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By-catch of sharks and incidental catches of sea turtle in the long line fishery of Indian waters as observed during tuna resources survey

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Abstract

Among the bycatch of tuna fisheries sharks were found to be the major portion of the catch. In Indian waters the percentage of sharks in the long line fishery is observed to be 20.83% to the total catch by number and 23.36% by weight. The percentages of sharks were found to be higher in the Bay of Bengal, particularly in the Andaman & Nicobar waters. As many as 18 species of sharks were recorded in the long lines operated in the Indian waters. Among the different shark species, pelagic thresher shark (*Alopias pelagicus)* and bigeye thresher sharks (*A. superciliosus)* of Family Alopiidae and blacktip shark (*Charcharhinus limbatus*) are the main species contributing to the catch. Incidental catches of sea turtles were also reported during the survey predominantly on the East coast.

Introduction

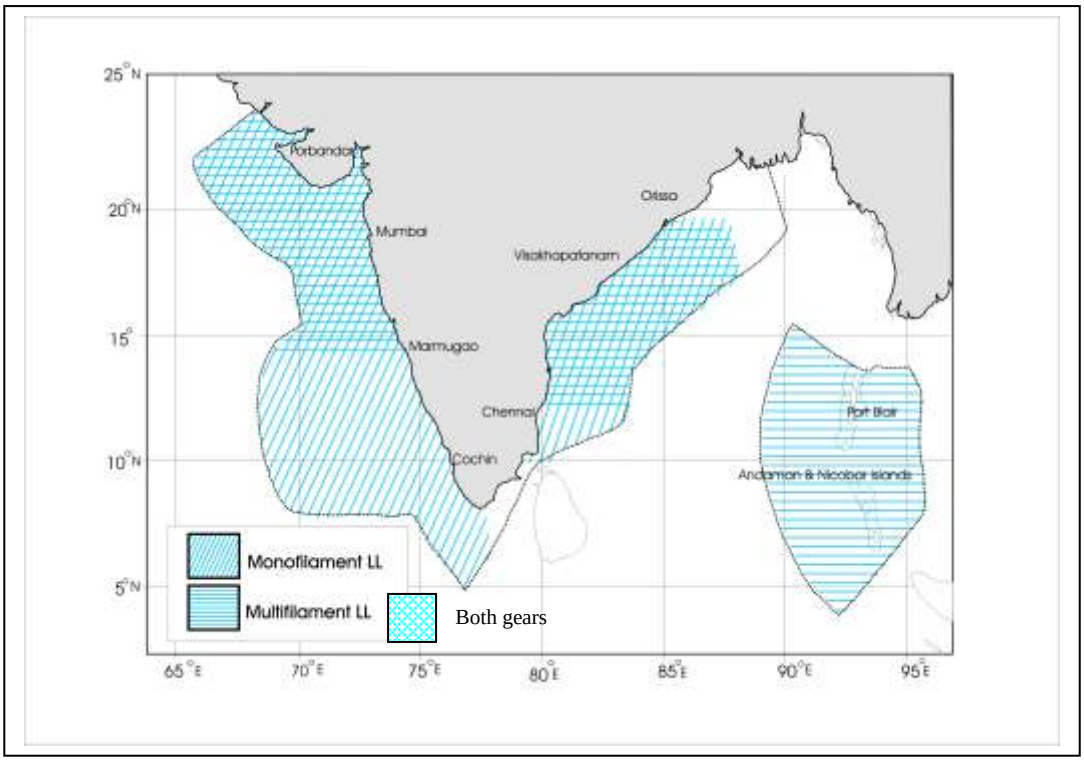
In the Indian waters long line fishing is practiced targeting Yellowfin and Big eye tunas. As reported elsewhere in the Indian Ocean, the bycatches of the targeted fishery constitute a major portion of the long line fishery in the Indian waters also. The major bycatch components are the sharks and bill fishes. Turtles are encountered and get entangled in the lines at times. The Olive ridley turtle nest at several sites in the Western Indian ocean, Indian sub continent and South-east Asia. The single most important breeding area for Olive ridleys in the Indian Ocean along the Bay of Bengal is Orissa coast. Information on the bycatch species of the long line fishery in the Indian waters is obtained from the survey operations being carried out by the Fishery Survey of India (FSI) vessels in the Indian EEZ. The commercial vessels operating in the Indian waters for tunas and allied fishes underreport details of shark bycatch. On comparing the data from the commercial long line fishery with that of the survey vessels data indications are given on the magnitude of discards of sharks in the commercial long line fishery in the Eastern Indian Ocean. In the long line fishing of distant water fishing nations which was introduced in the Bay of Bengal in the mid-fifties, significant part of sharks caught are discarded at sea after removing the fins. With the phenomenal growth of the long line fishery in the Indian Ocean during the recent past the quantum of shark catch has also increased significantly.

Today, the shark bycatch accounts for a major share of shark mortality. The high fishing mortality caused to the pelagic sharks in the oceanic waters warrants a cautious approach to ensure the sustainability of the shark stocks in the Indian waters. There are about forty species of the sharks belonging to five families in the Indian Ocean (Sivasubramaniam, 1992). The survey data reveals the capture of about 18 shark species belonging to 4 Families in the Indian waters. This paper presents the catch details of sharks caught on the long lines operated by four survey vessels of the FSI during 2005 and 2006.

Material and Method

The data collected by the four long line vessels of FSI, **Blue Marlin, Yellow Fin, Matsya Vrushti and Matsya Drushti** operating in the Oceanic waters of the Indian EEZ during 2005&2006 is analysed and presented here. Two vessels were deployed for survey in the Arabian Sea while other two vessels were conducting survey in the Bay of Bengal. Both multifilament and monofilament long line gears were operated from these vessels (Fig.1).

Fig. 1. Area covered by monofilament and multifilament longlining in the Indian EEZ



Altogether 4,09,501 hooks were operated by these four vessels during the survey. Table 1 gives the summary of surveys undertaken by these four vessels.

Table 1. Summary of longline survey conducted in the Indian EEZ during 2005 & 2006

Vessel	Area	Gear used	Hooks operated
Yellowfin (OAL 36.0m, GRT 290)	Arabian Sea	Multifilament LL (5 hooks/basket)	75120
Matsya Vrushti (OAL 37.5m, GRT 465)	Arabian Sea	Monofilament LL (7 hooks/basket)	112155
Blue Marlin (OAL 36.0m, GRT 290)	Bay of Bengal (Andaman & Nicobar waters and East coast of India)	Multifilament LL (5 hooks/basket; 9 hooks/basket)	116349
Matsya Drushti (OAL 37.5m, GRT 465)	Bay of Bengal	Monofilament LL (7 hooks/basket)	105877

Results and Discussion

Shark bycatch from the Arabian Sea

The two vessels **Yellow Fin** and **Matsya Vrushti** together operated 1,87,275 hooks. The total sharks landed during the above operation are 203 numbers weighing 3228kg (Table 2 & 4). The HR of sharks was 0.11%. The percentage of sharks to the total catch is 16.09% by number and 12% by weight. The diversity of species in the region indicates that 12 species were caught from Arabian Sea.

Table 2. Shark species caught, their hooking rate and percentage composition from Arabian Sea (2005&2006)

Shark Species	Total Shark by		HR	Species %	
	Nos	Wt. (kg)		by No.	by Wt
Pelagic thresher shark *(Alopias pelagicus)*	15	399	0.008	7.389	12.360
Bigeye thresher shark *(Alopias superciliosus)*	3	101	0.002	1.478	3.129
Thresher shark *(Alopias vulpinus)*	1	10	0.001	0.493	0.310
Silvertip shark *(Carcharhinus albimarginatus)*	2	13	0.001	0.985	0.403
Whitecheek shark *(C. dussumieri)*	14	221	0.007	6.897	6.846
Silky shark *(C. falciformis)*	2	9.2	0.001	0.985	0.285
Blacktip shark *(C. limbatus)*	88	864.5	0.047	43.350	26.780
Hardnose shark *(C. macloti)*	4	57	0.002	1.970	1.766
Blacktip reef shark *(C. melanopterus)*	24	243.5	0.013	11.823	7.543
Carcharhinus spp.	8	90	0.004	3.941	2.788
Tiger shark *(Galeocerdo cuvieri)*	2	151	0.001	0.985	4.678
Shortfin mako *(Isurus oxyrinchus)*	5	94	0.003	2.463	2.912
Smooth hammerhead shark *(Sphyrna zygaena)*	4	266	0.002	1.970	8.240
Other sharks	31	709	0.017	15.271	21.963
Total	**203**	**3228.2**	**0.108**		

Shark bycatch from the Bay of Bengal

In Bay of Bengal total 2,22,226 hooks were operated and recorded a shark hooking rate of 0.20% (Table 3 & 4). The two vessels, **Blue Marlin** and **Matsya Drushti** together landed 433 sharks weighing 14109 kg. Sharks constituted 24.18% by number and 29.82% by weight to the total catch.

Table 3: Shark species caught, their hooking rate and percentage composition from Bay of Bengal (2005-2006)

Shark Species	Total Shark by		HR	Species %	
	Nos	Wt. (kg)		by No.	by Wt
Pelagic thresher shark *(Alopias pelagicus)*	162	6046.5	0.073	37.587	43.152
Bigeye thresher shark *(Alopias superciliosus)*	49	2342	0.022	11.369	16.714
Thresher shark *(Alopias vulpinus)*	25	989	0.011	5.800	7.058
Silvertip shark *(Carcharhinus albimarginatus)*	1	20	0.000	0.232	0.143
Oceanic whitetip shark *(C. longimanus)*	1	35	0.000	0.232	0.250

Dusky shark *(C. obscurus)*	2	125	0.001	0.464	0.892
Spot tailed shark *(C. sorrah)*	3	78	0.001	0.696	0.557
Blacktip shark *(C. limbatus)*	87	1940	0.039	20.186	13.845
Blacktip reef shark *(C. melanopterus)*	72	943	0.032	16.705	6.730
Spadenose shark *(Scoliodon laticaudus)*	6	171	0.003	1.392	1.220
Tiger shark (G. cuvieri)	6	717	0.003	1.392	5.117
Scalloped hammerhead shark *(Sphyrna lewini)*	6	219	0.003	1.392	1.563
Graet hammerhead shark (*S. mokarran*)	1	150	0.000	0.232	1.071
Smooth hammerhead shark *(S. zygaena)*	2	67	0.001	0.464	0.478
Shortfin mako *(Isurus oxyrinchus)*	2	97	0.001	0.462	0.688
Other sharks	8	169	0.004	1.856	1.206
TOTAL	**433**	**14108.5**	**0.195**		

Shark bycatch in the Indian waters

When we consider the data for the Indian waters by pooling the data of the two regions, the total fishing effort expended is 409501 hooks and the aggregate HR recorded is 0.16. (Table 4 & 5). The contribution of sharks to the total catch is (636 Nos.) 20.83% by number and 23.36% by weight.

Table. 4. Hooking rate and percentage of sharks obtained in tuna longline survey from Arabian Sea and Bay of Bengal during 2005 &2006

Area	Hooks operated	Shark			Sharks weight	
		No.	HR %	% by number	(kg)	%
Arabian Sea (Area 51)	187275	203	0.11	16.09	3228.2	12
Bay of Bengal (Area 57)	222226	433	0.20	24.17	14109	29.82
Total	**409501**	**636**	**0.16**	**20.83**	**17337.2**	**23.36**

The hooking rate of pelagic sharks occurring in the long line fishing in different parts of Indian EEZ was reported by Sudarsan *et al.,* (1988). John and Somvanshi (2000) reported on the distribution and seasonality of sharks and species composition and length frequencies of predominant species occurring in Andaman and Nicobar waters. John and Neelakandan (2003) described the position of sharks as a major by catch in long line fishery and called for a cautious approach in their harvesting.

Table 5: Shark species caught, their hooking rate and species composition from the Indian EEZ (2005 & 2006)

Shark Species	Total Shark by		HR	Species %	
	Nos	Wt. (kg)		by No.	by Wt
Pelagic thresher shark *(Alopias pelagicus)*	177	6445.5	0.043	27.830	37.178
Bigeye thresher shark *(A. superciliosus)*	52	2443	0.013	8.176	14.091
Thresher shark *(A. vulpinus)*	26	999	0.006	4.088	5.762
Silvertip shark *(Carcharhinus albimarginatus)*	3	33	0.001	0.472	0.190
Oceanic white tip shark *(C. longimanus)*	1	35	0.000	0.157	0.202
Blacktip reef shark *(C. melanopterus)*	96	1186.5	0.023	15.094	6.844
Dusky shark *(C. obscurus)*	2	125	0.000	0.314	0.721
Spot tailed shark *(C. sorrah)*	3	78	0.001	0.472	0.450
White cheek shark *(C. dussumieri)*	14	221	0.003	2.201	1.275
Silky shark *(C. falciformis)*	2	9.2	0.000	0.314	0.053
Blacktip shark *(C. limbatus)*	175	2804.5	0.043	27.516	16.176
Hardnose shark *(C. macloti)*	4	57	0.001	0.629	0.329
Carcharhinus spp.	8	90	0.002	1.258	0.519
Shortfin mako *(Isurus oxyrinchus)*	7	191	0.002	1.101	1.102
Scalloped hammerhead shark *(Sphyrna lewini)*	6	219	0.001	0.943	1.263
Great hammerhead shark *(S. mokarran)*	1	150	0.000	0.157	0.865
Smooth hammerhead shark *(S. zygaena)*	6	333	0.001	0.943	1.921
Spade nose shark *(Scoliodon latiaudus)*	6	171	0.001	0.943	0.986
Tiger shark *(Galeocerdo cuvieri)*	8	868	0.002	1.258	5.007
Other sharks	39	878	0.010	6.132	5.064
TOTAL	**636**	**17336.7**	**0.155**	**100**	**100**

Shark caught by different gears

A comparison of the shark catch by the two different gears is made to understand if there is any difference in the shark bycatch between multifilament and monofilament gears (Table 6). The total catch of sharks by the multifilament gear was found to be on the higher side, the total number of sharks caught being 349 (12824kg) compared to the monofilament gear which recorded a lower catch of 287 individuals weighing 513.2kg. The percentage contribution of sharks to the total catch by the multifilament gear was 29.40% by number (38.04% by weight) and by monofilament gear it was 15.38% by number and 11.14% by weight. 18 shark species were caught on multifilament gear while 11 species were caught on monofilament longline.

Table 6. Total catch of sharks by monofilament and multifilament gear

Gear	Total catch		HR	% of shark catch	
	No	Wt.		No	Wt
Monofilament LL	287	4513	0.13	15.38	11.14
Multifilament LL	349	12824	0.18	29.4	38.04

Species composition of sharks in the Indian waters

18 species of sharks were recorded in the long line gears operated in the Indian waters during the year under report. The species composition of sharks obtained along with average weight of each species is given in Table 7. The species diversity is more pronounced in Bay of Bengal than in the Arabian Sea. Sharks of the Family Alopiidae (Thresher sharks) and Fam. Carcharhinidae (Requiem sharks) were prominent in the catch. The pelagic thresher shark (*Alopias pelagicus*) formed 37.17% of the total shark catch by weight followed by bigeye thresher shark (*A.superciliosus*)-14.09%, blacktip shark (*Carcharhinus limbatus*) - 16.17%, blacktip reef shark (*C.melanopterus)* – 6.84% and tiger shark (*Galeocerdo cuvieri*) – 5%. In the

Bay of Bengal alone, the thresher shark constituted 43.15% of the shark catch. The percentage contribution of *Alopias* spp. species was comparatively higher in Bay of Bengal (Tables 2&3).

Table 7: Species composition of sharks in Indian waters as observed in tuna longline survey during 2005-2006

Shark Species	Mean weight (kg)	Species % by No.	Species % by Wt.
Pelagic thresher shark *(Alopias pelagicus)*	36.415	27.830	37.178
Bigeye thresher shark (*A. superciliosus)*	46.981	8.176	14.091
Thresher shark (*A. vulpinus)*	38.423	4.088	5.762
Silver tip shark (*Carcharhinus albimarginatus)*	11.000	0.472	0.190
Oceanic whitetip shark *(C. longimanus)*	35.000	0.157	0.202
Blacktip reef shark (*C. melanopterus)*	12.359	15.094	6.844
Dusky shark (*C. obscurus)*	62.500	0.314	0.721
Spottailed shark *(C. sorrah)*	26.000	0.472	0.450
Whitecheek shark *(C. dussumieri)*	15.786	2.201	1.275
Silky shark *(C. falciformis)*	4.600	0.314	0.053
Blacktip shark (*C. limbatus)*	16.026	27.516	16.176
Hardnose shark (*C. macloti)*	14.250	0.629	0.329
Carcharhinus spp.	11.250	1.258	0.519
Shortfin mako (*Isurus oxyrinchus)*	27.286	1.101	1.102
Hammerhead shark (*Sphyrna lewini)*	36.500	0.943	1.263
Hammerhead shark (*S. mokarran)*	150.000	0.157	0.865
Hammerhead shark (*S. zygaena)*	55.500	0.943	1.921
Spadenose shark (Scoliodon laticaudus)	28.500	0.943	0.986
Tiger shark (*Galeocerdo cuvieri)*	108.500	1.258	5.007
Other sharks	22.513	6.132	5.064
TOTAL	**27.259**	**100**	**100**

Incidental catches of sea turtles

In the tuna long lining operation, sea turtles are occasionally caught as incidental catches. During the two years operation (2005-2006) in the Arabian Sea and Bay of Bengal altogether 24 sea turtles were reported (Table 8).

Table 8. Details of sea turtles entangled in longlining

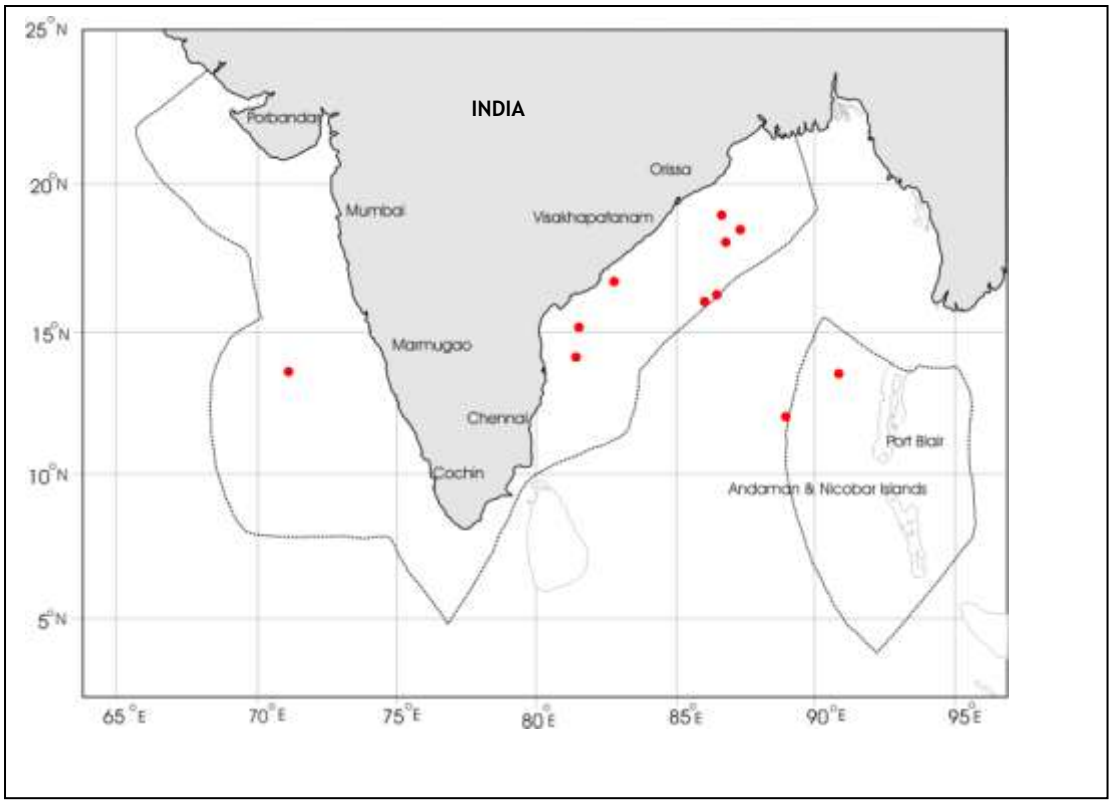
a). By Blue Marlin

Date	Latitude	Longitude	No. of Hooks	No. of turtles
13/02/2005	16°24"	86°29"	625	2
14/02/2005	16°54"	85°51"	625	7
19/02/2005	17°09"	83°41"	625	1
23/02/2005	15°06"	82°20"	625	1
24/02/2005	14°44"	82°67"	625	1
26/02/2005	14°09"	81°17"	625	1
19/1/2006	12°36"	89°56"	625	1
26/1/2006	13°14"	91°34"	625	1

Sub total				**15**
b). By Matsya Drushti				
20/10/2005	18°26"	86°20"	525	3
21/10/2005	18°42"	86°35"	525	3
23/10/2005	19°03"	86°12"	525	2
Sub total				**8**
c). By Matsya Vrushti				
15/12/2006	13°15"	71°40"	595	1
Sub total				**1**
Grand total				**24**

Of these, 15 sea turtles were reported in the operation of the vessel, *Blue Marlin* around Andaman & Nicobar Islands and upper east coast, 8 sea turtles were reported in the operation of the vessel, *Matsya Drushti* in the upper east coast of India and one sea turtle was

Figure 2. Location of incidental catches of marine turtles in the Indian EEZ



reported by the vessel, *Matsya Vrushti* while conducting long lining in the Arabian Sea (Fig. 2). It is observed that in majority of the instances the sea turtles were basically found to get entangled in the branch lines and in the process of escaping they reach hook side, the hooks were seen pierced in the shell-free parts of the body viz. legs, neck/mouth. The crew on these survey vessels usually make free the turtles from entanglement and release them back to the sea. It is seen that the instances of sea turtles getting entangled in the lines are more in Bay of Bengal. This may be due to the fact that the East coast of India, the olive-ridely turtles (L*epidochelys olivacea*) have large scale nesting in the Gahirmatha, Devi and Rushikulya shores along the Orissa coast in Bay of Bengal and the turtles are migrating to and fro to these shores. Besides the olive-ridely turtle, the leatherback turtle (*Dermochelys*

coriacea), hawksbill turtle (*Eretmochelys imbricata*) and green turtle (C*helonia mydas*) are commonly found in Andaman waters (Andrews *et al., 2006*). In order to avoid such entanglement the operation of the long lining could be avoided in the migratory routs of the sea turtles. Conservation measures like marine sanctuaries and ban on trawling in areas off the nesting sites are implemented in the maritime provinces of India (Aarthi*, et al., 2005*).

Discussion

Sharks constitute one of the major bycatch components in tuna long line fishing. The percentage contribution of sharks in tuna long line survey in the Indian waters is 23.36% by weight. However a higher percentage of sharks (29.61% by weight) is noticed in Bay of Bengal. Most of the Oceanic sharks have slow growth rate, delayed maturation, low fecundity and long life span. These factors determine the low reproductive potential of many shark species, which makes them more vulnerable to overfishing than other fish (Castro et al, 1999). The FAO Code of Conduct for Responsible Fisheries provides that States are required to minimize waste discards by adopting suitable measures.

Excess removal of non-target species can alter the biodiversity by removing the top predators and prey species at unsustainable level. Bycatch raise ecological concern, as some bycatch species are sensitive to increased mortality above natural level because of their life history traits. Discarding bycatch is also a social issue over waste. A major area of concern from conservation point of view is the magnitude of shark discards by the commercial fishery operators. In India, under the Wild life (Protection) Act certain species of sharks, skates and rays are banned as endangered species for fishing. Among the elasmobranches, whale shark is listed as an endangered species. However, there have been no instances of catching whale sharks in the long line operations.

Sea turtles form incidental catches of long lining. The turtles are caught due to their entanglement into the branch lines. Their reporting in comparatively higher numbers is an indication of migrating route for large scale nesting sites in Orissa coast in Bay of Bengal. The Orissa Province has conservation measures in place such as marine sanctuary, ban on trawling and use of TED by trawlers fishing in offshore waters (Aarthi, *et al*., 2005). Nevertheless, avoiding longline operation in migratory routs of the turtles will help to reduce their incidental catches in the high seas.

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