



A systematic review: Biodiversity of fishes in the River Benue and its impact in promoting aquaculture practices in Nigeria

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Abstract

The River Benue, one of Nigeria's major inland water bodies, supports a diverse array of fish species that play a crucial role in the local ecosystem and economy. This study aimed to review the biodiversity of fish species in the River Benue system. A systematic literature review of articles was used to carry out this research by synthesizing existing literature to provide a comprehensive understanding of the fish biodiversity in the river. Four articles were reviewed along the River Benue Basin up to the confluence. The articles covered Adamawa, Taraba, Benue and Kogi States. Twenty most occurring species in the catches were documented for each article. A total of 42 species from 17 families of fish were documented from the four articles reviewed. A study at River Benue Valley, Adamawa State, revealed *Alestes baremoze* and *Schilbe intermedius*, as the two most abundant species. The second article on Taraba State observed *Synodontis gambiensis*, *Siluranodon auratus*, *Mormyrus rume* and *Schilbe mystus* to be the most abundant in that region. *Clarias gariepinus* and *Tillapia zilli*, were observed to be the most abundant species from the third article on Benue State. *Hyperopisus bebe* and *Citharinus citharus* were the two most common species observed in the fourth research conducted in Kogi State at Idah town. *Clarias gariepinus* and *Synodontis schall* were observed to be readily available in all four locations reviewed. Further research on the domestication of these freshwater species in the River Benue system is recommended for more species diversity in our aquaculture sector to boost fish production.

Keywords: Biodiversity, fish, River Benue, aquaculture, Nigeria

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Introduction

Fishes are most researched species of aquatic organisms and they are the only food source harvested from natural populations. Fish are important because they contribute as much as 17% of the global animal protein reaching over 50 percent in several countries in Asia and Africa (NRC, 2005). The sector employs an estimated 58.5 million people in primary production alone – approximately 21% are women (FAO, 2022). Furthermore, fishes are often considered as engineers of aquatic ecosystems, not only react to physical and chemical changes in their environment, but they can also drive such changes and have important roles in cleansing and detoxifying their environment. (Ostroumov, 2005). Tropical freshwater small-scale artisanal fisheries provide cash income and animal proteins to many people in rural and urban areas of developing countries. Fish and fisheries have been increasingly threatened by man-made induced environmental changes, such as pollution, clearance for farmlands and cutting of trees for firewood (deforestation), habitat alteration like river impoundment, poor management and over exploitation, these decreases resource availability, resulting in poor income generation for fishing households and community (Amos and Linus, 2017).

The population of fishes in tropical water bodies experience fluctuations due to factors such as food composition and availability, spawning rate and changes in environmental factors (Ipinmoroti,

2013; Rodrigues and Cunha, 2017). A study (Welcomme, 2001) identified fishing, pollution and eutrophication among others as factors that could bring about series of changes in fish size, species composition and abundance in the aquatic environment. Over the past few decades, fish resources decreased dramatically, and endemic species have faced continuous threats globally (Guo *et al.*, 2018). It is a known fact that Overfishing, water diversion, pollution, global climate change, land erosion and other anthropogenic activities are considered as the main threats to fish biodiversity (Fu *et al.*, 2003; Arthington *et al.*, 2016).

The Benue River basin has undergone several changes caused by deforestation, overgrazing and land use change. For instance, deforestation for the purpose of large-scale agriculture which entails the cutting down of deep-rooted trees increases surface runoff. Intensification of agricultural practices on wetlands (which are floodplains) popularly known as Fadama has played a strong role in modifying the flow regime in the ecosystem. The Fadama ecosystem in Nigeria is very vast and rich in nutrients for cultivating crops like rice, sugarcane, and vegetables. As such, farmers usually are attracted to the area (Toro, 1997).

Therefore, the conservation of fish biodiversity has become more imperative and of utmost importance. The biodiversity of fish species in the river Benue plays a crucial in the development of aquaculture in the country. Local species of fish can easily be cultured and monitored because these

species have adapted to various environmental challenges in its natural habitat. Thus, aquaculture can be more viable when local species are cultivated to boost inland fish production. This study will help in highlighting the abundant fish species available. Also, identify suitable local species of fish that can be cultured to increase aquaculture productivity.

Materials and methods

River Benue is an international river flowing into Nigeria, originating from the highlands of northern Cameroon (Mayomi *et al.*, 2013). Only 350 km of the entire 1400 km length of River Benue is within the Cameroon territory. The river runs for about 950 km from the border to the confluence with River Niger at Lokoja, Kogi State. River Benue has two major hydrological water provinces in Nigeria - the Upper Benue and the Lower Benue. In Nigeria, River Benue is fed by tributaries from the two water provinces. Some of the major tributaries are Rivers Gongola, Kilunga, Mayo Ini, Mayo Belwa, Taraba, Donga, Ankwe and Katsina-Ala (FMWR, 1994). These rivers flow into the Benue before joining River Niger at Lokoja (Zoua *et al.*, 2020).

A systematic literature review of articles was used to carry out this research. The search engine 'Bing and Google Scholar' were used to browse the net for articles relating to the study. Keywords such as Articles, Biodiversity, River Benue, River Kogi Fish and Aquaculture, aided in streamlining the research articles acquired. A number of

18 articles were acquired from the net. Articles further were categorized based on location of study. Randomized sampling was used select four articles representing Four states (Adamawa, Taraba Benue and Kogi) which the river Benue flows through. inclusion criteria include articles must directly address or contribute to answering the research question or objective of the review, articles and journals published from the year 2014 till date, peer- reviewed articles published in reputable journals and articles reported in English language

Exclusion criteria include articles published in languages other than English, articles published before the year 2014, unpublished articles and research articles that were not carried out in the River Benue region in Nigeria and do not contribute to the objectives of the research.

Results and discussion

The river Benue is rich in various species of fresh water fishes comprising of multiple families. Four studies which were conducted along the River Benue Basin up to the confluence in Kogi State. Twenty most abundant fish species identified out of a total of a 42 species from 17 families of fin-fish encountered. In Table 1 highlights 20 most abundant fishes captured during the research in each article reviewed.

The first article (Modibbo, 2022) conducted its study in River Benue Valley Adamawa State, at five locations namely; Kochiel, Parda, Gongola/Benue Gwakra and Wuro-Bokki.

Table 1: 20 most abundant fish species Compiled from from four Articles.

S/ N	River Benue Valley, Adamawa State ¹⁶		Riverine wetlands Mayo Ranewo, Taraba State ¹⁷		River Fete Benue State ¹⁸		Confluence, Kogi State ¹⁹	
	Species	Percent	Species	Percent	Species	Percent	Species	Percent
1	<i>Alestes baremoze</i>	9.24%	<i>Synodontis gambiensis</i>	11.77%	<i>Tillapia zilli</i>	5.22%	<i>Hyperopisus bebe</i>	13.25%
2	<i>Schilbe intermedius</i>	9.12%	<i>Siluranodon auratus</i>	10.32%	<i>Heterotis niloticus</i>	5.16%	<i>Citharinus citharinus</i>	11.84%
3	<i>Hydrocynus forskali</i>	8.26%	<i>Mormyrus rume</i>	9.45%	<i>Auchenoglanis biscutatus</i>	5.09%	<i>Distichodontus rostratus</i>	9.82%
4	<i>Oreochromis niloticus</i>	8.22%	<i>Schilbe mystus</i>	8.91%	<i>Tilapia guntheri</i>	5.09%	<i>Clarias gariepinus</i>	9.13%
5	<i>Synodontis schall</i>	7.76%	<i>Labeo senegalensis</i>	7.38%	<i>Mormyrus rume</i>	5.05%	<i>Alestes baremoze</i>	5.87%
6	<i>Schilbe mystus</i>	7.28%	<i>Synodontis clarias</i>	5.43%	<i>Oreochromis niloticus</i>	5.05%	<i>Lates niloticus</i>	5.48%
7	<i>Labeo coubie</i>	6.81%	<i>Distichodontus rostratus</i>	4.89%	<i>Mormyrops deliciosus</i>	5.04%	<i>Alestes nurse</i>	5.06%
8	<i>Barbus macrops</i>	6.37%	<i>Bagrus bayad</i>	4.72%	<i>Sarotherodon galilaeus</i>	5.04%	<i>Synodontis nigritta</i>	4.98%
9	<i>Clarias gariepinus</i>	6.10%	<i>Petrocephalus bane</i>	4.60%	<i>Hemichromis faciatu</i>	5.03%	<i>Oreochromis niloticus</i>	3.67%
10	<i>Mormyrus rume</i>	5.68%	<i>Auchenoglanis occidentalis</i>	4.23%	<i>Bagrus bayad</i>	5.02%	<i>Schilbe mystus</i>	3.55%
11	<i>Synodontis budgetti</i>	5.11%	<i>Mormyrus macrophthalmus</i>	4.23%	<i>Bagrus decimac</i>	5.00%	<i>Synodontis membranaceus</i>	3.41%
12	<i>Synodontis nigritta</i>	4.85%	<i>Clarias gariepinus</i>	4.19%	<i>Petrocephalus bovei</i>	5.00%	<i>Tillapia zilli</i>	3.29%
13	<i>Clarias anguillaris</i>	4.82%	<i>Marcuseniusa badii</i>	4.06%	<i>Clarotes laticeps</i>	4.99%	<i>Protopterus annectens</i>	3.11%
14	<i>Mercusenius senegalensis</i>	4.16%	<i>Alestes nurse</i>	3.52%	<i>Synodontis nigritta</i>	4.98%	<i>Clarias anguillaris</i>	2.92%
15	<i>Auchenoglanis occidentalis</i>	1.84%	<i>Synodontis schall</i>	2.74%	<i>Gymnarchus niloticus</i>	4.96%	<i>Mormyrops deliciosus</i>	2.84%
16	<i>Heterotis niloticus</i>	1.21%	<i>Hyperopisus bebe</i>	2.20%	<i>Clarias anguillaris</i>	4.93%	<i>Heterotis niloticus</i>	2.84%
17	<i>Bagrus bayad</i>	1.11%	<i>Clarotes laticeps</i>	2.03%	<i>Clarias gariepinus</i>	4.90%	<i>Synodontis gambiensis</i>	2.40%
18	<i>Auchenoglanis biscutatus</i>	0.97%	<i>Synodontis membranaceus</i>	1.95%	<i>Alestes nurse</i>	4.82%	<i>Channa Obscura</i>	2.32%
19	<i>Citharinus citharinus</i>	0.62%	<i>Alestes baremoze</i>	1.74%	<i>Synodontis schall</i>	4.82%	<i>Synodontis schall</i>	2.22%
20	<i>Sarotherodon galilaeus</i>	0.48%	<i>Tillapia zilli</i>	1.66%	<i>Citharinus citharus</i>	4.80%	<i>Labeo Senegalensis</i>	2.00%

Table1 highlights 20 most abundant fishes captured during the research, *Alestes baremoze*, *Schilbe intermedius*, *Hydrocynus forskali*, *Oreochromis niloticus* and *Synodontis schall* were observed to be the five most abundant species respectively. The second study (Danba *et al.*, 2020) was conducted in

the Riverine wetlands of Mayo Ranewo Taraba State, Mayo Ranewo Local government area. In this article, *Synodontis gambiensis*, *Siluranodon auratus*, *Mormyrus rume*, *Schilbe mystus*, *Labeo senegalensis* had the highest population respectively. The third study (Iber and Ojutiku, 2018) was

conducted in River Fete Benue state, 20 most abundant species were extracted from the research where by *Clarias gariepinus*, *Tillapia zilli*, and *Oreochromis niloticus* were observed to be the most abundant species. The fourth article (Abiodun and John, 2017) carried out its research in Lower Niger river Idah Kogi state. Table 1 highlights 20 most abundant fishes captured during the research in each article reviewed. *Hyperopisus bebe*, *Citharinus citharus*, *Distichodontus rostratus*, *Clarias gariepinus* and *Alestes baremoze* were the five most populated fish species.

Two fish species as observed in table 2 (highlighted in red) namely; *Clarias gariepinus* and *Synodontis schall* were discovered to be readily available in all four articles reviewed in this study. *Synodontis schall* has been reported to be able to adapt to many different kinds of food and habitats, increasing the chances of survival (Abu-Gideiri and Nasr, 1973). *Clarias gariepinus* has only been documented for being the most cultivated fish species in Nigeria, although it was endemic to Africa, commercial culture of this catfish only started in the early 1970s (Beveridge and Haylor, 1998). The findings of this review align with the report that *Clarias gariepinus* has all the qualities of an aggressive and successful invasive species. Its high fecundity, flexible phenotype, rapid growth, wide habitat preferences, tolerance to extreme water conditions and the ability to subsist on a wide variety of prey can devastate indigenous fish and aquatic invertebrate populations (Bruton, 1986).

Nine species (Table 2: highlighted in green) were readily available at the confluence in Kogi and two of three articles conducted along River Benue Basin in Nigeria. These species were *Alestes baremoze*, *Schilbe mystus*, *Alestes nurse*, *Clarotes laticeps*, *Synodontis nigritta*, *Tillapia zilli*, *Clarias anguillaris*, *Heterotis niloticus* and *Citharinus citharus*.

Two fish species namely; *Mormyrus rume* and *Bagrus bayad* as observed in Table 2 (highlighted in yellow) were found to be readily available in all three-article research conducted in the river Benue Basin but were not readily available at the confluence in Kogi.

A study (Nhan *et al.*, 2007) postulates that, habitat heterogeneity and fragmentation, land use change, climate change, eutrophication and invasive species are the most prevalent driving factors in freshwater biodiversity studies. Fish species (highlighted in Table 2) were observed to be readily available in atleast three of four articles reviewed for this study, signifying that these species have good adaptive, locomotive and reproductive ability to withstand factors influencing biodiversity. These characteristics make them suitable for aquaculture production.

The Order *Siluriformes* (Catfish) was the most diverse in this study. Families of this order such as *Claridae*, *Clarotidae*, *Mochochidae* and *Schilbeidae* can be further studied to improve inter- species polyculture in the country.

Table 2: 20 most abundant fish species across four articles conducted at Adamawa, Taraba, Benue and Kogi State, respectively.

S/N	Class	Order	Family	Species	River Benue Valley Adamawa ¹⁶	Riverine wetlands Mayo Ranewo, Taraba ¹⁷	River Fete Benue ¹⁸	Confluence Kogi State ¹⁹
		Characiformes	Alestidae	<i>Alestes baremoze</i>	+	+	-	+
				<i>Hydrocynus forskali</i>	+	-	-	-
		Characidae		<i>Alestes nurse</i>	-	+	+	+
		Bagridae		<i>Bagrus bayad</i>	+	+	+	-
				<i>Bagrus docmak</i>	-	-	+	-
		Claridae		<i>Clarias anguillaris</i>	+	+	+	+
				<i>Clarias gariepinus</i>	+	+	+	+
				<i>Auchenoglanis occidentalis</i>	+	+	-	-
		Clarotidae		<i>Auchenoglanis biscutatus</i>	+	-	+	-
				<i>Clarotes laticeps</i>	-	+	+	-
		Siluriformes		<i>Synodontis budgetti</i>	+	-	-	-
				<i>Synodontis clarias</i>	-	+	-	-
				<i>Synodontis schall</i>	+	+	+	+
		Mochochidae		<i>Synodontis gambiensis</i>	-	+	-	+
				<i>Synodontis membranaceus</i>	-	+	-	+
				<i>Synodontis nigrita</i>	+	-	+	+
				<i>Schilbe intermedius</i>	+	-	-	-
		Schilbeidae		<i>Schilbe mystus</i>	+	+	-	+
				<i>Siluranodon auratus</i>	-	+	-	-
		Perciformes	Centropomidae	<i>Lates niloticus</i>	-	-	-	+
	Actinopterygii			<i>Oreochromis niloticus</i>	+	-	+	+
				<i>Sarotherodon galilaeus</i>	+	-	+	-
		Cichliformes	Cichlidae	<i>Tilapia zillii</i>	-	+	+	+
				<i>Tilapia guntheri</i>	-	-	+	-
				<i>Hemichromis fasciatus</i>	-	-	+	-
		Gymnarchidae		<i>Gymnarchus niloticus</i>	-	-	+	-
		Osteoglossidae		<i>Heterotis niloticus</i>	+	-	+	+
				<i>Mormyrus rume</i>	+	+	+	-
				<i>Mercusenius senegalensis</i>	+	-	-	-
		Osteoglossiformes		<i>Hyperopisus bebe</i>	-	+	-	+
				<i>Petrocephalus bane</i>	-	+	-	-
		Mormyridae		<i>Mormyrus macrothalmus</i>	-	+	-	-
				<i>Marcusenius abadii</i>	-	+	-	-
				<i>Petrocephalus bovei</i>	-	-	+	-
				<i>Mormyrops deliciosus</i>	-	-	+	+
				<i>Labeo coubie</i>	+	-	-	-
		Cypriniformes	Cyprinidae	<i>Barbus macrops</i>	+	-	-	-
				<i>Labeo senegalensis</i>	-	+	-	+
		Anabantiformes	Channidae	<i>Channa obscura</i>	-	-	-	+
		Characiformes	Distichodontidae	<i>Distichodontus rostratus</i>	-	+	-	+
			Citharinidae	<i>Citharinus citharus</i>	+	-	+	+
	Dipnoi	Ceratodontiformes	Lepidosirenidae	<i>Protopterus annectens</i>	-	-	-	+

Legend: + = Dominant specie present - = Dominant specie absent  = Dominant in Kogi and 2 of 3 studies at River Benue  = Dominant in all 3 studies at river Benue excluding Kogi = Dominant in all four for articles (river Benue and Kogi)

Conclusion

The Anthropocene has brought numerous threats to freshwater systems including rapid population decline and highrisk extinction of local species. Freshwater habitats offer highly valuable ecosystems services to nature and human beings. Therefore, it is paramount for a fast-growing population of the country to improve aquaculture yield to meet demand. Culture of local species can be engineered to meet the protein demand of the populace, provide

farmers with variety of local species for aquaculture, regulate overfishing and human influence to preserve biodiversity of aquatic species and its habitat.

In Nigeria, the most cultivated fish family for aquaculture purposes is *Claridea* due to its good adaptive features to environmental change and growth rate. Therefore, more research into the adaptive features of the many identified freshwater finfish species is encouraged for possible domestication.

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