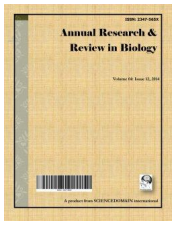

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A Study of Fish Diversity of Two Lacustrine Wetlands in the Upper Benue Basin, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author DLD designed the study, wrote the protocol and interpreted the data. Authors DLD and BWD anchored the field study, gathered the initial data and performed preliminary data analysis. While authors JAW, UNB and BDA managed the literature searches and produced the initial draft. All authors read and approved the final manuscript.

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ABSTRACT

The studies were conducted to evaluate the fish species diversity of two lakes viz: Kiri and Gyawana, at monthly intervals for the period of two years. Fish records were based entirely on the landings of fishermen. Fish were sorted into taxonomic groups, identified to family or species level, counted and weighed in groups by species. 57 species in 16 fish families were observed at Kiri Lake and 40 species in 16 fish families were observed at Gyawana Lake. There was no significant difference in species diversity within fish families in Kiri and Gyawana lakes (P>0.05). Under criteria 1 and 4 of the Ramsar, both Kiri and Gyawana Lakes were qualified as Ramsar sites. This result further confirmed how urgent and critical our natural wetland ecosystems especially the Kiri and Gyawana Lakes should be conserved.

Keywords: Fish diversity; lakes; wetlands; Nigeria.

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1. INTRODUCTION

Wetlands were often regarded as wastelands because of some problems like disease vectors associated with them [1,2]. They are considered as important elements of Nigeria's watershed systems [3,4]. Asibor, [4] also stated that, for an area to be considered a wetland, it must possess water, wetland plants and wetland soils. However, in 1972 at Ramsar, Iran, the issues on wetlands were key at the international environmental convention, organized to specifically deliberate on conservation of the world's wetlands.

At that Convention, the following criteria were used for the identification of wetlands of international importance:

1.1 Criteria Representing Unique Wetlands

A wetland is characterized internationally important if meets any of the following characteristics:

a. It should be a good representative of a natural or near-natural wetlands (characteristics of an appropriate bio-geographical region);
b. Wetland should play a substantial hydrological, biological or ecological role in the natural functioning of a major river basin or coastal system.
c. It should be able to be a good example of a specific type of wetland, which very rare or unusual in the proper bio-geographical region.

1.2 Criteria Directed to Plants or Animals

A wetland is characterized internationally important if meets any of the following characteristics:

d. It should be able to supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plants and animals, or an appreciable number of individuals of plants and animals;
e. It should have a special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna;
f. It should have a special value as the habitat of plants or animals at some stage of their life cycle;
g. It should be of special value for one or more endemic plants or animals species or for the communities.

1.3 Criteria Directed to Waterfowl

A wetland is characterized internationally important if meets any of the following characteristics:

h. It should be able to regularly supports about 20,000 waterfowls;
i. It should also be able to support substantial numbers of individuals regularly from certain groups of waterfowl;
j. In a situation where data on populations are available, it should be able to support 1% of the individuals in a population of one species or subspecies of waterfowl regularly.

1.4 Criteria Directed to Fish

A wetland is characterized internationally important if meets any of the following characteristics:

k. It should be able to support a reasonable number of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representing wetland benefits and/or values and thereby contributing to global bio-diversity;
l. It is should be able to provide food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere.

(Source: Ramsar Convention Website; www.ramsar.org [5]).

With an estimated over 14 million hectares of inland water bodies in Nigeria being fished [6], the inland water bodies still exert pressure especially from the artisanal fishermen, who predominantly supply about 90% of domestic fish need in Nigeria [7]. According to Ahmed and Yusuf [8], Nigerians consume about 1.2 million metric tonnes of fish which is the largest in Africa. Eni et al. [9] reported that the pressures contributing to wetland utilization in Nigeria include population pressure on the highlands leaving wetlands as alternatives for cultivation, poor methods of grazing in the wetlands as the only suitable place for growing crops, scarcity of building materials such as reeds, poles and so

on and low supply of fish leading to establishment of fish ponds in wetlands. The pressure can lead to ecological imbalances in wetlands as the products are not used sustainably. The focus on fishes to be utilized sustainably is because the ICBP [10] postulated that they are good bio-indicators of the wellbeing of aquatic ecosystems as well as a cheap source of protein. Ogbe [11] reported that fish provides 21% and 28% of animal protein in Africa and Asia respectively. Globally, fish requirements for direct human consumption will double in the next ten years, yet we are already over – fishing most of our marine stocks and future yields are unlikely to increase significantly. Inland fisheries are supplying an increasing amount of this fish. Today they provide 12% of fish directly consumed by human and this is rising with widespread unsustainable exploitation too. The awareness generated by the Ramsar convention, led to the research works of Fiselier [12] and Barbier et al. [13] in which wetlands began to be recognized as very important and valuable ecosystems. Wangari [14] is of the view that scientific literature on tropical wetlands is poor, and that gaps stills exist in our knowledge of these important ecosystems. The percentage of Nigerian land under environmental reservation has declined from the near 11% of the 1980s as result of habitat degradation and loss, brought about by environmentally unfriendly anthro-pogenic activities. This has prompted the need for identification and placing of more land areas under some form of environmental protection especially for fish. It is with a view to contributing to the identification of such sites of conservation significance that this study was conceived and carried out.

2. MATERIALS AND METHODS

In the Upper Benue River Basin near Numan (9°30'N, 12°05'E), the studies were conducted on Kiri Lake (9°40'N, 12°00'E), and Gyawana Lake (9°33' N, 11°49' E) as shown in Figs.1a, b and c between January, 2004 to December, 2005.

Fish records were based entirely on the landings of fishermen. The numbers of canoes that land fish at each of the study sites were counted. Fish were sorted into taxonomic groups, identified to family and species level, counted and weighed in groups by species. A field guide to Nigerian freshwater fishes [16], the illustrated key to the fishes of Lake Kainji [17] and West African Freshwater Fish [18] were used as field identification guides.

Ita [19] and Opara and Al-Juflaili [20] reported that processing and preservation of fish is carried out for the purpose of extending the shelf-life of fish. The major processing and preservation methods are:

- **Chilling**: Chilling may be defined as cooling of fish to low temperature without necessarily hardening fish. Chilling does not prevent spoilage.

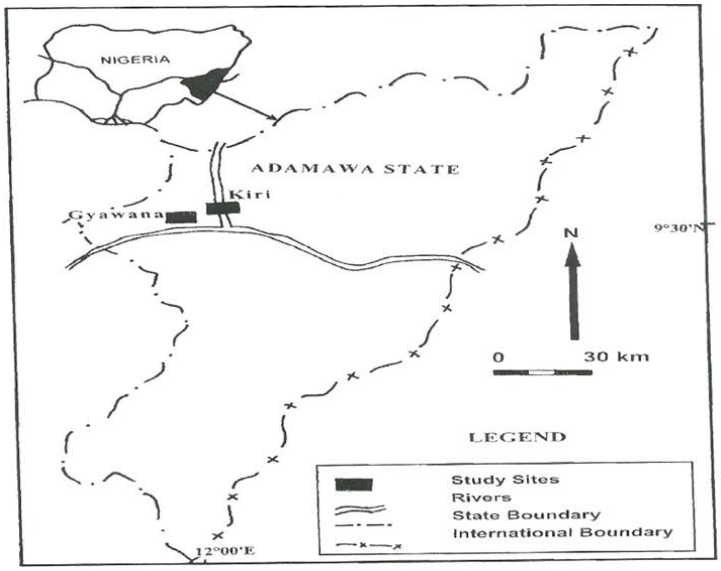

Fig. 1a. Map of Adamawa state showing the study sites

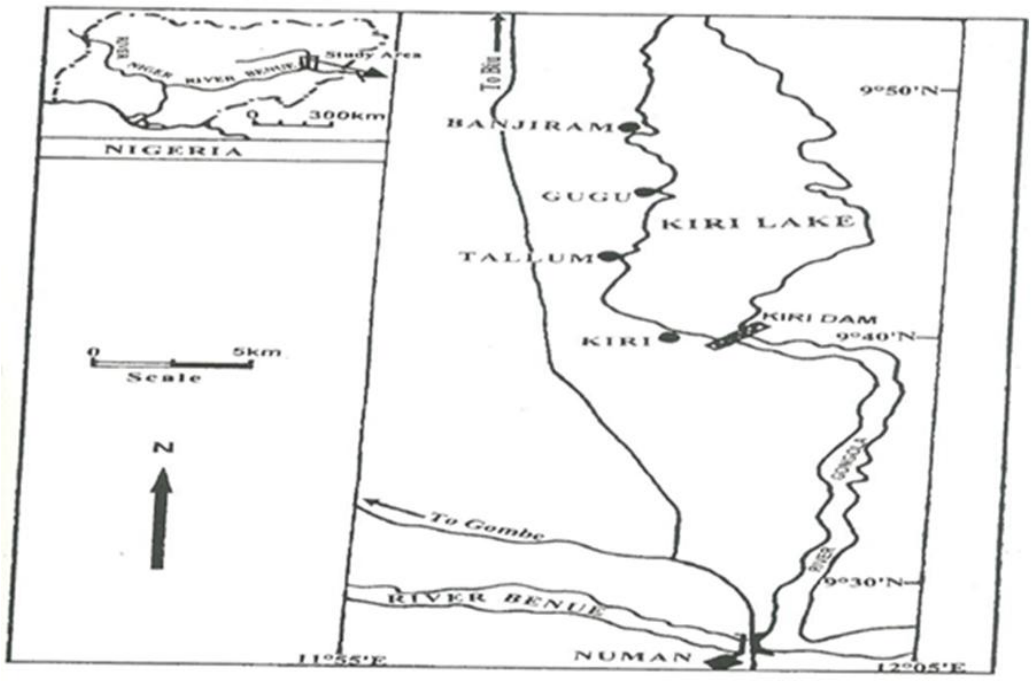

Fig. 1b. The location of Kiri study site

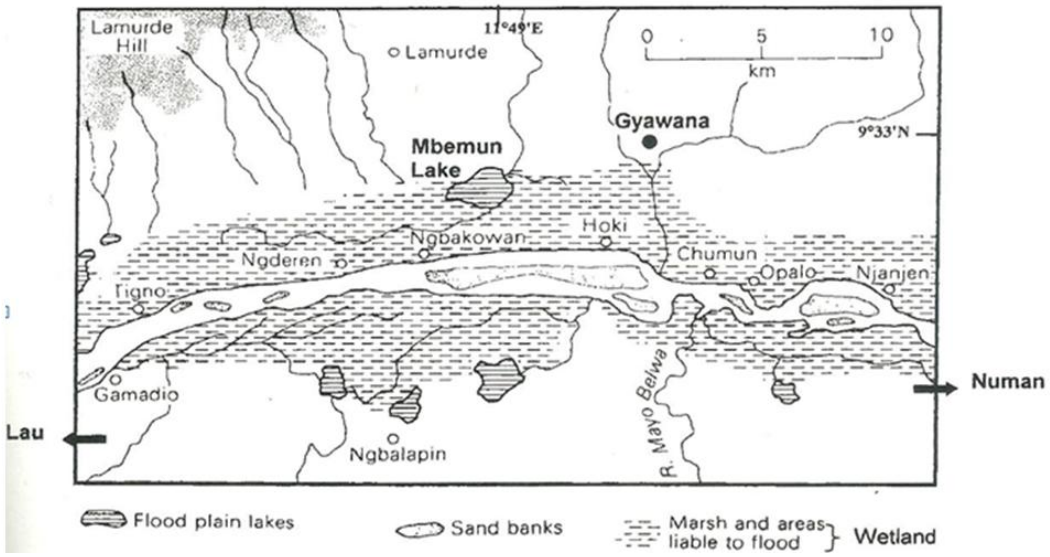

Fig. 1c. The location of Guawana study site
Source: Buckle [15].

However, the colder the fish the better and the lower are the incidence of microbial or enzymatic spoilage [19].

- **Super chilling**: This is not a common method. Super chilling implies reducing the temperature of fish uniformly below 0°C. At this temperature, half the water in the fish freezes; bacteria action is greatly reduced and shelf-life is extended [19].
- **Freezing**: Freezing is distinct from chilling of fish. Freezing can keep products in near perfect condition for very prolonged periods. Freezing is essential for export

purpose. Freezing becomes extremely effective if it is combined with cold storage [21].

- **Drying:** Is the removal of water by evaporation. When applied to fish, drying is the removal of water by any method as a means of fish preservation to prolong the shelf life. In areas where sun drying is used traditionally, the effects of wind and weather conditions are important. Basically, the drying effect of the sun depends on the emission of heat from the sun. This is transferred to the fish and it is accompanied by heat transfer within the fish. During drying, the fish shrinks and undergoes irreversible changes [22].
- **Fermentation:** Majority of the methods used in fish preservation involves the removal of water. These processes involve drying by use of either heat or smoke. The method that may be employed determines the end product flavor and texture. Fermentation methods have been widely employed to conserve or utilize surplus products [19,20].
- **Smoking:** This is a popular traditional method of fish preservation in most developing countries. Smoking combines the effect of the destruction of bacteria by compounds in the smoke such as phenols and the cooking of the fish, since high temperatures will be generated. Smoked fish products have long shelf life, which has been attributed to the drying and cooking effect. When wood and sawdust are burnt, smoke is produced as a result of incomplete combustion. The smoke produced depends on the amount of air available and the quantity of wood or sawdust [23].
- **Salting:** There are four standard methods of salting fish. These are brine, drying, kench and pickle salting methods.

  a. **Brine salting:** This process involves the immersion of the fish in a solution of salt in water.
  b. **Drying salting:** This is the process whereby the granular salt is rubbed on the surface of fish.
  c. **Kench salting:** In this process, the salt is rubbed on the surface of split fish and the fish are stored with salt placed between each layer of fish.
  d. **Pickle salting:** The fish are packed in watertight containers with salt between each layer of fish [24].

Following the statistical procedures described by Fowler and Cohen [25] and Sokal and Rohlf [26], Mann-Whitney U-tests were used to compare possible differences in fish diversity between the two Lakes.

3. RESULTS

In the two study sites, the number of species observed were noted and compiled as shown in Table 1.

In Table 2, comparison of the diversity of vertebrate class at family, genus and species levels is shown.

From Table 2, 57 species were observed in 16 fish families at Kiri Lake while 40 species were observed in 16 fish families at Gyawana Lake. When compared, there was no significant difference ($p \leq 0.05$; Mann-Whitney U-test) in species diversity within fish families in Kiri Lake and Gyawana Lake.

Table 3, shows the comparison of the biotic characteristics of Kiri Lake and Gyawana Lake following the criteria used in assessing sites with characteristics of Ramsar site.

4. DISCUSSION

The fish diversity of the two Lakes represents a significant percentage of Ita's [27] record of 239 species in 46 families of freshwater fish in Nigeria. 106 species in 26 families of fresh water fish in major reservoirs/lakes in Nigeria was also recorded by Ita [27] out of which 21 species in 10 families was recorded at Kiri Lake, while there is no documented record for Gyawana Lake. 104 species in 24 families at Kainji Lake, 27 species in 10 families at Shiroro Lake; 50 species in 20 families at Jebba Lake. Variation in catchability as reported by Gulland [28] may be attributed to the type of gear used, the weather or other environmental condition, and the time (during migration).

The diverse numbers of fish species may be resulted from the aquatic microphytes and macrophytes (flora), good number of aquatic insects including their larval stages (fauna) that were supported by the Kiri Lake and Gyawana Lake as food, cover or shelter.

The droppings and egested pellets of the birds are used as food for the fishes especially around heronries. This study contradicts Ita [27], in which less fishes were observed at Kiri Lake.

Table 1. Comparative fish species diversity of Kiri and Gyawana lacustrine ecosystems

Family/species	Hausa name	Kiri-2004	Gyawana-2004	Kiri-2005	Gyawana-2005	Comments
Anabantidae-Climbing perches						
Ctenopoma kingsleyae	Karpas bado	-	*	-	*	
Bagridae-Catfishes						
Bagrus bayad	Doza (Rago ruwa)	*	*	*	*	Tail tinged red.
Bagrus docmac	Dinko	*	*	*	*	
Chrysichthys auratus	Kurkoni	*	-	*	-	Fins are yellowish
Chrysichthys longifilis	Sarkin kwata	*	-	-	-	
Chrysichthys nigrodigitatus	Sarkin kwata	*	-	*	-	Adipose fin round and not rayed.
Chrysichthys spp.	Yaka yaka	*	-	-	-	
Clarotes macrocephalus	Barushe	*	-	-	-	
Bagrus filamentosus	Rago ruwa	*	-	-	-	
Clarotes laticeps		-	-	*	-	Only species with rayed adipose fin proceeded by a spine; Fin is pointed.
Auchenoglanis biscutatus		-	-	*	-	
Centropomidae-Niger Perch (Elephant of the water)						
Lates niloticus	Giwan ruwa	-	-	*	-	Most characteristic feature is the first dorsal fin with strong spines.
Channidae-Snakehead						
Channa obscura	Dumna	-	*	*	*	Has a distinctive head.
Characidae-Tigerfish						
Hydrocynus forskahlii	Sage	*	-	*	*	Fearsome array of teeth.
Alestes nurse	Kawara	*	*	*	*	Conspicuous spot behind operculum. Caudal fin pink to bright red colour.
Alestes baremose	Shemani (jaga jaga)	*	*	*	*	
Alestes macrolepidotus	Kawara (shemani)	*	*	*	-	Large scaled; Largest species of Alestes.
Hydrocynus vittatus (lineatus)	Sagai	*	-	*	-	
Alestes leuciscus	Shemani	-	-	*	-	Dark spot on either side of the

Family/species	Hausa name	Kiri-2004	Gyawana-2004	Kiri-2005	Gyawana-2005	Comments
						caudal peduncle.
Alestes sp.	Gamre	*	-	*	-	
Alestes imberi		-	*	-	-	
Cichlidae-perch-like fish						
Oreochromis niloticus	Karpasa	*	*	*	*	
Tilapia zillii		*	*	*	*	Dominant specie.
Sarotherodon galilaeus	Karpasa	*	*	*	*	
Tilapia aurea	Karpasa Barkin karp	-	*	-	-	Vertical bars of dorsal fin replaced by clear spot.
Hemichromis bimaculatus	Kausa	-	*	-	*	Change color within seconds when startled. Has three dark spot on each side of the body.
Hemichromis fasciatus	Zambai	*	-	-	*	
Citharinidae-moonfish						
Citharinus citherus	Pallia	*	*	*	-	
Clariidae-Catfishes						
Clarias gariepinus	Tarwada	*	*	*	*	Rayed dorsal fin extends the whole length of the body; Do not possess lungs; Breathe air.
Clarias anguillaris	Tarwada	*	*	*	*	Same as above
Clarias spp.	Tarwada	*	-	-	-	Same as above
Heterobranchus bidorsalis	Jerri (marri)	-	*	-	-	Has a rayed dorsal followed by a large adipose fin.
Cyprinidae-African carp						
Labeo senegalensis	Datta	*	*	*	*	
Labeo coubie	Bakin data	*	-	*	*	
Raiamas senegalensis	Jangali	*	-	-	-	
Distichodontidae -Moonfish (Grass-eaters)						
Distichodus brevipinnis	Chichiyawa	*	*	*	*	
Distichodus rostratus	Chichiyawa	*	*	*	-	
Gymnarchidae-elephant-snout fish						
Gymnarchus niloticus	Yauni (Dan sarki)	*	*	*	*	Have electric organs; Move

Family/species	Hausa name	Kiri-2004	Gyawana-2004	Kiri-2005	Gyawana-2005	Comments
						backward and forward with some agility.
Lepidosirenidae-Lungfish						
Protopterus annectens	Bodami	-	*	*	*	Has pair of lungs which enable it to breathe; Only species which aestivate; Ancient fish.
Malapteruridae-Catfish						
Malapterurus electricus	Mijiriya	-	-	*	-	Gives an electric shock when handled carelessly; Has an electric organ.
Mochokidae-Catfishes						
Synodontis clarias	Kurungu	*	*	*	*	Breathe air though no lungs; fins have serrated spines, which make it difficult to handle; Presence of spines in the front of dorsal fin.
Synodontis nigrita	Kurungu	*	*	*	*	Same as above
Synodontis membranaceus	Kurungu (Farin golaki)	*	*	*	-	Same as above, upside-down catfish, habitually swims in an inverted position with belly uppermost
Synodontis gambiensis	Kurungu	*	*	*	-	Same as above
Synodontis violaceus	Kurungu	*	-	-	-	Same as above
Synodontis batensoda	Kurungu	*	-	-	-	Same as above
Synodontis filamentosus	Kurungu	*	-	*	-	Same as above
Synodontis ocellifer	Kurungu	-	*	*	-	Same as above
Synodontis eupterus	Kurungu	-	-	*	-	Same as above
Mormyridae-Elephant-Snout fish						
Marcusenius psittacus	Kuma	*	*	-	*	Have electric organs situated on each terminal portion of the tail, which aid poor sight.
Petrocephalus bane	Farin wata	*	*	*	-	Same as above
Gnathonemus abadii	Parpar	*	*	*	-	Same as above
Mormyrus macrophthalmus	Gandaga (Maikolli)	*	-	*	-	Same as above
Hyperopisus bebe	Budock (Hura)	*	-	*	-	Same as above
Mormyrops deliciosus	Milligi	*	-	*	-	Same as above

Family/species	Hausa name	Kiri-2004	Gyawana-2004	Kiri-2005	Gyawana-2005	Comments
Mormyrus rume	Gandaga	*	-	*	*	Same as above
Gnathonemus niger	Kuma	*	-	-	-	Same as above
Petrocephalus bovei	Faya	-	*	-	-	Same as above
Osteoglossidae						
Heterotis niloticus	Bargi	-	*	-	*	Ancient fish
Polypteridae-Sailfin						
Polypterus senegalus	Garsa	*	*	-	*	Has lungs though can survive out of the water for long.
Schilbeidae-Catfishes						
Siluranodon auritus	Sole (Aflo Bokoloji)	*	*	-	*	
Schilbe mystus	Sole	*	*	*	*	Butterfish
Physailia pellucida	Sole	*	*	*	*	Called Glass catfish because body lacks pigmentation. Quite translucent.
Eutropius niloticus	Sole	-	-	*	-	Prominent dark mark behind the operculum.

** Fish family and species present; - fish family and species absent*

Table 2. A comparison of fish species of the two wetlands

	Kiri lake			Gyawana lake		
Taxonomic class	**Family**	**Genus**	**Species**	**Family**	**Genus**	**Species**
Pisces	16	32	57	16	26	40

Table 3. Comparison of biotic characteristics of Kiri Lake and Gyawana Lake following the Ramsar Criteria

		Possess Ramsar Characteristics?	
Ramsar criteria		**Kiri lake**	**Gyawana lake**
Criteria 1: Criteria for representing a unique wetlands	a.	No	Yes (Naturalness)
	b.	No	Yes (Sump for flood water)
	c.	No	No
Criteria 4: criteria directed to fish	a.	Yes	Yes
	b.	No	No

Both sites qualify as Ramsar sites under criteria 1 and 4

This could be attributed to changing ecological regime on the Lake, which tends to favour certain fish species and cause the disappearance of other fish species [29].

5. CONCLUSION

From the results obtained, the Kiri and Gyawana Lakes were all qualified as Ramsar sites under criteria 1 and 4. This result further confirmed how urgent and critical our natural wetland ecosystems especially the Kiri and Gyawana Lakes should be conserved.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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