Estimate of catch per unit effort of 'shark' in inshore Atlantic off Ibaka, Nigeria

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Abstract: A study of shark (shark, skate and ray) fishery was conducted in inshore Atlantic Ocean off Ibaka, Cross River estuary with a view to providing baseline information for the conservation of shark, being an endangered species according to IUCN Red List. Study methods included reconnaissance and observer based surveys. The result showed that there is no fishery targeting shark as a single species. Gill net, long line and purse seine are the three shark fishing gears. Gill net and long line caught shark as a target species in multispecies 'big fish' fishery while purse seine caught shark as a by-catch in bonga fishery. There was no significant difference between the weights of shark caught by the three gears (F-test P > 0.05). The total weight and number of 'shark' caught by gill net, long line and purse seine were (408.82kg, 131) (536.9kg, 139), and (443.9kg, 110) respectively. Catch per unit effort was highest (6.28kg/man/hour) in long line ray fishery and the least (0.08kg/man/hour) was obtained in purse seine ray fishery. The result is discussed in terms of shark exploitation for protein food and shark conservation for future.

Key Words: Red list, Shark, Inshore Atlantic, Nigeria.

Introduction

Sharks, rays and skates are chondrichthyan fishes and are commonly called sharks. In recent years, increased in fishery pressure upon these fishes with their comparatively, slow growth and reproductive abilities and late maturity have led to massive depletion of population of these fishes globally. Decline in shark population is most pronounced due to the high demand of shark for fins and other products in international market.

Sharks inhabit a very brood range of habitats from deep oceans to fresh waters, some undertake long migration while other are confined to one habitat. Most sharks inhabit continental shelves up to a depth of 200 meter (Cortes, 2000). It is difficult to manage fisheries involving shark and conserving shark population. This is because reproductive biology of shark contrast with that of bony fishes which release large number of eggs, few of which survive to adulthood, sharks on the other hand produce few young one, many of which survives to adulthood. (Lock and Sant, 2000). Compagno (1984) highlighted five main ways that man can adversely affect sharks sustainability to include; overfishing, shark fining, by-catch, pollution and habitat loss and degradation.

IUCN red list classified shark and other cartilaginous fishes as threatened. The wildlife trade monitoring network through TRAFFIC mandated coastal nations to ban marketing of threatened species such as shark to reduce their fishing pressure. Nigeria ranked 18 among the 20 top shark producing countries of the world from 1950-2003 producing 457,656 tonnes of shark (FAO, 2000). The FAO code of conduct for responsible fisheries requested coastal states to develop management/conservation strategies for threatened species of fishes like shark. This can only be done through collecting data on the quantity of shark caught and the type of gear used which this work aimed at achieving.

Materials and methods
1.   The Study Area

The present study area lies between Latitude $4^0 30^1$N and $5^0 0^1$N and Longitude $8^0 10^1$E and $^0 30^1$ in the lower cross river.

Ibaka fish landing site comprises of tidal creeks, lagoon and fringing mangrove swamps. The macrophytes of the coastal mangrove swamps are pre dominated by *Rhizophora racemosa, Rhizophora harrizonii, R. mangel, Aviecenna africana, Laguncularia racemosa and Nypa fruitcans.* Two seasons (dry and wet) are discerned in this area. The dry season extends from November to February with the peak in January. The wet season ranges between March and October with peak in July (*Teugel et al.,* 1992).

2.   Study Methods

The study was accomplished in two phases namely; reconnaissance phase (January –February 2015) and study phase (March 2015-February, 2016).

2.1 Reconnaissance Survey

Reconnaissance survey trips were embarked for familiarization and identification of suitable field stations along the estuaries of three great rivers that drained Akwa Ibom State namely, Cross River, (Ibaka and Mbe Ndoro fishing villages), Imo River (Ikot Abasi and Uta Ewa fishing villages), and Qua Iboe River (Ibeno, Ukpenekang fishing villages). During the survey, shark landings by three types of fishing gear namely, purse seine, long line and gill net were identified. It was only at Ibaka that fishers exploiting shark resources with gill net, purse seine and long line were found. Other villages operated one or two of these gear hence Ibaka, was chosen as the study site and field station.

2.2 Study Trips and Methods

Study trips were made weekly to Ibaka and 3 contact fishermen operating gill net, purse seine and long line were identified. Phone numbers were exchanged for effective communication, weighing balance, measuring board were given to the fishers after teaching them how to use them. Daily landing records were kept by the fishers. On repeated visits weight and number of shark and other species landed were recorded and design specifications of the gear taken. Weekly samples of each landing were collected for one year from the landings of the artisanal fishers at Ibaka beach in the lower Cross River estuary. During the sampling periods, the lengths, depth of the gear were measured using measuring tape. Mesh sizes of nets (gill nets and purse seine net) were also taken using meter rule, length and thickness of long line and the hooks were recorded.

3. Fish Identification

The sharks caught were identified, measured for their lengths (total length) and weight. Photographs/drawings of shark caught were also made. Identification of shark was based on the compilation of the work by Schneider, (1990).

Oral interviews with the artisanal fishers at Ibaka settlement were conducted on the catch of shark, the size caught, the period caught and what is done to the shark caught. The endangered status of shark was asked to know the opinion of the fishers on shark fishery and conservation.

4. Data Analysis

One way ANOVA was used to compare the weight of shark caught by the different gear, with the hypothesis that they caught equal weight of shark.

5. Estimation of Catch Per Unit Effort (CPUE)

Catch per unit effort was taken as an index of efficiency of the gear in the catching of shark fishes It

was estimated according to the method of Stamatopoulous, (2002) as:

$$CPUE = \frac{\text{mean weight of total catch (kg)}}{\text{Fishing effort}}$$

Fishing effort = No. of fishermen (gill net = 3, long line = 3, purse seine = 18)

Results

The results showed that there is no fishery targeting shark as a single species. Shark in the study area are exploited as commercial enterprise with three fishing gears, namely gill net, long line and purse seine. While gill net and long line caught shark as a target species in multi species 'big fish fishery', purse seine on the other hand caught shark as a by-catch in bonga fishery.

1. Species Caught

The species of shark caught included angel shark *Squatina squatina,* Atlantic sharp nose *Rhizoprionodon terraenovae*, basking shark *Cetorhinus maximus*, *Carcharias taurus, Sphyrna diplana,* bull shark *Carcharhinus leucas*, black tip shark *Carcharhinus limatus, milk shark* Rhizoprionodon acutus, white fin hammer *sphyrna couardi*. The species of skate caught included big skate *Raja binoculata* and *Raja imiraletus*, and the species of ray caught included *Dasyatis pastinaca,* brown sting ray and manta ray, rough tail sting ray *Dasyatis centroura*, daisy sting ray *Dasyatis margarita,* common sting ray *Dasyatis postinaca*.

2. Number and Weight of Shark Caught

Multi filament gill net with stretched mesh size of 450 mm caught 86 specimens of shark weighting 253.52kg from 20 replicate landings of one boat. A total of 17 skate weighing 56kg was also caught by multi filament gill net with a stretched mesh size of 450mm. The gill net also caught 28 specimens of ray fish with a total weight of 99.3kg (Table 1).

Upon sorting, the number of fishes caught by hook No 4 for 'big fish' fishery, the total number of shark landed from 20 fishing trips was 26 and the weight was 120.2kg. The same long line caught 9 specimens of skate weighing 40.1kg. Number and weight of ray caught by the same long line with hook No. 4 respectively was 104 and 376.6kg (Table 2).

The result of the study also showed that purse seine gear caught 87 numbers of sharks weighing 347.6kg from 20 replicate landings. However the same purse seine gear caught and landed 15 specimens of skate with a total weight of 67.1kg. Eight numbers of rays weighing 29.2kg was also caught by the same purse seine gear (Table 3). Table 4 is a summary of total and mean weight of shark fishes (shark, ray and

skate) caught by the three fishing gears off Ibaka sea fishing village. The highest weight of shark (538.9kg) was caught by long line while gill net and purse seine respectively caught 410.12kg and 444.5kg of shark. There was no significant difference between the weight of shark caught by the three fishing gear (F-test $p > 0-05$).

3. Size Range

Shark caught by the three gears used in fishing (gill net, long line and purse seine) range in size between 10 cm to 91cm. (Tables 1-3) Skate caught by the three gears used in fishing (gill net, long line and purse seine) range in size between 10cm to 85cm. (Tables 1-3) Ray caught by the three gears used in fishing (gill net, long line and purse seine) range in size from 11cm to 85cm. (Tables 1-3). On the whole, purse seine caught immature species of shark than other two gears.

4. Catch Per Unit Effort

Estimation of catch per unit effort (Table 5) for all the three fishing gear employed in shark

exploitation showed that long line fishery for ray is more profitable (6.28kg/man/hour) while purse seine gear for ray is less profitable (0.08kg/man/hour). Probably because shark species is a by catch in purse seine fishing and could also be due to the large number of fishing crew which is 18.

5. Percentage Compositions of Shark, Skate and Ray

The percentage abundance of the three groups of shark fishes (shark, skate and ray) showed a marked difference in their compositions. As shown in table 6, gill net caught 65.65% of shark, 12.98% of skate and 21.37% of ray in the total landings. Long line gear caught 18.7% of shark, 6.47% of skate and 74.82% of ray. Table 6 also showed that 79.09% of shark mostly juveniles, 13.64% of skate and 7.27% of ray were caught by purse seine gear.

Thus the highest number of shark was caught by purse seine while the highest number of ray was caught by long line and the highest number of skate was caught by gill net.

Table 1:   **Number and weight of shark, skate and ray caught by multifilament gill net (450mm mesh size) off Ibaka N= Number of Replications**

Number				Weight (kg)			Length range (cm)		
N	Shark	Skate	Ray	Shark	Skate	Ray	Shark	Skate	Ray
1	3	-	2	9.10	-	7.0	20-50	-	11-21
2	9	-	-	27.90	-	-	25-61	-	-
3	1	1	-	4.50	3.5	-	85	25-42	-
4	5	-	1	15.50	-	2.5	20-61	-	20-42
5	2	2	-	6.00	7.0	-	41.59	30-51	-
6	6	2	-	18.60	75	-	45-58	10-45	-
7	2	-	2	7.50	-	8.5	30.51	-	15-35
8	1	1	2	2.10	3.0	8.0	5.2	15-30	20-40
9	5	3	3	20.00	8.0	11.5	30-61	35-85	50-91
10	4	-	1	12.20	-	2.0	20-45	-	60-75
11	3	-	2	6.10	-	5.0	25-42	-	52-65
12	8	-	4	24.80	-	15.0	30-90	-	72-85
13	9	1	-	27.10	2.8	-	35-65	20-45	-
14	15	3	-	48.00	9.5	-	33-91	25-61	-
15	2	-	4	6.90	-	16.5	30-51	-	80-92
16	3	-	3	5.43	-	12.0	25-42	-	72-80
17	2	-	2	3.16	-	5.5	15-30	-	65-78
18	1	1	1	0.80	3.5	3.0	42	33-91	60-72
19	3	1	1	6.51	4.0	2.8	15-60	30-90	50-05
20	2	2	-	1.32	7.0	-	10-45	25-42	-
Total	86	17	28	253.52	56	99.3			
Mean	4.3	0.85	1.4	12.676	2.8	4.97			

Table 2:　　**Number and weight of shark, skate and ray caught by long line (Hook number 4) off Ibaka.**
N = Number of replications N= number of replications

Number				Weight (kg)			Length range (cm)		
N	Shark	Skate	Ray	Shark	Skate	Ray	Shark	Skate	Ray
1	2	-	2	8.5	-	6.0	30-52	-	20-30
2	1	-	1	4.0	-	3.0	25	-	25-35
3	-	1	5	-	5.1	15.0	-	40	28-42
4	-	-	10	-	-	30.1	-	-	27-42
5	2	-	8	9.0	-	28.0	20-40	-	27-45
6	1	2	-	5.0	11.5	-	40	30-40	-
7	1	-	2	3.5	-	7.5	32	-	20-40
8	2	-	14	10.8	-	56.0	15-50	-	30-50
9	3	-	-	13.8	-	-	40-50	-	-
10	2	1	1	8.8	3.0	3.5	25-45	25	35
11	-	-	5	-	-	17.5	-	-	35-50
12	-	-	6	-	-	21.0	-	-	30-40
13	2	-	12	11.2	-	42.0	25-50	-	40-50
14	3	1	3	15.8	4.2	14.4	20-40	35	35-40
15	4	2	4	16.0	8.4	15.2	35-40	30-35	35-40
16	1	-	4	5.0	-	20.0	40	-	35-40
17	-	-	12	-	-	44.0	-	-	27-40
18	-	1	11	-	4-5	39.5	-	37	25-35
19	1	1	4	4.8	3.5	17.0	38	328.5	29-45
20	1	-	-	4.0	-	-	35	-	-
Total	26	9	104	120.2	40.1	376.6			
Mean	1.3	0.45	5.2	6.01	2.00	18.83			

Table 3:　　**Number and weight of shark, skate and ray caught by purse seine off Ibaka. N= number of replications N= number of replications**

Number				Weight (kg)			Length range (cm)		
N	Shark	Skate	Ray	Shark	Skate	Ray	Shark	Skate	Ray
1	8	1	-	34.4	5.0	-	25-50	40	-
2	5	-	-	21.5	-	-	25-50	-	-
3	10	2	-	43.0	11.5	-	25-50	40-50	-
4	2	-	-	7.0	-	-	30-45	-	-
5	7	-	-	24.5	-	-	30-40	-	-
6	-	2	1	-	10.0	3.5	-	30-40	35
7	5	1	1	18.0	4.0	3.2	15-30	30-40	42
8	6	2	-	17.4	8.5	-	28-42	30-45	-
9	2	3	-	7.5	13.6	-	35-40	30-55	-
10	2	-	2	8.0	-	7.6	35-40	-	45-60
11	3	-	-	11.2	-	-	32-38	-	-
12	2	-	-	8.2	-	-	27-48	-	-
13	4	1	1	16.8	3.8	3.0	20-50	25-35	35
14	1	1	-	3.7	4.3	-	25-35	25-45	-
15	2	-	1	7.4	-	4.0	25-45	-	48
16	5	-	1	22.5	-	4.2	30-45	-	50
17	6	-	1	27.0	-	3.7	30-45	-	40
18	10	1	-	45.0	2.9	-	25-50	25-38	-
19	4	-	-	14.0	-	-	25-35	-	-
20	3	1	-	10.5	35	-	30-40	35	-
Total	87	15	8	347.6	67.1	29.2			
Mean	4.35	0.75	0.4	17.38	3.36	1.46			

Table 4: Summaries of total and mean weight of all shark fishes caught by the 3 gear (Treatment, T) that was used in F-test (N=20) (total number of fish in parenthesis)

Replicate	Gill net (kg)		Long line (kg)		Purse seine (kg)	
1	16.1	(5)	14.5	(4)	39.4	(9)
2	27.9	(9)	7.0	(2)	21.5	(5)
3	8.0	(2)	20	(6)	54.5	(12)
4	18.0	(6)	30	(10)	7.0	(2)
5	13.0	(4)	37	(10)	24.5	(7)
6	26.1	(8)	16.5	(3)	13.5	(3)
7	16	(4)	11.0	(3)	25.8	(7)
8	13.1	(4)	66.8	(16)	25.9	(8)
9	40.5	(11)	13.8	(3)	21.1	(5)
10	14.2	(5)	15.3	(4)	15.6	(4)
11	11.1	(5)	17.5	(5)	11.2	(3)
12	39.8	(12)	21	(6)	8.2	(2)
13	29.9	(10)	53.2	(14)	23.6	(6)
14	57.5	(18)	31.4	(7)	8.0	(2)
15	23.4	(6)	29.9	(10)	11.4	(3)
16	17.43	(6)	57.5	(5)	26.7	(6)
17	8.66	(4)	44.0	(12)	30.7	(7)
18	7.3	(3)	44.0	(12)	47.9	(11)
19	13.31	(5)	25.3	(6)	14.0	(4)
20	8.82	(4)	4.0	(1)	14.0	(4)
Total:	408.82	131	536.9	139	443.9	110
Mean	20.44	6.55	26.95	10.95	22.19	5.5

Table 5:   Estimation of catch per unit effort of shark, skate and ray in gill net, long line and purse seine

Gear	Catch per unit effort		
	Shark	Skate	ray
Long line	2.00	0.67	6.28
Purse seine	0.97	0.19	0.08
Gill net	4.26	0.93	1.66

Table 6:   Percentage number of skate, ray and shark caught by fighting gears in the area

Fishing gear	Type of 'shark'		
	Shark	Ray	skate
Long line	18.7	74.82	6.47
Gill net	65.65	21.37	12.98
Purse seine	79.09	7.27	13.64
Total	163.44	103.46	33.09

Discussion

Shark (shark, skate and ray) are caught mostly during the dry season which is due to hydro-meteorological factors such as heavy rainfall, which affect fishing operation, gear design and type of fish. The result also showed that there is no significant difference in the weight of shark caught by the three gears. This is because long line and gill net mostly caught big sizes of shark but less number, whereas purse seine mainly caught shark of smaller and medium sizes and many in number compensating for the large size caught by long line and gill net. The efficiency of long lines was found to depend on the size of the hook and type of baits used. Hook number four which was mainly used in the study area caught large shark with a total length up to 60 cm and weighing between 4-6kg. The most commonest and effective baits used in the area for catching shark fish was red snapper which recorded the highest percentage of fish caught by long line. Thus the type of baits used depends on the target fish and hydro graphic features of the water. Studies on catch-bait relationship of long lines operated in different water bodies will be highly appreciated. It was observed that the weight of ray caught by long line was the highest followed by that of shark and skate, this is because ray is purely dermesal species. Due to their habitat and feeding method and the type of food they eat ray were mainly captured by long line because of long lines mode of operation which is the use of bait (squid and small fishes fed on by the ray). This allowed the fishermen operating on the long line to be able to capture it since the ray always is attracted to the bait used by the fishermen. Gill net caught the highest

number and weight of shark. It was observed that gill net caught mostly shark. Gill nets are effective for pelagic and demersal fish of which shark is an example. Visuality of gill nets by fishes during the day makes them less effective, thus are usually fished at night. Most sharks hunt for prey at night this makes them vulnerable to the fishermen's gill net which is operated mainly at night (Von Brandt, 1984). In some estuaries the turbidity of the water often renders them effective in daylight. The amount of catch by gill net is a factor of width and mesh size of the net. The reason gill net caught more of shark than ray and skate is because gill net is mostly operated at night and also in deep waters where shark is present mostly, while skate and ray are mostly found in shallow part of the sea with sandy bottom.

Purse seine is characterized by a line at the bottom of the net that is used to close off the escape route. Light may be used to attract species. Purse seines are highly mobile and can capture whole or large school of pelagic species (BOSTID, 1988). Pelagic shark are taken as by-catch in offshore fisheries for tuna, bonga. Sharks are not targeted in purse seine fisheries, although due to the non-selective nature of the gear, pelagic sharks are taken as by-catch. Purse seine captures more sharks than ray and skate.

From the results it is observed that there is no significance difference between the weights of shark caught by the three gears used (long line, gill net and purse seine) to capture shark in the study area. This is because; long line catches big sizes of shark some amounting to 5 kg but less number and mostly ray. Ray is not as weighty as shark therefore 3-4 rays weight could be equivalent to the weight of one shark. Because of this the weight of shark caught by long line is equivalent to that caught by gill net. Gill net also captured shark of large sizes but not too large to overwhelm that caught by long line. Purse seine captured shark of medium sizes because of the mesh size of the purse seine net which is small targeting small shoaling species of fish. Shark caught by purse seine is smaller in size but more in number amounting to the same weight of shark caught by long line and gill net. Therefore there is no significant difference between the weight of shark caught by gill net, purse seine and long line.

The fishery of lower Cross River estuary including the present study area (Ibaka) is of great importance to the riverine areas and other neighbouring states including Cross River, Abia, Imo and Akwa Ibom. Even though the fisheries of the study area are mainly artisanal, characterized by being labour intensive, low catch per unit effort and the use of traditional fishing gear and methods in the exploitation of both fin and shell fishes that abound in the ecotine habitat, the catch forms only about 4.9% of the total Cross River and Akwa Ibom States domestic fish harvest and about 0.9% of the total national domestic catch (Moses, 1979 and 1990). Shark is one of the major by-catch of the fisheries in the study area, accounting up to 0.4% of the total catch of the area. (Moses, 1990).

In addition to fishing pressures, chondrichthyans in Ibaka sea may face potential threats from *inter alia,* habitat loss, pollution, disturbance from ecotourism and climate change. The magnitude of these potential impacts is likely to be small in comparison to fishing but, where stocks are already depleted, may be sufficient to inhibit recovery. IUCN (2007) listed ten objectives that should be achieved by national shark plans; ensure that shark catches from directed and non-directed fisheries are sustainable, assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use, identify and provide special attention in particular to vulnerable or threatened shark stocks, improve and develop frameworks for establishing and coordinating effective consultation involving all stakeholders in research, management and educational initiatives, minimize unutilized incidental catches of sharks, contribute to the protection of biodiversity and ecosystem structure and function, minimize waste and discards from shark catches and encourage full use of dead sharks. If these measures are adopted also by Nigerian government shark extinction will be greatly reduced if not eradicated completely.

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