to 228 cm (Last and Stevens, 2009). Studies from Indian waters are lacking. In South Africa, 50% of males and females are mature at 309 cm and 336 cm respectively (Cliff, 1995). In Australia, the litter size ranges from 6 to 33 (maximum 42) (Stevens and Lyle, 1989). A comparison of maximum size and age estimates and size/age at maturity estimates from different localities is given in Table 2 while estimates of growth parameters of great hammerheads are given in Table 3.

Table 2. Measures of maximum size, age, size at maturity from different locations for *S. mokarran*

	Sex	Measure (TL cm)	Location	References
Max size	F	482 – 549 326 439.1	Global South Africa E Australia	Compagno, 1984 Cliff, 1995 Harry et al., 2011
	M	341 264 369.1	Global South Africa E Australia	Compagno, 1984 Cliff, 1995 Harry et al., 2011
Size at maturity	F	250-300 210 237 227.9	Global Northern Australia South Africa E Australia	Compagno, 1984 Stevens and Lyle, 1989 Cliff, 1995 Harry et al., 2011
	M	234-269 225 217 227.9	Global Northern Australia South Africa E Australia	Compagno, 1984 Stevens and Lyle, 1989 Cliff, 1995 Harry et al., 2011
Max age (years)	F	44 39.1	Gulf of Mexico E Australia	Piercy et al, 2010 Harry et al., 2011
	M	31.7	E Australia	Harry et al., 2011

Age at maturity	M	8.3	E Australia	Harry et al., 2011
	F	8.3	E Australia	Harry et al., 2011

Table 3. Growth parameters of great hammerhead shark *S. mokarran*

Parameters	Sex		Location	References
L_{∞} (cm)		402.7 (sexes pooled)	E Australia	Harry et al., 2011
	F	307.8 (FL)	Gulf of Mexico	Piercy et al, 2010
	M	264.2 (FL)	Gulf of Mexico	Piercy et al, 2010
K ($year^{-1}$)		0.079 (sexes pooled)	E Australia	Harry et al., 2011
	F	0.11	Gulf of Mexico	Piercy et al., 2010
	M	0.16	Gulf of Mexico	Piercy et al., 2010
L_0 (cm)		70	E Australia	Harry et al., 2011
t_0 (year)		-1.99	Gulf of Mexico	Piercy et al, 2010

Sphyrna zygaena

The maximum reported size of *Sphyrna zygaena* is 370-400 cm (Compagno, 1984). Males mature at around 250-260 cm TL, while females mature at 265 cm TL (Stevens, 1984). The life span of *S. zygaena* is thought to be 20 years or longer. Adults are found to occur singly or in small groups (Bester, 2008). Studies from Indian waters are sparse. Table 4 presents estimates of maximum size and age and size at maturity from different localities around the globe while Table 5 presents growth parameter estimates for *S. zygaena.*

Table 4. Measures of maximum size, age, size at maturity from different locations for male and females of *S. zygaena*

	Sex	Measure (TL cm)	Location	References
Max size	F	370-400	Global	Compagno, 1984
	M	370-400	Global	Compagno, 1984
Size at maturity	F	265 270 200	E Australia Global Gulf of California	Stevens, 1984 Bester, 2011c Nava and Farias, 2014
	M	250-260 210.25 193.7 210-240	E Australia Global Gulf of California Global	Stevens, 1984 Nava and Farias, 2014 Ritte, 2001
Max age (years)	F	18	Eastern Equatorial Atlantic Ocean	Coelho et al., 2011
	M	21	Eastern Equatorial Atlantic Ocean	Coelho et al., 2011

Table 5. Growth parameters of smooth hammerhead shark *S. zygaena*

Parameters	Sex		Location	References
L_{∞} (cm)		277.7 (combined) 362.25 (combined)	E. Equatorial Atlantic Ocean Kerala, India	Coelho et al., 2011 Manjusha et al., 2011
	F	285 (FL)	E. Equatorial Atlantic Ocean	Coelho et al., 2011
	M	272 (FL)	E. Equatorial Atlantic Ocean	Coelho et al., 2011
K ($year^{-1}$)		0.06 (combined) 0.23(combined)	E. Equatorial Atlantic Ocean Kerala, India	Coelho et al., 2011 Manjusha et al., 2011
	F	0.07	E. Equatorial Atlantic Ocean	Coelho et al., 2011
	M	0.06	E. Equatorial Atlantic Ocean	Coelho et al., 2011
L_0 (cm)		29	E. Equatorial Atlantic Ocean	Coelho et al., 2011
t_0 (year)		-8.3	E. Equatorial Atlantic Ocean	Coelho et al., 2011

Reproduction

Sphyrna lewini

The scalloped hammerhead shark is viviparous (i.e., gives birth to live young), with a gestation period of 9-12 months (Branstetter, 1987; Stevens and Lyle, 1989), which may be followed by a one-year resting period (Liu and Chen, 1999). The age at maturity varies from region to region (Table 1). Females move inshore for breeding and often use near-shore nurseries (Duncan et al., 2006). The litter size is between 1 to 41 pups (Baum et al., 2007).

In Indian waters the breeding season is reported to be from August to October (Raje et al., 2007). The litter size is found to be 38-40. The size at birth ranges from 38-57 cm (Table 6). Observations along the Karnataka coast, India, indicate the size at birth to be 38-40 cm for a female of 285 cm. However small size groups ranging from 18-29 cm have also been observed in the fishery (CMFRI, 2015) probably indicating a much lower size at birth or exploitation of pregnant sharks, which is more likely to be the case. The occurrence of juveniles (>50%) in inshore water fishery in most of the maritime states of India shows that the females move towards the coast for breeding; the maximum density of juveniles were recorded from near shore waters during August to December (CMFRI, 2015). There have been suggestions that *S. lewini* may exhibit natal philopatry; however, recent mtDNA evidence does not support this, suggesting instead that they stray between proximal nursery areas (Duncan et al., 2006).

Table 6. Reproductive traits of scalloped hammerhead shark *S. lewini*

		Location	Reference
Litter size (no.s)	2-21	SW Atlantic/E Australia	Hazin et al., 2001
	1-25	Australia	Noriega et al., 2011
	12-41	World	Baum et al., 2007
	15-31	World	Compagno, 1984
	14-41	Indonesia	White et al., 2008
	13-23	N Australia	Stevens and Lyle, 1989
	38-40	Karnataka, India	CMFRI, 2015. Unpublished
Size at birth (cm)	45-55	E Australia	Baum et al., 2007
	42-55	Global	Compagno, 1984
	45-50	N Australia	Stevens and Lyle, 1989
	39-57	Indonesia	White et al., 2008
	12-41	India	Kizhakudan et al., 2015
Breeding season	Year round (peak in late spring/summer)	E Australia	Harry et al. (2011)
	Year round (peak in Oct-Nov).	Indonesia	White et al. (2008)
	Summer	South Africa	Chen et al., (1988), (1990)
	Summer	NE Taiwan	Bass et al (1975)
	Aug- Oct	PortoNovo, India	Raje et al., 2007

Sphyrna mokarran

The great hammerhead shark is viviparous, with a gestation period of 11 months (Stevens and Lyle, 1989); size at birth is 50-70 cm. Reports are scanty regarding the reproduction of great hammerheads in the Indian waters, whereas in Australia pups are known to be born between December and January and during late spring to summer in the Northern Hemisphere (Last and Stevens, 2009). Females breed only once every two years. There is not much published information on reproductive behaviour of great hammerhead. The available information has been compiled and presented in Table 7.

Table 7. Reproductive traits of great hammerhead shark *S. mokarran*

		Location	Reference
Litter size (nos.)	13-56	Global	Sharksider.com
	6 – 42	Global	Compagno, 1984
	15	Northern Australia	Stevens and Lyle, 1989
Size at birth (cm)	50 – 70	Global	Compagno, 1984
	65	Northern Australia	Stevens and Lyle, 1989
	46.5-56.3	E Australia	Harry et al., 2011
Breeding season	January	Northern Australia	Stevens and Lyle, 1989
	Spring and early summer	Florida	Clark and Von Schmidt, 1965

Sphyrna zygaena

The smooth hammerhead is viviparous with a gestation period of 10-11 months. Birth occurs during summer months. The litter size is large, ranging from 20 to 40 pups. Pups measure approximately 20 inches (50 cm) length at birth (Bester, 2011c). There is no information on reproduction of *S. zygaena* in Indian waters.

Table 8. Reproductive traits of smooth hammerhead shark *S. zygaena*

		Location	Reference
Litter size (no.s)	30-40 20-40 29-37 20-49	Global Global Global E Australia	CoP16 Prop. 43 Bester, 2011c Ritte, 2001 Stevens, 1984
Size at birth (cm)	50-61 29-39 50 50-60	Global E. Equatorial Atlantic Ocean Global Global	Compagno, 1984 Coelho et al., 2011 Bester, 2011c Ritte, 2001
Breeding season	January-March Summer	E Australia Global	Stevens, 1984 Bester, 2011c

Diet

Sphyrna lewini occupies a high trophic level in the ecosystem. These sharks are reported to prey upon a range of food items including bony fish, other sharks, cephalopods and crustaceans (Compagno, 1984). Diet of the species from Indian waters includes sardines, anchovies, eels, catfishes, halfbeaks, mullets, lizardfishes, barracudas, mackerel, goatfish, parrotfish, gobies, sharks, rays, squid, octopus, crabs and lobsters. In a recent study along the west coast of India, the diet of the species was found to consist of sardines, the golden anchovy *Coilia dussumeri,* the non-penaeid shrimp *Acetes* sp., the ribbonfish *Trichurus lepturus,* croakers (*Otolithes* sp.), silverbellies (*Leiognathus* spp.), trevallies (*Caranx* spp.), penaeid shrimp (*Solenocera* sp.), shrimp scad (*Alepes* sp.) and cardinal fishes (*Apogon* spp.) (CMFRI, unpublished data).

Sphyrna mokarran are active high trophic level predators, preying upon a wide variety of marine organisms, and they eat a range of food items including bony fish, elasmobranchs, cephalopods and crustaceans (Compagno, 1984; Last and Stevens, 2009; Strong et al., 1990). Their favourite prey items are stingrays, crabs, squids, octopus, and lobsters while commonly consumed bony fish are groupers, catfishes, jacks, grunts, and flatfishes. They exhibit cannibalism, eating individuals of their own species. They feed primarily at dusk along the seafloor as well as near the surface using their complex electro-sensory system to locate prey (Bester, 2011b).

Sphyrna zygaena is primarily a piscivore, feeding on a variety of bony fishes including clupeids and small scombrids as well as elasmobranchs such as smaller sharks and stingrays. Skates and stingrays form a major component of their diet in inshore locations. Invertebrate prey include benthic crustaceans and cephalopods (Bester, 2011c; Compagno, 1984). Squid and teleosts are the most common prey (Stevens, 1984). The presence of crustaceans in the diet of smooth hammerhead has also been reported (Bass et al., 1975; Compagno, 1984; Last and Stevens, 2009).

DISTRIBUTION

Global Distribution and Habitat

Sphyrna lewini is a circumglobal species occurring in coastal warm temperate and tropical seas (Compagno, 1984) (Fig 1). It is highly mobile and partly migratory and is possibly the most abundant of the hammerhead sharks (Maguire et al., 2006). It occurs over continental and insular shelves, as well as adjacent deep waters, but is seldom found in waters cooler than 22°C (Compagno, 1984; Schulze-Haugen and Kohler, 2003). The range of occurrence extends from the intertidal and surface zones to depths up to 450-512 m (Sanches, 1991; Klimley, 1993). It has been documented to dive occasionally to still deeper waters (Jorgensen et al., 2009), and also known to enter enclosed bays and estuaries. Both juveniles and adult scalloped hammerhead sharks occur as solitary individuals, pairs, or in schools (Compagno, 1984).

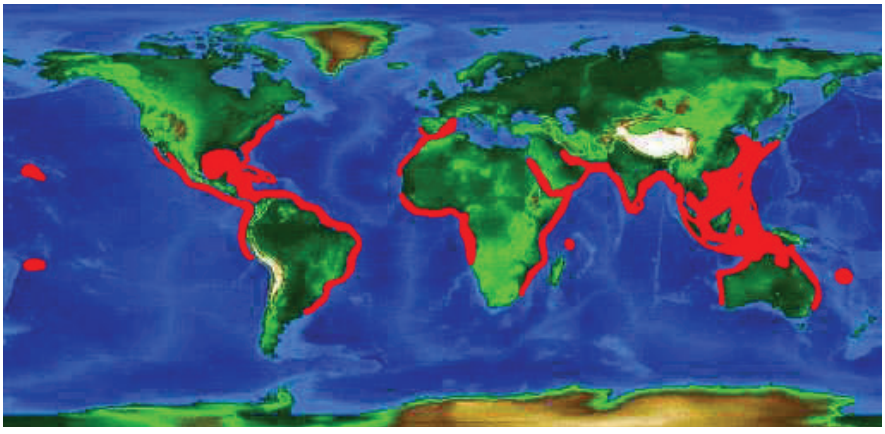


Fig. 1. Global Distribution of *Sphyrna lewini* (Source: Bester 2011a)

Sphyrna mokarran is a circumglobal species occurring in coastal warm temperate and tropical seas (Compagno, 1984) (Fig. 2). The great hammerhead is found in the western Atlantic Ocean from North Carolina in the United States, south to Uruguay, including the Gulf of Mexico and Caribbean Sea (Compagno, 1984). It occurs from Morocco to Senegal, including the Mediterranean Sea in the eastern Atlantic Ocean. In the eastern Pacific Ocean, the range of distribution of the great hammerhead is from southern Baja California in the United States, south to Peru. It is abundant in the Indian Ocean

in the range of Indo-Pacific region from Ryukyu Island to New Caledonia and French Polynesia (WildEarth Guardians, 2012). The great hammerhead is present in coastal and semi-oceanic regions and can be found far offshore to depths of 300 m as well as in shallow coastal areas such as over continental shelves and lagoons. It migrates seasonally, moving poleward to cooler waters during the summer months.

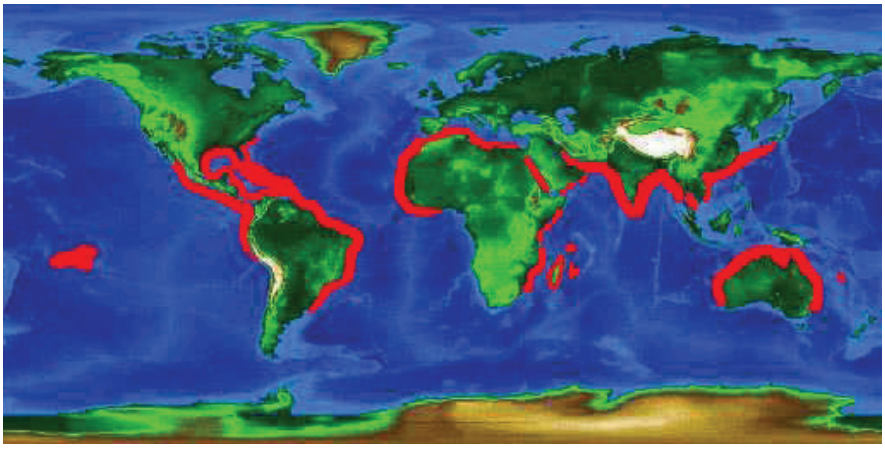


Fig. 2. Global Distribution of *Sphyrna mokarran*
Source: Petition to List the Great Hammerhead Shark under the ESA, 2012

Sphyrna zygaena has a worldwide distribution. The occurrence of this species in the western Atlantic Ocean is from Canada south to the Virgin Islands and from Brazil south to Argentina, while in the eastern Atlantic it appears from the British Isles south to Côte d'Ivoire, including the Mediterranean Sea. The smooth hammerhead is present in the Western Indian Ocean also, off the coasts of South Africa, India, and Sri Lanka. The distribution within the Pacific Ocean includes from Vietnam to Japan and Australia and New Zealand in the west, the Hawaiian Islands in the central region, and California (U.S.), Panama, Galapagos, Ecuador and Chile in the east (Bester, 2011c).

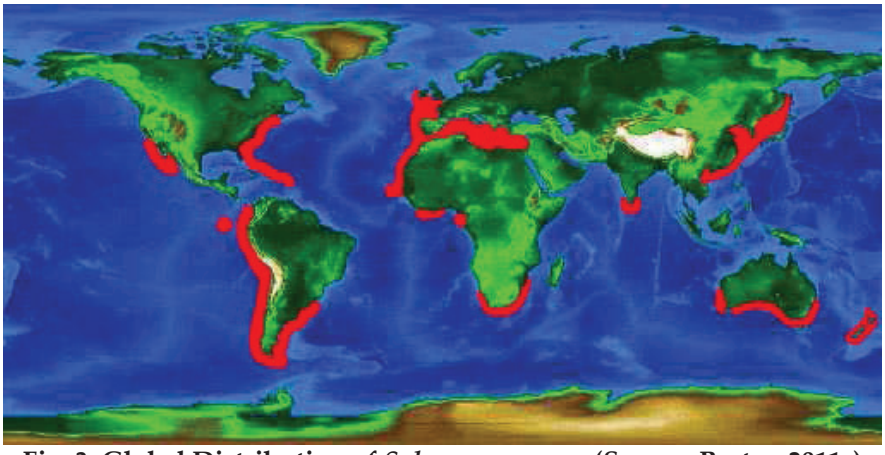


Fig. 3. Global Distribution of *Sphyrna zygaena* (Source: Bester, 2011c)

Distribution in India

Sphyrna lewini is reported from western Indian Ocean (eastern Arabian Sea) and eastern Indian Ocean (western Bay of Bengal) including the seas around Andaman and Nicobar Islands. The landings are recorded from east and west coasts of India (Fig 4).

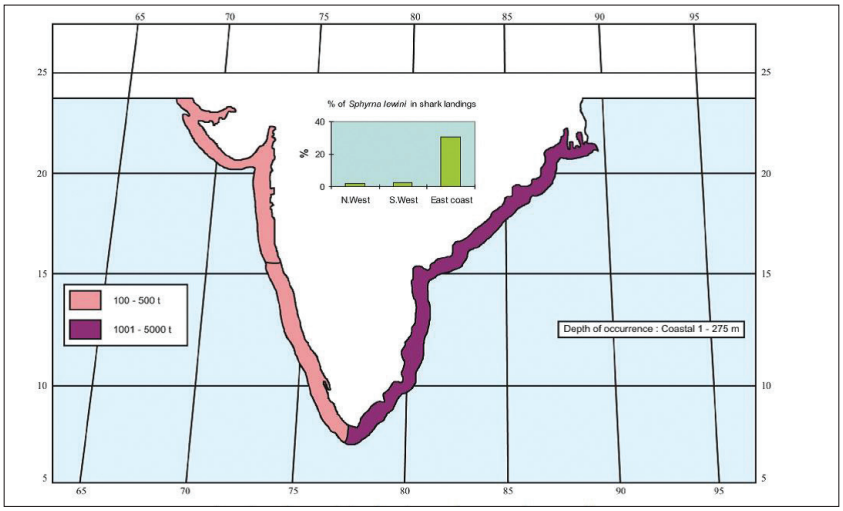


Fig 4. Coast-wise abundance (t) of *Sphyrna lewini* along the Indian coast
(Source: Raje et al., 2007)

Sphyrna mokarran is reported from western Indian Ocean (eastern Arabian Sea) and eastern Indian Ocean (western Bay of Bengal) including the seas around Andaman and Nicobar Islands. The landings are recorded from east and west coasts of India (Fig. 5).

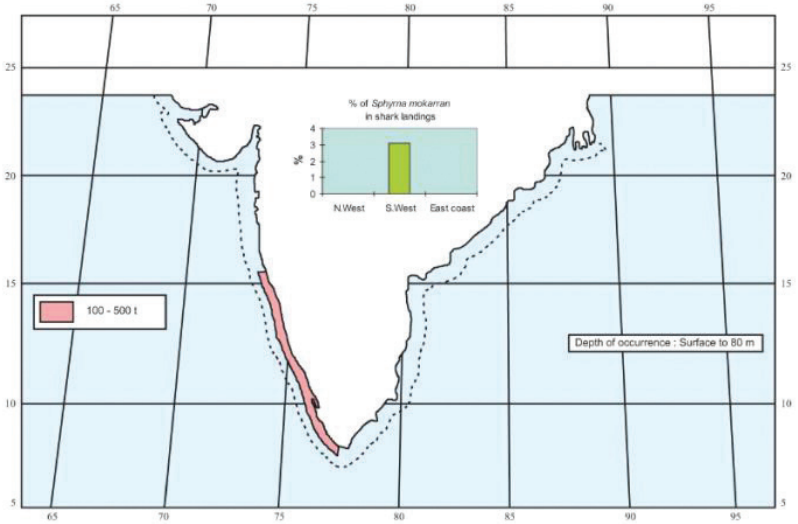


Fig. 5. Coast-wise abundance (t) of *Sphyrna mokarran* along the Indian coast
(Source: Raje et al., 2007)

Sphyrna zygaena is reported from western Indian Ocean (eastern Arabian Sea) and eastern Indian Ocean (western Bay of Bengal) including the seas around Andaman and Nicobar Islands. The landings are recorded from east and west coasts of India (Fig 6).

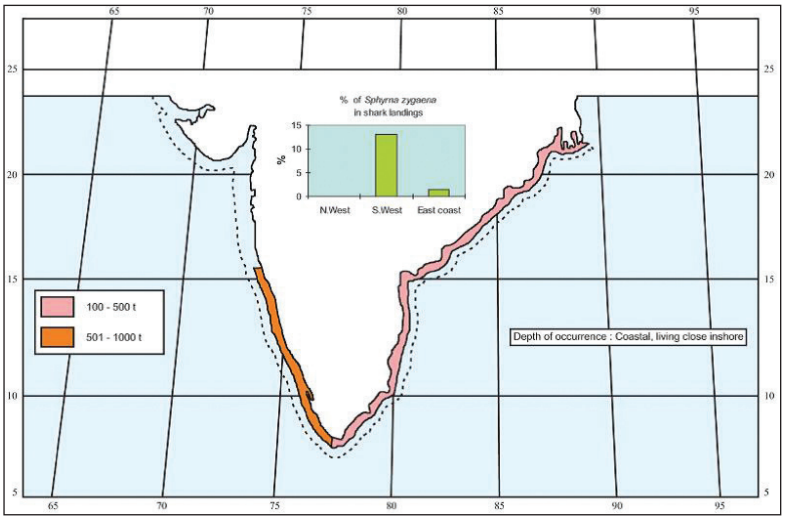


Fig. 6. Coast-wise abundance (t) of *Sphyrna zygaena* along the Indian coast
(Source: Raje et al., 2007)

HARVEST OF THE RESOURCE

Global Harvest

The production of hammerhead sharks is not reported species-wise. In the continent-wise production estimates given by FAO, production from Asia is given under the group "hammerhead". Species-wise production of *Sphyrna lewini* catch is given from the Americas and Africa and to some extent from Europe. Species-wise production of *Sphyrna zygaena* is available in the FAO database for the period 2000-2010. The average global production of hammerhead during 2000-2014 was 4511 t with a minimum of 1908 t in 2004 and maximum of 6941 t in 2014. The average catch of *S. lewini* during 2000-2014 was 322 t with a minimum of 55 t in 2014 and maximum of 523 t in 2002 (FAO, 2016) (Fig 7).

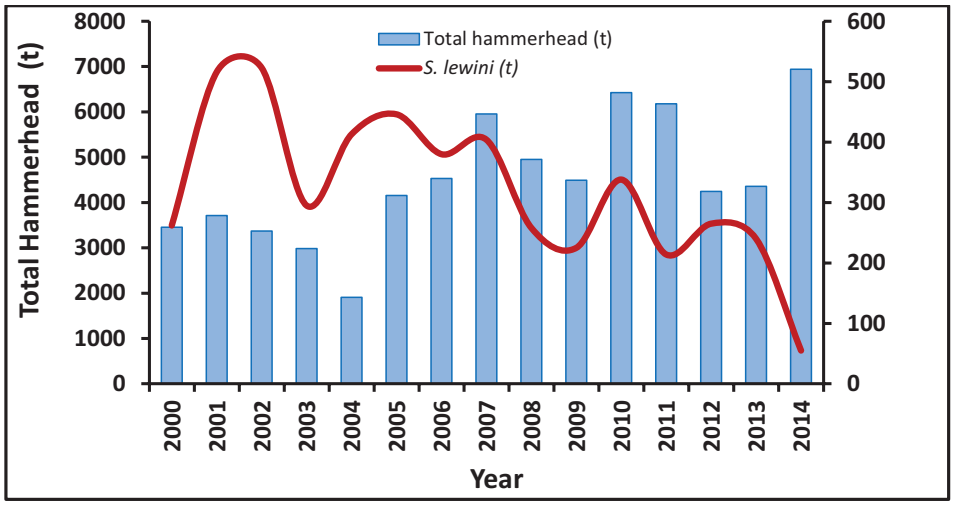


Fig. 7. Global production of hammerheads and *Sphyrna lewini* (2000-2014)
(Data source: FAO, 2016)

The average global catch of *S. zygaena* during 2000-2010 was 165 t (CITES: CoP16 Prop. 43) (Fig. 8).

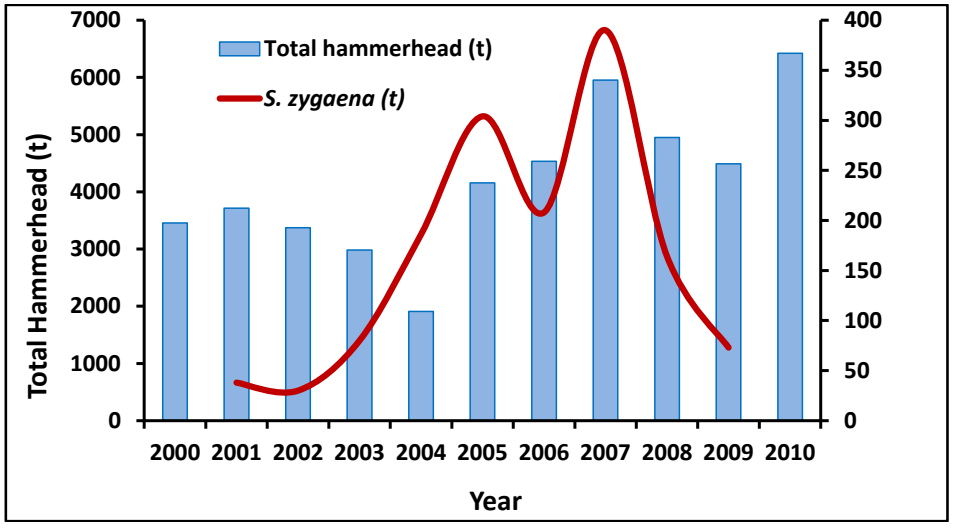


Fig. 8. Global production of hammerhead and *Sphyrna zygaena* (2000-2010)
(Data source: CITES: CoP16 Prop. 43)

Fishery in India

Average catch of hammerhead sharks during 2007-2015 from Indian waters is estimated at 632 t (Source: NMFDC, ICAR-CMFRI). FAO estimates do not include the catch estimate from CMFRI. The average landing of *S. lewini* along the Indian coast is about 621 t (2007-2015). Maximum catch was during 2007 (1070 t) which decreased to 627 t in 2015 (Fig 9).

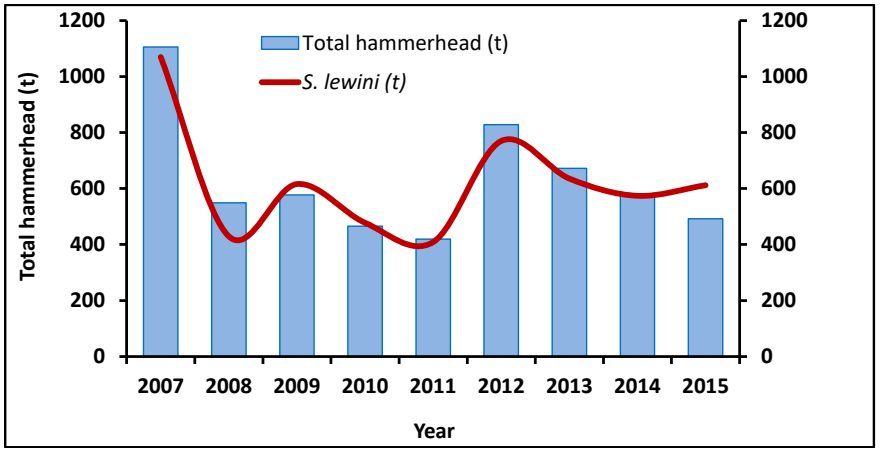


Fig. 9. All India landings of hammerhead sharks and *Sphyrna lewini* during 2007-2015

Sphyrna lewini forms only 0.73 % of the total shark landings in India. Trawl is the major gear by which the species is caught, followed by gill net and hooks and line. There is no targeted fishery of this species and it forms a bycatch in the fishery (CMFRI, 2016).

Reports of species-wise landing of *S. mokarran* is limited in India since the catches are dominated mostly by *S. lewini* and it is not easy to distinguish the species when contribution to the bulk is negligible, as in the case of *S. mokarran.* From 2000-2002 the species comprised only around 0.75% of total shark landings at Cochin Fisheries Harbour on the south-west coast of India; since then the landing has declined (CoP16 Prop. 43). Trawl is the major gear by which the species is caught, followed by gill net and hooks and line. There is no targeted fishery of this species and it forms a bycatch in the fishery. The average catch of *S. mokarran* during 2003-04 was 125 tonnes in India (Raje et al., 2007). The all-India average landing during 2007-2015 was 9 t with a maximum of 17 t in 2007 and minimum of 7 t in 2015 (NMFDC, ICAR-CMFRI).

The average landing of *S. zygaena* during 2007-2015 was 59 t with maximum landing of 171 t in 2013 and minimum landing of 3 t in 2007 (NMFDC, ICAR-CMFRI) (Fig.10).

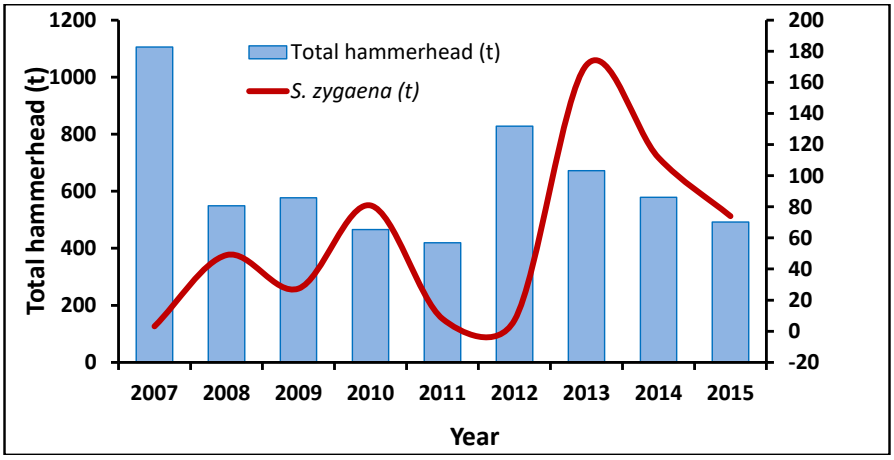


Fig. 10. All India landings of of hammerhead sharks and *Sphyrna zygaena* (2007-2015)

CONSERVATION STATUS OF HAMMERHEADS

Sphyrna lewini is listed as 'Endangered' on the International Union for the Conservation of Nature (IUCN)'s Red List (Baum et al., 2007). There is no global stock assessment currently in place for *S. lewini* due to aggregation of catch data for all hammerheads. However, efforts are being taken by CMFRI to assess the status of the species in Indian waters.

Sphyrna mokarran is listed as 'Endangered' on the International Union for the Conservation of Nature (IUCN)'s Red List (Baum et al., 2007). There is no global stock assessment currently in place for *S. mokarran* due to aggregation of catch data for all hammerheads. However, efforts have been started by CMFRI to assess the status of the species in Indian waters.

Sphyrna zygaena is listed as 'Vulnerable' on the International Union for the Conservation of Nature (IUCN)'s Red List (Baum *et al*., 2007). There is no global stock assessment currently in place for *S. zygaena* due to aggregation of catch data for all hammerheads. However, efforts have begun by CMFRI to assess the status of the species in Indian waters.

THREATS AND MORTALITY

The hammerheads are fished worldwide and global catch estimates show a fluctuating trend over the years. From Indian waters the hammerhead sharks including *S. lewini* show a declining trend. This forms only about 0.73 % of the total elasmobranch fishery and forms a bycatch in the fishery. Hammerheads are used for a variety of purposes such as fresh, frozen, dried and smoked meat for consumption, fins for shark fin soup,

skin for leather and livers for oil (Compagno, 1984). In India, they are mainly used for domestic consumption. However, the fins used to be exported along with other shark fins from India. Since there has been no quantification of species-wise hammerhead fin export, it is difficult to ascertain the quantity that has been exported from India until implementation of total ban on shark fin trade by the Government of India.

Several traits increase the susceptibility of hammerheads to capture, including increased risk due to their unique head shape, which can easily become tangled in nets (Harry et al., 2011; Noriega et al., 2011). *Sphyrna lewini* is the most abundant species in Indian waters and *S. mokarran* is the largest species among hammerheads. The tendency of juvenile hammerhead sharks to aggregate near shore and in coastal waters make it more susceptible to fisheries operating in this region (Maguire et al., 2006). In most of the maritime states of India, juveniles of these species are landed by fishing vessels operating in coastal waters. The aggregating behaviour displayed by both adults (around sea mounts and during small migrations) and juveniles (in nursery areas) increases their risk of capture in fisheries (Baum et al., 2007). This behaviour increases the vulnerability of either juveniles or pregnant females, both of which negatively impact successful population growth.

Oceanic whitetip shark, *Carcharhinus longimanus*

The oceanic whitetip shark *Carcharhinus longimanus* is a moderately large requiem shark of the family Carcharhinidae. It derives its common name from its whitetipped fins which make it easily distinguishable from other members of the same family. This shark has a flattened torpedo shaped body of heavy build, with a bluntly rounded snout with powerful jaws. The teeth of the lower jaw has thin serrated tips that are triangular in shape. There are 13-15 teeth on either side of the upper jaw. Denticles (small tooth-like bones in the skin) lie flat and have approximately 5-7 ridges. The dorsal fins are of a generous size and are rounded in shape while the fins of the pectoral region are paddle shaped, lengthy and broad (Arkive, 2008). The body shape is flattened with slightly humpback appearance. Oceanic whitetip sharks are brown, bluish or grey on dorsal side and white or pale yellow colour at ventral side although the colour may vary with their geographic location (Babcock et al., 2008).

BIOLOGY

Growth

The oceanic whitetip shark is a large slow-growing shark, growing to more than 3 m in total length (TL), with a lifespan of 11-18 years. Reports of maximum size and age vary worldwide. Arkive (2008) records that male and female sexes of this species can grow upto 2 m and weigh upto 170 kg. However, substantial evidence suggests that *C. longimanus* is a large species that can grow to lengths ranging between 2 m and 3.5 m TL (Bigelow and Schroeder, 1948; Backus et al., 1956; Strasburg, 1958; Bass et al., 1973; Garrick, 1982; Saika and Yoshimura, 1985; Taniuchi, 1994; Seki et al., 1998). Bigelow and Schroeder, 1948 suggested maximum size of 365-395 cm TL. Studies from Indian waters are sparse, the size obtained in the fishery is reported to be 55-265 cm (CMFRI, unpublished data). Varghese et al. (2016) reported a length range of 65-265 cm TL in 212 oceanic whitetip shark specimens sampled from fish landings at Cochin Fisheries Harbour on the southwest coast of India. Table 9 presents a comparison of size and age estimates for growth and maturity of oceanic whitetips from different localities over the globe.

Reproduction

The Oceanic white tip shark is a viviparous species and embryos have a yolk sac placenta attached to the uterine wall of the mother (Bigelow and Schroeder, 1948). The fish attains maturity at 170-200 cm TL (Bass et al., 1973; Seki et al., 1998). From Indian waters (eastern Arabian Sea), Varghese et al. (2016) estimated the size at maturity in

Table 9. Measures of maximum size, age, size at maturity of *Carcharhinus longimanus* from different locations

	Sex	Measure	Location	References
Maximum size (TL, cm)	F	230.0	Southwestern Equatorial Atlantic	Lessa et al., 1999
	M	275	Southwestern Equatorial Atlantic	Lafrance, S., 1994
		235.5		Lessa et al., 1999
Size at maturity (TL, cm)	F	170-190	Western North Pacific Ocean	Seki *et al*., 1998
		245	Red sea	Gohar and Mazure, 1964
		190	Western North Pacific Ocean	Shoou-Jeng Joung et al ., 2016
		181-203	Southwestern Equatorial Atlantic	Coelho et al., 2009
		180-190	South Africa	Bass et al., 1973
		171	West Pacific	Saika and Yoshimura, 1985
		225	Northern Gulf of Mexico	Branstetter & Stiles, 1987
	M	170-172	Western North Pacific Ocean	Seki *et al*., 1998
		160-196	Southwestern Equatorial Atlantic	Shoou-Jeng Joung et al., 2016 Coelho et al., 2009
		185-198	South Africa	Bass et al., 1973
		170-180	West Pacific	Saika and Yoshimura, 1985
		210-220	Northern Gulf of Mexico	Branstetter & Stiles, 1987
Max age (years)	F	12	Western North Pacific Ocean	Compagno, 1984
		15		NMFS, 2014
		8.5, 8.8	Northern Gulf of Mexico	Shoou-Jeng Joung et al., 2016
		18		Branstetter & Stiles, 1987
	M	6.8-8.9	Western North Pacific Ocean	Shoou-Jeng Joung et al., 2016
		14-15	Northern Gulf of Mexico	Branstetter & Stiles, 1987
Age at maturity (years)	M	4-5	Pacific Ocean	Smith et al., 1998
	F	18	Northern Gulf of Mexico	Branstetter & Stiles, 1987

male and female *C. longimanus* at 207.19 cm and 187.74 cm respectively. The young are born at sizes of 60 to 65 cm TL after a gestation period of about 10 to 12 months. However, the minimum size recorded in the landings at Cochin Fisheries Harbour during 2015 was 55 cm TL (CMFRI, unpublished data), indicating that the size at birth may be smaller than presumed. Table 10 lists the estimates of reproductive traits of *C. longimanus* recorded from different localities.

Table 10. Reproductive traits of *C. longimanus* from different locations

		Location	Reference
Litter size	1-14	North Pacific	Seki et al., 1998
	6-8	South Africa	Bass et al., 1973
	4-8	Southwest Pacific	Stevens, 1984
	10-11	Western North Pacific Ocean	Shoou-Jeng Joung et al., 2016
	3-9	Eastern Arabian sea	Varghese et al., 2016
Size at birth (cm)	60-65 cm	Southern Africa	Bass et al., 1973
	63-77	North Pacific	Seki et al., 1998
	65-70	North Atlantic	Bigelow and Schroeder, 1948
	60-65	South Africa	Bass et al., 1973
	64.2-65	Eastern Arabian sea	Varghese et al., 2016
Breeding Season	June-July	North Pacific	Seki et al., 1998
	Early summer	South Africa	Bass et al., 1973
	March-May	Southwest Pacific	Stevens, 1984
	March-May (parturition)	Eastern Arabian sea	Varghese et al., 2016

Diet

The oceanic whitetip shark is high in the trophic level; an aggressive predator, feeding on animal sources of food mainly bony fish including tunas, white marlin, dolphin fish, threadfins, swordfish, barracuda and cephalopods (IUCN, 2007) and, to a lesser extent on seabirds, stingrays, marine mammals, flotsam, including garbage (Ramsoomair, 2016). The shark is observed to be bold and persistent when inspecting a potential food source; however, it quickly turns into a hostile hunter for prey in the presence of competition for food, becoming fast and aggressive to outsmart its opponents. While feeding, the shark opens its mouth, ingesting food whole without chewing. It moves swiftly through schools of fish with open mouth, consuming as much food as it can until it has had its fill.

Global distribution

The oceanic whitetip shark is a tropical, epipelagic species found within 150 m of the surface of the water (Babcock et al., 2008). It is widespread in the Atlantic and Pacific Oceans. Its distribution ranges across tropical and subtropical oceans between 30°N and 35°S (Fig. 11). It has occasionally been recorded inshore, but is more typically found offshore or around

oceanic islands and areas with narrow continental shelves (Fourmanoir, 1961). There is a direct proportional relationship between the distance from the land and the abundance of the shark; as distance increases, so does the number of sharks. It is most abundant in waters above 21°C (FLMNH, 2016).

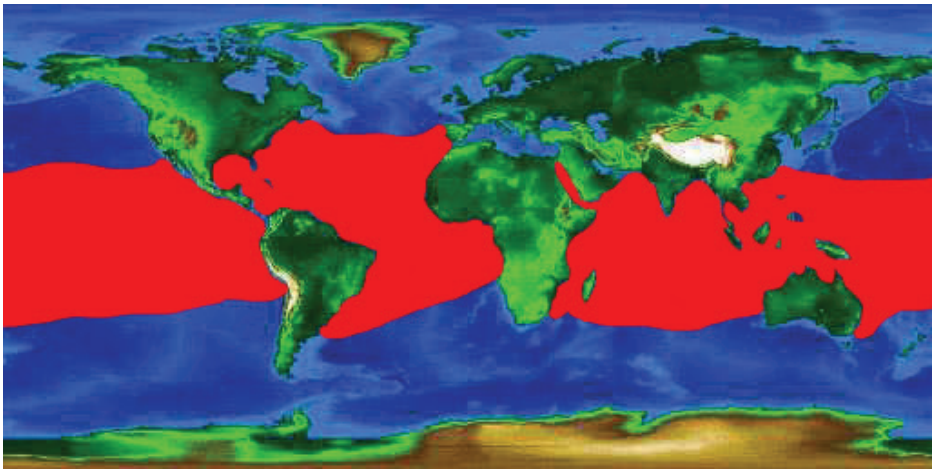


Fig. 11. Global distribution range of oceanic whitetip shark

(Source: Bester, 2011d)

Distribution in India

The oceanic whitetip is distributed in Indian waters in the eastern Arabian Sea, western Bay of Bengal and northern Indian Ocean.

Fishery

They are caught abundantly in almost every place that they occur, especially in pelagic long line fisheries and drift net fisheries (Baum et al., 2015). Strasburg (1958) stated that *C. longimanus* made up 29% of the quantity of sharks caught in exploratory tuna longline fishing in the Pacific Ocean. Global landings increased from 98 t in 1986 to 3270 t in 2000; since then it has declined and in 2011, the production was 544 t (Fig. 12). The fins command a value of US$20-40 per pound in international fin trade (NMFS, 2014).

There is no targeted fishery of this species in Indian waters but it is often landed as by-catch of pelagic longline and gill net fisheries. Cochin Fisheries Harbour on the south-west coast of India is the major landing centre for this shark. The landings steadily increased from 1.3 t in 2007 to 381.2 t in 2014; it has since then decreased to 283.6 t in 2015 (Fig 13).

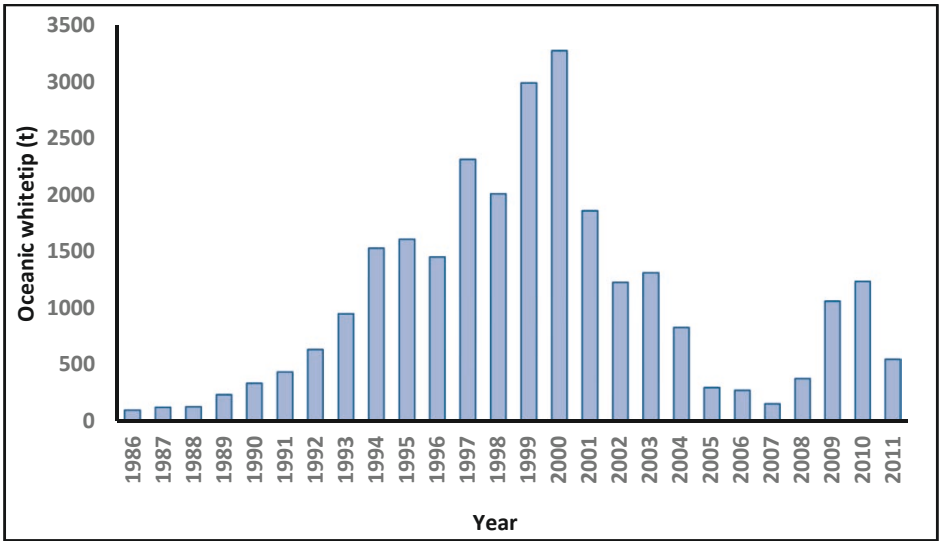


Fig. 12. Global production (t) of oceanic whitetip shark

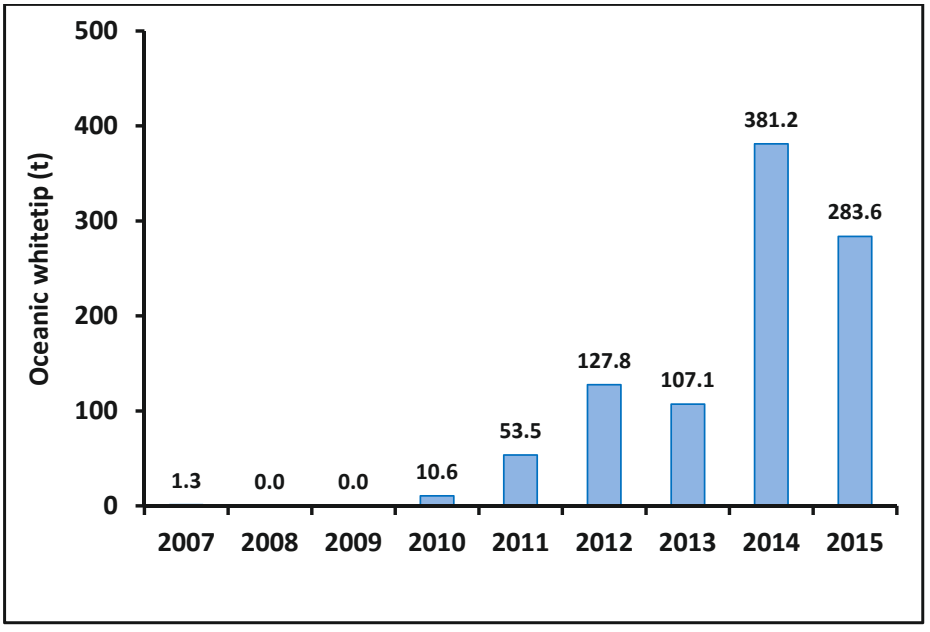


Fig. 13. Annual production of oceanic whitetip shark in India (in tonnes)

Conservation status

Carcharhinus longimanus is currently listed as a Vulnerable species by the World Conservation Union (IUCN). The only conservation measure known for the species is the multispecies pelagic shark quota for US Atlantic Waters (IUCN, 2007).

Threats and mortality

Large size, slow growth, long lifespan, high trophic level, low fecundity and long gestation period make the oceanic whitetip shark particularly vulnerable to population depletion through unregulated fishing. However, at present there is no targeted fishing for this species in Indian waters; it is landed as by-catch of other fisheries. India is party to an IOTC regulation which encourages the release of this shark, to the extent possible, if caught as by-catch in IOTC regulated pelagic fisheries. This shark has been documented to have a hooking survival of >75% (Gallagher et al., 2014), which is encouraging. A major threat to the stock in Indian waters is the low mean size of 60 cm TL (CMFRI, unpublished data) in the landings, which is below the size at maturity estimated for the species from different localities, including India.

Manta rays

Manta rays belong to the cartilaginous fish group of family Mobulidae. These rays, along with other mobulid species are often called "devil rays" because of the cephalic fins on the front of their heads that resemble "horns". The cephalic fins unfurl and help guide water into their mouths, and modified gill features help to filter their primary food sources, zooplankton and other small fishes. The diamond shaped large bodied, wing-like pectoral fins help in propulsion.

BIOLOGY

Giant manta ray, *Manta birostris* (Walbaum 1792)

The giant manta ray reaches disc widths (DW) of at least 700 cm, (Compagno, 1999; Alava et al., 2002). Size at maturity may vary slightly throughout its range; males mature at approximately 400 cm DW while females appear to mature well over 400 cm DW in southern Mozambique (Marshall, 2009). In Indonesia, males mature at 375 cm DW, while females may mature by approximately 410 cm DW (White et al., 2006). The average age at sexual or reproductive maturity of the female is 2190 days.

Manta birostris is sexually mature at 5 years of age. The mating season of manta rays occurs from early December to late April. Mating takes place in tropical waters (26-29^{0}C) and around rocky reef areas at 10-20 meters in depth. Manta rays gather in large numbers during this season, where several males will court a single female. The males swim closely behind the tail of the female at faster than usual speeds (9-12km/h). The gestation period of *M. birostris* is 13 months, after which females give birth to 1 or 2 live young ones of 1.1 to 1.4 meters DW. Pups are born wrapped up by their pectoral fins, but become free swimmers soon after and move independantly (Acker, 2001; Yano et al., 1999).

While the actual longevity of the species remains unknown, photographic databases indicate that individuals have an average lifespan of more than 20 years (Rubin, 2002; G. Kodja, unpubl. data 2010). Natural mortality is thought to be low (other than in juveniles), although limited predation from large sharks does occur (Marshall, 2009).

Manta rays are solitary, free swimmers and are not territorial. *Manta birostris* use their flexible pectoral fins to swim gracefully through the ocean. During the mating season, manta rays have been recorded leaping out of the water to heights of 7 feet, then smacking against the surface which helps to remove irritating parasites and dead skin on their large bodies. *Manta birostris* have been seen at "cleaning stations" with wrasse fish swimming around them picking off parasites and dead skin. A symbiotic interaction that mantas have is with remora fish, which attach to the giant mantas and

hitch rides with them while feeding on the manta's parasites and on plankton. Manta rays have no particular anti-predator specializations other than their tough skin, but due to their size they do not have many natural predators. Large sharks have been known to attack manta rays ("Manta Rays", 1989; Bigelow and Schroeder, 1954; Dive Asia, 2004)

Reef mantaray, *Manta alfredi* (Krefft 1868)

The reef manta ray or Alfred manta ray *Manta alfredi* is a large filter-feeding elasmobranch with a maximum reported disc width of 500 cm. Manta rays have rectangular mouths which project forward to facilitate feeding. The spiracles are not used; instead, water enters through the manta ray's mouth while they swim and passes over the gills, providing oxygen to the blood. They have evolved large pectoral fins that are used like wings to propel themselves through the water. Their skin is covered with dermal denticles. On the bottom jaw exist 6-8 rows of small cusped teeth in oceanic manta rays, and mucus coating covers their skin, creating an important defence against infection.

These are among the lowest fecund of all elasmobranchs, giving birth to one pup every two to three years, after reaching maturity at 6-8 years.

Critical knowledge gaps about *M. alfredi* reproduction still exist. Manta rays employ internal fertilization to reproduce (Wourms, 1977) and the mating process consists of a complex ritualised sequence that involves chasing, biting, copulating, post-copulation holding and separation; requiring many kilometres of space to perform these behaviours (Marshall and Bennett 2010). Reports of occurrence in Indian waters are scarce. Nair et al. (2015) has reported of a baby *Manta alfredi* at Cochin Harbour. Males mature at smaller size *i.e.* 270-300 cm (disc width) and between the ages of three to six years compared to 370-390 cm DW in females (Clark, 2010; Deakos, 2010 a,b; Marshall & Bennett, 2010). Clark (2010) reports longevity > 31 years. *M. alfredi* is aplacental viviparous, with embryos developing within the uterus. Wourms (1977) reported of yolk ingestion by embryos initially followed by nourishment by uterine milk. The gestation period is normally 12-13 months, with resting period of two of more years between pregnancies (Marshall and Bennett, 2010). Females usually give birth to only a single pup (Clark, 2010; Marshall and Bennett, 2010).

Generation time is suspected to be 25 years based on conservative estimates of life history parameters. Female mantas are thought to mature at 8–10 years of age and longevity is estimated to be at least 40 years. Generation time is the average age of adults which can be approximated as halfway between age at first maturity and maximum age. Thus, female mantas may be actively breeding for 30 years and the age at which 50% of total reproductive output is achieved would be approximately 24–25

years (Table 11).

Fecundity: The reef manta ray has very low fecundity. The production of a single pup appears to be the normal situation for these rays, although two pups are conceived on occasion (Marshall et al., 2008, Marshall and Bennett, 2010). In southern Mozambique, the reef manta ray gives birth in the austral summer period after a gestation period of approximately one year (Marshall and Bennett, 2010). Reproductive periodicity in the reef manta ray is commonly biennial (Deakos 2010; Kitchen-Wheeler 2010; Marshall and Bennett 2010) or longer (Ito 2000, G. Stevens unpubl. data) in the wild, but this species has an annual ovulatory cycle (Marshall and Bennett, 2010) and individuals can and have reproduced annually in the wild (Marshall and Bennett, 2010; M. De Rosemont pers. comm. 2009) and in captivity.

Table 11: Length at maturity of *M. alfredi* from different locations

Sex	Location	Disc width	Reference
		500 cm	Marshall et al. 2009
Males	southern Mozambique	300 cm DW	Marshall and Bennett 2010
Females	southern Mozambique	400 cm DW	Marshall and Bennett 2010
Males	Republic of Maldives	250 cm DW	G. Stevens unpubl. data 2011
Females	Republic of Maldives	300 cm DW	G. Stevens unpubl. data 2011
Females	Hawaii	335 cm DW	Deakos 2010b
Males	Hawaii	280 cm DW	Deakos 2010b

Diet

Manta rays are filter feeders and primarily planktivores, feeding on plankton by sieving them through their modified gills (Bigalow and Schroeder, 1953; Cortes et al., 2008). They feed by swimming with an open mouth allowing a water flow through a gill-raker apparatus; a behaviour called ram filter feeding (Sanderson and Wassersug, 1990; 1993, Cortes et al., 2008). Their large, gaping mouths and cephalic lobes unfurled are used to coral planktonic crustaceans and small schooling fish. Manta rays filter water through their gills and organisms in the water are trapped by a filtering device, which consists of plates in the back of the mouth that are made of pinkish-brown tissue that span between the support structures of the gills. They often swim slowly in vertical loops. Some researchers suggest this is done to keep the prey within the area while feeding. They are also said to exhibit chain feeding (Law, 2010) wherein aggregates of individuals follow each other in a circular movement creating cyclonic motions. The teeth of *Manta birostris* are non-functional during feeding (Perlmutter, 1961; "Manta Rays", 1992; Dive Asia, 2004).

Stomach content analysis showed that *M. alfredi* feed on zooplankton (Whitley, 1936). Guts examined showed the presence of digested zooplankton material (Nair, pers.

DISTRIBUTION

Global distribution

Manta birostris

Manta birostris

Manta alfredi

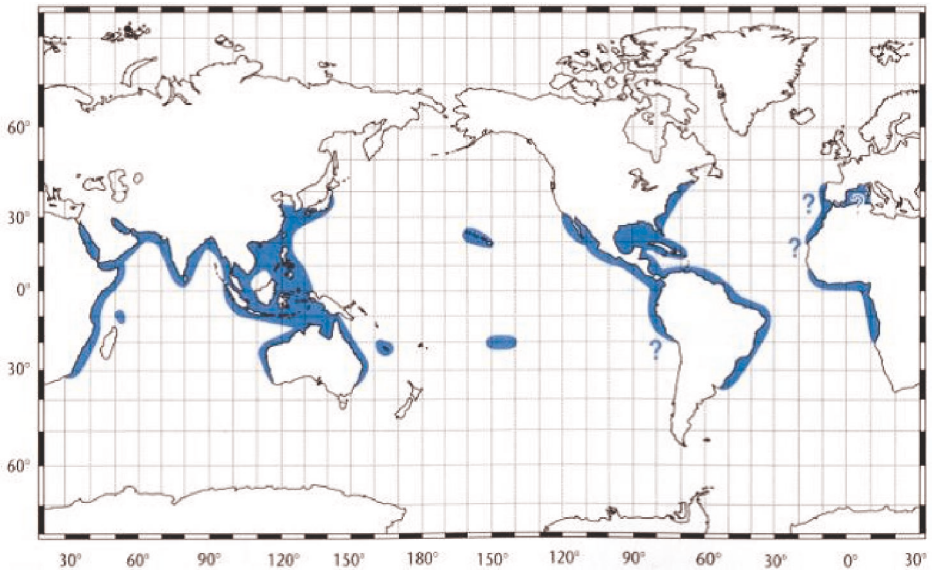


Fig. 14. Global distribution of *Manta birostris*

2009; Marshall et al., 2011c). The species has been recorded as being sympatric in some locations and allopatric, with the giant manta ray *M. birostris*, in others (Kashiwagi et al., 2011). Aggregation sites are strongly believed to represent critical habitats for this species. Long term site fidelity has been recorded for *M. alfredi* in other parts of the world, such as Indonesia (Dewar et al., 2008), Mozambique (Marshall, 2009), Maldives (Kitchen-Wheeler, 2010), Hawaii (Deakos et al. 2011) and eastern Australia. The migratory nature of *M. alfredi* is thought to be influenced by local oceanographic conditions (e.g. current dynamics) and related to seasonal productivity (Anderson et al., 2011; Couturier et al., 2011).

Manta alfredi occurs along the coastal areas of the following countries Australia (West Australian, Northern Territory, New South Wales and Queensland coastal zones), British Indian Ocean Territory (Chagos Archipelago), Cape Verde, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Djibouti, Egypt (African part), Sinai), Fiji, French Polynesia (Society Is., Tuamotu), Guam, India (West coast, Andaman Is.), Indonesia (Bali, Irian Jaya, Jawa, Sulawesi), Japan (Nansei-shoto), Madagascar, Malaysia, Maldives, Marshall Islands, Micronesia, Federated States of Mozambique, New Caledonia, Northern Mariana Islands, Oman, Palau, Papua New Guinea (Bismarck Archipelago, North Solomons, main island group Papua New Guinea, Philippines, Saudi Arabia, Senegal, main island group of Seychelles, South Africa (KwaZulu-Natal), Spain (Canary Is.), Sudan, Thailand, United States (Hawaiian Is.) and Yemen, Red Sea, South Africa, Thailand, north and south Japan (Yaeyama Is.), Solitary Is. (Kashiwagi et al., 2008, 2010, 2011, Marshall et al. 2011c, Couturier et al., 2012, McEachran, pers. comm).

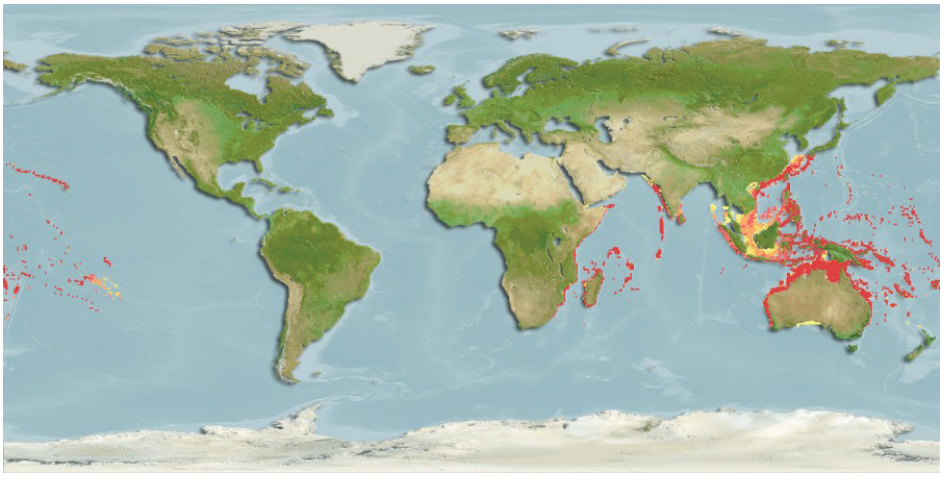


Fig. 15. Global distribution map of *M. alfredi*
Source: Computer generated distribution maps for *Manta alfredi* (Alfred manta), with modelled year 2100 native range map based on IPCC A2 emissions scenario. www.aquamaps.org, version of Aug. 2013. Web.Accessed 19 Aug. 2016.

Distribution in India

The giant manta ray *Manta birostris* is known to occur in Indian waters, both in the Arabian Sea and the Bay of Bengal; a good stock of this species is believed to exist in the waters between the Indian peninsula and Sri Lanka. This species is often encountered as by-catch in the fishery. Although the distribution range of *Manta alfredi* extends across Indian waters, this species is seldom encountered in the fishery and there is not much information on the presence of resident stocks in these waters.

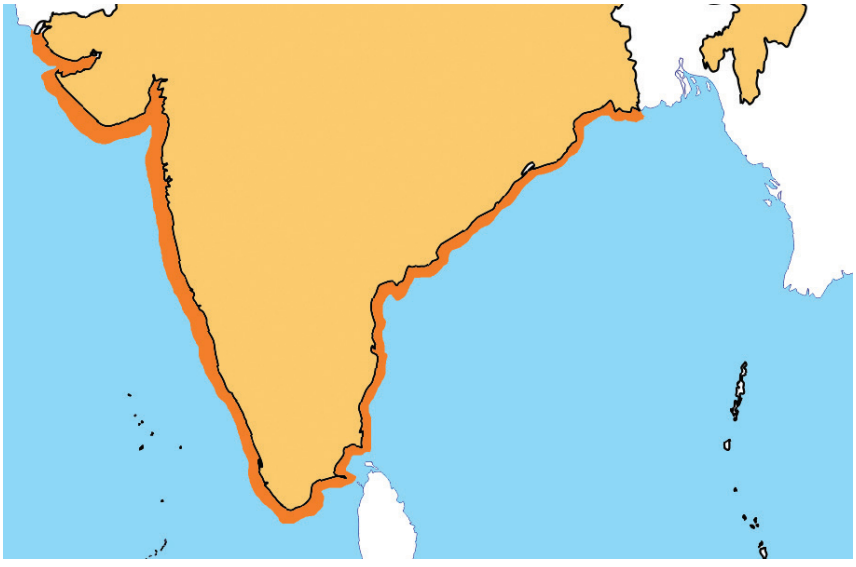


Fig. 16. Coast-wise distribution of *Manta birostris* along the Indian coast

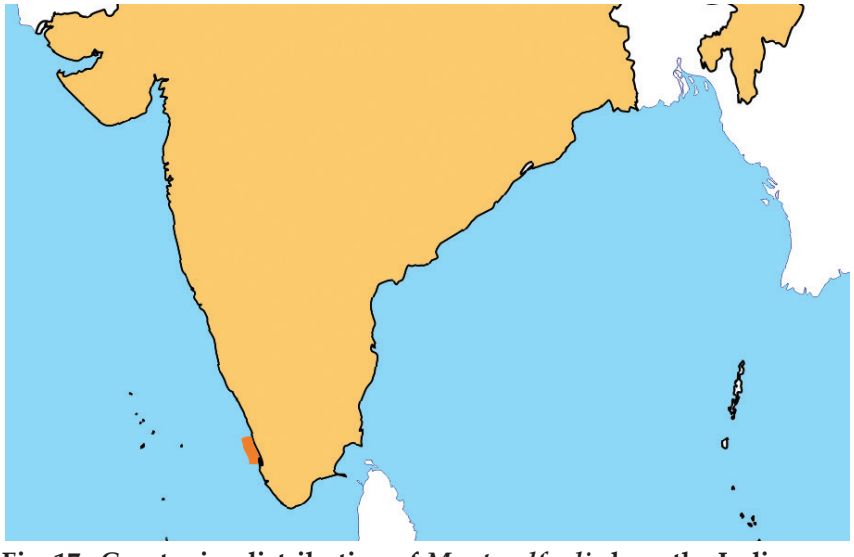


Fig. 17. Coast-wise distribution of *Manta alfredi* along the Indian coast

Population Size

Estimates of total population size for *M. alfredi* are very difficult to assess due to the migratory nature and global distribution of the species (Couturier et al., 2012). Regional population size estimates using sight-resight data in Mozambique and Hawaii showed that regional populations are small (less than 900 individuals) (Deakos et al., 2011; Marshall et al. 2011a). In contrast, population estimates of *M. alfredi* at key aggregation sites in the Maldives archipelagos range between 181 and 562 individuals, while the population for the entire Maldives, where several protection and conservation acts were enacted to protect the species, was estimated between 9,677 individuals (Kitchen-Wheeler et al. 2011) and 5000 (unpubl data). Minimum numbers of *M. alfredi* individuals identified are provided in Kashiwagi et al. (2011) for other locations. Apart from the Maldivian population (n=1835; Kitchen-Wheeler et al. 2011), all minimum numbers of individuals are less than 700 individuals per location. To date, no interaction between regional populations has been found and dispersion of individuals is likely to be restricted by bathymetric features and/or regional ocean circulation patterns, isolating the different sub-populations (e.g. Hawaii, Deakos et al. 2011).

Population Trend

Manta rays are targeted by fisheries in some parts of the world. Population reduction appears to be very high in several regions and globally the species is believed to have declined by >30%. In some regions, manta ray populations have collapsed due to directed fisheries (e.g. Anon, 1997; Alava et al., 2002). The population trend for *M. alfredi* is stated as 'decreasing' in the IUCN Red List. (Marshall et al., 2011c). This species is a long-lived, slow-growing, k-selected species (Marshall et al., 2011c) and hence sustained pressure from directed fishing and by-catch is likely to cause rapid decline in sub-population abundances. Low fecundity and long life span of *M. alfredi*, will not give it the capacity to recover from a depleted state (Alava et al., 2002; Mohanraj et al., 2009; Marshall et al., 2011a).

Fishery

Manta rays are targeted by fisheries around the world. The increase in demand for manta ray product in the South East Asian Market (mostly for gill rakers) has led to the creation of new and highly specialised fisheries. Manta gill rakers are particularly sought for and valued; the trade for this manta product has become more lucrative than shark-fin trade (Heinrichs et al., 2011; Couturier et al., 2012). Direct fisheries have significantly reduced the population abundance in several regions. In Indonesia, over 1500 manta rays are captured each year (Dewar; 2002, White et al., 2006). The fishing effort for mobulid rays has increased internationally, but the annual landing in many areas is declining (Dewar, 2002; Nair, 2003; White et al., 2006; Couturier et al., 2012). In

India there have been reports of mobulid rays contributing upto 11% of the daily catch in some regions (Zacharia & Kanthan, 2010). It is important to note that most manta ray fisheries around the world remain unreported and illegal capture of these rays occurs even in protected areas. It is highly probable that local and regional extinctions will occur in heavily fished areas.

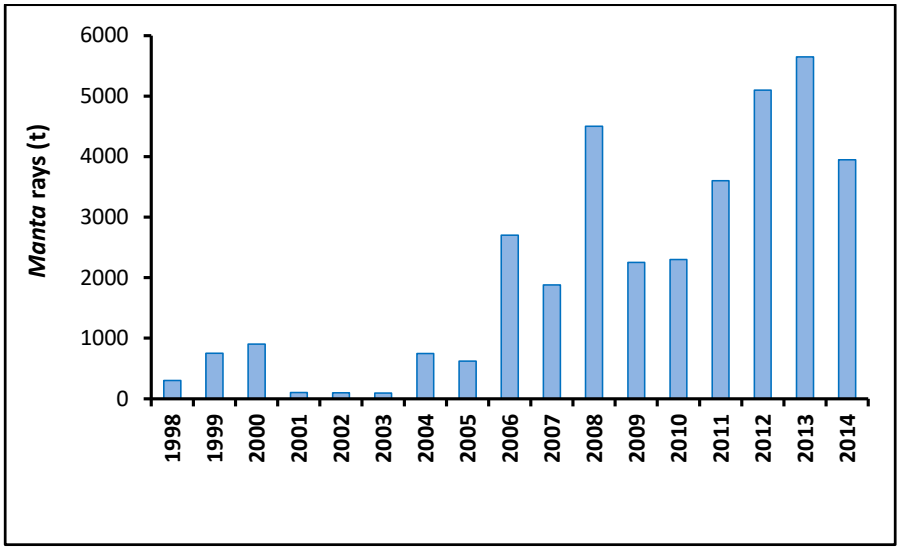


Fig. 18. Global catch of Manta rays

Manta rays and other mobulids are regularly caught as by-catch in purse seine, trawl and net fisheries throughout their distribution (Couturier et al., 2012). Tuna purse seine fisheries are a major contributor to by-catch, with mobulid species caught in relatively large numbers in most oceans (Romanov, 2002; Couturier et al., 2012). Long line fisheries in the Atlantic Ocean also regularly land mobulid species (Beerkircher et al., 2002; Beerkircher et al., 2008; Rey & Muñoz-Chápuli, 1992). *M. alfredi* individuals are regularly caught in shark control nets off Australian and South African coasts (Sumpton et al., 2011; Young, 2001). In Queensland, 93 mobulid rays were caught in shark control nets between 1992 and 2008 with a mortality rate of 41% for manta rays (Sumpton et al., 2011).

While the full extent of mobulid landings in India is not known, numerous published references document significant manta and mobula ray landings from the Indian coastal trawl, gillnet and longline fisheries (Nair et al., 2015). The available fishery reports account for at least 690 manta rays (*M. birostris*) and an estimated 24,260 mobula rays (various species). Given the vast size of the Indian trawl and gillnet fleets targeting sharks, skates and rays, and limited fisheries oversight, the landings of mobulids in these fisheries may be significantly underreported. To properly estimate total manta and mobula ray landings in India, further investigation is required.

Global conservation status

Manta birostris is listed as 'Vulnerable' on the IUCN Red List (Marshall et al., 2011b). Population sizes of *Manta birostris* are unknown.

Manta alfredi is listed as "Vulnerable" in the IUCN Red List (Marshall et al., 2011c). Because of their slow reproductive rate, they are very vulnerable to overfishing.

Threats and Mortality

The main threat to both *Manta* species is fishing, whether targeted or incidental. Manta rays are currently killed or captured by a variety of methods including hooks and line, netting and trawling. These rays are easy to target because of their large size, slow swimming speed, aggregative behaviour, predictable habitat use, and lack of human avoidance. Manta ray products have a high value in international trade markets. Their gill rakers are particularly sought after and are used in Asian medicinal products.

Marshall et al. (2011b) and Couturier et al. (2012) report of threats such as entanglement in marine debris, boat strikes, water pollution, habitat degradation, and irresponsible tourism practises for this species. In Australian waters reports of manta rays entangled in marine debris such as mooring lines and lost fishing lines (Deakos et al., 2011; Marshall & Bennett, 2010) have been reported. In Maui, Hawaii 10% of the *M. alfredi* population have amputated or non-functioning cephalic fins likely caused by monofilament fishing line entanglement (Deakos et al., 2011). These injuries are likely to impend on the overall fitness and survival.

High concentrations of heavy metals such as platinum, mercury and arsenic are present in manta ray tissues (Essumang, 2009; 2010). Manta rays in the Maldives have been observed carrying injuries resulting from boat interaction, although the number of fatalities remains unknown (Anderson et al., 2011).

Considering the potential threat to the species, Couturier et al. (2012) points to the possible impact on the seasonal diet of the manta rays due to the loss of climatic habitat caused by anthropogenic emissions of greenhouse gases and Boerger et al. (2010) and Mascarenhas et al. (2004) points to the ingestion of plastic debris by marine species causing fatalities, ulcerations, intestinal blockages, malnutrition and internal perforation. Hays et al. (2005) observes that *M. alfredi* is likely to be impacted by loss of climatic habitat caused by anthropogenic emissions of greenhouse gases, due to the predicted impact this phenomenon will have on the manta ray food source, the zooplankton.

NDF - Fishery management and Recommendations

Scalloped hammerhead shark

From the information available on the fishery and stock status of *Sphyrna lewini* in Indian waters, and likely threats posed to the species, ICAR-CMFRI has found that at present, the fishery does not pose a serious threat to the stock of this species, provided there is a check on the exploitation of juveniles from the inshore waters. A positive NDF is therefore recommended, and international trade in this shark and its by-products can be done with CITES certification, subject to existing regulatory laws on shark fin trade implemented by the Government of India. Since the species is not targeted by a particular fishing fleet, gear or method, and the landings are not consistent throughout the year, it is not possible to fix recommended harvest levels.

Great hammerhead shark

From the information available on the fishery and stock status of *Sphyrna mokarran* in Indian waters, and likely threats posed to the species, ICAR-CMFRI has found that at present, the fishery does not pose a serious threat to the stock of this species, provided there is a check on the exploitation of juveniles from the inshore waters. A positive NDF is therefore recommended, and international trade in this shark and its by-products can be done with CITES certification, subject to existing regulatory laws on shark fin trade implemented by the Government of India. Since the species is not targeted by a particular fishing fleet, gear or method, and the landings are not consistent throughout the year, it is not possible to fix recommended harvest levels.

Smooth hammerhead shark

From the information available on the fishery and stock status of *Sphyrna zygaena* in Indian waters, and likely threats posed to the species, ICAR-CMFRI has found that at present, the fishery does not pose a serious threat to the stock of this species, provided there is a check on the exploitation of juveniles from the inshore waters. A positive NDF is therefore recommended, and international trade in this shark and its by-products can be done with CITES certification, subject to existing regulatory laws on shark fin trade implemented by the Government of India. Since the species is not targeted by a particular fishing fleet, gear or method, and the landings are not consistent throughout the year, it is not possible to fix recommended harvest levels.

Oceanic whitetip shark

From the information available on the fishery and stock status of *Carcharhinus longimanus* in Indian waters, and likely threats posed to the species, ICAR-CMFRI has found that at present, the fishery does not pose a serious threat to the stock of this

species. A positive NDF is therefore recommended, and international trade in this shark and its by-products can be done with CITES certification, subject to existing regulatory laws on shark fin trade implemented by the Government of India. Since the species is not targeted by a particular fishing fleet, gear or method, and the landings are not consistent throughout the year, it is not possible to fix recommended harvest levels.

Giant manta ray

From the information available on the fishery and stock status of *Manta birostris* in Indian waters, ICAR-CMFRI has found that at present the extent of threat posed to the stock cannot be clearly assessed. Collection and analysis of data on fishery and trade of this species must be continued for three more years, with better transparency in data sharing by stakeholders. The NDF study can be taken up after three years, during which time international trade in this ray and its by-products can be done with CITES certification, subject to existing regulatory laws on elasmobranch trade implemented by the Government of India. Since the species is characterised by high biological vulnerability, a precautionary approach is recommended, which includes intensive awareness generation among stakeholders.

Reef manta ray

From the scanty information available on the stock status of *Manta alfredi* in Indian waters and its rare occurrence in the fishery, ICAR-CMFRI has found that at present the extent of threat posed to the stock cannot be clearly assessed. Collection and analysis of data on fishery and trade of this species must be continued for three more years, with better transparency in data sharing by stakeholders. The NDF study can be taken up after three years, during which time international trade in this ray and its by-products can be done with CITES certification, subject to existing regulatory laws on elasmobranch trade implemented by the Government of India. Since the species is characterised by high biological vulnerability, a precautionary approach is recommended, which includes intensive awareness generation among stakeholders.

The positive NDFs recommended are subject to the following conditions:

- Monitoring of the stock status, biological performance and fishery of all the species to be continued.
- Recommendations of NDFs for the four shark species to be reviewed after five years and sustainable production levels to be fixed to the extent possible.
- NDF study to be repeated for manta rays after a period of three years to strengthen database on biology and stock indicators for the two species and assess the stock status, considering the biological vulnerability of the manta rays.

Specific monitoring and management protocols recommended are:

1. Population monitoring through
    - Tag and release
    - Abundance estimation
    - Identifying breeding seasons, grounds and aggregations of the species
    - Fishery monitoring
    - Monitoring of IUU fishing
    - Creation of platform for data sharing among all stakeholders
    - Biology and stock assessment studies
2. Monitoring of domestic and international trade through
    - Improved data reporting – data declaration by traders
    - Market survey, interviews with fishermen & traders, information from Customs & other databases, trade channels
    - Implementation of species-specific product-specific code for trade
    - Genetic analysis for ambiguous products
3. Improving management measures through
    - Strict implementation of MFRAs regarding gear, mesh size, operation in no-take zones and closed seasons
    - Strengthen Monitoring, Control and Surveillance (MCS)
    - Improve participatory management through regional fishery management councils
    - Create awareness through visual, print and electronic media and mass campaigns
    - Seasonal closure of fishing in identified breeding/nursery grounds

References

Acker (MRBH), B. 2001. "Manta facts" (On-line). Manta Ray Bay Hotel and Yap Divers. Accessed 11/01/04 at http://www.mantaray.com.

Alava, M.N.R., Dolumbaló, E.R.Z., Yaptinchay, A.A. and Trono, R.B. 2002. Fishery and trade of whale sharks and manta rays in the Bohol Sea, Philippines. Pp. 132-148. In:S.L. Fowler, T.M. Reed and F.A. Dipper (eds), Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop. Sabah, Malaysia, July 1997. Occasional paper of the IUCN Species Survival Commission No. 25.

Anderson, R.C., Adam, M.S. and Goes, J.I. 2011. 'From monsoons to mantas: seasonal distribution of *Manta alfredi* in the Maldives' Fisheries Oceanography, 20(2), 104-113.

Anon, 1997. Fisheries Conservation Crisis in Indonesia: massive destruction of marine mammals, sea turtles and fish reported from trap nets in pelagic migratory channel. URL: http://darwin.bio.uci.edu/sustain/bio65/indonesia/indon97e.htm.[online].

Arkive, 2008. Oceanic whitetip shark *(Carcharhinus longimanus)*. http://www.arkive.org/oceanic-whitetip-shark/carcharhinus-longimanus, downloaded 28 January 2016.

Babcock E.A., Camhi M.D., and Pikitch E.K. 2008. Sharks of the open ocean: Biology Fisheries and Conservation, United Kingdom: Blackwell Publishing Ltd.

Backus R.H., Springer S. and Arnold E.L. Jr. 1956. A contribution to the natural history of the white-tip shark, *Pterolamiops longimanus* (Poey). *Deep-Sea Research* 3, 178–188.

Bass A.J., D'Aubrey J.D. and Kistnasamy N. 1973. Sharks of the east coast of Southern Africa. I. The genus *Carcharinus* (Carcharhinidae). Investigational Report Oceanographic Research Institute Durban 33, 1–168.

Bass, A.J., D'Aubrey, J.D. and N. Kistnasamy. 1975. Sharks of the east coast of southern Africa.III. The families Carcharinidae (excluding *Mustelus* and *Carcharhinus*) and Sphyrnidae. South African Association for Marine Biological Research. Oceanographic Research Institute Investigational Report 38: 1-100.

Baum, J., Clarke, S., Domingo, A., Ducrocq, M., Lamónaca, A.F., Gaibor, N., Graham, R.,Jorgensen, S., Kotas, J.E., Medina, E., Martinez-Ortiz, J., MonziniTaccone di Sitizano, J.,Morales, M.R., Navarro, S.S., Pérez-Jiménez, J.C., Ruiz, C., Smith, W., Valenti, S.V. andVooren, C.M. 2007. *Sphyrna lewini*.The IUCN Red List of Threatened Species.Version 2014.2.<www.iucnredlist.org>. Downloaded on 15 July 2016.)

Baum, J., Medina, E., Musick, J.A. and Smale, M. 2015. *Carcharhinus longimanus*. The IUCN Red List of Threatened Species 2015: e.T39374A85699641. http://dx.doi.org/10.2305/IUCN. UK.2015. RLTS.T39374A85699641.en. Downloaded on 17 September 2016.

Beerkircher, L.R., Cortés, E. andShivji, M.S. 2002. Characteristics of shark bycatch observed on pelagic longlines off the Southeastern United States, 1992-2000. Mar. Fish. Rev., 64(4), 40-49.

Beerkircher, L.R., Cortés, E.and Shivji, M.S. 2008, Case study: Elasmobranch bycatch in the pelagic longline fishery off the southeastern United States, 1992–1997. In: Sharks of the open ocean, pp. 242-246.

Bester, C. 2008. Smooth hammerhead, *Sphyrna zygaena*. In: Florida Museum of Natural History 2011. Biological Profiles. http://www.flmnh.ufl.edu/fish/discover/species-profiles/sphyrna-zygaena Accessed on 30 July 2016

Bester, C. 2011a. Species Profile: Scalloped Hammerhead. Florida Museum of Natural History. Accessed 20 July, 2016. http://www.flmnh.ufl.edu/fish/Gallery/-Descript/Schammer/ScallopedHammerhead.html

Bester, C. 2011b. Species Profile: Great Hammerhead. Florida Museum of Natural History. Accessed 25 July, 2016. https://www.flmnh.ufl.edu/fish/discover/species-profiles/sphyrna-mokarran

Bester, C. 2011c. Species Profile: Smooth Hammerhead. Florida Museum of Natural History. Accessed 30 July, 2016. http://www.flmnh.ufl.edu/fish/Gallery/-Descript/Schammer/Smooth Hammerhead.html

Bester, C. 2011d. Species Profile: *Carcharhinus longimanus*. Florida Museum of Natural History. Accessed 30 October, 2016. https://www.flmnh.ufl.edu/fish/discover/species-profiles/carcharhinus-longimanus/

Bigelow, H.B. and Schroeder, W.C. 1948. Sharks. In Tee-Van J., Breder C.M., Hildebrand S.F., Parr A.E. and Schroeder W.C. (eds) Fishes of the Western North Atlantic. Part 1. Lancets, cyclostomes and sharks. New Haven, CT: Sears Foundation for Marine Research, Memoirs, Yale University, pp. 59–546.

Bigelow, H.B and Schroeder, W.C. 1954. Fishes of the Western North Atlantic. Copenhagen: Yale University.

Boerger, C.M., Lattin, G.L., Moore, S.L. and Moore, C.J. 2010. Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre. Marine Pollution Bulletin, vol. 60(12), 2275-2278.

Branstetter, S. 1987. Age, growth and reproductive biology of the silky shark, *Carcharhinus falciformis*, and the scalloped hammerhead, *Sphyrna lewini,* from the northwestern Gulf of Mexico. Environmental Biology of Fishes 19, 161-173.

Branstetter, S. and Stiles, R. 1987. Age and growth estimates of the bull shark, *Carcharhinus leucas*, from the northern Gulf of Mexico. Environmental Biology of Fishes, 20, 169–81. doi:10.1007/BF00004952

Chen, C., Leu, T. and Joung, S. 1988. Notes on reproduction in the scalloped hammerhead, *Sphyrna lewini* in northeastern Taiwan waters. Fishery Bulletin, 86, 389-393.

Chen C.T., Leu T.C., Joung S.J. and Lo N.C.H. 1990. Age and growth of the scalloped hammerhead, *Sphyrna lewini*, in northeastern Taiwan waters. Pacific Science, 44,156–70.

Clark, E. and Von Schmidt, K. 1965. Sharks of the central Gulf coast of Florida. Bull. Mar. Sci. 15(1), 13-83.

Clark, T.B. 2010. Abundance, home range, and movement patterns of manta rays (*Manta alfredi, M. birostris*) in Hawai'i. University of Hawai'i, Mãnoa.

Cliff, G. 1995. Sharks caught in the protective gill nets off KwaZulu-Natal, South Africa. 8. The great hammerhead shark *Sphyrna mokarran* (Ruppell). South African Journal of Marine Science, 15, 105−114.

CMFRI, 2015. Annual Report 2014-15. Central Marine Fisheries Research Institute, Cochin, 353 p

CMFRI, 2016. Data collected under the project FISHCMFRISIL201200500005 Assessment of elamobranch resources in the Indian seas. Demersal Fisheries Division, ICAR-Central Marine Fisheries Research Institute, Kochi.

Coelho R., Hazin F.H.V., Rego M., Tambourgi M., Oliveira P., Travassos P., Carvalho F. and Burgess G. 2009. Notes on the reproduction of the oceanic whitetip shark, *Carcharhinus longimanus*, in the southwestern Equatorial Atlantic Ocean. Collective Volume of Scientific Papers - ICCAT 64, 1734–1740.

Coelho, R., Carvalho, J. F., Amorim, S. and Santos, M. N. 2011. Age and growth of the smooth hammerhead shark, *Sphyrna zygaena*, in the Eastern Equatorial Atlantic Ocean, using vertebral sections. Aquat. Living Resour. 24, 351–357.

Compagno, L.J.V., Dando, M. and Fowler, S. 2005. Sharks of the World. Princeton Field Guide. 480 pp.

Compagno, L.J.V., 1981. Legend versus reality: the jaws image and shark diversity. Oceanus, 24(4), 5-16

Compagno, L.J.V. 1984. Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Part II (Carcharhiniformes). FAO Fisheries Synopsis No. 125, Vol. 4, Part II. FAO, Rome.

Compagno, L.J.V. 1998. Sphyrnidae. Hammerhead and bonnethead sharks. pp. 1264-1267. In: Carpenter, K.E.and. Niem, V.H (Eds.), FAO identification guide for fishery purposes. The Living Marine Resources of the Western Central Pacific FAO, Rome.

Compagno, L.J.V. 1999. Checklist of living elasmobranchs. p. 471-498. In W.C. Hamlett (ed.) Sharks, skates, and rays: the biology of elasmobranch fishes. Johns Hopkins University Press, Maryland.

CoP16 Prop. 43 Inclusion of Scalloped Hammerhead Shark *Sphyrna lewini* Great Hammerhead Shark *Sphyrna mokarran* and Smooth Hammerhead Shark *Sphyrna zygaena* in Appendix II, Sixteenth meeting of the Conference of the Parties.

Cortés, E., Papastamatiou, Y.P., Carlson, J.K., Ferry-Graham, L., Wetherbee, B.M., Cyrino, J.E.P., Bureau, D.P. and Kapoor, B.G. 2008. An overview of the feeding ecology and physiology of elasmobranch fishes. In: Cyrino, J.E.P., Bureau, D. and Kapoor, B.G. (Eds.), Feeding and Digestive Functions of Fishes. Science Publishers, Edenbridge.

Couturier, L.I.E., Jaine, F.R.A., Townsend, K.A., Weeks, S.J., Richardson, A.J. and Bennett, M.B. 2011. Distribution, site affinity and regional movements of the manta ray, *Manta alfredi* (Krefft, 1868), along the east coast of Australia. Marine and Freshwater Research, 62(6), 628-637.

De Rosemont, M. 2008 Observation and sighting description of the *Manta birostris* , in BoraBora Island (French Polynesia-South Pacific). In: Donnelly, M (Ed.) Joint Meeting of Ichthyologists and Herpetologists. Montreal, Canada.

Couturier, L.I.E., Marshall, A.D., Jaine, F.R.A., Kashiwagi, T., Pierce, S.J., Townsend, K.A., Weeks, S.J., Bennett, M.B. and Richardson, A.J. 2012. Biology, ecology and conservation of the Mobulidae. Journal of Fish Biology 80(5), 1075-1119.

Deakos, M.H. 2010a. Paired-laser photogrammetry as a simple and accurate system for measuring the body size of free-ranging manta rays Manta alfredi. Aquatic Biology 10, 1–10.

Deakos, M.H. 2010b. Ecology and social behaviour of a resident manta ray (*Manta alfredi*) population off Maui, Hawaii. PhD Thesis. University of Hawaii at Manoa.

Deakos, M.H., Baker, J.D. and Bejder, L 2011. Characteristics of a manta ray *Manta alfredi* population off Maui, Hawaii, and implications for management. Marine Ecology Progress Series, 429, 245-260.

Dewar, H. 2002. Preliminary report: Manta harvest in Lamakera, Pfleger Institute of Environmental Research and the Nature Conservancy, Oceanside.

Dewar, H., Mous, P., Domeier, M., Muljadi, A., Pet, J. and Whitty, J. 2008. Movements and site fidelity of the giant manta ray, *Manta birostris*, in the Komodo Marine Park, Indonesia. Marine Biology, 155(2), 121-133.

Dive Asia, 2004. Dive Asia Reef Ecology Guide- Cartilaginous Fishes (On-line). Dive Asia, Diving in Phuket, Thailand and Burma. Accessed 11/01/04 at http://www.diveasia.com/reef-guide/cartilaginous.htm.

Duncan, K.M., Martin, A.P., Bowen, B.W and Couet, H.G. 2006. Global phylogeography of the scalloped hammerhead shark (*Sphyrna lewini*). Molecular Ecology 15, 2239-2251.

Essumang, D.K. 2009. Analysis and human health risk assessment of arsenic, cadmium, and mercury in *Manta birostris* (Manta ray) caught along the Ghanaian coastline. Human and Ecological Risk Assessment, 15(5), 985-998.

Essumang, D.K. 2010, First determination of the levels of platinum group metals in *Manta birostris* (Manta ray) caught along the Ghanaian coastline. Bulletin of Environmental Contamination and Toxicology, 84(6), 720-725.

FAO Smartfish, 2014. On board guide for the identification of pelagic sharks and rays of Western Indian Ocean. FAO, Rome.

FAO, 2016. http://www.fao.org/figis/servlet/SQServlet?file=/work/FIGIS/prod/webapps- /figis/temp/hqp_3095396310054557929.xmlandouttype=html

Fischer, W. and Bianchi, G. 1984. FAO Species identification sheets for fishery purposes – Western Indian Ocean Fishing Area 51-Volume V, FAO, Rome

FLMNH. 2016. *Carcharhinus longimanus*. http://www.flmnh.ufl.edu/fish/discover/species-profiles/carcharhinus-longimanus downloaded 31 October 2016.

Fourmanoir, P. 1961. Requins de la Côte Ouest de Madagascar. Memoires de L'InstitutScientifique de Madagascar. Série F. Oceanographie. ORSTOM. Tome IV.

Gallagher, A.J., Orbesen, E.S., Hammerschlag, N. and Serafy, J.E. 2014. Vulnerability of oceanic sharks as pelagic longline bycatch. Global Ecology and Conservation 1, 50-59

Garrick, J.A.F. 1982. Sharks of the Genus *Carcharhinus*. U.S. Dep.Commer. NOAA Tech. Rep. NMFS Circular, 445, 194

Gohar H.A.F. and Mazhar F.M. 1964. The elasmobranchs of the northwestern Red Sea. Publications of the Marine Biological Station Al-Ghardaqa (Red Sea) 13, 1–144.

Harry, A.V., Macbeth, W.G., Gutteridge, A.N. and Simpfendorfer, C.A. 2011. The life histories of endangered hammerhead sharks (Carcharhiniformes, Sphyrnidae) from the east coast of Australia. Journal of Fish Biology 78, 2026-2051.

Hays, G.C., Richardson, A.J. and Robinson, C. 2005. Climate change and marine plankton Trends in Ecology and Evolution, 20(6), 337-344.

Hazin, F., Fischer, A. and Broadhurst, M. 2001. Aspects of reproductive biology of the scalloped hammerhead shark, *Sphyrna lewini*, off northeastern Brazil. Environmental Biology of Fishes 61, 151-159.

Heinrichs, S., O'Malley, M., Medd, H. and Hilton, P. 2011, The global threat to *Manta* and *Mobula* rays, New York.

Ito, T. 2000. *Manta swims as if he flapped the wings*. Metamor Publishing, Tokyo, Japan.

IUCN 2007. *Carcharhinus longimanus.* http://www.iucnredlist.org/details/39374/0, downloaded 22 January 2016.

Jorgensen, S.J., Klimley, A.P. and Muhlia-Melo, A.F. 2009. Scalloped hammerhead shark *Sphyrna lewini*, utilizes deep-water, hypoxic zone in the Gulf of California. Journal of Fish Biology 74, 1682–1687.

Kashiwagi, T., Marshall, A.D., Bennett, M.B. and Ovenden, J.R. 2011. Habitat segregation and mosaic sympatry of the two species of manta ray in the Indian and Pacific Oceans, *Manta alfredi* and *M. birostris.* Marine Biodiversity Records, vol. 4, e53.

Kashiwagi, T., Ito, T., Ovenden, J. and Bennett, M., 2008. Population characteristics of *Manta birostris* observed in Yaeyama, Okinawa, Japan, 1987 - 2006. Abstracts of Joint Meeting of Ichthyologists and Herpetologists, Montreal, Quebec, pp. 235-236.

Kashiwagi, T., Ito, T. and Sato, F., 2010. Occurences of reef manta ray, *Manta alfredi*, and giant manta ray, *M. birostris*, in Japan, examined by photographic records. Report of Japanese Society for Elasmobranch Studies 46, 20-27.

Kitchen-Wheeler, A.M. 2010. Visual identification of individual manta ray (*Manta alfredi*) in the Maldives Islands, Western Indian Ocean. Marine Biology Research, 6(4), 351-363.

Kitchen-Wheeler, A.M., Ari, C. and Edwards, A.J., 2011. Population estimates of Alfred mantas (*Manta alfredi*) in central Maldives atolls: North Male, Ari and Baa. Environmental Biology of Fishes, 93, 557–575.

Kizhakudan S.J., Zacharia, P.U., Thomas Sujitha, Vivekanandan, E. and Muktha Menon 2015. Guidance on National plan of Action for Sharks in India. CMFRI Marine Fisheries Policy Series, No. 2, 104 p.

Klimley, A.P. 1993. Highly directional swimming by scalloped hammerhead sharks, *Sphyrna lewini*, and subsurface irradiance, temperature, bathymetry, and geomagnetic field. Marine Biology 117, 1–22.

Lafrance, S., 1994. Archipel des Bijjagos: ichtyofauna et élementsd'ecologie marine. Doc. Scient. CIPA No. 1. 66 p.

Last, P.R. and Stevens, J.D. 2009. Sharks and Rays of Australia. CSIRO Publishing, Collingwood, Victoria.

Law, M. 2010. The twister of mantas. Ocean Geographic. Ocean Geographic Society.

Lessa, R., Santana, F. M. and Paglerani, R. 1999. Age, growth and stock structure of the oceanic whitetip shark, *Carcharhinus longimanus*, from the southwestern equatorial Atlantic. Fish. Res., 42(1/2), 21-30.

Liu, K.M. and C.T. Chen. 1999. Demographic analysis of the scalloped hammerhead, *Sphyrna lewini*, in the northwestern Pacific. Fisheries Science 65, 218-223.

Macbeth, G.M., Broderick, D., Ovenden, J.R. and Buckworth, R.C. 2011. Likelihood-based genetic mark-recapture estimates when genotype samples are incomplete and contain typing error. Theoretical Population Biology, doi:10.1016/j.tpb.2011.06.006.

Maguire, J.J., Sissenwine, M.P., Csirke, J., Grainger, R.J.R. and Garcia, S.M.. 2006. The state of world highly migratory, straddling and other high seas fisheries resources and associated species. FAO Fisheries Technical Paper No. 495. FAO, Rome. 84p.

Manjusha, S., Kurup, B.M., Saravannane, N. and Sanjeevan, V.N. 2011. Studies on population structure, mortality, growth and exploitation level of smooth hammerhead *Sphyrna zygaena* (L) (Carcharhiniformes - Sphyrnidae) in the coastal region of Kerala,

Manta Rays. 1989. In: Wildlife of the World Encyclopedia, vol. 10 (Rav-Slo). New York: Cavendish Publishing. pp. 582-583

Manta Rays. 1992. In: Encyclopedia of the Animal, vol. 8 (Ott-Rhe). New York: Boy Books. pp. 1512-1514

Marshall, A.D. 2009. Zootaxa, Redescription of the genus *Manta* with resurrection of *Manta Alfred* Zootaxa, 28, 1-28.

Marshall, A.D. and Bennett, M.B. 2010. Reproductive ecology of the reef manta ray (*Manta alfredi*) in southern Mozambique. Journal of Fish Biology 77, 169-190.

Marshall, A.D., Pierce, S.J. and Bennett, M.B. 2008 Morphological measurements of manta rays (*Manta birostris*) with a description of a foetus from the east coast of Southern Africa. Zootaxa, 1717, 24–30.

Marshall, A., Compagno, L. and Bennett, M. 2009. Redescription of genus Manta with resurrection of *Manta alfredi* (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). Zootaxa, 2301: 1-28. Accessed March 06, 2013 at http://www.mapress.com.proxy.lib.umich.edu/zootaxa/2009/2/zt02301p028.pdf.

Marshall, A, Dudgeon, C and Bennett, M. 2011a. 'Size and structure of a photographically identified population of manta rays *Manta alfredi* in southern Mozambique' Marine Biology, 158(5), 1111-1124.

Marshall, A., Bennett, M.B., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M., Stevens, G. and Kashiwagi, T. (2011b). *Manta birostris*. In: IUCN Red List of Threatened Species. Available at www.iucnlist.org

Marshall, A., Kashiwagi, T., Bennett, M. B., Deakos, M. H., Stevens, G., McGregor, F., Clark, T., Ishihara, H. and Sato, K. 2011c. *Manta alfredi.* In: IUCN Red List of Threatened Species.Version 2011. 1. Available at www.iucnlist.org

Marshall, L. J. and Barone, M., 2016. Food and Agriculture Organization of the United Nations (FAO) Sharkfin Guide: Identifying Sharks from their Fins, Page No.73.

Mascarenhas, R, Santos, R and Zeppelini, D 2004. Plastic debris ingestion by sea turtle in Paraiba, Brazil Marine pollution bulletin, 49(4), 354-355.

Mohanraj, G, Rajapackiam, S, Mohan, S, Batcha, H and Gomathy, S 2009. Status of elasmobranchs fishery in Chennai, India. Asian Fisheries Science, 22(2), 607-615.

Munday-Taylor, V. Crook V., Foster S., G. Fowler S., Sant G and Rice J. 2014. CITES Non-detriment Findings Guidance for shark species (2nd Revised Version). A framework to assist Authorities in making Non-detriment Findings (NDFs) for species listed in CITES Apendix II. Report prepared for the Germany federal Agency for Nature Conserevation (Bundesamt for Naturschutz, BfN). pp.142

Nair, Rekha. J. 2003. Targeted shark fishery in Kerala. Marine Fisheries Information Service Technical and Extension Series, 176, 8-9.

Nair, Rekha. J., Zacharia, P.U., Dinesh Kumar, S., Kishor, T.G., Divya, N.D., Seetha, P.K. and Sobhana, K.S. 2015. Recent trends in the mobulid fishery in Indian waters. Indian Journal of Geo-Marine Sciences, 44(10), 1265-1283.

Nava, P. N. and Farias, J. F. M. 2014. Size at maturity of the smooth hammerhead shark, *Sphyrna zygaena*, captured in the Gulf of California. Hydrobiologia, 24(2),129-135

NMFS, 2014. Oceanic whitetip shark *Carcharhinus longimnus.* http://www.nmfs.noaa.gov/pr/species/fish/oceanicwhitetipshark.htm downloaded 31 October 2016.

Noriega, R., Werry, J.M., Sumpton, W., Mayer, D. and Lee, S.Y. 2011. Trends in annual CPUE and evidence of sex and size segregation of *Sphyrna lewini*: Management implications in coastal waters of northeastern Australia. Fisheries Research, 110, 472-477.

Notarbartolo di Sciara, G. 1988. Natural history of the rays of the genus *Mobula* in the Gulf of California. U S Fish and Wildlife Service Fishery Bulletin, 86, 45-66.

Perlmutter, A. 1961. Guide to Marine Fishes. New York: New York University Press.

Piercy, A.N., Carlson, J.K., Sulikowski, J.A. and Burgess, G.. 2007. Age and growth of the scalloped hammerhead shark, *Sphyrna lewini*, in the north-west Atlantic Ocean and Gulf of Mexico. Marine and Freshwater Research 58, 34-40.

Piercy A.N., Carlson J.K. and Passerotti M.S., 2010. Age and growth of the great hammerhead shark, *Sphyrna mokarran*, in the northwestern Atlantic Ocean and Gulf of Mexico. Mar. Freshw. Res., 61, 992–998.

Raje, S.G., Sivakami, S., Mohanraj, G., Manojkumar, P.P., Raju, A. and Joshi, K.K. 2007. An Atlas on the elasmobranch fishery resources of India. CMFRI Spl. Publ. No.95, 253 pp.

Ramsoomair, Kristina, A. 2016. *Carcharhinus longimanus* (Oceanic whitetip shark). The online guide to the animals of Trinidad and Tobago.

Rey, J.C. and Muñoz-Chápuli, R. 1992, Intra and interspecific association of large pelagic fishes inferred from catch data of surface longline. Environmental biology of fishes, 35(1), 95-103.

Ritte, E.K., 2001. Shark Info-International Media Service-Research News and Background Information on the Protection, Ecology, Biology and Behaviour of Sharks.http://www.sharkinfo.ch/SI4_01e/szygaena.html accessed on 30 July 2016.

Romanov, E.V. 2002, By-catch in the tuna purse-seine fisheries of the western Indian Ocean. Fishery Bulletin, 100, 90-105.

Rubin, R. 2002. Manta rays: not all black and white. Shark Focus 15, 4-5.

Saika, S. And Yoshimura, H. 1985. Oceanic whitetip shark (*Carcharhinus longimanus*) in the western Pacific. Report of the Japanese Group for Elasmobranch Studies, 20, 11-21.

Sanches, J.G. 1991. Catálogo dos principaispeixesmarinhos da República de Guiné-Bissau. Publicaçõesavulsas do I.N.I.P. No. 16. 429 p. as cited in Froese, R. and D. Pauly, Editors. FishBase 2000: concepts, design and data sources. ICLARM, Los Baños, Laguna,Philippines. 344 p.

Sanderson, S.L. and Wassersug, R. 1990. Suspension-feeding vertebrates. Sci. Amer. 262, 96-101.

Sanderson, S.L. and Wassersug, R. 1993. Convergent and alternative designs for vertebrate suspension feeding. pp. 37-112. In: Hankenand, J. and Hall, B.K. (eds.) The Skull. Volume 3. Functional and Evolutionary Mechanisms. University of Chicago Press, Chicago.

Schulze-Haugen, M. and Kohler, N.E. (eds.). 2003. Guide to sharks, tunas, and billfishes of the U.S. Atlantic and Gulf of Mexico. RI Sea Grant/National Marine Fisheries Service.

Seki T., Taniuchi T., Nakano H. and Shimizu M. 1998. Age, growth and reproduction of the oceanic whitetip shark from the Pacific Ocean. Fisheries Science 64, 14–20.

Shoou-Jeng Joung, Nien-Fu Chen, Hua-Hsun Hsu and Kwang-Ming Liu. 2016. Estimates of life history parameters of the oceanic whitetip shark, *Carcharhinus longimanus*, in the Western North Pacific Ocean. Marine Biology Research, 12(7), 758–768.

Smith, S.E., Au, D.W. and Show, C. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. Marine and Freshwater Research, 49(7), 663–678.

Stevens, J.D. 1984, Biological observations on sharks caught by sport fishermen off New South Wales. Australian Journal of Marine and Freshwater Research, 35, 573-590.

Stevens, J. D. and Lyle, J. M., 1989. Biology of three hammerhead sharks (*Eusphyra blochii, Sphyrna mokarran* and *S. lewini*) from Northern Australia. Australian Journal of Marine and Freshwater Research, 40(2), 129 - 146

Strasburg D.W. 1958. Distribution, abundance and habits of pelagic sharks in the central Pacific Ocean. Fishery Bulletin, 58, 335–61.

Strong, W.R., Snelson, F.F. and Gruber, S.H. 1990. Hammerhead shark predation on stingrays: an observation of prey handling by *Sphyrna mokarran*. *Copeia,* 1990, 836-840.

Sumpton, W.D., Taylor, S.M., Gribble, N.A., McPherson, G. and Ham, T. 2011, 'Gear selectivity of large-mesh nets and drumlines used to catch sharks in the Queensland Shark Control Program' African Journal of Marine Science, 33(1), 37-43.

Taniuchi, T.. 1994. Some biological aspects of sharks caught by floating longline-1. Species, distribution, species composition and hookrates. Reports of Japanese Society for Elasmobranchs Studies, 31, 1-12.

Varghese, Sijo P., Unnikrishnan, N., Gulati, Deepak K. and Ayoob, A.E. 2016. Size, sex and reproductive biology of seven pelagic sharks in the eastern Arabian Sea. Journal of Marine Biological Association U.K., 96(7), 1437-1447.

White, W.T., Last, P.R., Stevens, J.D., Yearsley, G.K., Fahmi and Dharmadi, 2006. Economically important sharks and rays of Indonesia. [Hiudanpari yang bernilai ekonomispenting di Indonesia]. Australian Centre for International Agricultural Research, Canberra, Australia.

White, W.T., Giles, J., Dharmadi, and Potter I.C. 2006. Data on the bycatch fishery and reproductive biology of mobulid rays (Myliobatiformes) in Indonesia Fisheries Research, 82(1-3), 65-73.

White, W. T., Barton, C. and Potter, I. C. 2008. Catch composition and reproductive biology of *Sphyrna lewini* (Griffith and Smith) (Carcharhiniformes, Sphyrnidae) in Indonesian waters. Journal of Fish Biology, 72, 1675-1689.

Whitley, G.P. 1936. The Australian devil ray, Daemo *Manta alfredi* (Krefft), with remarks on the Superfamily Mobuloidae (Order Batoidei). Australian Zoologist 8, 164-188.

WildEarth Guardians, 2012. Petition to List the great Hammerhead Shark (*Sphyrna mokarran*) Under the U.S. Endangered Species Act.

Wourms, JP 1977. Reproduction and Development in Chondrichthyan Fishes. American Zoologist, 17(2), 379-410.

Yano, K., Sato, F. and Takahashi, T. 1999. Observations of mating behavior of the manta ray, Manta birostris, at the Ogasawara Islands, Japan. Ichthyological Research, 46(3), 289-296.

Young, N. 2001. An analysis of the trends in by-catch of turtle species, angelsharks and batoid species in the protective gillnets off KwaZulu-Natal, South Africa. Reading, University of Reading.

Zacharia, P.U. and Kanthan, K.P. 2010. Unusual heavy landings of rays and skates at Tuticorin Fisheries Harbour. Marine Fisheries Information Services (T&E Series), 205, 13-15.

NON-DETRIMENT FINDINGS WORKSHEET

Sphyrna lewini (Griffith & Smith 1834).

Step 1			
Question 1.1 (a) Is the specimen subject to CITES control? (How did you identify the species?)			
Species Name	**Product form**	**CITES Appendix**	**Source of identification**
Sphyrna lewini	Whole fish/fins	II	The specimen was identified to the species level by an expert of CMFRI at the point of landing. (Fischer and Bianchi 1984, Marshall and Barone 2016).
In the view of the above, is the specimen subjected to CITES control?	YES	II	Condition (c) is met, as mentioned above.
Concerns and uncertainties	Fillets and cartilage cannot be identified to the species level at the point of trade.		
Question 1.1 (b) From which stock will the specimen be taken/was the specimen taken? (Can the origin and stock be confidently identified?)			
		Description/ Comments	**Sources of information**
Ocean basin		Western Indian Ocean - Eastern Arabian Sea, Eastern Indian Ocean - Western Bay of Bengal including the seas around Andaman and Nicobar Islands.	Appukuttan and Nair, 1988 Raje et al., 2007 Fischer and Bianchi 1984 FSI survey reports
Stock location/distribution/ boundaries (Attach a map)		Indian EEZ	NMFDC, ICAR- CMFRI
Is this a shared stock (i.e. occurring in more than one EEZ and/or the high seas?)		Not certain, probably yes, CMS	Duncan et al. 2006 CMS 2016 Appendix II

If the stock occurs in more than one EEZ which other parties share this stock?	Not known	-
If a high seas stock which other parties fish this stock?	Not known	-
Which, if any, RFB(s) cover(s) the range of this stock?	None	-
Are all parties listed above (which fish or share the stock concerned) members of the relevant RFB(s)?	NA	-
Are there geographical management gaps?	Not certain	-
How reliable is the information on origin?	Reliable	Conditions **a** AND **c** have been met (the origin of the specimen has been identified to a sufficient level, and the origin of the specimen has been confirmed by an expert from CMFRI at the point of landing.
Is the information on origin sufficiently detailed for Question 1.2 to be answered?		Yes

Question 1.2 **Was (will) the specimen (be) legally obtained and is export allowed?**		
Is the species:	**Description/ Comments**	**Sources of information**
Protected under wildlife legislation, regional biodiversity Agreement, or (for a CMS Party) listed in CMS Appendix 1?	No	-
Sourced from illegal fishing activities (e.g. in contravention of finning regulations, or where a TAC is zero or exceeded)?	No	-
Taken from a no-take marine protected area or during a closed season?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi

Taken in contravention of RFB recommendations, if any?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Listed as species whose export is prohibited?	Yes, for fin export	Notification No. 110/(RE-2013)2009-2014 dated 6 February 2015
Of concern for any other reason?	No	-
In view of the above and the final section of the Worksheet for Question 1.1(b), was the specimen legally acquired and can exports be permitted?		Yes; subject to conditions laid down by national regulations
Concerns and uncertainties:		Stock status and species-specific trade data not available

Question 1.3
What does the available management information tell us?

Part 1. Global-level information

	Description/Comments	Sources of information
Reported global catch	336 t (2010) to 55 t (2014) (This includes data only from Africa and Americas; data from other areas not included)	FAO Fishstat
Species distribution	Circumglobal in coastal warm temperate and tropical seas. Western Atlantic: New Jersey, USA to Uruguay, including the Gulf of Mexico and Caribbean. Eastern Atlantic: western Mediterranean to Namibia. Indo-Pacific: Red Sea, East Africa and throughout the Indian Ocean; Japan to New Caledonia, Hawaii and Tahiti. Eastern Pacific: southern California, USA to Ecuador, probably Peru.	http://shark-references.com/species/view/Sphyrna-lewini

Known stocks/ populations	Indo- west Pacific, central Pacific, eastern Pacific, southern Africa	Duncan et al. 2006
Main catching countries	Guinea-Bissau, Brazil, Ecuador, Venezuela, Spain, UK, Mauritania India*	Miller et al. 2013 NMFDC, ICAR- CMFRI
Main gear types by which the species is taken	Trawl nets, hooks and line, gillnets, longline	Baum et al. 2007 NMFDC, ICAR-CMFRI
Global conservation status	Endangered	Baum et al. 2007
Multilateral Environmental Agreements	CMS Appendix II CITES Appendix II	CMS Appendix II CITES Appendix II
Part 2: Stock/context-specific information		
Stock assessments	Not available	
Main management bodies	State Fisheries Departments (SFDs), Ministry of Agriculture, Cooperation & Farmers Welfare (MoA), Ministry of Environment, Forests and Climate Change (MoEF&CC), National Biodiversity Board (NBB)	https://cof.gujarat.gov.in/contact-us.htm https://fisheries.maharashtra.gov.in/ http://fisheries.goa.gov.in/ http://www.karnataka.gov.in/fisheries/Pages/Home.aspx http://www.fisheries.kerala.gov.in/ http://www.fisheries.tn.gov.in/ https://www.py.gov.in/knowpuducherry/dept_fisheries.html http://apfisheries.gov.in/ http://www.odishafisheries.com/ http://www.wbfisheries.gov.in/wbfisheries/do/Forwordlink?val=32 http://agricoop.nic.in/# http://www.moef.nic.in/ http://nbaindia.org/
Cooperative management arrangements	Participatory management with Association of Deep Sea Going Artisanal Fishermen (ADSGAF), Thuthoor – National Mission on Conservation of Sharks - India (NMCSI)	http://deepseafishersindia.org/

Non-membership of RFBs	NA	-
Nature of harvest	Landed as bycatch	NMFDC, ICAR-CMFRI
Fishery types	Multiday trawl fishery, Mechanized hook and line fishery, Mechanized gillnet fishery, small scale outboard hook and line fishery, small scale outboard gillnet fishery	NMFDC, ICAR-CMFRI
Management units	11 management units (SFDs) pertaining to territorial waters of each maritime state of India and 1 management unit pertaining to rest of the areas in Indian EEZ	MFRA of each maritime state of India http://164.100.150.120/mpeda/state_mfras.php# DADF http://dahd.nic.in/about-us/divisions/fisheries
Products in trade	Fresh and dried whole fish, fins, meat, skin, cartilage, liver oil, jaws	Marine Products Export Development Authority (MPEDA) http://www.mpeda.com/HOMEPAGE.asp Statistics of Marine Products Seafood Export Association of India (SEAI) http://seai.in
Part 3: Data and data sharing		
Reported national catch(es)	All-India average landing 653 t (2007-2015) 1103 t in 2007 627 t in 2015*	NMFDC, ICAR – CMFRI *National marine landings estimated by CMFRI not included in FAO statistics
Are catch and/ or trade data available from other countries fishing this stock?	No	-
Reported catches by other countries	NA	-
Catch trends and values	Decreasing trend continuously from a peak of 1103 t in 2007. Price of whole fish in domestic markets approximately `300 per kg (~ US$ 5)	NMFDC, ICAR-CMFRI

Have RFBs and/ or other countries fishing this stock been consulted during or contributed data during this process?	NA	-

Step 2		
Question 2.1 **What is the level of intrinsic biological vulnerability of the species?** *In the worksheet below, circle the level of vulnerability associated with each intrinsic biological factor.*		
Intrinsic biological factors	**Level of vulnerability**	**Indicator/Merit**
a) Median age at maturity	(Low)	3-4 years (Taiwan waters, Chen et al. 1990)
	Medium	
	High	
	Unknown	
b Median size at maturity	Low	
	(Medium)	140-165 cm TL (IOTC 2007)
	High	
	Unknown	
c) Maximum age/longevity in an unfished population	Low	
	Medium	
	(High)	41.6 years (Froese and Pauly 2016)
	Unknown	
d) Maximum size	Low	
	Medium	
	(High)	385 cm TL 180 kg (Maharashtra, unpublished data ICAR-CMFRI) 346 cm TL females (Chen et al. 1990)
	Unknown	

e) Natural mortality rate (M)	Low	
	Medium	
	(High)	0.19 (Maharashtra, unpublished data, ICAR-CMFRI) 0.14 (Froese and Pauly 2016)
	Unknown	
f) Maximum annual production (no. of pups per mature female)	(Low)	40 (Karnataka, unpublished data, ICAR-CMFRI)
	Medium	
	High	
	Unknown	
g) Intrinsic rate of population increase (r)	Low	
	Medium	
	(High)	0.103 (Dudley and Simpfendorfer 2006)
	Unknown	
h) Geographical distribution of stock	(Low)	Ocean basin (Froese and Pauly 2016)
	Medium	
	High	
	Unknown	
i) Current stock size relative to historic abundance* (landing is taken as an indicator of the stock size)	Low	
	(Medium)	Consistent decrease in landings from 2007-2015; Landings of 2015 was 43% less from peak landings of 2007 (NMFDC, ICAR - CMFRI)
	High	
	Unknown	
j) Behavioural factors	Low	
	Medium	

	High	Aggregating behavior, coastal nursery and feeding grounds which make it an easy target for fisheries (unpublished data, ICAR-CMFRI) 54 percent post-release mortality (Gallagher et al., 2014)
	Unknown	
k) Trophic level	Low	
	Medium	4.1 (Froese and Pauly 2016)
	High	
	Unknown	

SUMMARY for question 2.1
Intrinsic biological vulnerability of species

Provide an assessment of the overall intrinsic biological vulnerability of the species (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High	Medium	Low	Unknown

Explanation of conclusion and sources of information used:

High: Behavioural features, slow intrinsic rate of increase, low natural mortality, large maximum size, long life span cause the intrinsic biological vulnerability of the species to be high.

Question 2.2
What is the severity and geographic extent of the conservation concern?

Based on existing stock assessments or conservation status assessments, evaluate the severity and geographic extent/scope of conservation concern by including reasons for conclusions drawn, and information on sources used.
In the worksheet below, circle the level of severity/scope of concern associated with each factor using the descriptions and indicator columns in Table B in the Guidance.

Conservation concern factors	**Level of severity/ scope of concern (circle as appropriate)**	**Indicator/metric**
Conservation or stock assessment status	Low	
	Medium	

	High	Endangered (Baum *et al.* 2007)
	Unknown	
	Comments: Since stock assessment for this species has not been done from Indian waters, IUCN Red List category has been applied to this species.	
Population trend	Low	
	Medium	
	High	
	Unknown	No stock/population trend data
	Comments: So far there is no information on stock status on the species from Indian waters; however, available landings data indicate that there is a consistent decrease from 2007; landings in 2015 were 43% less from peak landings of 2007 (NMFDC, ICAR-CMFRI).	
Geographic extent/scope of conservation concern	Low	
	Medium	Identified threats (juvenile fishing) affect the national stock of the species.
	High	
	Unknown	
	Comments: Fishery consists of juveniles from near shore waters, especially during Aug-Sept in some states.	

SUMMARY for question 2.2
Severity and geographic extent of the conservation concern

Provide an assessment of the overall severity and geographic extent of conservation concern for this species or stock (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High	**Medium**	Low	Unknown

Explanation of conclusion and sources of information used:

Medium: Endangered status, decreasing trend in landings and identified threats (juvenile fishing) could affect national stock.

Step 3		
Question 3.1 **What is the severity of trade pressure on the stock of the species concerned?**		
Factor	**Level of severity of trade pressure (*circle as appropriate*)**	**Indicator/metric**
a) Magnitude of legal trade	(Low)	
	Medium	Though information on exact trade figures is not available, however, this species is sold/ marketed/ traded if it is landed. Market demand for this species is stable.
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g.has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) Multiple use in domestic markets. Once landed there is regular trade for this species. Demand for fins is high but is subject to national regulations.		
b) Magnitude of illegal trade	Low	
	Medium	
	High	
	(Unknown)	No information available
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) There is no information on illegal trade.		

Question 3.2 **What is the severity of fishing pressure on the stock of the species concerned?**			
Factor		**Level of severity of trade pressure (*circle as appropriate*)**	**Indicator/metric**
a) Fishing mortality (retained catch)		Low	

	(Medium)	Moderate proportion of the stock is caught as bycatch by multiple fishing gears
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium (High)	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) This species is vulnerable to multiple gears and the fishing effort shows an increasing trend over the years. This species is landed as bycatch in fishing operations.		
b) Discard mortality	(Low)	There is no discard of the species if caught. The species is either consumed or traded. This species has a post-release survival of 46% (Gallagher *et al*. 2014).
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium (High)	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) All scalloped hammerheads that are caught are retained for consumption or trade. There is no discard of this species.		
c) Size/sex/age/selectivity	Low	
	(Medium)	Though this species is not targeted, the presence of large number of sub-adults in the fishing grounds, particularly in the nearshore waters, makes it susceptible to capture by various fishing gears.

	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

Mean size of landings of this species is in the 70-80 cm TL size class which are sub-adults. Since it is known that juvenile scalloped hammerhead sharks are nearshore in distribution they are particularly vulnerable to being fished by gears operating in nearshore waters.

d) Magnitude of illegal, unreported and unregulated (IUU) fishing	Low	
	Medium	
	High	
	Unknown	No information
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There is no information on IUU fishing of this species.

Step 4		
Preliminary Stage **Compile information on existing management measures**		
Existing management measures (see Annex 5 for examples)	**Is the measure generic or species-specific?**	**Description/comments/sources of information**
(SUB-NATIONAL)		
Fins-attached policy	Generic	In August 2013, the Ministry of Environment and Forests (Wildlife Division) approved a policy advisory by ICAR-CMFRI 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 advocating landing of the whole shark

Ban on shark fin export – Dept of Commerce of Ministry of Commerce and Industry	Generic	The Union Ministry of Commerce and Industry prohibited the export of fins of all species of shark, by way of a notification on February 6 2015 (Notification No. 110 (RE-2013)/2009-2014) inserting a new entry in 'Chapter 3 of Schedule 2 of ITC (HS) Classification of Export and Import Items.' The new entry (31 A) resulted in the ban on export of all shark fins.
Seasonal ban on mechanized fishing	Generic	Closure of mechanized fishing activities for 61 days from 15th April to 14th June along east coast and 1st June to 31st July along west coast (both days inclusive), implemented through State MFRAs.
No take zones	Generic	There are 33 Marine Protected Areas where fishing activities are regulated (Sivakumar, 2013).
Gear-specific regulations	Generic	Regulation of mesh size, restrictions on operation of certain gears like ring seines, purse seines and pair trawling, implemented through State MFRAs. http://indianfisheries.icsf.net/en/page/827-Indian%20Legal%20Instruments.html http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112187832409***Gujarat_Marine_Fisheries_Rules_2003.PDF http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112240177836***Maharashtra_Marine_Fishing_Regulation_Rules,_1982.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_goa.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_karnataka_1987.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_kerala.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_tamil_nadu.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1165227972133***Andra_Pradesh_Marine_Fishing_Regulation_Rules_1995_Amendment_dated_26th_October_2004.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_orrissa.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112241236819***West_bengal_Marine_Fishing_Regulation_(Amendment)_Rules,_1998.PDF
REGIONAL/INTERNATIONAL		

CITES	Species-specific	Inclusion of the species in CITES Appendix II w.e.f. September 2014 http://www.cites.org/eng/app/appendices.php
IOTC	Species-specific	Catch and effort has to be recorded http://www.iotc.org/
IUCN	Species-specific	Listed as Endangered http://www.iucn.org/
CMS	Species-specific	Scalloped hammerhead is a member of the family Sphyrnidae, which is listed in Appendix II of CMS. http://www.cms.int/
BOBLME	Generic	Evolve a common strategy to optimize the use of marine resources on a sustainable basis in the Bay of Bengal region http://www.boblme.org/
UNCLOS	Species-specific	Listed under Annex I (Highly Migratory Species) of the United Nations Convention on the Law of the Sea http://www.unclos.com/

Question 4.1(a)
Are existing management measures appropriately designed and implemented to mitigate the pressures affecting the stock/population of the species concerned?

Factor	Existing management measure(s)	Relevant monitoring, control and surveillance (MCS) measure(s)	Overall assessment of compliance regime (tick as appropriate)
TRADE PRESSURE			
(a) Magnitude of legal trade	Closed season	State Department Officials through MFRA s	Unknown (no information on compliance)
	Fins-attached policy	Wildlife Dept, SFDs	Poor (limited relevant compliance measures in place)
	Total ban on shark fin exports	Wildlife Dept, State Bodies, MPEDA, Customs& Central Excise, Indian Coast Guard	Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Management measures are all known to be implemented and complied with.		

b) Magnitude of illegal trade			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no information on illegal trade.		
Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MCS) measure(s)**	**Overall assessment of compliance regime (tick as appropriate)**
FISHING PRESSURE			
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	State Department Officials through MFRA s	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) These management measures are all complied with but are not specific for this species.		

(b) Discard mortality			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) All scalloped hammerheads that are caught are retained for consumption/ trade. There is no discard of this species.		
(c) Size/age/ sex selectivity			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Management measures regarding size limits are lacking.		

(d) Magnitude of IUU fishing	Marine patrolling	Monitoring and surveillance by Enforcement wing of SFDs, State Forest Dept., Indian Coast Guard & Coastal Police	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no report of IUU fishing for this species.		

Question4.1(b) **Are existing management measures effective (or likely to be effective) in mitigating the pressures affecting the stock/population of the species concerned?**				
Factor	**Existing management measure(s)**	**Are relevant data collected and analysed to inform management decisions? (e.g. landings, effort, fisheries independent data)** *Tick as appropriate*		**Is management consistent with expert advice?** *Tick as appropriate*
TRADE PRESSURE				
(a) Magnitude of legal trade	Closed season Fins-attached policy Total ban on shark fin export	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified
		Limited relevant data are collected AND analysed to inform management		Not consistent

		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s) effective/likely to be effective? *(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) All management measures are being complied with.				
(b) Magnitude of illegal trade	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective? *(circle as appropriate)* Yes Partially No **Insufficient information**				

	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better informand evaluate management decisions? How is management inconsistent with expert advice?) There is no information on illegal trade.				
FISHING PRESSURE					
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s) effective/likely to be effective? *(circle as appropriate)* **Yes** (circled) Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Data is consistently collected and analyzed by the experts. All fish caught is retained for consumption or trade.				
(b) Discard mortality	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓

		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective? *(circle as appropriate)* Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Discard of this species is not known. All individuals caught are landed and traded.				
(c) Size/age/ sex selectivity		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	

	Management measure(s) effective/likely to be effective? *(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) No measures in place to manage fishing of juvenile scalloped hammerheads in India. Comprehensive data is being collected by CMFRI. Elucidation of stock status needs to be done evolve suitable management measures. Size data collected by experts. Smallest size recorded in the fishery was 41.6 cm TL and largest was 475 cm TL. Majority of the landed specimens fell in the 60-80 cm TL range.				
(d) Magnitude of IUU fishing	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/ likely to be effective? *(circle as appropriate)* Yes Partially No **Insufficient information**				

	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on IUU of this species in Indian waters

Step 5			
Question 5.1 **Based on the outcomes of the previous steps, is it possible to make a positive NDF (with or without associated conditions or is a negative NDF required?**			
Step 2: Intrinsic biological vulnerability and conservation concern			
Intrinsic biological vulnerability (Question 2.1) Conservation concern (Question 2.2)			High Medium Low Unknown High Medium Low (Unknown)
Step 3: Pressure on species			**Step 4: Existing management measures**
Pressure	Level of severity (Questions 3.1 and 3.2)	Level of confidence (Questions 3.1 and 3.2)	Are the management measures effective* at addressing the concerns/ pressures/impacts identified? (Question 4.1(b)) **taking into account the evaluation of management appropriateness and implementation under Question 4.1(a)*
TRADE PRESSURE			
a) Magnitude of legal trade	High (Medium) Low Unknown	(High) Medium Low	(Yes) Partially No Insufficient information Not applicable**

b) Magnitude of illegal trade	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.			
a) Fishing mortality (retained catch)	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
b) Discard mortality	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
c) Size/ age /sex selectivity	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**

d) Magnitude of IUU fishing	High Medium Low (Unknown)	High (Medium) Low	Yes Partially No (Insufficient information) Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any ofthe Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.

A) Can a positive NDF be made?	**YES** - *go to B*	**NO-***go to* ***Step 6*** *and list recommendations for measures to improve monitoring/ management under Reasoning/comments below*
B) Are there any mandatory conditions to the positive NDF?	**YES** - *list under Reasoning/ comments below and go to C*	**NO-** *go to C*
C) Are there any other further recommendations? *(e.g. for improvements to monitoring /management)*	**YES** - *go to* ***Step 6*** *and list recommendations for measures to improve monitoring/management under Reasoning/comments below*	**NO**

Reasoning/comments *(include justification for decision made and information on mandatory conditions and/or further recommendations)*

Management measures must be evolved and implemented to minimize fishing of juvenile smooth hammerheads in India. Participatory management by fishermen must be ensured.

Step 6: Further measures

Section 6.1
Improvements in monitoring or information required

1. **Population monitoring (fishery independent)**

- Tag and release
- Abundance (survey data/collaboration)
- Identifying area & season breeding and nursery aggregations of the species

2. **Population monitoring (fishery dependent)**

- Fishery monitoring – species-specific landing observation, vessel monitoring systems, interviews, databases, logbooks
- Improved surveillance to check for IUU fishing
- Sharing of log data – species, catch, date & area of capture (geolocation) and gear
- Identifying area & season breeding and nursery aggregations of the species
- Biology and stock assessment studies (sex ratios, size/age structure, annual reproductive output, BRPs, fishing effort, BRPs)

3. **Monitoring of domestic and international trade**

- Improve the level of trade data reporting – data declaration by traders (species, source of obtaining the product, size of fish (length & weight), quantity, product form)
- Market survey, interviews with fishermen & traders, information from Customs & other databases, trade channels
- Species-specific product-specific code for trade
- Genetic analysis for ambiguous products

Section 6.2
Improvement of management required

1. **Improvement in management measures**

- Strict implementation of MFRAs regarding gear, mesh size, operation in no-take zones and closed seasons
- Strengthen Monitoring, Control and Surveillance (MCS)
- Improve participatory management through regional fishery management councils
- Create awareness through visual, print and electronic media and mass campaigns
- Seasonal closure of fishing in identified breeding/nursery grounds

References

Appukuttan, K.K. and Nair, K.P. 1988. Shark resources of India, with notes on biology of a few species. The First Indian Fisheries Forum. Proceedings. pp. 173-184.

Baum, J., Clarke, S., Domingo, A., Ducrocq, M., Lamónaca, A.F., Gaibor, N., Graham, R.,Jorgensen, S., Kotas, J.E., Medina, E., Martinez-Ortiz, J., MonziniTaccone di Sitizano, J.,Morales, M.R., Navarro, S.S., Pérez-Jiménez, J.C., Ruiz, C., Smith, W., Valenti, S.V. andVooren, C.M. 2007. *Sphyrna lewini*.The IUCN Red List of Threatened Species.Version 2014.2.<www.iucnredlist.org>. Downloaded on 15 July 2016.)

CMS 2016. Convention on Migratory Species, http://www.cms.int/.

Chen C.T., Leu T.C., Joung S.J. and Lo N.C.H. 1990. Age and growth of the scalloped hammerhead, *Sphyrna lewini*, in northeastern Taiwan waters. Pacific Science, 44,156–70.

Dudley, S. and Simpfendorfer, C. 2006. Population status of 14 shark species caught in the protective gillnets off KwaZulu-Natal beaches, South Africa, 1978-2003. Marine and Freshwater Research 57: 225-240.

Duncan, K. M., Martin, A. P., Bowen, B. W and Couet, H. G. 2006.Global phylogeography of the scalloped hammerhead shark (*Sphyrna lewini*). Molecular Ecology 15: 2239-2251.

Fischer, W. and Bianchi, G. 1984. FAO Species identification sheets for fishery purposes – Western Indian Ocean Fishing Area 51-Volume V, FAO, Rome

Froese, R. and D. Pauly, (Eds.) 2016. FishBase. World Wide Web electronic publication. www.fishbase.org, Version (10/2016).

Gallagher, A.J., Orbesen, E.S., Hammerschlag, N. and Serafy, J.E. 2014. Vulnerability of oceanic sharks as pelagic longline bycatch. Global Ecology and Conservation 1, 50-59

IOTC 2007. Compilation of information on blue shark (*Prionace glauca*), silky shark (*Carcharhinus falciformis*), oceanic whitetip shark (*Carcharhinus longimanus*), scalloped hammerhead (*Sphyrna lewini*) and shortfin mako (*Isurus oxyrinchus*) in the Indian Ocean. Working paper. file:///C:/Users/Admin/Downloads/IOTC-2007-WPEB-INF01.pdf

Marshall, L. J. and Barone, M., 2016. Food and Agriculture Organization of the United Nations (FAO) Sharkfin Guide: Identifying Sharks from their Fins, Page No.73.

Miller M.H., Carlson, J., Cooper, P., Kobayashi, D., Namack, M. and Wilson, J. 2013. Status Review Report: Scalloped Hammerhead Shark (*Sphyrna lewini*). National Marine Fisheries Service, National Oceanic and Atmospheric Admnistration, 125p

Raje, S.G., S. Sivakami, G. Mohanraj, P.P. Manojkumar, A. Raju and K.K. Joshi. 2007. An Atlas on the elasmobranch fishery resources of India. CMFRI Spl. Publ. No.95.253 pp.

Sivakumar, K. 2013. Coastal and Marine Biodiversity Protected Areas in India: Challengesand Way Forward, K. Venkataraman et al. (eds.), Ecology and Conservation of TropicalMarine Faunal Communities, Springer-Verlag Berlin Heidelberg.

Sphyrna zygaena (Linnaeus 1758)

Step 1			
Question 1.1 (a) Is the specimen subject to CITES control? (How did you identify the species?)			
Species Name	**Product form**	**CITES Appendix**	**Source of identification**
Sphyrna zygaena	Whole fish/fins	II	The specimen was identified to the species level by an expert of CMFRI at the point of landing. (Fischer and Bianchi 1984, Sharkfin identification guides)
In the view of the above, is the specimen subjected to CITES control?	YES	II	Condition (c) is met, as mentioned above.
Concerns and uncertainties	Fillets and cartilage cannot be identified to the species level at the point of trade.		
Question 1.1 (b) From which stock will the specimen be taken/was the specimen taken? (Can the origin and stock be confidently identified?)			
	Description/Comments	**Sources of information**	
Ocean basin	Worldwide warm temperate and tropical oceans. Arabian Sea and Bay of Bengal including Andaman and Laccadives islands of India	Ebert et al., 2013 Jones and Kumaran, 1980 Appukuttan & Nair, 1988; Raje et al., 2007	
Stock location/distribution/ boundaries (Attach a map)	Coastal pelagic semi oceanic, 0-200 m depths. In shore and offshore, common in depths below 20 m. Indian EEZ	Raje et al., 2007 Sajeevan and Sanadi, 2012; Ebert et al., 2013; Jabado and Ebert, 2015; Froese & Pauly, 2016 NMFDC, ICAR- CMFRI	
Is this a shared stock (i.e. occurring in more than one EEZ and/or the high seas?)	Not certain, probably yes (based on distribution in world). No tagging studies in Indian waters	Casper et al., 2005; Bester 2008	

If the stock occurs in more than one EEZ which other parties share this stock?	Unknown, studies needed (population genetics, stock structure)	Casper et al., 2005
If a high seas stock which other parties fish this stock?	Not known	-
Which, if any, RFB(s) cover(s) the range of this stock?	None	-
Are all parties listed above (which fish or share the stock concerned) members of the relevant RFB(s)?	NA	-
Are there geographical management gaps?	Not certain	-
How reliable is the information on origin?	Reliable	Conditions **a** AND **c** have been met (the origin of the specimen has been identified to a sufficient level, and the origin of the specimen has been confirmed by an expert from CMFRI at the point of landing)
Is the information on origin sufficiently detailed for Question 1.2 to be answered?		Yes

Question 1.2 **Was (will) the specimen (be) legally obtained and is export allowed?**		
Is the species:	**Description/Comments**	**Sources of information**
Protected under wildlife legislation, regional biodiversity Agreement, or (for a CMS Party) listed in CMS Appendix 1?	No	-
Sourced from illegal fishing activities (e.g. in contravention of finning regulations, or where a TAC is zero or exceeded)?	No	-

Taken from a no-take marine protected area or during a closed season?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Taken in contravention of RFB recommendations, if any?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Listed as species whose export is prohibited?	Yes, for fin export	Notification No. 110/(RE-2013)2009-2014 dated 6 February 2015
Of concern for any other reason?	No	-
In view of the above and the final section of the Worksheet for Question 1.1(b), was the specimen legally acquired and can exports be permitted?		Yes; subject to conditions laid down by national regulations
Concerns and uncertainties:		Stock status and species-specific trade data not available

Question 1.3
What does the available management information tell us?

Part 1. Global-level information

	Description/Comments	**Sources of information**
Reported global catch	176 tonnes (possibly excluding catch data some regions)	FAO Fishstat 2010-14
Species distribution	Wide distribution, Circumglobal in warm temperate oceans	Casper et al., 2005
Known stocks/ populations	No studies from Indian region Possibly single stock, limited	
Main catching countries	India, Oman, Pakistan, Australia, USA, Brazil, Portugal, USA, Ecuador Spain, Taiwan and Philippines, Liberia, New Zealand, Korea, Japan	FAO fishstat, Casper et al., 2005, NMFDC, ICAR- CMFRI (unpub. data)
Main gear types by which the species is taken	Long liners, gillnet and hook and lines, trawls	Raje et al., 2007

Global conservation status	Vulnerable	Casper et al., 2005
Multilateral Environmental Agreements	CITES Appendix II	CITES Appendix II
Part 2: Stock/context-specific information		
Stock assessments	Limited information	Manjusha et al., 2011
Main management bodies	State Fisheries Departments (SFDs), Ministry of Agriculture, Cooperation & Farmers Welfare (MoA), Ministry of Environment, Forests and Climate Change (MoEF&CC), National Biodiversity Board (NBB)	https://cof.gujarat.gov.in/contact-us.htm https://fisheries.maharashtra.gov.in/ http://fisheries.goa.gov.in/ http://www.karnataka.gov.in/fisheries/Pages/Home.aspx http://www.fisheries.kerala.gov.in/ http://www.fisheries.tn.gov.in/ https://www.py.gov.in/knowpuducherry/dept_fisheries.html http://apfisheries.gov.in/ http://www.odishafisheries.com/ http://www.wbfisheries.gov.in/wbfisheries/do/Forwordlink?val=32 http://agricoop.nic.in/# http://www.moef.nic.in/ http://nbaindia.org/
Cooperative management arrangements	Participatory management with Association of Deep Sea Going Artisanal Fishermen (ADSGAF), Thuthoor – National Mission on Conservation of Sharks - India (NMCSI)	http://deepseafishersindia.org/
Non-membership of RFBs	NA	-
Nature of harvest	Landed as bycatch	NMFDC, ICAR-CMFRI

Fishery types	Traditional, Small scale to commercial, caught in variety of gears. Multiday/single day trawl, mechanized/non mechanized hook	NMFDC, ICAR-CMFRI
Management units	11 management units (SFDs) pertaining to territorial waters of each maritime state of India and 1 management unit pertaining to rest of the areas in Indian EEZ	MFRA of each maritime state of India http://164.100.150.120/mpeda/state_mfras.php# DADF http://dahd.nic.in/about-us/divisions/fisheries
Products in trade	Fresh and dried whole fish, fins, meat, skin, cartilage, liver oil, jaws	Marine Products Export Development Authority (MPEDA) http://www.mpeda.com/HOMEPAGE.asp Statistics of Marine Products Seafood Export Association of India (SEAI) http://seai.in
Part 3: Data and data sharing		
Reported national catch(es)	705 tonnes in 2003	Raje et al. 2007 NMFDC, ICAR – CMFRI *National marine landings estimated by CMFRI not included in FAO statistics
Are catch and/ or trade data available from other countries fishing this stock?	No	-
Reported catches by other countries	NA	-
Catch trends and values	Decreasing trend	NMFDC, ICAR-CMFRI
Have RFBs and/ or other countries fishing this stock been consulted during or contributed data during this process?	NA	-

Step 2		
Question 2.1 **What is the level of intrinsic biological vulnerability of the species?** *In the worksheet below, circle the level of vulnerability associated with each intrinsic biological factor.*		
Intrinsic biological factors	**Level of vulnerability**	**Indicator/Merit**
a) Median age at maturity	Low	
	(Medium)	6-8.8 year, 15 years in Atlantic Ocean (Coelho et al. 2011)
	High	
	Unknown	
b) Median size at maturity	Low	
	Medium	
	(High)	>200 cm TL, males mature at about 250-260 cm TL and females at about 265 cm TL (Stevens,1984) 220 cm FL Atlantic and Australia (Castro & Mejuto 1995, Last and Stevens 2009) Arabian Seas 210-270 females, 210-250 m (Jabado & Ebert, 2015)
	Unknown	
c) Maximum age/ longevity in an unfished population	Low	
	(Medium)	18-21 years (Co P16.43, Coelho et al., 2011)
	High	
	Unknown	
d) Maximum size	Low	
	Medium	
	(High)	362 TL Cochin (Manjusha et al., 2011), 370-400 cm TL (Appukuttan and Nair 1988; Last and Stevens 2009; Jabado & Ebert, 2015), 500 cm TL (Froese & Pauly, 2016), 386 (Nair and James,1972)
	Unknown	

e)	Natural mortality rate (M)	Low	
		Medium	
		High	0.1-.06 (Froese & Pauly, 2016), 1.39 (Manjusha et al., 2011)
		Unknown	
f)	Maximum annual production (no. of pups per mature female)	Low	30-40 (Muus and Nielsen, 1999) 29-37 (Appukuttan and Nair 1988; Raje et al., 2002) 20-49 pups (Stevens, 1984)
		Medium	
		High	
		Unknown	
g)	Intrinsic rate of population increase (r)	Low	
		Medium	2.5/3 (Oldfield et al., 2012)
		High	
		Unknown	
h)	Geographical distribution of stock	Low	
		Medium	Circumglobal (Ebert et al., 2013) Common in 0-20 m, coastal waters
		High	
		Unknown	
i)	Current stock size relative to historic abundance *(landing is taken as an indicator of the stock size)	Low	
		Medium	
		High	
		Unknown	Possibly declined (NMFDC, ICAR-CMFRI)
j)	Behavioural factors	Low	
		Medium	
		High	Sex, age wise segregating behavior, grounds not known, frequent juvenile captures from coastal waters.
		Unknown	

k) Trophic level	Low	
	Medium	
	High	4.5-4.9 (Froese & Pauly, 2016)
	Unknown	

SUMMARY for question 2.1
Intrinsic biological vulnerability of species

Provide an assessment of the overall intrinsic biological vulnerability of the species (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High	**Medium**✓	Low	Unknown

Explanation of conclusion and sources of information used:

Medium: Species is data limited in the region. However, with the behavioral, physiological features, low natural mortality, low fecundity, late maturity. IUCN classified as Vulnerable (Casper et al., 2005), which is also used for considering as Medium vulnerable in India.

In 2000-2002, *S. zygaena* formed 0.36 % sharks landed (157) at Cochin (Joshi et al., 2008).

In 2001-2011, S. *zygaena* formed 16.7% of the sharks landed in the Malabar region (Manojkumar et al., 2012).

Juveniles are observed in the landings, suggesting aggregating habit and exploitation of juvenile grounds.

Question 2.2
What is the severity and geographic extent of the conservation concern?

Based on existing stock assessments or conservation status assessments, evaluate the severity and geographic extent/scope of conservation concern by including reasons for conclusions drawn, and information on sources used.
In the worksheet below, circle the level of severity/scope of concern associated with each factor using the descriptions and indicator columns in Table B in the Guidance.

Conservation concern factors	**Level of severity/scope of concern (circle as appropriate)**	**Indicator/metric**
Conservation or stock assessment status	Low	
	Medium	
	High	Vulnerable (Casper et al. 2005)
	Unknown	
	Comments: Studies are limited from India to assess the conservation status, in the single study from Kerala, overexploitation has been observed (Manjusha et al., 2011), vulnerable in IUCN assessment (Casper et al., 2005).	

Population trend	Low	
	Medium	
	High	
	Unknown	No stock/population trend data
	Comments: There is no population /stock trend data or a dedicated assessment for the species from country. However, landings have declined from 205 tonnes in 2013 to 99 tonnes in 2015 (NMFDC- CMFRI). The possibility of stock overexploitation along the Kerala coast has been suggested (Manjusha et al., 2011), but this needs to be confirmed	
Geographic extent/scope of conservation concern	Low	
	Medium	
	High	
	Unknown	Insufficient data to evaluate the species
	Comments: National status assessment is not available, data deficient species. Juveniles catch a concern in coastal fishery.	

SUMMARY for question 2.2
Severity and geographic extent of the conservation concern
Provide an assessment of the overall severity and geographic extent of conservation concern for this species or stock (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High	**Medium**✓	Low	Unknown

Explanation of conclusion and sources of information used:

Medium: Endangered species in Indian waters, decreasing catch trend, juvenile catch affects the stock. However, it's not a common species in the fishery and there is no targeted fishery for this species. In India, the maximum recorded fishery is from the Malabar region where Manoj Kumar *et al.*, 2012, reported 16.75% of the fishery was contributed by *S. zygaena.*

Step 3		
Question 3.1 **What is the severity of trade pressure on the stock of the species concerned?**		
Factor	**Level of severity of trade pressure (*circle as appropriate*)**	**Indicator/metric**
a) Magnitude of legal trade	Low	
	(Medium)	Though information on exact trade figures is not available, however, this species is sold/ marketed/ traded if it is landed. Market demand for this species is stable.
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) Multiple use in domestic markets. Once landed there is regular trade for this species. Demand for fins is high but is subject to national regulations.Meat is utilized as fresh, frozen, dried and salted for consumption. Liver oil, offal, hide, cartilage etc. have various applications in domestic market. Most of the time the traded fins are combined with look-alike congener fins; this may affect quantification species wise.		
b) Magnitude of illegal trade	Low	
	Medium	
	High	
	(Unknown)	No information available
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) There is no information on illegal trade.		

Question 3.2 What is the severity of fishing pressure on the stock of the species concerned?		
Factor	**Level of severity of trade pressure (*circle as appropriate*)**	**Indicator/metric**
a) Fishing mortality (retained catch)	(Low)	
	Medium	Moderate proportion of the stock is caught as bycatch by multiple fishing gears
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium (High)	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) This species is vulnerable to multiple gears and the fishing effort shows an increasing trend over the years. This species is landed as bycatch in fishing operations.		
b) Discard mortality	(Low)	There is no discard of the species if caught. The species is either consumed or traded. This species has a post-release survival of 46% (Gallagher et al. 2014).
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium (High)	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) All smooth hammerheads that are caught are retained for consumption or trade. There is no discard of this species.		

c) Size/sex/age/selectivity	(Low)	Though the species is not targeted, the occurrence of sub adults/juveniles in the coastal fishing grounds, it is susceptible to capture by various fishing gears. However, the numbers reported in the landings are very meagre.
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium (High)	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) There is no targeted fishery for this species and the contribution of this species to the fishery is very meagre.		
d) Magnitude of illegal, unreported and unregulated (IUU) fishing	Low	
	Medium	
	High	
	(Unknown)	No information
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) There is no information on IUU fishing of this species.		

Step 4		
Preliminary Stage **Compile information on existing management measures**		
Existing management measures (see Annex 5 for examples)	**Is the measure generic or species-specific?**	**Description/comments/sources of information**
(SUB-NATIONAL)		
Fins-attached policy	Generic	In August 2013, the Ministry of Environment and Forests (Wildlife Division) approved a policy advisory by ICAR-CMFRI 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 advocating landing of the whole shark
Ban on shark fin export – Dept of Commerce of Ministry of Commerce and Industry	Generic	The Union Ministry of Commerce and Industry prohibited the export of fins of all species of shark, by way of a notification on February 6 2015 (Notification No. 110 (RE-2013)/2009-2014) inserting a new entry in 'Chapter 3 of Schedule 2 of ITC (HS) Classification of Export and Import Items.' The new entry (31 A) resulted in the ban on export of all shark fins.
Seasonal ban on mechanized fishing	Generic	Closure of mechanized fishing activities for 61 days from 15th April to 14th June along east coast and 1st June to 31st July along west coast (both days inclusive), implemented through State MFRAs.
No take zones	Generic	There are 33 Marine Protected Areas where fishing activities are regulated (Sivakumar, 2013).

Gear-specific regulations	Generic	Regulation of mesh size, restrictions on operation of certain gears like ring seines, purse seines and pair trawling, implemented through State MFRAs. http://indianfisheries.icsf.net/en/page/827-Indian%20Legal%20Instruments.html http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112187832409***Gujarat_Marine_Fisheries_Rules_2003.PDF http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112240177836***Maharashtra_Marine_Fishing_Regulation_Rules,_1982.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_goa.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_karnataka_1987.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_kerala.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_tamil_nadu.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1165227972133***Andra_Pradesh_Marine_Fishing_Regulation_Rules_1995_Amendment_dated_26th_October_2004.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_orrissa.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112241236819***West_bengal_Marine_Fishing_Regulation_(Amendment)_Rules,_1998.PDF
REGIONAL/INTERNATIONAL		
CITES	Species-specific	Inclusion of the species in CITES Appendix II w.e.f. September 2014 http://www.cites.org/eng/app/appendices.php
IOTC	Species-specific	Catch and effort has to be recorded http://www.iotc.org/

IUCN	Species-specific	Listed as Endangered (IUCN, 2015) http://www.iucn.org/
CMS	Species-specific	Scalloped hammerhead is a member of the family Sphyrnidae, which is listed in Appendix II of CMS. http://www.cms.int/
BOBLME	Generic	Evolve a common strategy to optimize the use of marine resources on a sustainable basis in the Bay of Bengal region http://www.boblme.org/
UNCLOS	Species-specific	Listed under Annex I (Highly Migratory Species) of the United Nations Convention on the Law of the Sea http://www.unclos.com/

Question 4.1(a)

Are existing management measures appropriately designed and implemented to mitigate the pressures affecting the stock/population of the species concerned?

Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MCS) measure(s)**	**Overall assessment of compliance regime (tick as appropriate)**
TRADE PRESSURE			
(a) Magnitude of legal trade	Closed season	State Department Officials through MFRA s	Unknown (no information on compliance)
	Fins-attached policy	Wildlife Dept, SFDs	Poor (limited relevant compliance measures in place)
	Total ban on shark fin exports	Wildlife Dept, State Bodies, MPEDA, Customs& Central Excise, Indian Coast Guard	Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Management measures are all known to be implemented and complied with.		

b) Magnitude of illegal trade			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no information on illegal trade.		
Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MCS) measure(s)**	**Overall assessment of compliance regime (tick as appropriate)**
FISHING PRESSURE			
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	State Department Officials through MFRA s	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) These management measures are all complied with but are not specific for this species.		

(b) Discard mortality			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) All great hammerheads that are caught are retained for consumption/ trade. There is no discard of this species.		
(c) Size/age/ sex selectivity			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Management measures regarding size limits are lacking.		

(d) Magnitude of IUU fishing	Marine patrolling	Monitoring and surveillance by Enforcement wing of SFDs, State Forest Dept., Indian Coast Guard&Coastal Police	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no report of IUU fishing for this species.		

Question4.1(b)
Are existing management measures effective (or likely to be effective) in mitigating the pressures affecting the stock/population of the species concerned?

Factor	**Existing management measure(s)**	**Are relevant data collected and analysed to inform management decisions?(e.g. landings, effort, fisheries independent data)** *Tick as appropriate*		**Is management consistent with expert advice?** *Tick as appropriate*	
TRADE PRESSURE					
(a) Magnitude of legal trade	Closed season Fins-attached policy Total ban on shark fin export	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	

		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Managemen tmeasure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g.Is effectiveness compromised by poor design and/ or implementation, or is a greater diversity or amount of management required?What data ar erequired to betteri nform and evaluate management decisions? How is management in consistent with expert advice?) All management measures are being complied with.				
(b) Magnitude of illegal trade	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**				

	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How ismanagement inconsistent with expertadvice?) There is no information on illegal trade.				
FISHING PRESSURE					
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s)effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Data is consistently collected and analyzed by the experts. All fish caught is retained for consumption or trade.				
(b) Discard mortality	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓

		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s)effective/likely to be effective?*(circle as appropriate)* Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Discard of this species is not known. All individuals caught are landed and traded.				
(c) Size/age/ sex selectivity		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	

	Management measure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) No measures in place to manage fishing of juvenile great hammerheads in India. Comprehensive data is being collected by CMFRI. Elucidation of stock status needs to be done evolve suitable management measures.				
(d) Magnitude of IUU fishing	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s)effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on IUU of this species in Indian waters				

Step 5			
Question 5.1 **Based on the outcomes of the previous steps, is it possible to make a positive NDF (with or without associated conditions or is a negative NDF required?**			
Step 2: Intrinsic biological vulnerability and conservation concern			
Intrinsic biological vulnerability (Question 2.1)			(High) Medium Low Unknown
Conservation concern (Question 2.2)			High (Medium) Low Unknown
Step 3: Pressure on species			**Step 4: Existing management measures**
Pressure	Level of severity (Questions 3.1 and 3.2)	Level of confidence (Questions 3.1 and 3.2)	Are the management measures effective* at addressing the concerns/pressures/impacts identified? (Question 4.1(b)) **taking into account the evaluation of management appropriateness and implementation under Question 4.1(a)*
TRADE PRESSURE			
a) Magnitude of legal trade	High (Medium) Low Unknown	(High) Medium Low	(Yes) Partially No Insufficient information Not applicable**
b) Magnitude of illegal trade	High Medium Low (Unknown)	High (Medium) Low	Yes Partially No (Insufficient information) Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.			
a) Fishing mortality (retained catch)	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
b) Discard mortality	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
c) Size/age / sex selectivity	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
d) Magnitude of IUU fishing	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any ofthe Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.		
A) Can a positive NDF be made?	YES - *go to B*	**NO-***go to **Step 6** and list recommendations for measures to improve monitoring/ management under Reasoning/comments below*
B) Are there any mandatory conditions to thepositive NDF?	YES - *list under Reasoning/comments below and go to C*	**NO-** *go to C*
C) Are there any other further recommendations? *(e.g.for improvements to monitoring/management)*	YES - *go to **Step 6** and list recommendations for measures to improve monitoring/management under Reasoning/ comments below*	**NO**
Reasoning/comments *(include justification for decision made and information on mandatory conditions and/or further recommendations)* Management measures must be evolved and implemented to minimize fishing of juvenile smooth hammerheads in India. Participatory management by fishermen must be ensured.		

Step 6: Further measures

Section 6.1
Improvements in monitoring or information required

1. **Population monitoring (fishery independent)**
- Tag and release
- Abundance (survey data/collaboration)
- Identifying area & season breeding and nursery aggregations of the species

2. **Population monitoring (fishery dependent)**
- Fishery monitoring – species-specific landing observation, vessel monitoring systems, interviews, databases, logbooks
- Improved surveillance to check for IUU fishing
- Sharing of log data – species, catch, date & area of capture (geolocation) and gear
- Identifying area & season of breeding and nursery aggregations of the species
- Biology and stock assessment studies (sex ratios, size/age structure, annual reproductive output, BRPs, fishing effort, BRPs)

3. **Monitoring of domestic and international trade**
- Improve the level of trade data reporting – data declaration by traders (species, source of obtaining the product, size of fish (length & weight), quantity, product form)
- Market survey, interviews with fishermen & traders, information from Customs & other databases, trade channels
- Species-specific product-specific code for trade
- Genetic analysis for ambiguous products

Section 6.2
Improvement of management required

1. **Improvement in management measures**
- Strict implementation of MFRAs regarding gear, mesh size, operation in no-take zones and closed seasons
- Strengthen Monitoring, Control and Surveillance (MCS)
- Improve participatory management through regional fishery management councils
- Create awareness through visual, print and electronic media and mass campaigns
- Seasonal closure of fishing in identified breeding/nursery grounds

References

Appukuttan, K.K. and Nair, K.P. 1988. Shark resources of India, with notes on biology of a few species. The First Indian Fisheries Forum Proceedings. pp. 173-184.

Bester, C. 2008. Smooth hammerhead, *Sphyrna zygaena*. In: Florida Museum of Natural History 2011. Biological Profiles. http://www.flmnh.ufl.edu/fish/discover/species-profiles/sphyrna-zygaena Accessed on 30 July 2016

Casper, B.M., Domingo, A., Gaibor, N., Heupel, M.R., Kotas, J.E., Lamónaca, A.F., Pérez-Jimenez, J.C., Simpfendorfer, C.A., Smith, W.D., Stevens, J.D., Soldo, A. and Vooren, C.M. 2005. *Sphyrna zygaena*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. www.iucnredlist.org

Castro, J.A. and Mejuto, J. 1995. Reproductive Parameters of Blue Shark, Prionace glauca, and other Sharks in the Gulf of Guinea. Marine and Freshwater Research, 46(6), 967-973

Coelho, R., Carvalho, J. F., Amorim, S. and Santos, M. N. 2011. Age and growth of the smooth hammerhead shark, *Sphyrna zygaena*, in the Eastern Equatorial Atlantic Ocean, using vertebral sections. Aquat. Living Resour. 24, 351–357.

CoP16 Prop. 43 Inclusion of Scalloped Hammerhead Shark *Sphyrna lewini* Great Hammerhead Shark *Sphyrna mokarran* and Smooth Hammerhead Shark *Sphyrna zygaena* in Appendix II, Sixteenth meeting of the Conference of the Parties.

Ebert, D.A., Fowler, S. and Compagno, L.J.V. 2013. Sharks of the World – A fully illustrated guide. Wild Nature Press, ISBN 978-0-9573946-0-5: 528pp

Fischer, W. and Bianchi, G. 1984. FAO Species identification sheets for fishery purposes – Western Indian Ocean Fishing Area 51-Volume V, FAO, Rome

Froese, R. and D. Pauly. (Eds.) 2016. FishBase. World Wide Web electronic publication. www.fishbase.org, Version (10/2016).

Gallagher, A.J., Orbesen, E.S., Hammerschlag, N. and Serafy, J.E. 2014. Vulnerability of oceanic sharks as pelagic longline bycatch. Global Ecology and Conservation 1, 50-59

Jabado, R.W. and Ebert, D.A. 2015. Sharks of the Arabian Seas: an identification guide. The International Fund for Animal Welfare, Dubai, UAE. 240 pp.

Jones, S. and Kumaran, M. 1980. Fishes of the Laccadive archipelago. The Nature Conservation and Aquatic Sciences Service.

Joshi, K.K., Balachandran, K. and Raje, S.G. 2008. Changes in the shark fishery at Cochin. Journal of the Marine Biological Association of India, 50(1), 103-105.

Last, P.R. and Stevens, J.D. 2009. Sharks and Rays of Australia. CSIRO Publishing, Collingwood, Victoria.

Manjusha, S., Kurup, B.M., Saravannane, N. and Sanjeevan, V.N. 2011. Studies on population structure, mortality, growth and exploitation level of smooth hammerhead *Sphyrna zygaena* (L) (Carcharhiniformes - Sphyrnidae) in the coastal region of Kerala, International Journal of Biosciences, 1 (6), 14-26.

Manojkumar, P.P., Zacharia, P.U. and Pavithran, P.P. 2012. Fishery of elasmobranchs with some observations on the biology and stock assessment of *Carcharhinus limbatus* (P. Muller & Henle, 1839) exploited along Malabar coast. Indian Journal of Fisheries, 59(4), 35-41.

Muus, B.J. and Nielsen, J.G. 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340p.

Nair, R.V. and James, D.B. 1972. On the occurrence of sting-ray spines in the jaws and gills of the hammerhead shark *Sphyrna zygaena* (Linnaeus). Journal of the Bombay Natural History Society, 69 (2), 432-434.

Oldfield, T.E.E., Outhwaite, W., Goodman, G. and Sant. G. 2012. Assessing the intrinsic vulnerability of harvested sharks. Draft JNCC report provided as an Information Document to CITES (the Convention on International Trade in Wild Species of Fauna and Flora) Animals Committee. http://www.cites.org/common/com/AC/26/E26-09i.pdf

Raje, S.G., Mathew, G., Joshi, K.K., Nair, R.J., Mohanraj, G., Srinath, M., Gomathy, S. and Rudramurthy, N. 2002. Elasmobranch fisheries of India - An appraisal. CMFRI Special Publication, 71, 76p.

Raje, S.G., S. Sivakami, G. Mohanraj, P.P. Manojkumar, A. Raju and K.K. Joshi. 2007. An Atlas on the elasmobranch fishery resources of India. CMFRI Spl. Publ. No.95. 253 pp.

Sajeevan, M.K. and Sanadi, R.B. 2012. Diversity, distribution and abundance of oceanic resources around Andaman and Nicobar Islands. Indian Journal of Fisheries, 59(2), 63-67

Sivakumar, K. 2013. Coastal and Marine Biodiversity Protected Areas in India: Challenges and Way Forward, K. Venkataraman et al. (eds.), Ecology and Conservation of Tropical Marine Faunal Communities, Springer-Verlag Berlin Heidelberg.

Stevens, J.D. 1984, Biological observations on sharks caught by sport fishermen off New South Wales. Australian Journal of Marine and Freshwater Research, 35, 573-590.

Sphyrna mokarran (Rüppell 1837)

Step 1			
Question 1.1 (a) Is the specimen subject to CITES control? (How did you identify the species?)			
Species Name	**Product form**	**CITES Appendix**	**Source of identification**
Sphyrna lewini	Whole fish/fins	II	The specimen was identified to the species level by an expert of CMFRI at the point of landing (Fischer and Bianchi 1984, Marshall and Barone 2016).
In the view of the above, is the specimen subjected to CITES control?	YES	II	Condition (c) is met, as mentioned above.
Concerns and uncertainties	Fillets and cartilage cannot be identified to the species level at the point of trade.		
Question 1.1 (b) From which stock will the specimen be taken/was the specimen taken? (Can the origin and stock be confidently identified?)			
		Description/Comments	**Sources of information**
Ocean basin		Tropical and warm temperate oceans Western Indian Ocean - Eastern Arabian Sea, Eastern Indian Ocean - Western Bay of Bengal including the seas around Andaman and Nicobar Islands	Appukuttan and Nair, 1988 Raje *et al*., 2007 Fischer and Bianchi 1984 FSI survey reports
Stock location/distribution/ boundaries (Attach a map)		Indian EEZ	NMFDC, ICAR- CMFRI

Is this a shared stock (i.e. occurring in more than one EEZ and/or the high seas?)	Not certain, probably yes, CMS	Duncan et al. 2006 CMS 2016 Appendix II
If the stock occurs in more than one EEZ which other parties share this stock?	Not known	-
If a high seas stock which other parties fish this stock?	Not known	-
Which, if any, RFB(s) cover(s) the range of this stock?	None	-
Are all parties listed above (which fish or share the stock concerned) members of the relevant RFB(s)?	NA	-
Are there geographical management gaps?	Not certain	-
How reliable is the information on origin?	Reliable	Conditions **a** AND **c** have been met (the origin of the specimen has been identified to a sufficient level, and the origin of the specimen has been confirmed by an expert from CMFRI at the point of landing.
Is the information on origin sufficiently detailed for Question 1.2 to be answered?		Yes

Question 1.2 **Was (will) the specimen (be) legally obtained and is export allowed?**		
Is the species:	**Description/ Comments**	**Sources of information**
Protected under wildlife legislation, regional biodiversity Agreement, or (for a CMS Party) listed in CMS Appendix 1?	No	-

Sourced from illegal fishing activities (e.g. in contravention of finning regulations, or where a TAC is zero or exceeded)?	No	-
Taken from a no-take marine protected area or during a closed season?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Taken in contravention of RFB recommendations, if any?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Listed as species whose export is prohibited?	Yes, for fin export	Notification No. 110/(RE-2013)2009-2014 dated 6 February 2015
Of concern for any other reason?	No	-
In view of the above and the final section of the Worksheet for Question 1.1(b), was the specimen legally acquired and can exports be permitted?		Yes; subject to conditions laid down by national regulations
Concerns and uncertainties:		Stock status and species-specific trade data not available

Question 1.3
What does the available management information tell us?

Part 1. Global-level information

	Description/Comments	**Sources of information**
Reported global catch	20 tonnes from Atlantic. Data from other areas not included.	FAO Fishstat (http://www.fao.org/figis/servlet/SQServlet?file=/work/FIGIS/prod/webapps/figis/temp/hqp_7321795185961415815.xml&outtype = html)

Species distribution	Circumglobal in coastal warm temperate and tropical seas . Western Atlantic: New Jersey, USA to Uruguay, including the Gulf of Mexico and Caribbean. Eastern Atlantic: western Mediterranean to Namibia. Indo-Pacific: Red Sea, East Africa and throughout the Indian Ocean; Japan to New Caledonia, Hawaii and Tahiti. Eastern Pacific: southern California, USA to Ecuador, probably Peru.	Denham et al 2007 http://shark-references.com/species/view/Sphyrna-mokarran http://shark-
Known stocks/ populations	No specific studies	
Main catching countries	North Carolina to Uruguay, Baja California to Peru, Ryukyu Island to new Caledonia and French Polynesia Pakistan, India, Srilanka India*	Fishbase, Denham et al 2007 NMFDC, ICAR- CMFRI
Main gear types by which the species is taken	Trawl nets, hooks and line, gillnets, longline	Raje et al 2007 NMFDC, ICAR-CMFRI
Global conservation status	Endangered	Denham et al 2007 The IUCN Red List of Threatened Species2007:e. T39385A10190088. http://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T39385A10190088.en.Downloaded on **12 July 2016**
Multilateral Environmental Agreements	CMS Appendix II CITES Appendix II	CMS Appendix II CITES Appendix II
Part 2: Stock/context-specific information		
Stock assessments	Not available	

Main management bodies	State Fisheries Departments (SFDs), Ministry of Agriculture, Cooperation & Farmers Welfare (MoA), Ministry of Environment, Forests and Climate Change (MoEF&CC), National Biodiversity Board (NBB)	https://cof.gujarat.gov.in/contact-us.htm https://fisheries.maharashtra.gov.in/ http://fisheries.goa.gov.in/ http://www.karnataka.gov.in/fisheries/Pages/Home.aspx http://www.fisheries.kerala.gov.in/ http://www.fisheries.tn.gov.in/ https://www.py.gov.in/knowpuducherry/dept_fisheries.html http://apfisheries.gov.in/ http://www.odishafisheries.com/ http://www.wbfisheries.gov.in/wbfisheries/do/Forwordlink?val=32 http://agricoop.nic.in/# http://www.moef.nic.in/ http://nbaindia.org/
Cooperative management arrangements	Participatory management with Association of Deep Sea Going Artisanal Fishermen (ADSGAF), Thuthoor – National Mission on Conservation of Sharks - India (NMCSI)	http://deepseafishersindia.org/
Non-membership of RFBs	NA	-
Nature of harvest	Landed as bycatch	NMFDC, ICAR-CMFRI
Fishery types	Multiday trawl fishery, Mechanized hook and line fishery, Mechanized gillnet fishery, small scale outboard hook and line fishery, small scale outboard gillnet fishery	NMFDC, ICAR-CMFRI

Management units	11 management units (SFDs) pertaining to territorial waters of each maritime state of India and 1 management unit pertaining to rest of the areas in Indian EEZ	MFRA of each maritime state of India http://164.100.150.120/mpeda/state_mfras.php# DADF http://dahd.nic.in/about-us/divisions/fisheries
Products in trade	Fresh and dried whole fish, fins, meat, skin, cartilage, liver oil, jaws	Marine Products Export Development Authority (MPEDA) http://www.mpeda.com/HOMEPAGE.asp Statistics of Marine Products Seafood Export Association of India (SEAI) http://seai.in
Part 3: Data and data sharing		
Reported national catch(es)	125 tonnes in 2003-04	Raje at al 2007
Are catch and/or trade data available from other countries fishing this stock?	No	-
Reported catches by other countries	NA	-
Catch trends and values	In East Pacific-189 tons in 2003 and declined to 21tons in 2011 All-India average landing 9 t (2007-2015) 17 t in 2007 7 t in 2015)	CoP16 Prop. 43 – p. 11 NMFDC, ICAR-CMFRI
Have RFBs and/or other countries fishing this stock been consulted during or contributed data during this process?	NA	-

Step 2		
Question 2.1 **What is the level of intrinsic biological vulnerability of the species?** *In the worksheet below, circle the level of vulnerability associated with each intrinsic biological factor.*		
Intrinsic biological factors	**Level of vulnerability**	**Indicator/Merit**
a) Median age at maturity	Low	
	(Medium)	8-8.2 (CoP16 Prop.43)
	High	
	Unknown	
b) Median size at maturity	Low	
	Medium	
	(High)	Males -225 cm and females - 210 to 228 cm (Last and Stevens 2009). In South Africa, 50% of males and females are mature at 309 cm and 336 cm respectively (Cliff 1995).
	Unknown	
c) Maximum age/ longevity in an unfished population	Low	
	Medium	
	(High)	20-30 yrs (CoP16 Prop.43), 20-40 yrs (Froese & Pauly 2016)
	Unknown	
d) Maximum size	Low	
	Medium	
	(High)	480-550, 610 cm (Compagno, 1984)
	Unknown	
e) Natural mortality rate (M)	Low	
	(Medium)	0.08 (Froese & Pauly 2016)
	High	
	Unknown	

f)	Maximum annual production (no. of pups per mature female)	Low	30-40 (Muus and Nielsen, 1999) 29-37 (Raje et al 2002)
		Medium	
		High	
		Unknown	
g)	Intrinsic rate of population increase (r)	Low	
		Medium	
		High	0.08/year (CoP16 Prop. 43 – p. 6)
		Unknown	
h)	Geographical distribution of stock	Low	Circumglobal in warm coastal temperate and tropical seas, coastal pelagic, semi oceanic (Compagno, 1984, Froese & Pauly 2016)
		Medium	
		High	
		Unknown	
i)	Current stock size relative to historic abundance*(landing is taken as an indicator of the stock size)	Low	
		Medium	
		High	
		Unknown	Possibly declined, very little information available
j)	Behavioural f actors	Low	
		Medium	
		High	Aggregating behavior, coastal nursery and feeding grounds which make it an easy target for fisheries (unpublished data, ICAR-CMFRI) 54 percent post-release mortality (Gallagher et al., 2014)
		Unknown	
k)	Trophic level	Low	
		Medium	4.3 (Froese and Pauly 2016)
		High	
		Unknown	

SUMMARY for question 2.1 Intrinsic biological vulnerability of species *Provide an assessment of the overall intrinsic biological vulnerability of the species (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.*			
High✓	Medium	Low	Unknown
Explanation of conclusion and sources of information used: **High:** Behavioural features, slow intrinsic rate of increase, low natural mortality, large maximum size, long life span cause the intrinsic biological vulnerability of the species to be high.			

Question 2.2 What is the severity and geographic extent of the conservation concern? *Based on existing stock assessments or conservation status assessments, evaluate the severity and geographic extent/scope of conservation concern by including reasons for conclusions drawn, and information on sources used.* *In the worksheet below, circle the level of severity/scope of concern associated with each factor using the descriptions and indicator columns in Table B in the Guidance.*		
Conservation concern factors	**Level of severity/scope of concern (circle as appropriate)**	**Indicator/metric**
Conservation or stock assessment status	Low	
	Medium	
	(High)	Endangered (Denham et al. 2007)
	Unknown	
	Comments: Studies are limited in Indian waters; Endangered in IUCN Red List categorization has been applied to this species. (Denham et al 2007).	
Population trend	Low	
	Medium	
	High	
	(Unknown)	No stock/population trend data
	Comments: So far there is no information on stock status on the species from Indian waters; however, available landings data indicate that there is a consistent decrease from 2007 to 2015 (NMFDC, ICAR-CMFRI).	

Geographic extent/scope of conservation concern	Low	
	Medium	Identified threats (juvenile fishing) affect the national stock of the species.
	High	
	Unknown	
	Comments: Fishery consists of juveniles from near shore waters, especially during Aug-Sept in some states.	

SUMMARY for question 2.2
Severity and geographic extent of the conservation concern

Provide an assessment of the overall severity and geographic extent of conservation concern for this species or stock (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High✓	Medium	Low	Unknown

Explanation of conclusion and sources of information used:

High: Endangered status, decreasing trend in landings and identified threats (juvenile fishing) could affect national stock. Abundance in Indian waters not studied. In a recent study, the catch rate reported from operation of 4 lakh hooks was 0.001 (Varghese et al., 2007).

Step 3

Question 3.1
What is the severity of trade pressure on the stock of the species concerned?

Factor	**Level of severity of trade pressure (*circle as appropriate*)**	**Indicator/metric**
a) Magnitude of legal trade	Low	
	Medium	Though information on exact trade figures is not available, however, this species is sold/ marketed/ traded if it is landed. Market demand for this species is stable.
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g.has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

Multiple use in domestic markets. Once landed there is regular trade for this species. Demand for fins is high but is subject to national regulations.

b) Magnitude of illegal trade	Low	
	Medium	
	High	
	(Unknown)	No information available
	Level of confidence (*circle as appropriate*)	
	Low (Medium) High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There is no information on illegal trade.

Question 3.2 **What is the severity of fishing pressure on the stock of the species concerned?**		
Factor	**Level of severity of trade pressure (*circle as appropriate*)**	**Indicator/metric**
a) Fishing mortality (retained catch)	Low	
	(Medium)	Though this species is not targeted, the presence of large number of sub-adults in the fishing grounds, particularly in the near shore waters, makes it susceptible to capture by various fishing gears. (Fisheries Scientific Committee, Ref. No. PD 49 File No. FSC 10/02)
	High	
	Unknown	
	Level of confidence (*circle as appropriate*)	
	Low (Medium) High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) This species is vulnerable to multiple gears and the fishing effort shows an increasing trend over the years. This species is landed as bycatch in fishing operations.		
b) Discard mortality	(Low)	There is no discard of the species if caught. The species is either consumed or traded. This species has a post-release survival of 54% (Gallagher et al. 2014).
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium (High)	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) All great hammerheads that are caught are retained for consumption or trade. There is no discard of this species.		
c) Size/sex/age/selectivity	Low	
	(Medium)	Though this species is not targeted, the presence of large number of sub-adults in the fishing grounds, particularly in the nearshore waters, makes it susceptible to capture by various fishing gears.
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium (High)	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) Landings of this species include sub-adults and juveniles. Since it is known that juvenile great hammerhead sharks are near shore in distribution they are particularly vulnerable to being fished by gears operating in near shore waters.		

d) Magnitude of illegal, unreported and unregulated (IUU) fishing	Low	
	Medium	
	High	
	Unknown	No information
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There is no information on IUU fishing of this species.

Step 4		
Preliminary Stage **Compile information on existing management measures**		
Existing management measures (see Annex 5 for examples)	**Is the measure generic or species-specific?**	**Description/comments/sources of information**
(SUB-NATIONAL)		
Fins-attached policy	Generic	In August 2013, the Ministry of Environment and Forests (Wildlife Division) approved a policy advisory by ICAR-CMFRI 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 advocating landing of the whole shark
Ban on shark fin export – Dept of Commerce of Ministry of Commerce and Industry	Generic	The Union Ministry of Commerce and Industry prohibited the export of fins of all species of shark, by way of a notification on February 6 2015 (Notification No. 110 (RE-2013)/2009-2014) inserting a new entry in 'Chapter 3 of Schedule 2 of ITC (HS) Classification of Export and Import Items.' The new entry (31 A) resulted in the ban on export of all shark fins.
Seasonal ban on mechanized fishing	Generic	Closure of mechanized fishing activities for 60 days from 15th April to 15th June along east coast and 1st June to 31st July along west coast (both days inclusive), implemented through State MFRAs.

No take zones	Generic	There are 33 Marine Protected Areas where fishing activities where fishing activities are regulated (Sivakumar, 2013).
Gear-specific regulations	Generic	Regulation of mesh size, restrictions on operation of certain gears like ring seines, purse seines and pair trawling, implemented through State MFRAs. http://indianfisheries.icsf.net/en/page/827-Indian%20Legal%20Instruments.html http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112187832409***Gujarat_Marine_Fisheries_Rules_2003.PDF http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112240177836***Maharashtra_Marine_Fishing_Regulation_Rules,_1982.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_goa.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_karnataka_1987.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_kerala.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_tamil_nadu.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1165227972133***Andra_Pradesh_Marine_Fishing_Regulation_Rules_1995_Amendment_dated_26th_October_2004.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_orrissa.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112241236819***West_bengal_Marine_Fishing_Regulation_(Amendment)_Rules,_1998.PDF
REGIONAL/INTERNATIONAL		
CITES	Species-specific	Inclusion of the species in CITES Appendix II w.e.f. September 2014 http://www.cites.org/eng/app/appendices.php
IOTC	Species-specific	Catch and effort has to be recorded http://www.iotc.org/

IUCN	Species-specific	Listed as Endangered (IUCN, 2015) http://www.iucn.org/
CMS	Species-specific	Scalloped hammerhead is a member of the family Sphyrnidae, which is listed in Appendix II of CMS. http://www.cms.int/
BOBLME	Generic	Evolve a common strategy to optimize the use of marine resources on a sustainable basis in the Bay of Bengal region http://www.boblme.org/
UNCLOS	Species-specific	Listed under Annex I (Highly Migratory Species) of the United Nations Convention on the Law of the Sea http://www.unclos.com/

Question 4.1(a)
Are existing management measures appropriately designed and implemented to mitigate the pressures affecting the stock/population of the species concerned?

Factor	Existing management measure(s)	Relevant monitoring, control and surveillance (MCS) measure(s)	Overall assessment of compliance regime (tick as appropriate)
TRADE PRESSURE			
(a) Magnitude of legal trade	Closed season	State Department Officials through MFRA s	Unknown (no information on compliance)
	Fins-attached policy	Wildlife Dept, SFDs	Poor (limited relevant compliance measures in place)
	Total ban on shark fin exports	Wildlife Dept, State Bodies, MPEDA, Customs& Central Excise, Indian Coast Guard	Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Management measures are all known to be implemented and complied with.		

b) Magnitude of illegal trade			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no information on illegal trade.		
Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MCS) measure(s)**	**Overall assessment of compliance regime (tick as appropriate)**
FISHING PRESSURE			
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	State Department Officials through MFRA s	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) These management measures are all complied with but are not specific for this species.		

(b) Discard mortality			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) All great hammerheads that are caught are retained for consumption/ trade. There is no discard of this species.		
(c) Size/age/ sex selectivity			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Management measures regarding size limits are lacking.		

(d) Magnitude of IUU fishing	Marine patrolling	Monitoring and surveillance by Enforcement wing of SFDs, State Forest Dept., Indian Coast Guard&Coastal Police	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no report of IUU fishing for this species.		

Question4.1(b) **Are existing management measures effective (or likely to be effective) in mitigating the pressures affecting the stock/population of the species concerned?**					
Factor	**Existing management measure(s)**	**Are relevant data collected and analysed to inform management decisions?(e.g. landings, effort, fisheries independent data)** *Tick as appropriate*		**Is management consistent with expert advice?** *Tick as appropriate*	
TRADEPRESSURE					
(a) Magnitude oflegal trade	Closed season Fins-attached policy Total ban on shark fin export	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	

		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Managemen tmeasure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g.Is effectiveness compromised by poor design and/ or implementation, or is a greater diversity or amount of management required?What data ar erequired to betteri nform and evaluate management decisions? How is management in consistent with expert advice?) All management measures are being complied with.				
(b) Magnitude of illegal trade	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**				

	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How ismanagement inconsistent with expertadvice?) There is no information on illegal trade.				
FISHING PRESSURE					
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s)effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Data is consistently collected and analyzed by the experts. All fish caught is retained for consumption or trade.				

(b) Discard mortality	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s)effective/likely to be effective?*(circle as appropriate)* (Yes) Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Discard of this species is not known. All individuals caught are landed and traded.				
(c) Size/age/ sex selectivity		No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified Not consistent Expert advice partially implemented Consistent	✓
		Limited relevant data are collected AND analysed to inform management			

		Some relevant data are collected AND analysed to inform management	✓		
		Comprehensive data collected AND analysed to inform management			
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) No measures in place to manage fishing of juvenile great hammerheads in India. Comprehensive data is being collected by CMFRI. Elucidation of stock status needs to be done evolve suitable management measures.				
(d) Magnitude of IUU fishing	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	

	Management measure(s)effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on IUU of this species in Indian waters

Step 5			
Question 5.1 **Based on the outcomes of the previous steps, is it possible to make a positive NDF (with or without associated conditions or is a negative NDF required?**			
Step 2: Intrinsic biological vulnerability and conservation concern			
Intrinsic biological vulnerability (Question 2.1) Conservation concern (Question 2.2)			High Medium Low Unknown High Medium Low Unknown
Step 3: Pressure on species			**Step 4: Existing management measures**
Pressure	Level of severity (Questions 3.1 and 3.2)	Level of confidence (Questions 3.1 and 3.2)	Are the management measures effective* at addressing the concerns/ pressures/impacts identified? (Question 4.1(b)) **taking into account the evaluation of management appropriateness and implementation under Question 4.1(a)*

TRADE PRESSURE			
a) Magnitude of legal trade	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
b) Magnitude of illegal trade	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.			
a) Fishing mortality (retained catch)	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
b) Discard mortality	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**

c) Size/age/ sex selectivity	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
d) Magnitude of IUU fishing	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.

A) **Canapositive NDF be made?**	**YES** -*go to B*	**NO-***go to* ***Step 6*** *and list recommendations for measures to improve monitoring/ management under Reasoning/comments below*
B) Are there any mandatory conditions to the positive NDF?	**YES** - *list under Reasoning/ comments below and go to C*	**NO-***go to C*
C) Are there any other further recommendations? *(e.g. for improvements to monitoring/management)*	**YES** -*go to* ***Step 6*** *and list recommendations for measures to improve monitoring/management under Reasoning/comments below*	**NO**

Reasoning/comments *(include justification for decision made and information on mandatory conditions and/or further recommendations)*

Management measures must be evolved and implemented to minimize fishing of juvenile scalloped hammerheads in India. Participatory management by fishermen must be ensured.

Step 6: Further measures

Section 6.1
Improvements in monitoring or information required

1. **Population monitoring (fishery independent)**
- Tag and release
- Abundance (survey data/collaboration)
- Identifying area & season breeding and nursery aggregations of the species

2. **Population monitoring (fishery dependent)**
- Fishery monitoring – species-specific landing observation, vessel monitoring systems, interviews, databases, logbooks
- Improved surveillance to check for IUU fishing
- Sharing of log data – species, catch, date & area of capture (geolocation) and gear
- Identifying area & season breeding and nursery aggregations of the species
- Biology and stock assessment studies (sex ratios, size/age structure, annual reproductive output, BRPs, fishing effort, BRPs)

3. **Monitoring of domestic and international trade**
- Improve the level of trade data reporting – data declaration by traders (species, source of obtaining the product, size of fish (length & weight), quantity, product form)
- Market survey, interviews with fishermen & traders, information from Customs & other databases, trade channels
- Species-specific product-specific code for trade
- Genetic analysis for ambiguous products

Section 6.2
Improvement of management required

1. **Improvement in management measures**
- Strict implementation of MFRAs regarding gear, mesh size, operation in no-take zones and closed seasons
- Strengthen Monitoring, Control and Surveillance (MCS)
- Improve participatory management through regional fishery management councils
- Create awareness through visual, print and electronic media and mass campaigns
- Seasonal closure of fishing in identified breeding/nursery grounds

References

Appukuttan, K.K. and Nair, K.P. 1988. Shark resources of India, with notes on biology of a few species. The First Indian Fisheries Forum. Proceedings. pp. 173-184.

Cliff, G. 1995. Sharks caught in the protective gill nets off KwaZulu-Natal, South Africa. 8. The great hammerhead shark *Sphyrna mokarran* (Ruppell). S. Afr. J. Mar. Sci., 15, 105–114.

CMS 2016. Convention on Migratory Species, http://www.cms.int/.

Compagno, L.J.V. 1984. Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Part II (Carcharhiniformes). FAO Fisheries Synopsis No. 125, Vol. 4, Part II. FAO, Rome.

CoP16 Prop. 43 Inclusion of Scalloped Hammerhead Shark *Sphyrna lewini* Great Hammerhead Shark *Sphyrna mokarran* and Smooth Hammerhead Shark *Sphyrna zygaena* in Appendix II, Sixteenth meeting of the Conference of the Parties .

Denham, J., Stevens, J., Simpfendorfer, C.A., Heupel, M.R., Cliff, G., Morgan, A., Graham, R., Ducrocq, M., Dulvy, N.D, Seisay, M., Asber, M., Valenti, S.V., Litvinov, F., Martins, P., Lemine Ould Sidi, M., Tous, P. and Bucal, D. 2007. *Sphyrna mokarran*. The IUCN Red List of Threatened Species 2007: e.T39386A10191938. http://dx.doi.org/10.2305/IUCN.UK.2007.RLTS.T39386A10191938.en.

Duncan, K.M., Martin, A.P., Bowen, B.W and Couet, H.G. 2006. Global phylogeography of the scalloped hammerhead shark (*Sphyrna lewini*). Molecular Ecology 15, 2239-2251.

Fischer, W. and Bianchi, G. 1984. FAO Species identification sheets for fishery purposes – Western Indian Ocean Fishing Area 51-Volume V, FAO, Rome

Froese, R. and D. Pauly, (Eds.) 2016. FishBase. World Wide Web electronic publication. www.fishbase.org, Version (10/2016).

Gallagher, A.J., Orbesen, E.S., Hammerschlag, N. and Serafy, J.E. 2014. Vulnerability of oceanic sharks as pelagic longline bycatch. Global Ecology and Conservation 1, 50-59

Last, P.R. and Stevens, J.D. 2009. Sharks and Rays of Australia. CSIRO Publishing, Collingwood, Victoria.

Marshall, A., Kashiwagi, T., Bennett, M. B., Deakos, M. H., Stevens, G., McGregor,

F., Clark, T., Ishihara, H. and Sato, K. 2011. *Manta alfredi.* In: IUCN Red List of Threatened Species.Version 2011. 1. Available at www.iucnlist.org

Muus, B.J. and Nielsen, J.G. 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340p.

Raje, S.G., Mathew, G., Joshi, K.K., Nair, R.J., Mohanraj, G., Srinath, M., Gomathy, S. and Rudramurthy, N. 2002. Elasmobranch fisheries of India - An appraisal. CMFRI Special Publication, 71, 76p.

Raje, S.G., S. Sivakami, G. Mohanraj, P.P. Manojkumar, A. Raju and K.K. Joshi. 2007. An Atlas on the elasmobranch fishery resources of India. CMFRI Spl. Publ. No.95.253 pp.

Sivakumar, K. 2013. Coastal and Marine Biodiversity Protected Areas in India: Challengesand Way Forward, K. Venkataraman et al. (eds.),Ecology and Conservation of Tropical Marine Faunal Communities, Springer-Verlag Berlin Heidelberg.

Varghese, S., Somvanshi, V.S. and Varghese, S.P. 2007. By-catch of sharks and incidental catches of sea turtle in the long line fishery of Indian waters as observed during tuna resources survey. IOTC-2007-WPEB-13.

Carcharhinus longimanus (Poey 1861)

Step 1			
Question 1.1 (a) **Is the specimen subject to CITES control?** **(How did you identify the species?)**			
Species Name	**Product form**	**CITES Appendix**	**Source of identification**
Carcharhinus longimanus	Whole fish/fins	II	The specimen was identified by an expert from CMFRI at the point of landing (based on FAO Fish Identification Sheets, FAO, 2016. Identifying sharks by their fins; Identifying shark fins: Pew Trust)
In the view of the above, is the specimen subjected to CITES control?	YES	II	Condition (c) is met, as mentioned above.
Concerns and uncertainties	Fillets, cartilages and jaws cannot be identified to the species level at the point of trade.		
Question 1.1 (b) **From which stock will the specimen be taken/was the specimen taken?** **(Can the origin and stock be confidently identified?)**			
	Description/Comments		**Sources of information**
Ocean basin	Western Indian ocean – eastern Arabian Sea Eastern Indian ocean – western Bay of Bengal including the seas around Andaman & Nicobar Is.		Appukuttan and Nair, 1988 Raje et al., 2007 FSI survey reports FAO Fish Identification Sheets
Stock location/distribution/ boundaries (Attach a map)	Western Indian EEZ		
Is this a shared stock (i.e. occurring in more than one EEZ and/or the high seas?)	Not certain; probably yes: mixing of stocks between eastern Indian ocean and western central Pacific		Howey-Jordan et al., 2013; Simpfendorfer, 2014

If the stock occurs in more than one EEZ which other parties share this stock?	Not known	
If a high seas stock which other parties fish this stock?	Not known	
Which, if any, RFB(s) cover(s) the range of this stock?	IOTC (Fishery status being studied; compliance status not known)	
Are all parties listed above (which fish or share the stock concerned) members of the relevant RFB(s)?	NA	
Are there geographical management gaps?	Not known	
How reliable is the information on origin?	Reliable	Conditions **a** AND **c** have been met (the origin of the specimen has been identified to a sufficient level, and the origin of the specimen has been confirmed by an expert from CMFRI at the point of landing
Is the information on origin sufficiently detailed for Question 1.2 to be answered?		Yes

Question 1.2 **Was (will) the specimen (be) legally obtained and is export allowed?**		
Is the species:	**Description/ Comments**	**Sources of information**
Protected under wildlife legislation, regional biodiversity Agreement, or (for a CMS Party) listed in CMS Appendix 1?	No	
Sourced from illegal fishing activities (e.g. in contravention of finning regulations, or where a TAC is zero or exceeded)?	No	

Taken from a no-take marine protected area or during a closed season?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Taken in contravention of RFB recommendations, if any?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Listed as species whose export is prohibited?	Yes, for fin export	Notification No. 110/(RE-2013)2009-2014 dated 6 February 2015
Of concern for any other reason?	No	
In view of the above and the final section of the Worksheet for Question 1.1(b), was the specimen legally acquired and can exports be permitted?		Yes; subject to conditions laid down by national regulations
Concerns and uncertainties:		Stock status and species-specific trade data not available

Question 1.3
What does the available management information tell us?

Part 1. Global-level information

	Description/Comments	Sources of information
Reported global catch	271 t (2014)	FAO, 2016 Fishstat / Froese and Pauly, 2016
Species distribution	Circumglobal in all tropical and sub-tropical waters	Baum et al. 2015; Froese and Pauly, 2016
Known stocks/ populations	Unknown	Simpfendorfer, 2014; Baum et al. 2015
Main catching countries	U.S. Mexico, China, Brazil, Taiwan, Sri Lanka, Australia India*	Froese and Pauly, 2016; Baum et al. 2015 NMFDC, ICAR-CMFRI
Main gear types by which the species is taken	Pelagic longlines, gill nets, hook & lines and pelagic trawls	Baum et al. 2015; NMFDC, ICAR-CMFRI
Global conservation status	IUCN status – Vulnerable	Baum et al. 2015
Multilateral Environmental Agreements	Listed in CITES Appendix II	CITES, 2014

Part 2: Stock/context-specific information		
Stock assessments	No information available	Baum et al. 2015
Main management bodies	State Fisheries Departments (SFDs), Ministry of Agriculture, Cooperation & Farmers Welfare (MoA), Ministry of Environment, Forests and Climate Change (MoEF&CC), National Biodiversity Board (NBB)	https://cof.gujarat.gov.in/contact-us.htm https://fisheries.maharashtra.gov.in/ http://fisheries.goa.gov.in/ http://www.karnataka.gov.in/fisheries/Pages/Home.aspx http://www.fisheries.kerala.gov.in/ http://www.fisheries.tn.gov.in/ https://www.py.gov.in/knowpuducherry/dept_fisheries.html http://apfisheries.gov.in/ http://www.odishafisheries.com/ http://www.wbfisheries.gov.in/wbfisheries/do/Forwordlink?val=32 http://agricoop.nic.in/# http://www.moef.nic.in/ http://nbaindia.org/
Cooperative management arrangements	Participatory management with Association of Deep Sea Going Artisanal Fishermen (ADSGAF), Thuthoor – National Mission on Conservation of Sharks - India (NMCSI)	http://deepseafishersindia.org/
Non-membership of RFBs	NA	
Nature of harvest	Bycatch	
Fishery types	Multiday pelagic trawl fishery mechanized hook & line fishery, mechanized gill net fishery, mechanized longline fishery, small-scale outboard hook & line fishery, small-scale outboard gillnet fishery	NMFDC, ICAR-CMFRI

Management units	11 management units (SFDs) pertaining to territorial waters of each maritime state of India and 1 management unit pertaining to rest of the areas in Indian EEZ	MFRA of each maritime state of India http://164.100.150.120/mpeda/state_mfras.php# DADF http://dahd.nic.in/about-us/divisions/fisheries
Products in trade	Whole fish, fillet, meat (fresh & dried), fins, teeth, jaws, cartilage, skin, liver oil	Marine Products Export Development Authority (MPEDA) http://www.mpeda.com/HOMEPAGE.asp Statistics of Marine Products Seafood Export Association of India (SEAI) http://seai.in
Part 3: Data and data sharing		
Reported national catch(es)	2007: 1.331 t 2008: - 2009: - 2010: 10.618 t 2011:53.508 t 2012:127.75 t 2013:107.124 t 2014:381.168 t 2015:286.639 t	NMFDC, ICAR – CMFRI *National marine landings estimated by CMFRI not included in FAO statistics
Are catch and/ or trade data available from other countries fishing this stock?	No	
Reported catches by other countries	NA	
Catch trends and values	1.331 t (2007) to 286.639 t (2015); max 381.168 t (2014)	NMFDC, ICAR-CMFRI
Have RFBs and/ or other countries fishing this stock been consulted during or contributed data during this process?	NA	

Step 2		
Question 2.1 **What is the level of intrinsic biological vulnerability of the species?** *In the worksheet below, circle the level of vulnerability associated with each intrinsic biological factor.*		
Intrinsic biological factors	**Level of vulnerability**	**Indicator/Merit**
a) Median age at maturity	Low	
	(Medium)	7.36 years (females); 9.6 years (males) (converted from Varghese et al. 2016)
	High	
	Unknown	
b) Median size at maturity	Low	
	(Medium)	187.7 cm TL (female) 207.19 cm TL (male) Varghese et al. 2016
	High	
	Unknown	
c) Maximum age/ longevity in an unfished population	Low	
	Medium	
	(High)	23.18 years (max size converted using VBGF (Froese and Pauly, 2016; Bonfil et al. 2008 Linf)
	Unknown	
d) Maximum size	Low	
	(Medium)	265 (CMFRI primary data)
	High	
	Unknown	
e) Natural mortality rate (M)	Low	
	Medium	
	(High)	0.18 (Froese and Pauly, 2016)
	Unknown	

f)	Maximum annual production (no. of pups per mature female)	Low	
		Medium	15 (Bonfil et al. 2008); 9 (Varghese et al. 2016)
		High	
		Unknown	
g)	Intrinsic rate of population increase (r)	Low	
		Medium	
		High	0.081 (Smith et al. 1998)
		Unknown	
h)	Geographical distribution of stock	Low	Ocean basin; Cosmopolitan; Circumtropical (Froese and Pauly, 2016)
		Medium	
		High	
		Unknown	
i)	Current stock size relative to historic abundance*(landing is taken as an indicator of the stock size)	Low	Current landing is 264.5% of the last 9-year average (CMFRI primary data)
		Medium	
		High	
		Unknown	
j)	Behavioural factors	Low	
		Medium	Fast, aggressive, opportunistic predator, easily prone to hooking (Compagno, 1984); post hooking survival 75%; mean size in landings close to size at maturity
		High	
		Unknown	
k)	Trophic level	Low	
		Medium	
		High	4.2 (Froese and Pauly, 2016)
		Unknown	

SUMMARY for question 2.1 Intrinsic biological vulnerability of species *Provide an assessment of the overall intrinsic biological vulnerability of the species (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.*			
High	**Medium**✓	Low	Unknown

Explanation of conclusion and sources of information used:

Medium: Although the species, by virtue of its longevity, natural mortality rate and high trophic level is prone to high intrinsic biological vulnerability, its median age and size at maturity, maximum size in the fishery, current landing trends and post release survival indicate medium vulnerability.

Question 2.2
What is the severity and geographic extent of the conservation concern?
Based on existing stock assessments or conservation status assessments, evaluate the severity and geographic extent/scope of conservation concern by including reasons for conclusions drawn, and information on sources used.
In the worksheet below, circle the level of severity/scope of concern associated with each factor using the descriptions and indicator columns in Table B in the Guidance.

Conservation concern factors	**Level of severity/scope of concern (circle as appropriate)**	**Indicator/metric**
Conservation or stock assessment status	Low	
	Medium	Baum et al. 2015; CMFRI primary data
	High	
	Unknown	
	Comments: Since stock assessment for this species has not been done from Indian waters, IUCN Red List category has been applied to this species.	

Population trend	Low	
	Medium	
	High	
	Unknown	No stock/population trend data
	Comments: So far there is not much information on stock status of this species from Indian waters; however, available landings data indicate that there is an increasing trend and the current landing is 264.5% of the last 9-year average (CMFRI primary data).	
Geographic extent/scope of conservation concern	Low	
	Medium	
	High	
	Unknown	There are insufficient data to evaluate the conservation status of the species, population or stock against defined criteria (IUCN Red List Category – Vulnerable)
	Comments: There is no information of stock status of this species in Indian waters. However, landing data indicates an increasing trend from 2007 and the current landing is 264.5% of the last 9-year average (2007-2015). Juvenile composition does not form a significant proportion of the landings.	

SUMMARY for question 2.2
Severity and geographic extent of the conservation concern

Provide an assessment of the overall severity and geographic extent of conservation concern for this species or stock (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High	**Medium**✓	Low	Unknown

Explanation of conclusion and sources of information used:

Medium: Increasing trend in landings; unknown stock status and threats.

Step 3		
Question 3.1 **What is the severity of trade pressure on the stock of the species concerned?**		
Factor	**Level of severity of trade pressure** **(*circle as appropriate*)**	**Indicator/metric**
a) Magnitude of legal trade	Low	
	Medium	
	High	
	(Unknown)	
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) Multiple use in domestic markets. Once landed there is regular trade for this species. Demand for fins is high but is subject to national regulations.		
b) Magnitude of illegal trade	Low	
	Medium	
	High	
	(Unknown)	
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) There is no information on illegal trade.		

Question 3.2 **What is the severity of fishing pressure on the stock of the species concerned?**		
Factor	**Level of severity of trade pressure** **(*circle as appropriate*)**	**Indicator/metric**

a) Fishing mortality (retained catch)	Low	
	Medium	Moderate proportion of the stock is caught as bycatch by multiple fishing gears
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

This species is prone to capture by multiple gears and is mostly landed as bycatch of tuna longline/hook & line fishery and drift gill net fishery. Current landing trend does not indicate decline in abundance due to fishing.

b) Discard mortality	Low	
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There are no reports of discard of the species and available information obtained through primary surveys indicate that the species, whenever caught, are landed and traded. The species is known to have a post hooking survival rate of 75% (Gallagher et al.2014).

c) Size/sex/age/selectivity	Low	
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There is no targeted fishery of this species in Indian waters and it is usually taken as by-catch in multiple gears, predominantly in hook & line/longlines. Therefore there is no selective fishing on the basis of size/age/sex.

d) Magnitude of illegal, unreported and unregulated (IUU) fishing	Low	
	Medium	
	High	
	Unknown	No information
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There is no information on IUU fishing of this species.

Step 4		
Preliminary Stage Compile information on existing management measures		
Existing management measures (see Annex 5 for examples)	**Is the measure generic or species-specific?**	**Description/comments/sources of information**
(SUB-NATIONAL)		
Fins-attached policy	Generic	In August 2013, the Ministry of Environment and Forests (Wildlife Division) approved a policy advisory by ICAR-CMFRI 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 advocating landing of the whole shark
Ban on shark fin export – Dept of Commerce of Ministry of Commerce and Industry	Generic	The Union Ministry of Commerce and Industry prohibited the export of fins of all species of shark, by way of a notification on February 6 2015 (Notification No. 110 (RE-2013)/2009-2014) inserting a new entry in 'Chapter 3 of Schedule 2 of ITC (HS) Classification of Export and Import Items.' The new entry (31 A) resulted in the ban on export of all shark fins.

Seasonal ban on mechanized fishing	Generic	Closure of mechanized fishing activities for 61 days from 15th April to 14th June along east coast and 1st June to 31st July along west coast (both days inclusive), implemented through State MFRAs.
No take zones	Generic	There are 33 Marine ProtectedAreas where fishing activities where fishing activities are regulated (Sivakumar, 2013).
Gear-specific regulations	Generic	Regulation of mesh size, restrictions on operation of certain gears like ring seines, purse seines and pair trawling, implemented through State MFRAs. http://indianfisheries.icsf.net/en/page/827-Indian%20Legal%20Instruments.html http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112187832409***Gujarat_Marine_Fisheries_Rules_2003.PDF http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112240177836***Maharashtra_Marine_Fishing_Regulation_Rules,_1982.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_goa.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_karnataka_1987.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_kerala.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_tamil_nadu.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1165227972133***Andra_Pradesh_Marine_Fishing_Regulation_Rules_1995_Amendment_dated_26th_October_2004.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_orrissa.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112241236819***West_bengal_Marine_Fishing_Regulation_(Amendment)_Rules,_1998.PDF
REGIONAL/INTERNATIONAL		
IOTC	Species-specific	IOTC Resolution 13/06/2013 which states that Oceanic white tips are not to be retained and are to be released unharmed, to the extent practicable, when caught in association to IOTC regulated fisheries http://www.iotc.org/

CITES	Species-specific	Inclusion of the species in CITES Appendix II w.e.f. September 2014 http://www.cites.org/eng/app/appendices.php
IUCN	Species-specific	Listed as Vulnerable (Baum et al. 2015) http://www.iucn.org/
BOBLME	Generic	Evolve a common strategy to optimize the use of marine resources on a sustainable basis in the Bay of Bengal region http://www.boblme.org/
UNCLOS	Species-specific	Listed under Annex I (Highly Migratory Species) of the United Nations Convention on the Law of the Sea http://www.unclos.com/

Question 4.1(a)
Are existing management measures appropriately designed and implemented to mitigate the pressures affecting the stock/population of the species concerned?

Factor	Existing management measure(s)	Relevant monitoring, control and surveillance (MCS) measure(s)	Overall assessment of compliance regime (tick as appropriate)
TRADE PRESSURE			
(a) Magnitude of legal trade	Closed season Fins-attached policy Total ban on shark fin exports	State Department Officials through MFRA s Wildlife Dept, SFDs Wildlife Dept, State Bodies, MPEDA, Customs& Central Excise, Indian Coast Guard	Unknown (no information on compliance) Poor (limited relevant compliance measures in place) Moderate (some relevant compliance measures in place) Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Management measures are all known to be implemented and complied with.		

b) Magnitude of illegal trade			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no information on illegal trade.		
Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MCS) measure(s)**	**Overall assessment of compliance regime (tick as appropriate)**
FISHING PRESSURE			
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	State Department Officials through MFRA s	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) These management measures are all complied with but are not specific for this species.		

(b) Discard mortality			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) These fishes are not known to be discarded. All available information suggests that the species, when caught, is landed and traded		
(c) Size/age/ sex selectivity			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Since there is no targeted fishery for this species, and the individuals landed are caught as bycatch in different pelagic gears, there is no selective fishing based on size/age/sex.		

(d) Magnitude of IUU fishing	Marine patrolling	Monitoring and surveillance by Enforcement wing of SFDs, State Forest Dept., Indian Coast Guard&Coastal Police	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no report of IUU fishing for this species.		

Question4.1(b) **Are existing management measures effective (or likely to be effective) in mitigating the pressures affecting the stock/population of the species concerned?**			
Factor	**Existing management measure(s)**	**Are relevant data collected and analysed to inform management decisions?(e.g. landings, effort, fisheries independent data)** *Tick as appropriate*	**Is management consistent with expert advice?** *Tick as appropriate*
TRADE PRESSURE			
(a) Magnitude of legal trade	Closed season Fins-attached policy Total ban on shark fin export	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	No expert advice on management identified
		Limited relevant data are collected AND analysed to inform management	Notconsistent

		Somerelevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s) effective/likely to be effective? *(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g.Is effectiveness compromised by poor design and/ or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) All management measures are being complied with.				
(b) Magnitude of illegal trade	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**				

	Reasoning/comments (e.g.Is effectiveness compromised by poor design and/ or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on illegal trade.				
FISHING PRESSURE					
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Data is consistently collected and analyzed by the experts. All fish caught is retained for consumption or trade.				
(b) Discard mortality	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓

		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* (Yes) Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Discard of this species is not known. All individuals caught are landed and traded.				
(c) Size/age/ sex selectivity	There is no selective fishing and this species does not form a targeted fishery. There is no record of indiscriminate fishing of juveniles or breeding adults/ pregnant females. Hence species specific management measures have not been formulated.	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓

		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Comprehensive data is being collected by CMFRI. Elucidation of stock status needs to be done to evolve suitable management measures.				
(d) Magnitude of IUU fishing	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	

	Management measure(s) effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on IUU of this species in Indian waters

Step 5			
Question 5.1 **Based on the outcomes of the previous steps, is it possible to make a positive NDF (with or without associated conditions or is a negative NDF required?**			
Step 2: Intrinsic biological vulnerability and conservation concern			
Intrinsic biological vulnerability (Question 2.1)			High **Medium** Low Unknown
Conservation concern (Question 2.2)			High **Medium** Low Unknown
Step 3: Pressure on species			**Step 4: Existing management measures**
Pressure	Level of severity (Questions 3.1 and 3.2)	Level of confidence (Questions 3.1 and 3.2)	Are the management measures effective* at addressing the concerns/pressures/impacts identified? (Question 4.1(b)) **taking into account the evaluation of management appropriateness and implementation under Question 4.1(a)*
TRADE PRESSURE			
a) Magnitude of legal trade	High **Medium** Low Unknown	**High** Medium Low	**Yes** Partially No Insufficient information Not applicable**

b) Magnitude of illegal trade	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.			
a) Fishing mortality (retained catch)	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
b) Discard mortality	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
c) Size/ age/ sex selectivity	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
d) Magnitude of IUU fishing	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.			
A)	**Can a positive NDF be made?**	**YES** *-go to B*	**NO-***go to* ***Step 6*** *and list recommendations for measures to improve monitoring/management under Reasoning/comments below*
B)	**Are there any mandatory conditions to the positive NDF?**	**YES** *-list under Reasoning/ comments below and go to C*	**NO-***go to C*
X)	**Are there any other further recommendations?** *(e.g.for improvements to monitoring/ management)*	**YES** *- go to* ***Step 6*** *and list recommendations for measures to improve monitoring/ management under Reasoning/ comments below*	**NO**
Reasoning/comments *(include justification for decision made and information on mandatory conditions and/or further recommendations)*			

Step 6: Further measures

Section 6.1
Improvements in monitoring or information required

1. **Population monitoring (fishery independent)**
- Tag and release
- Abundance (survey data/collaboration)
- Identifying area & season breeding and nursery aggregations of the species

2. **Population monitoring (fishery dependent)**
- Fishery monitoring – species-specific landing observation, vessel monitoring systems, interviews, databases, logbooks
- Improved surveillance to check for IUU fishing
- Sharing of log data – species, catch, date & area of capture (geolocation) and gear
- Identifying area & season breeding and nursery aggregations of the species
- Biology and stock assessment studies (sex ratios, size/age structure, annual reproductive output, BRPs, fishing effort, BRPs)

3. **Monitoring of domestic and international trade**
- Improve the level of trade data reporting – data declaration by traders (species, source of obtaining the product, size of fish (length & weight), quantity, product form)
- Market survey, interviews with fishermen & traders, information from Customs & other databases, trade channels
- Species-specific product-specific code for trade
- Genetic analysis for ambiguous products

Section 6.2
Improvement of management required

1. **Improvement in management measures**
- Strict implementation of MFRAs regarding gear, mesh size, operation in no-take zones and closed seasons
- Strengthen Monitoring, Control and Surveillance (MCS)
- Improve participatory management through regional fishery management councils
- Create awareness through visual, print and electronic media and mass campaigns
- Seasonal closure of fishing in identified breeding/nursery grounds

References

Appukuttan, K.K. and Nair, K.P. 1988. Shark resources of India, with notes on biology of a few species. The First Indian Fisheries Forum. Proceedings. pp. 173-184.

Baum, J., Medina, E., Musick, J.A. and Smale, M. 2015. *Carcharhinus longimanus*. The IUCN Red List of Threatened Species 2015: e. T39374A85699641. http://dx.doi.org/10.2305/IUCN.UK.2015. RLTS.T39374A85699641.en. Downloaded on 17 September 2016.

Bonfil, R., Clarke, S. and Nakano, H. (2008) The biology and ecology of the Oceanic whitetip shark, *Carcharhhinus longimanus*. In: Camhi, M.D., Pikitch, E.K. and Babcock, E.A. (Eds.). *Sharks of the open ocean: biology, fisheries and conservation*. Oxford: BlackwellScience, 2008. Chapter 11, p. 128-139. (Fish and aquatic resources series; 13) [International Pelagic Shark Workshop, 2000, Pacific Grove, Calif.].

Compagno, L.J.V. 1984. Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Part II (Carcharhiniformes). FAO Fisheries Synopsis No. 125, Vol. 4, Part II. FAO, Rome.

Froese, R. and D. Pauly. (Eds.) 2016. FishBase. World Wide Web electronic publication. www.fishbase.org, Version (10/2016).

Gallagher, A.J., Orbesen, E.S., Hammerschlag, N. and Serafy, J.E. 2014. Vulnerability of oceanic sharks as pelagic longline bycatch. Global Ecology and Conservation 1, 50-59

Howey-Jordan, L.A., Brooks, E.J., Abercrombie, D.L., Jordan, L.K.B., Brooks, A., Williams, S., Gospodarczyk, E. and Chapman, D.D. 2013. Complex movements, philopatry and expanded depth range of a severely threatened pelagic shark, the oceanic whitetip (*Carcharhinus longimanus*) in the western North Atlantic. PLoS ONE, 8(2), e56588

Raje, S.G., Sivakami, S., Mohanraj, G., Manojkumar, P.P., Raju, A. and Joshi, K.K. 2007. An Atlas on the elasmobranch fishery resources of India. CMFRI Spl. Publ. No.95, 253 pp.

Simpfendorfer, C.A. 2014. Sharks, fisheries and the future. Abstract. In: Programm and Abstracts of Shark International, Durban 2014: 162

Sivakumar, K. 2013. Coastal and Marine Biodiversity Protected Areas in India: Challenges and Way Forward, K. Venkataraman et al. (eds.), Ecology and Conservation of Tropical Marine Faunal Communities, Springer-Verlag Berlin Heidelberg.

Smith, S.E., Au, D.W. and Show, C. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. Marine and Freshwater Research, 49(7), 663–678.

Varghese, Sijo P., Unnikrishnan, N., Gulati, Deepak K. and Ayoob, A.E. 2016. Size, sex and reproductive biology of seven pelagic sharks in the eastern Arabian Sea. J. Mar. Biol. Assn. U.K.

Manta birostris (Walbaum 1792)

Step 1			
Question 1.1 (a) Is the specimen subject to CITES control? (How did you identify the species?)			
Species Name	**Product form**	**CITES Appendix**	**Source of identification**
Manta birostris	Whole specimen, fresh and dried gill rakers	II	The specimen was identified by an expert from CMFRI at the point of landing following Stevens, 2012a, b; Marshall et al. 2009.
In the view of the above, is the specimen subjected to CITES control?	YES	II	Condition (c) is met, as mentioned above.
Concerns and uncertainties	Cartilage, meat has to be subjected to DNA analysis for correct identification at the point of trade and is not possible at the field level.		
Question 1.1 (b) From which stock will the specimen be taken/was the specimen taken? (Can the origin and stock be confidently identified?)			
		Description/ Comments	**Sources of information**
Ocean basin		Western Indian Ocean - Eastern Indian Ocean - Western Bay of Bengal including the seas around Andaman and Nicobar Islands.	FAO sheets Stevens, 2012 Raje et al., 2007
Stock location/ distribution/ boundaries (Attach a map)		Indian EEZ	NMFDC, ICAR-CMFRI
Is this a shared stock (i.e. occurring in more than one EEZ and/or the high seas?)		Not certain; probably yes	CMS Heinrichs et al. 2011
If the stock occurs in more than one EEZ which other parties share this stock?		Not known	-
If a high seas stock which other parties fish this stock?		Sri Lanka, Maldives	Heinrichs et al. 2011

Which, if any, RFB(s) cover(s) the range of this stock?	Not known	-
Are all parties listed above (which fish or share the stock concerned) members of the relevant RFB(s)?	NA	-
Are there geographical management gaps?	Not certain	-
How reliable is the information on origin?	Reliable	Conditions **a** AND **c** have been met (the origin of the specimen has been identified to a sufficient level, and the origin of the specimen has been confirmed by an expert from CMFRI at the point of landing
Is the information on origin sufficiently detailed for Question 1.2 to be answered?		Yes

Question 1.2 Was (will) the specimen (be) legally obtained and is export allowed?		
Is the species:	**Description/ Comments**	**Sources of information**
Protected under wildlife legislation, regional biodiversity Agreement, or (for a CMS Party) listed in CMS Appendix 1?	No Yes	 Listed in Appendix I of CMS. India is a signatory to the CMS.
Sourced from illegal fishing activities (e.g. in contravention of finning regulations, or where a TAC is zero or exceeded)?	No	
Taken from a no-take marine protected area or during a closed season?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Taken in contravention of RFB recommendations, if any?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Listed as species whose export is prohibited?		Listed in Appendix I of CMS and Appendix II of CITES. India is a signatory to the CMS & CITES. http://www.cites.org/eng/cop/16/prop/E-CoP16-Prop-46.pdf

Of concern for any other reason?	Yes; Information is lacking on fishery and stock status.	
In view of the above and the final section of the Worksheet for Question 1.1(b), was the specimen legally acquired and can exports be permitted?		Yes; subject to conditions laid down by national regulations
Concerns and uncertainties:		Stock status and species-specific trade data not available. More studies have to be taken up on the fishery and stock status.

Question 1.3
What does the available management information tell us?

Part 1. Global-level information

	Description/Comments	Sources of information
Reported global catch	Total annual documented global landings are about 3,400 mantas (*M. birostris* only); 4033 t was landed globally	Heinrichs et al. 2011 FAO Fishstat
Species distribution	Indian distribution: West coast and South East coast Global distribution: Angola, Ascension Is., Canary Is., Cape verde, Djibouti, Guinea, Guinea-Bissau, Madeira Is., Mauritania, Mauritius, Mayotte, Reunion, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Andaman Is., Chagos Is., China, Christmas Is., Cook Is. (Keel), Hongkong, India, Indonesia, Japan, Maldives, Ogasawara Is., Oman, Philippines, Taiwan, Vietnam, Yemen, Aruba, Bermuda, Canada, Cayman Is., Costa Rica, Cuba, Curaçao I., El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Puerto Rico, Revillagigedo, Trinidad Tobago, USA, Virgin Is. (US), Australia, Cook Is., Fiji, French Polynesia, Guam, Hawaii, Marquesas Is., Marshall Is., Micronesia, Midway Is., New Zealand, North Marianas, Palau, Papua New Guinea, Tonga, Tuamotu Is., Wake I., Brazil, Cocos I. (C.R.), Colombia, Ecuador, French Guiana, Galapagos Is., Guyana	Nair et al., 2015 Marshall et al. 2011. Couturier et al. 2012

Known stocks/ populations	Highly migratory stock. Since landing is also sparse further studies are required to assess exact stocks. Sparsely distributed with small subpopulations in the range of 100 to 1,000 individuals. The maximum number of individuals identified in the four largest monitored aggregation sites (Mexico, Ecuador, the Maldives and Mozambique) ranges from 180 to 650.* * These figures are from monitored aggregation sites only. Stock assessments are yet to be conducted.	CMFRI; Nair et al., 2015 Marshall et al. 2011.
Main catching countries	Sri Lanka, India, Peru, Maldives, Indonesia, Philippines, Ghana, Myanmar, China and Mozambique	Heinrichs et al. 2011 Couturier et al. 2012
Main gear types by which the species is taken	Gillnets, hooks and line	NMFDC, ICAR-CMFRI
Global conservation status	IUCN status – Vulnerable	Marshall et al. 2011.
Multilateral Environmental Agreements	Listed in CITES Appendix II Listed in CMS Appendix I	CITES, 2014 CMS, 2016
Part 2: Stock/context-specific information		
Stock assessments	Sufficient landing data not available for stock assessment	

Main management bodies	State Fisheries Departments (SFDs), Ministry of Agriculture, Cooperation & Farmers Welfare (MoA), Ministry of Environment, Forests and Climate Change (MoEF&CC), National Biodiversity Board (NBB)	https://cof.gujarat.gov.in/contact-us.htm https://fisheries.maharashtra.gov.in/ http://fisheries.goa.gov.in/ http://www.karnataka.gov.in/fisheries/Pages/Home.aspx http://www.fisheries.kerala.gov.in/ http://www.fisheries.tn.gov.in/ https://www.py.gov.in/knowpuducherry/dept_fisheries.html http://apfisheries.gov.in/ http://www.odishafisheries.com/ http://www.wbfisheries.gov.in/wbfisheries/do/Forwordlink?val=32 http://agricoop.nic.in/# http://www.moef.nic.in/ http://nbaindia.org/
Cooperative management arrangements	Participatory management with Association of Deep Sea Going Artisanal Fishermen (ADSGAF), Thuthoor – National Mission on Conservation of Sharks - India (NMCSI)	http://deepseafishersindia.org/
Non-membership of RFBs	NA	
Nature of harvest	Bycatch	
Fishery types	Gillnet and longlines	NMFDC, ICAR-CMFRI
Management units	11 management units (SFDs) pertaining to territorial waters of each maritime state of India and 1 management unit pertaining to rest of the areas in Indian EEZ	MFRA of each maritime state of India http://164.100.150.120/mpeda/state_mfras.php# DADF http://dahd.nic.in/about-us/divisions/fisheries

Products in trade	Meat, skin, branchial plate, cartilage	Marine Products Export Development Authority (MPEDA) http://www.mpeda.com/HOMEPAGE.asp Statistics of Marine Products Seafood Export Association of India (SEAI) http://seai.in
Part 3: Data and data sharing		
Reported national catch(es)	All India average landings 40 t 2012 to 5 t in 2015	NMFDC, ICAR – CMFRI *National marine landings estimated by CMFRI not included in FAO statistics
Are catch and/or trade data available from other countries fishing this stock?	No	-
Reported catches by other countries	NA	
Catch trends and values	Catch has decreased during the last three years	NMFDC, ICAR-CMFRI
Have RFBs and/or other countries fishing this stock been consulted during or contributed data during this process?	NA	

Step 2		
Question 2.1 **What is the level of intrinsic biological vulnerability of the species?** *In the worksheet below, circle the level of vulnerability associated with each intrinsic biological factor.*		
Intrinsic biological factors	**Level of vulnerability**	**Indicator/Merit**
a) Median age at maturity	Low	
	Medium (circled)	15-20 years (Manta Trust, 2016)
	High	
	Unknown	
b) Median size at maturity	Low	
	Medium	
	High (circled)	256 cm (males) CMFRI; 413 cm. (female) DW (Rajapackiam et al. 2007) 400 cm (Marshall, 2009)
	Unknown	
c) Maximum age/ longevity in an unfished population	Low	
	Medium	
	High (circled)	Based on current data: >20 years (Couturier et al., 2012)
	Unknown	
d) Maximum size	Low	
	Medium	
	High (circled)	910 cm (White et al. 2006) 680 cm, Veraval, Indian waters (Nair et al. 2015)
	Unknown	
e) Natural mortality rate (M)	Low (circled)	0.012 – 0.04 yr^{-1} (Dulvy et al., 2014)
	Medium	
	High	
	Unknown	

f)	Maximum annual production (no. of pups per mature female)	Low	
		Medium	
		High	1 (Compagno et al., 1989); (Manta Trust, 2016)
		Unknown	
g)	Intrinsic rate of population increase (r)	Low	
		Medium	
		High	0.042 – 0.05 (Ward-Paige et al. 2013) [0.089–0.139] (Dulvy et al., 2014)
		Unknown	
h)	Geographical distribution of stock	Low	
		Medium	Found in tropics, subtropics and temperate waters. Populations partially restricted and sparsely distributed.
		High	
		Unknown	
i)	Current stock size relative to historic abundance*(landing is taken as an indicator of the stock size)	Low	
		Medium	
		High	
		Unknown	No accurate data available
j)	Behavioural factors	Low	
		Medium	
		High	Generally solitary but tend to aggregate at off-shore pinnacles and sea mounts. They also visit cleaning stations in shallow reefs, and are sighted feeding at the surface inshore and offshore. Possible nursery grounds near the continental shelf edge (e.g. Sri Lanka, Peru and Ecuador). Particularly vulnerable to tuna long line and gill nets (Manta Trust, 2016)
		Unknown	

k) Trophic level	Low	
	Medium	3.5 ± 0.50 Likely low-medium based on feeding ecology
	High	
	Unknown	

SUMMARY for question 2.1
Intrinsic biological vulnerability of species

Provide an assessment of the overall intrinsic biological vulnerability of the species (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High✓	Medium	Low	Unknown

Explanation of conclusion and sources of information used:

High: Behavioural features, slow intrinsic rate of increase, low natural mortality, low fecundity, long life span makes it highly vulnerable. Moreover, is a solitary species frequenting surface waters near shallow reef areas

Question 2.2
What is the severity and geographic extent of the conservation concern?

Based on existing stock assessments or conservation status assessments, evaluate the severity and geographic extent/scope of conservation concern by including reasons for conclusions drawn, and information on sources used.
In the worksheet below, circle the level of severity/scope of concern associated with each factor using the descriptions and indicator columns in Table B in the Guidance.

Conservation concern factors	Level of severity/scope of concern (circle as appropriate)	Indicator/metric
Conservation or stock assessment status	Low	
	Medium	Vulnerable (Marshall et al. 2011) IUCN
	High	
	Unknown	
	Comments: As per IUCN Red List it is listed as Vulnerable. Since landings of *Manta birostris* on the Indian coast are less, the number of pups is also less, they are highly vulnerable to decline if caught indiscriminately. Assessment studies have to be done on national basis.	

Population trend	Low	
	Medium	
	High	
	Unknown	No stock/population trend data
	Comments: Not much information on the stock status of this species from Indian waters. However, landings data indicate there is no regular landing of this species along the Indian coast.	
Geographic extent/scope of conservation concern	Low	
	Medium	
	High	
	Unknown	There is insufficient data to evaluate the conservation status of the species, population or stock against defined criteria (IUCN Red List Category – Vulnerable).
	Comments: There is not much information on the stock status of this species from Indian waters.	

SUMMARY for question 2.2
Severity and geographic extent of the conservation concern

Provide an assessment of the overall severity and geographic extent of conservation concern for this species or stock (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High	**Medium**✓	Low	Unknown

Explanation of conclusion and sources of information used:

Medium: Not much information on the stock status of this species from Indian waters. No regular landing of this species along the Indian coast and the reported landing has decreased during the last few years.

Step 3		
Question 3.1 **What is the severity of trade pressure on the stock of the species concerned?**		
Factor	**Level of severity of trade pressure** **(*circle as appropriate*)**	**Indicator/metric**
a) Magnitude of legal trade	Low	
	(Medium)	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g.has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) Multiple use in domestic markets. Once landed there is regular trade for this species. Demand for fins is high but is subject to national regulations.		
b) Magnitude of illegal trade	Low	
	Medium	
	High	
	(Unknown)	
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) There is no information on illegal trade.		
Question 3.2 **What is the severity of fishing pressure on the stock of the species concerned?**		
Factor	**Level of severity of trade pressure** **(*circle as appropriate*)**	**Indicator/metric**

a) Fishing mortality (retained catch)	Low	
	Medium	Moderate proportion of the stock is caught as bycatch by multiple fishing gears
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) Since this species lives for a long period, natural mortality is less. However, the fish is targeted by tuna longliners and gill netters as a bycatch for its branchial plates.		
b) Discard mortality	Low	
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	
Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?) No information available on manta rays thrown back at sea. Since this is a solitary species and the chances of accidental gill netting are rare, throwing back the species into the seas may be rare. Sufficient data is not available on this.		
c) Size/sex/age/selectivity	Low	All size classes are fished Rekha et al. 2015
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

All size groups are landed and more often the larger ones are caught in gill nets.

d) Magnitude of illegal, unreported and unregulated (IUU) fishing	Low	
	Medium	
	High	
	Unknown	No information
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There is no information on IUU fishing of this species.

Step 4		
Preliminary Stage Compile information on existing management measures		
Existing management measures (see Annex 5 for examples)	**Is the measure generic or species-specific?**	**Description/comments/sources of information**
(SUB-NATIONAL)		
Seasonal ban on mechanized fishing	Generic	Closure of mechanized fishing activities for 61 days from 15th April to 14th June along east coast and 1st June to 31st July along west coast (both days inclusive), implemented through State MFRAs.
No take zones	Generic	There are 33 Marine Protected Areas where fishing activities are regulated (Sivakumar, 2013).

Gear-specific regulations	Generic	Regulation of mesh size, restrictions on operation of certain gears like ring seines, purse seines and pair trawling, implemented through State MFRAs. http://indianfisheries.icsf.net/en/page/827-Indian%20Legal%20Instruments.html http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112187832409***Gujarat_Marine_Fisheries_Rules_2003.PDF http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112240177836***Maharashtra_Marine_Fishing_Regulation_Rules,_1982.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_goa.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_karnataka_1987.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_kerala.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_tamil_nadu.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1165227972133***Andra_Pradesh_Marine_Fishing_Regulation_Rules_1995_Amendment_dated_26th_October_2004.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_orrissa.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112241236819***West_bengal_Marine_Fishing_Regulation_(Amendment)_Rules,_1998.PDF
REGIONAL/INTERNATIONAL		
CITES	Species-specific	Inclusion of the species in CITES Appendix II w.e.f. September 2014 http://www.cites.org/eng/app/appendices.php
CMS	Species-specific	Inclusion of the species in Appendix I of CMS http://www.sharksmou.org/ http://www.cms.int/species/index.htm
IUCN	Species-specific	Listed as Vulnerable (IUCN, 2015) http://www.iucn.org/

BOBLME	Generic	Evolve a common strategy to optimize the use of marine resources on a sustainable basis in the Bay of Bengal region http://www.boblme.org/	
UNCLOS	Species-specific	Listed under Annex I (Highly Migratory Species) of the United Nations Convention on the Law of the Sea http://www.unclos.com/	
Question 4.1(a) Are existing management measures appropriately designed and implemented to mitigate the pressures affecting the stock/population of the species concerned?			
Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MCS) measure(s)**	**Overall assessment of compliance regime (tick as appropriate)**
TRADE PRESSURE			
(a) Magnitude of legal trade	Closed season	State Department Officials through MFRA s	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)✓
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) At present no management measures are in place in India for *Manta birostris.*		
b) Magnitude of illegal trade			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)

			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no information on illegal trade.		
Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MCS) measure(s)**	**Overall assessment of compliance regime (tick as appropriate)**
FISHING PRESSURE			
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	State Department Officials through MFRA s	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) These management measures are all complied with but are not specific for this species.		
(b) Discard mortality			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)

			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Manta rays are not known to be discarded. All available information suggests that the species, when caught, is landed and traded		
(c) Size/age/ sex selectivity			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Since there is no targeted fishery for this species, and the individuals landed are caught as bycatch in different pelagic gears, there is no selective fishing based on size/age/sex.		
(d) Magnitude of IUU fishing	Marine patrolling	Monitoring and surveillance by Enforcement wing of SFDs, State Forest Dept., Indian Coast Guard&Coastal Police	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)

			Good (comprehensive relevant compliance measures in place)✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no report of IUU fishing for this species.		

Question 4.1(b) **Are existing management measures effective (or likely to be effective) in mitigating the pressures affecting the stock/population of the species concerned?**					
Factor	**Existing management measure(s)**	**Are relevant data collected and analysed to inform management decisions? (e.g. landings, effort, fisheries independent data)** *Tick as appropriate*		**Is management consistent with expert advice?** *Tick as appropriate*	
TRADE PRESSURE					
(a) Magnitude of legal trade	Closed season	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		Noexpertadviceon management identified	
		Limited relevant data are collected AND analysed to inform management		Notconsistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓

	Management measure(s) effective/likely to be effective? *(circle as appropriate)* **Yes** Partially No Insufficientinformation				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) All management measures are being complied with.				
(b) Magnitude of illegal trade	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Managemen tmeasure(s) effective/likely to be effective?*(circl ea sappropriate)* Yes Partially No **Insufficient information**				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on illegal trade.				

FISHING PRESSURE					
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Data is consistently collected and analyzed by the experts. All fish caught is retained for consumption or trade.				
(b) Discard mortality	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	

		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Discard of this species is not known. All individuals caught are landed and traded.				
(c) Size/ age/ sex selectivity	There is no selective fishing and this species does not form a targeted fishery. Species specific management measures have not been formulated.	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	

	Management measure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) No measures are in place to manage fishing of mantas in India. Comprehensive data is being collected by CMFRI. Elucidation of stock status needs to be done to evolve suitable management measures Elucidation of stock status needs to be done to evolve suitable management measures.				
(d) Magnitude of IUU fishing	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on IUU of this species in Indian waters				

Step 5			
Question 5.1 **Based on the outcomes of the previous steps, is it possible to make a positive NDF (with or without associated conditions or is a negative NDF required?**			
Step 2: Intrinsic biological vulnerability and conservation concern			
Intrinsic biological vulnerability (Question 2.1) Conservation concern (Question 2.2)			High Medium Low Unknown High Medium Low Unknown
Step 3: Pressure on species			**Step 4: Existing management measures**
Pressure	Level of severity (Questions 3.1 and 3.2)	Level of confidence (Questions 3.1 and 3.2)	Are the management measures effective* at addressing the concerns/pressures/ impacts identified? (Question 4.1(b)) **taking into account the evaluation of management appropriateness and implementation under Question 4.1(a)*
TRADE PRESSURE			
a) Magnitude of legal trade	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
b) Magnitude of illegal trade	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.			
a) Fishing mortality (retained catch)	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
b) Discard mortality	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
c) Size/ age/ sex selectivity	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
d) Magnitude of IUU fishing	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.

A) Can a positive NDF be made?	**YES** - *go to B*	**NO-***go to* ***Step 6*** *and list recommendations for measures to improve monitoring/ management under Reasoning/ comments below*
A) **Are there any mandatory conditions to the positive NDF?**	**YES** -*list under Reasoning/ comments below and go to C*	**NO-***go to C*
B) **Are there any other further recommendations?** *(e.g.for improvements to monitoring / management)*	**YES** - *goTo* ***Step 6*** *and list recommendations for measures to improve monitoring/ management under Reasoning/ comments below*	**NO**

Reasoning/comments *(include justification for decision made and information on mandatory conditions and/or further recommendations)*

Although a positive NDF is recommended for *Manta birostris*, since there is not sufficient information on the fishery and stock status, an NDF cannot be made for *Manta birostris* at present. All landing or trade or of this species must be closely monitored. A period of three years is required to reassess the fishery and elucidate the stock status, after which the NDF study must be repeated.

Step 6: Further measures

Section 6.1
Improvements in monitoring or information required

1. Population monitoring (fishery independent)
- Tag and release
- Abundance (survey data/collaboration)
- Identifying area & season breeding and nursery aggregations of the species

2. Population monitoring (fishery dependent)
- Fishery monitoring – species-specific landing observation, vessel monitoring systems, interviews, databases, logbooks
- Improved surveillance to check for IUU fishing
- Sharing of log data – species, catch, date & area of capture (geolocation) and gear
- Identifying area & season breeding and nursery aggregations of the species
- Biology and stock assessment studies (sex ratios, size/age structure, annual reproductive output, BRPs, fishing effort, BRPs)

3. Monitoring of domestic and international trade
- Improve the level of trade data reporting – data declaration by traders (species, source of obtaining the product, size of fish (length & weight), quantity, product form)
- Market survey, interviews with fishermen & traders, information from Customs & other databases, trade channels
- Species-specific product-specific code for trade
- Genetic analysis for ambiguous products

Section 6.2
Improvement of management required

1. Improvement in management measures
- Strict implementation of MFRAs regarding gear, mesh size, operation in no-take zones and closed seasons
- Strengthen Monitoring, Control and Surveillance (MCS)
- Improve participatory management through regional fishery management councils
- Create awareness through visual, print and electronic media and mass campaigns
- Seasonal closure of fishing in identified breeding/nursery grounds

References

CMS 2016. Convention on Migratory Species, http://www.cms.int/.

Compagno, L.J.V., Ebert, D.A. and Smale, M.J. 1989. Guide to the sharks and rays of southern Africa. New Holland (Publ.) Ltd., London. 158 p.

Couturier, L.I.E., Marshall, A.D., Jaine, F.R.A, Kashiwagi, T., Pierce, S.J., Townsend, K., Weeks, S.J., Bennett, M.B. and Richardson, A.J. 2012. Biology, ecology and conservation of the Mobulidae. Journal of Fish Biology, 80(5), 1075–1119. doi:10.1111/j.1095-8649.2012.03264.x

Dulvy, N.K., Fowler, S.L., Musick, J.A., Cavanagh, R.D.,Kyne, P.M., Harrison, L.R., Carlson, J.K., Davidson,L.N.K., Fordham, S.V., Francis, M.P., Pollock, C.M.,Simpfendorfer, C.A., Burgess, G.H., Carpenter, K.E.,Compagno, L.J.V., Ebert, D.A., Gibson, C., Heupel,M.R., Livingstone, S.R., Sanciangco, J.C., Stevens,J.D., Valenti, S. and White, W.T. (2014). Extinction risk and conservation of the world's sharks and rays. eLIFE 3:e00590. http://dx.doi.org/10.7554/eLife.00590

Heinrichs S., O'Malley M., Medd H. & Hilton P. (2011). The Global Threat to Manta and Mobula Rays. A Manta Ray of Hope Report. < http://www.mantarayofhope.com/downloads/The-Global-Threat-to-Manta-and-Mobula-Rays.pdf>. [Accessed 10th September, 2014].

Marshall, A. D. (2009). Biology and Population Ecology of *Manta birostris* in Southern Mozambique. *PhD thesis for the University of Queensland*

Marshall, A., Compagno, L. J. V., & Bennett, M. B. (2009). Redescription of the genus Manta with resurrection of *Manta alfredi* (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). Zootaxa, 1 – 28.

Marshall, A., Bennett, M.B., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M.,Stevens, G. and Kashiwagi, T. 2011. *Manta birostris*. In: IUCN 2012. IUCN Red List of Threatened Species.Version 2012.2 [online]. [Cited 13 March 2013]. www.iucnredlist.org.

Nair, R.J., Zacharia, P.U., Dinesh Kumar, S., Kishor, T.G., Divya, N.D., Seetha, P.K. and Sobhana, K.S. 2015. Recent trends in the mobulid fishery in Indian waters. Indian Journal of Geo-Marine Sciences. 44(10), 1265-1283.

Rajapackiam S, Mohan S & Rudramurthy N, Utilization of gill rakers of lesser devil ray *Mobuladiabolus* - a new fish byproduct, *Mar. Fish. Infor. Serv. T & E Ser*., 191(2007) 22-23.

Raje, S.G., Sivakami, S., Mohanraj, G., Manojkumar, P.P., Raju, A. and Joshi, K.K. 2007.

An Atlas on the elasmobranch fishery resources of India. CMFRI Spl. Publ. No.95, 253 pp.

Sivakumar, K. 2013. Coastal and Marine Biodiversity Protected Areas in India: Challenges and Way Forward, K. Venkataraman et al. (eds.), Ecology and Conservation of Tropical Marine Faunal Communities, Springer-Verlag Berlin Heidelberg.

Stevens, G. 2012a. Field Guide to the Identification of Mobulid Rays; Indo West Pacific. The Manta Trust. University of York.

Stevens, G. 2012b. Field Identification Guide of the Prebranchial Appendages (Gill Plates) of Mobulid Rays for Law Enforcement and Trade Monitoring Applications. The Manta Trust. University of York.

Ward-Paige CA, Davis B, Worm B (2013) Global Population Trends and Human Use Patterns of Manta and Mobula Rays. PLoS ONE 8(9): e74835. doi:10.1371/journal.pone.0074835

White, W.T., J. Giles, Dharmadi and I.C. Potter. (2006). Data on the bycatch fishery and reproductive biology of mobulid rays (Myliobatiformes) in Indonesia. *Fisheries Research* 82, 65–73.

Manta alfredi (Krefft 1868)

Step 1			
Question 1.1 (a) Is the specimen subject to CITES control? (How did you identify the species?)			
Species Name	**Product form**	**CITES Appendix**	**Source of identification**
Manta alfredi	Whole specimen, fresh and dried gill rakers	II	The specimen was identified by an expert from CMFRI at the point of landing following Stevens 2012a,b; Marshall et al. 2009
In the view of the above, is the specimen subjected to CITES control?	YES	II	Condition (c) is met, as mentioned above.
Concerns and uncertainties	Cartilage, meat has to be subjected to DNA analysis for correct identification at the point of trade and is not possible at the field level.		
Question 1.1 (b) From which stock will the specimen be taken/was the specimen taken? (Can the origin and stock be confidently identified?)			
		Description/ Comments	**Sources of information**
Ocean basin		Western Indian Ocean - Eastern Indian Ocean - including the seas around Andaman and Nicobar Islands.	Stevens, 2012; Nair ***pers. observ***
Stock location/distribution/ boundaries (Attach a map)		Indian EEZ. Present along the tropics and sub-tropics in the Indian and Pacific oceans.	NMFDC, ICAR-CMFRI
Is this a shared stock (i.e. occurring in more than one EEZ and/or the high seas?)		Not certain; probably yes	CMS Heinrichs, 2011.

If the stock occurs in more than one EEZ which other parties share this stock?	Not known	-
If a high seas stock which other parties fish this stock?	Sri Lanka, Maldives	Heinrichs, 2011
Which, if any, RFB(s) cover(s) the range of this stock?	Not known	-
Are all parties listed above (which fish or share the stock concerned) members of the relevant RFB(s)?	NA	-
Are there geographical management gaps?	Not certain	-
How reliable is the information on origin?	Reliable	Conditions **a** AND **c** have been met (the origin of the specimen has been identified to a sufficient level, and the origin of the specimen has been confirmed by an expert from CMFRI at the point of landing
Is the information on origin sufficiently detailed for Question 1.2 to be answered?		Yes

Question 1.2 **Was (will) the specimen (be) legally obtained and is export allowed?**		
Is the species:	**Description/ Comments**	**Sources of information**
Protected under wildlife legislation, regional biodiversity Agreement, or (for a CMS Party) listed in CMS Appendix 1?	No Yes	 Listed in Appendix I of CMS. India is a signatory to the CMS.

Sourced from illegal fishing activities (e.g. in contravention of finning regulations, or where a TAC is zero or exceeded)?	No	
Taken from a no-take marine protected area or during a closed season?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Taken in contravention of RFB recommendations, if any?	No	National Marine Fisheries Data Center (NMFDC), ICAR-CMFRI, Kochi
Listed as species whose export is prohibited?		Listed in Appendix I of CMS and Appendix II of CITES. India is a signatory to the CMS & CITES. http://www.cites.org/eng/cop/16/prop/E-CoP16-Prop-46.pdf
Of concern for any other reason?	Yes; Information is lacking on fishery and stock status.	
In view of the above and the final section of the Worksheet for Question 1.1(b), was the specimen legally acquired and can exports be permitted?		Yes; subject to conditions laid down by national regulations
Concerns and uncertainties:		Stock status and species-specific trade data not available. More studies have to be taken up on the fishery and stock status.

Question 1.3
What does the available management information tell us?

Part 1. Global-level information

	Description/Comments	**Sources of information**
Reported global catch	Total annual documented global landings are about 3,400 mantas (*M. birostris* only); however species specific catch data is not avaialable for *Manta alfredi*.	Heinrichs et al. 2011 FAO Fishstat

Species distribution	Indian distribution: West coast and South East coast (map provided) Global distribution: Angola, Ascension Is., Canary Is., Cape verde, Djibouti, Guinea, Guinea-Bissau, Madeira Is., Mauritania, Mauritius, Mayotte, Reunion, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Andaman Is., Chagos Is., China, Christmas Is., Cook Is. (Keel), Hongkong, India, Indonesia, Japan, Maldives, Ogasawara Is., Oman, Philippines, Taiwan, Vietnam, Yemen, Aruba, Bermuda, Canada, Cayman Is., Costa Rica, Cuba, Curaçao I., El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Puerto Rico, Revillagigedo, Trinidad Tobago, USA, Virgin Is. (US), Australia, Cook Is., Fiji, French Polynesia, Guam, Hawaii, Marquesas Is., Marshall Is., Micronesia, Midway Is., New Zealand, North Marianas, Palau, Papua New Guinea, Tonga, Tuamotu Is., Wake I., Brazil, Cocos I. (C.R.), Colombia, Ecuador, French Guiana, Galapagos Is., Guyana	Nair et al., 2015 (FAO) Marshall et al. (2011). Couturier et al. 2012

Known stocks/ populations	Populations recorded at most monitored aggregation sites range from around 100 to 700 individuals. Subpopulations estimates for Mozambique: 890; Maldives: 6000-9000 individuals; Ningaloo Reef Australia: 1200-1500 individuals, Maui Hawaii: 350*. Most sites observe a female bias. * These figures are from monitored aggregation sites only. Stock assessments are yet to be conducted in India	Marshall et al. 2016 http://dx.doi.org/10.2305/IUCN.UK.20112.RLTS.T195459A8969079.en.Downloaded on 30 July 2016.
Main catching countries	Sri Lanka, India, Peru, Maldives, Indonesia, Philippines, Ghana, Myanmar, China and Mozambique	Heinrichs et al. 2011 Couturier et al. 2012
Main gear types by which the species is taken	Gillnets, hooks and line	Marshall et al. 2011; NMFDC, ICAR-CMFRI
Global conservation status	IUCN status – Vulnerable	Marshall et al. 2011.
Multilateral Environmental Agreements	Listed in CITES Appendix II Listed in CMS Appendix I	CITES, 2014 CMS, 2016
Part 2: Stock/context-specific information		
Stock assessments	Sufficient landing data not available for stock assessment	

Main management bodies	State Fisheries Departments (SFDs), Ministry of Agriculture, Cooperation & Farmers Welfare (MoA), Ministry of Environment, Forests and Climate Change (MoEF&CC), National Biodiversity Board (NBB)	https://cof.gujarat.gov.in/contact-us.htm https://fisheries.maharashtra.gov.in/ http://fisheries.goa.gov.in/ http://www.karnataka.gov.in/fisheries/Pages/Home.aspx http://www.fisheries.kerala.gov.in/ http://www.fisheries.tn.gov.in/ https://www.py.gov.in/knowpuducherry/dept_fisheries.html http://apfisheries.gov.in/ http://www.odishafisheries.com/ http://www.wbfisheries.gov.in/wbfisheries/do/Forwordlink?val=32 http://agricoop.nic.in/# http://www.moef.nic.in/ http://nbaindia.org/
Cooperative management arrangements	Participatory management with Association of Deep Sea Going Artisanal Fishermen (ADSGAF), Thuthoor – National Mission on Conservation of Sharks - India (NMCSI)	http://deepseafishersindia.org/
Non-membership of RFBs	NA	
Nature of harvest	Bycatch	
Fishery types	Gillnet and longlines	NMFDC, ICAR-CMFRI
Management units	11 management units (SFDs) pertaining to territorial waters of each maritime state of India and 1 management unit pertaining to rest of the areas in Indian EEZ	MFRA of each maritime state of India http://164.100.150.120/mpeda/state_mfras.php# DADF http://dahd.nic.in/about-us/divisions/fisheries

Products in trade	Meat, skin, branchial plate, cartilage	Marine Products Export Development Authority (MPEDA) http://www.mpeda.com/HOMEPAGE.asp Statistics of Marine Products Seafood Export Association of India (SEAI) http://seai.in
Part 3: Data and data sharing		
Reported national catch(es)	All India average landings 40 t 2012 to 5 t in 2015	NMFDC, ICAR – CMFRI *National marine landings estimated by CMFRI not included in FAO statistics
Are catch and/or trade data available from other countries fishing this stock?	No	-
Reported catches by other countries	NA	
Catch trends and values	Catch has decreased during the last three years	NMFDC, ICAR-CMFRI
Have RFBs and/or other countries fishing this stock been consulted during or contributed data during this process?	NA	

Step 2		
Question 2.1 **What is the level of intrinsic biological vulnerability of the species?** *In the worksheet below, circle the level of vulnerability associated with each intrinsic biological factor.*		
Intrinsic biological factors	**Level of vulnerability**	**Indicator/Merit**
a) Median age at maturity	Low	
	Medium	6-8 years (Marshall et al. 2011)
	High	
	Unknown	
b) Median size at maturity	Low	
	Medium	
	High	270 – 300 cm for males and 370-390 cm for females (Clark, 2010; Deakos, 2010; (S. Mozambique) Marshall & Bennett, 2010).
	Unknown	
c) Maximum age/ longevity in an unfished population	Low	
	Medium	
	High	Greater than 31 years (Clark, 2010).
	Unknown	
d) Maximum size	Low	
	Medium	
	High	500 cm DW (Mozambique); 362 cm DW (Hawaii); 410 cm DW (Western Australia); 420 cm DW (Japan) (Marshall et al. 2011)
	Unknown	

e) Natural mortality rate (M)	Low	Unconfirmed, but assumed to be low (Marshall et al.2011)
	Medium	
	High	
	Unknown	
f) Maximum annual production (no. of pups per mature female)	Low	
	Medium	
	High	0.2 – 0.5 per annum (1 pup every 2-3 years in Mozambique; 1 pup every 5 years in Maldives).
	Unknown	
g) Intrinsic rate of population increase (r)	Low	
	Medium	
	High	0.050 (Ward-Paige et al., 2013)
	Unknown	
h) Geographical distribution of stock	Low	
	Medium	Found in tropics, subtropics and temperate waters. Populations partially restricted and sparsely distributed.
	High	
	Unknown	
i) Current stock size relative to historic abundance*(landing is taken as an indicator of the stock size)	Low	
	Medium	
	High	
	Unknown	No accurate data available in India; however; long term site fidelity has been recorded for *M. alfredi* in other parts of the world, such as Indonesia (Dewar et al. 2008), Mozambique (Marshall 2009), the Maldives (Kitchen-Wheeler 2012), Hawaii (Deakos et al. 2011).

j) Behavioural factors	Low	
	Medium	
	High	No information available
	Unknown	
k) Trophic level	Low	
	Medium	3.6 ±0.5 Likely low-medium based on feeding ecology
	High	
	Unknown	

SUMMARY for question 2.1
Intrinsic biological vulnerability of species

Provide an assessment of the overall intrinsic biological vulnerability of the species (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.

High✓	Medium	Low	Unknown

Explanation of conclusion and sources of information used:

High: Behavioural features, slow intrinsic rate of increase, low natural mortality, low, minimum population doubling time, long life span makes it highly vulnerable. Moreover, long term site fidelity has been recorded in other parts of the world.

Question 2.2
What is the severity and geographic extent of the conservation concern?

Based on existing stock assessments or conservation status assessments, evaluate the severity and geographic extent/scope of conservation concern by including reasons for conclusions drawn, and information on sources used.
In the worksheet below, circle the level of severity/scope of concern associated with each factor using the descriptions and indicator columns in Table B in the Guidance.

Conservation concern factors	Level of severity/scope of concern (circle as appropriate)	Indicator/metric

Conservation or stock assessment status	Low	
	Medium	Vulnerable (Marshall et al. 2011) IUCN
	High	
	Unknown	
	Comments: As per IUCN Red List it is listed as Vulnerable. Since landings of *Manta alfredi* on the Indian coast are less, the number of pups is also less, they are highly vulnerable to decline if caught indiscriminately. Assessment studies have to be done on national basis.	
Population trend	Low	
	Medium	
	High	
	Unknown	No stock/population trend data
	Comments: Not much information on the stock status of this species from Indian waters. However, landings data indicate there is no regular landing of this species along the Indian coast.	
Geographic extent/scope of conservation concern	Low	
	Medium	
	High	
	Unknown	There is insufficient data to evaluate the conservation status of the species, population or stock against defined criteria (IUCN Red List Category – Vulnerable).
	Comments: There is not much information on the stock status of this species from Indian waters.	

SUMMARY for question 2.2 Severity and geographic extent of the conservation concern *Provide an assessment of the overall severity and geographic extent of conservation concern for this species or stock (tick appropriate box below). Explain how these conclusions were reached and the main information sources used.*			
High✓	Medium	Low	Unknown
Explanation of conclusion and sources of information used: **High:** Not much information on the stock status of this species from Indian waters. No regular landing of this species along the Indian coast and the reported landing has decreased during the last few years; however, specific landing data for *Manta alfredi* is not available.			

Step 3		
Question 3.1 What is the severity of trade pressure on the stock of the species concerned?		
Factor	**Level of severity of trade pressure (*circle as appropriate*)**	**Indicator/metric**
a) Magnitude of legal trade	Low	
	Medium	
	High	
	(Unknown)	
	Level of confidence (*circle as appropriate*) Low (Medium) High	
Reasoning(e.g.hasthisassessmentinvolvedtheexerciseofprecaution,and/orhasseverityoftradepressurebeenincreasedinlightoftheassessmentinStep2?) Multiple use in domestic markets. Once landed there is regular trade for this species. Demand for fins is high but is subject to national regulations.		
b) Magnitude of illegal trade	Low	
	Medium	
	High	
	(Unknown)	
	Level of confidence (*circle as appropriate*) Low (Medium) High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There is no information on illegal trade.

Question 3.2 What is the severity of fishing pressure on the stock of the species concerned?		
Factor	**Level of severity of trade pressure (*circle as appropriate*)**	**Indicator/metric**
a) Fishing mortality (retained catch)	Low	
	(Medium)	Moderate proportion of the stock is probably caught as bycatch by multiple fishing gears
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low (Medium) High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

Since this species lives for a long period, natural mortality is less. However, the fish is landed occasionally by tuna longliners and gill netters as a bycatch.

b) Discard mortality	(Low)	
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium (High)	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

No information available on manta rays thrown back at sea. Since this is a solitary species and the chances of accidental gill netting are rare, throwing back the species into the seas may be rare. Sufficient data is not available on this.

c) Size/sex/age/selectivity	Low	All size classes are fished Nair et al. 2015
	Medium	
	High	
	Unknown	
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

All size groups are landed and more often the larger ones are caught in gill nets.

d) Magnitude of illegal, unreported and unregulated (IUU) fishing	Low	
	Medium	
	High	
	Unknown	No information
	Level of confidence (*circle as appropriate*) Low Medium High	

Reasoning (e.g. has this assessment involved the exercise of precaution, and/or has severity of trade pressure been increased in light of the assessment in Step2?)

There is no information on IUU fishing of this species.

Step 4		
Preliminary Stage Compile information on existing management measures		
Existing management measures (see Annex 5 for examples)	**Is the measure generic or species-specific?**	**Description/comments/sources of information**
(SUB-NATIONAL)		
Seasonal ban on mechanized fishing	Generic	Closure of mechanized fishing activities for 60 days from 15th April to 15th June along east coast and 1st June to 31st July along west coast (both days inclusive), implemented through State MFRAs.

No take zones	Generic	There are 33 Marine ProtectedAreas where fishing activities where fishing activities are regulated (Sivakumar, 2013).
Gear-specific regulations	Generic	Regulation of mesh size, restrictions on operation of certain gears like ring seines, purse seines and pair trawling, implemented through State MFRAs. http://indianfisheries.icsf.net/en/page/827-Indian%20Legal%20Instruments.html http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112187832409***Gujarat_Marine_Fisheries_Rules_2003.PDF http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112240177836***Maharashtra_Marine_Fishing_Regulation_Rules,_1982.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_goa.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_karnataka_1987.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_kerala.pdf http://164.100.150.120/mpeda/pdf/state_mfras/mfra_tamil_nadu.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1165227972133***Andra_Pradesh_Marine_Fishing_Regulation_Rules_1995_Amendment_dated_26th_October_2004.PDF http://164.100.150.120/mpeda/pdf/state_mfras/mfra_orrissa.pdf http://old.icsf.net/icsf2006/uploads/resources/legalIndia/pdf/english/state/1112241236819***West_bengal_Marine_Fishing_Regulation_(Amendment)_Rules,_1998.PDF
REGIONAL/INTERNATIONAL		
CITES	Species-specific	Inclusion of the species in CITES Appendix II w.e.f. September 2014 http://www.cites.org/eng/app/appendices.php
CMS	Species-specific	Inclusion of the species in Appendix I of CMS http://www.sharksmou.org/ http://www.cms.int/species/index.htm

IUCN	Species-specific	Listed as Vulnerable (IUCN, 2015) http://www.iucn.org/
BOBLME	Generic	Evolve a common strategy to optimize the use of marine resources on a sustainable basis in the Bay of Bengal region http://www.boblme.org/
UNCLOS	Species-specific	Listed under Annex I (Highly Migratory Species) of the United Nations Convention on the Law of the Sea http://www.unclos.com/

Question 4.1(a)
Are existing management measures appropriately designed and implemented to mitigate the pressures affecting the stock/population of the species concerned?

Factor	Existing management measure(s)	Relevant monitoring, control and surveillance (MCS) measure(s)	Overall assessment of compliance regime (tick as appropriate)
TRADE PRESSURE			
(a) Magnitude of legal trade	Closed season	State Department Officials through MFRA s	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place) ✓
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) At present no management measures are in place in India for *Manta birostris.*		

b) Magnitude of illegal trade			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no information on illegal trade.		
Factor	**Existing management measure(s)**	**Relevant monitoring, control and surveillance (MCS) measure(s)**	**Overall assessment of compliance regime (tick as appropriate)**
FISHING PRESSURE			
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	State Department Officials through MFRA s	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place) ✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) These management measures are all complied with but are not specific for this species.		

(b) Discard mortality			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Manta rays are not known to be discarded. All available information suggests that the species, when caught, is landed and traded		
(c) Size/age/ sex selectivity			Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) Since there is no targeted fishery for this species, and the individuals landed are caught as bycatch in different pelagic gears, there is no selective fishing based on size/age/sex.		

(d) Magnitude of IUU fishing	Marine patrolling	Monitoring and surveillance by Enforcement wing of SFDs, State Forest Dept., Indian Coast Guard&Coastal Police	Unknown (no information on compliance)
			Poor (limited relevant compliance measures in place)
			Moderate (some relevant compliance measures in place)
			Good (comprehensive relevant compliance measures in place)✓
	Reasoning/comments (e.g. Are management measures being implemented to varying degrees? Which compliance measures are lacking?) There is no report of IUU fishing for this species.		

Question4.1(b) **Are existing management measures effective (or likely to be effective) in mitigating the pressures affecting the stock/population of the species concerned?**					
Factor	**Existing management measure(s)**	**Are relevant data collected and analysed to inform management decisions?(e.g. landings, effort, fisheries independent data)** *Tick as appropriate*		**Is management consistent with expert advice?** *Tick as appropriate*	
TRADEPRESSURE					
(a) Magnitude oflegal trade	Closed season	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	

		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s) effective/likely to beeffective? *(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g.Is effectiveness compromised by poor design and/orimplementation, or is a greater diversity or amount of management required?What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) All management measures are being complied with.				
(b) Magnitude of illegal trade	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s)effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**				

	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/orimplementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on illegal trade.				
FISHING PRESSURE					
(a) Fishing mortality (retained catch)	Closed season Gear regulations MPA's	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management	✓	Consistent	✓
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Data is consistently collected and analyzed by the experts. All fish caught is retained for consumption or trade.				
(b) Discard mortality	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	

		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* Yes Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) Discard of this species is not known. All individuals caught are landed and traded.				
(c) Size/age/ sex selectivity	There is no selective fishing and this species does not form a targeted fishery. Species specific management measures have not been formulated.	No data OR data are of poor quality OR data are not analysed (adequately) to inform management		No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management	✓	Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	

	Management measure(s)effective/likely to be effective?*(circle as appropriate)* **Yes** Partially No Insufficient information				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) No measures are in place to manage fishing of mantas in India. Comprehensive data is being collected by CMFRI. Elucidation of stock status needs to be done to evolve suitable management measures Elucidation of stock status needs to be done to evolve suitable management measures.				
(d) Magnitude of IUU fishing	NA	No data OR data are of poor quality OR data are not analysed (adequately) to inform management	✓	No expert advice on management identified	✓
		Limited relevant data are collected AND analysed to inform management		Not consistent	
		Some relevant data are collected AND analysed to inform management		Expert advice partially implemented	
		Comprehensive data collected AND analysed to inform management		Consistent	
	Management measure(s) effective/likely to be effective?*(circle as appropriate)* Yes Partially No **Insufficient information**				
	Reasoning/comments (e.g. Is effectiveness compromised by poor design and/or implementation, or is a greater diversity or amount of management required? What data are required to better inform and evaluate management decisions? How is management inconsistent with expert advice?) There is no information on IUU of this species in Indian waters				

Step 5			
Question 5.1 **Based on the outcomes of the previous steps, is it possible to make a positive NDF (with or without associated conditions or is a negative NDF required?**			
Step 2: Intrinsic biological vulnerability and conservation concern			
Intrinsic biological vulnerability (Question 2.1)			(High) Medium Low Unknown
Conservation concern (Question 2.2)			(High) Medium Low Unknown
Step 3: Pressure on species			**Step 4: Existing management measures**
Pressure	Level of severity (Questions 3.1 and 3.2)	Level of confidence (Questions 3.1 and 3.2)	Are the management measures effective* at addressing the concerns/pressures/ impacts identified? (Question 4.1(b)) **taking into account the evaluation of management appropriateness and implementation under Question 4.1(a)*
TRADE PRESSURE			
a) Magnitude of legal trade	High (Medium) Low Unknown	(High) Medium Low	(Yes) Partially No Insufficient information Not applicable**
b) Magnitude of illegal trade	High Medium Low (Unknown)	High Medium (Low)	Yes Partially No (Insufficient information) Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.			
a) Fishing mortality (retained catch)	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
b) Discard mortality	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
c) Size/ age/ sex selectivity	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**
d) Magnitude of IUU fishing	High Medium Low Unknown	High Medium Low	Yes Partially No Insufficient information Not applicable**

Only to be used where the fishing pressure severity was assessed as "Low" for any of the Factors in **Step 3 and a judgement is made that the impacts on the shark stock/ population concerned are so low that mitigation is not required.

A)	**Can a positive NDF be made?**	**YES** - *go to B*	**NO** - *go to* ***Step 6*** *and list recommendations for measures to improve monitoring/ management under Reasoning/comments below*
B)	**Are there any mandatory conditions to the positive NDF?**	**YES** - *list under Reasoning/ comments below and go to C*	**NO-***gotoC*
X)	**Are there any other further recommendations?** *(e.g.for improvements to monitoring/ management)*	**YES** - *go to* ***Step 6*** *and list recommendations for measures to improve monitoring/ management under Reasoning/ comments below*	**NO**

Reasoning/comments *(include justification for decision made and information on mandatory conditions and/or further recommendations)*

Since there is not sufficient information on the fishery and stock status an NDF cannot be made for *Manta alfredi* at present. All landing or trade of this species must be closely monitored. A period of three years is required to reassess the fishery and elucidate the stock status, after which the NDF study must be repeated.

Step 6: Further measures

Section 6.1
Improvements in monitoring or information required

1. Population monitoring (fishery independent)
- Tag and release
- Abundance (survey data/collaboration)
- Identifying area & season breeding and nursery aggregations of the species

2. Population monitoring (fishery dependent)
- Fishery monitoring – species-specific landing observation, vessel monitoring systems, interviews, databases, logbooks
- Improved surveillance to check for IUU fishing
- Sharing of log data – species, catch, date & area of capture (geolocation) and gear
- Identifying area & season breeding and nursery aggregations of the species
- Biology and stock assessment studies (sex ratios, size/age structure, annual reproductive output, BRPs, fishing effort, BRPs)

3. Monitoring of domestic and international trade
- Improve the level of trade data reporting – data declaration by traders (species, source of obtaining the product, size of fish (length & weight), quantity, product form)
- Market survey, interviews with fishermen & traders, information from Customs & other databases, trade channels
- Species-specific product-specific code for trade
- Genetic analysis for ambiguous products

Section 6.2
Improvement of management required

1. Improvement in management measures
- Strict implementation of MFRAs regarding gear, mesh size, operation in no-take zones and closed seasons
- Strengthen Monitoring, Control and Surveillance (MCS)
- Improve participatory management through regional fishery management councils
- Create awareness through visual, print and electronic media and mass campaigns
- Seasonal closure of fishing in identified breeding/nursery grounds

References

Clark, T.B. 2010. Abundance, home range, and movement patterns of manta rays (*Manta alfredi, M. birostris*) in Hawai'i, University of Hawai'i, Mãnoa.

CMS 2016. Convention on Migratory Species, http://www.cms.int/.

Couturier, L.I.E., Marshall, A.D., Jaine, F.R.A, Kashiwagi, T., Pierce, S.J., Townsend, K., Weeks, S.J., Bennett, M.B. and Richardson, A.J. 2012. Biology, ecology and conservation of the Mobulidae. Journal of Fish Biology, 80(5), 1075–1119. doi:10.1111/j.1095-8649.2012.03264.x

Deakos, M.H. 2010. Paired-laser photogrammetry as a simple and accurate system for measuring the body size of free-ranging manta rays *Manta alfredi*. Aquatic Biology 10, 1–10.

Deakos, M.H., Baker, J.D. and Bejder, L 2011. Characteristics of a manta ray *Manta alfredi* population off Maui, Hawaii, and implications for management. Marine Ecology Progress Series, 429, 245-260.

Dewar, H., Mous, P., Domeier, M., Muljadi, A., Pet, J. and Whitty, J. 2008. Movements and site fidelity of the giant manta ray, *Manta birostris*, in the Komodo Marine Park, Indonesia. Marine Biology, 155(2), 121-133.

Heinrichs S., O'Malley M., Medd H. & Hilton P. (2011). The Global Threat to Manta and Mobula Rays. A Manta Ray of Hope Report. < http://www.mantarayofhope.com/downloads/The-Global-Threat-to-Manta-and-Mobula-Rays.pdf>. [Accessed 10th September, 2014].

Kitchen-Wheeler, A.M. 2010. Visual identification of individual manta ray (*Manta alfredi*) in the Maldives Islands, Western Indian Ocean. Marine Biology Research, 6(4), 351-363.

Marshall, A. D. 2009. Biology and Population Ecology of *Manta birostris* in Southern Mozambique. *PhD thesis for the University of Queensland*

Marshall, A.. and Bennett, M.B. 2010. Reproductive ecology of the reef manta ray (*Manta alfredi*) in southern Mozambique. Journal of Fish Biology 77, 169-190.

Marshall, A., Compagno, L. J. V., & Bennett, M. B. 2009. Redescription of the genus Manta with resurrection of *Manta alfredi* (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). Zootaxa, 1 – 28.

Marshall, A.D, Kashiwagi, T., Bennett, M. B., Deakos, M. H., Stevens, G., McGregor, F., Clark, T., Ishihara, H. and Sato, K. 2011. *Manta alfredi.* In: IUCN Red List of Threatened Species. Version 2011. 1. Available at www.iucnlist.org

Nair, R.J., Zacharia, P.U., Dinesh Kumar, S., Kishor, T.G., Divya, N.D., Seetha, P.K. and Sobhana, K.S. 2015. Recent trends in the mobulid fishery in Indian waters. Indian Journal of Geo-Marine Sciences. 44(10), 1265-1283.

Sivakumar, K. 2013. Coastal and Marine Biodiversity Protected Areas in India: Challenges and Way Forward, K. Venkataraman et al. (eds.), Ecology and Conservation of Tropical Marine Faunal Communities, Springer-Verlag Berlin Heidelberg.

Stevens, G. 2012a. Field Guide to the Identification of Mobulid Rays; Indo West Pacific. The Manta Trust. University of York.

Stevens, G. 2012b. Field Identification Guide of the Prebranchial Appendages (Gill Plates) of Mobulid Rays for Law Enforcement and Trade Monitoring Applications. The Manta Trust. University of York.

Ward-Paige CA, Davis B, Worm B (2013) Global Population Trends and Human Use Patterns of Manta and Mobula Rays. PLoS ONE 8(9): e74835. doi:10.1371/journal.pone.0074835

White, W.T., J. Giles, Dharmadi and I.C. Potter. (2006). Data on the bycatch fishery and reproductive biology of mobulid rays (Myliobatiformes) in Indonesia. *Fisheries Research* 82, 65–73.

Stevens, G. 2012a. Field Guide to the Identification of Mobulid Rays; Indo West Pacific. The Manta Trust. University of York.

Stevens, G. 2012b. Field Identification Guide of the Prebranchial Appendages (Gill Plates) of Mobulid Rays for Law Enforcement and Trade Monitoring Applications. The Manta Trust. University of York.

Ward-Paige CA, Davis B, Worm B (2013) Global Population Trends and Human Use Patterns of Manta and Mobula Rays. PLoS ONE 8(9): e74835. doi:10.1371/journal.pone.0074835

SPECIES FACT SHEETS

Scalloped hammerhead shark *Sphyrna lewini*

Local names:

Kannar (Guj), Kombuthatae/ Kebae (Karn) Magala, Kanmushi, Kannar (Mar) Chadayansravu (Mal) Kombansorrah (Tamil), Koma-sorrah (Tel)

Distribution:

Global: Circumglobal in warm tropical and temperate seas.

Indian waters: all along the coast

Conservation Status:

IUCN redlist: Endangered

CITES: Appendix II

Identification: A large hammerhead with a distinct notch at the center of head; first dorsal fin moderately high, second dorsal and pelvic fins low. Front margin of head broadly arched with prominent median notch. Side wings of head narrow, rear margins swept backward. Uniform grey, greyish brown, or olivaceous above, shading to white below; pectoral fins tipped with grey or black ventrally.

Biology:

Size at birth:38-50 cm TL

Litter size : 15-40 embryos

Length at maturity:

140 – 165 cm TL for males and 200 cm TL for females

Maximum total length: 385 cm

Threats: Increasing fishing pressure in Indian waters. Juvenile catch all along the coast.

Current trends: Average landing of *S. lewini* along Indian coast is about 621 t (2007-2015). Maximum catch was during 2007 (1070t) which decreased to 627 t in 2015. *S. lewini* forms only 0.73 % of the total shark landings in India. Trawl is the major gear by which the species is caught (dominantly juveniles) followed by gill net and hook and line

How can you help: Avoid fishing in juvenile habitats and spawning grounds. Share information.

Great hammerhead shark *Sphyrna mokarran*

Local names:

Kannar (Guj), Kombuthate/ Kebae (Karn) Magala, Kanmushi, Kannar (Mar) Chadayansravu (Mal) Kombansorrah (Tamil), Koma-sorrah (Tel)

Distribution:

Global: Circumglobal in warm tropical and temperate seas.
Indian waters: all along the coast, but rare

Conservation Status:

IUCN Red list: Endangered
CITES: Appendix II

Identification: A large hammerhead shark, head nearly straight, deep median indentation, Indentations on each side of the head before eye, First dorsal fin extremely large and strongly falcate, High second dorsal fin with a strongly concave rear margin, Falcate pelvic fins, Deeply notched posterior anal margin. Colour: Dark brown to light grey or olive dorsally, white ventrally.

Biology:

Size at birth : 50-70 cm TL	Length at maturity Male: 225 cm Female: 210 cm
Litter size: 6-33 embryos	Maximum total length: 610 cm

Threats: Increasing fishing pressure in Indian waters. Juvenile catch all along the coast.

Current trends: All India average landing of *S. mokarran* was about 9t (2007-2015). Maximum catch was during 2007 (17t) which decreased to 7t in 2015. Trawl is the major gear by which the species is caught followed by gill net and hook and line

How can you help: Avoid fishing in juvenile habitats and spawning grounds. Share information.

Smooth hammerhead shark *Sphyrna zygaena*

Local names: Kannar (Guj), Kombuthate/ Kebae (Karn) Magala, Kanmushi, Kannar (Mar) Chadayansravu (Mal) Kombansorrah (Tamil), Koma-sorrah (Tel)

Distribution:

Global: Circumglobal in tropical and sub-tropical seas. Coastal pelagic semi oceanic, 0-200 m depths. In shore and offshore, common in depths below 20 m.

India: All along the Indian coast including its Islands, not a common species stray occurrence in fishery.

Status:

IUCN Red list: Vulnerable

CITES: Appendix II

Identification: The smooth hammerhead is easily recognized by the broadly arched anterior margin of its hammerhead without a median notch at any stage. First dorsal fin high, broad, moderately falcate, its origin over pectoral fin inner margins, free rear tip ends well before pelvic fin origin. Second dorsal fin small/low, less than anal height, with short free rear tip not reaching upper caudal fin origin, weakly concave posterior margin and long inner margin about twice fin height, its origin slightly posterior to anal fin origin. Pelvic fins low and not falcate, with nearly straight posterior edges. Anal base about as large as/larger than second dorsal base, its posterior margin is deeply notched. Prenarial grooves well-developed. The underside of free rear tip is stark white in contrast to dorsal skin, and colour is more olive-brown

Biology:

Size at birth : 50-60 cm TL

Length at maturity: 210-270 cm TL for females
210-250 cm TL for males

Litter size : 20-50

Maximum total length: 500 cm

Threats: Increasing fishing pressure in Indian waters. Mean size in the landings is close to or slightly under the size at maturity. Frequent juvenile captures from coastal waters.

Current trends: Not a regular component in the fishery; likely to be misidentified in trade with other hammerheads; stock status in Indian waters unassessed due to paucity of data.

How can you help: Share information on fishing/juvenile grounds and catch details. Ensure closure of fishing in areas of juvenile aggregation.

Oceanic whitetip shark *Carcharhinus longimanus*

Local names: Kannar (Guj), Kombuthate/ Kebae (Kann), Magala, Kanmushi, Kannar (Marathi), Paalsorrah (Tam), Koma-sorrah (Tel)

Distribution:

Global: Circumglobal in tropical and sub-tropical seas andformerly most abundant pelagic shark in ocean.

India: All along the Indian coast including its Islands, rare in northwest coast and north eastern regions.

Status:

IUCN red list: Vulnerable, **UNFSA:** Highly migratory Species

CITES: Appendix II

IOTC: To be released back to the sea, live, to the extent possible when caught as by-catch in IOTC associated fisheries

INDIA: Not a common species mostly landed as by-catch of longlining. Landing has been steadilyincreasing since 2010 due to increased longline efforts. Regional assessment needed.

Identification: A large sized grey /brownishshark, with whitish belly (sometimes with a yellow tinge). bluntly rounded snout. Conspicuously huge, rounded, white tipped first dorsal-fin, long, white-tipped pectoral fins and caudal fin. Pelvic fins, apices of anal and second dorsal, and ventral lobe of caudal often with black spots.

Biology:

Size at birth: 38-50 cm

Length at maturity: Male: 190-210 cm
Female: 180-200 cm

Litter size :9-15

Maximum total length: 400 cm

Threats: Increasing fishing pressure in Indian waters. Mean size in the landings is close to or slightly under the size at maturity.

Current trends: Average annual landing of *C. longimanus* along Indian coast is about 107.2 t (2007-2015). Maximum landing was in 2014 (381.2 t) which decreased to 283.6 t in 2015.

C. longimanus forms 1.2 % of the total shark landings in India. Pelagic longline is the major gear with which the species is caught, followed by gill net, hook and line and pelagic trawl net.

How can you help: Share information on fishing/juvenile grounds and catch. Release back live sharks to the extent possible – this shark has a post-release survival rate of 75%.

Giant manta ray *Manta birostris*

Local names: Aanathirandi (Mal), Yanaithirvkkai (Tam)

Distribution:

Global: Circumglobal in tropical and sub-tropical seas.

Indian waters: Rare in northern Arabian Sea coast fishery landings, common in southern coasts and Bay of Bengal.

Conservation Status:

IUCN Redlist: Vulnerable
CITES: Appendix II listed

Identification: Dark bluish grey on dorsal surface, broad flattened body with fins spread, with terminal mouth; spine absent on spine. Ventral surface with black coloured at outer end and at the lower edge of the gill slits and mouth. Knob-like bulge at the base of the tail just posterior to the dorsal fin, ventral spot pattern clustered around the lower abdominal region.

Biology:

Size at birth :150 cm DW	Length at maturity: 256 cm DW (males) 413 cm DW (female)
Litter size: 1	Maximum length: 680 cm DW

Threats: Increasing fishing pressure in Indian waters. High value trade in gill rakers. Large size, migratory in nature.

Current trends:The species was initially landed only very rarely along the southwest coast and more on the east coast. However, landings rose to 40 t in 2012 and thereafter decreased to 5 t in 2015.

How can you help: Share information on fishing grounds and catch. Pass on photos and details of juveniles whenever you obtain them. Create awareness among fishermen and traders about the high biological vulnerability of this species.

Reef manta ray *Manta alfredi*

Local names: Aanathirandi (Mal),Yanaithirvkkai (Tam)

Distribution

Global: Found in tropics, subtropics and temperate waters. Populations partially restricted and sparsely distributed.

Indian waters: Very rare species, reported only on the southern west coast from Kerala

Conservation status:

IUCN: Vulnerable
CITES: Appendix II

Identification: Dark bluish grey on dorsal surface, broad flattened body with fins spread, with terminal mouth; DW 2.2-2.4 times as broad in length, spine absent on slender whip-like tail. Ventral surface white with black markings in the inter gillslit areas.

Biology:

Size at birth:180 cm DW

Length at maturity:270 – 300 cm DW (males)
370-390 cm DW (females)

Litter size: 1 every 2-5 years

Maximum total length: 500 cm DW

Threats: Increasing fishing pressure in Indian waters. High value trade of gill rakers and large size of the animal.

Current trends: No catch details available for this species as it is a rare recording.

How can you help: Share information on fishing grounds and catch. Pass on photos and details of juveniles whenever you obtain them. Create awareness among fishermen and traders about the high biological vulnerability of this species.

STAKEHOLDER CONSULTATIONS

Stakeholder Consultations on Non-Detriment Findings (NDF) for CITES Appendix II listed species of sharks and manta rays

A series of stakeholder consultations were held at different centres in the Indian maritime states to present the outcome of the study and obtain stakeholder opinion on the same. The stakeholder meetings were held at Visakhapatnam on 24/08/16, Tuticorin on 26/08/16, Mumbai, Chennai and Mandapam on 27/08/16, Veraval on 29/08/16, Mangalore on 01/09/16, Cochin on 08/09/16 and Thuthoor on 01/10/16. The meetings were convened by ICAR-CMFRI and attended by fishermen, fisher union leaders, merchants and exporters associated with shark fisheries and representatives from NGOs, along with the officials from the State Fisheries Departments, Wildlife Departments, MPEDA and other Government agencies.

The stakeholders were briefed about the NDF, its necessity and how it functions. Scientists of Demersal Fisheries Division at the respective centres presented the biological characters and vulnerability status of the 4 species of sharks and 2 species of manta rays in question. The outcome of the NDF study was positive for the shark species with conditions for management improvement. For the manta rays, no NDFs are possible at present since there is paucity of information on the fishery trade. Hence, a period of three years is suggested to gather relevant information and repeat the NDF study with mandatory conditions to monitor and regulate the fishery and trade, along with conditions to improve management. Fishermen and traders/exporters shared their experience of fishing and trade in these species. Fishermen unanimously agreed that these species do not form targeted fisheries along the Indian coast, and are mostly obtained as by-catch of other fisheries. At all the centres the stakeholders agreed to the recommendations included in the NDF, and expressed their willingness to share information of capture and trade details of the resources. They also stressed on the need to review the document after five years. A major action plan suggested is the setting up of a data-sharing platform between all the stakeholders include researchers and management authorities to fill up the existing gaps in available data and evolve better species-specific management measures. All stakeholders also stressed the need for better awareness generation on the status and biological vulnerability of these resources.

VISAKHAPATNAM

A meeting of major stakeholders of the marine fisheries sector of Andhra Pradesh was held at Visakhapatnam RC of CMFRI on 24 August 2016. Nearly 20 participants from state and central fisheries agencies, fishermen co-operative societies and NGOs attended the program. The state government was represented by the In-Charge Joint Director

(Fisheries) of Visakhapatnam along with the FDO (Vizag). Other central government agencies that were represented include Research Centre of CIFT. The fishing industry was represented by the members of the mechanized fishing boat owners' associations of Visakhapatnam. Members of various motorized fishermen societies and NGOs of Visakhapatnam district were also present. Stakeholders from the processing industry were also present during the meeting. The major points of the draft NDF document prepared by CMFRI were presented to the stakeholders. Fishermen agreed to the recommendations as put forth by CMFRI in the NDF report.

TUTICORIN

A stakeholders meeting on Non-Detrimental Findings for the CITES Appendix II listed species of sharks and manta rays was conducted at Tuticorin RC of CMFRI on 26th August 2016. The programme was attended by 25 fisherfolk from fishing villages in and around Tuticorin. Shri. Amal Xavier (Joint Director of Fisheries, Tuticorin District), Dr. Shine Kumar (Deputy Director of MPEDA, Tuticorin), Inspector of Fisheries, Tuticorin, Scientist and Technical staffs of TRC of CMFRI also participated in the meeting.The major points of the draft NDF document prepared by CMFRI were presented to the stakeholders. All the stakeholders agreed for positive NDF on the shark species. In thecase of *M.birostis* the fishermen suggested conditional positive NDF while for *M. alfredi* they suggested negative NDF. All the fishermen unanimously demanded compensation for loss of net, revenue loss due to release of live manta rays, banned sharks and other fishes back to the seas. The fishermen expressed concern over the fact while they do not target any of the protected elasmobranch species, sometimes the animals get entangled in their gear, in which case, they (the fishermen) are taken to task by the Government (Wildlife Authority); they requested that in the event of accidental entangling, charges should not be framed against them. They also stressed on the need for appropriate training to the law enforcing officers for identification of specimens. All the stakeholders insisted on a review of the NDF after five years.

MUMBAI

A stakeholders meeting to discuss the draft Non-Detriment Finding (NDF) document on CITES Appendix II listed species of sharks and manta rays was conducted on 27th August, 2016 at Mumbai RC of CMFRI in the Bal auditorium of ICAR-CIFE Mumbai. The meeting was attended by the fishermen, fisher union leaders, merchants and exporters associated with shark fisheries along with the officials from the State Fisheries Department, Govt. of Maharashtra, Fishery Survey of India (FSI), Scientists, technical staff and researchers from Central Institute of Fisheries Education (CIFE) and RC of CMFRI, Mumbai. The stakeholders were briefed about the NDF, its necessity and how it functions. The biological characters and vulnerability status of 4 species of sharks and 2 species of rays in CITES were explained and fishers shared their experience during fishing. The stakeholders agreed on the vulnerable nature of these resources and also shared their concern about the status of these elasmobranch species along Maharashtra coast. They opined that since elasmobranchs are not targeted resources in the state, ban for fishery and trade will not have much impact on the fishery in Maharashtra waters. They stressed that the species listed in CITES are not targeted fisheries along Maharashtra coast and form only a very negligible portion of the catch, however they agreed that juveniles of hammerheads and other sharks are caught in large quantity as bycatch in commercial fishery. Fishermen and traders welcomed and offered support for all initiatives by CMFRI for further studies. All the stakeholders supported the NDF recommendations put forth but reiterated that that they should not be punished for accidental catches of protected animals.

CHENNAI

A meeting of stakeholders from the marine fishing and north Tamil Nadu was held at Chennai RC of CMFRI on 24 August 2016. The participants included fishermen from mechanized and artisanal sectors, traders, representatives from State Fisheries Department, MPEDA and scientists and technical staff of the centre. The background and major findings of the NDF study carried out by CMFRI were presented to the stakeholders. A description of the biological vulnerability and fishery status of the CITES species was also presented for the benefit of the fishermen. The stakeholders

agreed to the recommendations of positive NDFs put forth by CMFRI in the NDF report. They also assured their support in fulfilling the condition set out in the NDFs and agreed that the NDFs had to be reviewed after five years. They also agreed to share relevant information on manta ray landings and trade to help in reassessment. The traders expressed concern over the total ban on shark fin trade and requested that it must be looked into. All the stakeholders opined that CMRI should take a lead role in drafting management actions to regulate shark fishing and trade for conservation of the species. They also agreed to share all possible information on occurrences, incidental landings and trade in any of he CITES listed and protected species.

MANDAPAM

The meeting conducted at Mandapam Regional Centre of ICAR-CMFRI on 27th of August 2016 was attended by fishermen, boat owners, leaders of fishermen associations, official from State Fisheries Department and exporters associated with shark fisheries The stakeholders were appraised about the NDF for the CITES listed species based on these biological and fisheries characteristics of the species and their feedback were collected accordingly. All the stakeholder's opined that the listed species seldom formed a fishery along Mandapam coast and there is no regular targeted fishery for the same. They expressed the need to exercise caution before protecting any shark species under the Indian Wildlife (Protection) Act, 1972. They also expressed their doubts on the chances of post-release survival of sharks which had been captured by hooks.

VERAVAL

A stakeholder consultation to discuss the Non-Detriment Finding (NDF) on the selected 4 shark species, and 2 ray species, was organized at Veraval Regional Centre of ICAR-CMFRI on 29 August 2016. The meeting was attended by the fishermen and exporters associated with shark fisheries along with the officials from the State Fisheries Department, Marine Product Export Development Authority (MPEDA) and Export Inspection Agency (EIA). Scientists and the technical officers of the Centre also attended the meeting and participated in the discussions.The fishermen stated that while elasmobranchs once formed a lucrative fishery in the state, it lost its market when the shark fin trade was banned and now most of the shark fishers have diverted for other resources. They expressed their concern about the status of these species along Indian coast. They said that the species included under CITES Appendix II are not targeted fisheries along the Gujarat coast and only form very negligible and irregular by-catch which are landed occasionally along with the targeted resources. Therefore, any ban for fishery and trade may not affect the stock status of these species considerably in Gujarat waters. According to the fishermen, putting a ban on the ray species will not help in the conservation as these are very sensitive and delicate species which die quickly after encountering the gear. Since the chances of revival is very slim after the catch, discarding these species will not add any benefit to the fishermen, especially for the artisanal fishermen who depend on small scale traditional gill net fishing for their livelihood. Removal of these dead or about to die ray species from the gear not only damage the net but also increase the risk of subsequent net damage for other fishermen when discarded as such in to the sea. They also insisted that in the case of protected species, penalty should be imposed only on the fishermen who target the same. They also suggested that there should be some reward system in place for the live release of live sharks and rays to the sea.They requested that they should be provided with some user-friendly field identification tools for these sharks and ray species because many of them look alike and distinguishing the banned species from those that are not banned might not be always practicable for them. They were agreeable to positive NDFs for all the CITES listed shark species.

MANGALORE

A meeting of stakeholders from the fisheries sector was organized at the center to discuss on NDF document prepared for CITES Appendix II listed species of sharks and rays on 01 September 2016. State officials, fish merchants, trawl boat owners and fishermen, and officials from the Wildlife Department and Scientists and Technical staff of the centre participated in the meeting. The stakeholders were briefed about the background of the NDF study and the highlights of the findings were presented. In the discussion that followed the fishermen told that the species of concern in the NDF document formed only a negligible quantity in the fishery and no export of these species in any form was there from Karnataka. They agreed to the recommendations included in the NDF. They were ready to share the information of the capture details of the resources if required. The officials also agreed to the recommendations of the NDF and stressed on the review of the document after five years.

COCHIN

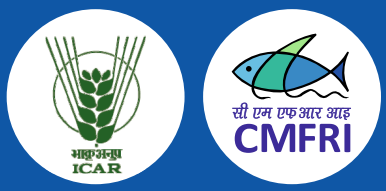
Stakeholders meeting to discuss the draft Non-Detriment Finding (NDF) document on CITES Appendix II listed species of sharks and manta rays was conducted on 08th Sept, 2016 at CMFRI, Kochi at 11.30 A.M. The meeting was attended by fishermen, fisher union leaders, merchants and exporters associated with shark fisheries along with the officials from the NetFish, Marine Products Exports Development Authority and Wildlife Crime Control Bureau, Director-in-charge, CMFRI, Heads of Divisions of CMFRI and the Scientists and Technical staff of CMFRI, CIFRI and NBFGR, Kochi.The stakeholders were briefed about the background of the NDF study and the highlights of the findings were presented. The stakeholders opined that unlike other maritime countries sharks are utilized whole in India as most of the parts are utilized domestically and only 1.5 to 20% are exported from the country; however, due to the sudden ban on fin export, exports have suffered a huge setback. They observed that the catch of *C. longimanus* is increasing although it is a bycatch of yellowfin tuna longline fishery. They said that Cochin Fisheries Harbour has the best managed longline fishery in the country. Any further regulations will affect the labour force in the harbor and about

5000 people directly and 50000 people indirectly are dependent on the fishery in CFH. They agreed that there is a gap in data projected for Manta rays and suggested that the main areas of manta ray landings are on the east coast. It was suggested that a data sharing platform on a national level is to be planned including fishermen, traders, researchers etc., to collect data on trade and landing since even with the information of fin/gill plate weight the whole weight of the shark/ray could be computed. The importance of data sharing was highlighted to the traders as lacunae in data may lead to arrival at a positive NDF for certain species, which are at present reported as less abundant. All stakeholders agreed that juvenile fishing is an issue and more awareness needed on this. All stakeholders suggested more stakeholder consultation on policy matters.

THUTHOOR

A stakeholder consultation meeting with shark fishermen and traders of Thoothoor was held at the conference hall of Association of Deep Sea Going Artisanal Fishermen, Thoothoor, Tamil Nadu on 1 October 2016. The meeting was attended by 27 fishermen/ traders/fishermen organisation representatives, scientists and technical staff of CMFRI, Kochi and Vizhinjam Research Centre of CMFRI. the draft NDF document on CITES listed shark and manta ray species was presented to the stakeholders, following which there was an active deliberation on the findings and recommendations. The fishermen highlighted the futility of total ban on shark fin trade when fishing ban is applicable only to certain species. Being the major shark fishing force in the country, they suggested that they should be involved in meetings related to shark fishing and conservation and should be consulted before making decisions or management plans. They cautioned that there appeared to be some mismatch in data projected and actual catch, particularly in the case of manta rays; they said that the projected data is far less than the actual catch. CMFRI scientists reiterated that the data is based on fishery survey at the landing centres and suggested that there should be a platform for data sharing between fishers, traders and researchers to avoid data gaps and get a better picture of the status of these resources. The stakeholders promised to extend their

cooperation to such initiatives taken by CMFRI and reiterated that CMFRI being the peer research organization in the sector, should take up a lead role in extending advice on fishery ban related issues. They also requested that awareness generation must be done among shark fishermen when policies on banning/protecting particular species of sharks come into effect or are altered. The fishermen agreed to the positive NDFs for the CITES listed species and to the mandatory conditions set forth therein.



ICAR-Central Marine Fisheries Research Institute
P.B. NO.1603, Kochi -682018, India