Commentary Article

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Fish Biodiversity in Relation to Water Quality in River Benue Valley Adamawa State, North-Eastern Nigeria

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Abstract

Thirty-seven (37) species belonging to fifteen (15) families were identified during twelve months period of study (2020/21), on river Benue valley. Fish biodiversity and abundance showed a significance increase with increasing fishing efforts. The highest catch per unit effort was observed in Gongola/Benue confluents in Numan and kocheyel with more than 80.89kg/day and 78.29 kg/day with a cumulative fish weight of more than 432347.8kg per annum and 341931kg respectively. The lowest catch per unit efforts was observed in Parda and Gwakra with 24.97kg/day and 29.59 kg/day and a cumulative fish weight of 114321.5kg and 122008.2kg per annum respectively. Fishing gears used during the study indicates frequent use of gill/cast nets with 45% rate and traps at 43% rate, and other gears like hooks and line showed the lowest catch at 12%. The percentage composition of boats/canoes used during fishing was highest in Wurobokki at 25% and lowest in Parda with 13% rate. The highest number of fish species was observed in the family Claridae with five different spp and a cumulative number of 13119 fish followed by family Mormyridae with five spp with a cumulative number of 12075 fish and then followed by family, Cichlidae with four spp and a cumulative fish amounting to 12015. The lowest fish spp observed was Distichodoidae, Arapaimidae and Malapteruridae. Therefore, the most dominant fish amongst the family family were Claridae and Mormyridae and the near extinction fish family was Channidae. The dominant fish amongst the species were Alestes boremose followed by Schilbe intermedius, hydrocynus and Oreochromis. The decreasing number of fish species observed amongst the family Channidae was an indication that the river was under fishing pressure. Meanwhile, the mean physic-chemical parameters in the study areas revealed a normal water quality parameters throughout the year, except for the conductivity and total dissolved solid whose levels were high during raining season and low in the dry season. Results of the fish abundance indicates positive correlation with the water quality in all the stations studied. Hence, there were fish abundance and a sustainable livelihood amongst the fishermen.

Keywords: Abundance; Biodiversity; Species; family; Catch; Drag nets

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Introduction

In Nigeria fresh waters, lakes ecosystem have two groups of fishes identified based on their adaptive strategies [1]. Migratory fishes, they occupy environmental variability and exhibit a high fecundity and a short breeding period at the beginning of floods, the spawners concentrate in few sites, later disseminate in the whole river, where genetic mixing is enhanced. Most of those fishes have low fecundity, but can breed several times in a year; their young once survive due to parental care ranging from territorial behaviour associated with nest building to mouth brooding and their abundance depends on the variability of the

hydrological cycle both in space and time strategies. In Nigeria considering that all natural lakes and reservoirs are supplied with fish from the inflowing rivers, it is expected that the rivers will have high fish species diversity, but are not visible in the adjacent floodplains and wetlands, after each flood season during which the fishes breed. Thus the natural phenomena cause by drought or damming will disrupt the natural cycle of flooding which is bound to affect fish species diversity both in the natural, artificial and the wetlands [2]. At the dry season when the tide is low at brackish, coastal shores and in the freshwater fishing is very intense and low fishing is seen during raining season, decreasing exploitation when fishes are dispersed in the wetlands. All these lead to fishers to modify their fishing gears according to space and time diagram based on the hydrological cycle, being river Niger and Benue take their courses in the Sudano-sahel savannah they have high fish biodiversity composed of small sized fishes [3].

Water quality is the first most important limiting factor in fish production. It is also the most difficult production factor to understand, predict and manage. Water is not just where the fish live. Its quality directly affects feed efficiency, growth performances, the fish health and survival. Most fish deaths, disease outbreaks, poor growth, poor feed conversion efficiency and similar management problems are directly related to poor water quality. Water quality refers to anything in the water, be it physical, chemical or biological that affects the production of fish [4]. The chemistry of lake water is a cumulative reflection of catchment geology, weathering and erosional processes as well as anthropogenic inputs [5]. Pollution arising from anthropogenic substances is capable of altering a lake ecosystem and reduces its economic productivity. Organic wastes and other nutrient inputs from sewage and industrial discharges, agricultural and urban runoff can result in low oxygen level. Nutrient input often leads to excessive algal growth; when the algae die, the organic matter is decomposed by bacteria, a process which consumes a great deal of oxygen that could lead to oxygen depletion [6]. Low concentration of dissolved oxygen is known to be one of the major problems of faunal and floral survival in the aquatic environment, because it creates anoxic condition. High water temperature is known to enhance the growth of microorganisms. However, changes in temperature can have critical effect on living organisms. Relative depth of water at a particular site in a water body is one of the major physical factors controlling the water quality. Therefore, temperature and water depth relationship can provide vital information on Lake Ecosystem [7]. Water lakes and reservoirs are static (lentic), they water sources have different physical, chemical and biological characteristics which correspondingly affect the quality of fish [8-10]. In virtually every case a change in one of these factors may result in change to one or more of the other factors. Even though, there are many water quality variables in fish production only a few of these usually play important role. However, some parameters interact with other and influence the overall water quality [11]. The quality of water plays a vital role in the production of any water body. The fertility of water is related to its chemical properties which will determine the primary production such as planktons and micro-benthic invertebrates and that water quality influences fish survival, production and growth performance and the overall biological production of the water body and organisms, greenness appearance is one of the indicators of primary productivity and good water quality parameters. The importance of chemical factors is owing to their lethal and sub-lethal effect on aquatic organisms and also owing to their effect on biological productivity i.e. productivity of the organism in the food chain. The chemical aspects of water include dissolved gasses such as oxygen, carbon-dioxide and concentration of various ions.

The objective of this study was to determine fish biodiversity and abundance in relation to water quality (**Figure 1**).

Materials and Method

The direct method was used to obtaining data for the Biodiversity and fish abundance by deploying observers. Species composition and weights of fish. Areas and time fished were also recorded as described by. The fish samples were identified by identification

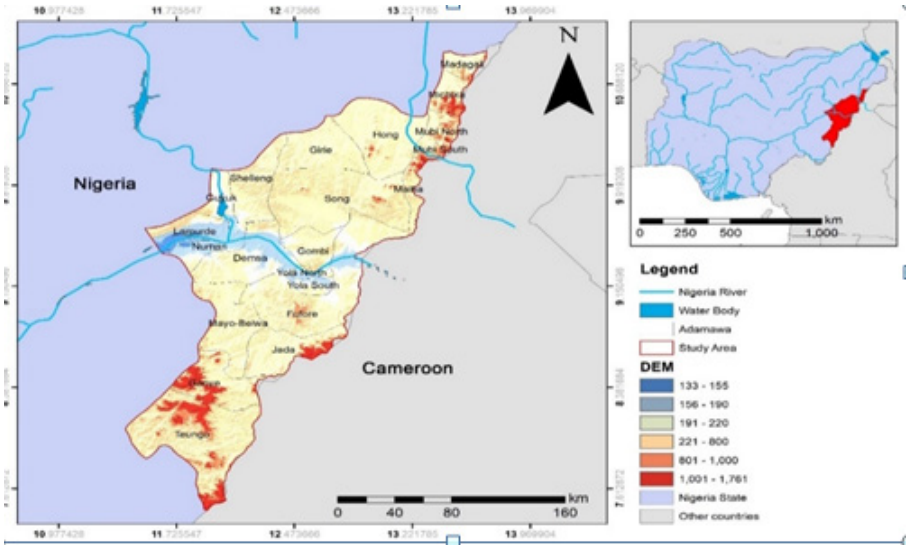

Figure 1 Study area.

key. Catch per Unit Efforts was estimated using the formula below. APHA (1995) was used to analyze physic-chemical parameters in all the lakes.

CPUE = Weight of fish species caught (Kg) /Time in hour.

Results were analysed and presented in a tabular and charts form. Microsoft excel 2010 and IBM SPSS statistics with the statistical tools employed.

Results and Discussion

Thirty-seven (37) species belonging to fifteen (15) families were identified in 2020/21. Fish biodiversity and abundance showed a significance increase with increasing fishing efforts. The highest catch per unit effort was observed in Gongola/Benue confluents in Numan and kocheyel with more than 80.89kg/day and 78.29 kg/day with a cumulative fish weight of more than 432347.8kg per annum and 341931kg respectively, **Table 1**. The lowest catch per unit efforts was observed in Parda and Gwakra with 24.97kg/day and 29.59 kg/day and a cumulative fish weight of 114321.5kg and 122008.2kg per annum respectively. Fishing gears used during the study indicates frequent use of gill/cast nets with 45% rate and traps at 43%, and other gears like hooks and line showed the lowest catch at 12%. The percentage composition of boats/canoes used during fishing was highest in Wurobokki at 25% and lowest in Parda with 13% rate **Figure 1**. The highest fish of different *spp* was observed in the family Claridae (five spp) and a cumulative number of 13119 fish followed by Cichlidae five spp with a cumulative number of 12015 fish and then followed by family Mormyridae (four spp) and a cumulative fish amounting to 12075. The lowest fish spp observed was Distichodoidae, Arapaimidae and Malapteruridae. The most dominant fish family in the study areas were Claridae and Cichlidae and the near extinction fish family was Channidae. The dominant fish amongst species was Alestes boremose followed by *Schilbe* intermedius, hydrocynus and Oreochromis respectively. The decreased number of fish species observed amongst the family *Channidae* was an indication that the river is under fishing pressure because, they were one of the most common families of fish species found mostly in abundance in Nigerian freshwaters and one of the most highly utilized fish species by fish consumers. Fish were caught by mesh nets and hooks. Drag/cast/gill nets and traps showed the highest gear utilization, while hooks and line appeared to be the lowest (**Tables 1 and 2, Figure 2**)

Field survey (2021)

Field survey (2021) Key :< 1=Extinct; 1-50 = Rare; 51-100 = Few; 101-200 = Common; 201-400 = Abundant; >400 = Dominant

Field survey (2021)

Study of the mean physic-chemical parameters revealed a seasonal water quality variations. The mean conductivity and Total Dissolved Solid appeared to be very high during the raining

Table 1. Catch per Unit Effort (CPUE) in 5 stations on River Benue per Annum.

Study areas	Total weight of fish caught (Kg)	Time (days)	Effort (CPUE)Kg
Kochiel	341931	4367	78.29
Parda	114321.5	4578	24.97
Numan	432347.8	5345	80.89
Gwakra	122008.2	4123	29.59
Wuro-bokki	321323.2	6743	47.65

Table 2. Fish species composition and abundance on River Benue valley, Adamawa.

Family	Fish Species	Kochiel (Fufore)	Parda (Fufore)	Gongola/Benue Confluence (Numan)	Gwakra/ Labondo (Girei)	Wuro-Bokki (fufore)	Total	Abundance score in lakes
Cichlidae	Sarotherodon galilaeus	125	100	107	112	120	564	Dominant
	Copton zilli	100	84	98	124	65	471	Dominant
	Oreochromis niloticus	2164	2341	1674	2294	1094	9,567	Dominant
	Hemichromis niloticus	230	323	250	470	230	1,405	Dominant
Total		2619	2858	2129	2900	1509	12,007	
Claridae	Clarias gariepinus	2307	3008	800	1087	900	7,102	Dominant
	Clarias angullaris	2113	901	711	1001	784	5,610	Dominant
	Heterobranchus bidorsalis	67	65	28	77	70	307	Abundant
	Heterobranchus longifilis	28	14	5	30	9	86	Small number
	Clarias lazera	4	2	1	4	3	14	Instinct/few
Total		4519	3990	1545	2799	1766	13,119	
Clarotidae	Chrysichtys auratus	103	78	82	93	88	444	Dominant
	Auchenoglanis occidentalis	408	309	403	510	515	2,145	Dominant

	Auchenoglanis biscutatus	209	198	274	318	128	1,127	Dominant
Total		720	585	759	921	731	3,716	
Cyprinidae	Labeo coubie	1907	1704	700	1901	1718	7,930	Dominant
	Barbus macrops	2600	2408	1011	1401	784	7,420	Dominant
Total		4507	4112	1711	3302	2502	15,350	
Schilbeidae	Schilbe intermedius	2807	2904	1408	2902	597	10618	Dominant
	Schilbe mystus	2013	2204	1107	1772	1377	8472	Dominant
Total		4820	5108	1515	4674	1974	18,090	Dominant
Bagridae	Bagrus filamentous	278	215	118	217	108	935	Dominant
	Bagrus bayad	412	217	188	258	214	1,289	Dominant
	Bagrus docmak	30	42	51	40	38	191	Common
Total		720	474	257	515	350	2,415	
Allestidae	Alestes baremose	2207	2477	1974	1889	2207	10,754	Dominant
	Hydrocynus forskali	4326	2611	1990	1704	1603	9,617	Dominant
Total		6533	5408	4104	3805	3797	21,440	
Citharinidae	Citharinus citharinus	217	127	102	137	140	723	Dominant
Total		217	127	102	137	140	723	
Protopteridae	Protopterus annectus	79	70	50	44	30	273	Abundant
Total		79	70	50	44	30	273	
Polypteridae	Polypterus senegalensis	17	14	9	14	3	79	Small number
	Polypterus bichir	55	3	2	4	4	30	Instinct/few
Total		72	17	11	18	7	109	
Mochokidae	Synodontis budgetti	2402	1056	1004	1911	578	5,950	Dominant
	Synodontis schall	1604	2107	2001	1104	1415	9029	Dominant
	Synodontis nigritta	5407	1374	1161	1191	1314	5644	Dominant
Total		9413	4477	4166	4206	3307	20623	
Mormyridae	Mormyrus rume	1722	1301	1114	1642	948	6616	Dominant
	Mercusenius senegalensis	98	1404	312	1124	331	4893	Dominant
	Hyperopius bebe	78	76	51	81	41	347	Abundant
	Mormyrops anguilloides	3509	39	24	58	22	219	Abundant
Total		5407	2820	1501	1905	1342	12075	
Distichodontidae	Distichodus rostratus	24	44	30	21	19	138	Common
Total		24	44	30	21	19	138	
Channidae	Parachanna africana	34	17	2	17	8	68	Small
	Parachanna obscura	58	14	12	11	2	73	Small
Total		92	31	14	28	10	141	
Malapteruridae	Malapterurus electricus	14	11	20	18	8	71	Small
Total		14	11	20	18	8	71	Small
	Heterotis niloticus	34	64	21	28	10	159	Common

season that was between months of March and September and dropped in the dry season that was between the months of October and February. All other parameters especially temperatures, transparency, ph., Dissolved Oxygen and depth revealed a steady levels throughout the year (**Figures 3 and 4**).

Field survey (2021)

The fish stock abundance on the river valleys was observed to be dependent on the fishing efforts, gears selectivity and species population density, fishing methods and season of the year. The highest catch per effort was 80.89kg and lowest of 24.97kg indicated that fishing efforts in a water body will be higher if

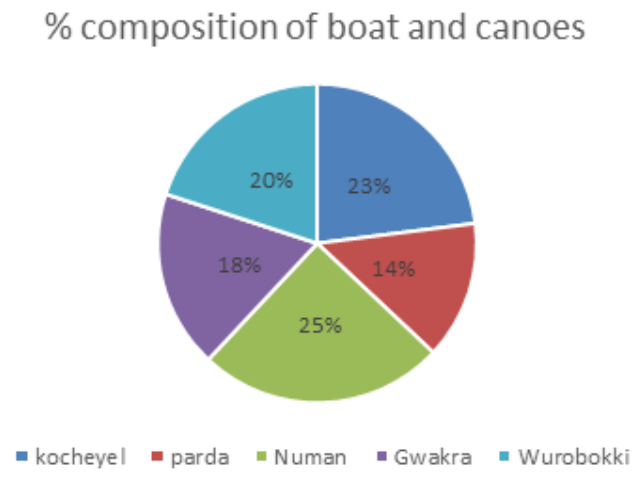

Figure 2 Percentage composition of boats and canoes in study areas.

the effort was small and catch was much and it depends on the weight of fishes caught divided by the time spent. The number of fishermen recorded against the boats used on all the stations, showed that some fishermen had more than one canoe and hired them to fishers to gain and check their gears and some were used for commercial transport to nearby markets and farms, despite the conditions of availability of canoes some fishermen used foot to cast their gears at shallow waters. Gill/cast nets were recorded as the highest in number used on the river and that could be attributed to the high catch per unit effort and the prohibition of the use of less than 76 millimeters of nets mesh size to construct any fishing gears or used on the river. There were different fishing gears and traps used on the river and the frequency indicated high level of computation amongst the fishermen due to over dependency on the water and increase their chances to survival since fishing is one of the major means for survival as well as reducing the chances of been redundant, where one gear failed to catch fish the other will do. Total of 15 families and 37 species of fishes were recorded and Claridae Cichlidae family

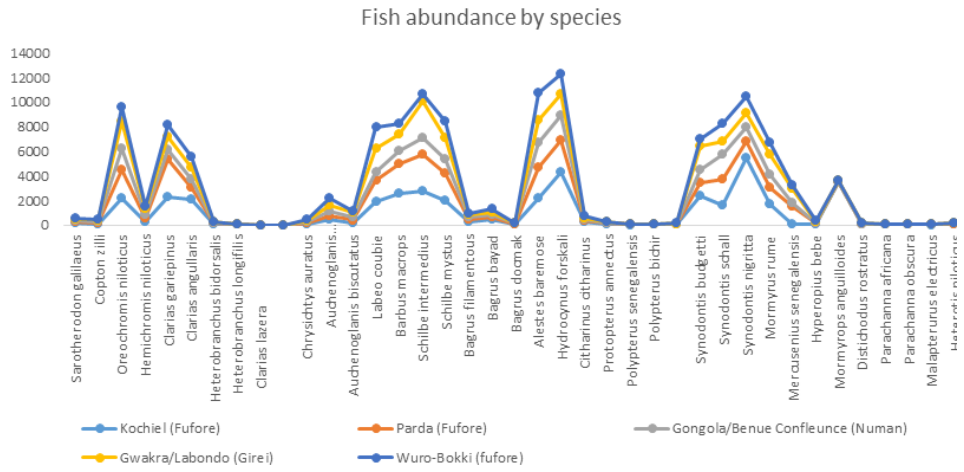

Figure 3 Fish species abundance on river Benue valley.

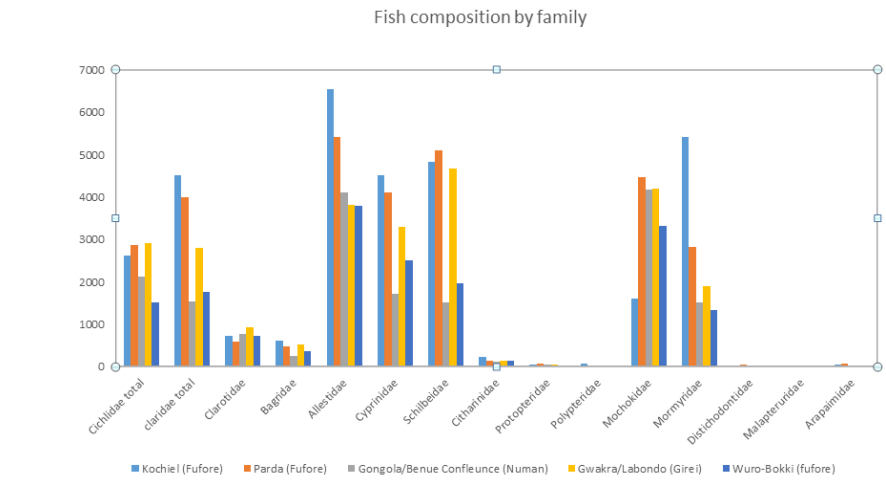

Figure 4 Fish composition by family on river Benue valley, North-eastern Nigeria.

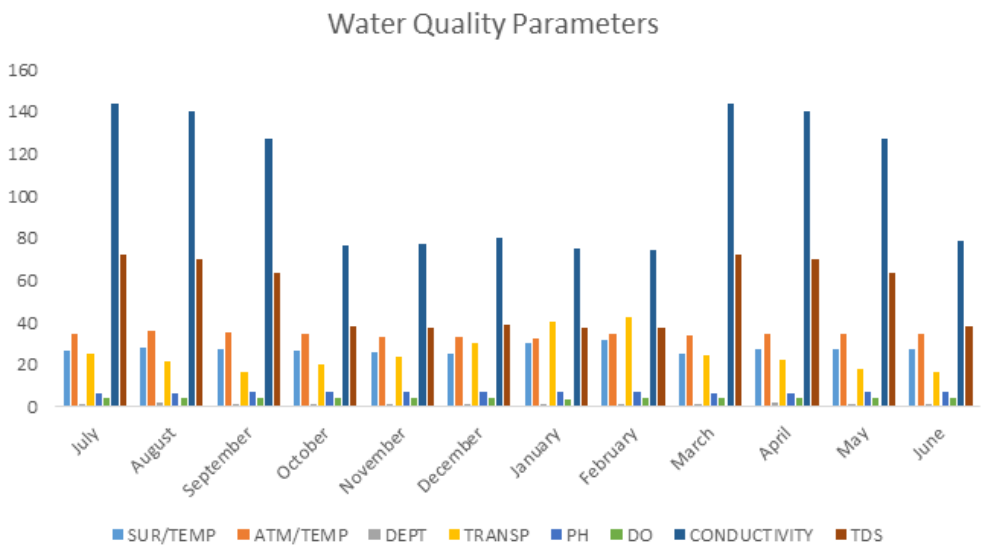

Figure 5 Physic-chemical parameters on river Benue Nigeria.

was among the dominant family in all the study areas. These may be due to their certain characters like high productivity rate, high sense of parental care after hatching, ability to breed in a swampy habitat with plenty organic matter to feed on by their fry, breed early during floods at the margins of advancing water, high fecundity, growth, and have high feeding ratio on aquatic macrophytes. These coincides with findings of and Polypteridae, Distichodontidae, channidae and Malapteruridae family were in an extinct form and could be attributed to over fishing. Fish were abundant in the dry season than rainy season, and that could be either because fish generally exhibit restricted movement during the rainy season to undergo breeding and thus become scattered into lakes for reproduction, feeding and escape being captured and or eaten by predators and also fish harvesting is usually very high at all the stations (**Figure 5**).

Conclusion

The families of fishers were extended and the physico-chemical and biological properties of the river valleys were within the recommended standard levels for maximum fish production.

Multiple gears were used to catch different fish species and family Distichodontidae, polypteridae, channidae, Malapteruridae and spp clarias lazera were becoming extinct at the lakes.

Recommendations

The production of mesh size net of less than 76millimeter should be discouraged to prevent overfishing of small fishes. Agricultural activities around the lakes should be discouraged because of possible residual deposit of agrochemicals that can lead water quality declination.

Limitations of the study

Even though the method used provides the most reliable data but, it is the most expensive and requires relatively well-trained personnel to manage and report the data accurately.

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