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Impacts of Anthropogenic Activities on the Fish Compositions and Diversity of Okerenkoko Estuarine, Delta State, Nigeria

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ABSTRACT

Water quality impairment due to anthropogenic activities affects fishery resources. Surface water bodies in the Niger Delta Region of Nigeria are being adversely impacted by the effects of pollution and the destruction of its fishery resources. This study was carried out to assess the impacts of anthropogenic activities on the fish compositions and diversity of Okerenkoko Estuarine, Delta State, Nigeria. Okerenkoko Estuarine (62.79 Km) was spatially stratified into five stations (Z1, Z2, Z3, Z4 and Z5) based on nearness to major anthropogenic activities. Temporal stratification covered June to December. Fish samples were collected for 7 months from each station at the study area with prior arrangement with the fishers. Fishing gears used were Mid – Water Drift Gill Net of mesh sizes 101 mm and 127 mm; Bottom Set Gill Net (50 – 100 m) of mesh size 76 mm, 101 mm and 127 mm; Hook and line (2 – 6 m) of hook sizes No. 5, No. 7, No. 8, No. 9, No. 12 and No. 15; Long Line (300 – 1000 m) of hook sizes No. 7, No. 8. Parameters determined were Numbers of Species, Abundance (%), Simpson and Shannon by using standard procedures. Data were analysed by using Excel (Window 10) and Palaeontological Statistics (Past Version 3.6). A total number of 1261 of fishes and 45 species belonging to 14 families were identified. Highest 383 (30.4 %) and least 152 (12.1 %) number of fishes were obtained in Z5 and Z4, respectively. The most abundant fish species recorded was *Sardinella aurita* 192 (15.2 %), while the least was *Sphyraena afra* 1 (0.1 %), respectively. Temporally, the highest 331 (26.2 %) and least 45 (3.6 %) fish species Occurred in December and September. Simpson index ranged from 0.69 to 0.89 in Z1 and Z3, Shannon (1.97, 2.98) occurred in Z4 and Z2, respectively. Fish biodiversity richness (0.69) of Okerenkoko Estuarine could be threatened.

Keywords: Water quality, Anthropogenic activities, Fishing gears, Niger Delta and Pollution.

1. INTRODUCTION

The coastal environment

The coastal ecosystem is known as the interface between three habitable environments which are: the earth, air and sea (Egorge 2010). All coastal area contains at least two major habitats which are the (i) marine time zone and (ii) sea itself (Egborge 2001; Olaifa, 2003; Ogaga *et al*. 2015a). Ohimain *et al.*, (2008a) reported that a combination of the increasing pollution, agricultural modernisation and human population largely hampered the productivity of coastal waters. Industrial effluent is one of the main sources of aquatic pollution in Nigeria Ohimain *et al.*, (2008b). Discharged of industrial effluents directly into the aquatic environment without treatment have the capacity of increasing water quality parameters abnormally Ohimain, (2002); Ogaga *et al*., (2015a). This has led to excessive load of inorganic metals (Pb, Cr and Fe) in most water bodies (Nodu and Ohimain, 2014). The resultant impacts on the receiving water bodies include be reduction in the abundance and diversity of flora and fauna species and water quality impairment (Ohimain, 2008).

High phosphate levels in these effluents may lead to a rise in nutrients in the receiving water bodies thereby leading to ecological disaster (Ewutanure and Olaifa, 2018a). The Marine, Estuarine and Freshwater ecosystem of Nigeria is endowed with abundant fisheries resources (Ita, 1993). Nigeria has eight coastal states which include: Ogun; Lagos; Ondo; Delta; Bayelsa; Akwa-Ibom and Cross River States (Ewutanure and Olaifa, 2017). The activities of the oil companies within the Niger – Delta Region of Nigeria have drastically reduced its surface water quality (Olaifa *et al.* 2019). This has led to water scarcity and poor aesthetic value.

Most of the Estuaries and rivers within the Niger – Delta Region of the country cannot be treated for both aquaculture and drinking purposes because of the impact of oil pollution (Ewutanure and Olaifa, 2018b). The decline in fisheries resources of Nigeria could be linked with over exploitation and inadequate management of her coastal waters (Ogbeibu and Ezeunara, 2002). For sustainability of these resources, an adequate knowledge of species compositions and abundance of her water bodies must be recognised and be deliberately pursued.

The establishment of industries and urban development along the shores of surface water may injected large volume of organic and inorganic wastes into its water (Ewutanure and Olaifa, 2021). Increase urbanisation and industrialization, non – standard town planning system and inadequate regulation and enforcement activities could serve as means for the release of untreated effluents into the aquatic environment and its adjoining tributaries. The people of Okerenkok Communities rely on the Estuarine for fishing activities and as a major source of transportation.

But oil exploitation, dredging, reclamation, sand mining and waste water disposal are the main anthropogenic activities carried out in the Niger Delta Region (Aghoghovwia *et al.* 2015b). The main anthropogenic activities in most coastal communities of the Niger Delta Region is oil exploration which include seismic exploration, drilling and completion, construction, installation and operation of production facilities such as flow stations, compressor stations, gas plants and pipelines (Aghoghovwia, 2008).

Effluents from the production facilities are being constantly discharged into Okerenkok Estuarine, while gas flaring has continued uncontrollably. Solid wastes from artisanal refineries equally release effluents into the estuarine. In Okerenkok Estuarine, oil spillage is a common phenomenon, while Ogaga *et al.*, (2015b) was of the opinion that this could result in the death of flora and fauna abundance in a water body. Ewutanure and Olaifa, (2017) reported that the presence of oil and gas infrastructure, oil spills are now increasing in the Niger Delta due to illegal oil bunkering and artisanal refineries.

Fisheries resources of Delta State

Olaifa, (2004) reported some fisheries resources of Delta State to include four main types which include: The coastal pelagic fishery with some of its catches as *Ethmalosa fimbriata* (bonga), *Ilisha africana* (shad), *Sardinella eba*; Freshwater fishery with some of its compositions as *Clarias gariepinus, Oreochromis niloticus, Xenomystus nigri, Hemisynodontis membranaceous, Malapterurus electricus, Siluranodon auritus* and *Hepsetus odoe;* Coastal demersal fishery with some of the catches as *Pseudolithus typpus* and *P. brachygnathus* (croakers), *Chrysichthys nigrodigitatus, Arius* sp.; *Cyanoglossus goreensis* (sole), *Luthjanus* sp. (snappers); *Polydactylus quadrifilis* (shiny nose) and the Cray fish fishery. The presence of a standing crop of penaeids shrimps off coast of Delta State has been reported (Idodo – Umeh, 2004).

Artisanal fishers harvest large size penaeids and Palaemonids shrimps but the largest crustaceans caught are the tiny *Carideid* shrimps (Palaemonidae) and the juveniles of *Penaeus notialis* that breeds in the sediment rich estuarine and brackish mangrove swamps (Ogaga *et al.* 2015b). The species are usually smoked dried and commonly referred to as crayfish in Nigeria.

Reasons for decline in fish yield

An estimated 40% of the total protein in – take of Nigerians is obtained from fish (Olaifa, 2015). It has been reported that surface water bodies are the most endangered ecosystem (Ewutanure and Olaifa, 2017). In most parts of the world, inland water ecosystems are over fished and are mostly degraded by the devastating effects of pollution (Baran and Guerin, 2014). With respect to population explosion and rise in technology, decrease in the abundance and fish diversity are fast becoming a major concern.

Habitat alteration and loss, climatic changes, surface water pollution, invasive species and over exploitation of the fishery resources are some of the factors responsible for the decline in fish species abundance in the inland water bodies of Nigeria (Olaifa, 2006). The coastal areas are subject to the negative effects of anthropogenic activities. Industrial waste may contain heavy metals such as copper, zinc, lead, cadmium, nickel, chromium and iron which may be toxic to fish and eventually bio – accumulate in man through the food chain.

Aghoghovwia *et al.,* (2015a) linked the decline in fisheries resources of the Niger Delta to oil and gas exploration in the area. A comparison of the fish fauna of Okerenkok Estuarine and some inland river such as Warri River, Ase, Ogun and Niger/Benue show that these water bodies have wide variety of fish species diversity. Fish fauna of Nigerian freshwater bodies has been the major focus of research for quite sometimes (Ogaga *et al.* 2015), while the paucity of information on the fisheries resources of Okerenkoko Estuarine, birthed this research into the determination of its fish species compositions and diversity.

2. MATERIALS AND METHODS

Description of the Study Area

Okerenkok Estuarine is located within latitudes 5°30′0″N and 5°50′0″N of the Equator and Longitudes 5°10′0″ E and 5°40′0″ E of the Greenwich meridian (Figure 1). Its source is the Eschravos River. It situated in Warri – South Local Government Area of Delta State, Nigeria. Okerenkoko Estuarine with an average depth of 35 m is 62.79 Km long. Okerenkoko Estuarine was spatially stratified into five stations (Z1, Z2, Z3, Z4 and Z5) based on closeness to major anthropogenic activities. Temporal stratification covered June to December. Fish samples were collected for 7 months from each station at the study area with prior arrangement with the fishers. Collected fish samples were identified to species level, counted and recorded by using standard keys (Boulenger, 1909 – 1916; Hoden and Reed, 1972; Idodo – Umeh, 2003). Fish were caught using Mid – Water Drift Gill Net of mesh sizes 101 mm and 127 mm; Bottom Set Gill Net (50 – 100 m) of mesh size 76 mm, 101 mm and 127 mm; Ita Trap (7 – 15 m) of mesh sizes 12.5 mm, 24 mm, 25 mm, 76 mm, 127 mm and 144 mm; Ngo Trap (5 m) of mesh size 12 mm; Stone Trap (5.7 m) of mesh sizes 12 mm, 24 mm, 48 mm; Gura Fishing Trap (1 m) of mesh sizes 12 mm, 24 mm, 48 mm; Shore net gill net (30 – 100 m) of mesh sizes 24 mm and 62 mm; Tilapia Cast net of mesh sizes 76 mm, 101 mm and 127 mm; Surface Bonga Drift Net (100 – 500 m) of mesh sizes 40 mm, 52 mm and 64 mm; Bottom Drift Gill Net (50 – 100 m) of

mesh sizes 64 mm, 76 mm and 125 mm; Beach Seine net (50 – 200 mm) of mesh sizes 25 mm, 38 mm, 50 mm, ply 18 and 3b; Cast Net (3 – 7 m) of mesh sizes 38 mm, 50 mm, 62 mm and 76 mm; Hook and line (2 – 6 m) of hook sizes No. 5, No. 7, No. 8, No. 9, No. 12 and No. 15; Long Line (300 – 1000 m) of hook sizes No. 7, No. 8, No. 9, No. 12 and No. 15, respectively.

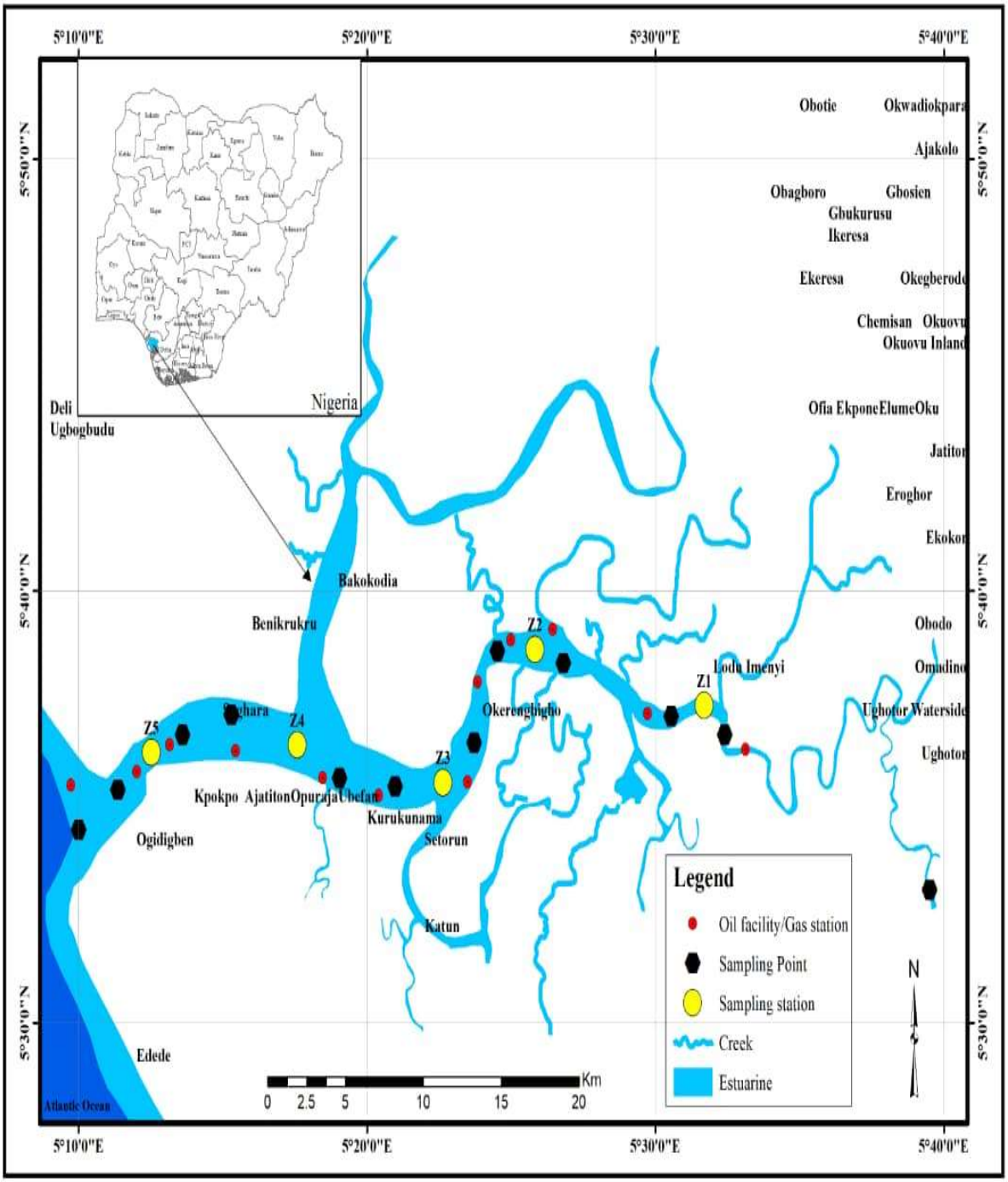

Figure 1. Map of Okerenkoko Estuarine
Source: Ewutanure, (2021)

Diversity index calculated

Margalef's Diversity Index

$Ri = \frac{S-1}{\ln(N)}$ Margalef, (1958)

S = Total number of species, N = Total density of species.

Simpson's index (S_i) = 1 – Dominance. It is a measurement of evenness

$\mathrm{Si} = \frac{D}{Dmax}$ Llody, 1964

S_i measures the evenness/richness of the community from 0 – 1,

D = Species diversity, Dmax = Maximum amount of the species' diversity index

Shannon-Wiener Index

$H' = -\sum_{i=1}^{n} Pi\ log2Pi$ Shannon and Weaver, 1949

It takes into account the number of individuals as well as the number of taxa. It varies from 0 (community with only a single taxa) to high values (community with many taxa) each with few individual. n = Total number of species I, P_i = Ratio of the species i.

Statistics

The data were analysed using Excel (Window 10 and Palaeontological Statistics (Past, version 3.6).

3. RESULTS

The results of fish species abundance and distribution among Stations and Months are presented in Tables 1 and 2, while Species diversity index are shown in Table 3, respectively. A total of 1261 number of fishes comprising 14 families and forty – five (45) fish species were identified during the study. Stations Z5 recorded the highest 383 (30.4 %) followed by Z3 264 (20.9 %), while Z1 and Z2 recorded same 231 (18.3 %) number of fishes, respectively. Spatially, the most abundant fish species recorded was *Sardinella aurita* 192 (15.2 %) followed by *Ethmalosa fimbriata* 62 (4.9 %), while the least was *Sphyraena afra* 1 (0.1 %), respectively.

Sardinella aurita 260 (20.6 %) and *Sphyraena afra* 2 (0.2 %) were recorded as the highest and least fish species in December and October, respectively. The highest number of fishes were recorded in December 331 (26.2 %) followed by November 244 (19.3 %), August 233 (18.5 %), July 229 (18.2 %), while the least occurred in September 45 (3.6 %), respectively. Simpson index ranged from 0.69 to 0,89 in Z1 and Z3, Shannon (1.97, 2.98) occurred in Z4 and Z2, Evenness (0.31, 0.85) were obtained in Z3 and Z1, Margalef (1.41, 2.91) were obtained in Z1 and Z3, respectively.

Table 1. Abundance and distribution of fish species in Okerenkoko Estuarine among Stations

		Stations						
Families	Species	Z1	Z2	Z3	Z4	Z5	Total	Percentage
Sparidae	*Diplodus carvinus*	3	6	9	4	3	25	2.0
	D. puntazzo	3	9	5	9	7	33	2.6
	D. sarqus	1	6	3	1	3	14	1.1
	Pagellus bagaravo	3	4	3	3	0	13	1.0
	Pagrus pagrus	11	7	4	6	7	35	2.8
Sciaenidae	*Pseudotolithus enlonagutus*	9	7	6	2	3	27	2.1
	P. typus	9	7	3	1		20	1.6
	P. senegalensis	1	1	3	5	0	10	0.8
Polynemidae	*Galeoides decadactylus*	9	6	12	1	0	28	2.2
	Pentanemus quinquarius	5	6	7	2	1	21	1.7
	Polydactylus quadritilis	2	7	10	4	1	24	1.9
Scombridae	*Scomberus totor*	4	3	4	7	3	21	1.7
	Euthynnus alleteratus	7	2	5	1	0	15	1.2
	Katsuwonus palamis	7	5	3	1	1	17	1.3
Lutjanidae	*Lutjanus agennes*	7	5	6	2	0	20	1.6
	L. dentatus	4	1	2	6	7	20	1.6
	L. endecacanthus	1	0	7	4	10	22	1.7
Ariidae	*Arius gigas*	10	19	16	0	5	50	4.0
	A. heudeiot	1	5	6	7	3	22	1.7
	A. laticutatus	4	9	11	8	5	37	2.9
Cynoglossidae	*Cynoglossus brown*	3	12	15	11	7	48	3.8
	C. cadenati	1	9	4	1	3	18	1.4
	C. senegalensis	3	8	3	3	0	17	1.3
	Symphurus normani	11	7	4	6	7	35	2.8

Table 1. Abundance and distribution of fish species in Okerenkoko Estuarine among Stations Cont'd

Families	Species	Stations					Total	Percentage (%)
		Z1	Z2	Z3	Z4	Z5		
Soleidae	*Monochirus hispidus*	6	9	1	2	0	18	1.4
	Pequsa cadenati	12	10	1	1	2	26	2.1
	P. lascoris	13	9	5	6	3	36	2.9
Mugiledae	*Mugil bananasis*	0	1	5	3	10	19	1.5
	M. cephalus	20	1	2	3	20	46	3.6
	M. curema	3	1	4	5	1	14	1.1
	Liza dumerilli	2	3	6	0	9	20	1.6
Clupeidae	*Ilisha Africana*	1	1	1	3	2	8	0.6
	Pollonula leonensis	9	4	5	2	11	31	2.5
	Ethmalosa fimbriata	4	6	3	6	43	62	4.9
	Sardinella aurita	1	15	19	7	150	192	15.2
Carangidae	*Caranx crysos*	23	5	50	9	8	95	7.5
	C. hippos	8	2	7	2	35	54	4.3
	C. latus	9	10	1	6	11	37	2.9
Sphyrangidae	*Sphyraena afra*	0	0	0	1	0	1	0.1
	S. barracuda	0	3	1	0	2	6	0.5
	S. quachancho	1	0	2	1	0	4	0.3
Total		231	231	264	152	383		
Percentage		18.3	18.3	20.9	12.1	30.4		

Table 2. Monthly abundance and distribution of fish species in Okerenkoko Estuarine

Families	Genus & Species	Catch per month							Total	%
		Jun	Jul	Sep.	Aug	Oct.	Nov.	Dec.		
Sparidae	*Diplodus carvinus*	5	12	14	7	4	0	0	42	3.3
	D. puntazzo	4	13	14	10	7	0	0	48	3.8
	D. sarqus	2	10	3	1	2	0	0	18	1.4
	Pagellus bagaravo	3	9	3	1	0	0	0	16	1.3
	Pagrus pagrus	12	10	4	3	1	0	0	30	2.4
Sciaenidae	*Pseudotolithus enlonagutus*	10	15	5	1	2	0	0	33	2.6
	P. typus	7	8	4	1	0	0	0	20	1.6
	P. senegalensis	2	2	4	2	1	0	0	11	0.9
Polynemidae	*Galeoides decadactylus*	9	10	12	1	0	0	0	32	2.5
	Pentanemus quinquarius	5	7	8	1	2	0	0	23	1.8
	Polydactylus quadritilis	3	14	12	2	0	0	0	31	2.5
Scombridae	*Scomberus totor*	5	4	5	3	0	0	0	17	1.3
	Euthynnus alleteratus	6	4	7	0	2	0	0	19	1.5
	Katsuwonus palamis	4	2	4	2	0	1	2	15	1.2
Lutjanidae	*Lutjanus agennes*	5	4	7	3	1	0	1	21	1.7
	L. dentatus	6	0	0	5	4	1	3	19	1.5
	L. endecacanthus	0	2	9	6	9	0	0	26	2.1
Ariidae	*Arius gigas*	9	21	11	4	1	0	0	46	3.6
	A. heudeiot	0	1	12	1	2	0	0	16	1.3
	A. laticutatus	0	10	13	0	1	0	0	24	1.9
Cynoglossidae	*Cynoglossus brown*	0	10	12	0	1	0	0	23	1.8
	C. cadenati	1	12	13	0	2	0	0	28	2.2
	C. senegalensis	0	10	13	0	0	0	0	23	1.8
	Symphurus normani	1	11	10	1	0	0	0	23	1.8

Table 2. Monthly abundance and distribution of fish species in Okerenkoko Estuarine cont'd

		Catch per month								
Families	Genus/Species	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
Soleidae	*Monochirus hispidus*	2	6	9	1	2	0	0	20	1.6
	Pequsa cadenati	4	10	11	2	0	0	0	27	2.1
	P. lascoris	13	12	14	3	1	0	0	43	3.4
Mugiledae	*Mugil bananasis*	0	0	0	0	0	13	21	34	2.7
	M. cephalus	0	0	0	0	0	30	35	65	5.2
	Liza dumerilli	0	0	0	0	0	13	14	27	2.1
Clupeidae	*Pollonula leonensis*	0	0	0	0	0	11	10	21	1.7
	Ethmalosa fimbriata	0	0	0	0	0	0	1	1	0.0
	Sardinella aurita	0	0	0	0	0	110	150	260	20.6
Carangidae	*Caranx crysos*	0	0	0	0	0	15	25	40	3.2
	C. hippos	0	0	0	0	0	35	21	56	4.4
	C. latus	0	0	0	0	0	10	20	30	2.4
Sphyrangidae	*Sphyraena afra*	0	0	0	0	0	0	2	2	0.2
	S. barracuda	0	0	0	0	0	2	4	6	0.5
Drepamidae	*Catemo Africana*	0	0	0	0	0	3	11	14	1.1
Monodactytidae	*Pseltias sebae*	0	0	0	0	0	0	12	12	1.0
	Total	118	229	233	61	45	244	331		
	Percentage	9.4	18.2	18.5	4.8	3.6	19.3	26.2		

Table 3. Diversity indices of sampled fish species of Okerenkoko Estuarine

Parameters	Z1	Z2	Z3	Z4	Z5
Individuals (N)	231	231	264	152	383
Simpson (1-D)	0.68	0.81	0.89	0.85	0.88
Shannon (H)	2.08	2.98	3.81	1.97	2.54
Evenness (E)	0.31	0.63	0.85	0.66	0.73
Margalef	1.41	2.45	2.91	2.42	1.99

4. DISCUSSION

The responses of aquatic fauna to increasing pollution varies (Ewutanure and Olaifa, 2017). Changes in water quality caused by industrialization and technological development, are known to affect fish and other aquatic communities (Ohimain 2009). The overall number of species (1261) recorded in all the 5 stations during the study was higher compared with 34 and 91 species earlier reported by Ogaga *et al.*, (2015b), Agada (1994) for Warri River. The number of species recorded was also higher than 58 species documented for flood plain rivers in Africa by Welcome (1979).

The increase in the number of fish species could be attributed to the constant flow of the Estuarine into the Atlantic Ocean as well as high amount of rainfall which to a great extent cause dilution of anthropogenic effluents along its course (Ewutanure and Olaifa, (2018a). Fish species that are unable to withstand the pollution effects of the Estuarine may die off or migrate to a more favourable environment, while those that can withstand the pollution effects survive (Ewutanure and Olaifa, 2018b).

The two similarity indices computed to compare fish species from the five stations showed that there was a remarkable dissimilarity among the stations in the study area (Ogaga *et al.* 2015b). The highly crude oil impacted (Station Z4) recorded the least species diversity. This may be linked with the uncontrolled discharge of toxic effluents by the petroleum industries which could be responsible for water quality impairment and the destruction of estuarine fisheries resources (Olaifa, 2006). Constants flow, higher amount of rainfall and tidal action might have been reasons for the relatively high diversity index recorded at Z3, Z2 and Z5, respectively. Similarly, Stations Z3 and Z2 with the highest diversity index could be associated with minimal anthropogenic activities in the study area.

5. CONCLUSION

Okerenkoko Estuarine is a major source of fish protein for the dwellers living along its course. This study revealed that oil and gas exploration, dredging, reclamation and effluents discharge may be responsible for the fluctuation in fish species diversity and number in Okerenkoko Estuarine. An overview of this work shows that the sources of pollution of the Okerenkoko Estuarine are linked with anthropogenic activities (petroleum industries). The accumulation of anthropogenic effluents may have contributed to the changes in its fish composition, abundance and diversity of Okerenkoko Estuarine.

From the results of this study, it is therefore paramount to have the understanding of the social, economic and environmental consequences of the impact of pollutants on the Okerenkoko aquatic biota. It is expedient to control the amount and quality of effluent that enters the estuarine so as to avoid incessant pollution that could threaten its biodiversity.

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