

Management of Scombroid Fisheries

Editors

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Pelagic sharks by-catch in the tuna longline fishery of the Indian EEZ

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ABSTRACT

Several species of pelagic and oceanic sharks are caught by the tuna longliners of FSI while surveying the oceanic tuna resources in the Indian EEZ. Though the sharks are not targeted species in tuna longlining, they constitute a major share of the catches. The sharks hooked could be, therefore, treated as by-catches or incidental catches of the tuna longline fishery. The exploratory surveys conducted by FSI vessels reported high hooking rates for pelagic sharks thereby supporting the view on possible emergence of a major fishery in the oceanic region of the EEZ for sharks. The species of sharks identified are *Carcharhinus dussumieri* (white cheek shark), *C. limbatus* (blacktip shark), *C. melanopterus* (blacktip reef shark), *Galeocerdo cuvieri* (tiger shark), *Rhizoprionodon acutus* (milk shark), *C. sorrah* (spot tail shark), *C. macroti* (hardnose shark), *Lamiopsis temmincki* (broad fin shark), *Scoliodon laticaudus* (spadenose shark), *Sphyrna lewini* (hammerhead shark), *Isurus oxyrinchus* (shortfin mako shark), *C. longimanus* (oceanic whitetip shark), *Prionace glauca* (blue shark) and *C. albimarginatus* (silvertip shark). The catches of the longliners of FSI since 1983 in the Indian EEZ and adjacent oceanic waters consist of three major groups of fishes viz., tunas, bill fishes and sharks. The percentage composition of sharks in the total catch was highest in south-east (52%) followed by Andamans (50%) and the north-east (45%) sectors of the EEZ. The contribution of sharks in the north-west and equatorial sectors was 49% and 32% respectively. The south-west sector (Lat.5°N -15°N) recorded the highest hooking rate of 1.26% for pelagic sharks. The Andaman and Nicobar and south-east sectors also registered hooking rates of 1.1% each for this group of species. The percentage composition of sharks in the catches taken by tuna longliners operated under the charter scheme ranged from 4% to 11% whereas in the catches by the vessels under the lease and joint venture scheme the percentage contribution ranged between 6% to 85%. Thus, commercial longline fishery in the Indian waters, comprising the operations of chartered foreign vessels and Indian owned joint venture and leased vessels, during past two decades are also in conformity with the findings by the research vessels. There are ample indications that the pelagic sharks can sustain a longline fishery in the oceanic region of the EEZ. However, the catches and sizes of individual sharks supporting them need to be monitored for taking suitable management and conservation measures as fishery progresses from developing to advanced stage.

INTRODUCTION

Worldwide there are 30 families, 96 genera and about 350 species of sharks. The Indian Ocean has a diverse shark fauna with about 115 species. Here, the sharks are used mainly for human food and also for fins, liver oil, fish meal and possibly for leather. They are caught by pelagic longlines, fixed and floating gill nets, bottom trawls and purse seines.

During 1991-'97 sharks, rays and chimaeras contributed to about 0.85% of the total world fish landings. The catches of these species showed steady increase from 713,379 t in 1991 to 789,862 t during 1997. In the Indian Ocean sector (FAO Fishing Area 51 and 57) average production was about 226,716 t annually, of which sharks alone constituted 30% whereas globally it formed about 23.4% annually to the world total fish catch. Contribution of species of family *Carcharhinidae* to the world catch of sharks, rays and chimaeras ranged from 7.74% in 1997 to 9.76% in 1994.

Several species of pelagic and oceanic sharks are caught by the tuna longliners of Fishery Survey of India (FSI) while conducting exploratory surveys for oceanic tuna resources in the Indian EEZ, though they are not a targeted species. The sharks hooked could be therefore treated as by-catch or incidental catches of the tuna longline fishery. The exploratory surveys conducted by FSI vessels reported high hooking rates of pelagic sharks thereby supporting the view on possible emergence of a major fishery in the oceanic sector of the Indian EEZ for sharks.

The results of tuna longline surveys conducted by FSI have been discussed by various authors with particular reference to yellowfin tuna. Sudarsan *et al.* (1989) estimated the potential of oceanic resources of all the large growing species as 246,000 t with 31,600 t of pelagic sharks to be caught from surface and sub-surface fishery in equal quantity. In this paper results of tuna longline surveys undertaken by FSI are discussed with special emphasis on pelagic sharks.

DATA SOURCES

Tuna longline survey data gathered by FSI survey vessels *viz.*, *Matsya Sugundhi* (OAL 31.5 m, GRT 257.95, 750 BHP) *Matsya Harini* (OAL 32.5m, GRT – 257.95, 750 BHP) and two sister longliners *Yellowfin* and *Blue Marlin* (OAL 36.0 m, GRT 290.0 and 800 BHP) are used in the present study. A total of 1872.4 thousand hooks were operated by these vessels in the Indian EEZ and adjoining seas. Region-wise and year-wise sampling efforts in tuna longline surveys during October 1983 to March 1999 are presented in Table 1. It may be seen that of the total effort expended, 31.28% of the effort was in Andaman and Nicobar waters followed by 27.84% in north-west coast, 17.49% in south-east coast, 15.06% in south-west coast and 0.98% in equatorial waters. The results are discussed region-wise for better understanding of distribution of pelagic / oceanic sharks.

RESULTS

A. Species of sharks in longline catches

During the course of longline surveys 15 species of sharks were

identified and recorded in the catches, 7 of genus *Carcharhinus*, 3 of *Alopias* and one each of *Lamiopsis*, *Galeocerdo*, *Sphyrna*, *Isurus* and *Prionace*. Details of pelagic/oceanic sharks encountered in longline gears in the Indian EEZ are presented in Table 2.

B. Hooking rates obtained in longline surveys

Region-wise and species-wise hooking rates obtained in tuna longline surveys are presented in Fig.1. South-west coast yielded the best aggregate hooking rate of 4.77% with 1.26% for sharks followed by Andaman and Nicobar waters with 2.21% for all fish and 1.10% for sharks and south-east coast 2.08% for all fish and 1.08% for sharks. Lowest hooking rates for sharks was obtained in north-east coast (0.62%) whereas sharks formed about 50% in the total hooking rate of 1.65% in north-west coast.

C. Lat.2° x Long.2° - wise results

The area of longline survey extended from Lat.2°N to 22°N and Long.64°E to 96°E. For sharks, latitudes from 6°N to 18°N yielded hooking rate above 1%. In southern latitudes between 2°- 4°N the hooking rate obtained was low (Fig.2).

Highest hooking rate of 1.45% was obtained in between Lat.6° and 8°N with as high as 1.96 to 2.06% in the Nicobar sector. Along south-west coast highest hooking rate was recorded in Lat.12°N-14°N Long. 68°-70°E followed by 1.92 in same latitude but with Long.72°-74°E. Along south-east coast Lat.10°-12°N and Long. 82°-84°E yielded impressive hooking rate of 2.94% for sharks. In north-west coast, areas south of Mumbai recorded better hooking rates of 1.71 and 1.66% in Lat.16°-18°N and Long. 70°-74°E. Nicobar Sector of the Indian EEZ around the Andaman and Nicobar Islands also gave comparatively better results. In general, areas along Lat.6°N to 16°N provides good potential fishing ground for sharks in Indian EEZ.

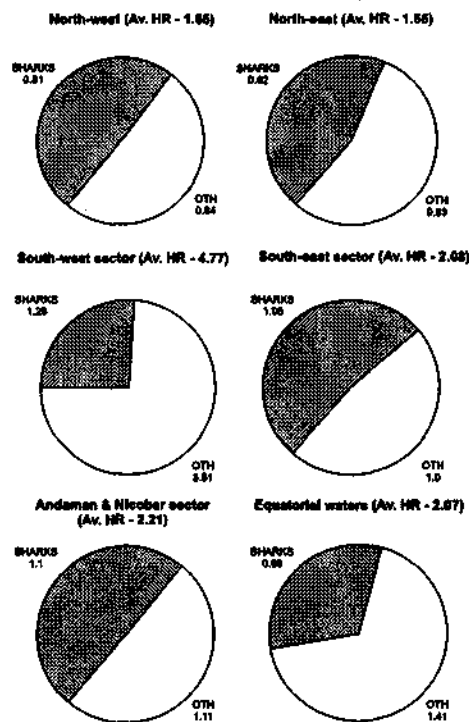


Fig.1 Hooking rate for sharks obtained in tuna longline survey during 1983-'98

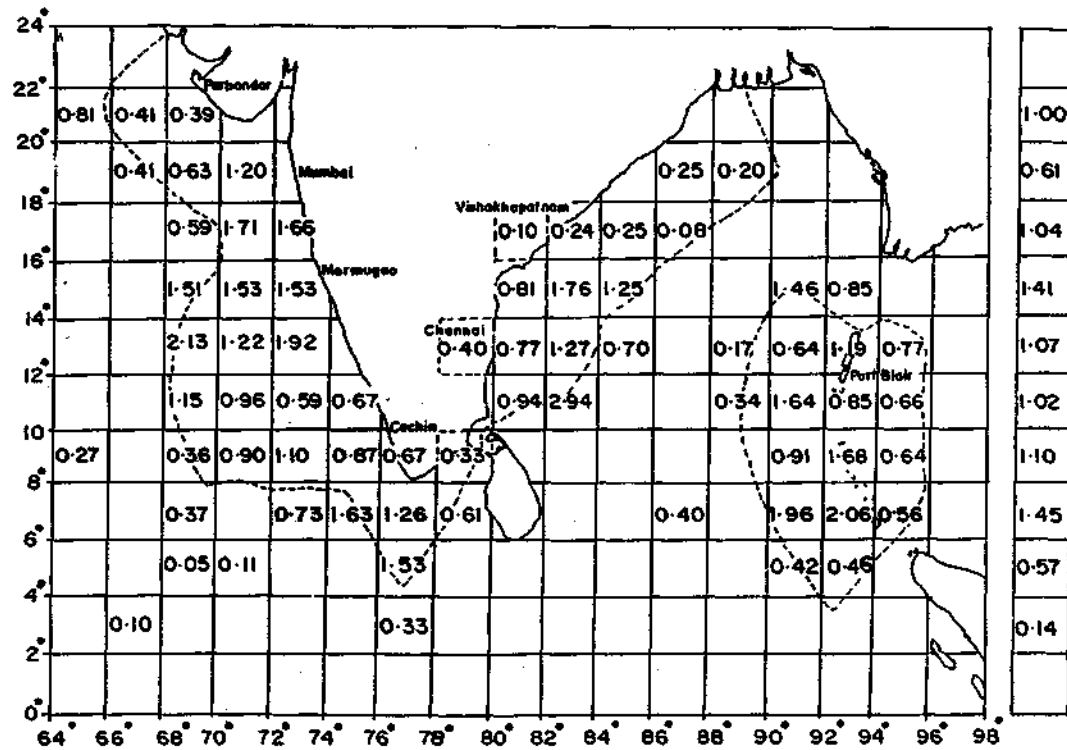


Fig. 2. Hooking rate (%) obtained for sharks in longline survey (1983 - '98)

D. Catch composition of longline gears

The catch composition of longline gears specifically operated for yellowfin tuna in the Indian EEZ also comprised of bigeye tuna, skipjack tuna, bill fishes (marlin, sword fish and sail fish), sharks and other fishes comprising of barracudas, dolphin fish, sun fishes etc.

(i) **By number** : By number, along south-west coast and in equatorial waters sharks constituted only 26.3% and 31.6% of the catches respectively whereas, the composition of sharks along other areas was in the order of 45.2% in north-east sector to 51.9% in south-east sector. Catch composition (by number) obtained in longline surveys are depicted in Fig.3.

(ii) **By weight** : By weight also the catch composition of sharks in longline gears shows similar trend as that of by number (Fig.4). South-east sector yielded maximum sharks with 51.9% in total catch followed by 49.8% in Andaman and Nicobar sector and 49.3% and 45.2% in north-west and north-east sectors respectively. South-west coast yielded the lowest shark contribution where it formed only 26.3% of the fishes hooked.

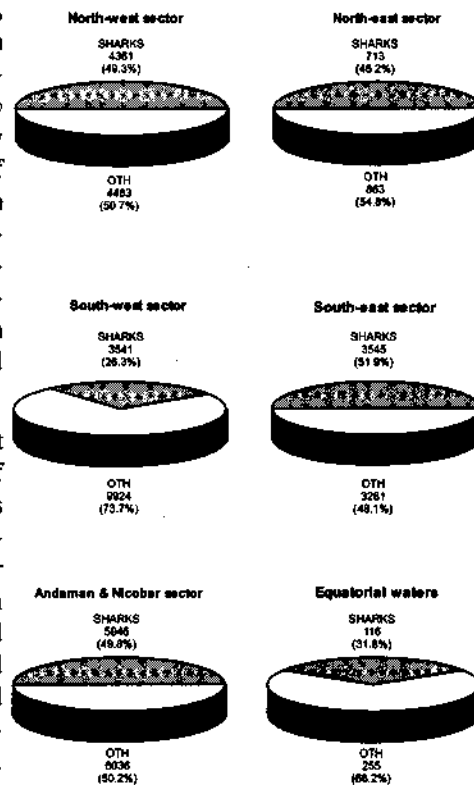


Fig. 3. Catch composition of sharks (by number) obtained in the tuna longline surveys during 1983 - 1998 (%)

E. Month-wise hooking rate for sharks

Month-wise hooking rates obtained in respect of sharks are presented in Fig.5. Sector-wise results obtained in the EEZ are as follows :

(i) **North-west sector** : Minimum hooking rate for shark was recorded in July (0.27%) and maximum hooking rate (1.83%) in January. High hooking rates were recorded from November to February (0.81 to 1.83%). From March to May the hooking rate was between 0.50 to 0.65%. The results indicate that shark fishery in the north-west sector

commence from November and extend upto May.

- (ii) **South-west sector :** In this sector highest hooking rate of 2.33% for shark was recorded during February. The minimum hooking rate recorded in the sector was 0.54% in August. During the other months the hooking rate ranged from 0.78% in June to 2.17% in May. This sector provides fishing grounds for sharks round the year except during August.

- (iii) **South-east sector :** Hooking rate for shark in this sector ranged from 0.64% in April to 1.76% in January. This sector also provides scope for round the year fishing for sharks.

- (iv) **North-east sector :** In this sector highest hooking rate of 3.79% for sharks was recorded in the month of November and September (3.79%) followed by June (0.61%) and July (0.64%). During the remaining months hooking rates obtained for sharks in this region was below 0.5%. Therefore, the fishing season for sharks in this sector could be from June to September.

- (v) **Andaman and Nicobar Sector :** In this sector minimum hooking rate obtained for sharks was 0.61% in May, while the remaining months yielded hooking rates above 0.7%. Highest hooking rates recorded for sharks are in the months of February (2.04%), followed by November (1.72%), October (1.31%) and December (1.21%). The best fishing season for sharks in the region begins from October (1.31%) and extends upto April (0.88%).

- (vi) **Equatorial waters :** Sampling in this sector was limited to six months

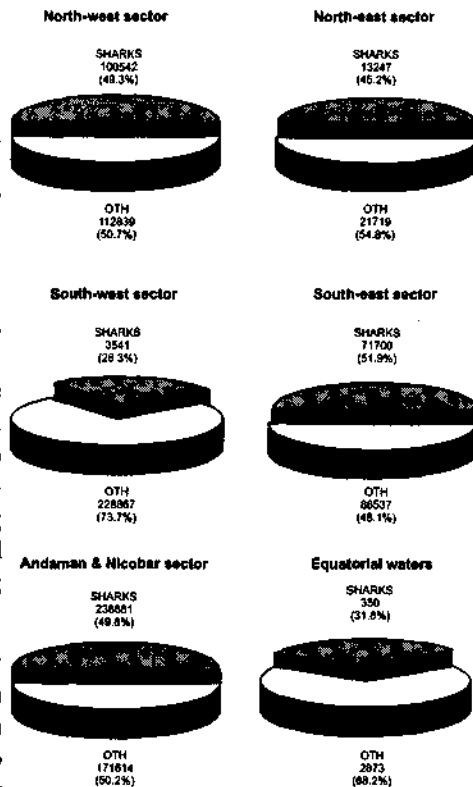


Fig. 4. Catch composition of sharks (by weight) obtained in the tuna longline surveys during 1983 - '98 (%)

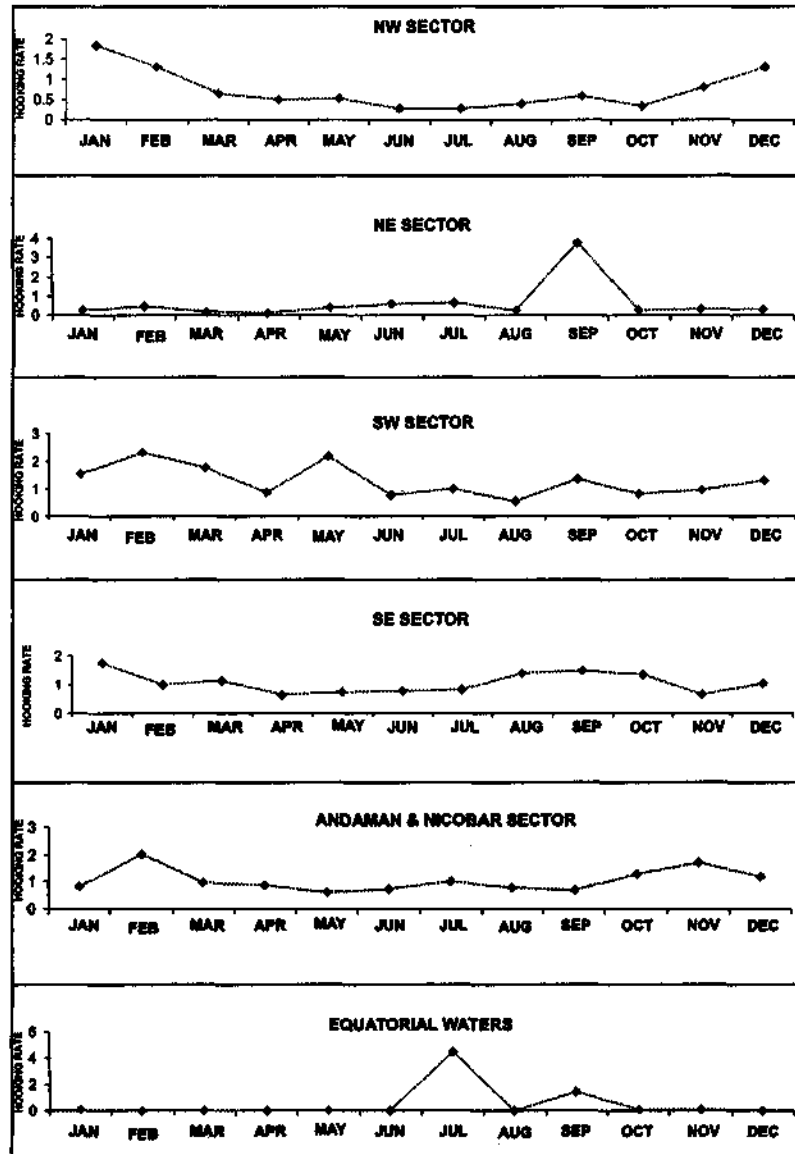


Fig. 5. Monthly hooking rate for sharks during 1983-'98

only. The maximum hooking rate of 4.43% for sharks was recorded during July followed by 1.47% in September. During other months the hooking rates obtained for sharks were low ranging from 0.04% in December to 0.14% in January.

(vii) **Average weight of sharks :** Average weight of sharks ranged from minimum of 3 kg in equatorial waters to maximum of 40.1 kg in Andaman and Nicobar Sector

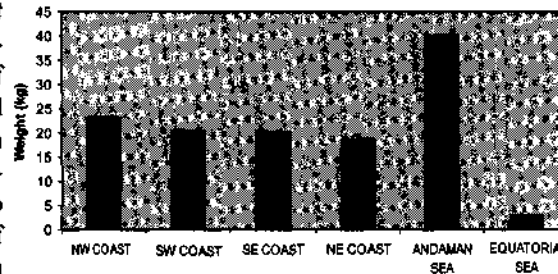


Fig. 6. Region-wise average weight of sharks obtained in tuna longline surveys during 1983-'98

(Fig.6). In north-west sector average weight of sharks was 23.1 kg followed by 20.4 kg in south-west sector, 20.2 kg in south-east sector and 18.8 kg in north-east sector. In general, the sharks caught from Andaman and Nicobar sector were heaviest while sharks from west coast were larger compared to those from east coast.

Shark catches in industrial longline fishery

- (i) **Chartered foreign fishing vessels :** Foreign fishing vessels under chartered fishing scheme were introduced in 1985. The fishing operations under the scheme witnessed phenomenal growth in subsequent years and activity was at its peak in the year 1990 when 58 foreign longline vessels were in operation in Indian waters. The chartered longline vessels mainly targeted yellowfin tuna and sharks were caught only for their fins and liver oil, and as such the catches reported may not present the true picture of shark availability in the Indian seas. During 1989 to 1995 these vessels landed a total catch of 5,200 t with sharks contributing about 358 t per annum and forming about 6.9% of the total catches. Year-wise total catches by chartered longline vessels and sharks contributions are given in Fig.7a. Sharks contributed maximum of 528 t in 1992 when it formed only 9.3% of the total catches. However, percentage-wise contribution during 1989 indicates that sharks constituted maximum of 10.8% to the total catches followed by 9.5% and 9.3% during 1995 and 1992 respectively.
- (ii) **Indian owned joint venture and leased vessels :** Making use of the liberal policy initiatives and institutional financing, the Indian fishing industry had taken up tuna longline fishing in the early nineties. Apart from one industrial longliner that was in operation since 1986, five longliners of 42 to 50 m OAL were added to the fleet in 1992-'93.

Due to operational constraints and economic reasons these five vessels discontinued operation by 1994-'95. Fresh joint venture arrangements and leasing of vessels came into force from 1996 and as on 1998 five foreign tuna longliners are in operation under these schemes.

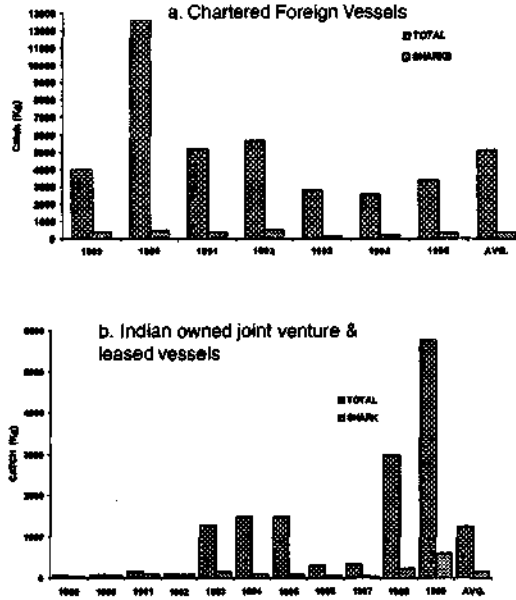


Fig. 7. Shark catches from industrial longline fishery in Indian waters

The catches by these vessels since 1989 to 1999 including the sharks catches are depicted in Fig.7 b. The catches in the initial years of 1989 to 1992 mainly comprised of sharks, the percentage contribution ranging from 52 to 85%. Subsequently, the share of sharks in the total catches of these vessels reduced drastically and was below 20%. On an average these vessels hooked 1248.5 t of 'all fish' per annum with 138.5 t of sharks forming about 10.9% of the total catch. Since these vessels mainly targeted yellowfin tuna, the shark catches does not

reflect true picture of their availability. Moreover, the sharks were used for their fins and liver and remaining parts discarded at sea.

DISCUSSION

Presence of sharks in longline fishery targeting for yellowfin tuna indicates prospects for developing a resource specific fishery for sharks in the Indian EEZ. Sharks under the genus *Carcharhinus* and *Alopias* contribute the majority of shark catches and are commercially important for fins, liver oil and human consumption. In the western Indian ocean, family *Carcharhinidae* is by and large the most important for fisheries (FAO, 1984).

The hooking rates obtained in the surveys indicates commercially viable fishery for sharks in the area. The hooking rates obtained for sharks from all the sectors of the EEZ except north-east sector are above one percent. Further, the hooking rates obtained from Lat.6°N to 18°N for sharks present a bright picture. The month-wise hooking rates obtained from all the sectors in the Indian EEZ suggest round the year fishing for this re-

source. The fishing for this pelagic shark resource may not require shifting to distant water fishing like for the highly migratory and straddling tuna stocks.

Sudarsan *et al.* (1989) based on hooking rates obtained in longline surveys, the MSY estimates in waters of adjoining countries and the share of oceanic resources in surface and sub-surface fishing, estimated the potential of sharks as 31,600 t. The results were based on data for the period from 1984-'87. Considering the hooking rates and share of sharks in the longline catches it can be inferred that the estimates for sharks could be much higher. The species specific longline gear for sharks may yield better production.

Recently, Somvanshi *et al.* (1999) based on declared catches by Indian owned joint venture and leased longline vessels during 1998 indicated a CPUE of 2 t per fishing day consisting of only 4.6% of sharks. As mentioned earlier, the shark catches by chartered, leased, and joint venture vessels may not give any precise information on the distribution and abundance in the Indian EEZ. The operation of Indian owned vessels during 1981-'92 perhaps present the true picture, where shark contributed 52 to 85% of the total longline catches of these vessels. The commercial longline fishery in the Indian waters, comprising the operations of chartered foreign vessels and Indian owned joint venture and leased vessels, during past two decades are also in conformity with the findings by the survey vessels. Thus, there are ample indications that the pelagic sharks can sustain a longline fishery in the oceanic sector of the EEZ. However, the catches and sizes of individual sharks supporting them need to be monitored for taking suitable management and conservation measures as fishery progresses from developing to advanced stage.

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Table 1. Region-wise and year-wise sampling effort in tuna longline survey during October 1983 and March 1999

Year / Region	Equatorial waters	North-west coast	South-west coast	South-east coast	North-east coast	Andaman Sea	Total
	0-50°N/ 64-87°E	15-23°N/ 64-75°E	05-15°N/ 66-77°E	05-15°N/ 77-88°E	15-22°N/ 80-89°E	5-16°N/ 88-96°E	
1983	12.6	-	6.3	-	-	-	18.9
1984	5.8	1.5	39.5	29.4	2.3	0.7	79.2
1985	-	-	71.7	17.2	0.7	54.8	144.4
1986	-	2.5	71	37.7	-	-	111.2
1987	-	7.2	77.4	67.4	-	-	152
1988	-	2.3	12.4	84.4	11	-	110.1
1989	-	21.9	0.3	50.6	7.9	30.9	111.6
1990	-	74.6	2	20.4	29	37.6	163.6
1991	-	31	-	-	25.7	15.1	71.8
1992	-	74.3	1.3	16	12	92.5	196.1
1993	-	37.2	-	-	-	50.7	87.9
1994	-	44.7	-	-	-	93.6	138.3
1995	-	64.5	-	-	5.6	62.5	132.6
1996	-	65.2	-	2.6	23.1	58	148.9
1997	-	84.4	-	-	11.8	27.8	124
1998	-	9.9	-	1.8	6.8	63.3	81.8
TOTAL	18.4	521.2	281.9	327.5	135.9	587.5	1872.4
%	0.98	27.84	15.06	17.49	7.26	31.38	

(*1000 hooks)

Table 2. Species of oceanic pelagic sharks in the Indian EEZ

Common Name	Species Name
Spot-tail shark	<i>Carcharhinus sorrah</i> (Valenciennes, in Muller & Henle, 1839)
Blacktip shark	<i>Carcharhinus limbatus</i> (Valenciennes, in Muller & Henle, 1839)
Silvertip shark	<i>Carcharhinus albimarginatus</i> (Ruppell, 1837)
Oceanic whitetip shark	<i>Carcharhinus longimanus</i> (Poey, 1861)
Blacktip reef shark	<i>Carcharhinus melanopterus</i> (Quoy & Gaimard, 1824)
White cheek shark	<i>Carcharhinus dussumieri</i> (Valenciennes, in Muller & Henle, 1839)
Hardnose shark	<i>Carcharhinus macloti</i> (Muller & Henle, 1839)
Blue shark	<i>Prionace glauca</i> (Linnaeus, 1758)
Broadfin shark	<i>Lamiopsis temmincki</i> (Muller & Henle, 1839)
Tiger shark	<i>Galeocerdo cuvieri</i> (Peron & Le Sueur, in Le Sueur, 1822)
Bigeye thresher shark	<i>Alopias supercilliosus</i> (Lowe, 1839)
Thresher shark	<i>Alopias vulpinus</i> (Bonnaterre, 1788)
Pelagic thresher shark	<i>Alopias pelagicus</i> (Nakamura, 1936)
Hammerhead shark	<i>Sphyrna</i> spp.
Shortfin mako shark	<i>Isurus oxyrinchus</i> (Rafinesque, 1810)