Management of Scombroid Fisheries

Editors

N.G.K. Pillai
N.G. Menon
P.P. Pillai
U. Ganga

ICAR

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
Post Box No. 1603, Tatapuram P.O.
Kochi-682 014, India

Drift gill net fishery for large pelagics at Cochin – A case study on by-catch of pelagic sharks

A.A.Jayaprakash, N.G.K.Pillai and M.N.K.Elayathu

Central Marine Fisheries Research Institute, Kochi

ABSTRACT

In India, the elasmobranchs contributed on an average 60,800 t during 1986 to 1999 forming 2.7% of the total marine fish landings. The production varied from 50,000t in 1990 to a highest of 75,000 t in 1998. The sharks dominated forming 62.4%, followed by rays (33.5%) and skates the rest. The west coast accounted for 55.5% and east coast 44.5%. The highest contribution of 30.2% was from Gujarat followed by Tamilnadu (26.2%). The drift gillnets, sharing 48.5% of the production, was the major gear, followed by trawls (31.5%) and hooks and line (6.1%). Since the drift gillnets (DGN), apart from the scombroids, exploit a variety of larger pelagics, a case study of the shark fishery by the gear at Kochi was made based on the data from 1979 to 1999 and the results are presented here. The elasmobranchs constituted 4-12% in the gear. The production of the elasmobranchs by the gear varied from 1,238 t in 1979 to 42 t in 1994 indicating a gradual decline in the catch. The effort came down from 39,389 units in 1979 to 6,152 in 1995. The c/e also showed a similar downfall from 31.4 kg in 1979 to 6.1 kg in 1994. The highest production of 45.1% was during the third quarter, followed by first quarter (27.3%), fourth (14.4%) and second quarter (13.2%). The pelagic sharks constituted 93%, rays 6% and skates the rest of the elasmobranchs exploited by the DGN. Among the pelagic sharks *Rhizoprionodon acutus, Carcharhinus melanopterus, C.limbatus, C.macloti, C.brevipinna, R.oligolinx, Sphyrna lewini* and *Scoliodon laticaudus* were important species. Rays such as *Mobula diabolus, Rhinoptera javanica* are occasionally caught. Among skates *Rhynchobatus* spp., *Rhina ancylostoma* and rarely *Pristis* spp. were noticed. The size frequency studies on important species like *R.acutus* and *C.melanopterus* have been carried out. The reasons for the reduction in effort, catch, c/e and measures for optimum exploitation have been discussed.

INTRODUCTION

The drift gill nets using mechanised boats are operated all along the Indian coast. The economy in operation of the craft due to low fuel consumption, easy maintenance and, though not high, steady returns have made this gear most popular among the fishermen of the small scale sector. At Kochi, this gear with a variety of mesh size combinations (70-130 mm) targets the larger pelagics like tunas, seerfishes, sharks, pomfrets, barracudas, carangids, catfishes, mackerel and garfishes. Details of the drift gill net units and their catches have been described by Silas *et al.* (1984) and Jayaprakash (1989). The unit is operated throughout the year. However, the peak catch is during April/May to September. October to March is the lean period. The

target groups, the scombroids occur almost through out the year and contribute nearly 60 % of the total catch of the gear. The occurrence of most of the other resources are seasonal, but the sharks support a regular fishery forming 5-20% in the gill net landings. In fact the occurrence of sharks along with the tunas in the drift gill nets as well as in the tuna lining indicates a close association between these two. The annual landings of sharks in India have been increasing ever since the introduction of mechanisation. However, the production of sharks by the drift gill nets at Kochi indicated a downward trend. Though details of the statewise landings of resource are available, not much is known on the species composition of landings and biological aspects of many sharks. Hence, a case study of the sharks exploited by the drift gill nets (1979-'99) has been made and the results of the observations on effort, catch, c/e, species and size composition and biological aspects of dominant species are presented in this paper.

MATERIALS AND METHODS

Data on effort, catch and resource composition of the landings by the drift gillnetters at Kochi for the period 1979 to 1999 was collected from the National Marine Living Resource Documentation Centre (NMLRDC). Since the senior author was attached (1981-'88) to the Field Laboratory of CMFRI at Cochin Fisheries Harbour, detailed observations on the catch, species and size composition, and biological aspects of a number species that support the shark fishery could be collected. The results presented on the species, length composition and biological aspects, pertains to the period 1981 -'82.

RESULTS

Evolution of the fishing fleet and harvest process

The drift gillnetting using *Pablo* type mechanised units was introduced in Kochi way back in the late sixties. Initially the base of operation was at Fort Kochi, but with the commissioning of the Cochin Fisheries Harbour in 1978 it was shifted to this place. By the end of the seventies there were nearly 90 units in operation. High returns and less competition attracted many more local entrepreneurs in the field. While many of the trawl and purseseine fishermen were initially hesitant to explore the unknown offshore grounds, the drift gill net fishermen were daring and successfully extending the fishing areas further deep in the sea.

The *Pablo* type mechanised boats of 7.6 –9.4 m OAL fitted with *Ruston* two cylinder (24 HP) or three cylinder (38 HP) engine, and *Bukh* two cylinder (30 HP) or three cylinder (45 HP), and *Yanmar* two cylinder (30 HP) engines are engaged in drift gill net operation at Kochi. The mesh sizes of the gear varied from 7-11 cm and are fabricated from 6, 8 or 22 nylon threads. Mesh size 8-11 cm is common. The length of the net varied

from 800-1000 m and the width of the net usually consisted of 80-120 meshes. Setting and hauling time ranged from 1 to 2 hours and soaking time from 3-4 hours in the night. The areas of operations that initially were in the 30-50m depth zone have been extended far beyond this zone during the eighties. Only daily operations are made and no stay fishing is done as in trawls. The catches landed early in the morning from 05:00 - 08:00 hours are auctioned. Resource like tunas and some times the sharks are segregated size-wise as large, medium and small before auctioning.

Fishery of sharks and evolution of catch

During 1979 to 1999 the landings of sharks by the drift gill net units varied from 891 t in 1979 to a lowest of 33 t in 1994. The resource contributed 3.7% (1994) to 19.2% (1982) of the total catch of the gear. Sharks constituted 95% of the elasmobranchs exploited by the gear. The analysis indicated that the production of this resource which started declining from 891 t in 1979 to 279 t in 1985, however, increased to 520 t in 1986 and thereafter slumped to an all time low of 32 t in 1994. Though the production was found gradually picking up for the next two years it was not as promising as expected. Further, there was a decrease in the share (%) of sharks in the total landings of the gear from 1979 onwards. The details of effort, landings of sharks, the catch per unit effort (c/e), percentage contribution of sharks to the total fish catch and the trends in the total fish catch of the gear are given in Figures 1 to 5 respectively.

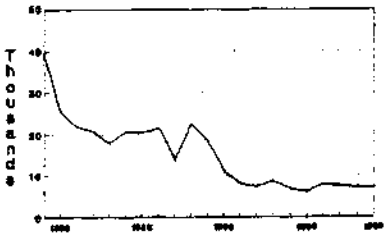

Fig. 1. Evolution of effort input of drift gill nets at Cochin

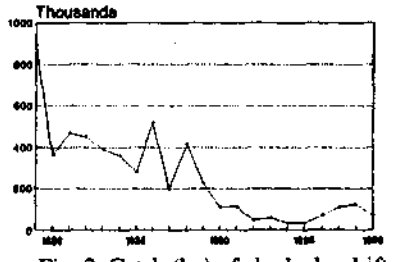

Fig. 2. Catch (kg) of sharks by drift gill nets at Cochin

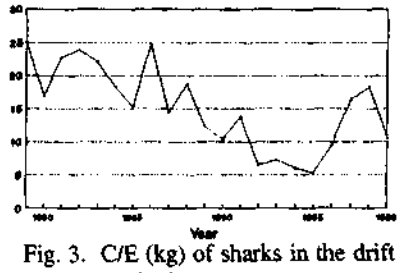

Fig. 3. C/E (kg) of sharks in the drift gill nets at Cochin

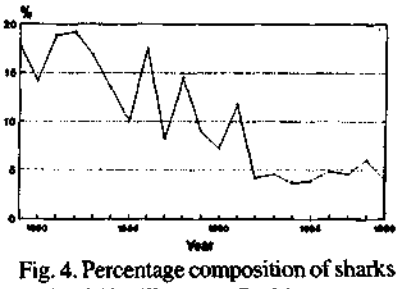

Fig. 4. Percentage composition of sharks in the drift gill nets at Cochin

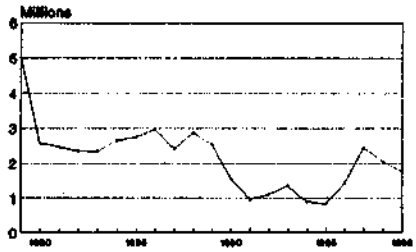

Fig. 5. Total fish catch (kg) in drift gill nets at Cochin

The decadal (1980-'89) average production of sharks was 3,777t. The effort input (boat days) and c/e for the period were 20,285 and 181.3 kg respectively. In the next decade (1990-'99) the average production plummeted to 784 t, a decrease to the tune of 78.7%. The c/e of 100 kg realised during the period was down by 44.7% and effort (7,810 boat days) input by 61.5%. This trend of decrease was discernable in the total fish landed by the gear. The average total fish catch of 2,594 t during 1980-'89 slumped to 1,442 t in the next decade, which amounted to 44.4%. But the c/e realised for all fish catch indicated a promising trend. It increased by 44.4% from 128 kg to 185 kg in the second decade. The effort input (boat days) from 39,389 in 1979 gradually came down to 11,109 by 1990. From 1991 it fluctuated from 6,152 to 8,675 boat days annually and appeared to have stabilised around 7,400.

Species composition

A number of species contributed the shark landings by the drift gill nets at Kochi. The various species noticed in the order of abundance were *Carcharhinus melanopterus* (blackfin reef shark), *Rhizoprionodon acutus* (milk dog shark) *Sphyrna lewini* (scalloped hammerhead shark), *Scoliodon laticaudus* (Indian dog-shark), *R.oligolinx* (grey dog-shark), *C. macloti* (Maclot's shark), *C. brevipinna* (Spinner-shark) and *C. limbatus* (blacktip-shark). The monthly production trends of various species are given in Table 1.

Except the last four species, others contribute a regular fishery. *R. acutus, R.oligolinx, C.brevipinna* and *S. laticaudus* are not large growing forms, and are represented mainly by the adults and juveniles in the fishery. Others are large growing species and mainly the juveniles contribute to the fishery with occasional representation of adults and large specimens.

The blackfin reef shark *(C. melanopterus)*: Juveniles of 35-75 cm total length are mainly represented in the fishery. However, large specimens up to 230 cm are found to occur at times. The species dominated the catch during 1981 and 1982 and occurred throughout the year accounting for 31.7% to 33.8% of the total shark landings. During 1981 the species formed 98.9 t. The monthly catch varied from 284 kg in December to 17.7 t in July with an average of 8.3 t per month. During 1982 the species contributed 87.4 t. The monthly average was 7.3 t. During the two year period a total of 349 large specimens (100-230 cm) have been encountered. The males indicated a size range of 100-220 cm and the females 100-230 cm. Males of 155-190

cm occurred in higher numbers compared to 175-210 cm in females. The dominant mode in males was at 170 cm compared to 190 cm in females.

The milk dog-shark *(R. acutus)* constituted the second dominant species forming 23-26% of the total sharks. The size varied from 20- 75 cm. Annually the species contributed 80 t and 61 t respectively with a monthly average of 6.6 t and 5.1 t during 1981 and 1982.

The Indian dog-shark (*S. laticaudus*) is a small growing form and both adults and juveniles contributed the fishery. This species was found to occur throughout the year and formed 4.7-8% of the sharks landed. During 1981 the species formed 25 t compared to 12 t in 1982. The size ranged from 17-60 cm, however, 40-50 cm fishes supported the commercial catch. The monthly production varied from 0.5 t in May to 6.4 t in January during 1981. During 1982 the highest monthly catch of 3.6 t was in September.

Scalloped hammerhead (*S. lewini*) is a large growing form. But the fishery is mainly supported by juveniles of the size range 40-90 cm. Occasional catch of large size specimens up to 250 cm have been noticed. The species contributed 26-31% of the shark landed by the gear. The catch during 1981 and 1982 were 82.5t and 79.4 t respectively, the average monthly catch being 6.8 t during the period. During 1981 the highest monthly catch of 16.7 t was in August compared to 22.3 t realised in July 1982.

The Grey dog-shark (*R.oligolinx*) supported a seasonal fishery contributing 1.7 to 2.7% of the sharks landed. The annual production during 1981 and 1982 were 5.1 t and 7.1 t respectively. The size ranged from 40-90 cm, with 60-70 cm size groups supporting the fishery.

The Maclot's shark (*C. macloti*) contributed 7 t (2.3%) and 5.6 t (2.2%) during 1981 and 1982. The species mostly occurred during the first half of the year. The species indicated a size range of 45-75 cm.

The spinner-shark *(C. brevipinna)* contributed 1.4-3% of the sharks landed. 60-105 cm size fishes were mostly represented in the catches.

Quarter-wise production

The monthly landings for the two years were pooled for finding the quarter-wise (Table 2) abundance of each species. The third quarter was most productive for the blackfin reef shark, the milk dog shark and the scalloped hammerhead and fourth quarter for the spinner shark. The first quarter was highest productive for Indian dog-shark and the Maclot's shark, compared to the second quarter for the grey dog-shark and the blacktipped shark.

Biology

Food and feeding

A qualitative analyses of the food of four common sharks have been made.

***R. acutus*:** The food items in the order of abundance were whitebaits (40%), juveniles of threadfin breams (21%), *Decapterus russelli* (20%), prawns like *Parapenaeopsis stylifera* (5%), *Sepiella* spp. (6%) and squids (8%).

S. laticaudus: The main food item was the prawn *P.stylifera* (45%), *Cynoglossus macrostomus* (25%), whitebaits (10%), squids (10%) and *Squilla* (10%).

***C. melanopterus*:** *Decapterus russelli* (45%) and whitebaits (40%) were the dominant food items followed by cuttlefishes (10%) and threadfin breams (5%) in fishes less than 100 cm. But in fishes above this size (especially 160 cm and above) the main food items were tunas (*Auxis rochei*), and cephalopods(*Sepia pharaonis* and *Loligo duvauceli*).

***S. lewini*:** Both *Cynoglossus macrostomus* and threadfin breams constituted 35% each followed by squids (15%) and *P.stylifera* (5%).

The food analyses indicated that *R.acutus* and *C.melanopterus* are more pelagic than *S.laticaudus* and the hammerhead shark.

Sex ratio

Studies on sex ratio of *R.acutus* and *C.melanopterus* (less than 100 cm) carried out indicated that in both the species mostly the males dominated (Table 3). In the first species females were dominant during September-October 1981; January, May to July and September 1982; and in March 1983. The ratio was significant during November and December 1981; November-December 1982; and January-February 1983. In the second species females dominated during August, October to December 1981; December, January and March-April 1982; and January to April 1983.The sex ratio was significant during January, April to June 1982; and March 1983. In the large specimens (100-230 cm) the sex ratio M: F was 1:0.6 (Sample size 349).

Population parameters

Since *R.acutus* of all size groups were available, the population parameters of this species were estimated by FiSAT programme. Accordingly L_{∞} was found to be 90cm, K (annual) 0.98, natural mortality 1.33, fishing mortality 3.29 and E_{max} 0.537.

DISCUSSION

At Kochi, though the shrimp trawls, purse seines, ring seines and drift gill nets are in operation, only the last gear exploits the sharks in quantity. The trawl is operated mostly beyond the 50 m depth zone. The purse seines cover areas from 25-40 m and the ring seines up to 25-30 m depth. Initially, during the seventies to early eighties the drift gill nets were operated in the 50 m depth zone. Later, these fishermen have been extending

their ambit of operation to deeper grounds mostly as result of dwindling catches in the traditional fishing grounds. Though the scombroids are the target species, the occurrence of a variety of other larger pelagics as by-catches always increased the profit margin. Till the mid eighties the catfishes were an important by-catch component in the gear. No doubt, the decline in the catches of catfishes like *Tachysurus serratus*, *T. thalassinus*, *T.dussumieri* and *Arius tenuispinis* by the latter half of eighties due to indiscriminate fishing have had serious effect on the stock of this resource and thereby has affected the profit margin of these units. Further, the purse seine operations and the heavy landings of small pelagics like oil sardine and mackerel and consequent reduction of the price of fishes have also made serious dent on the profit margin of the gill net units (Jayaprakash, 1989). Extension of fishing to further deep areas and diversification of fishing, therefore, were an eventuality to tide over the situation of low returns. By the late eighties many units ventured to new fishing grounds, while others resorted to *Kalava* fishing during the lean season (November-March) or to a more profitable hooks and line fishing for large sharks. Many of the units are rigged for hand trawling (manual hauling). Some of the drift net units used to migrate to other areas like Mangalore.

The changes in the catch composition of the drift gill net units, as a result of extension of fishing to deeper grounds were worthwhile to note. Species such as the yellowfin tuna (*Thunnus albacares*) and the skipjack tuna (*Katsuwonus pelamis*) which hitherto were not occurring in this gear have become common in the catches. There appeared to have increase in catches of the longtail tuna (*Thunnus tonggol*) also. However, the total drift net catch has come down from 2,596 t in the eighties to 1,428 t in the nineties. But the c/e registered an increase from 132 kg to 192 kg. This is reflected in the landings of tunas also. The average catch of tunas during the eighties was 924 t against 828 t of the nineties. The catch has come down due to reduction in effort input. Consequent on the diversification of fishing the effort input of the drift gill nets has stabilised around 7,400 boat days during the nineties. This appears to be the optimum effort because this stabilisation of effort input guaranteed a better catch (c/e) as well as good returns. For instance, the c/e of 60-70 kg realised for tunas in the past is 104kg at present. Further, the qualitative changes in the tuna landings have increased the profit margin.

The dwindling catch of sharks in the drift gill nets is to be viewed in the context of (1) reduction in fishing effort due to diversification, (2) change in areas of fishing and (3) effort stabilisation. Consequently the catch as well as the percentage contribution of sharks to the total fish catch has come down. The inshore area is the nursery ground for the juveniles of larger sharks and is the abode of small growing forms. Occasionally large growing forms also enter the area. The change in the fishing areas of the drift gill net

fishing can be attributed to the decline in the catches of resources like sharks. Of late the trend of production of sharks in Kerala is on a descending phase compared to an increased production noticed in other states. The production trend in Kerala indicated a decrease from 1987. In the drift gill nets the shark landings started declining from 1979 onwards and came down to 113 t in 1991 and further it was a steep fall to 33 t in 1995. However, the production ascended to 125 t in 1998. It should be remembered here that the effort during the nineties has stabilised around 7,400 boat days that works out to approximately one third the annual effort expended during the eighties. But it was promising to note that the c/e of 18.4 kg realised during 1998 was comparable to that realised during the eighties. This gives more solace that the sharks are not at present destined to a fate as that of the catfishes. Therefore, there exists good shark resource, mostly small growing forms, in the inshore areas that remain under exploited. The vacuum created in the inshore grounds by the change in fishing areas of the drift gill net units can be taken up by small drift net/gill net units.

Presently not much information is available on the species and gearwise composition, and biological aspects of elasmobranchs. The country earns about Rs.100 crores from export of shark products. Low fecundity, slow growth and high rate of exploitation can lead to depletion of stocks. An in depth study on the fishery and biological aspects of sharks and other components is of prime importance in this context to evolve management strategies for optimising the yield.

ACKNOWLEDGEMENTS

The authors are grateful to Dr.Mohan Joseph Modayil, Director, CMFRI for the encouragement given in the preparation of the paper.

REFERENCES

Jayaprakash, A.A. 1989. Trends in drift gillnet fishery off Cochin with special reference to effort inputs and returns during 1981-82 and 1986-87. FAO/DANIDA/FSI workshop on fish stock assessment, Visakhapatnam, 14 Nov. –14 Dec., 1989, *FSI Spl. Publn.*, 2: 87- 105.

Silas, E.G., P.P.Pillai, A.A.Jayaprakash and M.A. Pillai.1984. Focus on small-scale fisheries: Drift gill net fishery off Cochin, 1981 and 1982. *Mar. Fish. Infor. Serv., T&E Ser.*, **55**: 1-12.

Table 1. Species composition of sharks (kg) in drift gill nets at Cochin Fisheries Harbour during 1981- '82 period

Species-1981	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
C.melanopterus	8960	12217	16324	8002	4650	8119	17710	12287	6385	964	3095	284
R.acutes	3586	8786	7400	585	6274	4433	3465	28484	5172	6621	2640	2765
S.laticaudus	6420	1516	3226	512	896	3847	1987	4129	918	1129	708	-
S.lewini	7215	1824	8548	9631	2118	14666	12373	16725	2547	928	3173	2706
R.oligolinx	950	2342	515	-	-	-	777	498	-	-	-	-
C.macloti	665	1855	-	-	882	975	-	2664	-	-	-	-
C.brevipinna	1030	-	-	-	-	-	-	3152	1718	308	2174	1105
C.limbatus	395	-	627	-	-	-	1228	1385	-	-	-	-
Species-1982												
C.melanopterus	1121	10738	6820	9015	5420	7792	21245	7325	10131	1130	3560	3055
R.acutes	305	1134	631	5319	9208	1124	12110	8199	10775	3375	3115	5755
S.laticaudus	1755	2167	675	-	19	21	945	2300	3550	742	-	-
S.lewini	255	2047	873	8008	1213	15543	22300	8596	10036	3692	2980	3865
R.oligolinx	-	351	371	646	1472	3134	-	-	750	340	-	-
C.macloti	174	563	1070	356	137	167	-	-	8980	-	485	1740
C.brevipinna	-	-	-	194	-	-	-	-	-	1076	-	2235
C.limbatus	-	-	-	-	815	1559	-	-	-	-	-	-

Table 2. Quarter-wise production trends (Avg. 1981-'82) in kg of various shark species exploited by drift gill nets at Cochin

Species	IQ	IIQ	IIIQ	IVQ	Total
C.melanopterus	28090	21499	37542	6044	93175
%	30.1	23.1	40.3	6.5	
R.acutus	10924	13472	34102	12136	70634
%	15.4	19.1	48.3	17.2	
S.laticaudus	7879	2648	6915	1290	18732
%	42.1	14.1	36.9	6.9	
S.lewini	10381	25590	36289	8672	80932
%	12.8	31.6	44.8	10.7	
R.oligolinx	2265	2626	1012	170	6037
%	37.3	43.2	16.7	2.8	
C.macloti	2164	1259	1332	-	4755
%	45.5	26.5	28	-	
C.brevipinna	515	97	-	538	1150
%	44.8	8.4	-	46.8	
C.limbatus	511	1187	614	-	2312
%	22.1	51.3	26.6	-	

Table 3. Sex ratio in *R.acutus* and *C.melanopterus* taken by the drift gill nets at Cochin Fisheries Harbour

	R.acutus		*C.melanopterus*	
Month	Sample size	M : F	Sample size	M : F
May 1981	-	-	33	1:0.7
Jun	28	1:0.6	58	1:0.4
Jul	29	1:0.6	25	1:0.9
Aug	56	1:0.6	51	1:1.3
Sep	32	1:1.5	85	1:0.66
Oct	23	1:1.6	30	1:1.3
Nov	31	1:0.6*	11	1:2.7
Dec	30	1:0.3*	4	1:3
Jan '82	39	1:1.2	59	1:1.9*
Feb	111	1:0.9	94	1:0.9
Mar	36	1:1	38	1:1.9
Apr	18	1:0.6	39	1:2.3*
May	31	1:1.6	86	1:0.6*
Jun	50	1:1.2	125	1:0.4*
Jul	49	1:1.04	83	1:0.8
Aug	21	1:0.5	18	1:1
Sep	19	1:1.4	115	1:0.9
Oct	67	1:0.8	53	1:0.6
Nov	171	1:0.6*	14	1:0.8
Dec	101	1:0.6*	7	1:0.7
Jan."83	195	1:0.7*	138	1;1.03
Feb.	137	1:0.5*	52	1:1.4
Mar	158	1:1.1	114	1:2.1*
Apr	7	1:0.8	33	1:1.06

*** significant at 5% level**