Design Characteristics And Bycatch Mortality Of Beach-Seine Operations In Atlantic Coast Of Eastern Obolo Local Government Area, Nigeria

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Abstract: Bycatch become an important global environmental issue in marine capture fisheries. The major problems identified were mortality of juveniles of commercially important species, ecosystem simplification and trophic structure destruction and changes and depletion in fish population. Therefore, the aim of the research was to study the design characteristics and bycatch mortality of beach seine operations. The beach seine net deployed in the area were made of polyamide, multifilament and monofilament stretched mesh sizes and its corresponding thickness respectively. Sinking force and buoyancy force were computed, while hanging co-efficient were also calculated. The names, length and weight of fish species caught by near shore beach seine and its corresponding families in twenty (20) landings were observed, identified and recorded as well as the comparison of mature and juvenile bycatches compositions. A relative paired T-test analysis of catch compositions showed an extremely statistically significant results ($P < 0.05$, $n = 20$, $df = 19$). The average minimum to maximum length and weight of each species were measured and recorded, the least length (0.5mm) and weight (0.5g) were for *parapenaeopsis atlantica* while the highest length (88cm) and weight (56.50kg) were for *mugil cephalus* and *sphyraena sphyraena* respectively. Percentage contributions were as follows; *pseudotolithius elongatus* (10.07%; $P < 0.05$, $n = 26$, $df = 25$), *Ethmalosa fimbriata* (9.48%; $P < 0.05$, $n = 26$, $df = 25$) and *Caranx carangus* (8.78%; $P < 0.05$, $n = 26$, $df = 25$) while *Lutjanus goreensis* (0.67%; $P < 0.05$, $n = 26$, $df = 25$) showed least significant.

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Keywords: Design characteristics, Bycatch mortality, Beach-seine operations, Juvenile and Atlantic coast.

Introduction

In almost all the literature reviewed, bycatch is unintentional and not desirable. Bycatch is a fish or other marine species that is caught unintentionally while catching certain target species and target sizes of fish, Crab etc. It is either of different species, or is undersized or juvenile individuals of the target species (Garrison, 2003). Ambrose *et. al.,* (2005) defined bycatch as non-target catch of multi-species landed, which are marketed and consumed to an extent. The Marine Stewardship Council (MSC) (2014) defined bycatch as organisms that had been taken incidentally and are not retained (usually because they have no commercial value). FAO (2010) define bycatch as the incidental take of undesirable size or age classes of the target species or to the incidental take of other non-target species or protected, endangered, or threatened species. Beach seine nets have been used in fisheries for several thousand years and on every continent. (Gabriel *et al.,*2005) Bycatch can be sold, or it may be unusable or unwanted for a number of regulatory and economic reasons and therefore thrown back to sea (i.e., discarded), either alive with injuries or dead (Harrington, *et al.,* 2006). This means that bycatch is captured along with target species because there is no enough space on board, is not utilized by the society or the law forbids the landing of bycatch species. This research is aimed at studying the design characteristics and bycatch mortality of beach seine operations.

Materials And Methods

Study area was ina fishing settlement in South-south Region of Nigerian Atlantic coastline. It is located in the Niger Delta between latitudes $4^0 28"$ and $4^0 53"$ North and longitudes $7^0 50"$ and $7^0 55"$ East. It is bounded in the (North) by Mkpat Enin Local Government Area, (North East) by Onna, (West) by Ikot Abasi, (South East) by Ibeno Local Government Areas and in the (South) by the Atlantic Ocean. (Fig. 1)

Design; The mesh size was measured as a distance between two sequential knots when stretched in the normal 'N' direction, and was designated as stretched mesh size in millimeters (FAO, 1975). Twine thickness was measured and presented in mm, they were converted to R-tex, using the conversion table by Klust (1982) and Udolisa *et al.,* (1994). The material used in the construction of the frameline was identified based on the chemical classification of netting materials by Klust (1982). The length of the framelines; upper or float line, lower or sinker line and stapling line were measured and designated in meters. Sinking and buoyancy forces were computed, using Fridman, (1986) and Normura and Yomazaki, (1985) methods. The specific gravity (relative density) of cork float and lead sinker are given respectively as 0.75 and 11.35. Hanging coefficient was determined as relationship between the length of the stapling rope and the total stretched length of meshes hang to it, Udolisa *et al.,* (1994).

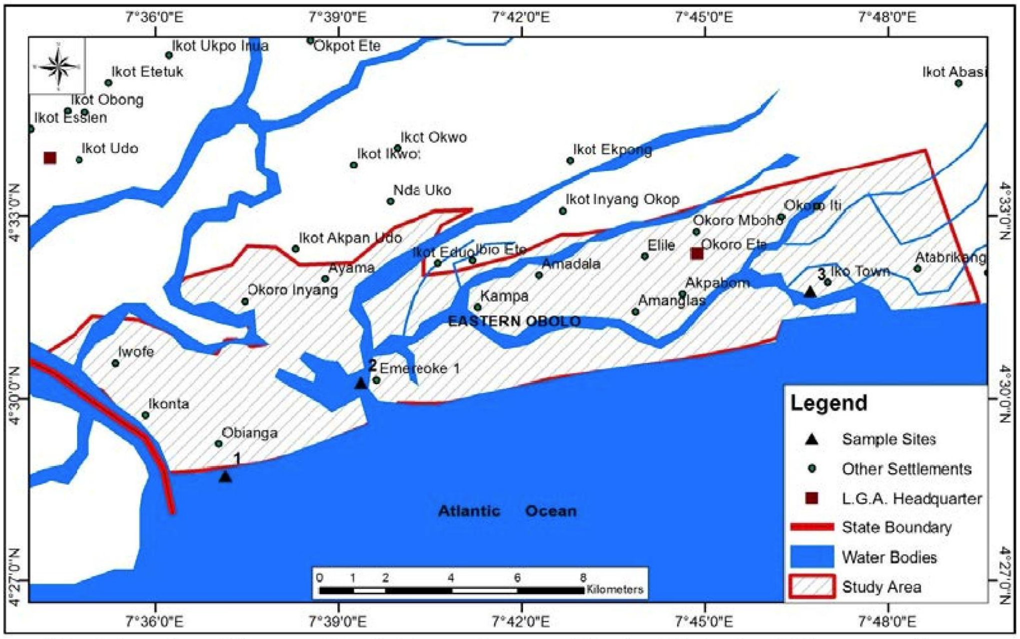

Fig. 1: Location of the sampling stations on the map of Eastern Obolo Local Government Area

Fishery Survey; Dependently, oral interviews were conducted for the compositions of landed catch and estimation of the diversity of bycatch (George *et al.,* 1982). Independent observation onboard the fishing vessel, net shooting, soaking, hauling, handling, fish sorting weighing and identifying of fish caught (Ambrose *et al.,* 2005). Identification of fish species caught were carried out using meristic features and morphometric body projections with identification keys (Schneider, 1990; Tobor and Ajayi, 1992).

Data collection; landing organisms were sorted, into matured (target species) and juvenile fishes (bycatches). Juvenile categories were identified, sorted according to species in 20 replicate landings. T- test analysis of catch data was used to pooled the landings from both 10 fishery dependent and 10 fishery independent landings. CPUE was calculated according to the method of Stamatopoulous (2002).

Results:

Design characteristics of conventional beach seine; The beach seine net used consisted of three panels of nettings. The bunt panel is made with polyamide multifilament netting with stretched mesh size 35mm and a thickness of 4mm (R270tex), the center panel has a stretched mesh size of 45mm and thickness of 2mm (R155tex), while the terminal panel is made of monofilaments netting with stretched mesh size of 65mm and a thickness of 1mm (R130tex). These mesh sizes decreases from the two terminal wing panels towards the bunt. The bunt meshes retained the captured fishes; while other two meshes act as fish leaders toward bunt, hence has larger mesh sizes. The thickness of twine used in mesh design varied, just like mesh size in each of three panels; twine thickness increases towards bunt to impart strength and abrasive resistance against wearing and tearing to the net during hauling along the sandy bottom. The net was 0.8km in length and 4m in depth.

Buoyancy and sinking forces from the computations, was buoyed negatively with a sinking force of 154,567.05kg/f and a positively buoyancy force of 7071.4g/f. The rigging pattern is therefore appropriate because beach seine catch bottom dwelling fishes more than pelagic, hence height sinking power net is required. The sinkers at the bunt panel were closely spaced (2-5m) than that of the remaining two panels (5-10m). The bunt meshes were hang at E-values of 0.3, while the middle and terminal panels have E-value of 0.5 and 0.8 respectively to allow for height or mesh lift reduction and increase in speed or horizontal extension of the mesh size.

Catches and operations of the gear; was in near-shore Atlantic all year around, but more frequent during the dry season. Hauling with a pair of ropes (250m) from both sides, facing the ocean current and adjusted to fishing ground prior to shooting. The net was operated during the day in calm waters by 7-8 men fishing crew from wooden canoes of 9.5m LOA and powered with 15HP outboard engine. Accomplished in two (2) stages, namely; setting and pulling the trapped fishes ashore. Bycatch compositions of twenty-six (26) species belonging to fifteen (15) families with scientific and common names and some identified local names were revealed (table 1). The average minimum to maximum length and weight of each species were measured and recorded accordingly (Table 1), the least length (0.5mm) and weight (0.5g) was recorded for *Parapenaeopsis atlantica* (peneaidae) while the highest length (88cm) and weight (56.50kg) were also recorded for *Mugil cephalus* and S*phyraena sphyraena* respectively (Table 1). The highest catch was recorded in dry season (October – January) than the wet season (April – September). Relative paired T-test was used because both mature target species and juvenile bycatches were from the same population. The calculated P-value for each landing were tabulated with it corresponding T-test (P<0.05) to test their significant differences (table 2). Total fish caught from 20 replicate landings was 3417 out of which 2513 were juvenile called bycatch while 904 were matured called target catch. From 20 replicated landings, T-test analysis showed statistically significant (SS) (p <0.05), between the number of mature and juvenile fishes indicating more juveniles than mature fishes per landing. Four landings in the rainy months of June and August caught more number of matured fishes than juveniles and were statistically not significant (NS) (p > 0.05). While the four landing in the dry months of December and January reveals matured target catch also increased greatly in respect of juvenile bycatch and were extremely significant (ES) (p <0.05). Table 3; With regard to the temperature ranges of 27^0 c – 31^0c in both seasons, showed that *Pseudotolithius elongatus* (10.07%) are more vulnerable to exploitation while *Lutjanus goreensis* (0.67%) are less exploited at (P<0.05, n = 26, df = 25). The table also showed that for one (1) sample of mature fish caught by beach seine, three (3) samples of juvenile bycatch species are incidentally killed. Nearly all commercially importance species of fin fishes maintained this ratio, some more juvenile are killed like (6:1) in *Parapenaeopsis atlantica.* Except for less valued shell fish like *Callinectus amnicola* in which matured specimens are killed more than juveniles (1:2).

Table I: Names, length and weight of fish species caught by nearshore beach seine.

S/N	Family/Names	Scientific Names	Common Names	Local Names	Min-Max Total Length (cm)	Min-max Total Weight
1.	Mugilidae	*Mugil cephalus*	Mullets	Okurukuru	1.4 – 88.0	0.5 – 10.0
2.	Mugilidae	*Mugil falcipinus*	Sickle fin	Aseke	1.3 – 19.5	0.19- 31.45
3.	Scieanidae	*Pseudotolithius typus*	Long neck croaker	Okpo	1.0 – 16.2	0.34- 9.82
4.	Scieanidae	*Pseudotolithius elongates*	Bobo croaker	Broke marry	1.7 – 44.2	0.34-2.2
5.	Scieanidae	*Pseudotolithius senegalensis*	Short neck croaker	Onna	3.2 – 10.0	0.11 – 4.80
6.	Polynemidae	*Pentanemus quinquarius*	Royal threadfin	Ora	1.7 – 18.2	0.28 – 1.80
7.	Polynemidae	*Galeoides decadactylus*	Shiny nose	Ora	1.3 – 17.5	1.50 – 31.34
8.	Polynemidae	*Polydactylus quadrilifilis*	African threadfin	Ora	1.9 – 31.4	2.05 – 3.50
9.	Clupeidae	*Illisha africana*	African shad	Ebat	1.6 – 57.0	3.50 - 56.07
10.	Clupeidae	*Ethmalosa fimbriata*	Bonga shad	Ebat	1.0 – 172.5	3.55 – 30.50
11.	Ariidae	*Arius latisculatuls*	Catfish		1.5 – 46.1	0.21 – 43.11
12.	Carangidae	*Caranx carangus*	Color jack fish	Nnkukang	1.3 – 20.5	11.0 – 25.33
13.	Carrangidae	*Caranx hippos*	Crevalle jack fish	Nkikang	2.1 – 13.5	3.05 – 7.90
14.	Lutjanidae	*Lutjanus dentatus*	Red snapper		2.5 – 18.5	10.50 – 17.50
15.	Lutjanidae	*Lutjanus goreensis*	Gorean Snapper		2.0 – 8.8	5.20 – 8.16
16.	Pomadasyidae	*Pomadasys jubelini*	Grunters		1.9 – 13.9	2.0 – 5.50
17.	Pomadasyidae	*Pomadasys peroteti*	Pigsnout grunt		1.5 – 13.5	0.70 – 10.05
18.	Sphyraenidae	*Sphyraena sphyraena*	Barracuda		1.1 – 28.6	4.50 – 56.50
19.	Sphyraenidae	*Sphyraena guachancho*	Senects		2.0 – 25.8	0.35 – 15.8
20.	Tetraodontidae	*Lagocephalus laevigatus*	Smooth puffer		1.5 – 12.7	18 – 2.70
21.	Tetraodontidae	*Sphoeroides senegalensis*	Blunthead puffer		1. – 10.52	1.5 – 15.5
22.	Serranidae	*Epinephelus aneus*	Grouper (white)		1.6 – 17.0	4.50 – 7.50
23.	Dasyatidae	*Dasyastis margarita*	Sting Ray	Cover pot	1.5 – 15.8	3.20 – 3.50
24.	Cynoglossidae	*cynoglossus senegaslensis*	Tongue sole		1.5 – 15.8	1.50 – 7.20
25.	Portunidae	*Callinectus amnicola*	Blue crab	Isob	2cl – 10cl	1.20 – 1.70
26.	Penaeidae	*Parapenaeopsis atlantica*	Guinea shrimp	Obu	0.5mm – 125mm	0.5 – 100g

Source: ***Field survey, 2017.***

Table II: Number of mature and juvenile (bycatch) species caught per landings that was used in T-test analysis (N=20; SS=Statistically Significant; NS=Not Statistically Significant; ES= Extremely Statistically).

S/N	Month	Monthly Species	Juvenile A	Matured B	Total A + B	Difference A - B	P-value	T-value	Degree of Freedom Df.	Error	Remark
1.	8/4/16	7	25	9	34	16	0.0428	2.5621	6	0.892	SS
2.	22/4/16	6	29	5	34	24	0.0288	3.0382	5	1.317	SS
3.	12/5/16	10	58	12	70	46	0.0025	4.1533	9	1.108	SS
4.	20/5/16	8	51	7	58	44	0.0004	6.2048	7	0.886	SS
5.	10/6/16	7	29	20	49	9	0.4354	0.8356	6	1.539	NS
6.	24/6/16	6	24	11	35	13	0.1946	1.4971	5	1.447	NS
7.	8/7/16	10	52	15	67	37	0.0726	2.0330	9	1.820	NS
8.	22/7/16	8	55	11	66	44	0.0089	3.5824	7	1.535	SS
9.	12/8/16	9	78	30	108	48	0.1114	1.7889	8	2.981	NS
10.	26/8/16	9	62	9	71	53	0.0074	3.5611	8	1.654	SS
11.	9/9/16	8	86	14	100	72	0.0048	4.0540	7	2.220	SS
12.	23/9/16	8	58	7	65	51	0.0355	4.6364	7	1.375	SS
13.	4/10/16	9	87	37	124	50	0.0279	2.5262	8	2.199	SS
14.	28/10/16	9	98	41	139	57	0.0281	2.6803	8	2.363	SS
15.	11/11/16	12	165	74	239	91	0.0153	2.5268	11	3.001	SS
16.	25/11/16	12	181	79	260	102	0.0001	2.8686	11	2.963	SS
17.	9/12/16	16	272	99	372	174	0.0001	5.3606	15	2.029	ES
18.	23/12/16	16	293	110	403	183	0.0001	5.7611	15	1.985	ES
19.	6/1/17	23	404	160	564	244	0.0001	6.7743	22	1.502	ES
20.	20/1/17	23	405	154	559	251	0.0001	7.6125	22	1.405	ES
Total		**216**	**2513**	**904**	**3417**	**1609**	**0.0001**	**15.1856**	**215**	**0.494**	**ES**

Source: ***Field survey, 2017.***

Table III: Number of target (matured) catch and juvenile (bycatches) of twenty-six (26) species caught by nearshore beach seine that was used in percentage and ratio comparison. (Matured versus Juveniles) (N=20).

S/N	Species	Total No. of Juvenile (A)	Total No. of Mature (B)	Total No. of individual sp. (A + B) = C	Percentage %	Ratio (A:B)
1.	*Mugil cephalus*	144	40	184	5.38	3:1
2.	*Mugil falcipinus*	59	14	73	2.14	4:1
3.	*Pseudotolithius typus*	117	58	175	5.12	2:1
4.	*Pseudotolithius elongatus*	253	91	344	10.07	2:1
5.	*Pseudotolithius senegalensis*	36	18	54	1.58	2:1
6.	*Pentanemus quinquarius*	37	12	49	1.43	3:1
7.	*Galeoides decadactylus*	198	61	259	7.58	3:1
8.	*Polydactylus quadrilfilis*	65	16	81	2.37	4:1
9.	*Illisha africana*	99	25	124	3.63	3:1
10.	*Ethmalosa fimbriata*	268	56	324	9.48	4:1
11.	*Arius latiscutatus*	155	50	205	5.99	3:1
12.	*Caranx carangus*	247	53	300	8.78	4:1
13.	*Caranx hippos*	134	28	162	4.74	4:1
14.	*Lutjanus dentatus*	111	23	134	3.92	4:1
15.	*Lutjanus goreensis*	18	5	23	0.67	3:1
16.	*Pomadasys jubelini*	68	21	89	2.61	3:1
17.	*Pomadasys peroteti*	40	14	54	1.58	2:1
18.	*Sphyraena sphyraena*	100	25	125	3.66	4:1
19.	*Sphyraena guachancho*	55	12	67	1.96	3:1
20.	*Lagocephalus laevigatus*	47	18	65	1.90	2:1
21.	*Sphoeroides senegalensis*	33	9	42	1.23	3:1
22.	*Epinephelus aneus*	105	25	130	3.80	4:1
23.	*Dasyatis margarita*	24	29	53	1.55	1:1
24.	*Cynoglossus senegalensis*	7	34	41	1.19	1:4
25.	*Callinectus amnicola*	63	162	225	6.58	1:2
26.	*Parapenaeopsis atlantica*	30	5	35	1.02	6:1
	Total	**2513**	**904**	**3417**	**100.00**	**-**
	Means	96.65	34.76	131.42	-	-

Source: ***Field survey, 2017.***

Table IV: Different between target matured catch and juvenile bycatches of each species caught by nearshore beach seine that was used in T-test paired composition (N=20).

S/N	Species	Total of No. of Juvenile (A)	Total No. of Mature (B)	Difference A- B = D	$(A – B)^2$	Calculated T-test values	Level of significant (0.05)	Inference
1.	*Mugil cephalus*	144	40	104	10816	4.36	2.060	SS
2.	*Mugil falcipinus*	59	14	45	2025	4.19		SS
3.	*Pseudotolithius typus*	117	58	59	3481	4.35		SS
4.	*Pseudololithius elongatus*	253	91	162	26244	4.35		SS
5.	*Pseudotolithius senegalensis*	36	18	18	324	4.35		SS
6.	*Pentanemus quinquarius*	37	12	25	625	3.14		SS
7.	*Galeoides decadactylus*	198	61	137	18769	4.36		SS
8.	*Polydactylus quadrilifilis*	65	16	49	2401	4.36		SS
9.	*Illisha africana*	99	25	74	5476	4.36		SS
10.	*Ethmalosa fimbriata*	268	56	212	44944	4.36		SS
11.	*Arius latiscutatus*	155	50	105	11025	4.36		SS
12.	*Caranx carangus*	247	53	194	37636	4.36		SS
13.	*Caranx hippos*	134	28	106	11236	4.36		SS
14.	*Lutjanus dentatus*	111	23	88	7744	4.25		SS
15.	*Lutjanus goreensis*	18	5	13	169	4.36		SS
16.	*Pomodasys jubelini*	68	21	47	2209	4.36		SS
17.	*Pomadasys peroteti*	40	14	26	676	4.36		SS
18.	*Sphyraena sphyraena*	100	25	75	5625	4.36		SS
19.	*Sphyraena guachancho*	55	12	39	1521	4.36		SS
20.	*Lagocephalus laevigatus*	47	18	29	841	4.36		SS
21.	*Sphoeroides senegalensis*	33	9	24	576	4.36		SS
22.	*Epinephelus aneus*	105	25	80	6400	4.35		SS
23.	*Dasyatis margarita*	24	29	-5	25	-4.35		NS
24.	*Cynoglossus senegalensis*	7	34	-27	729	-4.36		NS
25.	*Callinectus amnicola*	63	162	-99	9801	-4.36		NS
26.	*Parapenaeopsis atlantica*	30	5	25	625	4.36		SS
Total		**2513**	**904**	**1609**	**2588881**	**5.0**	**2.060**	**ES**

Source: ***Field survey, 2017.***

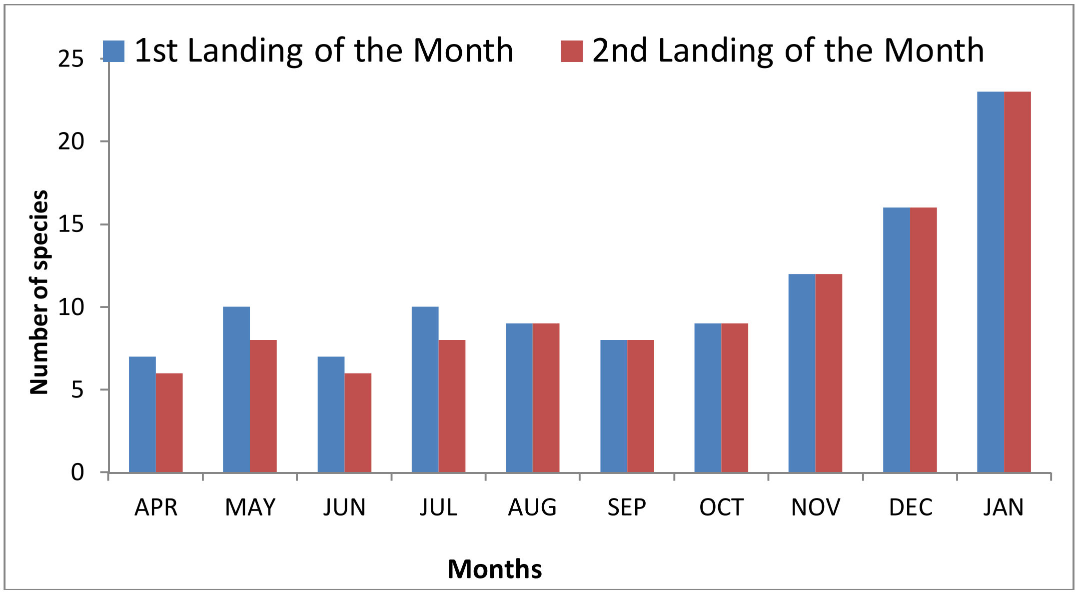

Figure V: Number of species landed per month**.**

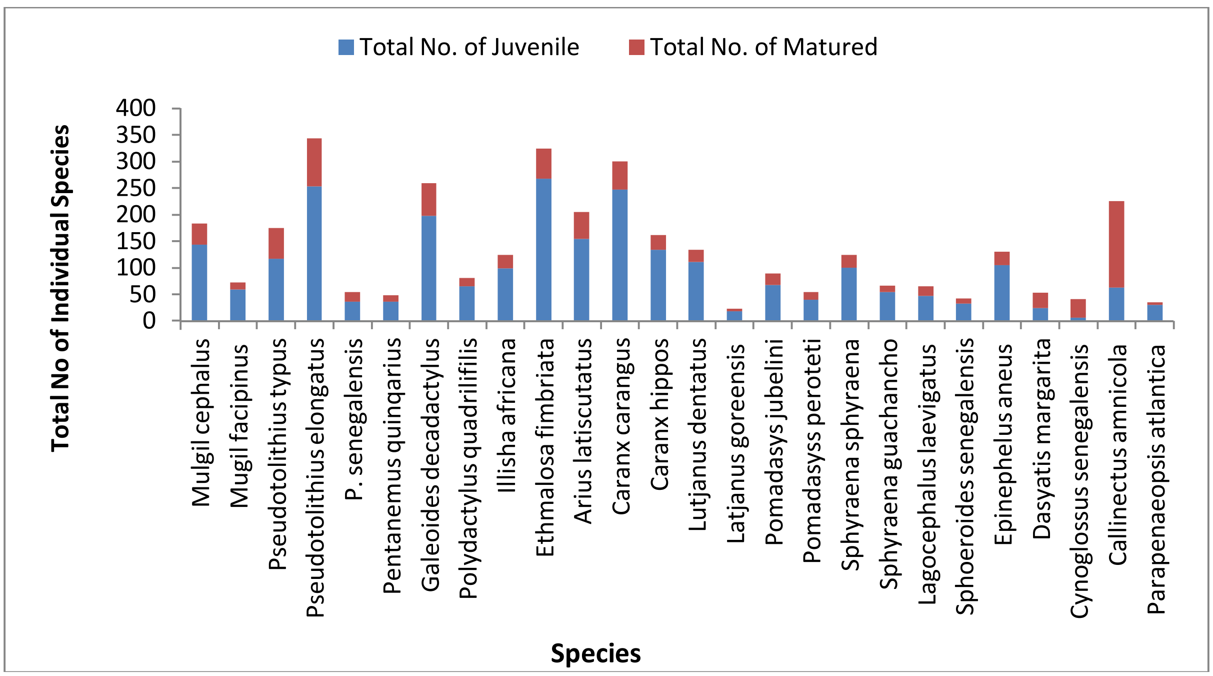

Figure VI: Total number of individual species landing for 26 species in 20 replicate

Discussion:

The result of the present study, have proven that as far as the impact of beach seining bycatch on marine environment is concerned, all studies observe a high percentage of juvenile in the catches of beach seine. Hicks *et al.,* (2012) reported that beach-seine lands high volumes of fish under 5cm whilst of the same time damaging habitat it is pulled through; the damage to corals with repeated usage limits resettlement. Portt *et al.,* (2006) saw the size of the fish caught in the beach seine depends on the mesh size, avoidance and encircling efficiency. (Bentes *et al.,* 2006, Rooker *et al.,* 1991) observed that seasonal migration and juvenile recruitment of species can affect fish communities over long term time frames. The massive captured of juveniles Bobo Croaker (Scieanda) and Bonga (clupeidae) is invariant with the report of Moses (2000), the use small mesh net to harvest massively juveniles bonga (*Ethmalosa fimbiriata)* and other clupeids from the brackish water nursery grounds of south eastern Nigerian. Tsai and Ali (1997) reported same that supply of fish depends upon the season, number of fishermen engaged in fishing and their fishing method.

Conclusion/Recommendations

The beach seining once accounted for the bulk of the catch and employment in the fisheries sectors of the nation. Over the last few decades, however, the reverse is the case. While the basic design of beach seining has not change much over the years, changes are introduced in size of seine, mesh sizes and material used as well as in the way beach seine are operated. Scientists need to quantify the impacts of bycatches on the target species and others and to incorporate them into management schemes. But even more important is to understand the effects of the discarded process on the ecosystem (Kennelly, 1995; Hall, 1999).

- The use of fisher's ecological knowledge in resource management and opportunities for value addition and post-harvest improvements.
- Diversification to move selective and environmentally friendly fishing methods, technical improvements of beach seine gear and methods to reduce catches of juvenile fish.
- Government and NGOs involvement in micro financing support and micro enterprising development.

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