

Techno – economic and efficiency of coloured gillnet operations in a tropical Lagoon in south western Nigeria

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ABSTRACT

The techno – economic and efficiency of coloured gillnets operations in a tropical lagoon in south western Nigeria was carried out in 2013. A total of 1083 fishes, belonging to 13 families were caught in both green (588) and white (495) gillnets in Lagos Lagoon. A total of 56kg of fish was landed by both gillnets at 31.5kg for green and 24.5kg for white gillnet. *Ethmalosa fimbriata* had the highest weight (18.81kg) and percentage frequency of 33.59% while *Eleotris vittata* had the lowest weight (0.11kg) and percentage frequency of 20%. The average catch per trip was 59 and 50 for green and white gillnet, respectively, while the average weight of fish caught per trip for green gillnet was 3.2kg and 2.4kg for white gillnet. Statistically, the chi-square test showed that there was significant difference between the catch composition of the coloured nets (green and white) throughout the study as well as between the day and night catches. The green gillnet landed a total of 200 fish during the day and 388 fish at night while the white gillnet landed a total of 171 fish during the day and 324 fish at night. The green gillnet fin-fish least condition factor (0.4) was found in *Cynoglossus senegalensis* and the highest condition factor (6.2) was found in *Caranx hippos*. The white gillnet fin –fish least condition factor (0.4) was found in *Liza dumerilli* and the highest (3.4) was found in *Sarotherodon melanotheron*. The green net caught of 31.5kg was sold for ₦7, 875, N785 per trip at N250/kg of fish while white gillnet caught of 24.5kg that was sold for ₦ 6, ₦ 145, ₦ 615 per trip at N250/kg of fish. The durability of the nets depended on the maintenance and timely mending. The use of green coloured gillnet influenced the efficiency of the net catch ability. Although the green coloured gillnet is more expensive to construct but the catch output justifies the cost.

Keywords: Fish, coloured net, gillnets, efficiency, tropical lagoon.

INTRODUCTION

Gillnet is a large wall of netting vertically hanging in the water. They are common fishing gears in the artisanal fisheries, which provide large yields compared to other fishing gears (Hamley 1975, Gonzalez *et al.*, 1995). 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). Gillnet is one of the oldest types of fishing gear and is widely used to harvest diverse marine species (Sainsbury 1996). Its construction can be single, double or triple (trammel net) netting. Gillnet is the most widely used artisanal fishing gear in Nigerian brackish and coastal waters (Emmanuel *et al* 2008b).

There are two components in the mechanics of gillnet catching fish, namely “gilling” and “tangling” (Emmanuel 2009). These two components can work independently or in combination, e.g., when fish, which are initially gilled are retained in the net only by tangling in the opercula. The relative effectiveness of either of the two components depends on the shape of the fish, thread material of the net and net construction (particularly the way the net is hung

and the type of knot used). In catching spindle-shaped fish, without spines, such as salmon and mackerel, gilling is of primary importance. In some species of fish, however fishermen have learned that a larger portion of the catch is retained by tangling in the nets “hung in” considerably, i.e., with more netting hung on the cork and lead lines.

The use of gillnets in Lagos Lagoon is done by both sexes because it is simple to use and require no formal skill by the operators. It can also be operated singly or by two able men or women. Generally, while fish can use other senses to detect net, less visible nets catch more fish in the water and vision seems to be the most important feature in fish catching in gillnet operation. Balik and Çubuk (2001) implicated that the greatest effect in day fishing or in fishing in limpid water is the colour net used. Backiel and Welcomme (1980) cited by Balik and Çubuk (2001) reported that the time of the day and the seasonal changes in water clarity on colour affected the visibility of the nets depending on the net colour and the tone contrast with the background. Gillnets are separated from other type of fishing gears in that the mesh of gillnets serves two

functions of selecting the fish to be caught and catching it. Fish captured in gillnet depends on the net construction and the morphology of the fish body. Gillnets capture fish by creating barrier in the column of the water and when a fish approaches it and try to passes through the mesh then it is being gill or entangled (Emmanuel, 2009). Despite the long time use of gillnet in the Lagos Lagoon, very little information is available on the design and operation of different colours of gillnets in Lagos Lagoon. Therefore, this study was carried out to investigate the design details of different colours of gillnet with view of comparing the catch composition, selectivity, economic importance of catches in the two different colour type gillnets.

MATERIALS AND METHODS

Description of study area

Lagos lagoon (latitudes 6° 26' N and 6° 38' N and longitudes 3° 23' E and 3° 43' E) experiences both brackish and freshwater characteristics and is a large stretch of water which is part of a continuous train of lagoons and creeks along the coast of Nigeria from the republic of Benin border to the Niger Delta. It has an area of about 208 km² (Emmanuel *et al.*, 2008 a & b) and is being fed from the north mainly by the perennial Ogun river. Bounded in the south by five cowrie creek, the lagoon opens into the Gulf of Guinea via the Lagos harbor all year round (Figure 1).

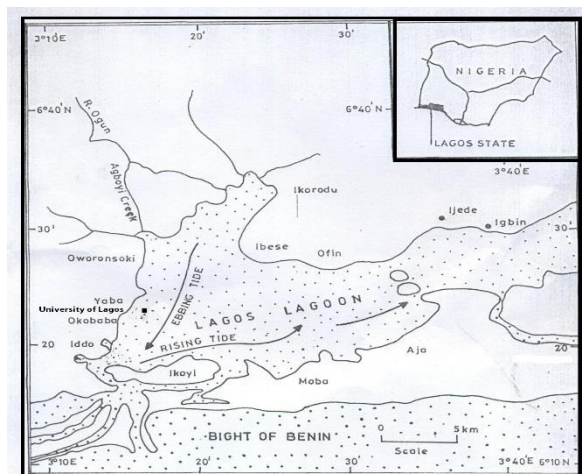


Figure 1: Map of Lagos Lagoon showing the sampling site.

The lagoon has a salinity range of 0-28.9‰ between the peak of the rainy season (June & July; September & October) and to the peak of the dry season (January - March) (Emmanuel and Onyema, 2007). Having varying depths of less than 2 metres in most places, the bottom is muddy and sandy. Lagos Lagoon covers a total area of about 426.0 km² with a coastline and inland waterways; it reaches an average depth of about 1.6 m throughout the year with negligible or insignificant variations (Adejare *et al.* 2011).

There are many fish landing places/stations along the lagoon beach. The fishermen are mostly Eguns and the Ilajes. Some of the villages scattered around the lagoon are Ajeboh, Makoko, Ilaje-Bariga, on the lagoon include Eko Bridge, Carter Bridge, Falomo Bridge, Five Cowrie Bridge and Third Mainland Bridge. In addition to serving the transport system in Lagos, the bridges also serve as Fish Aggregating Devices (FAD). Some extensive stretches of swamps surround the lagoon with mangroves vegetation, with plants like *Rhizophora racemosa*, *Avicennia nitida*, *Typha australis* and *Phoenix reclinata* dominating (Edokpayi 2005). The fishing ground where the fish specimens were caught in Lagos lagoon is the university of Lagos jetty.

Gillnet design details

The gillnet designed and constructed for catch of fish in the Lagos Lagoon was the bottom fixed gillnet. It is a wall of netting hanging vertically in the water by the combined action of the rubber slipper floats attached to the headlines and the lead sinkers attached to the foot ropes. The sinkers were attached at intervals of 1.5 to 1.57 m to the footropes, sink the feet of the net to the lagoon bed while the floats, attached at intervals of 1.8 to 1.95 m to the headlines, allowed the heads of the nets to float thereby maintaining the vertical opening of the gillnet. The net material was white and green monofilament nylon. The headline and footrope material is kuralon with diameters ranging from 2.5 to 3.0 mm. The height/ depth of the net between the headline and the footrope is approximately 2 m.

The rubber slippers float has a circumference of 170.81 mm. The float number on the headline varied from 80 to 85 for the white and green gill nets respectively while the headline length was 199.3 m. The distance between the floats varied from 1.8-1.95 m for the green and white nets, respectively. The lead sinkers varied in weight from 32 to 38 g for white gillnet and 30 to 37 g for green gill net. The numbers of sinker per footrope ranged from 125 for the green gill net to 127 for the white gill net. The footrope length was 199.3 m. The distance between the sinkers ranged from 1.5 - 1.57 m (Table 1).

Periods and duration of fishing operation

The fish specimens were caught with both gillnets during both day and night. For the night trips, setting of the gillnet was between 1700 hours and 1900 hours while retrieval at 0700 hours in the morning, setting was carried out in the morning by 0600 hours and retrieval at 1700 hours with a duration of 11 hours for the day trips. Both the night and day sampling were collected for five months between February and June 2013.

Table 1: Gillnet design detail for green and white gillnets

Design characteristics	Measurement and Description	
	White gillnet	Green gillnet
Gear colour	White	Green
Type of Set	Bottom fixed net	Bottom fixed net
Type of Mesh Net	Knotted	Knotted
Headline Length	199.3m	199.3m
Headline Material	Kuralon	Kuralon
Headline Diameter	3mm	3mm
Footrope Length	199.3m	199.3m
Footrope Material	Kuralon	Kuralon
Footrope Diameter	3mm	3mm
Mesh size	29mm	27mm
Mesh opening	50mm	50mm
Hanging Ratio	0.91	0.92
Float material	Rubber Slipper	Rubber Slipper
Numbers of Float	80	85
Float circumference	170.81	170.81
Distance between the floats	1.8	1.95
Number of Sinkers	127	125
Weight of Sinkers	(32-38)	(30-37)
Distance between Sinkers	(1.5-1.57)	(1.5-1.57)
Materials of Sinkers	Lead (pb)	Lead (pb)
Depth of Net	2m	2m
Total length of Net	199.3m	199.3m

Laboratory analysis

Identification and catch composition

All samples were transported to the Marine Sciences Postgraduate laboratory University of Lagos, Lagos Nigeria and put in deep freezers (<4⁰c) immediately after appropriate labeling and identifications were made with the aid of relevant texts (Tobor and Ajayi, 1979; Schneider, 1990; Holden and Reed, 1991). Numerical abundance of fish species were recorded.

Measurement of length and weight

The total lengths of the specimens were measured with a calibrated measuring board. The weights were taken using OHAUS weighing balance, model CS 5000.

Condition factor K

The condition factor (k) was calculated using the formula (Bannister, 1976). $K=100W/L^3$(Equation 1) where W= weight of individual fish (in gram); L=Length of the fish (in centimeter).

Hanging ratios

The hanging ratios (E) was calculated using the formula $E = D/2S$ (Equation 2)

Where D= The length of the horizontal diagonal of the mesh; S= The length of one of the mesh sides

Statistical analysis

Statistical analysis was done using chi – square test (X^2) with the formula:

$$X^2 = \sum \frac{(\text{Observed frequency} - \text{Expected frequency})^2}{\text{Expected frequency}}$$

..... (Equation 3)

RESULTS

Catch composition of gillnets used in Lagos Lagoon.

A total of one thousand and eighty-three fish specimens belonging to thirteen (13) families were caught in both green gillnet (588) and white gillnet (495) in five months in the Lagos Lagoon as shown in Tables 2 and 3. Out of these, *Ethmalosa fimbriata* was the most dominant fish species

caught with total catch of 348 or 32.19% of total fish caught while *Eleotris vittata* was the least dominant fish species caught with total catch of one (1) or 0.09% A total of 56 kg of fish specimens was landed by both gillnets, at 32 kg in green gillnet and 24 kg in white gillnet. *Ethmalosa fimbriata* accounted for the highest weight (18.81 kg), which 33.59% of total fish weight while *Eleotris vittata* has the lowest weight 0.11kg and percentage composition of 0.20%.

Colour preference by fishes in Lagos Lagoon

The species, *Sarotherodon melanotheron*, *Polydactylus quadrifilis*, *Citharus linguatula* and *Eleotris vittata* preferred white gillnet to green gillnet while *Ethmalosa fimbriata*, *Caranx hippos*, *Cynoglossus senegalensis*, *Mugil cephalus*, *Callinectes amnicola*, *Chrysichthys nigrodigitatus*, *Liza dumerilli*, *Hemichromis fasciatus* and *Lutjanus dentatus* preferred green coloured gillnet to white coloured gillnet in Lagos Lagoon (Figure 2). The chi square test analysis showed that the calculated (1 d.f, 5%) was 7.98 was more than the tabulated (3.84 at 1 d.f, 5 %) an indication that there was significant differences between the catch composition of the coloured nets (green and white) throughout the five months.

Monthly variation in fish caught with green and white gillnets in Lagos Lagoon

The monthly number of fish specimen caught by the green gillnets throughout the five months ranged from 70 to 169 between February and June (Table 4). The highest fish species were recorded in February, while the lowest was recorded in March. *E. fimbriata* was the most abundant fish species caught in the study while *P. quadrifilis* and *M. cephalus* and *E. vittata* were the least caught fish species with the green gillnet. The monthly number of fish specimen caught by the white gillnets varied from 51 to 232 between February and June (Table 5). The highest fish species were recorded February, while the lowest was recorded in March. *E. fimbriata* was the most abundant fish caught while *H. fasciatus* was the least caught fish species in white gillnet.

Table 2: Green gillnet catch composition for five months in Lagos Lagoon

S/N	Family	Species	Number	Percentage (%)	Weight (kg)	Percentage (%)
1	Clupeidae	<i>Ethmalosa fimbriata</i>	188	31.97	10.39	32.91
2	Cichlidae	<i>Sarotherodon melanotheron</i>	148	25.17	7.09	22.46
		<i>Hemichromis fasciatus</i>	8	1.36	0.43	1.36
3	Carangidae	<i>Caranx hippos</i>	53	9.01	2.18	6.91
4	Cynoglossidae	<i>Cynoglossus senegalensis</i>	17	2.89	0.77	2.44
5	Polynemidae	<i>Polydactylus quadrifilis</i>	1	0.17	0.021	0.067
6	Mugilidae	<i>Mugil cephalus</i>	6	1.02	0.73	2.31
		<i>Liza dumerilli</i>	11	1.87	0.27	0.86
7	Citharidae	<i>Citharus linguatula</i>	6	1.02	0.12	0.38
8	Portunidae	<i>Callinectes amnicola</i>	130	22.11	7.49	23.73
9	Bagridae	<i>Chrysichthys nigrodigitatus</i>	2	0.34	0.19	0.60
12	Lutjanidae	<i>Lutjanus dentatus</i>	18	3.06	1.89	5.99
	Total		588	100	31.57	100

Table 3: White gillnet catch composition for five months

S/N	Family	Species	Number	Percentage (%)	Weight (kg)	Percentage (%)
1	Clupeidae	<i>E. fimbriata</i>	160	32.32	8.44	34.34
2	Cichlidae	<i>S. melanotheron</i>	154	31.11	7.09	28.84
3		<i>H. fasciatus</i>	2	0.40	0.07	0.28
4	Carangidae	<i>C. hippos</i>	33	6.67	1.27	5.17
5	Polynemidae	<i>P. quadrifilis</i>	7	1.41	0.29	1.18
6	Mugilidae	<i>M. cephalus</i>	1	0.20	0.11	0.45
7		<i>L. dumerilli</i>	5	1.01	0.12	0.49
8	Cynoglossidae	<i>C. senegalensis</i>	13	2.63	0.78	3.17
9	Eleotridae	<i>E. vittata</i>	1	0.20	0.11	0.45
10	Citharidae	<i>C. linguatula</i>	5	1.01	0.076	0.31
11	Lutjanidae	<i>L. dentatus</i>	5	1.01	0.37	1.51
12	Portunidae	<i>C. amnicola</i>	109	22.02	5.86	23.84
	TOTAL		495	100	24.58	100

Day and night variation in abundance of fish species caught with green and white gillnets

The green gillnet landed a total of two hundred (200) fish specimens during the day and three hundred and eighty-eight (388) fish specimens at night. Out of the twelve fish species caught with the green gillnet, *Ethmalosa fimbriata*, *Sarotherodon melanotheron*, and *Callinectes amnicola* were caught in greater numbers at night than during the day, with *Ethmalosa fimbriata* being the highest caught fish species at night and *Callinectes amnicola* being the highest caught shell-fish species recorded during the day (Table 6). The chi square test analysis for white day and night catch

variations showed that the calculated (1 d.f, 5%) was 47.3 was more than the tabulated (3.84 at 1 d.f, 5 %) an indication that there was significant differences the catch composition between day and night catches; the same was recorded for green coloured net (Tabulated 60.10 at 1 d.f, 5%). The white gillnet landed a total of a hundred and seventy-one (171) fish specimens during the day and three hundred and twenty-four (324) fish specimens at night. Out of the twelve fish species caught with the white gillnet, *Ethmalosa fimbriata*, *Sarotherodon melanotheron*, and *Callinectes amnicola* were caught in greater numbers at night than during the day (Table 6).

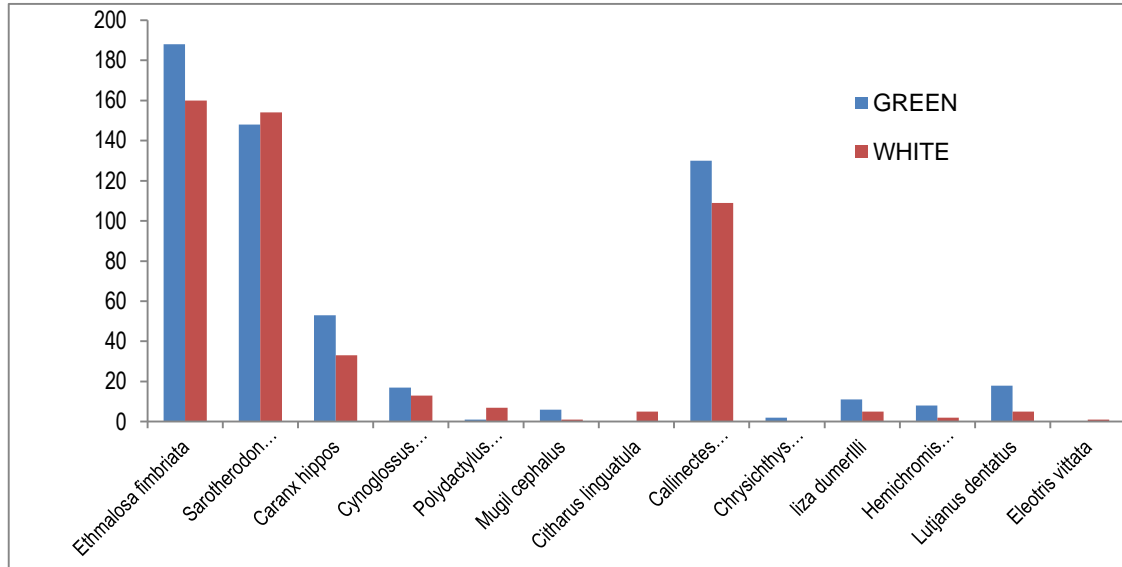


Figure 2: Total catch composition from green and white gillnets in the Lagos Lagoon.

Table 4: Monthly variation in fish caught by green gillnet

No.	Species	February		March		April		May		June	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	<i>E. fimbriata</i>	73	43.2	23	32.9	31	32.0	31	24.6	30	23.8
2	<i>S. melanotheron</i>	64	37.9	10	14.3	19	19.6	26	20.6	29	23.0
3	<i>C. hippos</i>	11	6.5	6	8.6	14	14.4	14	11.1	8	6.3
4	<i>C. senegalensis</i>	1	0.6	2	2.9	0	0.0	10	7.9	4	3.2
5	<i>P. quadrifilis</i>	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0
6	<i>M. cephalus</i>	4	2.4	0	0.0	2	2.1	0	0.0	0	0.0
7	<i>C. linguatula</i>	6	3.6	0	0.0	0	0.0	0	0.0	0	0.0
8	<i>E. vittata</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
9	<i>C. amnicola</i>	9	5.3	26	37.1	30	30.9	24	19.0	41	32.5
10	<i>C. nigrodigitatus</i>	0	0.0	1	1.4	0	0.0	0	0.0	1	0.8
11	<i>L. dumerilli</i>	0	0.0	2	2.9	1	1.0	5	4.0	3	2.4
12	<i>H. fasciatus</i>	0	0.0	0	0.0	0	0.0	6	4.8	2	1.6
13	<i>L. dentatus</i>	0	0.0	0	0.0	0	0.0	10	7.9	8	6.3
	Total	169	100	70	100	97	100	126	100	126	100

Table 5: Monthly variation in fish caught by white gillnet

No.	Species	February		March		April		May		June	
		No.	%	No.	%	No.	%	No.	%	No.	%
1	<i>E. fimbriata</i>	105	45.3	11	21.6	15	26.3	18	22.0	11	15.1
2	<i>S. melanotheron</i>	83	35.8	15	29.4	23	40.4	21	25.6	12	16.4
3	<i>C. hippos</i>	11	4.7	4	7.8	4	7.0	7	8.5	7	9.6
4	<i>C. senegalensis</i>	1	0.4	2	3.9	0	0.0	5	6.1	5	6.8
5	<i>P. quadrifilis</i>	7	3.0	0	0.0	0	0.0	0	0.0	0	0.0
6	<i>M. cephalus</i>	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0
7	<i>C. linguatula</i>	5	2.2	0	0.0	0	0.0	0	0.0	0	0.0
8	<i>E. vittata</i>	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0
9	<i>C. amnicola</i>	16	6.9	19	37.3	15	26.3	26	31.7	33	45.2
10	<i>C. nigrodigitatus</i>	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
11	<i>L. dumerilli</i>	2	0.9	0	0.0	0	0.0	2	2.4	1	1.4
12	<i>H. fasciatus</i>	0	0.0	0	0.0	0	0.0	2	2.4	0	0.0
13	<i>L. dentatus</i>	0	0.0	0	0.0	0	0.0	1	1.2	4	5.5
	Total	232	100	51	100	57	100	82	100	73	100

Table 6: Day and night variations in abundance of fishes caught with green and white gillnets in Lagos Lagoon

Species	Day time				Night-time			
	Green gillnet		White gillnet		Green gillnet		White gillnet	
	No.	%	No.	%	No.	%	No.	%
<i>E. fimbriata</i>	53	26.5	50	29.2	135	34.8	110	33.9
<i>S. melanotheron</i>	53	26.5	47	27.5	95	24.5	107	33.0
<i>C. hippos</i>	20	10.0	17	9.9	33	8.5	16	4.9
<i>C. senegalensis</i>	7	3.5	5	2.9	10	2.6	8	2.5
<i>P. quadrifilis</i>	0	0.0	0	0.0	1	0.3	7	2.2
<i>M. cephalus</i>	3	1.5	0	0.0	3	0.8	1	0.3
<i>C. linguatula</i>	2	1.0	1	0.6	4	1.0	4	1.2
<i>E. vittata</i>	0	0.0	0	0.0	0	0.0	1	0.3
<i>C. amnicola</i>	55	27.5	50	29.2	75	19.3	59	18.2
<i>C. nigrodigitatus</i>	0	0.0	0	0.0	2	0.5	0	0.0
<i>L. dumerilli</i>	0	0.0	0	0.0	11	2.8	5	1.5
<i>H. fasciatus</i>	1	0.5	0	0.0	7	1.8	2	0.6
<i>L. dentatus</i>	6	3.0	1	0.6	12	3.1	4	1.2
TOTAL	200	100	171	100	388	100	324	100

Table 7: Fishing trips, duration and number of fish caught by the green and white gillnets

Month	Green gillnet			White gillnet		
	No. of trip	No. of fish caught	Duration (Hour)	No. of trip	No. of fish caught	Duration (Hour)
February	2	169	22	2	232	22
March	2	70	21	2	51	21
April	2	97	21.3	2	57	21.3
May	2	126	20.5	2	82	20.5
June	2	126	22	2	73	22
Total	10	588	106.8	10	495	106.8

Table 8: Catch per unit effort (CPUE) of the gillnets

Parameter	Green gillnet (kg)	White gillnet (kg)
Average weight of fish caught per trip	3.2	2.4
Average weight of fish caught per hour	0.32	0.24
Average no of fish caught per trip	59	50
Average no of fish caught per hour	6	5

Table 9: Variations in sizes and weights of thirteen species of fish caught by green and white gillnets.

Species	Total length size range (cm)		Weight range (g)	
	Green gillnet	White gillnet	Green gillnet	White gillnet
<i>Ethmalosa fimbriata</i>	8.70 – 23.00	8.00 – 20.00	14.80 – 100.7	14.80 – 91.70
<i>Sarotherodon melanotheron</i>	8.00 – 15.80	8.00 – 16.00	16.90 – 74.90	17.60 – 85.00
<i>Citharus linguatula</i>	10.80 – 13.10	10.00 - 12.00	13.50 - 28.80	10.40 - 18.30
<i>Mugil cephalus</i>	16.70 - 25.00	0.00 – 21.00	40.00 - 172.0	0.00 - 110.1
<i>Caranx hippos</i>	5.00 – 17.20	7.80 – 16.50	7.80 – 71.00	8.70 – 66.10
<i>Polydactylus quadrafilis</i>	0.00 - 12.00	11.40 – 25.00	0.00 - 58.10	15.80 - 112.9
<i>Cynoglossus senegalensis</i>	10.00 – 27.60	9.50 – 34.40	12.00 – 86.10	14.70 – 187.0
<i>Callinectes amnicola</i>	5.80 – 13.80	5.50 – 13.20	8.70 – 117.4	10.80 – 108.8
<i>Lutjanus dentatus</i>	14.00 – 20.30	13.50 – 17.20	63.10 – 200.9	61.30 – 88.10
<i>Hemichromis fasciatus</i>	9.70 – 16.90	9.00 – 13.90	20.50 – 75.60	23.50 – 50.30
<i>Liza dumerilli</i>	12.70 – 20.00	11.50 – 20.10	14.60 – 41.90	13.90 – 33.30
<i>Eleotris vittata</i>		0.00 - 21.00		0.00 - 111.8
<i>Chrysichthys nigrodigitatus</i>	0.00 – 19.90		0.00 - 95.00	

Fishing trips, duration and number of fish caught by green and white gillnets

Ten (10) fishing trips were carried out for both white and green gillnets fish catches. The trips, which were carried out under the same duration of 106.8 hours, yielded a total catch of 588 fish specimens weighing about 32 kg for the green gillnet and 495 fish specimens weighing 24kg for the white gillnet (Table 7).

Catch per unit effort (CPUE) of green and white gillnets in Lagos Lagoon.

The catch per unit effort of the fishing operation is presented in Table 8. The average weight of fish caught with the green gillnet was 3.2 kg, with the average weight of fish caught per hour being 0.32 kg. The average weight of fish caught with the white gillnet was 2.4 kg, with the average weight of fish caught per hour being 0.24 kg.

Length – weight distribution of fishes caught with the coloured nets.

The smallest fish caught with green gillnet was *Polydactylus quadrafilis*, with length of 12.0 cm while the longest fish was *Cynoglossus senegalensis*, with length ranging from 10.0 to 27.60 cm (Table 9). The green gillnet recorded the smallest weight in the crustaceans, *Callinectes amnicola* (shell fish) of 8.70g and the smallest weight of

7.8g was recorded in *Caranx hippos* (fin fish). The highest weighing fish (200.9 g) caught with the green gillnet was *Lutjanus dentatus*. For fishes caught with the white gillnet, the smallest size range of (9.0 cm – 13.9 cm) was recorded by *Hemichromis fasciatus* while the highest size range was recorded in *Polydactylus quadrafilis* (11.4 cm – 25.0 cm). *Callinectes amnicola* was the lowest (10.8g) weighing fish caught with the white gillnet. The heaviest fish caught with the white gillnet was *Cynoglossus senegalensis*, with weight of about 187g (Table 9).

Condition factor

The green gillnet fin-fish least condition factor of 0.4 was found in *Cynoglossus senegalensis* while the highest condition factor of 6.2 was found in *Caranx hippos* (Table 10). The green gillnet total fin-fish mean condition factor was 2.1. The lowest fin-fish mean condition factor of 0.6 was found in *Liza dumerilli*, while the highest mean condition factor of 3.8 was found in *Caranx hippos*. For the white gillnet, the lowest condition factor of 0.4 was found in *Liza dumerilli* while the highest condition factor of 3.4 was found in *Sarotherodon melanotheron*. The white gillnet total fin-fish mean condition factor was 1.9. The lowest fin-fish mean condition factor of 0.65 was found in *Liza dumerilli* while the highest mean condition factor of 2.75 was found in *Sarotherodon melanotheron* (Table 10). The crustacean *Callinectes amnicola* had the highest condition factor range of 4.5 – 4.5, with a mean of 4.5 for

green gill-net, while for the range of 6.5 – 4.7 and a mean of 5.6 were recorded for white gill-net.

Total landing by weight and price of fishes caught by green and white gillnets

The total fish landings recorded in the study was 56 kg in weight for both green and white gillnets. The green net landed 31.5 kg which sold for a total amount of ₦7,875 at ₦785.00 and ₦250 per trip and per kg of fish, respectively. The total weight of fish specimens caught with the white gillnet was 24.5 kg at a total selling price of N6, 145, N615 per trip at N250/kg of fish. In total, the 56 kg total landings yielded ₦14, 000. The average price per kilogram was therefore ₦250 (Table 11).

DISCUSSION

The netting materials used in this study for construction of gillnet was monofilament nylon, this agreed with Emmanuel *et al.* (2008b) who reported that the netting materials used for gillnet construction was monofilament nylon, polyethylene (PE) and kuralon. The floats were improvised rubber slippers and the sinkers were lead. The materials used agreed with Emmanuel *et al.* (2008b) who reported the use of the net in the catch rates of pelagic fishes in the Lagos lagoon. The hanging ratios of between 0.91 and 0.92 were reported in this study which disagreed with the values of between 0.45 and 0.51 reported by Emmanuel *et al.* (2008b). The hanging ratio was observed to affect the length of the nets and their catchability in that if footrope is shorter than head rope, most fish with larger girth tend to recede and escape. Losanes *et al.* (1992) stated that the excess netting gathering at the lower part of the nets due to high values in slackness can increase visibility, lowering net efficiency.

Table 10: Range and mean condition factors of fish caught by green and white gillnets

Species	Green gillnet		White gillnet	
	Condition factor (K)		Condition factor (K)	
	Range	Mean	Range	Mean
<i>E. fimbriata</i>	2.2 – 0.8	1.5	2.9 – 1.1	2.0
<i>S. melanotheron</i>	3.3 – 1.9	2.6	3.4 – 2.1	2.75
<i>C. linguatula</i>	1.1 – 1.3	1.2	1.0 – 1.1	1.05
<i>M. cephalus</i>	0.9 – 1.1	1.0	1.2	1.2
<i>C. hippos</i>	6.2 – 1.4	3.8	1.8 – 1.5	1.65
<i>P. quadrafilis</i>	3.4	3.4	1.1 – 0.7	0.9
<i>C. senegalensis</i>	1.2 – 0.4	0.8	1.7 – 0.5	1.1
<i>C. amnicola</i>	4.5 – 4.5	4.5	6.5 – 4.7	5.6
<i>L. dentatus</i>	2.3 – 2.4	2.35	2.5 – 1.7	2.1
<i>H. fasciatus</i>	2.2 – 1.6	1.9	3.2 – 1.9	2.6
<i>L. dumerilli</i>	0.7 – 0.5	0.6	0.9 – 0.4	0.65
<i>E. vittata</i>			1.2	1.2
<i>C. nigrodigitatus</i>	1.2	1.2		

Table 11: Total weight fish landings and price of fishes caught by green and white gillnets from Lagos lagoon.

Month	Green gillnet		White gillnet	
	Weight (kg)	Price (₦)	Weight (kg)	Price (₦)
February	8.35	2,085	11.3	2,825
March	3.46	865	2.45	615
April	5.50	1,375	2.97	745
May	6.70	1,675	4.07	1,020
June	7.51	1,875	3.79	940
Total	31.5	7,875	24.5	6,145
Price per kg. (N)		250		250
Price per trip		785		615

A total of 13 fish species belonging to 11 families were caught in this study, which is lower compared with the 16 fish species belonging to 14 families reported by Emmanuel *et al.* (2008b). Lower fish diversity is a good indicator of a stressed ecosystem (Leveque, 1995). It is commonly accepted that the higher the fish diversity, the more stable the fish community (Albarat and Lae, 2003; Emmanuel and Onyema, 2007). The low species diversity in this study may be a reflection of the gear type used and a result of fish availability in Lagos lagoon. Consequently, the response of the Lagos lagoon fish community to high fishing pressure had resulted in catching of smaller sizes of fish species in the lagoon, which in turn has affect the fish economic value and indirectly affected fisher folks passion for the fishing job. The duration gillnetting was 1-12 hours compared with Lateef (1997) 1-14 hours and Udolisa and Solarin (1979) 8-15 hours. The highest catch was reported for February, which could be related to the well-being of fish around this time in relation to availability of food as well as environmental favourability as reported by Nwankwo (2004) and Emmanuel *et al.* (2008). *E. fimbriata* was the most common species throughout the five months of this study with the highest catch composition percentage of 32.19%. Emmanuel *et al.* (2008a,b) reported the dominance of *E. fimbriata*, though with a higher catch composition percentage of 81.99%.

According to Albaret and Lae (2003), *E. fimbriata* occurrences indicated that the species lives and reproduces from nearly fresh water to hyperhaline waters and it is an opportunistic feeder. The short period of five months of this investigation was not enough to exhaust all of the fish species in the Lagos lagoon. There may have been a lot of changes in the ecological factors of Lagos Lagoon in the past years. These changes and human activities, like sand filling, dredging, oil spill and sewage disposal may be responsible for the decline in fish species composition in Lagos Lagoon.

Gillnets caught more number of fish during the night than in the day at ratio 2:1. More fishes were caught at night than during the day, which is in consonance with the report of Udolisa and Solarin (1979) but disagreed with that of Emmanuel (2008b), who reported that more fishes were caught during the day than at night. Also Emmanuel and Kusemiju (2005) noted that more fish were caught during the day than at night due to the fact that most of their day fishing operations was done at low tide, an indication that the time of the day does not matter but the tidal level and environmental condition of the fishing environment. It is a common practice of the fisher folks to operate the nets at night in the Lagos lagoon due to the higher catchability at night and also prevent thugs from damaging their gillnets or stealing them during the day. Generally, the effects of fishing on fish communities include: a decrease in their abundance, changes in age, structure, size composition and species composition. These effect have been well

documented in other 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 of West Africa (Albaret and Lae 2003). The overall length of the fish caught showed that most fish in Lagos lagoon were small. This could imply that most of this species probably use the lagoon as their nursery ground opined by Emmanuel *et al.* (2008b). In the gillnets catch composition, *E. fimbriata* had the highest catch composition percentage by number of 32.19%, *Caranx hippos* had 7.96%, *L. dumerilli* had 1.29% while *E. vittata* had the lowest catch percentage composition of 0.09%. There is a similar trend in catch composition with the report of Emmanuel *et al.* (2008b). Solarin (1998) also reported that gillnets with stretched mesh size ranges of 30 to 45mm caught predominantly *E. fimbriata*, *S. melanotheron* and *L. falcipinnis* which accounted for 55% of the catch.

In this study, ten fishing trips yielded an average catch of 3.2 kg per trip for green gillnet and 2.4 kg for the white gillnet, and price of ₦790 per trip for the green gillnet and ₦615 for the white gillnet. These values are higher than the price per trip of ₦477 reported by Emmanuel *et al.* (2008b). The price per kg for this study was ₦250, which is higher than the ₦150 per kg reported by Emmanuel *et al.* (2008b). The higher price per kg in this study may be attributed to high monetary inflation in Nigeria as the time of this study. The use of gillnets generally is affected by several factors including colour of net, mesh size, twine size and strength, and morphology and behaviour of fish among others. Generally, the green gillnet caught bigger fishes like *E. fimbriata*; *M. cephalus*; *C. hippos*; *C. amnicola*; *L. dentatus*; *H. niloticus*; *L. dumerilli* compared to those caught with the white gill-net. This could explain the higher price per trip of ₦790 for the 588 fishes caught with green gillnet compared with the ₦615 per trip for the fishes caught with the white gillnet. Contrary to our results, Akongyuure *et al.* (2012) concluded that white colour was preferred by fishermen to other colours because it blended relatively well with the colour of the water to ensure maximum gilling, entangling, wedging and nagging of fish.

The weight variations of the fish specimens commonly caught by the two coloured gillnet clearly revealed that the green gillnet caught bigger fishes than the white gillnet. The total weight of the 588 fish specimens caught with the green gillnet was 31.5 kg against 24.5 kg, which was the total weight of 495 fish specimens caught by the white gillnet. This may be due to the dense visibility of the green gillnet allowing more fishes to be wedged or entangled at the gills. In the interest of conservation and judicious exploitation of the fishery, the use of green coloured gillnets could be prescribed since it catches bigger fishes and allows most fish species to reach sexual maturity and grow big enough before they are caught (Akongyuure *et al.* 2012). The condition factor for the green gillnet fin-fish species ranged from 0.6 for *L. dumerilli* to 3.8 for *C. hippos*. For the white

gillnet fin-fish species, the condition factor ranged from 0.65 for *L. dumerilli* to 2.75 for *S. melanotheron*. Bolarinwa and Popoola (2013) gave a range of condition factor from 0.56 in *Sphyraena piscatorium* to 1.62 in *Pomadasys jubelini* in Lagos Lagoon. Lateef (1997) recorded a condition factor ranging from 0.11 for *Strongylura senegalensis* to 1.3 for *Pomadasys jubelini* and *C. hippos* in the same water body used in this study.

CONCLUSION

Monofilament nylon is one of the most used netting materials for gillnets construction in Lagos Lagoon. This study showed that floats material can be improvised with rubber slippers without any issues. The lower fish diversity recorded in this study was associated with type of fishing gear used and high fishing pressure which in turn has affected the economic value of fish caught. The outcome of this study has supported the view that the colour of the fishing gears considerably affected the output in term of catch and economic value of the fishing gear.

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