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Gill Net Selectivity and Stock Assessment of Kugbo Creek in the Delta Region of the River Niger, Nigeria

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Abstract
Gill net selectivity and stock assessment studies were carried out in Kugbo Creek, in the Delta region of River Niger, Nigeria. Nine-gill nets of varying sizes (¾", 1", 1½", 1¾", 2", 2½", 3½", 4"and 7") were used at 7 hours-day active fishing. Mean biomass of 2,054kg represented the mean total daily catch of 2,243 individuals. Highest mean catch per net was observed in mesh size 2½" with a total mean catch of 653 individuals or 981.31kg biomass that represented 47.78% of the total daily catch. The lowest catch was with 7" mesh, 21 individuals or 130kg biomass per day representing 6.33%. The analytical method of the age composition of catch in the fisheries stock assessment showed there were few old fishes in the fisheries which depicts high fishing pressure (overfishing), which here may have resulted from loss due to pollution. Generally, biomass decreases with decreasing fishing net mesh and increases with increasing mesh sizes.

Keywords: Gill Net Selectivity, Stock Assessment, Kugbo Creek, River Niger Delta, Fisheries Management

Introduction
In Nigeria, fishing constitutes 18 to 24% of the country's agricultural produce (The Federal Government of Nigeria, 1992). The practice of fishing is as old as the culture of the people of the riverine communities in the Niger Delta. Fishing gears of cast nets, gill nets, Siene nets, impounding nets and assorted traps (including the earthen pond trap) are commonly used in this artisanal fisheries industry and most Nigerian waters probably due to catch efficiency (Fabrizio et al., 2015; Lucchetti et al., 2020) and affordable cost. To increase efficiency, Hinz et. al. (2012), Zhang et al. (2021) and Braimah (2020) have recommended transparent monofilament nets in clear waters. However, this has its disadvantage. Monofilament plastic nets are not environmentally friendly as it is non-degradable. If carelessly left in the water without proper disposal, it continues to kill fish that entangled with it. The choice of fishing gear in a fishery depends on the target species' behaviour and the fishery characteristics (Wulff, 2022). That is, whether species are pelagic or demersal, economic value, depth of water, fishing depth and characteristics of the bottom (as gears are set in contact with bottom) and the physiognomy.

Materials and Methods
Location of the study area was as described in Edoghotu et al. (2016). The study involves experimental fishing, observation, enumeration, identification and classification of fish samples, establishing gill net selectivity and stock assessment. Sampling was carried out in all 3 aquatic zones differentiated by salinity and vegetation type. Nine varying sizes of gill net of ¾", 1", 1½", 1¾", 2", 2½", 3½", 4"and 7" stretched mesh were employed. Each net was 40m long and 3m wide, the surface area for each net was 120 m^2 while the fleet area was 540 m^2. Catch from each zone were separately kept and transported in cool boxes to the laboratory for proper identification, classification and analysis. The total number, weight and total length of each species caught were recorded. Weighing of the fish was done with an electronic sensitive weighing balance (model Scout pro 601) with 1-600g measuring capacity, for fish with relatively small weights, while those with weights larger than 600g were weighed with model HANA commercial weighing balance. Fish weights were determined after draining water from buccal cavity and blot – drying the samples. Sampling was done weekly for a 24-month period while the regime for each day was 6 hours of intensive fishing. In each of the 3 aquatic zones sampled, 3 sites (stations) were established for experimental fishing. The major fisher communities within the zones are Amorokeni, Amuruto and Emago, Ebililagh communities (Edoghotu et al., 2016).

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Identification of fish specimens was according to the descriptions contained in Idodo –Ume (2003), Reed (1967). Seasonal variation, abundance and frequency of occurrence were established for the three zones sampled. Fish age were determined with Von Bertalanffy Growth Model (VBGM) for the stock assessment. Statistical analysis such as mean; and standard deviation was also employed.

Results

Tab. 1: Mean fish count and biomass (kg) per mash size of the kugbo Creek during March 2009 – February 2011.

Mesh(inch)	No of fish	% composition	Biomass (kg)	% composition
¾"	35	1.53	0.97	0.04
1"	63	2.81	5.35	0.26
1½"	26	1.16	8.81	0.43
1¾"	815	36.34	205.49	10.00
2½"	653	29.11	981.31	47.78
3¾"	223	9.94	337.06	16.41
4"	48	2.14	110.83	5.40
7"	21	0.94	130.0	6.33
Total	2,243	100	2,054.00	100

Table 2: Monthly mean variation in catch and biomass(Bm) of fish caught per net mesh in the Kugbo Creek during the study period.

Mesh	Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Total	
	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C	Bm
¾"	0	0	0	0	0	0	6	0.20	10	0.30	3	0.09	9	0.22	5	0.07	2	0.07	0	0	0	0	0	0	35	0.97
1"	2	0.15	3	0.24	9	0.43	2	0.15	15	1.38	16	1.78	2	0.15	7	0.33	4	0.29	1	0.15	1	0.15	1	0.15	63	5.35
1½"	1	0.25	0	0	2	0.30	0	0	0	0	4	1.02	0	0	1	0.25	10	4.15	6	2.54	2	0.30	0	0	26	8.81
1¾"	58	9.26	26	3.05	15	0.650	9	9.49	13	1.80	43	5.77	10	0.94	49	2.15	81	6.82	21	11.60	19	6.79	25	10.16	359	68.43
2"	72	31	62	31	52	9	13	6	21	7	73	14	37	6	48	16	75	22.10	50	27	61	8	89	10.8	653	274.18
2½"	105	71	108	66	11	108.9	52	99.33	5	28.2	20	61	3	33	6	58	11	115	91	110	141	86	334	97	815	952.54
3½"	21	54	17	60	11	74.06	6	45	9	33	20	66.04	13	29	28	37	21	71	16	69.02	29	80	32	56	223	674.12
4"	5	4.2	5	4	3	5	015	0	0	0	8	15	0	0	2	3	9	12.4	5	5.8	7	9	4	5.2	48	10.83
7"	2	6.1	1	2.8	0	0	0	0	7	0	2	5.6	0	0	1	2.5	4	10	0	0	0	0	4	3	21	30.00
Total	266	175.56	222	167.09	1103	197.58	88	160.17	80	71.5	189	170.66	74	69.31	147	115.3	27	241.83	118	226.11	260	190.24	489	182.31	2243	2054.00
% composition	11.8	8.55	9.9	8.13	4.6	9.62	3.9	7.80	3.6	3.48	8.4	8.31	3.3	3.34	6.5	5.63	9.6	11.77	5.2	11.00	11.5	9.26	21.7	8.88	100	100

Results of the study are presented in Tables 1 - 5. (see appendices) It was observed that there was a decline of the fish assemblage with the various gill nets in both number and biomass, especially in large mess sizes of 4" and 7" (Table 1) and small mesh sizes of ¾", 1", 1½" and 1¾". Highest biomass (981.31kg) of fish caught per mesh size was recorded in 2½" mesh size. Its catch represented 47.79% of the total biomass. This was followed by mesh size 3½" with biomass of 337.06kg, representing 16.41% of the total biomass. The least biomass (0.9kg) was with mesh size ¾" representing 0.04% of the total biomass. The result further revealed that mesh size 2½"and 3½" were the most efficient accounting for 64.19% of the total biomass, while the rest accounted for 35.89%.

However, the number of fish caught per mesh size was highest with mesh size 1¾" having daily mean count of 815 individuals that representing 36.34% of total number caught during the period. This was followed by mesh size 2½" with 653 individuals that represented 29.11% of the total catch. Least number of fish caught (21 individuals) was with mesh size 7", representing 0.94% of the total fish caught. Monthly mean catch was highest in February with 489 individuals representing 21.70% of the total catch. This was followed by a march with 266 individuals representing 11.81% of the total catch. The last was September with 74 individuals or 3.28% of the total catch. Similarly, monthly biomass was highest in November with 5,241.83kg (or 71.77%) of the total biomass. Next was in December with 1,226.1kg representing 11% of total biomass. The least monthly biomass was 169.31kg in the month of September, representing 3.34% of the total. However, the distribution of the three zones sampled showed that the brackish water zone was highest with 876.71kg or 25.71% of the total biomass. Number of fish caught per zone increased from fresh water to the brackish water zone. Stock assessment of the fisheries further revealed the largest individual fish landed

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during the study is *Gymnarchus niloticus*, a freshwater species with a total length and weight of 117cm and 4,484.4g respectively. This was followed by another freshwater species, *Heterotis niloticus* (87cm and 4,524g) and *Papyrocranus afar* (40cm and 691.6g), while the largest of the brackish water was *Chrysichthys nigrodigitatus* (59.8cm and 2,601.1g). The smallest fish recorded in the freshwater zone was *Polycentropsis abriviata* that was 3.68cm in length and 27.9g weight, while in the brackish zone was *Syngnathus sp* with 8.4cm length and 4.8gweight respectively. Catch per unit effort was highest in the month of November with the mean daily catch of 37 individuals per hour. It was lowest in September with a mean daily catch of 7 individuals per hour. Catch per unit biomass had the highest (20.2kg/hour) in the month of November. The lowest value (0.9kg/hour) was in the month of February. Stock mean total was 14.2kg/hr. Estimated catch biomass and potential yield biomass during the period of this study was 2,054kg, and gave an average daily production of 2.1metric ton/km^2. Total catch landed in number was 2,243 individuals. This gave an annual mean daily production estimate of 187 fish and a standing stock of 5 individuals per km^2.

Discussion

The small mesh-sized gill nets of 2½" to 3½" were the most commonly used nets in this artisanal fishery which may be due to their efficiency. The decline in the fish number caught with increasing and decreasing mesh sizes of 4" and 7" was a reflection of the reduction in stock size which increased with the age of individual fish caught. However, the result showed that gill nets of mesh size 1¾", 2", 2½"and 3½" were the most efficient fishing gill nets constituting daily catch of 36.3%, 24.9%, 29.11% and 9.1% respectively, of the total catch. This was in agreement with the findings of Lucchetti et al., (2020); Fabrizio et al., (2015) and Abowei (2000) in the river Nun and is in accordance with the recommendations on the use of 2½" mesh of (Sanchez-Gonzalez and Casals, 2022 & Zairon, 2020) for artisanal fishing due to efficiency. Least fish biomass was with mesh size 4"and 7" while sizes 1¾" to 3½" had the highest. The maximum of 981.3kg was observed with mesh 2½" representing 47.8% of the total biomass and gill net size 1¾" to 3½" were most efficient with percentage catch of 10%, 13.4%, 47.8% and 16.4% of total biomass respectively. The smaller mesh sizes of ¾" to 1½"did not have much catch since they were designed for small fishes which are predominantly fries and fingerlings in nurseries or taking shelter in less disturbed areas with little or no predation such as the fresh water grass mat, mangrove and fresh water swamps. Thus are not yet recruited in the available cohort. Similarly, the large mesh size of 4" and 7" did not have much catch because most of the fish population easily escaped from the escape from such coarse mesh. Also, the population of the cohort for this mesh size is sparsely populated as most of the members are out of the fisheries either through natural or fishing mortality.

Stock size estimated from the gill nets was highest in November and lowest in the month of September. This was attributed to the seceding flood associated with this month and the end of August break respectively and was in agreement with Zairon et al., (2020). All through the year migration into swamps and back to the main creek, from the freshwater creek to the brackish and marine environment and back to freshwater occur. At this period, fishes that were in the adjourning flood plains and swamps begin to return to the mainstream of the creek, the climax of which is in the month of November. Thus, the estimated catch and potential of 2.16 metric tons km^{-2}. Hence, catch and potential yield in number gave a mean value of 2,243 individuals per day, while the daily estimate of 1,027 fish and standing stock of 4.72 individuals/km^2. This was high relative to the observation of Braimah, (2020) and Abowei, (2000) in other aquatic systems of the Niger Delta.

Conclusion

The study on gill net selectivity and stock assessment in Kugbo Creek revealed that mesh sizes between 1¾" and 3½" were the most efficient, contributing significantly to daily catch and biomass. The 2½" mesh size was particularly effective, representing nearly half of the total daily catch. Smaller mesh sizes, designed for juveniles, and larger mesh sizes, targeting older fish, had lower efficiency due to the scarcity of their target fish populations. The findings highlight overfishing pressures, indicated by the low number of older fish, and seasonal variations in stock size, with the highest stock observed in November. These results underscore the importance of selecting appropriate mesh sizes to optimize catch while ensuring sustainable fisheries management.

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Appendices

Table 3: Catch (C) and biomass (Bm)kg of fish caught per sampling zone per net mesh in Kugbo Creek.

Mesh	Zone1		Zone2		Zone3		Total		%Composition	
	Bm	C	Bm	C	Bm	C	Bm	C	Bm	C
¾"	0.23	9	0.28	13	0.46	23	0.97	45	0.05	2
1"	1.36	14	2.15	28	1.85	21	5.36	63	0.27	2.81
1½"	1.95	5	3.12	10	3.74	11	8.81	26	0.44	1.16
1¾"	20.70	43	25.16	58	22.57	50	68.43	115	3.41	5.13
2"	92.16	178	65.19	116	116.83	262	274.18	556	13.67	24.92
2½"	154.55	211	286.88	278	491.11	364	932.54	853	46.51	38.03
3½"	228.67	180	217.82	167	227.63	176	674.12	523	33.61	23.32
4"	2.45		3.21		5.17		10.83		0.12	2.14
7"	13.44	6	9.32	3	7.24	2	30.00	11	1.50	0.49
Total	515.51	657	613.13	689	876.71	930	2005.24	2243	100	100
% composition	25.71	28.87	30.57	30.27	43.72	40.86	100	100		

Table 4: Fishing effort and catch per unit effort of fish caught in Kugbo Creek.

Months	Catch		Fishing Effort (hours)		Catch per Unit Effort	
	Catch	Biomass	Catch	Biomass	Cash	Biomass
March	196	175.6	12	12	17	14.6
April	279	167.1	12	12	24	13.9
May	163	197.6	12	12	14	16.5
June	93	160.2	12	12	8	13.4

July	89	71.5	12	12	78	6.0
August	212	170.7	12	12	18	14.2
September	84	69.3	12	12	7	5.8
October	147	115.3	12	12	13	9.6
November	444	241.8	12	12	37	20.2
December	398	226.1	12	12	34	18.8
January	210	190.2	12	12	18	15.9
February	181	10.3	12	12	16	0.9
Total	2496	2054	144	12	284	14.2

Table 5: Estimated vital production parameter of exploited fish number caught and biomass (kg) in Kugbo Creek.

S/N	Parameters	Catch Number	Biomass (kg)
1	Number of hours	144	144
2	Total catch	2243	2, 054kg
3	Mean catch/hour	4	14.2kg
4	Mean catch/day	172	171.2kg
5	Total catch/day	187	1,027tons
6	Total Area	75km^2	75km^2
7	Total catch and biomass (ton) per km^2	2154	2.2 tons

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