SPATIAL RHYTHM AND PERIODIC PATTERN OF FISH SPECIES IN ENIONG RIVER, SOUTH EASTERN NIGERIA

Abstract

The spatial rhythm and periodic pattern of fish species was studied in lower and upper streams in Eniong River, Southeastern Nigeria for 12 consecutive months (April, 2019- March, 2020) using standard methods and procedures. A total of 178 individuals of fish species belonging to 14 families and 25 species were recorded in the study. The results revealed species abundance in favour of the lower stream with only two species: *Clarias macromystax* (Clariidae) and *Malapterurus electricus (*Malapteruridae) not found in the lower stream. Populations were generally bigger in lower stream 122 (69.32%) than their counterparts in upper stream with 56 (30.68%) samples. The family Cichilidae dominates the lower stream while Clariidae dominates the upper stream. The result of Jaccard Index Similarity of the number of species found between the upper stream and lower stream revealed the value of 0.461<50%. The overall range of fish sampled falls within (9.7-25.5cmTL) with size structure generally bigger in the wet season than in the dry season. Species had seasonal abundance in the wet season than the dry season. In the wet season, *Oreochromis niloticus* and *Clarias macromystax* were the most abundant species in June and September (wet season) while *Malapterurus electricus* and *Citharinus citharus* were not found in the wet season. In the dry season, twelve (12) species were completely absent-*Hepsetus akawo, Ctenopoma nebulosum, pollimyrus asperses, Marcusens senegaleusis, Ccoptodon zelli,Cclarias gariepinus,Cclarias macromystax, Synodontis obesus, Schilbe mystus, Schilbe uranoscopus* and *Protopterus annectens* and *Hemichromis fasciatus*. The most abundant species found in both dry and wet seasons were *Oreochromis niloticus, Chrysichthys nigrodigitatus* and *Hemichromis fasciatus*. The fish diversity ranges from typical freshwater fishes to brackish species. The greatest dissimilarity between the wet and dry seasons' samples was generated by *Oreochromis niloticus*. The study recorded the highest species richness (Margaleaf) and diversity (Shanno-Wiener) in the wet season with 23 species while the lowest with the smallest abundance was observed in the dry season with 13 species. The study recommends low exploitation in the upper stream and in the dry season to enhance species productivity and sustainability in Eniong River, Southeastern Nigeria.

Key Wards: *Spatial rhythm and periodic patterns, recruitment overfishing, over-exploitation, species zonation, Eniong River*

1.0 Introduction:

Spatial rhythm and periodic pattern are critical climatic and geographical principles that sponsor spatial migration and trigger profuse seasonal abundance of fish species in any given aquatic environment. Seasonal elements as well as spatial or natural designs can equally create regular quantitative changes and regulate orderly sequence in species systematic distribution, occurrence and frequency. Besides, biogeographic actions and episodic environmental manifestations over time can equally influence and control Icthyofaunal abundance and species spread in water bodies. These abiotic catalogues can be used to model and predict species stencil, survival strategies and communion pattern among the Icthyofaunal assemblage and yet the records of periodic pace, spatial pruning as well as nominal indices and relationships among the Icthyofaunal assemblage in Eniong River are lagging.

In other localities, several studies have been done on the seasonal distribution and spatial variation of fish species in Nigerian waters. For instance, Soyinka *et al;* (2010) reported on the seasonal distribution and richness of fish species in the Badagry Lagoon, South-west Nigeria; Oluwajoba *et al.* (2017) reported on seasonal variation in species abundance, diversity and composition of fish fauna in Lagos Lagoon, Nigeria. Seasonal variation in fish distribution and physico-chemical parameters of wetland areas in Oyo State, Nigeria was studied by Ayoola and Ajani (2009). Eniong River houses some important commercial and economic fish species, especially the popular "inaha"–catfish (*Chrysichthys* sp), and the "ecomog" (*Heterotis niloticus*) and yet records of spatial rhythm and periodic pattern of fish species as well as the comprehensive piscine species identification and quantification of Ichthyofaunal assemblage in Eniong River are scanty.

Besides, Eniong River is regarded as one of the most productive aquatic ecosystems with greater ecological and economic importance in the Southeastern region of Nigeria. Aquatic resources (fish species) are highly diversified and intensively exploited in the river and for several reasons, fish fauna compositions of the area have changed over the years and yet no recent information on seasonal pattern of Ichyofaunal assemblage and spatial distribution of fish species in the area. Thus, this compressive study on the periodic pattern and spatial rhythm of fish species of Eniong River would fill the existing gap in knowledge.

2.0 Materials and Methods

2.1 Study Area:

The Eniong River, Nigeria lies between latitudes 5^o11^1 to 5^o 28^1N and longitude 7^o51^1 to 8^o00E (Fig.1). Geologically, the area under study is underlain by a wide range of diverse geological formations ranging from Asu River formations example the Abakiliki Anticlinorium to the recent alluvium in the south. The Asu River Group underlies most areas in the northern part of the study area with its intensely fractured outcrops at Ubaru. The Asu River Group, which is Albian in age, is sub-divided into three formations, comprising essentially of over 200 m bluish-grey to olive brown shales and sandy shales, fine-grained micacceous and calcareous sandstones and some limestones (Offordile, 2002). The area is well represented by structurally controlled ridges, denudational hills, example the 150 m high Obotme conical hill, steep-sided valleys, saddle and col at Obot Ito Ikpo, extensive wetlands and alluvial plains forming soil covers of silty clay, sandy and heavily weathered loam and alluvium (Udosen, Esshiett and Etok, 2016).

The area enjoys tropical climate and the temperature ranges from 26 to 32º C. The fluctuations in temperature are fairly uniform in character, except during the dry months when the rise in temperature is higher than it is during the long wet period (March to October) and the level of humidity is high (84%) due to close proximity to the main Cross River Channel. The average annual rainfall in the basin is 2200mm with maximum contribution from southwest tropical maritime air-mass (Udosen, Esshiett and Etok, 2016). This study was conducted on four locations along the Eniong Creek viz; stream channels at Ekweme, Ukpa Okon, Ito/ Obio Usiere and the lower Eniong Creek at Itu (Fig.1)

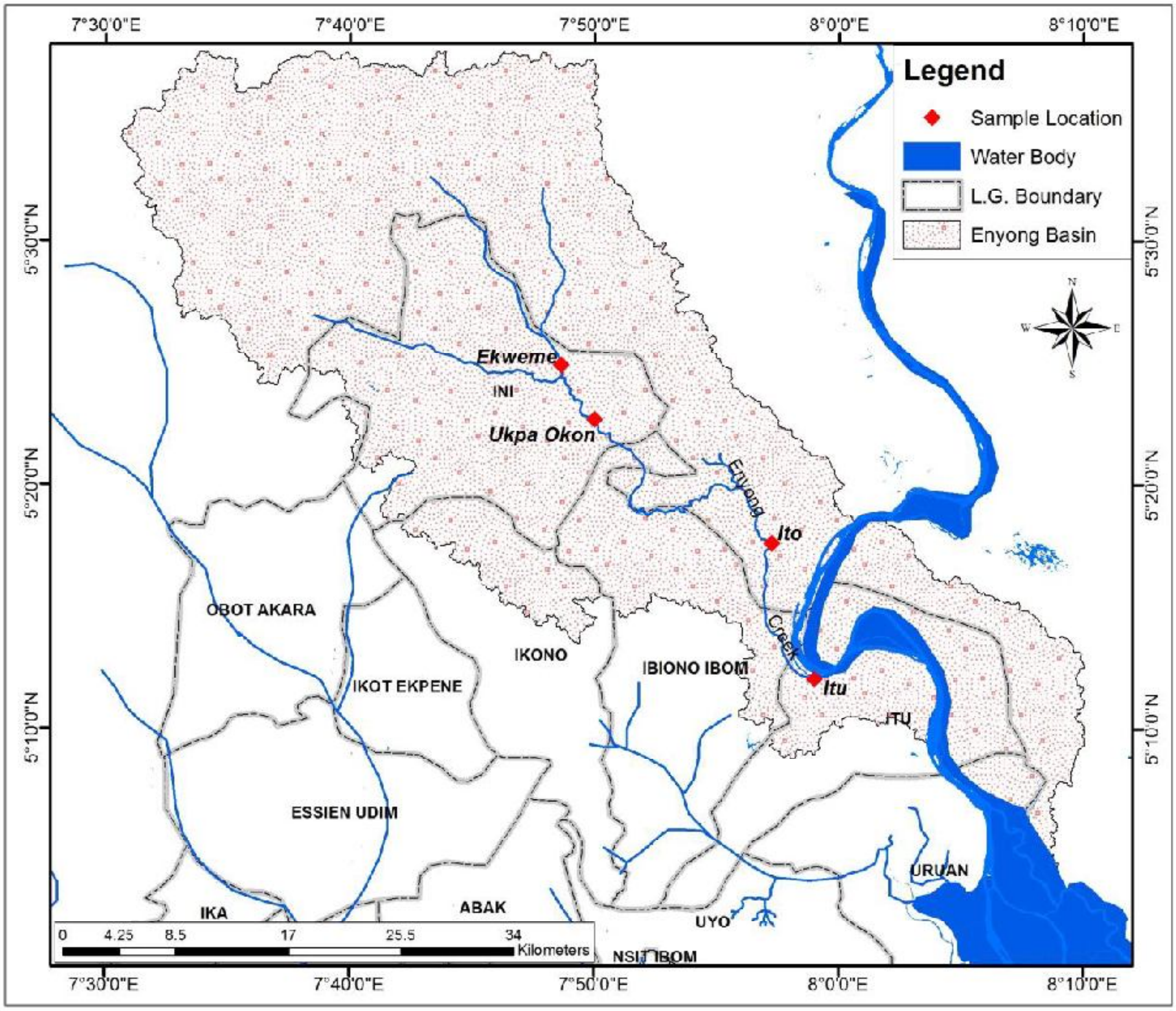

Figure1: Map of Eniong River, Nigeria showing sampling stations

2.2 Collection and Identification of fish samples

The fish species were collected on monthly basis between the months of April, 2019 and March 2020 at two (2) sampling points (upper and lower streams). Samples were collected with the assistance of artisanal fishermen using gill net at low tide. The artisanal fishermen used boats with sizes ranging from 5 to 12m long. The boats were powered by small outboard engine and manned by an average of two men per boat, to which the harvesting nets were attached. The specimens collected were preserved in an iced packed chest box in the field and later transferred to the Laboratory of the Department of Fisheries and Aquatic Environmental Management, University of Uyo, for sorting and identification according to keys provided in FAO (1981).

2.3 Measurement of the Samples

The total length was taken by the measuring distance from the tip of the snout to the end of the caudal fin. The standard length was obtained by measuring the length of the fish from the tip of snout to the end of the caudal peduncle using a measuring board. The weight was measured with the use of a weighing balance using the procedure of Pauly (1983). The samples were after preserved in 10% formalin.

2.4 Data Analysis:

Microsoft Excel (2007) was used for Data analysis for the mean, standard deviation and percentage abundance of the fish, while version 3.0 of PAST software Design was used to determine the fish species diversity (Shannon Diversity index) and richness (Margalef) of the fish community composition in each sample stations. Also, indices of species structure were calculated as follows: $D = ns/N \times 100$, Where, D = relative abundance, ns = no. of individual species. The significant value for the significances of the analysis were measured at $p<0.05$ significant level.

3.0 Results

Species zonation and abundance in lower and upper streams in Table 1 showed a total of 178 individuals of fish species belonging to 14 families and 25 species. Out of the 25 species, only two species*:* *Clarias macromystax* (Clariidae) and *Malapterurus electricus (*Malapteruridae) were not found in the lower stream; 11 species were not found in the upper stream: *Heterotis niloticus* (Cuvier), *Ctenopoma kingsleyae*(Günther), *Ctenopoma nebulosum* (Norris &Teugels), *Pollimyrus aspersus*(Günther), *Hemichromis fasciatus* (Peters), *Coptodon zelli* (Gervais), *Hemichromis fasciatus*, *Pelmatolapia mariae* (Boulenger), *Parachanna obscura*, *Clarias buthupogon* (Sauvage), *Schilbe uranoscopus*Ruppell, *Protopterus annectens* (Owen), while the remaining 12 species are found in both upper and lower streams. The species *Ctenopoma nebulosum* (Anabanitidae) and *Schilbe uranoscopus* (Schilbeidae) occurred only once during the study. Populations were generally bigger lower stream 122 (69.32%) than their counterparts' upper stream with 56 (30.68%) samples. The family Cichilidae dominates the lower stream followed by Clariidae which dominates the upper stream. The overall percentage contributions per family are shown in Table 2. Fourteen families were identified in the catch. Clariidae with 29.54% by number and 33.87% by weight dominated the catch, followed by Cichlidae 27.28% by number and 17.71% by weight in Eniong River. A total biomass of 9262.33 g was recorded in the study. Jaccard Index ranges from zero (for complete dissimilarity) to one (for complete similarity) and the higher the joint occurrace (Cj) or the index, the higher the similarity. The result of Jaccard Index Similarity of the number of species found between the upper stream and lower stream revealed the value of 0.461. The Jaccard Index Similarity is less than the critical value of 0.50 or 50%. Thus, the two stations are not similar in terms of species occurrence.

Table 1. Check list of species zonation and abundance in lower and upper streams

		Lower Stream	**Upper stream**	**Total**	**% Total Frequency**
SN	**Family/Species**				
	Hepsetidae				
1***	*Hepsetus akawo* Decru, Vreven&Snoeks	7	1	8	4.51
	Alestiidae				
2***	*Brycinus nurse* (Ruppell)	3	1	4	2.24
	Arapaimid ae				
3	*Heterotis niloticus* (Cuvier)		5	5	2.80
	Anabantidae				
4	*Ctenopoma kingsleyae*(Günther)	4	-	4	2.24
5	*Ctenopoma nebulosum* (Norris &Teugels)	1	-	1	0.56
	Mormyridae				
6	*Pollimyrus aspersus*(Günther)	3	-	3	1.68
7***	*Marcusenius senegalensis*(Steindachner)	1	1	2	1.12
8***	*Marcusenius mento*(Boulenger)	3	1	4	2.24
	Cichlidae				
9	*Hemichromis fasciatus* (Peters)	8	-	8	4.51
10***	*Coptodon guineensis*(Günther)	3	1	3	1.68
11	*Coptodon zelli* (Gervais)	3	-	3	1.68
12***	*Oreochromis niloticus*(Linne)	27	4	31	17.42
13	*Pelmatolapia mariae* (Boulenger)	2	-	2	1.12
	Channidae				
14	*Parachanna obscura*	9	-	9	5.05
	Claroteidae				
15***	*Chrysichthys nigrodigitatus*(Lacépède)	13	8	21	11.81
	Clariidae				
16***	*Clarias garriepinus* (Burchell)	2	2	4	2.24
17***	*Clarias agboyiensis* (Sydenham)	5	6	11	6.17
18	*Clarias buthupogon*(Sauvage)	16	-	16	8.98
19	*Clarias macromystax*(Günther)	-	21	21	11.81
	Mochokidae				

20***	*Synodontis obesus*	1	2	3	1.68
	Malapteruridae				
21	*Malapterurus electricus*	-	3	3	1.68
	Schilbeidae				
22***	*Schilbe mystus*	1	1	2	1.12
23	*Schilbe uranoscopus*Ruppell	1	-	1	0.56
	Citharinidae				
24***	*Citharinus citharus*	1	1	2	1.12
	Protopteridae				
25	*Protopterus annectens* (Owen)	2	-	2	1.12
	Total	122	56	178	
	%	69.32	30.68		100

*Key: *=species not found in the lower stream, **= species not found in the upper stream ***= species found in both lower and upper streams*

Table 2. Family Percentage contributions

		Total No	**%Abundance**	**TW**	**%Weight (biomass)**
1	Hepsetidae	8	4.54	343.72	3.71
2	Alestiidae	4	2.27	332.35	3.60
3	Arapaimidae	5	2.84	521.88	5.63
4	Anabantidae	7	2.84	123.43	1.34
5	Mormyridae	11	6.25	383.51	4.14
6	Cichlidae	48	27.28**	1640.61	17.71**
7	Channidae	9	5.11	705.88	7.62
8	Claroteidae	21	11.95*	880.25	9.51
9	Clariidae	52	29.54***	3137.84	33.87***
10	Mochokidae	3	1.7	99.82	1.08
11	Malapteruridae	3	1.7	589.47	6.36
12	Schilbeidae	3	1.7	96.71	1.04
13	Citharinidae	2	1.14	185.14	1.99
14	Protopteridae	2	1.14	221.72	2.40
	Total	178	100	9262.33	100

*Key: *Moderate abundant family; ** high abundant family; *** most abundant family*

Seasonal population structure

Seasonal population structure of the fish species shown in Table 3 revealed that Cichlidae (*Hemichromis fasciatus*, *Coptodon guineensis*, *Oreochromis niloticus*), Clarridae (*Clarias agboyiensis*, *Clarias buthupogon*) and Clarotieidae (*Chrysichthys nigrodigitatus*) had bigger sizes in the wet season while *Hepsetus akawo*, *Brycinus nurse*, *Ctenopoma kingsleyae* and *Marcusenius mento* grow larger in the dry season. The fish diversity ranges from typical freshwater fishes such as *Clarias gariepinus* to brackish species such as *Chrysichthys negrodigitatus* which are the most important commercial and economic fish species that sustain the fisheries of the area. The largest fish sample was *Heterotis niloticus* (20.4-25.5 cm; mean: 22.26 cmTL) and 69.02-137.09; mean: 104.37 g TW, while the smallest fish encountered was *Hemichromis fasciatus* (9.7-10.9 cm; mean: 10.23 cm TL) and 15.9-20.9 g; mean: 18.4gTW. The overall range of fish sampled falls within (9.7-25.5cmTL).

Table 3. Seasonal population structure of fish species in Eniong River

			Wet season			Dry season			**Combined seasons**	
Family	Species	N	TL cm ±Std err	TW(g) ±Std err	N	TL cm ±Std err	TW(g) ±Std err	SN	TL cm±Std err	TW(g) ±Std err
Hepsetidae	*Hepsetus akawo* Decru, Vreven&Snoeks	3	12.0-18.5 (15.8±1.33)	23.0-38.02 (30.02±7.01)	4	16.4-20.8 (18.85±1.12)	25.1-67.15 (47.4±3.76)	7	12-21.7 (18.025±1 .34)	23.0-67.15 (42.96 ±10.3)
Alestiidae	*Brycinus nurse* (Ruppell)	2	11-5-12.5 (12.0±2.29)	20.27-27.65 (23.96±3.87)	1	26.0-20.8	207.06±7.0 9	3	11.5-26 (16.875±4 .54)	20.27-207.06 (83.08±10 .2)
Arapaimidae	*Heterotis niloticus* (Cuvier)	4	20.4-25.5 (22.5±1.41)	69.02-137.09 (97.81±5.51)	1	20.4-21.3	69.02-100.0	5	20.4-25.5 (22.26±1. 76)	69.02-137.09 (104.37±1 1.2)
Anabantidae	*Ctenopoma kingsleyae*(Günther)	3	9.7-11.8 (10.56±0.56)	14.03-38.42 (25.51±5.06)	1	10.2	24.9	4	9.7-11.8 (10.475±0 .45)	14.03-38.42 (25.3575± 5.01)
Mormyridae	*Marcusenius mento*(Boulenger)	2	14.0-15.3 (14.65±1.03)	22.68-29.81 (26.25±9.50)	2	14.5-18.6 (16.55±0.89)	24.08-63.05 (43.56±7.5 6)	4	14-18.6 (15.6±1.5 2)	22.68-63.05 (34.905±9 .50)
Cichlidae	*Hemichromis fasciatus* (Peters)	3	9.7-10.9 (10.3±0.61)	15.9-20.9 (18.4±2.51)	5	8.4-10.9 (10.2±0.42)	11.0-24.65 (18.22±3.1 1)	8	9.7-10.9 (10.3±0.5 4)	15.9-20.9 (18.4±2.7 1)
	Coptodon guineensis(Günther)	1	10.0	21.01	3	8.5-12.1 (10.4±0.74)	23.96-115.8 (64.18±12. 1)	4	8.5-12.1 (10.325±0 .67)	21.01-115.8 (53.3925± 14.36)
	Oreochromis niloticus(Linne)	27	12.3-17.2 (14.52±0.55)	41.42-115.0 (68.08±10.5)	4	9.0-16.0 (12.63±0.78)	4.17-88.07 (32.24±9.6 0)	31	9.0-17.2 (12.61±0. 87)	4.17-115 (37.5±0.6 8)
Clarotieidae	*Chrysichthys nigrodigitatus*(Lacépède)	16	11.2-19.8 (16.7±0.76)	19.26-81.27 (44.15±4.24)	5	15.5-17.7 (15.6±0.58)	33.71-55.1 (41.3±8.87)	21	11.2-19.8 (15.8±0.4 5)	19.28-81.07 (44.35±6. 85)
Clariidae	*Clarias agboyiensis*	9	15.1-29.4 (19.95±1.57)	30.35-500.0 (105.46±8.51)	2	21-4-23.1 (22.2±1.73)	66.08-82.04	11	15.1-29.4 (20.36±1.	30.35-110 (64.3±6.7

	(Sydenham)						(74.06±6.37)		58)	6)
	Clarias buthupogon(Sauvage)	11	13.6-31.3 (20.1±0.97)	19.26-81.07 (59.03±6.08)	5	15.2-18.5 (17.2±0.88)	33.39-58.39 (42.57±5.13)	16	13.6-31.3 (18.98±0.98)	19.26-118 (55.13±0.87)

* Table 3 only shows the species that occurred in both seasons, ( )=mean values ±Std error, mono-species had zero std error

Table 4. Seasonal Abundance of species

			Wet	**Dry**	**Wet+Dry**	**% Frequency**
SN	**Family**	**Species**				
1	Hepsetidae	*Hepsetus akawo*	3	4	6	3.37
2	Alestiidae	*Brycinus nurse*	2	1	3	1.68
3	Arapaimidae	*Heterotis niloticus*	4	1	5	2.80
4	Anabantidae	*Ctenopoma kingsleyae*	3	1	4	2.24
		Ctenopoma nebulosum	1	-	1	0.56
5	Mormyridae	*Pollimyrus aspersus*	3	-	3	1.68
		Marcusenius senegalensis	4	-	4	2.24
		Marcusenius mento	2	2	4	2.24
6	Cichlidae	*Hemichromis fasciatus*	3	9	12	6,74
		Coptodon guineensis	1	3	4	2.24
		Coptodon zelli	3	-	3	1.68
		Oreochromis niloticus	27	4	31	17.42**
		Pelmatolapia mariae	2	-	2	1.12
7	Channidae	*Parachanna obscura*	9	-	9	5.05
8	Claroteidae	*Chrysichthys nigrodigitatus*	16	4	20	11.24.*
9	Clariidae	*Clarias garriepinus*	6	-	6	3.37
		Clarias agboyiensis	9	2	11	6.17
		Clarias buthupogon	11	5	16	8.98
		Clarias macromystax	21	-	21	11.81**
10	Mochokidae	*Synodontis obesus*	3	-	3	1.68
11	Malapteruridae	*Malapterurus electricus*	-	3	3	1.68
12	Schilbeidae	*Schilbe mystus*	2	-	2	1,12
		Schilbe uranoscopus	1	-	1	0.56
13	Citharinidae	*Citharinus citharus*	-	2	2	1.12
14	Protopteridae	*Protopterus annectens*	2	-	2	1.12
		Total	**137**	**41**	178	
		%	**77.0**	**23.0**		100

*Key: *Moderate abundant species; ** high abundant species; *** most abundant species* NB: wet season: 23 families, 23 species (all species, except *Malapterurus electricus* and *Citharinus citharus*), Dry season: 10 families, 12 species; wet+dry seasons: 11 species occurred in both seasons. Percentage distributions: wet season = 77.0%, dry season = 23.0%

Results on seasonal variation in species composition

Fish species showed three broad groups: the species that occurred only in the dry season; the species that occurred only in the wet season and the species that occurred in both seasons (Table 4). In the wet season, *Malapterurus electricus* and *Citharinus citharus* were not found in the wet season. In the dry season, twelve (12) species were completely absent- *Ctenopoma nebulosum, Pollimyrus asperses, Marcusens senegaleusis, Coptodon zelli, Pelmatolopia mariea ,Cclarias gariepinus, Clarias macromystax, Synodontis obesus,Sschilbe mystus, Schilbe uranoscopus* and *Protopterus annectens*. These species had seasonal abundance in the wet season. *Oreochromis niloticus* and *Clarias macromystax* were the most abundant species in the wet season of June and September. *Oreochromis niloticus* dominates the fishery of the Eniong River, Nigeria and was most abundant in June (wet season). *Hemichromis fasciatus* was the most abundant in the dry season. The most abundant species found in both dry and wet seasons were *Oreochromis niloticus*, *Chrysichthys nigrodigitatus* while *Clarias macromystax* was the most abundant In September (wet season).Summarily, 12 species were absent in both seasons. Percentage distributions in wet season was 77.0%, dry season was 23.0%. Fish species dominate in the wet season with two major peaks in June and September, while a minor peak is observed in dry season month of February (Fig. 2). The species dissimilarity percentage within-groups at every season are shown in Table 5. *Oreochromis niloticus* was the species that contributed the most to the dissimilarities within-groups at every season. In other words, the greatest dissimilarity between the wet and dry seasons' samples was generated by *Oreochromis niloticus*. The species contributed about 14.1% to the dissimilarity matrix, followed by *Clarias* sp, depicting the domination of freshwater species in the study area. The overall comparison between the wet and dry seasons revealed that the total average dissimilarity between samples in the two seasons was 73.84%. Thus, there is significant disparity between wet and dry season's samples and seasonal abundance of species at $p < 0.05$.

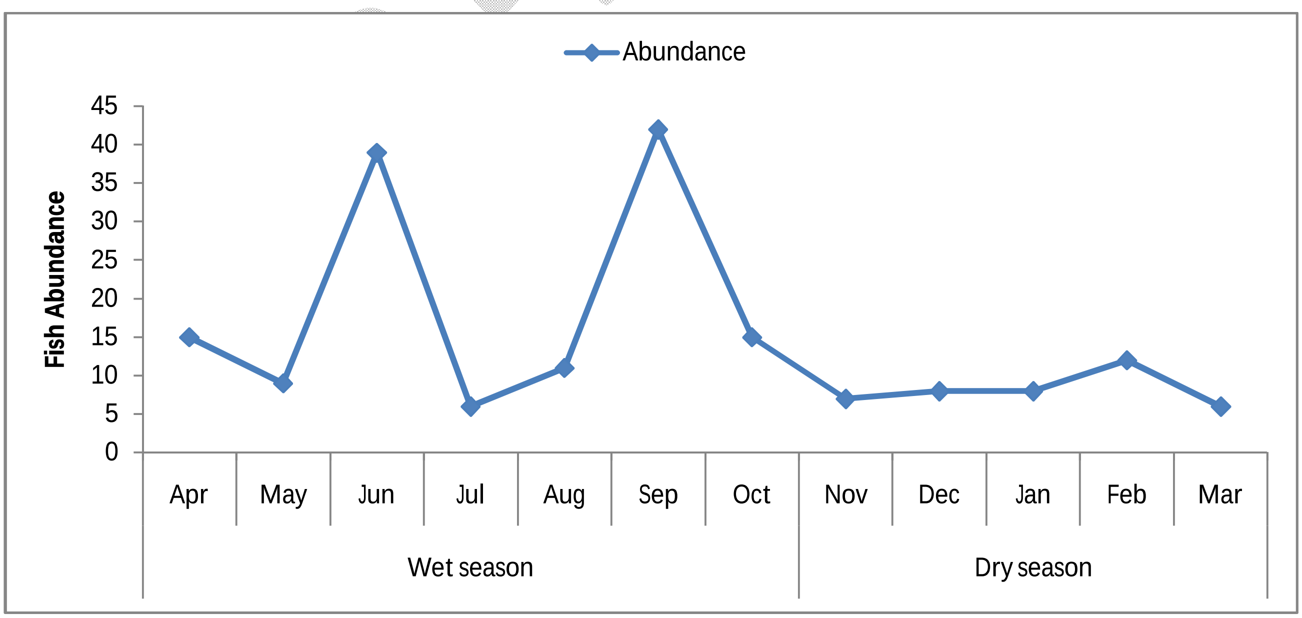

Fig 2. Monthly abundance of fish species in Eniong River

Table 5: Results of SIMPER (Similarity percentage) showing the contribution of individual taxa to the average Bray-Curtis dissimilarity between seasons

Taxon	Av. dissim	Contrib. %	Cumulative %
Oreochromis niloticus	10.41	14.1*	14.1
Clarias buthupogon	6.899	9.343*	23.45
Clarias agboyiensis	6.577	8.907*	32.35
Clarias macromystax	5.986	8.106*	40.46
Chrysichthys nigrodigitatus	5.321	7.206	47.67
Hemichromis fasciatus	3.935	5.33	52.99
Parachanna obscura	3.731	5.052	58.05
Coptodon guineensis	2.684	3.635	61.68
Malapterurus electricus	2.669	3.614	65.3
Heterotis niloticus	2.593	3.512	68.81
Marcusenius mento	2.465	3.338	72.15
Pollimyrus adspersus	2.335	3.162	75.31
Clarias gariepinus	2.231	3.022	78.33
Hepsetus akawo	2.164	2.93	81.26
Ctenopoma kingsleyae	2.086	2.825	84.08
Marcusenius senegalensis	1.81	2.452	86.54
Citharinus citharus	1.778	2.408	88.94
Synodontis obesus	1.765	2.39	91.33
Coptodon zelli	1.746	2.365	93.7
Brycinus nurse	1.63	2.207	95.91
Pelmatolapia mariae	1.24	1.68	97.59
Protopterus annectens	0.5882	0.7966	98.38
Schilbe mystus	0.5882	0.7966	99.18
Schilbe uranoscopus	0.3032	0.4106	99.59
Ctenopoma nebulosum	0.3032	0.4106	100
Overall dissimilarity	**73.84**	**100**	

**=dominate species*

Source: Researcher's Field Data (2020).

Monthly Species Diversity and Richness

Monthly Species Diversity and Richness showed that Shannon-Wiener index ranged from (1.56-1.90; mea: 1.64) in dry season while the values varied between (0.92-1.92; mean: 1.64) in wet season. Species richness (Margeleaf) ranged (1.92-2.57; mean: 2.21) in dry season while the values varied between (0.83-3.82; mean: 2.68) in wet season. The diversity and richness parameters of Shannon-Wiener and Margeleaf showed lower values during the dry season.

Table 6 Monthly Species Diversity and Richness

		Wet	Season						
Parameters	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Range**	**Mean**
Species occurrance	7	7	15	5	3	14	6	3-15	8.14
Numerical Abundance	15	9	39	6	11	42	15	6-42	19.57
Shannon –Wiener index Species Diversity)	1.89	1.88	1.92	1.56	0.92	1.91	1.41	0.92-1.92	1.64
Species richness (Margeleaf)	2.22	2.73	3.82	2.23	0.83	3.48	3.48	0.83-3.82	2.68
			Dry	**Season**					
	Nov	**Dec**	**Jan**	**Feb**	**Mar**				
Species occurrance	6	7	5	7	5			5-7	6.00
Numerical Abundance	7	8	8	12	6			6-12	8.21
Shannon –Wiener index Species Diversity)	1.75	1.56	1.56	1.90	1.56			1.56-1.90	1.66
Species richness (Margeleaf)	2.57	1.92	1.92	2.41	2.23			1.92-2.57	2.21

Key: April-October=wet season; November-March = dry season

4. Discussion

4.1 Individuals of fish species and families in Eniong River

Species diversity and composition of a fishery either vertical or horizontal are major ecological indicators of fish habitat preference and the expression of ecological viability of any habitat. The success of ichthyofaunal assemblage of any aquatic community therefore depends significantly on the numerical abundance, all-year-around availability and the profitability of the species in a particular ecosystem. In Eniong River for instance, a total of 178 individuals of fish species belonging to 14 families and 25 species were sampled in both the lower and upper, with 56 (30.68%) sampled in upper stream and 122 (69.32%) sampled in lower stream. The result is similar to the report of Allison and Okadi (2009) who recorded 25 species from 14 families from the Lower Nun River, Niger Delta area of Nigeria but higher than the report of Onuoha *et al*. (2010) who recorded 4 orders, 7 families, 14 genera and 25 species of fish in Ntak Inyang stream, Ikpa River, Akwa Ibom State. The result of this study is also higher than 11 species belonging to 6 families recorded by Ibemenuga *et al*. (2018) in Oguta Lake, Imo State, Nigeria.

However, the total number of individuals, families and species recorded in this study is smaller than the results of several researchers at different aquatic ecosystems. For instance, this result is smaller than the values; 103, 111 and 96 individuals recorded by Lawson and Olusanya (2010) in Igbesa, Itele and Iba tributaries of River Ore in Southwest Nigeria and smaller than 11 orders, 34 families, 59 genera and 136 species were recorded by Ekpo *et al*. (2012) in Ikpa River, Akwa Ibom State; 25 fish species, 15 genera, 21 families and 6 orders of freshwater species recorded by Adaka *et al*. (2014) from Oguta Lake, Southeast Nigeria; 51 fish species belonging to 21 families recorded by Ayamre and Ekelemu (2016) from Anwai River, Asaba, Delta State while a total of 605 freshwater fish belonging to 83 species, 43 genera, 24 families and 11 orders were recorded by Oladipo *et al*. (2021) across Jebba Hydro-Electric Power (HEP) dam, North-Central Nigeria. The individuals, families, genera and species recorded by these authors at different localities are similar in some extent and dissimilar to the findings of this study. The observed synchronization and dehumanization in numerical abundance of individuals, species, genera and families in different localities including this study may be attributed to various dynamics such as sampling location, fishing methods, fish survival strategies, breeding season, river zonation, season of the year, channel depth, bottom types (hydrographic heterogeneity), rainfall pattern and volume of discharge in various habitats.

4.2 Spatial Rhythm of Ichthyofauna in Eniong River

The results of this study revealed species zonation and spatial abundance in favour of the lower stream. Sikoki *et al*. (2008) also demonstrated that some ichthyofaunal species showed zonal affinities and various distributional ranges between the sampled zones. Fish assemblages recorded in this study were freshwater species and corroborated the reports of many authors on similar rainforest streams. (Sikoki *et al*. 2008, Fernandes *et al*., 2013; López-Delgado *et al*., 2018; Liu *et al*., 2021; Rodríguez *et al*., 2021). In particular, spatial variations in fish assemblage were usually caused by changes in habitat features along the longitudinal gradient (Garcia *et* al., 2018; Grubh, and Winemiller, 2018: Abdulkarim *et al*., 2020; Amachree and Soberekon, 2022),

Pelagic species were scanty in the upper Eniong River when compared with the lower Eniong River; this may not be unconnected to unorthodox fishing methods such as the use of ichythyocide and explosives in the upper river. The use of these chemicals, which include gammalin 20 and narcotic extracts can endanger the rare species and affect the mono-specific families. This affects majorly pelagic species since the benthic species escape to the bottom sediments. It is not out of place to state that aquatic ecosystems are possibly the most affected by human activity; thus rivers, lakes, lagoons, and seas receive a great quantity of contaminants from large cities, from industrial parks, and from livestock and agricultural activity. This situation has had its impact on freshwater species (Dirzo *et al*. 2014). According to Panja *et al.* (2022), relevant climatic, topographic, nutrients (sediments), and habitat attributes of which climate, topographic, substrate, and land cover features are the most contributory factors are responsible for spatial distribution of fish species.

4.3 Population, Occurrence and Size Structure of Fish in Eniong River

According to the result of this study, *Oreochromis niloticus* (17.61%), *Chrysichthys nigrodigitatus* (11.95%) and *Clarias macromystax* (11.92%) were the most abundant and significant species that sustain the freshwater fishery of the Eniong River. The dominance of *Oreochromis niloticus* (Cichlidae) is similar to the report of Okogwu and Ugumba (2010) on the abundance and diversity of the finned and shell fish of Mid-Cross River, South-east, Nigeria and similar to the findings of Moses (1979) and Mdaihli *et al*. (2003) in the lower and upper Cross River respectively. However, it is important to note that although *Heterotis niloticus* only appeared in a few samples, perhaps because of the larger sizes they carry (only the juvenile was included in the samples), this species still remains one of the most viable economic and commercial fish species that characterizes the Eniong Fishery. The analysis of community structure which identified several families in the ichthyofaunal assemblage of Eniong River shows that out of the 14 families identified in the study area, there were nine (9) mono-specific families accounting for 32.4%. But the percentage of mono-specific fish families recorded in this study which is 10% is however smaller than 42% of the mono-specific families recorded by Okogwu and Ugwumba (2010) in the Mid-Cross River, South-East, Nigeria. The presence of this monospecific fish, *Heterotis niloticus* in the Eniong River indicates ecological significance and biodiversity of the study area.

Furthermore, the low population of *Ctenopoma nebulosum* (0.56%), *Pollimyrus aspersus* (1.71%), *Coptodom zilli* (1.71%), *Pelmatolapia mariae* (1.14%), *Synodonts obesus* (1.71%), *Malapterurus eletricus* (1.71%), *Schilbe mystus*(0.56%), *Schilbe uranoscopus* (0.56%),*Citharinus citharus* (1.14%) and *Protopterus annectens* (1.14%) could be as a result of heavy exploitation which can cause recruitment failure and maturity disorder and abundance inadequacy. However, the presence of *Protopterus annectens* in the river could be due to their adaptive nature to macrophytes acting as cover and food. Also, the availability of the family Schilbeidae in the river could be influence by the presence of detritus and insect in that water body. The dominance of *Oreochromis niloticus* (17.6%) could be attributed to many factors: high prolific breeding nature or the ability to produce fries than other fishes; ability to protect their fertilized eggs by mouth brooding or good parental care and adaptation strategies in adverse climatic condition. Cichlidae recorded the highest number of taxa (5) and the families embraced one or more species which differ in number and weight from each other. Danba *et al* (2020) studied the Fish Biodiversity and abundance in River Taraba, Taraba state, and revealed that the family Cichlidae dominated the catch in number with 22.96%, followed by Clariidae (14.26%) Ayoola and Ajani (2009)-*Oreochromis niloticus* (30.6%) and *Clarias gariepinus* (20.8%) dominate the catches of wetland areas in Oyo state, Nigeria. Ayoola and Ajani (2009)-cichlidae was the most widely distributed family of fish dominating by four species (*O-niloticus,Tilapia zilli,Sarotherodon melanotheron and Sarotherodon galilaens*)=50.13% wetland areas in Oyo state, Nigeria. More so, the percentage abundance of *Citharinus citharus* (1.41%) is quite smaller than the percentage abundance of 9.02% recorded by Odo Didigwu and Eyo (2009) in Anambra River, while the percentage abundance of *Clarias gariepinus* (2.27%) is higher than 0.05% recorded by Ayanwale *et al*. (2013) for the same species in Tagwai Lake, Minna, Nigeria. Predatory species like *Caranx sp*, *Clarias sp* and *Hemichromis fasciitus* were caught among school of the juvenile population. Predation could be a major factor for reduction in growth and sizes of other species. However, Fagade and Olaniyan (1974) recorded the presence of *H.fasciatus* throughout the year in the Lagos lagoon.

4.4 Size composition and Overexploitation of the juvenile community

The morphometric characteristics of the collected species revealed differences in length and body weight. The class range of fish sampled (9.7-25.5cmTL) fall within the juvenile category. The overexploitation of the juvenile community portrays three things: first, it indicates that fishing gears with slender selectivity were hired to exploit the fish community of the study area. Second, it suggests that Eniong River system serves highly as the nursery grounds for most species, thus the high vulnerability of the juvenile population. Finally, it also indicates recruitment overfishing of the fish stock in the area especially during downstream migration. Therefore, gears that exclude fingerlings and juvenile should be encouraged to ensure the health, safety and integrity of the ichthyofaunal assemblages of the study area.

4.5 Seasonal Variation in Fish catch and Assemblages

The result showed that all the 26 species had a seasonal pattern in terms of abundance and distribution. During the study period, there were higher catches in the river during the wet season (77.0%) compared to the dry season (23.0%). This is in consonant with the report of Igbani and Uka (2019) who reported 69% abundance in the wet season and 31% in the dry season in the fish diversity and abundance in upper Ekole River, Bayelsa State, Niger Delta, Nigeria. The lower fish catch during the dry season may be due to the fact that this period serves as breeding season for most fishes while flood may break open the breeding grounds and force out the gravid females and juvenile, thus causing the abundance of catch during wet season. The wet dominance and abundance recorded in this study is similar to the result of Solomon *et al* (2012) who reported high fish fauna during wet season in Lower River Niger, Idah in Kogi State, Nigeria but differs from Adadu *et al*. (2019) who reported higher catches in dry season than in the wet season in River Okpokwu, Benue State, Nigeria. Seasonal variability in fish assemblages was often attributed to flood-related changes in habitat characteristics and induced seasonal migration of fish species (Fernandes *et al*., 2013; He *et al*., 2017; Pfauserová *et al*. 2021)

Specifically, the species such as *Clarias gariepinus* and *Protoptrus annectens* were dry season fishery of Eniong River. This is different from the findings of Adadu *et al. (*2019) who recorded 19.86% abundance for *Clarias gariepinus* and 7.08% for *Protoptrus annectens* in wet season in River Okpokwu, Benue State, Nigeria. Again, *Malapterirus electricus* was not recorded in the wet season. This is similar to the results of Adadu *et al*; (2019). The dominance of *O.niloticus* and *C.macromystax* in wet season is also similar to the findings of Adadu *et al* .2019. The availability of catfish (*Chrysicthys nigrodigitatus*) in all wet season months indicates that the migratory catfishes were the main targets species during the wet season. Also, the longitudinal and seasonal distribution of catfish, *C. nigrodigitatus* contributes to the economic significance of the freshwater fishery of the area. Nevertheless, the culture of these species can enhance all-year-around availability of fishes and stimulate local economy of the fishery in the area. Fagade and Olanyin (1974) also reported that *Chrysicthys nigrodigitatus*, *Coptodon guineenis*, *Hemischronis fasciatus*, *Caranx hippos* occurred throughout the year in Lagos lagoon. The ability of these species to tolerate variations in salinity and other oceanographic features could enhance their survival strategies in all seasons.

The largest catch was recorded in the month of May and July. Emmanuel and Osibola (2013) reported wet season of the period of the highest fish abundance and species richness in Lekki lagoon as well as the period of highest population densities of juvenile species. Breeding season, abundant vegetation, sufficient organic matter which provided a good habitat for their reproduction, migration pattern, exploitation rate, and climate change could influence species richness and diversity and vegetation cover could influence the monthly variation in abundance Thus, season is major trigger of species zonation in the Eniong River. This is similar to the results of Oluwajuba et al 2017 in Lagos lagoon, Nigeria. There was significant disparity between wet and dry season's samples. Seasonal variations in ichthyofaunal assemblages have been widely reported (Sikoki *et al*., 2008; Onuoha *et al*., 2010; Ekpo *et* al., 2012; Offem and Ikpi, 2012; Solomon *et al*.,2012; Udo, 2012; Amezcua and Amezcua-Linares, 2014; Duarte *et al.*, 2020; Kumar *et al*., 2020; Vyas *et al*., 2020; Dembe-Louvinguila *et al*., 2021). The highest biomass was observe during dry seasons and this may be linked to low level of water that facilitate catches and this agreed with the observation of Omitoyin and Ajani (2007) that the highest catch of fish during the dry seasons at Asejire and Eleyele lakes of Oyo state was due to low level of water. Oluwajoba *et al*; 2017 also identified *Caranx senegallus* in the dry season and *Hemichromis fasciatus* in the both seasons in Lagos lagoon, Nigeria. The results of this study revealed that the wet season was typically the period of the highest fish abundance as well as the period of the highest catches and the period of the highest species richness and species composition. The report Oluwajoba *et al*; 2017 on seasonal variation in species abundance, diversity and composition of fish fauna in Lagos lagoon, Nigeria supports the findings of this study.

The study recorded the highest species richness (Margaleaf) and diversity (Shanno-Wiener) in the wet season with 23 species while the lowest with the smallest abundance was observed in the dry season with 12 species. Species richness and total abundance were found to increase during the wet season. This is similar to the result of Soyinka et al (2010) from the Badagry Lagoon,South-west Nigeria. The study recommends low exploitation in the upper stream and in the dry season to enhance species productivity and sustainability in Eniong River, Southeastern Nigeria.

5.0 Conclusion and Recommendations

From the results, this study concludes that species zonation and spatial abundance in the study area is in favour of the lower stream which accommodates about twice the number of fish species in the upper stream. The area experience growth and recruitment overfishing with population generally bigger lower stream than their counterparts' upper stream and this elucidates the contributions of the upper stream as spawning grounds that enhances species productivity in the Eniong River. The Eniong River supports a high diversity of fish species of fresh, brackish and marine water origins. The fish species have the ability to adapt and cope with the incidental fluctuations, biological requirement, feeding regime, habitat changes, oceanographic uncertainties, climatic externalities, fish-habitat interaction and anthropogenic disturbance.

Species richness and total abundance increased during the wet season. Catch is dominant in the wet season and *Oreochromis niloticus*, *Chrysichthys nigrodigitatus* and *Clarias macromystax* were the most abundant and significant species that sustain the freshwater fishery of the Eniong River. The maximum size of 19.81TLcm caught in the study revealed intensive exploitation of juvenile population. Thus, the study recommends that unorthodox fishing methods such as the use of ichythyocide and explosives in the upper Eniong River should be discouraged. Gears that exclude fingerlings and juvenile fish should be encouraged to ensure the health, safety and integrity of the ichthyofaunal assemblages of the study area. Finally, low exploitation in the upper stream and in the dry season should be encouraged to enhance species productivity and sustainability in Eniong River, Southeastern Nigeria.

References

Abdulkarim, M., Magaji, I. M., Yusuf, Z. A. and Magaji, N.S (2020). Diversity and Spatio-temporal distribution of Fish species in Tiga Dam,   Kano State. *Journal of Fisheries, 17*:1969 – 1972

Adadu, M. O., Garba, A. A. and Mshelia, J. P. (2019). Diversity and Abundance of Fish species in RiverOkpokwu, Benue state, Nigeria. *International Journal of Fisheries and Aquatic Studies, 7(6)*: 55-60.

Adaka, G. S., Udoh, J. P. and Onyeukwu, D. C. (2014). Freshwater Fish Diversity of a Tropical Rainforest River in Southeast Nigeria. *Advances in Life Science and Technology, 24*:16-23

Allison, M.E. and Okadi, D. (2009). Species distribution and abundance in the lower Nun River, Niger Delta, Nigeria. *Journal of Fisheries International, 4: 13-18.*

Amachree, D and Soberekon, B. I. H. (2022). Fish Species Composition and Diversity along Creek, Rivers State, Nigeria. *IAR Journal of Agriculture Research and Life Sciences, 3(2):*1-10

Amezcua, F. and Amezcua-Linares, F. (2014). Seasonal Changes of Fish Assemblages in a Subtropical Lagoon in the SE Gulf of California. *The Scientific World Journal, 4(1-3)*:1-15.

Ayamre, E. U. and Ekelemu, J. K. (2016). Abundance and Distribution of Fish Species in three Waterbodiesin Asaba Metropolis, Delta State, Nigeria. *Journal of Agriculture and Environmental Sciences, 5 (1)*: 149-154.

Ayoola S.O and Ajani, E.K (2009).Seasonal variations in fish distribution and physico-chemical parameters of wetland areas in oyo state, Nigeria. *International Journal of Biological and Chemical Sciences,* 3(1):107-116

Danba, E.P; Afaru, J.A; Abubakar, K.A; Zira, J.D; Kefas, M and Barau, B.W. (2020). Fish Biodiversity and abundance in River Taraba, Taraba state, Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 13(5):535-544

Dembe-Louvinguila, T.H., Zamba, A.I., Mamonekene, V., Mikiembi, L.B., Ngot, F.H.P. and Goma-Tchimbakala, J. (2021). Diversity and Influence of Environmental Factors on the Spatio-temporal Distribution of the Ichthyofauna of Malonda Lagoon, Congo Brazzaville. *Natural Resources, 12*: 147-163.

Dirzo, R., Young, H. S., Galetti, M., Ceballos, G., Isaac, N. J. and Collen, B. (2014). Defaunation in the Anthropocene. *Science, 345*:401-6.

Duarte, C.; Espírito-Santo, H. M. V.; Zuanon, J.; Rapp Py-Daniel, L. H. (2020). What happens in the Darkness? Seasonal variations in Tropical Benthic Fish Assemblages. *Marine and Freshwater Research, 71(4):* 419-431.

Ekpo, I, E., Udo, M. T. and Usip, P. L. (2012). Seasonality and size variation of Fish Species in Nwaniba, Ikpa River, Southeast Nigeria. *Elixir Aquaculture, 51*:11043-11050.

Emmanuel, B.E. and Osibona, A.O.(2013). Ichthyofauna characteristics of a tropical low brackish open lagoon in south-western Nigeria. *Journal of Fisheries aquaculture, p. 607-242.*

Fagada, S.O and Olaniyan, C.I.O (1974).Seasonal distribution of the fish fauna of the Lagos lagoon, Bull. De 1:1.F.A. N.T.,Seria 36(1):244-252

FAO (1981). The State of food and agriculture. Food and agriculture.orgaization of the United Nations, Rome, 1981.

He, X., Y. Wada, N. Wanders, and J. Sheffield, 2017: Human water management intensifies hydrological drought in California. Geophys. Res. Lett., 44, no. 4, 1777-1785, doi:10.1002/2016GL071665.

Fernandes, I. M., Lourenço, L. S., Ota, R. P., Moreira, M. M. M., and Zawadzki, C. H. (2013). Effects of Local and Regional factors on the Fish Assemblage Structure in Meridional

Amazonian Streams. *Environmental Biology of Fish, 96*: 837–848.

Garcia, D. A. Z., Costa, A. D. A.,Almeida, F. S., Bialetzki, A. and Orsi, M. L. (2018). Spatial Distribution and Habitat use by early Fish stages in a Dammed River Basin, Southern Brazil. *Revista Biologia Tropical, 66(2)*: 605-621.

Grubh, A. R. and Winemiller, K. O. (2018). Spatiotemporal variation in Wetland Fish Assemblages in the Western Ghats region of India Knowledge Manager Aquatic Ecosystem, 419(35):1-12.

Ibemenuga, K. N., Uche, N. A., Nwosu, M. C. and Arazu, V. N. (2018). Assessing the current Fish Diversity and Abundance of a Tropical Rainforest Lentic Freshwater Ecosystem, South - Eastern Nigeria. *International Journal of Current Research, 10(01)*:63777-63781.

Igbani, F and Uka, A (2019). Fish diversity, abundance and fishing activities in the upper Ekole River, Bayelsa State, Niger Delta, Nigeria. International Journal of Aquactic studies, 7:1222-129.

Kumar, J. and Pandey, A. K. (2013). Present status of Ichthyofaunal Diversity and Impact of exotics in Uttar Pradesh. *Journal of Experimental Zoology India, 16 (2),* 429-434.

Lawson E. O. and Olusanya O. M. (2010). Fish Diversity in Three Tributaries of River Ore, South West, Nigeria. *World Journal of Fish and Marine Sciences, 2 (6)*: 524-531.

Liu, F., Lin, P., Liu, H., and Wang, J. (2021). Spatial and Seasonal patterns of Fish Assemblages in Mountain Streams of the Ren River, Southwest China. *Ecology and Evolution*, *11*: 11323–11332.

López-Delgado, E . O., Winemiller, K. O. and Villa-Navarro, F. A. (2018). Do Metacommunity Theories Explain Spatial Variation in Fish Assemblage Structure in a Pristine Tropical River?. *Willey Freshwater Biology, 64*:367-379.

Mdaihli, M., du Feu, T. and Ayeni, J. S. O. (2003). Fisheries in the Southern Border Zone of Takamanda Forest Reserve, Cameroon. In: Takamanda: *The Biodiversity of an African Rainforest. SI/MAB Series, 8*:141-154.

Moses, B.S. (1979). The Cross River, Nigeria. *It's Ecology and Fisheries*. Proceedings of the International Conference on the Kainji Lake and River Basin Development in Africa Kainji Lake Res. Inst. New Bussa, p. 355-371.

Odo, G.E; Didigwu, N. C, and Eyo, J.E (2009). The fish fauna of Anambra river basin, Nigeria: species abundance and morphometry, Revista de iologia Tropical (Int. J. Trop. Biol.) 57/1-2, 177-186

Offem, B. O. and Ikpi, G. U. (2012). Distribution and Dynamics of a Tropical Waterfalls Ecosystem. *International Journal of Ecosystem*, *2 (1)*: 28-37.

Offodile, M. E. (2002). Groundwater study and development in Nigeria. Mecon Services Ltd, Jos, Nigeria, p.303-332.

Okogwu, O.I. and Ugwumba, O. A. (2006). The Zooplankton and Environmental Characteristics of Ologe Lagoon, Southwest, Nigeria. *Zoologist, 3*: 86-92.

Oladipo, S. O., Nnejic, L. M., Iyiolab, O. A., Nnejid, I. C., Ayoolac, A. O., Adelakune, K. M., Anifowosheb, A. T., Adeolac, A. C. and Mustapha, M. K. (2021). Patterns of Ichthyofaunal Diversity and Distribution across JebbaHydro-Electric Power (HEP) dam, Jebba, north-central Nigeria. *Brazilian Journal of Biology, 81(2)*:258-267.

Oluwajoba, E.O, Fakayode, O.S, olu boba, T.F; Willams, A.B; ukaonu, S.U and fola-mathews, O.O (2017).seasonal variation in species abundance diversity and composition of fish fauna in Lagos lagoon, Nigeria .*Journal of Fisheries*, vol 14 1281-1288

Omitoyin, B.O and Ajani, E. K (2007). Feedig Habits and Bioaccumlation of Heavy Metal in Fishes of Lake Elelyele, Ibadan, Nigeria. *Journal of Afrotropical Zoology* special issues):165-169

Onuoha, G.C. (1991). Water quality management. Proceedings of the Fish Seed Propagation Course, August 14-28, 1991, ARAC, Port Harcourt, Nigeria, p.12-16.

Panja, S., Podder, A., Chakrabarty, M. *and* Homechaudhuri, S. (2022). Spatial pattern of Freshwater Habitats and their Prioritization using Additive Partitions of Beta Diversity of Inhabitant Piscine Assemblages in the Terai–Dooars Ecoregion of Eastern Himalayas. *Limnology*23**:** 57–72.

Pauly, D (1983). Some simple methods for assessment of tropical fish stocks. FAO Fisheries Technical paper No. 234, p.52

Pfauserová, N., Slavík, O., Horký, P., Turek, J. and Randák, T. (2021). Spatial Distribution of Native Fish species in Tributaries is altered by the Dispersal of non-Native species from Reservoirs. *Science of the Total Environment 755*: 143108-14320.

Rodríguez, F., Quintero, B., Amores, L., Madrid, D. and Salas-Peña, C. (2021). Salas, C. Spatial Cognition in Teleost Fish: Strategies and Mechanisms. Animals, 11 (2271): 3-25.

Sikoki, F. D., Zabbey, N. and Anyanwu, I. N. (2008). Fish Assemblages of Onu-Iyi-Ukwu Stream in SoutheasternNigeria. *Tropropical Freshwater Biology, 17*: 41-51.

Solomon, S. G., Okomoda, V. T. and Aladi, S. I. (2012). Fish Fauna inLower River Niger at Idah in Kogi State., *Journal ofAgriculture and Veterinary Sciences 4*:34-39.

Soyinka, O.O, Katon, M.P and Ayo-Olalus, C.I (2010).Seasonal distribution and richness of fish species in the Badary lagoon, south-west Nigeria. *Estonian Journal of Ecology*, 59(2):147-157.

Udo, I. U. (2012). Taxonomic composition, diversity and abundance of the Ichthyofaunal Assemblages of Iba-OkuStream, Ikpa River, Nigeria.*International Journal of Zoology, 8(2)*:71–81.

Udosen, C., Esshiett, A. A. and Etok, A. S. (2016). The Physicochemical Hydrology of a Humid Tropical RiverSystem in South Eastern, Nigeria. *International Journal of Research in Geography (IJRG), 2(2)*:22-35.

Vyas, U. D., Desai, A.Y., Masani, M. N. and Vandarwala, U. G. (2020). Diversity of Ichthyofauna in Hiran-II reservoir,Gujarat (India). *Journal of Entomology and Zoology Studies, 8(5)*: 1181-1188.