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Composite baseline survey of ichthyofaunal assemblage in a segment of lower Imo river estuary

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Abstract
A composite baseline survey of the Ichthyofaunal assemblage in a segment of the lower Imo River Estuary was carried out from March 2020 - February, 2021 at three sampling stations: Esene Creek (SI), Harbour Area (SII) and Uta Ewa Creek (SIII). Fish samples were collected from the catch of the artisanal and subsistence fishermen operating in the area. The assemblage revealed a rich and varied species, which were grouped into 17 families of 31 species. The contribution from the stations followed an increasing order from stations I to III: 324(8.20%), 350 (12.9%) and 2588 (79.33%). Station III had a higher density and varied significantly when compared to station II and I, respectively. Biotic statistics indices showed polydiversal conditions among the species. Results of the survey revealed that fish assemblage from the study area varied from species to species and from family to family, which implies that the fishery and fishery products of the area can contribute significantly in boosting foreign exchange if properly managed.

Keywords: Composite, ichthyofaunal, estuary, assemblage, lower Imo river

1. Introduction
The knowledge of Biodiversity is increasing on a daily basis, this is prompted by the frequent disturbances of the natural ecosystem (Jamu *et al.,* 2003 and Guo *et al.,* 2018) [29, 23], which lead to the rapid extinction of some species of flora-fauna origin, which fish is inclusive. This menace is as a result of anthropogenic perturbations, which enhances the alterations of the natural ecosystem (Arthington *et al.,* 2016 and Fu *et al.,* 2003) [10, 20]. Diversity is a fundamental property of every living system, which is manifested at every level of the hierarchy, from molecules to ecosystems. Fish exhibits the greatest biodiversity amongst vertebrates, with over 22,000 species (Cosgrove and Rijsberman, 2000) [12]. The high diversity of fish is probably the main source of stability to various tropical fisheries and also gives a strong reason for its conservation (Onuoha *et al*., 2010) [38]. Naturally, fauna assemblage, especially that of fish is a very valuable resource from the eco-economic viewpoint and as such its management and conservation is of great importance. Nowadays, fish diversity and its corresponding habitats management is a vital flash point and the ability to evaluate the effects of habitat distortion and several other impacts on fish population dynamics need a comprehensive survey of the fish population before and after change assessment (Dudgeon *et al.*, 2006) [15]. This could be achieved through a critical survey of its composition (King, 1992 and Essien-Ibok, 2020) [30, 18].
Imo River Estuary is an extensive coastal area, which encompasses the Niger Delta Region, of Nigeria and is also noted for its great potential in fish production (Orji and Onyejiaka, 1990) [39]. Aside from agricultural practices, fishing forms the economic basis of the people. At the lower estuary of the river, there are sketchy fishing settlements, which is situated within an effluent discharge zone of some industries. Transportation, dredging, agricultural practices etc. are the major activities going on within the river. There is a shortage of information on a composite baseline survey of Ichthyofaunal assemblage in a segment of Lower Imo River Estuary. This study aims at surveying the Ichthyofaunal assemblage in a segment of the Lower Imo River estuary.

2. Materials and Methods
2.1 Study Area
The study was conducted in a segment of Lower Imo River estuary (Figure 1), with three sampling sites at Esene Creek, Harbour Area and Uta Ewa Creek all located in Ikot Abasi,

Niger Delta Region, Nigeria.

It lies in the Lower Imo River Basin and extends from latitudes 5.0'00'N – 6.0'00'N and longitudes 6.0'00'E – 7.0'00'E. The river has a main channel total length of about 240km^2 between its source and where it discharges into the Atlantic Ocean. The source is dendritic and flows through coastal plain alluvium and mangrove swamp and empties into the Atlantic Ocean at the Bight of Bonny, forming a natural boundary between Akwa Ibom and River State. A detailed description of the study area is contained in (Akoma, 2008, Akpan, 2006, Petter *et al.*, 1994) [5, 7, 40].

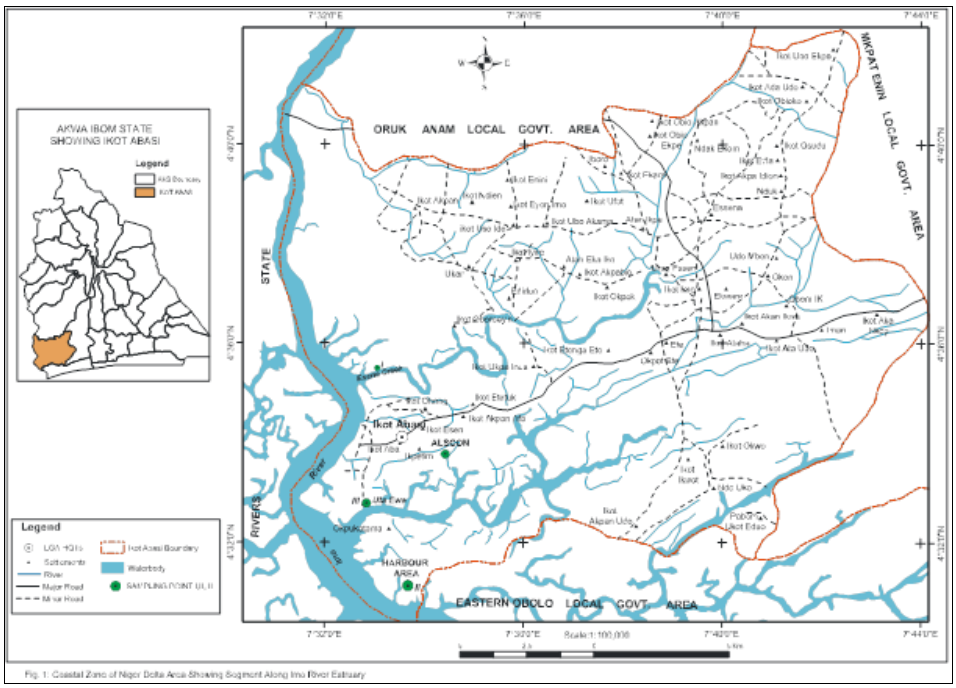

Fig 1: Map of the study area showing sampling locations

2.2 Sample Collection

Fish samples were collected for a period of one year (March, 2020 - February, 2021) from commercial landings of artisanal and subsistence fisheries landings. Sampling was done twice a month. Fish samples were selected and purchased from the fisherfolks. The samples purchased were preserved in an ice-chest and transported to the laboratory for sorting and identification. Oral interviews were conducted with f fisherfolks and inhabitants of the area to gain insight into the fisheries of the area. The samples were identified to the species level with the aid of identification keys as provided by Edwards *et al.*, (2001) [16], Fisher *et al.*, (1981) [19]., Schneider (1990) [41], Idodo Umeh (2003) [28] and Holden and Reed, (1972) [26]. Samples were weighed to the nearest 0.1g using a spring balance and total length using a meter rule.

2.3 Statistical Analysis

Basic simple statistics of range, length, weight, standard deviations and percentage composition were computed. The index of preponderance (%IP) was computed as follows:

$$IP = \frac{\%N \%W x 10}{\Sigma(\%N.\%Wt)}$$

Where, N = No. of fish species, Wt = Weight of species. Fishes with IP valued less than 0.5 were regarded as being a relatively insignificant contribution, while those with IP values greater than 0.5 were regarded as being of significant contribution. Analysis of variance was done with the aid of a statistical computer package (SPSS, version 20.0).

3. Result

The Ichthyofaunal composition in a segment of the Lower Imo River estuary is characterized by a rich and varied fish species assemblage. Table 1-3 indicates the species composition, size ranges, abundance and index of the preponderance of fish species collected at the sampling stations. Tables 4-6, showed an analysis of the variance of the species collected on a station, monthly and seasonal basis. Species richness of the collected samples on the family basis is represented in figures 2-4. A total of 3262 fish species weighing 4,057.8kg belonging to 17 families of 31 species were collected during the survey period.

The families comprised one or more species which differ in number from each other. The morphometric characters of the collected species revealed differences in length and body weight which is natural. Station III recorded the highest number of fish species totaling 2588 (79.33%), while station I had the least number of 324 (9.93%). *Liza grandisquamis* was the most abundant species as it recorded a total of 267 individual species in all the sampling stations.

From the index of preponderance, the most frequently occurring species in station III were *chrysichthys auratus* (71%), *Pseudotolithus elongatus* (0.40%) and *Chrysichthys nigrodigitatus* (1.10%). Station II recorded *Chrysichthys nigrodigitatus* (1.53%) *Pseudotolithus typus* (1.46%) and *Pseudotolithus elongatus* (0.44%) as the most frequently occurring species. *Chrysichthys auratus* (1.00%), *Chrysichthys nigrogiditatus* (0.64%) and *Pseudotolithus elongatus* (0.65%) were recorded as the most frequently occurring species in station 1. The least occurring fish species recorded was *Eleotris vitata* (0.001%) for station III, *Ethmalosa fimbriata* (0.001%) for station II and *Eleotris vitata* (0.02%) for the station I.

Analysis of variance of fish density at different stations, showed a higher density ($r = 230^0.08$ $P< 0.05$) at station III

and this varied significantly with the density at station I and station II respectively. Analysis of variance of the fish density on a monthly basis was high in the month of June (r = 152.00[a], $p< 0.05$). The analysis of fish density on a seasonal basis showed that the density was high at the wet season (r = 308.9[a], $P < 0.05$), but significantly different in the dry season (r = 74.3[b], $P< 0.05$).

Table 1: Species Composition, Size Range, Abundance and Index of Preponderance of Species in station 1 during the Period of Survey (March, 2020 to February, 2021).

Family/Specie	N	TL (cm) Min-Max	± SD	TW (g) Min-Max	± SD	% IP	% N	% W
Carangidae								
Caranx hippos	32	8.08-18.21	11.29 ± 1.50	17.28-58.18	29.40 ± 6.30	0.24	0.24	9.90
Trachinotus teraia	08	16.10-17.10	16.60 ± 0.50	195.40-211.40	203.40 ± 8.00	0.41	2.50	16.62
Trachinotus goreensis	20	4.75-8.05	6.02 v 0.70	6.18-9.45	8.02 ± 0.60	0.04	6.17	0.70
Eleotridae								
Eleotris senegalensis	13	23.18-25.10	24.14 ± 0.96	31.81-34.18	32.99 ± 1.20	0.11	4.01	2.70
Eleotris vitttata	12	6.01-8.01	7.01 ± 0.54	5.41-6.71	6.06 ± 0.65	0.02	3.70	0.50
Gobiidae								
Bathygobius soporator	13	23.18-25.10	24.14 ± 0.96	31.81-34.18	32.99 ± 1.20	0.11	4.01	2.70
Clupeidae								
Illisha Africana	29	10.39-21.38	16.9 ± 1.26	24.17 -47.38	32.60 ± 2.37	0.24	8.95	2.70
Odoxothrissa mento	04	7.28-8.00	7.64 ± 0.36	9.25-10.18	9.72 ± 0.47	0.010	1.23	0.80
Ethmalosa fimbriata	16	7.12-10.63	9.53 ± 0.54	14.18-16.10	14.60 ± 0.32	0.10	5.00	1.20
Mugilidae								
Liza grandisquamis	22	15.10-22.17	19.25 ± 0.95	34.02-48.18	41.93 ± 2.09	0.23	6.80	3.43
Mugil cephalus								
Trichiuridae								
Trichiurus lepturus	07	11.81-13.28	12.55 ± 0.51	39.51-48.20	44.67 ± 1.53	0.10	2.80	8.50
Malapteruridae								
Malapterurus electricus	09	8.71-11.71	10.57 ± 0.51	39.51-48.20	44.67 ± 1.53	0.10	2.80	3.65
Bothidae								
Citharichthys stampfi	08	09.01-10.01	9.43 ± 0.56	23.03-25.01	24.54 ± 0.52	0.10	2.50	2.01
Sciaenidae								
Pseudotholithus senegalensis	28	9.10-12.62	10.52 ± 0.42	25.38-36.20	31.03 ± 1.35	0.2	8.64	2.53
Psedotholithus elongathus	39	11.51-23.10	17.03 ± 1.20	45.02 -87.70	66.18 ± 4.56	0.65	12.04	5.41
Pseudotholithus typhus	13	18.16-22.01	20.50 ± 1.19	83.18-98.15	89.98 ± 4.41	0.30	4.0	7.40
Claroteidae								
Chrysichthys auratus	23	15.18-18.19	16.55 ± 0.31	125.30-218.20	173.50 ± 9.74	1.00	7.10	14.20
Bagrus docmack	08	06.18-8.32	7.10 ± 0.18	36.23-40.28	38.23 ± 0.18	0.08	2.50	3.12
Chrysichthys nigrodigitatus	13	28.17-39.81	35.23 ± 2.18	194.20 -200.12	197.17 ± 1.11	0.64	4.00	16.10
Cichlidae								
Tilapia zilli								
Σ	342						100.25	100.2

Source: Field Study, 2021

Table 2: Species Composition, Size Range, Abundance and Index of Preponderance of Species in station 2 during the Period of Survey (March, 2020 to February, 2021).

Family/Specie	N	TL (cm) Min-Max	± SD	TW (g) Min-Max	± SD	% IP	% N	% W
Carangidae								
Caranx hippos	22	9.01-10.13	*9.59* ± 0.29	19.18-23.48	22.31 ± 0.05	0.12	6.29	1.94
Trachinotus teraia	4	0.00-8.28	*8.28* ± 0.00	12.23-12.27	12.25 ± 0.54	0.01	1.14	1.07
Trachinotus goreensis	14	5.81-8.04	*6.93* ± 0.53	7.10 -8.08	7.46 v 0.22	0.03	4.00	0.65
Eleotridae								
Eleotris senegalensis	15	13.18-17.05	14.91 ± 1.01	35.38-40.35	38.51 ± 1.18	0.14	4.29	3.36
Eleotris vitttata	12	6.01-8.01	*7.01* ± 1.01	4.31-5.38	4.85 ± 0.54	0.01	3.43	0.42
Clupeidae								
Illisha Africana	27	12.40-24.28	20.01 ± 1.10	25.18-130.10	39.93 ± 10.92	0.27	7.71	3.50
Odoxothrissa mento	3	0.00-6.00	6.00 ± 0.00	7.18-8.18	8.08 ± 1.02	0.006	0.90	0.70
Pellonl leonennsis	32	9.10-11.72	10.52 ± 0.27	13.18 -19.20	16.06 ± 0.80	0.13	9.14	1.40
Ethmalosa fimbriata	2	0.00-5.18	5.18 ± 0.00	2.16-2.18	2.17 ± 1.00	0.001	0.57	0.19
Mugilidae								
Liza grandisquamis	34	18.18-25.11	21.86 ± 0.82	40.30-50.18	46.89 ± 1.14	0.40	9.71	4.10
Mugil cephalus	14	14.81-16.71	16.01 ± 0.60	49.18-58-18	54.89 ± 2.90	0.19	4.00	4.78
Ariidae								
Arius gigas	7	10.00-22.14	18.33 ± 2.80	37.20-80.18	59.21 ± 8.80	0.10	2	5.20
Cynoglossidae								
Cynoglossus senegalensis	8	19.18-26.01	22.79 ± 1.98	98.10-191.10	129.10 ± 1.00	0.25	2.29	11.25
Sciaenidae								
Pseudotholithus senegalensis	18	11.08-20.19	13.31 ± 1.40	30.18-88.70	41.60 ± 9.51	0.18	5.14	3.62

Psedotholithus elongathus	25	17.13-28.10	21.02 ± 1.52	48.70-80.18	71.65 ± 4.93	0.44	7.14	6.24
Pseudotholithus typhus	19	20.34-23.01	21.29 ± 0.60	93.18-100.31	97.51 ± 1.51	0.46	5.43	8.50
Claroteidae								
Chrysichthys auratus	31	17.18-20.18	18.55 ± 0.31	145.30-238.20	193.50 ± 9.74	1.50	8.86	16.90
Bagrus docmack	27	08.00-10.78	09.18 ± 0.96	48.20-53.32	50.32 ± 0.56	1.50	8.86	16.90
Chrysichthys nigrodigitatus	29	38.18-50.38	44.67 ± 1.80	232.10-328.10	212.68 13.81	1.53	8.29	18.53
Cichlidae								
Tilapia zilli	7	18.10-20.30	19.20 ± 1.10	31.10-40.34	35.72 ± 4.62	0.06	2.0	3.11
Σ	**350**						**100.04**	**100.11**

Source: Field Study, 2021

Table 3: Species Composition, Size Range, Abundance and Index of Preponderance of Species in station 3 during the Period of Survey (March, 2020 to February, 2021).

Family/Species	N	TL (cm) Min-Max	± SD	TW (g) Min-Max	± SD	% IP	% N	% W
Carangidae								
Caranx hippos	107	7.21-10.71	9.83 ± 0.3	18.19 -26.50	24.02 ± 0.30	0.06	4.13	1.43
Trachinotus teraia	93	7.90-11.21	9.30 ± 0.33	14.17-18.58	16.58 ± 0.58	0.04	4.00	0.98
Trachinotus goreensis	86	7.04-9.98	8.20 ±0.32	6.42-9.08	7.15 ± 0.29	0.01	3.32	0.42
Malapteruridae								
Malapterurus electricus	68	0.00-13.20	13.20 ± 0.00	0.00-52.00	52.00 ± 0.00	0.08	2.63	3.08
Eleotridae								2.32
Eleotris senegalensis	90	14.18-17.25	15.81 ± 0.33	4.20 -40.64	34.95 ± 4.44	0.07	3.50	2.07
Eleotris vitttata	10	8.9-9.10	8.96 ± 0.05	4.18-4.38	4.28 ± 0.10	0.001	0.40	2.05
Gobiidae								2.05
Bathygobius soporator	45	14.80-29.10	22.48 ± 3.12	31.38-38.10	34.51 ± 1.23	0.04	1.74	2.05
Mochokidae								7.73
Synodontis omias	10	4.60-48.10	26.35 ± 21.75	5.28-25.30	130.29 ± 125.01	0.03	0.40	7.73
Schilbedae								
Schilbe mytus	0.8	0.00-3.20	3.20 ± 0,00	0.00-5.31	5.31 ± 0.00	0.009	0.31	0.32
Clupeidae								4.79
Illisha Africana	198	18.18-31.13	23.81 ± 1.18	28.15-59.30	36.51 ± 3.16	0.2	7.65	2.17
Odoxothrissa mento	74	1.79-15.10	6.09 ± 1.72	10.18 -48.10	19.04 ± 4.72	0.03	2.90	1.13
Pellonua leonennsis	46	4.41-6.81	5.50 ± 0.46	1.85-13.01	10.28 ± 2.16	0.08	2.32	3.44
Ethmalosa fimbriata	134	3.40-12.40	10.33 ± 0.83	13.29-20.58	16.05 ± 0.84	0.05	5.20	0.95
Mugilidae								6.57
Liza grandisquamis	211	18.91-30.20	24.15 ± 1.06	41.28-65.81	52.79 ± 2.06	0.3	8.20	3.13
Mugil cephalus	60	8.46-18.30	15.60 ± 1.48	49.81 – 64.28	58.04 ±2.16	0.08	2.32	3.44
Ariidae								6.61
Arius gigas	05	0.00-18.78	18.78 ± 0.00	0.00-48.28	48.28 ± 0.00	0.006	0.20	2.86
Arius heudeloti	116	17.52-22.81	20.90 ± 0.65	45.82-70.18	63.24 ± 2.25	0.2	4.50	3.75
Cynoglossidae								5.80
Cynoglossus senegalensis	86	18.10-27.15	24.70 ± 1.15	78.28 -105.10	98.68 ± 3.55	0.02	3.32	5.86
Trichiuridae								
Trichiurus lepturus	71	10.98-16.18	14.30 ± 0.67	48.10-67.31	54.27	0.09	3.00	3.22
Bothidae								
Citharichthys stampfi	67	11.30-13.10	12.47 v 0.30	19.05-38.05	26.54 ± 2.84	0.05	3.00	1.57
Lutjanidae								
Lutjanus goreensis	87	9.10-25.10	11.94 ± 1.89	17.38-31.80	20.34 ± 1.70	0.04	3.40	1.21
Haemulidae								
Pomadasys jubelini	36	8.18-12.01	10.34 ± 0.70	19.41-33.18	26.78 ± 2.65	00.02	1.40	1.59
Sciaenidae								
Pseudotholithus senegalensis	126	9.20-15.50	12.93 ± 0.70	30.18-40.60	34.23 ±1.15	0.10	4.90	2.03
Psedotholithus elongathus	178	17.21-98.12	31.00 ± 8.51	83.18-94.70	87.76 ± 1.38	0.40	6.90	5.21
Claroteidae								
Chrysichthys auratus	147	19.20-24.18	21.55 ± 0.48	158.15-252.10	208.70 ± 10.19	0.71	5.70	12.38
Bagrus docmack	74	14.18-15.38	14.54 ± 6.23	49.21-65.28	61.60 ± 2.50	0.11	2.90	3.65
Chrysichthys nigrodigitatus	173	25.10-53.50	48.31 ± 2.14	52.18-352.10	269.75	1.10	6.70	15.99
Cichlidae								
Tilapia zilli	13	22.00-26.40	24.20 ± 2.20	34.21-42.34	38.28 ± 4.07	0.01	0.50	2.27
Tilapia goreensis	15	0.00-12.10	12.10 ± 0.00	0.00-17.01	17.00 ± 0.00	0.006	0.60	1.01
Tilapia mariae	10	0.00-21.10	21.00 ± 0.00	0.00-28.20	28.20 ± 0.00	0.007	0.40	1.67
Σ	**2588**				**1685.99**		**101.52**	**97.92**

Table 4: Analysis of Variance for Fish Density at various Stations in Lower Imo River Estuary

Stations	Fish Density
III	230.08[a]
I	32.33[b]
II	34.38[b]
LSD	52.54
P	0.05

* Means with the same subscripts are not significantly different.
Source: Field Study, 2021.

Table 5: Analysis of Variance for Fish Density at Lower Imo River Estuary on a Monthly Basis

Months	$\bar{X}$
January	39.67[b]
February	45.00[b]
March	40.67[b]
April	125.67[ab]
May	117.67[ab]
June	152.00[a]
July	141.33[ab]
August	123.33[ab]
September	124.33[ab]
October	104.33[ab]
November	118.00[ab]
December	57.00[ab]
LSD	105.08
P	0.05

*Means with the same subscripts are not significantly different.
Source: Field Study, 2021.

Table 6: Analysis of Variance for Fish Density at Lower Imo River Estuary on Seasonal Basis

Season	x
Wet	308.9[a]
Dry	74.3[b]
LSD	604.77
P	0.05

*Means with the same subscripts are not significantly different.
Source: Field Study, 2021.

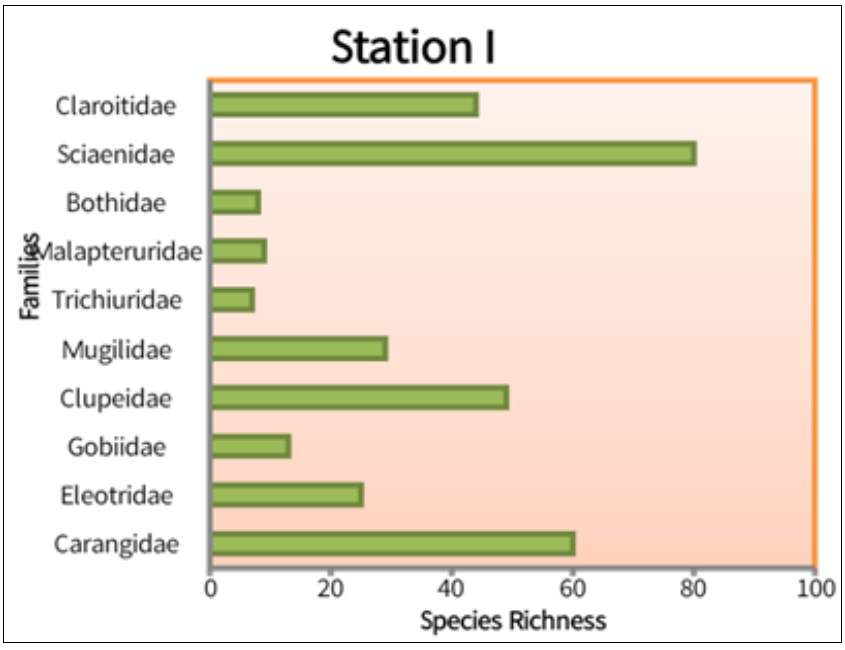

Fig 2: Species Richness for Fish Families is Station I of Imo River Estuary

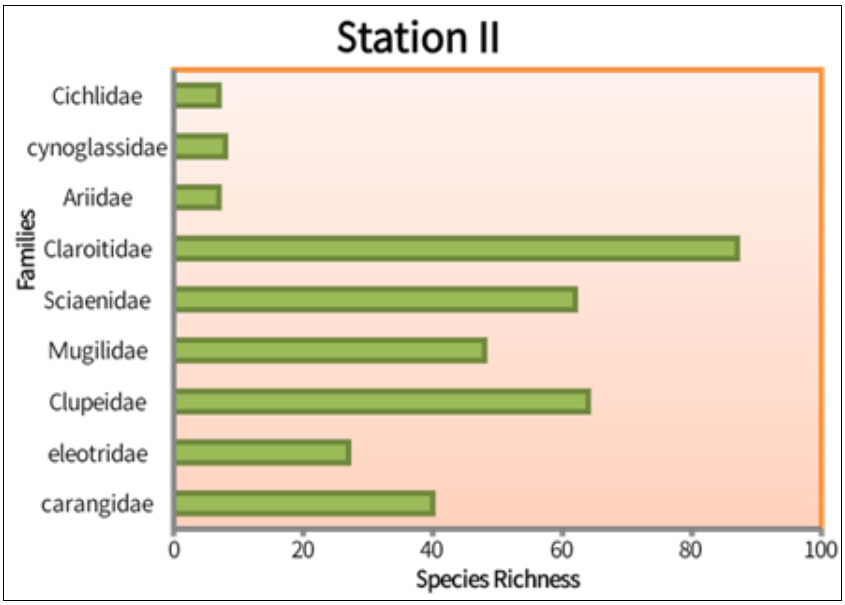

Fig 3: Species Richness for Fish Families is Station II of Imo River Estuary

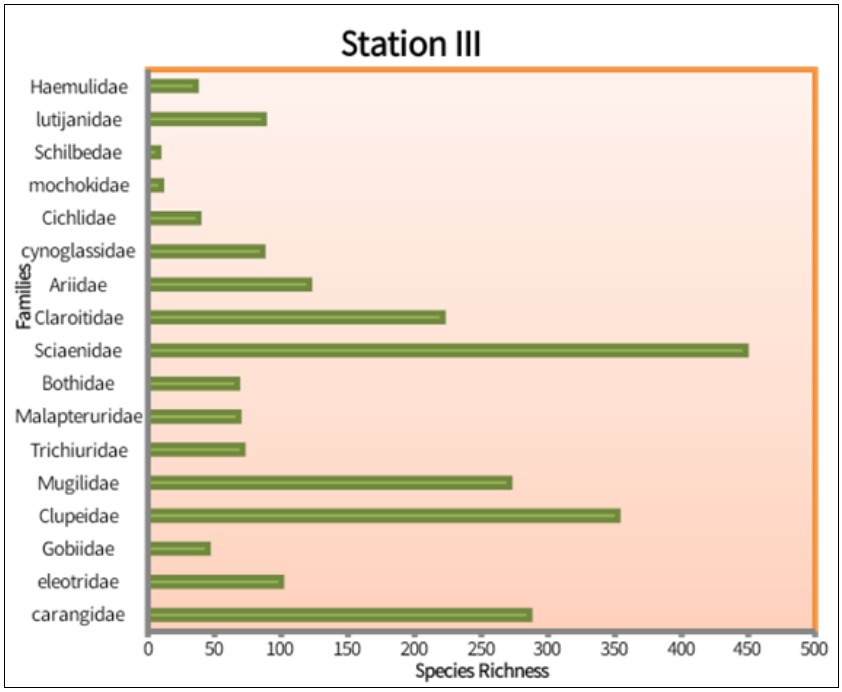

Fig 4: Species Richness for Fish Families is Station III of Imo River Estuary

4. Discussion

The composite baseline survey of Ichthyofaunal assemblage in a segment of Lower Imo River estuary, Niger Delta Region, Nigeria revealed an assemblage comprising of 17 families. The species distribution was found to be determined by the natural settings of the system coupled with other factors (Nwadiaro, 1989, Gaines *et al.*, 2009, Udoidiong and King, 2010 and David *et al.*, 2016) [36, 21, 42, 13]. The presence of a variety of dietary items and increased habitats could be linked to species richness in the system (Nwadiaro, 1989, Gaines *et al.*, 2009, Negi, *et al.*, 2013 and David *et al.*, 2016) [36, 21, 35, 13]. Also, its linkage to the Atlantic Ocean, may also account for its species richness and also the presence of some intrusive species (Essen, 1990) [17]. The fish species abundance in this study area could be linked to increased habitats availability and also due to the presence of various dietary materials. This agrees with the report of (Nwadiaro, 1989, Akpan, 2006 and Negi, *et al.*, 2013) [36, 7, 35] which the opined that fish species were distributed by order and increased with stream size. Adaka *et al.*, 2010; 2014 and Bonjoru *et al.*, 2016 attributed the abundance of fish species with river order and ability to utilize various sources of energy [2, 3, 11].

The Lower Imo River estuary was observed to be housed by three types of fish species. Freshwater species, brackish water species and marine water species; Vakily (1992) [43] observed that some freshwater fishes moved into the estuarine water (brackish). This includes *chrysichthys* species. These fishes exhibited tolerance of the brackish water and are probably euryhaline in nature. The typical brackish water fishes at the estuary included *Ethmalosa fimbriata* and *Illisha* Africana. Welcome (1985; 1986) [44, 45], reported that the species living in the estuary comes from different sources, which include; the freshwater stenohaline species which enter the zone during the flood, marine stenohaline species which live within the zone permanently. It listed the euryhaline fishes of marine

origin to include the families; Clupeidae, Muglidae, Lutjamidae, Sciaenidae, Arridae and Caranfidae. All these families were found in the Lower Imo River estuary.

The preponderance of some families in terms of species diversity, number and weight could be explained by the presence of high food resources (Komolafe and Arawomo, 2008) [33], prolific breeding capabilities and strong adaptation to the prevailing environmental conditions in the aquatic system (Onuoha *et al.*, 2010) [38]. Dike and Agunwamba (2012) [14], reported that estuaries are highly productive zones which benefits fisheries by providing nursery grounds and also open large feeding groups to adult fishes. This assertion might account for the numerous species recorded during the study. The low species diversity as observed in some species might be linked to their low rate of breeding, fluctuations in the environmental conditions which could be less suitable for the species, migration and over-exploitation of the species (Adite *et al.*, 2006) [4]. Seasonal variation occurred in the number of specimens collected, with more specimens during the rainy season than in the dry season. The rainy season is considered to be the feeding period when fish utilize the expanded feeding areas, due to the inundation as a result of the surface-run offs. Also, more allochthonous food materials and nutrients are brought into the habitat.

King (1989) [31] found a positive correlation which corroborated with the assertion that feeding intensity increase with food availability. It has been reported that many tropical freshwater fishes have a broader trophic spectrum during the rains, high species preponderance/dominance during the rainy season (Welcomme, 1985, Akpan, 2006) [44, 7]. There were high species richness and diversity. As the stream order increases, diversity also increases. This is attributed to increase living space leading to an increased number of microhabitats (Udoidiong and King, 2010) [42].

The commercial species of importance in Lower Imo River include*; Chrysichthys auratus, Chrysichthys nigodigitatus, Bagrus docmack*. The fishery of the area could be said to be based on the family Bagridae and Sciaenidae. Fish species composition of the Lower Imo River estuary compares with that of other Nigerian aquatic system, (Abowei *et al.*, 2008, Allison and Okadi, 2009 and Akpan, 2013) [1, 9, 8].

The aquatic system is endowed with a rich aquatic bio-faunal assemblage of fish species, which varied from species to species, and families to families, which could boost foreign exchange and contribute to subsistence levels in terms of fishery and fishery products, if properly managed.

5. Conclusion

Presently, Lower Imo River Estuary is made up of major fisheries which sustain the livelihoods of its dependents, and as such, is a viable source of the fishery. The rapidly increasing population and other human factors, as was observed during the study, are potential negative impacts on the ecosystem, which will invariably affect the fishery. Therefore, a management plan must be established, which should be fully strategized with a view of preventing a collapse of the fishing and its attendant socio-economic benefits, especially owing to the fact that the fisheries operate basically on free and open-access. The results recorded in this research is an eye-opener to the need of further studies on this ecosystem and similar ecosystems.

6. References

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