African Journal of Biotechnology Vol. 7 (21), pp. 3962-3971, 5 November, 2008
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB08.683
ISSN 1684–5315 © 2008 Academic Journals

Full Length Research Paper

Gill net selectivity and catch rates of pelagic fish in tropical coastal lagoonal ecosystem

B. E. Emmanuel*, L. O. Chukwu and L.O. Azeez

Department of Marine Sciences, Faculty of Science, University of Lagos, Lagos, Nigeria.

Accepted 26 September, 2008

The fish species and size selectivity of gillnets design with monofilament nylon polyethylene netting materials were investigated in Lagos Lagoon, Nigeria between September and December 2005. The gillnets floats and sinkers were improvised from rubber slippers and lead metallic objects which were attached at intervals of 1.35 to 2.0 m with hanging ratios of 45.2 and 51.7%. The number of miles per stapling distance was three. A total of sixteen fish species belonging to 14 families were caught and *Ethmalosa fimbriata* was numerically most abundant. The highest numbers of fish species were recorded during the dry season month of November. The higher the fishing effort the more the gillnet catches. More fishes were caught during daytime than at night. The effect of gillnet fishing activities on fish communities includes a decrease in their abundance, changes in age structure, size composition and species composition. The overall length sizes of the fish caught were comparatively small. Gillnets used were highly selective for smaller size of fish and were easily damaged by crabs, tugs and engine powered canoes. Fishes with head and body girths smaller than 126 mm which were not gilled, wedged or entangled by the gillnets are assumed to have escaped. The condition factor (K) of fishes in the lagoon ranged between 0.11 and 1.3 while a mean condition factor of 47.78 was recorded for swimming crab *Callinectes amnicola.* The gillnet price per kg of fish was (N150.00 or $1.07) while the price of fish per trip was N477.27 or $3.41). The durability of the nets depends on its continual and timely mending and maintenance.

Key words: Gill net designs, characteristics, catch composition, selectivity, lagoon.

INTRODUCTION

Gillnet is a large wall of netting vertically hanging in the water. The net may have just one sheet of twine in which the fish are trapped by their gills when they try to swim through or many sheets of various mesh sizes of which they are entangled (Sainsbury, 1986). This is a passive gear, but fish can also be driven into it using acoustics (Von Brandt, 1984). Furthermore, gillnets are net walls whose lower end is weighted by sinkers and whose upper end in raised above by floats. They are set to transverse direction of the migrating fish and through which the fish try to make their way (Von Brandt, 1984).

Until recently, the normal approach to lagoon fisheries management was based on global models (Schaefer, 1967), analytical models (Beverton and Holt, 1957) and stock recruitment models (Ricker, 1954). According to Henderson and Welcomme (1974), Lae (1992) and Albaret and Lae (2003), in tropical inland aquatic ecosystems, more empirical relationships based on morphological parameters (morphoedaphic index, surface area of lakes, river length or basin area) or productivity index (phytoplankton primary productivity, total phosphorus) have been preferred.

Albaret and Lae (2003) reported that such relationships have now become inadequate because they only define maximum yields without paying attention to the biological properties of the ecosystem. In addition, in recent years, attention has increasingly focused on the conservation of biodiversity and the maintenance of a ‘healthy environment’. Albaret and Lae (2003) further reported that as a consequence, one way to understand the impact of overfishing is to study the responses of assemblages through a sequence of changes in species

*Corresponding author. E-mail: monetemi@yahoo.com.

composition that may be termed 'fishing down processes'.

Knowledge of the size-selectivity of fishing gear types is crucial to fisheries management and ecology. The gillnet selectivity of most tropical lagoon fish is poorly known. Knowledge of the size-selectivity of fishing gear types is crucial to fisheries management in order to maximize a sustainable yield (Millar and Holst, 1997; Huse et al., 2000; Emmanuel et al., 2008). It is also essential for fish ecology in order to adjust the length distribution of the catches and to understand the population sampled. Gillnets are one of the most commonly used methods for sampling fish populations in reservoirs and lakes (Boy and Crivelli, 1988) and for commercial fisheries. The advantages of gillnets include ease of use, low cost, and possibility to be set at any depth and in areas with difficult bottom conditions (Hovgard and Lassen, 2000)

Gillnet selectivity studies are typically implemented by the simultaneous fishing of several gillnets of differing mesh sizes to guarantee no changes on the catchability of fishes when the fish size increases (Kurkilahti et al., 2002; Millar and Holst, 1997). In general, indirect estimates of gillnet selectivity are obtained by comparing the observed catch frequencies across several meshes (Millar and Holst, 1997).

Past reports on the uses of gillnet in Nigeria include those of Reed et al. (1967), FAO (1969), Solarin and Udolisa (1979) and Solarin (1998). Nedeleec (1982) identified the various types of gillnets used in the world as set gillnet, drifting gillnets, encircling gillnet, fixed gillnets, trammel net and bottom driftnets.

The size frequency distribution of the population and the selectivity parameters are thus estimated simultaneously (Hovgard and Lassen, 2000). Different approaches to indirect estimates have been used to obtain the selection curve using various manipulations of the selection equation. Holt's method (1963) is one of the most commonly used methods for estimating gillnets selectivity. However, it is restrictive due to the assumption of the normal location curve (the spread is constant for all mesh-sizes) as the selection model.

Karlsen and Bjarnasson (1986) described drift gillnets operations with respect to the depth positioning in the water column, as bottom, mid-water and surface drift gillnets. Sainsbury (1986) also described the operation of gillnets as anchored and drifting nets.

Recently, other methods apply Baranov's principle of geometric similarity (selection is described as a function of the fish length/mesh size ratio) to compare catches in the same length group taken by different gear, assuming that the fishing power is the same for all mesh sizes.

Despite the important of this fishing gear little is known about its efficiency, durability and selectivity especially in the Nigerian context and coastal waters of Nigeria specifically. Thus, this study investigate the design details of gillnet fishing gear with a view to its cost, durability, selectivity, catch composition, efficiency, economic importance and its impacts on the Lagos lagoon fishery.

MATERIALS AND METHODS

Description of study area

The Lagos lagoon (latitudes 6° 26'N and 6° 38' N and longitudes 3° 23' E and 3° 43'E) experiences both freshwater and brackish characteristics and is a large stretch of water which is part of continuous train of lagoons and creeks along the coast of Nigeria from the Republic of Benin boarder to Niger Delta. It has an area of about 208 km^2 (FAO, 1969) and is being fed from the north mainly by the perennial Ogun River, bounded in the South by five cowrie creek and opens into the Gulf of Guinea via the Lagos Harbour all year round.

The lagoon has a salinity range of 0 – 28.9% between the peak of the rainy season to the peak of the dry season (Emmanuel and Onyema, 2007). There are many fish landing stations along the lagoon beach (Figure 1). Most of the fishermen in these landing sites have their houses constructed of planks and raffia directly on the lagoon. The houses are connected to the land by wooden jetties. Some of the fish landing places are Bariga jetty, Oko-Baba, Makoko better, Maroko and Ajah.

Gillnet operations in Lagos lagoon

A canoe was used with two fishermen, one manoeuvring the canoe with a paddle and the other was busy setting the net. The net was orderly packed in the canoe with the floats line separated from the sinkers line and gradually released into the lagoon from one end to the other. As the setting progresses, the net was released astern and the fisherman paddling the canoe manoeuvres ahead usually setting parallel to the direction of current flow for ease of operation. The distinction was observed between surface and bottom set gillnet. The fishermen stayed with the surface driftnet and the bottom set gillnet was left overnight was done by pulling it into the canoe and the fish caught were singly removed from the nets.

Gillnet was mostly used at night, except for the special research trips that were done during the day. The fishing duration for gillnet ranged from 12 – 14 h (18.00 – 6.00 h or 16.00 – 6.00 h).

Fishing grounds, periods and durations

The fishing grounds used for this study were: Oko-Baba, Moba, Oworonsoki, Ogudu, Ofin, Aja, Ijede, Ibese and University of Lagos beach (Figure 1). The fish specimens were either caught during daytime or during night time. The specimens collected from each trip were conveyed to the laboratory in ice chests.

Laboratory analysis

The species were identified and sorted using relevant and available literatures (Reed et al. (1967), Fischer et al. (1981), Holden and Reed (1991) and Schneider (1990).

The total and standard lengths of the specimens were measured with fish measuring board to the nearest 0.1 cm and the weight was measured with an upper top loading Sartorius balance. The fish growths were also measured with a thread folded round the fish at the operculum for the head girth and just before the first dorsal spine for the body girth. The thread was then stretched on the measuring board for actual girth measurement as described by Karlsen and Bjarnasson (1986).

The sex determination was by dissecting the specimen and viewing the gonads while the external features of the lagoon crab,

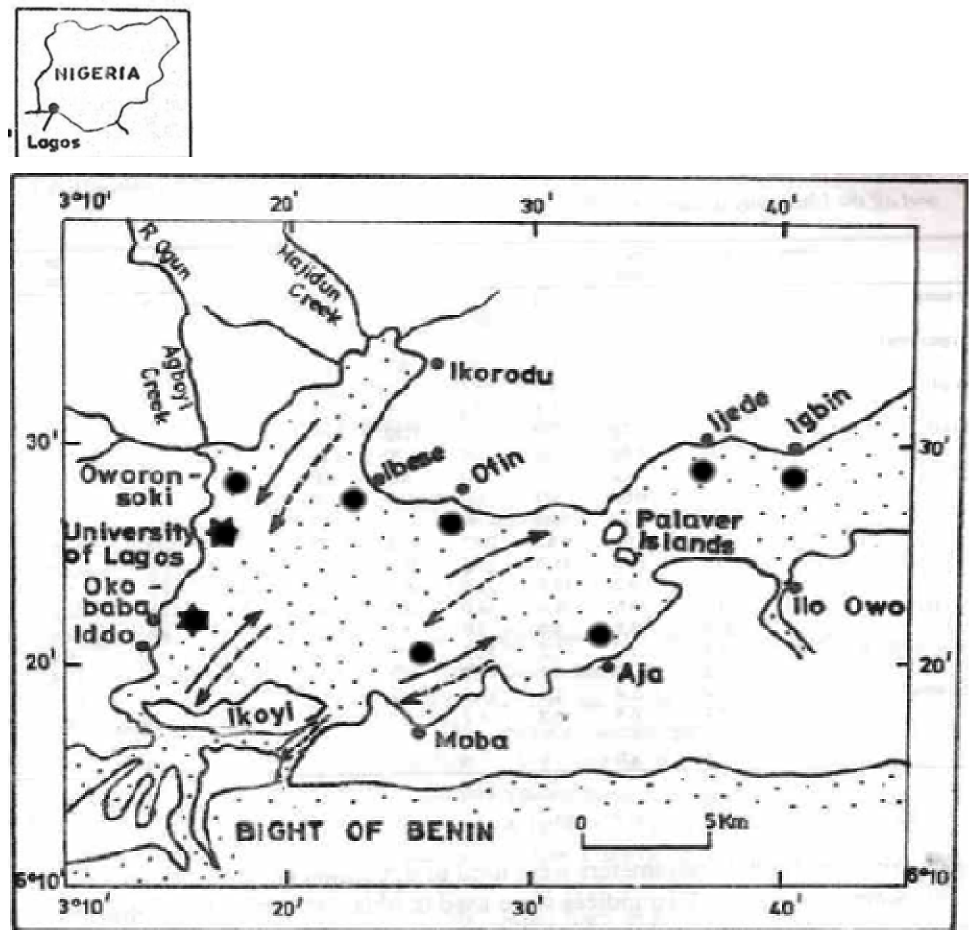

Figure 1. Map of Lagos lagoon showing fish sampling sites.

Callinectes amnicola was examined. The condition factor (k) was calculated using the formula:

$K = 100W / L_3$ (Sturm, 1976)

Where W = weight of individual fish in grammes, and L = length of the fish in centimeters.

RESULTS

Gillnets design detail

The gillnets were walls of netting hanging vertically in water by the combined action of the rubber slippers floats attached to the headline and the sinkers (lead) at intervals of 1.35 – 2.0 m to the footropes sink the feet of the nets to the lagoon bed while the floats attached at interval of 1.1 – 1.95 m to the headlines allow the heads of the nets to float thereby maintaining the vertical opening of the gillnets. The surface driftnet/gillnet had less number of weights (stones) attached to the footrope; more floats were attached to the headline. More weights (stones), anchor and less float were used for the design of the anchored bottom gillnet.

The net material used was white monofilament nylon. The headline material were polyethylene and kuralon with diameters ranging from 2.5 – 3.0 mm and R-Tex values ranged from R2939Tex - R4048Tex. The footrope material was kuralon with diameters ranged from 3.0 – 3.5 mm and R Tex values ranged from R4351Tex to R5926Tex.

The mesh sizes ranged from 39 – 70 mm; mesh opening ranged from 38 – 69 mm and mesh circumferences ranged from 76 – 138 mm.

The rubber slipper floats had the following dimensions 6 x 4 x 4 cm; 8 x 5 x 1.3 cm and 7 x 5 x 4 cm. The floats numbers on the headlines varied from 733 to 2001 and the headline lengths varied from 804.67 on to 3,900 m. The distances between floats varied from 1.1 to 1.95 m. The lead sinker weighed 35 g and the numbers of sinker per footrope ranged from 404 to 2,890; the footrope lengths varied from 804.67 to 3,900 m. The distance between sinkers varied from 1.35 to 2 m (Table 1).

The number of meshes per stapling distance was 3 and the stapling distances/mounted lengths varied from 60 – 96 mm. The numbers of meshes in headline ranged from 38,936 to 130,000. The numbers of meshes in

Table 1. Gillnet designs characteristics in Lagos lagoon.

Design characteristics	Measurements and description
Gear colour	White; green
Type of Set	Surface drift; anchored bottom
Type of mesh net	Knotted
Headline length	804.67 – 3,900 m
Headline material	Polyethylene (PE) Kuralon
Headline diameter	2.5 – 3.0 mm
Headline Rtex value	R2939 Tex – R4048 Tex
Footrope length	804.67 – 3,000 m
Footrope material	Kuralon
Footrope diameter	3.0 – 3.5 mm
Footrope Rtex value	R4351 Tex – R5926Tex
Stapling distance/mounted length	60 – 96 mm
Number of meshes per stapling distance	3
Mesh size	39 – 70 mm
Mesh opening	38 – 69 mm
Mesh circumference	76 – 138 mm
Hanging ratio	45.24 – 52.7%
Float material	Rubber slipper
Number of floats	6 x 4 x 4 cm; 8 x 5 x 1.3 cm; 7 x 5 x 4 cm
Distance between float	1.1 – 1.95 m
Number of meshes in headline	38,936 – 130,000
Number of meshes in depth	30 – 81
Number of suckers	404 – 2,890
Weight of suckers	35g
Distance between suckers	1.35 – 2.0 m
Material of suckers	Lead (Pb)
Anchor rope material	Polyethylene (PE)
Diameter of anchor rope	8.0 – 80 mm

depths varied between 30 and 81. The anchor rope material was polyethylene (PE) with diameters ranged from 8 to 80 mm. The hanging ratios varied between 45.24 and 51.7% (Figures 2 and 3).

Catch composition

One thousand, one hundred and ten (1,110) specimens were caught at 35 kg total weight. The fish comprised 16 species belonging to 14 families. *E. fimbriata* had the highest percentage composition by number 909 (81.89%) and *S. senegalensis* had the least percentage of 3 (0.27%) (Table 2).

Monthly variations in fish caught with gillnet

The monthly variation in fish species caught with gillnet are shown in Table 3. The number of *E. fimbriata* caught was 69, 240 and 600 in September, October and November, respectively, with no record of catch in August. The least caught species by gillnet was *S. senegalensis*. The total numbers of fish caught were 19,173, 298 and 620, respectively, for four consecutive months.

Day and night variations in abundance of fish

Out of the nine fish species, four fin and one shell fish species: *Pomadasys jubelini*, *Siluranodon auritus*, *Caranx hippos*, *Polydactylus quadrifilis* and *Callinectes amnicola* were caught in greater numbers in daytime than at night while *Cynoglossus senegalensis*; *Pseudotolithus elongates, Liza falcipinnis* and *Elops lacerta* were caught in greater numbers during the night than during day time. More fishes were caught in the daytime than at night. The chi-square test indicated a significant difference in the number of fish caught during the daytime and at night by gillnet. Table 4 shows the day and night variations in the abundant fish caught with gillnet.

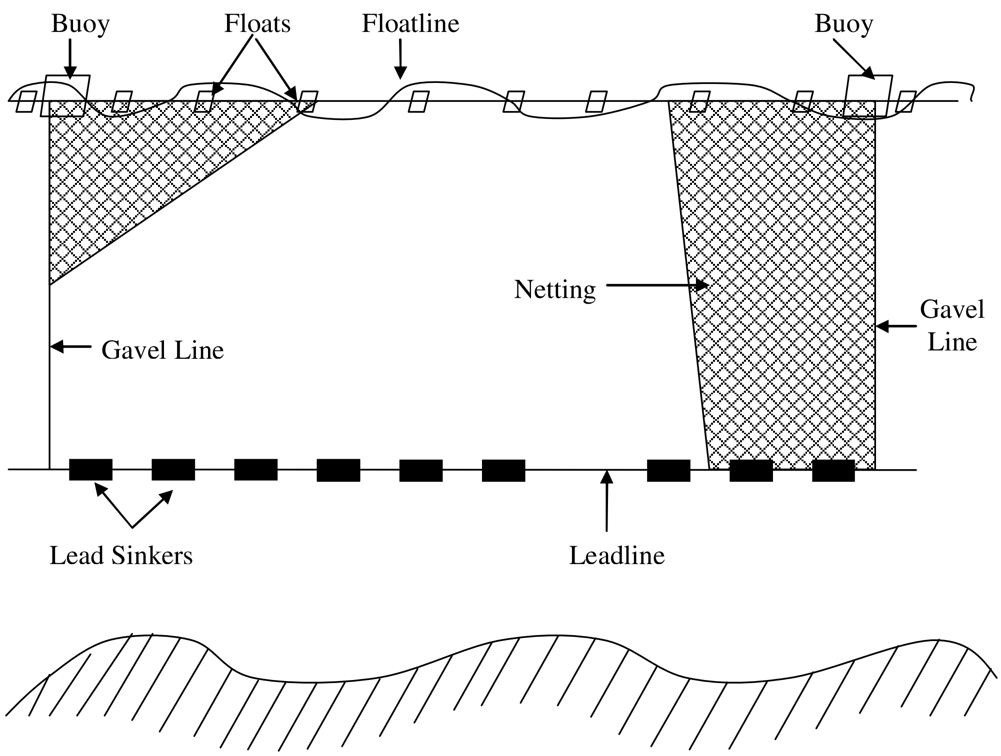

Figure 2. A surface gillnet.

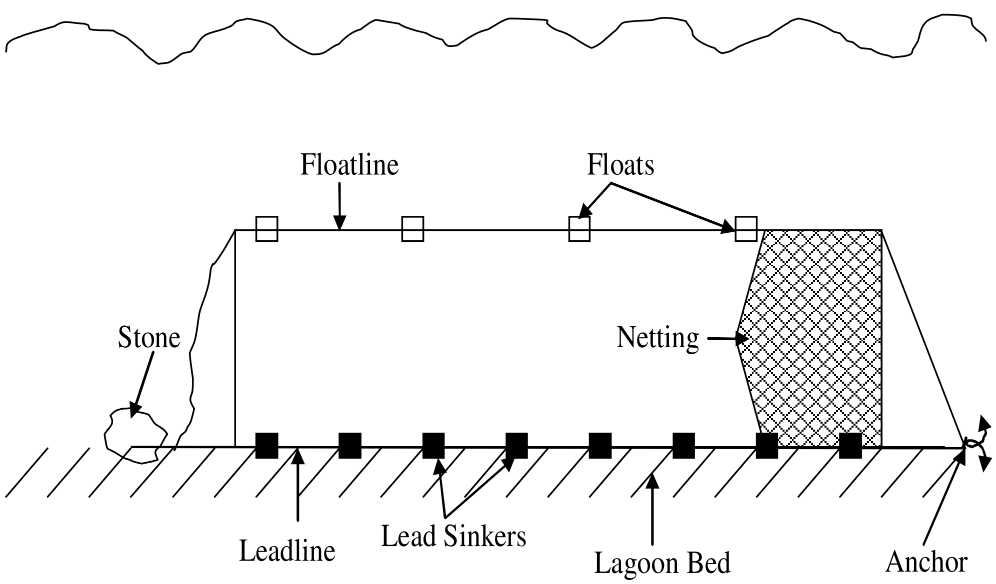

Figure 3. A botton gillnet.

Monthly variation in daytime and night of fish caught with gillnet

More fish were caught during the day that at night throughout the period of study using gillnets (Table 5).

Fishing trips, durations and number of fish caught

Eleven (11) gillnet fishing trips were carried out and the trips lasted for 87.5 h with a total catch of 1110 fishes. Table 6 shows the fishing trips, durations and number of

Table 2. Index of abundance of gill net catch composition in Lagos lagoon.

Family/Species	Number	Percentage (%)	Weight (kg)	Percentage (%)
Clupeidae *E. fimbriata*	909	81.89	20.132	57.52
Haemulidae *P. jubelini*	62	5.58	6.048	17.28
Elopidae *E. lacerta*	22	1.98	1.458	4.17
Carangidae *C. hippos*	17	1.53	1.010	2.89
Polynemidae *P. quadrifilis*	14	1.13	1.288	3.68
Sciaenidae *P. elongatus*	15	1.35	1.108	3.17
Schilbedae *S. auritus*	14	1.30	0.490	1.40
Haemulidae *B. auritus*	12	1.10	0.236	0.67
Sphyraenidae *S. barracuda*	9	0.81	0.698	1.99
S. afra	6	0.54	1.226	3.50
Scombridae *S. tritor*	6	0.54	0.157	0.45
Portunidae *C. amnicola*	7	0.63	0.526	1.50
Soleidae *D. cuneata*	6	0.54	0.064	0.18
Cynoglossidae *C. senegalensis*	4	0.36	0.182	0.52
Mugilidae *L. falcipinnis*	4	0.36	0.227	0.65
Belonidae *S. senegalensis*	3	0.27	0.115	0.33
Total	1110	100	35	100

Table 3. Monthly variation in fish species caught by gillnet in Lagos lagoon (Aug - Nov. 2005).

Species	August		September		October		November	
	No	%	No	%	No	%	No	%
E. fimbriata	0	0	69	39.88	240	80.54	600	96.77
P. jubelini	10	52.63	32	18.50	17	5.70	3	0.48
E. lacerta	0	0	15	8.67	0	0	7	1.13
C. hippos	0	0	6	3.47	11	3.70	0	0
C. amnicola	0	0	6	3.47	1	0.34	0	0
P. elongates	0	0	6	3.47	6	1.92	3	0.48
S. auritus	0	0	2	1.73	11	3.70	0	0
P. quadrifilis	0	0	0	0	11	3.70	3	0.48
B. auritus	0	0	12	6.94	0	0	0	0
S. barracuda	9	47.37	0	0	0	0	0	0
C. senegalensis	0	0	3	1.73	1	0.34	0	0
S. afra	0	0	6	3.47	0	0	0	0
S. tritor	0	0	6	3.47	0	0	0	0
D. cuneata	0	0	6	3.47	0	0	0	0
L. falcipinnis	0	0	0	0	0	0	4	0.65
S. senegalensis	0	0	3	1.73	0	0	0	0
Total	19	100	173	100	293	100	620	100

fish caught with gillnet.

Catch Per Unit Effort (CPUE)

The average number of fish caught with gillnet per trip was 101 while the average number of fish caught per hour was 13.

Length-weight distribution of fishes

The smallest size range was recorded *E. fimbriata* (10.1 – 15.6 cm) while the highest size range was recorded in

Table 4. Day and night variation in abundance of fishes caught with gillnets.

Species	Day time		Night time	
	Number	Percentage	Number	Percentage
P. jubelini	25	36.76	18	54.55
S. auritus	11	16.18	0	0
C. hippos	11	16.18	0	0
P. quadrifilis	14	20.59	0	0
C. amnicola	1	1.47	0	0
C. senegalensis	0	0	1	3.03
P. elongatus	3	4.41	6	18.18
L. falcipinnis	0	0	4	12.12
E. lacerta	3	4.41	4	12.12
Total	68	100	33	100

Table 5. Monthly variation in day and night fish specimen caught with gillnet in Lagos lagoon.

Species	September				October				November			
	Day time		Night time		Day time		Night time		Day time		Night time	
	No	%	No	%	No	%	No	%	No	%	No	%
P. jubelini	11	100	12	100	11	24.4	6	46.2	3	25	0	0
S. auritus	0	0	0	0	11	24.4	0	0	0	0	0	0
C. hippos	0	0	0	0	11	24.4	0	0	0	0	0	0
P. quadrifilis	0	0	0	0	11	24.4	0	0	3	25	0	0
C.amnicola	0	0	0	0	1	2.2	0	0	0	0	0	0
C.senegalensis	0	0	0	0	0	0	1	7.7	0	0	0	0
P. elongates	0	0	0	0	0	0	6	46.2	3	25	0	0
L. falcipinnis	0	0	0	0	0	0	0	0	0	0	4	50
E. lacerta	0	0	0	0	0	0	0	0	3	25	4	50
Total	11	100	12	100	45	100	13	100	12	100	8	100

Table 6. Fishing trips, duration and number of fish caught with gillnet.

Month	Number of trip	Number of fish caught	Duration (h)
August	2	19	17
September	3	179	23
October	3	298	21.5
November	3	620	26
Total	11	1110	87.5

Sphyraena afra (38.0 – 40.0 cm). The smallest weight of 4.59 g was recorded in the shell-fish, *Callinectes amnicola* and for the fin-fish; the smallest weight of 8.02 g was recorded in *E. fimbriata*. The heaviest weight was recorded in *Sphyraena barracuda* as 212.06 g (Table 7).

Condition factor (K)

The condition factor for the fin-fish was least in *Strongyhura senegalensis* (0.11) and the highest was recorded in both *Pomadasys jubelini* and *Caranx hippos* (1.3). The crustacean, *Callinectes amnicola* had the highest condition factor with a range of 37.7 to 59.7 and a mean of 47.78. The least mean condition factor (0.11) was found in *S. senetgalensis* and the highest mean condition factor (1.27) was found in *P. jubelini*.

Total landing by weight and price of factor caught with gillnet

The total weight of fish caught was 35 kg at a selling price of N5250 ($ 37.50). The gillnet price per kilogramme

Table 7. Variations in sizes and weight of fish species caught with gillnet.

Species	Total length (cm)	Weight range (g)
S. senegalensis	32.7 (1)	38.20 (1)
S. tritor	15.0 – 16.6	22.08 – 30.18
S. barracuda	28.4 – 39.8	35.83 – 115.52
S. afra	38.0 – 40.0	196.49 – 212.06
E. fimbriata	10.1 – 15.6	8.02 – 35.17
C. senegalensis	22.8 – 32.5	32.19 – 85.57
P. quadrifilis	22.3 – 25.0	66.64 – 98.93
B. auritus	11.0 – 12.9	15.75 – 24.37
P. jubelini	12.1 – 22.2	20.38 – 145.68
L. falcipinnis	19.8 (1)	56.65 (1)
E. lacerta	25.5 – 26.1	37.08 – 85.38
C. hippos	12.3 – 18.2	20.88 – 76.19
C. amnicola	4.4 – 6.3	4.59 – 126.52
D. cuneata	11.1 (2)	10.35 – 11.02
P. elongatus	12.7 – 24.6	13.71 – 139.94
S. auritus	14.1 – 15.5	20.79 – 38.89

of fish was N150 ($1.07) while the price of fish per trip was N477.27 ($3.41).

Gillnet selectivity

A gillnet of mesh circumference 126 mm caught fishes of head girths range (72 – 143 mm), body girths range (95 – 209 mm) and the total length range (13.5 – 32.5 cm). Fishes with head and body girths smaller than 126 mm which were not entangled would have escaped.

Problems of gillnets in Lagos lagoon

The causes of damages include tugs, powered canoes, rough grounds and crabs. The canoes are damaged by collision with wrecks or other objects and the bivalve *Crassostrea gasar* which eat deep into the wooden keel and hull. The financial constraint due to higher purchase repayment for materials always doubles the cost on cash and carry.

Bionomics of gillnet fishing in Lagos lagoon

The cost of inputs ranged between N21, 130 ($ 150.91) and N81, 750 ($583.93). The cost of rigging gillnets had a range of N15, 400($110) – N45, 500($325).

Output cost was N477.27 ($3.41) per trip. Assuming 365 trips in a year, the cost of output would be N174, 203.55 ($1244.31) (Table 8).

With regular maintenance, the easily available inputs have the following durability; nets (8 months to 1 ½ years), outboard engine (15 years) and *Canoes* (3 – 8 years).

Table 8. Total landing by weight and price of fishes caught with gillnet.

Month	Weight (kg)	Price	
		Naira	US Dollar
August	1.357	203.55	1.45
September	8.31	1246.5	8.90
October	10.448	1567.2	11.19
November	15.043	2256.45	16.11
Total	35	5250	37.50
Price per kg (₦)		150	1.07
Price per trip (₦)/$		477.27	3.41

DISCUSSION

The netting materials used for constructing gillnets used in Lagos Lagoon were monofilament nylon, polyethyelene (PE) and Kuralon. They were of high standards, and of good qualities. The floats used were improvised rubber slippers and the sinkers were lead, they were both attached at interval of (1.35 – 2.0) metres. The materials used agreed with Udolisa (1982) who reported the use of both in the shark driftnet fishery off Lagos coast. The hanging ratios of between 45.24 and 51.72% were reported in this study. The number of meshes per stapling distance was 3 in the study but was not so in Udolisa (1982) where 2 meshes per stapling distance was reported for shark drift gillnet off Lagos coast. The hanging ratio was observed to affect the length of the net and the catchability in that if footrope is shorter than the headrope, most fish with larger girth tend to recede and escaped.

A lowered fish diversity is a good indicator of a stressed ecosystem (Leveque, 1995) and it was commonly agreed that the higher the fish diversity, the more stable the fish community (Albarat and Lae, 2003; Emmanuel and Onyema, 2007). Consequently, the response of the Lagos lagoon fish community to high fishing pressure had resulted in catching of smaller size of fish species in the lagoon.

Owing to the economic recession in Nigeria, some of the materials used in the rigging of gillnet like buoys, floats and anchors were improvised with corks, rubber slippers and stones respectively. This agreed with Udolisa and Solarin (1979) report for the same lagoon.

The highest catch was reported for November, this could be related to the well being of the fish around this time in relation to availability of food and environmental favourability, since nutrients are flushed form inland and the catchement drainage, due to gravitational depression of the adjacent wet lands as reported by Nwankwo (2004) and Emmanuel et al. (2008). *E. fimbriata* was the most common species throughout the month except in August when no specimen was caught. The reason for the non availability is not known. *E. fimbriata* occurrence was explained by Albaret and Lae (2003) indicating that the species lives and reproduced from nearly fresh water to hyperhaline waters and is an opportunistic feeder.

The occurrence of *P. jubelini*, *S. auritus*, *C. hippos*, *P. quadrifilis* and *C. amnicola* in greater number during the daytime may be associated with their feeding habit or due to changes in light and the activeness of the fish during the day. Kim and Wardle (1997) associated swimming speed of fish with contraction time of swimming muscle for tail beat frequency, stride length and water temperature limit in relation to living conditions. These species may be said to be more active during the daytime than at night. Also, this result suggested that fishing for these species should be done more during the day than at night in the lagoon.

More fishes were caught in the day time than at night; this disagreed with Udolisa and Solarin (1979), that more fishes were caught at night than day time. Emmanuel and Kusemiju (2005) associated fish availability to tide where they reported that more fish were caught at low tide than high tide irrespective of the time of the day. Then, base on this report and that of Emmanuel and Kusemiju (2005) it could be ascertain that fishing during the day at low tide should be encourage to prevent fishing hazard like net destruction and pirate attack which in some case led to loss of engine and even loss of lives.

In general, the species abundance as recorded in this study was low compared to Fagade and Olaniyan (1974) and Solarin (1998) for the same lagoon. The lowering of fish diversity is a good indicator of a stressed ecosystem and it is commonly agreed that the higher the fish diversity, the more stable the fish community as reported by Leveque (1995), Albaret and Lae (2003) and Emmanuel and Onyema (2007).

This study showed that the higher the effort the more the catch. This agreed with Albaret and Lae (2003) who further noted that the response of lagoon fish community to high fishing pressure (high effort) is to evolve towards a smaller number of species.

Generally, the effects of fishing on fish communities include a decrease in their abundance, changes in age structure, size composition and species composition. These effects have been well documented in other coastal areas of the world including the Gulf of Thailand (Simpson, 1982), South Africa (Tomlin and Kyle, 1998), Australia (Blaber et al., 2000) and Ebrie lagoon West Africa (Albaret and Lae, 2003).

Sixteen fish species belonging to 14 families were caught, all of which were marine endemic species as reported by Schneider (1990) for the Gulf of Guinea. In comparison to Fagade and Olaniyan (1974), Solarin (1998) and Emmanuel and Onyema (2007) low diversity of species was recorded for this study. This low species diversity may be a reflection of the gear type used and a result of fish availability in the study area.

The overall length size of the fish caught showed that most fish size were small. This implied that most of this species probably use the lagoon as their nursery ground. The significance of the predominance of *E. fimbriata* (81.99% total catch) was that this West African species lives and reproduces from nearly fresh water to hyperhaline waters and is an opportunistic feeder. This was reported by Charles-Dominique and Albaret (2003) and Albaret and Lae (2003) in a West African lagoon. The sizes recorded in this study when compared with Schneider (1990), could be said to be juveniles. These species showed true migratory capacity.

The overall condition for the fish species indicated that the species were not healthy but the crustacean (*C. amnicola*) had a higher condition factor reflecting its feeding and its adaptability to the lagoon environment. The total landing for gillnet was small compared to what was reported by Solarin (1998). In view of the capital required to construct the gear and canoe, gillnet fishery was not encouraging with the financial output of N477.27 ($3.41) per fishing trip.

The study of the selectivity and efficiency of the fishing gears constitute a tool of great importance for the fishery manager, who will used this information to control fishing mortality through the size of fish. The selectivity recorded in this study indicated that fishes with both head and body girth less than 126 mm were entangled; fishes with head girth of 126 mm were gilled; fishes with head girths of more than 126 mm were snagged and fishes with head girths less than 126 mm and body girths more than 126 mm were wedged. Fishes with head and body girths smaller than 126 mm which were not entangled escaped. These data confirms the fact that gillnets are a highly selective gear as reported Baranov (1948). The author is of the opinion that this fishing gear type retains fish of lengths no more than 20% of the optimum length. Other authors such as Grant (1981), Nakatani et al. (1991), De Silva and Sirisena (1987) and Rojo-vazquez (2001) have also reported similar findings.

As evident from this study, gillnets were easily damaged by crabs tugs, and motorized canoes. Hence, gillnet durability depends on the mending, preservation and the nature of the area where they are used. The annual income for 365 days (a year) was estimated at N174, 203.55 ($1,244.31). Compared to the cost of investment, it means that a profits of N46, 953 ($335.38) will be made if outboard engine was not used. This also depends on the maintenance of the net, and the net being constructed once a year, which may not be possible. Therefore, it will be advisable to use gillnet without outboard engine for more profit since the use of outboard engine will not increase the gillnet yield.

REFERENCES

Albaret JJ, Lae R (2003). Impact of Fishing on Fish Assemblages intropical lagoons, the example of the Ebrie Lagoon, West Africa. Aquat. Living Resour, 16: 1-9.

Azeez LO (1997). A comparative study of cast net and gillnet fishing gears in Lagos lagoon. M.Sc. dissertation in Fisheries, University of Lagos, Nigeria. p. 185.

Baranov FI (1948). The theory and assessment of fishing gear. Pischche pronisdat, Moscow (Ch. 7 Theory of fishing with gillnets).

Transform Russian by Out Dep. Lands. For Maple, out. p. 45.
Beverton RJH, Holt SJ (1957). On the dynamics of exploited fish population s. HMSO Fish. Investig. 19: 533.
Blaber SJM, Cyrus DP, Albaret JJ, Chong VC, Day JW, Elliott M, Fonseca MS, Hoss DE, OrensanzJ, Potter IC, Silvert W (2000). Effects of fishing on the structure and functioning of estuarine and nearshore ecosystems.ICES J. Mar. Sci. 57: 590-602.
Boy V, Crivelli AJ (1988). Simultaneous determination of gillnet selectivity and population age-class distribution for two cyprinids. Fish. Res. 6: 337-343.
De Silva SS, Sirisena HKG (1987). New fish resources of reservoirs in Sri lanka Feasibility of Introduction of a subsidiary gillnet fishery for minor Cyprinids. Fish. Res. 6: 17-34.
Emmanuel BE (2004). Day and night variation in cast net catches in a barackish water pond. M.Sc. Fisheries. University of Lagos. Nigeria. p. 61.
Emmanuel BE, Chukwu LO, Azeez LO (2008). Cast net design characteristics, catch composition and selectivity in tropical open lagoon. Afr. J. Biotech. 7(12): 2081-2089.
Emmanuel BE, Kusemiju K (2005). Variations in castnet catch in a tropical brackishwater pond. J. Sci. Technol. Environ. 5(1&2): 6-14.
Emmanuel BE, Onyema IC (2007). The plankton and fishes of a tropical creek in south-western Nigeria. Turk. J. Fish. Aquat. Sci. 7(2): 105-113.
FAO (1969). Fisheries survey in the western and mid-western region of Nigeria. UNDP/FAO Rome SF:74/NIR6. p. 142.
Fagade SO, Olaniyan CIO (1974). Seasonal distribution of the fish fauna of the Lagos lagoon. Bulletin de I' L F.A.N. T.XXXVI, Ser A. pp. 244-252.
Grant CJ (1981). Gillnet selectivity and catch rates of coastal pelagic fish in Jamaica. Estuarine, Coastal Shelf Sci. 12: 167-175.
Henderson HF, Welcomme RL (1974). The relationship of yield to morpho-edaphic index and numbers of fishermen in African inland fisheries. CIFA Occ. Pap.1, FAO.
Hovgard H, Lassen H (2000). Manual on estimation of selectivity for gillnet and longline gears in abundance surveys. FAO Fish. Technol., Paper, p. 397.
Huse I, Lokkeborg S, Soldal AV (2000). Relative selectivity in trawl, longline and gillnet fisheries for cod and haddock. ICES J. Mar. Sci. 57: 1271-1282.
Kim YH, Wardle CS (1997). Modelling of swimming ability limits for marine fish. J. Korean Fish. Soc. 6(30): 929-935.
Kurkilahti M, Appelberg M, Hesthagen T, Rask M (2002). Effect of fish shape on gillnet selectivity: a study with Fulton's condition factor. Fish. Res. 54: 153-170.
Leveque C (1995). Role and consequence of fish diversity in the functioning of African freshwater ecosystems: a review. Aquat. Living Resour. 8: 59-78.
Millar RB, Holst R (1997). Estimation of gillnet and hook selectivity using log-linear models. ICES J. Mar. Sci. 54: 471-474.
Nakatani K, Gomes LC, Latini JD (1991). Selectividale em redes de espera para Captura de *Trachydoras paraguaysnsis* (Orio de Itaipue a'reas de sua influencia. Revista UMIMAR, Maringa. 12(2): 327-338.
Nwankwo DI (2004). Studies on the environmental preference of blue – green algae (Cyanophyta) in Nigerian coastal waters. J. Niger. Environ. Soc. (INES). 2(1): 44 -51.
Reed W, Burchard JA, Hopson J, Jennes J, Ibrahim Y (1967). Fish and fisheries of Northern Nigeria. Ministry of Agriculture Northern Nigeria. Gaskiya Corporation, Zaria. p. 226.
Ricker WE (1954). Stock and recruitment. J. Fish. Res. Board Can. 11: 559-653.
Rojo–Vazquez JA, Arreguin-Sanchez FA, Godinez-Dominguez E (2001). Fishing power, efficiency and selection of gillnets for the shortfin grunt (*Microlepidotus brevipinnis* Standachner, 1869), in the southern coast of Jahisco, Mexico. Revista Biologia Marina of Oceanografra 36(1): 9-14.
Sainsbury JC (1986). *Commercial fishing methods – an introduction to vessels and gear*. 2nd edition. Fishing News Books Limited.England. p. 207.
Schaefer MB (1967). Fishery dynamics and present status of the yellowfin tuna population of the eastern Pacific Ocean. IATTC. Bull. 12: 89-136.
Schneider W (1990). FAO species identification sheets for fishery purpose. Field guide to the commercial marine resources of the Gulf of Guinea. FAO, Rome. p. 268.
Simpson AC (1982). A review of the database on tropical multispecies stocks in the southeast Asian region. In: Theory and management of Tropical fisheries Pauly D. Murphy GL (Eds). ICLARM and CSIRO, Cronulla Australia, pp. 5-32.
Solarin BB (1998). The hydrology, fishes and fisheries of the Lagos lagoon, Nigeria. Ph.D Thesis. University of Lagos, Akoka, Nigeria. p. 255.
Sturm de LM (1976). Aspects of the biology of *Scombemorus maculates* (Mitchill) in Trinidad. J. Fish. Biol. 13: 155-172.
Tomlin BJ, Kyle R (1998). Subsistance and recreational mussel (Perna perna) collecting in KwaZulu – Natal, South Africa: fishing mortality and precautionary management. S. Afr. J. Zool. p. 525.
Udolisa REK, Solarin BB (1979). Design characteristics of cast nets and gillnets in Lagos lagoon, Nigeria. NIOMR Occ. Paper, 31: 24.
Udolisa REK (1982). Techno-economic Consideration of shark drift net fishery off Lagos, Nigeria. NIOMR Technical Paper. 12: p.9.
Von Brandt A (1984). Fish catching methods of the world. Fishing news Books. Surrey, United Kingdom.