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Studies on fish species diversity, abundance and Distributon along Onitsha axis of River Niger, Anambra State of Nigeria

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Abstract
A study on biodiversity, abundance and distribution was carried out in Onitsha Axis of River Niger in Onitsha North and South Local Government Area, Anambra State, Nigeria for a period of three months. The area was partitioned into Station I (Emejuru), Station II (Bridge Head) and Station III (Akpaka). Fish samples were collected weekly from July to September, 2019 with the aid of fisher folks using gill nets, cast nets, hook and lines and local traps. The results showed a total composition of 4,645 individuals belonging to 15 families and 31 species. Momyridae showed significance ($p<0.05$) species diversity with seven (7), followed by Bagridae (5) spp. with the remaining 13 families having one and two spp. Station III Akpaka recorded the highest fish diversity of 37%, followed by Station I Emejuru 34% and Station II Bridge head 29%. In terms of species abundance, *Bagrus bayad* 13.9% >*bagrus docmak* 8.8% >*Chryschythys Nigrodigitatus*7.2% >*Bargus filamentous* 4.5% >*Malapters electricus* 4.4% >*Heterotis niloticus* 4.0% >*Orochromis niloticus* 3.8% >*Mormyrus macrophatalmus* 3.3%) recorded the highest, followed by *Heterobranchus bidorsalis, Mormyrus rume, Mormyrus tarpirus, Mormyrus senegalensis, Schibe mystus Synodontis clarias* and *Cithrinus citharus* had 2.2%, 2.3%, 3.0%, 1.7%, 2.9%, 1.6% and 3.2% respectively, and *Hypothermirus pissitacus* the least with 0.4%. This research shows that the Onitsha axis of the River Niger is still rich in fish species diversity and abundance; hence concerted efforts should be made by the various government agencies to see that laws guiding the proper use of water bodies are enforced in the Onitsha axis of the River Niger, to enhance economics, conservation and sustainability.

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Keywords: Species abundance, Biodiversity, Distribution, Extinction, pollution, fisher folks, Anthropogenic

Introduction

Biodiversity is the variation in the genetics and life forms of populations, species, communities and ecosystems. Biodiversity affects the capacity of living systems to respond to changes in the environment, and is essential for providing goods and services from ecosystems (e. g., nutrient cycling, clean water (Hooper *et al.*, 2005) [6]. Fish consumption is about 80% protein diet and provides job up to 50% of the populations' resident in the Niger Delta (Edoghotu *et al*., 2016) [11].

Despite this great importance and value, the world's fish resources are suffering from the effects of heavy exploitation and, in cases, environmental degradation (FAO, 2012). Activities which may have contributed to the degrading environmental quality and production of fish is over fishing and oil exploration by various companies (Edoghotu *et al.*, 2016) [11]. Most aquatic systems have witnessed various changes in terms of natural diversity. These changes affect stock diversity and abundance caused by natural changes in habitat, food composition and uncontrolled exploitation. Due to this, the fish resources have been altered (Ipinmoroti, 2013) [18].

Over the last century, habitat loss and degradation have occurred due to the intense human interventions. The consequence of this is that, many fish species have been highly endangered (Negi and Shetal, 2013) [20].

Changes in fish diversity occur in the course of development of a lake after impoundment of rivers caused by changes in the physical environment. These changes in turn affect water quality and consequently the type and population of food organisms that evolve. Biomass, number and species composition usually increase due to increase in nutrient and food organisms from decayed materials. Human activities such as pollution, habitat degradation, introduced species and overfishing causes most changes in natural ecosystems. A major tool responsible for the alterations in the diversities of resources in a community is exploitation (Fishing) fish. This alters food webs; modify trophic structures and species interactions (Ipinmoroti, 2013) [18]. The conservation of biodiversity and management of aquatic environment in particular has become a major concern in recent years. It was noticed more than a decade ago that anthropogenic activities could lead to the periodic or permanent elimination of freshwater – dependent fish species from individual freshwater systems (Abowei, 2010) [5] Fish diversity and associated habitats management is a great challenge today. Furthermore the ability to evaluate the effects of habitat change which causes impact on the fish population often requires extensive surveying of the fish population before and after the change has occurred which is very tedious (Dudgeon *et al.*, 2006) [9]. It is important to know the fish species diversity, abundance and distribution in the aquatic habitat in order to develop management and conservation programs. Studies of spatial and temporal patterns of diversity, distribution and species composition of freshwater fishes are useful to examine factors influencing the structure of the fish community (Galactos *et al.*, 2004) [15].

The fish yield of most inland waters in Nigeria are generally on the decline for causes that may range from inadequate management of the fisheries to degradation of water bodies (Odo, Nwani, and Eyo, 2009). Due to a general lack of data, it is difficult to access the status of the inland water biodiversity. Indeed monitoring the status and trends of freshwater biodiversity is essential to quantify impacts of human activities on freshwater systems and to improve freshwater biodiversity conservation. According to Adaka *et al.*, (2014) [7] environmental awareness to educate the fishers and other stakeholders on the danger of extinction of the species and the need for its conservation was necessary. Similarly, (Ude *et al.*, 2011) [27] stated that detailed knowledge of the function of the river system and the responses of fish species are needed for effective fisheries management planning. Fisheries resources are fast reducing in Nigeria due to over exploitation and inadequate management of her coastal waters (Lawson and Moduke, 2010) [19].

Materials and Method

The study area is the Onitsha axis of River Niger, Onitsha North and South Local Government Areas of Anambra State of Nigeria. Onitsha lies between latitude 6^0 10'N/6^0 47'E and Longitude 6.167^0 N/6.783^0 E of the equator. The city of Onitsha has a land area of 36.12Km2 (13.95 sqmi) with water occupying 0.067 Km^2 (0.026sqmi). The study area was partitioned into Station I (Emejuru), Station II (Bridge Head) and Station III (Akpaka). The three stations served as landing stations where fish mongers and traders come to purchases fish. Onitsha is a city located on the eastern bank of River Niger, in Anambra State of Nigeria. it also serve as an economic hub for commerce, industry and education. There are two main seasons, the dry season (October/November – March) and the rainy season (April – September/October) approximately corresponding to the dry and flood phase, respectively, of the hydrological regime. The mean annual rainfall is between 1520 mm and 2020 mm.

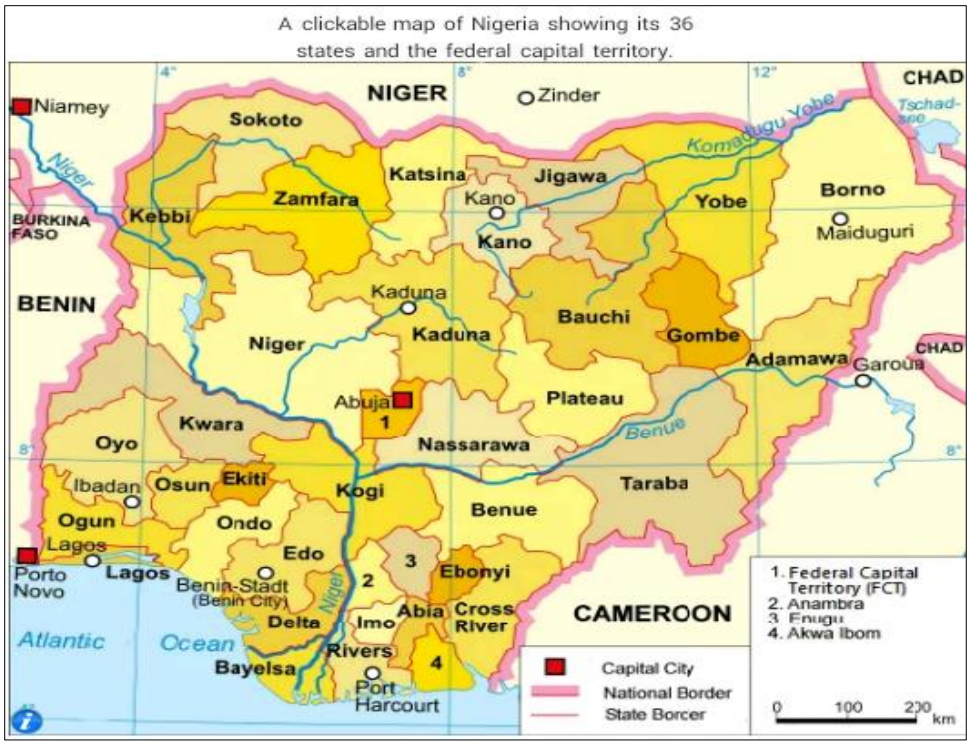

Fig 1: Map of Nigeria

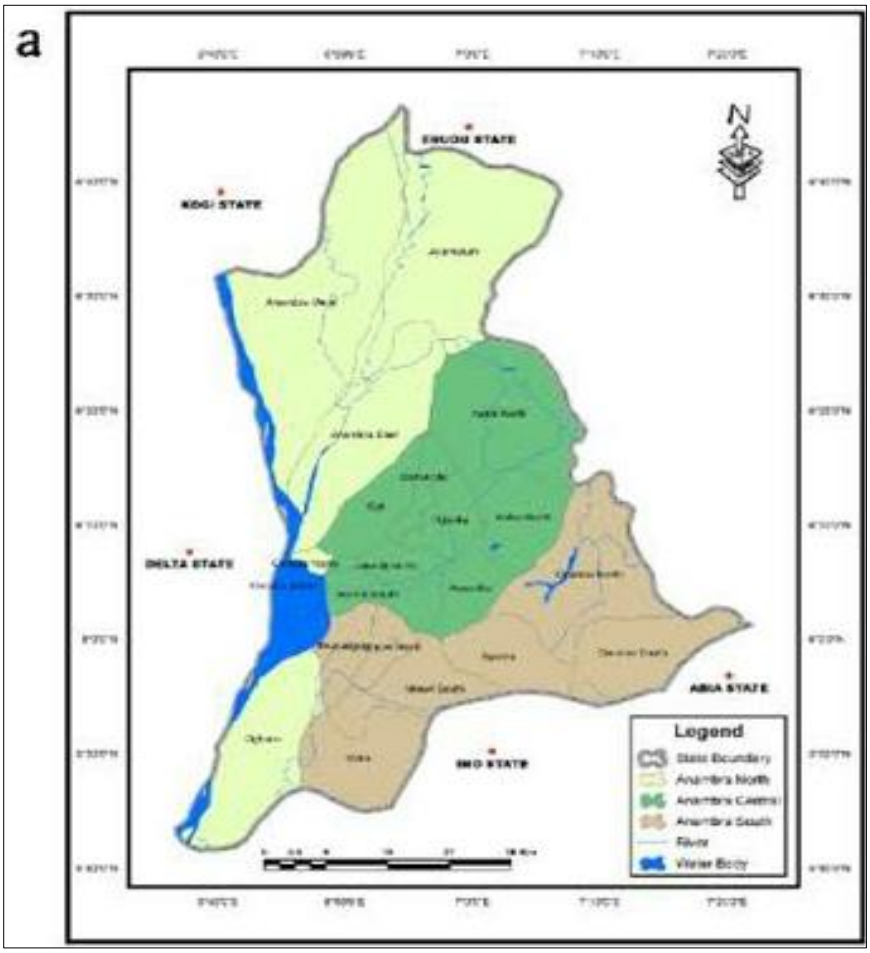

Fig 2: Map of Anambra State

Fig 3: Map showing the study area

Study design and sampling stations location

Data for this study was based on records of fish catches by local fishermen taken through the months of July to September 2019. Weekly fish species were sampled from three stations namely; Station I (Emejuru), Station II (Bridge Head) and Station III (Akpaka) of the Onitsha axis of River Niger. The fishing gears used in the study area were of four different types, viz hook and line, cast nets, different types of traps and gill nets. The sampling sites were also generally accessible throughout the year and at this point of the year the water level has increased. Water lilly (*Nymphaea spp.*) and floating filamentous plants were common.

Fish samples collection, treatment and Identification

The fishes were identified on the spot with the aid of Fish data base (Froese and Pauly, 2010), while the indigenous fishermen helped in the identification of the local name of most species of fish and Field Guide to the Freshwater Fishes of Nigeria, a Publication of the National Institute for Freshwater Fisheries Research, New Bussa, Niger State of Nigeria. The total number of fish caught from the river will was counted and recorded; this enabled the determination of the relative abundance of the various species in the river. The main system of classification of fish species that were caught in the reservoir was that of (Maddison, 1992) as adopted by (Babatunde and Raji, 2004). Aquatic and domestic wildlife animals sighted during the periods of data collection were counted and recorded.

Estimation of species abundance and diversity

(a) Margalef's Diversity Index (d): This was estimated using the formula as reported by Clifford and Stephenson (1975) to measure the diversity in the community structure:

$$d = \frac{(S - 1)}{\ln N}$$

Where: d = Species richness index

S = Number of species in a population. N = Total number of individuals in S species

(b). Shannon-Wiener diversity index (H'): This measures faunal diversity and gives the degree of uncertainty involved in predicting the species identified from randomly selected individuals. It was calculated using the following equation.

$$H' = -\sum\left[\left(\frac{n_i}{N}\right) \times ln\left(\frac{n_i}{N}\right)\right]$$

Where ni = number of individuals or amount of each species (the i th species)
N = total number of individuals for the site

OR

$H^1 = (-P_1 \text{ In } P_1) – (- P_2 \text{ In } P_2) - ….$(Shannon Wiener)
Where: H^1 = Shannon-wiener index
P = Total proportion of each species in the sample.

(c). Berger-Parker Dominance Index; This relate to species richness and abundance. It takes iinto account only the commonest species in the sample. The formula is:- D = $\frac{Nmax}{N}$
Where Nmax = the number of individual of the most abundance species. N =Total number of individuals of all species. This iis the total number of individuals of each species in a catch expressed as a percentage of the total number of individual of all species in the catch.
NOI = $\frac{C}{D} \times \frac{100}{1}$
Where: C = number of individual of each species in the catch
D = total number of individual of all species in the catch

Data Analysis
The data collected were analyzed using descriptive statistics, frequency count, percentages, also Margalef's diversity index, Shannon-wiener index, Berger-Parker dominance index and Number of Occurrence Index.

Results
Table 1 shows the fish families identified from Onitsha Axis of River Niger. The result of the different families of fish identified in the SS1, SS11 and SS111 of Onitsha Axis of River Niger is shown in table 1 below. A total of twenty (31) fish species, representing fifteen (15) families were identified. The table also showed that the family *Mormyridae* had the highest number of species (7), followed by families *Bagridae* (5), *Cyprinidae* (3), *Cichlidae*, *Citharinadae*, *Claridae*, *Mockochidae*, having two (2) species each. in the following descending order *(Mormyridae* > *Bagridae*> *Cyprinidae*> *Cichlidae*>*Citharinadae*>*Claridae*> *Mockochidae).* The remaining families *(Clarotidae*, *Centropomidae*, *Polypteridae*, *Clupeidae*, *Characidae*, *Malapteridae*, *Osteoglosidae* and *Shilbidae*) had only one species representing each of them. The table further showed that Family *mormyridae*, *Bagridae and Cyprinidae* constitutes 22.5%, 16.1% and 9.6% respectively. Families, *Chichlidae*, *Citharinidae*, *Claridae*, *Mochokidae*, constituted 6.4%% each. The remaining families constituted 3.2% each.

Table 1: Percentage Composition of Various Fish Families Identified in the Three Stations.

S/N	Family	Number of Species	Percentage (%)
1.	*Bagridae*	5	16.1
2.	*Cichlidae*	2	6.4
3.	*Citharinidae*	2	6.4
4.	*Claridae*	2	6.4
5.	*Cyprinidae*	3	9.6
6.	*Centropomidae*	1	3.2
7.	*Characidae*	1	3.2
8.	*Clarotidae*	1	3.2
9.	*Mochochidae*	2	6.4
10.	*Mormyridae*	7	22.5
11.	*Malapterudae*	1	3.2
12.	*Osteoglosidae*	1	3.2
13.	*Polypteridae*	1	3.2
14.	*Schilbedae*	1	3.2
15.	*Clupeidae*	1	3.2
16	**Total**	**31**	**100%**

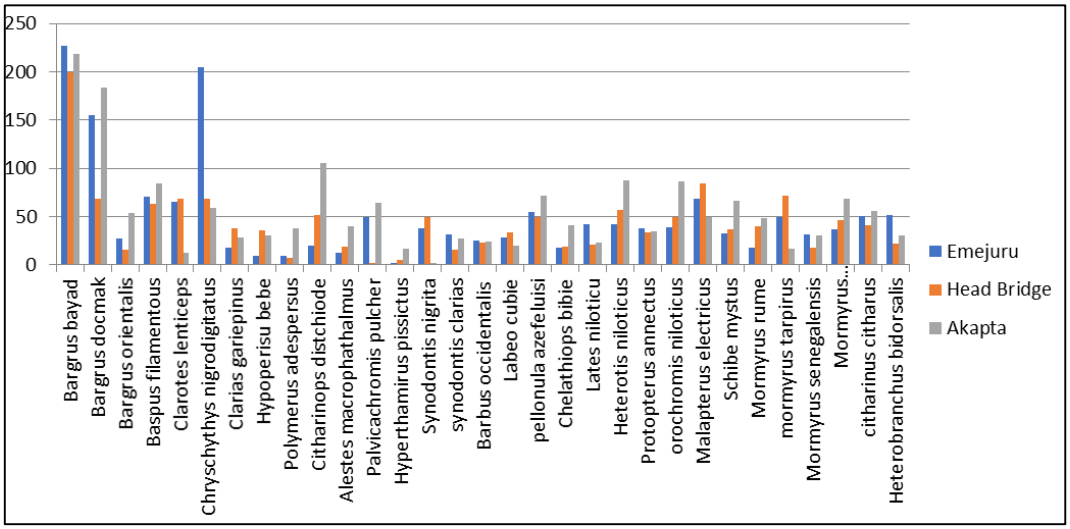

Fig 4. Fish biodiversity of River Niger at Onitsha axis

Figure 4 Shows that the highest relative abundance of fish species was recorded in station III Akpaka with (37%) and it's least relative abundance in station II Bridge Head and station I Emejuru with 29% and (34%) respectively as shown in Figure 4.

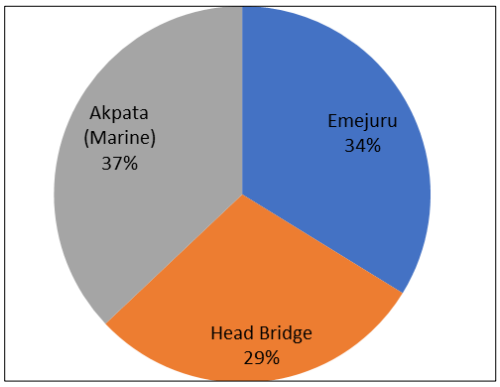

Fig 5: Percentage of species biodiversity in the three stations

Table 2 shows the relative percentage abundance of fish species identified in Onitsha Axis of the River Niger within the period under study. The table shows that the percentage of the fish species are decreasing in the following order with (*Bagrus bayad* 13.9% >*bagrus docmak* 8.8% >*Chryschythys Nigrodigitatus*7.2% >*Bargus filamentous* 4.5% >*Malapters electricus* 4.4% >*Heterotis niloticus* 4.0% >*Orochromis niloticus* 3.8% >*Mormyrus macrophatalmus* 3.3%) occurring the highest. *Heterobranchus bidorsalis, Mormyrus rume, Mormyrus tarpirus, Mormyrus senegalensis, Schibe mystus Synodontis clarias* and *Cithrinus citharus* had 2.2%, 2.3%, 3.0%, 1.7%, 2.9%, 1.6% and 3.2% identified respectively. *Labeo cubie, lates niloticus* and *protpeterus annectus, had* 1.8%, 1.9% and 2.3%, respectively. *Chelathiops bibie, Clarias gariepinus, Synodontis nigrita, and Pellonula azefeluisis* had 1.7%, 1.8%, 1.9%, 3.8% each respectively. *Hyperopisu bebe, Polymerus adespersus, Citharinops distichiode, Barbus occidentalis, Hypothermirus pissitacus* had 1.6%, 0.8%, 2.2%, 1.6% and 0.4% each respectively. The remaining fish species *Bargus Orientalis, Alestes macrolepidotus, Palvicachromis pulcher and Clarotes lenticeps* had 2.0%, 0.9%, 1.5% and 3.2% each respectively.

Table 2: Numerical abundance, relative occurrence and percentage of fish species from Onitsha axis of River Niger, Nigeria

S//N	Family	Fish Species	Station I	Station II	Station III	Total	%percentage
1	Bagridae	*Bagrus bayad*	227	200	219	646	13.8
		Bargus Dockmak	155	68	184	407	8.8
		Bargus Orientalis	27	16	54	97	2.0
		Bagus Filamentous	71	63	84	218	4.5
		Clarotes Lenticeps	65	69	13	147	3.2
2.	*Clarotidae*	*C. Nigrodigitatus*	205	69	59	333	7.2
3.	Claridae	*Clarias gariepinus*	18	38	28	84	1.8
		Heterobranchus bidorsalis	52	22	30	104	2.2
4.	Citharinidae	*Citharinus citharus*	51	41	56	148	3.2
		Citharinops distichiode	34	20	52	106	2.6
5.	Characidae	*Alestes macrolepidotus*	8	13	19	40	0.8
6.	Cichlidae	*Palvicachromis pulcher*	12	50	2	64	1.4
		Orochromis niloticus	39	49	87	175	3.8
7.	Mocokidae	*Synodontis nigrita*	38	49	2	89	1.9
		Synodontis clarias	32	16	27	75	1.6
8.	Cyprinidae	*Barbus occidentalis*	25	23	24	72	1.6
		Labeo cubie	28	34	20	82	1.8
		Chelathiops bibie	18	19	41	78	1.7
9.	Clupeidae	*Pellonula azefeluisis*	55	49	72	176	3.8
10.	Latidae	*Lates niloticus*	42	21	23	86	1.9
11.	Osteoglosidae	*Heterotis niloticus*	42	57	88	187	4.0
12.	Prpotopteridae	*Protopterus annectus*	38	34	35	107	2.3
13.	Malapteridae	*Malapterus eletricus*	69	84	50	203	4.4
14.	Scheibeidae	*Schibe mystus*	33	37	66	136	2.9
15.	Momyridae	*Mormyrus rume*	18	40	48	106	2.4
		Mornyrus tarpirus	49	72	17	138	3.0
		Mormyrus senegelensis	32	18	30	80	1.7
		M. macrophathalmus	37	46	68	151	3.3
		Hyperopisu bebe	9	36	31	76	0.4
		Polymerus adespersus	22	9	7	38	1.8
		Hypothermirus pissitacus	10	2	5	17	1.6
		Total	1569	1355	1721	4,645	100

Table 3: Biodiversity Index of Fish Species in Onitsha Axis of River Niger

Diversity Index	SSI	SSII	SSIII	Mean Value
Total Number of species	1569	1355	1721	1548
Margelef diversity index	4.0799	4.0176	3.3950	4.0161
Shanon Weiner index	3.3372	2.6773	2.9615	2.992
Berger Parker index	0.1447	0.1476	0.1273	0.1398

Discussion

The findings from this present research, has shown that Onitsha Axis of River Niger has a rich ichthyofauna with a total of 31 fish species and 15 families which is at variance with that reported by Agbugui *et al.* (2019) [8] with a total of 18 families, 35 species from River Niger at Agenebode, from the three stations. The result from this study surpasses that obtained by Okomoda *et al.* (2012) [24]; Abiodun and John (2017) [3], who recorded 13 families, 28 species and 16 families, 44 species respectively. This denotes that over time, there is increase in fish species in the river. Also, the numbers of catch were more in this study than those recorded by Okomoda *et al.* (2012) [24]. This increase in species diversity can be attributed to the fact that the River Niger at this axis has a lot of sanctuaries, tributaries, race ways and sites suitable for fish hiding and breeding. Another reason for this sudden increase might be consequence of loss of habitat at other communities along the River Niger due to increase in agricultural activities and the recent flooding experiences around the region. Sikoki *et al.* (2008) [26] reported that fish assemblage of 11 families and 15 genera were obtained in Onu –Iyi –Ukwu stream, South Eastern Nigeria. While Abiodun and Odunze (2011) [4] recorded a total of 51 species belong to 12 families. These disparities in the number of families and species within the same river and from one river to another could be attributed to seasonal change, environmental changes and anthropogenic factors giving rise to migration and movement of fish species from one location to another. In terms of representation, the family *Mormyridae* had the highest species (7) as shown in table 1 which is in line with the findings of Okomoda *et al.* (2012) [24]; Abiodun and John (2017) [3] who found that *Mormyrids* were represented by seven families each in their research, but the number of species differed. The result of this study is in contrast with the findings of Ataguba *et al.* (2014) who observed that cichlidae was the most abundant family in his study. In terms of relative abundance of the 31 species recorded, *Bagrus bayad* stands out as the most dominant species as shown in table 2. These findings slightly defers from the findings of Agbugui *et al.* (2019) [8] who reported that *Gymnarchus niloticus* as the most abundant species in River Niger at Agenebode, Edo State, Nigeria. Also Ataguba *et al.* (2014) observed *S. galilaeus* as the most abundant species in Gubi Dam, Bauchi State of Nigeria. The result disagrees with the fish species diversity reported by Adaka *et al.* (2014) [7] and Ibim and Owhonda (2017) [17] with similar result of high Cichlid diversity in the New Calabar River of Nigeriia.

Abubakar *et al.*, (2005) [6] reported *Oreochrornis niloticus* as the most abundant species in Lake Geriyo, Abdullahi (2005) [1] reported high species abundance of *Sarotherodon galileaus*. Abiodun *et al.* (2005) [2] also reported that *Oreochiomis spp*. and *Sarotherodon spp.* as the most abundant species in lake Geriyo, Adamawa State of Nigeria. The 31 species of fish recorded in this study was however higher than the 30 species in 16 families in Oramiri-Ukwa River as reported by Adaka *et al.* (2010) [7]. The reason why the *Bagrus bayad* according *to* Abiodun *et al.* (2005) [2] was dominant during the study period, might be attributed to the fact that cichlids are highly fecund and the presence of many piscivorous fish species such as *Hydrocynus* species which predate upon other fish species might have helped check their population in the water body. This might have resulted in a decrease in abundance of cichlid during the study period.

The Shannon-wiener index (H) for the fish species from Onitsha axis of River Niger within the period of study were within the range of 2.6-3.3 which is higher than 1.811 to 2.366 observed by Ataguba *et al.* (2014). The values obtained here are higher than those reported by Offem *et al.* (2011) for fish of the Ikwori Lake in South-Eastern Nigeria in the rainy season and also for three areas along the Anambra River as reported by Odo *et al.* (2009) [21]. Also, Emmanuel and Modupe (2010) [12] reported values of H' ranging from 1.869 to 2.015 in three tributaries of River Ore which are lower than those reported in this study. The difference can be attributed to disparity in ecological zones. The values for H^1 by stations, indicates a good spread of species diversity in Onitsha axis of River Niger.

This study showed that abundance of fish species differed between the three stations with SSIII (Akpaka) having the highest species as shown in figure 2. This can be as a result of abundance of zooplanktons and relatively stable and undisturbed aquatic ecosysytem. This station also recorded the highest number of fisher folks. SSI (Emejuru) recorded second highest in species abundance which may be due to its vast population of fisher folks who come to market with their catches after the days fishing and lastly SSII (Bridge Head) with the least species abundance, which must be as a result of synergistic effects from the various industries and commercial activities such as dredging and tipping activities that are going on in this station. Also, the effects of effluent discharge of municipal wastes, industries and warm- water effects from power stations.

Presently, the Onitsha Axis of River Niger serves as the main source of fisheries upon which the livelihoods of hundreds of thousands of people depends on, owing to the fact that the increasing population pressure and the high demand for livelihood opportunities which is a threat to the health of the fishery and ecosystem. A management plan must be initiated, enforced and properly funded to prevent the collapse of the fisheries, social and economic disruption which will inevitably follow when nothing is done. More especially when fisheries operate under conditions of free and open-access. The best approach to the conservation of the species is to disseminate conservation information, educate the fisher folks and other stakeholders about the danger of extinction of the species and the need for its conservation. This will go a long way towards protecting and preserving the biodiversity and abundance of the Onitsha axis of the River Niger. Prevention now is not only better, but also cheaper than looking for ways of recalling lost species. Once extinction occurs, it may not be easily reserved or recalled.

Furthermore, the fish yields are not very encouraging compared to similarly-sized inland rivers or lakes. This study recorded low species abundance probably owing to over exploitation and other factors earlier mentioned such as sand dredging activities which is one of the main activity going on in the river as this affect fish species diversity in many ways in that the release of heavy metals from petroleum products used in the operation of the machineries used and also noise pollution, dredging which can also destroy breeding grounds and other pollutants which effect fish diversity in many ways or to human error in sampling procedure such as the engagement of part time fishers, mostly young persons who fished either for sport or to enrich family meals. The results recorded in this study have only brought to light the need for further research on this river and many others in the country. The low value of species richness could be due to a combined effect of flooding and pollution of the aquatic ecosystem,

which have been known to have negative effect on the distribution of the resident organisms (Ogbeibu and Oribhabor (2002) [23].

Conclusion

The Onitsha Aixs of River Niger, has shown to be a rich habitat for diverse fish families and species, many of which are of great economic importance. The River Niger axis serves as a means of livelihood to both fisher folks and fish mongers and to the mindless sand dredgers and tippers who in the cause of dredging the river, destabilizes the aquatic ecosystem. It is pertinent that the Federal, State and Local Governments should work together to see that all legislations available for protection and conservation of the inland waters are enforced at River Niger, in order to forestall and check mate the use of obnoxious fishing methods, uncoordinated dredging and sand tipping and discharge of industrial effluents and sewage in the river. There should be a deliberate programme by the government to restock these water bodies based on the findings from this research, this is one of the ways to aid fish sustainability and conservation. In all these, the people should be well informed and sensitize on the negative effects of wrongful use of the river to their economy and their health.

Recommendation

From this study, the following recommendations are made;

1. The agencies managing the water bodies should urgently begin to implement all Fisheries Edict and laws in order to enforce proper management and conservation of the fisheries resources of the water bodies because the conservation of the ecosystem and sustainability of the fish population depends on it.
2. Gears that exclude juveniles and fingerlings should be encouraged; environmental awareness to educate the fisher folks and other stakeholders on the danger of extinction of the species and the need for its conservation is necessary.
3. The future developments of autogenic and anthropogenic threats, and activities and harmful practices which predispose fish species to extinction along the floodplain and catchment area of the river should be subjected to environmental scrutiny to maintain the environmental health and integrity of the ecosystem.
4. The fish species diversity, abundance and distribution studies should be a continuous project by all arms of the government, to determine the health of the people, fishery sustainability and conservation measures in Onitsha, axis of thr River Niger and other water bodies.

Declarations

Ethical Approval

Ethical approval was received from the Animal Ethics committee of Nnamdi Azikiwe University, Awka, Nigeria

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Financial Interests

The authors declare they have no financial interests.

Competing Interest

The authors have no competing interests to declare that are relevant to the content of this article.

Availability of data and materials

All data generated or analysed during the time of this study are included in this published article Appendix A

Authors contribution

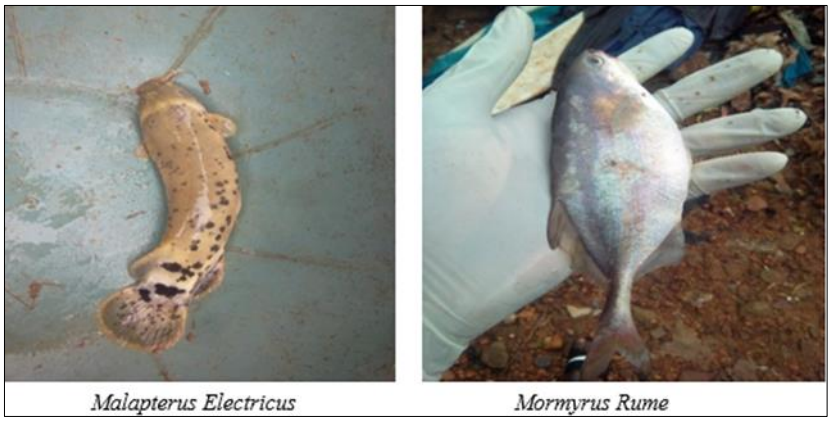
Conceptualization, material preparation, data collection/investigation and analysis was performed by (J.A. Igwe). The first draft, revie and editing of the manuscript was done by (P.A. Okeke), and all authors commented on previous versions of the manuscript. Also, supervision was done by (P.A. Okeke) All authors read and approved the final manuscript.

Consent to Publish

All the authors have given their consent for the manuscript to be published

Appendix A

Photo gallery of fish species identified



Malapterus Electricus *Mormyrus Rume*

Lates niloticus

Mormyrus Tarpirus

Orochromis Niloticus

Palvicachromis Pulcher

Polymerus adespersus

Mormyrus Senegalensis

Heterotis niloticus

Citharinus citharus

Citharinops distichiode *Schibe mystus*

References

1. Abdullahi M. Diversity and abundance of fish species in River Benue. Boronji Area. B.Tech Thesis, Department of Biological Sciences, FUTY Yola; c2005. p. 15-6.
2. Abiodun JA, Alamus SO, Miller JW. Assessment of inland water fisheries in Nigeria with implications for fish production, poverty alleviation, and food security. In: Proceedings of the 19th Annual Conference of the Fisheries Society of Nigeria (FISON); Lagos; c2005. p. 304-11.
3. Abiodun JA, John P. Biodiversity and abundance of fish and some processing methods in Lower Niger River, Idah, Kogi State Nigeria. Nigerian Journal of Fisheries and Aquaculture. 2017;5(2):20-5.
4. Abiodun JA, Odunze FE. Fish biodiversity and fisheries of Jebba Lake, Nigeria. Nigerian Journal of Fisheries. 2011;8(2):284-290.
5. Abowei JFN. Salinity, dissolved oxygen, pH, and surface water temperature conditions in Nkoro River, Niger Delta, Nigeria. Advance Journal of Food Science and Technology. 2010;2(1):36-40.
6. Abubakar KA, Haruna AB, Ladu BMB. Studies on fish yield, diversity, and abundance in Lake Gerio, Yola, Adamawa State, Nigeria. Nigerian Journal of Tropical Agriculture. 2005;7:91-97.
7. Adaka GS, Udoh JP, Onyeukwu DC. Freshwater diversity of a tropical rainforest river in southern Nigeria. Advances in Life Science and Technology. 2014;23:16-18.
8. Agbugui MO, Abhulimen EF, Inobeme A, Olori E. Biodiversity of fish fauna in River Niger at Agenebode, Edo State, Nigeria. Egyptian Journal of Aquatic Biology and Fisheries. 2019;23(4):159-166.
9. Dudgeon D, Arthington AH, Gessner MO, Kawabata ZI, Knowler DJ. Freshwater biodiversity: Importance, threats, status, and conservation challenges. Biological Reviews. 2006;81:163-182.
10. Babatunde DO, Raji A. Field Guide to Nigerian Freshwater Fishes. New Bussa, Nigeria: Federal College of Freshwater Fisheries Technology; 1998. p. 84-92.
11. Edoghotu AJ, George UU, Hart AI. The ichthyofauna and physico-chemical properties of Kugbo Creek in the Niger Delta, Nigeria. New York Science Journal. 2016;9(4). Available from: http://www.sciencepub.net/newyork
12. Emmanuel LO, Modupe OO. Fish diversity in three tributaries of River Ore, South West Nigeria. World Journal of Fisheries and Marine Science. 2010;2(6):524-531.
13. FAO. Fisheries Department. Rome: Food and Agriculture Organization of the United Nations; c2012.
14. Gabriel AA, Moses UT, Garba A. Fish species diversity and abundance of Gubi Dam, Bauchi State of Nigeria. Biological Diversity and Conservation. 2014. p. 1-9.
15. Galactos K, Barriga-Salazar R, Stewart DJ. Seasonal and habitat influences on fish communities within the lower Yasuni River basin of the Ecuadorian Amazon. Environmental Biology of Fishes. 2004;71:33-51.
16. Hooper DU, Chapin FS, Ewel JJ, Hector A, Inchausti P. Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. Ecological Monographs. 2005;75:3-36.
17. Ibim AT, Owhonda M. Composition and diversity of the fish fauna of Omuechi Stream, Aluu, Rivers State, Nigeria. IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT). 2017;11(1):34-39.
18. Ipinmoroti MO. Ichthyofauna diversity of Lake Asejire: Ecological implications. International Journal of Fisheries and Aquaculture. 2013;5(10):248-252.
19. Lawson OE, Moduke OO. Fish diversity in three tributaries of River Ore, South West Nigeria. World Journal of Fisheries and Marine Science. 2010;2(6):524-531.
20. Negi RK, Shetal M. Species diversity, abundance, and distribution of fish community and conservation status of Tons River of Uttarakhand State, India. Journal of Fisheries and Aquatic Science. 2013;8(5):617-626.
21. Odo GE, Didigwu NC, Eyo JE. The fish fauna of Anambra River Basin, Nigeria: Species abundance and morphometry. Revista de Biologia Tropical (International Journal of Tropical Biology). 2009;57(1-2):177-186.
22. Offem BO, Ayotunde EO, Ikpi GU, Ochang SN, Ada FB. Influence of seasons on water quality, abundance of fish, and plankton species of Ikwori Lake, South-Eastern Nigeria. Fisheries and Aquaculture Journal. 2011;13:1-18.
23. Ogbeibu AE, Oribhabor BJ. Ecological impact of river impoundment using benthic macro-invertebrates as indicators. Water Research. 2002;36(10):2427-436.
24. Okomoda VT, Solomon SG, Aladi SL. Fish fauna in Lower River Niger at Idah in Kogi State. Journal of Agricultural and Veterinary Science. 2012;4:34-40.
25. Olaosebikan BD, Raji A. Field Guide to Nigerian Freshwater Fishes. New Bussa, Nigeria: Federal College

of Freshwater Fisheries Technology; 2004. p. 111.
26. Sikoki FD, Zabbey N, Anyanwu N. Fish assemblage of Onu-Iyi-Ukwu Stream in southern Nigeria. Tropical Fish Biology. 2008;17(2):13-23.
27. Ude EF, Ugwu LLC, Mgbenka BO, Nwani CD. Baseline evaluation of length-weight relationship of fish species of Ebonyi River, Nigeria. Nigerian Journal of Fisheries. 2011;8(1):136-144.