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Fish Distribution, Abundance and Diversity in Gurara Reservoir, Kaduna State. Nigeria

***Auta, Y. I[1], R. O. Ojutiku[2], F. O Arimoro[1], A. Hamzat[3], Mohammed A.Z[1], Apollos T.G[4] and Aishattu Shettima[5]**
[1]Animal Biology Department, Federal University of Technology, Minna, Niger State, Nigeria
[2] Water resources, Aquaculture and Fisheries Technology Department, Federal University of Technology, Minna. Niger State, Nigeria
[3]Department of Biological Sciences, Ibrahim Badamasi Babangida University, Lapai, Niger State. Nigeria
[4]Department of Fisheries and Aquaculture Adamawa State University Mubi Adamawa State. Nigeria
[5]National Biotechnology Development Agency Abuja. Nigeria
Contact: *Auta.iliya@futminna.edu.ng*

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Abstract
Fish distribution and abundance of Gurara reservoir were investigated from March, 2016 to February, 2017. Atotal of 281,547 individuals belonging to 8 families and 12 species were identified from the Reservoir. The fish family cichlidae topped the list (67%) and was represented by *Tillapia zilli, S.Galilaeus* and *Oreochromis niloticus,* while Clariidae (12%) was represented by *C. angullaris.* The Characidae (6%) represented by *C. mento.* The Family Mormyridae (5.4%) was represented by *M. rume* and G.pictus, This was followed by the fish family Cyprinidae (4.3%) represented by *B. senegalensis and L.pseudocouble*. Schilbeidae (4%) Family was represented by *S. Mystus*. Alestidae (0.5%) is represented by *H. vittatus*. Mochokidae (0.3%) were represented by *M. acutidens.* The diversity indexes of fish species from the five stations in the Reservoir indicated low species diversity. The estimated diversity indexes from stations was H'-1.581 for Shannon, while for Simpson's index the values was 0.7436 across the stations. Species evenness or the distributions of individuals among the five stations based on H' and 1-D were even. While evenness based on 1-D values was 0.4048. The dominance of the three most abundant species (*Tilapia zilli*, *Sarotherodon galilaeus* and *Oreochromis niloticus* among the five stations was estimated between the range of 19% and 28%. The Reservoir can be richer in ichthyofauna with high species diversity proper future planning and management of the fisheries resources of Gurara reservoir, Kaduna State are deployed.

Keywords: Fish; Distribution; Abundance; Diversity; Gurara Reservoir**.**

Introduction

Fish is a first-class animal protein for human consumption, which is cheap and easily digestible. It is rich in oil and other essential mineral requirements, that are required for sound and healthy growth and also has, low-cholesterol level. It is therefore in high demand all over the world. Fishing practice is attracting a lot of focus because it contributes significantly to the world proteins requirement (Moses, 1990). Fish is a high quality food; its content of protein matter is important. It is rich in vitamins and contains variable quantities of fat, and calcium for human health (Moses, 1990). The protein is first class and inexpensive and its composition and consumption is desirable (Moses, 1990). Nigeria's populations live near water bodies such as lakes, lagoons, reservoirs, rivers, swamps and coastal lagoons. Many depend heavily on the resources of such water bodies for their main source of animal protein and family income (Abubakar *et al.,* 2006). Bolorunduro, (2003) reported an estimated fifty- two (52) fish species belonging to seventeen (17) families from Anambra River, Nigeria. The fisheries and fish resources of Nigeria are not only of considerable economic importance but they are also making a significant contribution to national food security and as well providing a major source of employment in rural areas. The fish stock diversities are directly dependent on the quality and quantity of water resources in the country (Bolorunduro, 2003). There are considerable potentials for fresh water fish production in Gurara Reservoir Kaduna State, Nigeria. Fish, as a renewable natural resource, if carefully exploited, can be utilized to meet part of the nation's animal protein requirements.

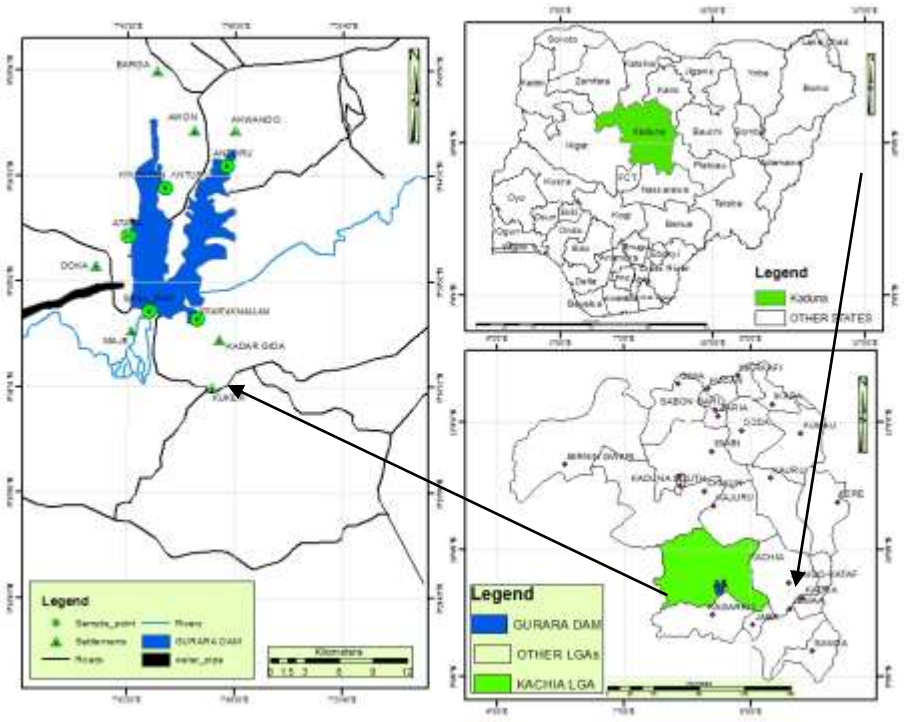
Materials and Methods

Description of Study area

The study area covers the Upper Gurara Dam area falling along Latitudes $9^0$13′N and $9^0$39′N and Longitudes 7^o26′E and 7^o42′E. The study area region comprises parts of the Akwana West and East reserves and some scattered settlements such as Atara, Angwan Kagarko, Akwana. Jere is where the Federal Ministry of Agriculture and Water Resources (FMA&WR) constructed a dam for the purpose of inter basin water transfer to supplement the lower Usman and Shiroro reservoirs for municipal water supply and hydroelectric power generation, respectively. The basin is oriented North East –South West with its headwaters originating from the west of Jos, Plateau State. Its climate is characterised by dry Northern-winters and wet Northern summers. The vegetation type is savannah (Southern guinea savannah zone) grassland interspersed with tropical forest remnants. The watercourse is forested with large trees.Terrain is undulating and dissected conforming to the dominant structure of the underlying rocks-undifferentiated basement complex. The soil type is generally gravely red literate and in the river valleys, it is alluvial. The mean annual rainfall at the location is 1400 mm, while the mean monthly maximum and minimum temperatures in the catchment are 37.3°C and 19.7°C, respectively, (Adedeji. and Ako, 2009. The study area has six tributaries namely River Iku, River Gurara, River Layi, River Rudu, River Kwohu , River Tapa and many streams, which are also tributaries of the Gurara River that flows North-South dropping urgently from the Kukku hill ranges.

Table1: Description of Stations

	Stations	Co-ordinates	Elevation	Description
	Kwatan Mallam	Latitude $9^0$38.8'N and Longitude $7^0$47.3'E	626M	This is the main tributary to the reservoir. Main settlers are farmers. Vegetation are scanty trees due to clearing of bush for farming crops such as maize, guinea corn and ginger area is surrounded by hills of various height and types. The reservoir bank is sandy and covered with grasses, without shed, shells of bivalves and life snails of different species observed at the reserve bank all year round.
	Kwatan Anturu	Latitude $9^0$42.8' and Longitude $7^0$44.8'E	628M	This is small settlement of local farmer and fishermen. Small canoes uses for fishing are on the bank of the reservoir. Commercial activities include transportation of passengers across the reservoir to the opposite site of the water body. Vegetation is mainly shrubs with few tall trees and grasses at the bank. Soil is muddy and sandy at some locations. Dead decay trees are observed at location in the water body. Discharge of domestic wastes is a common practice.
	Atara	Latitude $9^0$41.9'N and Longitude $7^0$42.9'E	625M	This is a community of koro speaking tribes from Kagarko local Government of Kaduna State. Located within two hills, with concentration of fishermen and their canoe. Commercial fish farm/hatchery at the reservoir. No cover trees, but grasses at the bank of the reservoir. Timber business is a common practice.
	Spill-Way	Latitude $9^0$38.7'N and Longitude $7^0$44.8'E	625M	This Station is located upstream of the reservoir and houses the electricity generating house of Gurara dam. There is no human activity due to restriction by the authority. No vegetation, but rocky bank. Shells of bivalves and life Snails of different species are observed.
5.	Anturu	Latitude $9^0$43.4'N and Longitude $7^0$43.9'E	627M	This is commercial station with large human settlement (Kadada tribe) with a fish market at the reservoir Domestic/fish wastes are emptied into the water. Macro invertebrates, such as snails of different species are collected at the reservoir bank. Common disease in the community is Bilhaziasis and other unidentified parasites.



KEY: A; Map of Nigeria showing Kaduna state**. B:** Map of Kaduna State showing Kachia local government. **C:** Hydrological map of Gurara Reservoir.

Figure 1: The Study Area
Source: Remote Sensing/ Geographical information system (GIS) Laboratory, Geography Department, FUTMINNA, (2017)

Water Sampling

The water sample for physicochemical parameters were collected on monthly basis for a period of twelve months (March, 2017 to February, 2018) or dry and wet season from five stations (kwatan Mallam, Anturu, kwatan Anturu, Atara and Spill-way) within the reservoir based on accessibility. Sample collection was in 200mls reagent bottles properly cleansed with de-ionized water prior to usage. Sampling was conducted by careful immersion of the sample containers in the lentic water. The containers were seal with tight fitting corks after collection in order to avoid air bubbles. DO, temperature, pH and conductivity were determined at teach station and recorded while the remaining parameters, samples were transfer to a refrigerator (4°C) prior to analysis. In addition, Fresh fish catches were on a monthly basis in each fish-landing site for twelve (12) months. The catches made by local canoe fishers utilizing all major gears were randomly sample. Diverse fishing gears used (depending on targeted species and size) were mainly mono-filamentous gill nets (25.4mm-50.8mm) to catch migratory species and cast nets(13mm-50.*8mm*) for mainly the Cichlids (tilapia species). The catches were sorted into taxonomic groups (families, genus and species) using standard fish identification keys provided by Adesulu and Syndenham, (2007); Olaosebikan and Raji, (2013).

Data Analysis

Data collected on water quality parameters were analysed using one way ANOVA. Fishes were counted, Species abundance and composition at the sampled site was calculated using Species Index of Abundance, while the Species Diversity was calculated using Margalef Index (d) of taxa richness, Simpson's Index of Heterogeneity (D), Shannon-Weiner index of General Diversity (H1) and Evenness index.

Results and Discussion

The summary of variation in standard deviation, minimum and maximum range of physico-chemical parameters in Gurara reservoir is presented in table 1. The results showed slight to wide variation among stations and seasons of the year throughout the study period. During the period, water temperature varied from 25.98±0.85 from 27.84± 0.83°c. Water temperature was generally high, ranging from 18.5-

32.5°c which is the standard for fisheries. (Boyd and Turker, 1998). The range of water temperature of Gurara reservoir was within the tolerable range for fresh water fishes, and higher in dry season at the surface due to high air temperature. The present observation is similar to the seasonal fluctuation in temperature studied by Kadye, and Marshal, (2006). Water temperature has a significant correlation with most water parameters. Aquatic organisms are affected by pH because most of their metabolic activities are dependent on it. pH of an aquatic system is an important indicator of water quality and the extent of pollution in water shed areas (Kumar *et al*., 2010). The mean pH was 7.65±1.11-8.65±0.74 at most of the station, which indicates the reservoir, is alkaline in nature. The high level may be due to sewage discharged by the settlements along the flow of the tributaries into the reservoir and agricultural fields. In the rainy season, the highest average pH was observed because in this period, sewages and agricultural discharges increase. Sewages and agricultural discharges are generally a complex combination of natural and inorganic materials and man-made compounds. It contains many fertilizers, metals, sediments, pesticides herbicides, nutrients, salts, phosphates, bicarbonates. (Ongley, 2004). Water with pH ranging from 3.0-10 is generally regarded as suitable for growth of organisms. (Huq, 2002) and results showed that values were within the permissible limit. Conductivity is a measure of the ability of water to conduct electricity. It is dependent on the ionic concentration and water temperature. The total load of salts in a water body is directly related to its conductivity (Mane *et al.,* 2013). The electrical conductivity value of the study area varied from (0.01-0.04). According to the Federal Environmental Protection Agency (FEPA, 1991) the sustainable E.C value for aquatic organism is 10.77 to 12.30 Aina *et al.* (1996).Total dissolved solids (TDS) is a measurement of organic salts, organic matter, and other dissolved materials in matter (Phyllis *et al.*, 2007). The values of TDS in the study areas ranged from (25-178ppm) and mean value was found to be 55.83-2.67-72.75+-11.09ppm.Water with TDS concentration within 0.1-20ppm is considered as suitable for aquatic life (Environmental Science Inquiry, 2000-2011). The TDS levels recorded in the entire sample stations were within the standard guidelines for the protection of fisheries and aquatic life. Nigerian industrial Standards, (NIS, 2007; World Health Organization, (WHO, 2011). If the TDS levels are high due to dissolved salts, many aquatic lives are affected. The salts act to dehydrate the skin of aquatic animals, which can be fatal (Mosummath *et al.*, 2017) in all stations sampled. The TDS was high in the Dry season because the parameters showed positive correlation with water temperature not exceeding the standard level Shinde and Deshmukh, (2008). This means that the TDS values of Gurara reservoir is not harmful to aquatic life. Alkalinity is a measure of its capacity to neutralize acid water with high alkalinity is undesirable. The obtained alkalinity ranged from (10-54) mg/ with a mean of 26.67+4.36 Table 1.

Fish Species Composition and Distribution

The result for fish species composition and distribution is presented in Table 2. Species composition showed the presence of fishes of fresh water. 281,547 individuals belonging to 8 families and 12 species were identified from the Reservoir (Table 2). The fish family cichlidae topped the list (67%) and was represented by *Tillapia zilli, S. galilaeus* and *Oreochromis niloticus,* While Clariidae (12%) is represented by *C. angullaris.* The Characidae (6%) represented by *C. mento.* The Family Mormyridae (5.4%) is represented by *M. rume* and *G. pictus*, This was followed by the fish family Cyprinidae (4.3%) represented by *B. senegalensis and L. pseudocouble*. Schilbeidae (4%) Family is represented by *S. mystus*. Alestidae (0.5%) is represented by *H. vittatus*. Mochokidae (0.3%) were represented by *M. acutidens.* The diversity indexes of fish species from the five stations in the Reservoir indicated low fish species diversity (Table 3). The estimated diversity indexes from stations were H'-1.581 for Shannon, while for Simpson's index the values was 0.7436 across the stations. Species evenness or the distributions of individuals among the five stations based on H' and 1-D were even. While evenness based on 1-D values was 0.4048. The dominance of the three most abundant species (*Tilapia zilli*, *Sarotherodon galilaeus* and *Oreochromis niloticus* among the five stations was estimated between the range of 19% and 28%.(Table 2)

Table 2: Mean Physicochemical Parameters of Gurara Reservoir (March 2016 - 2017)

	Stations					F-value		P-value	
Parameters	K/Mallam	Anturu	K/Anturu	Atara	Spill-way	Month	Station	Month	Station
pH	8.05±0.82	8.17±0.84	7.85±0.95	7.65±1.11	8.65±0.74	46.87	2.82	1.5	0.06
	(5.1-9.7)	(5.1-9.6)	(3.9-9.6)	(3.1-9.5)	(5.3-10)				
E.Cond (µ/cm)	36.85±0.93	36.75±1.06	37.95±1.15	38.26±1.18	37.16±0.94	2.01	2.58	5.75E-15	0.12
	(33.5-41.4)	(31.5-42.1)	(31.5-42.5)	(32.5-43.5)	(32.3-41.7)				
TDS (ppm)	55.83±2.67	72.75±11.09	62.67±4.69	59.33±2.98	57.83±6.27	2.23	1.22	0.04	0.32
	(40-80)	(48-178)	(50-109)	(49-79)	(25-102)				
Tempt Air (°C)	29.25±1.19	31.4±0.93	30.26±1.28	30.0±1.32	30.3±1.36	8.34	1.05	2.71	0.38
	(23.5-38)	(25.4-37.1)	(21.2-38.5)	(21.4-36.2)	(22.8-38.4)				
Tempt Water (°C)	26.94±0.76	27.84±0.83	27.28±1.03	27.46±1.01	25.98±0.83	7.99	1.71	4.15	0.19
	(22.0-31.0)	(22.3-32.5)	(18.5-31.3)	(19.9-32.0)	(20.7-30.3)				
DO(mg/l)	4.13±0.31	3.99±0.28	3.88±0.14	3.88±0.16	4.08±0.32	2.72	0.42	0.02	0.74
	(2.5-6.2)	(2.4-5.8)	(3.1-4.6)	(3.0-4.7)	(2.6-7.0)				
BOD)(mg/l	2.27±0.35	2.31±0.27	2.07±0.13	2.04±0.18	2.3±0.28	3.62	1.21	0.03	0.32
	(0.8-5.2	(0.7-4.4)	(1.2-2.8)	(1.3-3.2)	(1.3-4.4)				
Depth(cm)	22.83±0.99	23.58±1.12	23.25±1.23	`23.17±1.46	28.17±2.15	8.14	5.34	3.47	0.04
	(18-29)	(16-29)	(17-28)	(15-29)	(15-36)				
No_3-N(mg/l)	0.79±0.34	0.85±0.35	0.73±0.33	0.78±0.30	0.76±0.31	282.31	1.1	5.23E-37	0.37
	(o.32-4.5)	(0.3-4.6)	(0.19-4.3)	(0.2-4)	(0.22-4.1)				
Po_4-P(mg/l)	0.29±0.12	0.28±0.11	0.18±0.06	0.17±0.05	0.24±0.09	6.49	0.79	2.87E-06	0.54
	(0.06-1.2)	(0.06-1.19)	(0.09-0.73)	(0.07-0.66)	(0.09-1.22)				
T. Alkalinity(mg/l)	29.5±3.64	27.67±3.41	27.75±4.7	30.92±4.54	26.67±4.36	93.78	3.42	8.53E-37	0.37
	(16-50)	(18-49)	(12-52)	(14-54)	(10-53)				
T. Hardness(mg/l)	30.53±3.89	29.67±3.28	30.08±3.51	28.08±2.83	28.42±4.33	40.53	0.78	2.24E-19	0.55
	(22-66)	(18-53)	(22-60)	(20-50)	(18-64)				
Potassium(mg/l)	1.18±0.11	1.26±0.15	1.25±0.11	1.18±0.15	1.16±0.17	19.78	0.44	1.50E-13	0.78
	(0.6-1.8)	(0.6-2.2)	(0.6-2)	(0.6-2.2)	(0.11-2.3)				
Sodium(mg/l)	4.25±0.45	4.54±0.47	4.27±0.41	4.41±0.44	4.18±0.43	49.44	1.14	4.34E-21	0.35
	(0.36-6.3)	(0.38-6.7)	(0.3-5.6)	(0.25-6.3)	(0.28-6.4)				

Mean and Standard Deviation, Minimum and Maximum range of physic-Chemical parameters of water quality of Gurara Reservoir March, 2016-2017, Kaduna State, Nigeria

Table 3: Percentage Abundance and Distribution of fish species in Gurara Reservoir

S/NO	FAMILY	GENUS	SPECIES	Total	%
1	CICHLIDAE	Tilapia	T. zillii	55163	20
		sarotherodon	*S.Galilaeus*	54441	19
		Oreochromis	*O. Niloticus*	77706	28
2	CYPRINIDAE	*Barilius*	*B. senegalensis*	12233	4.3
		Labeo	*L.pseudocouble*	3025	1
3	SCHILBEIDAE	*Schilbe*	*S. Mystus*	11547	4
4	CLARIDAE	*Clarias*	*C. angullaris*	33382	12
5	MORMYRIDAE	*Mormyrus*	*M. rume*	1195	0.4
		Gnathoneus	*G. pictus*	13891	5
6	ALESTIDAE	*Hydrocynus*	*H. vittatus*	1327	0.5
7	CHARACIDAE	*Cynothrissa*	*C. mento*	16762	6
8	MOCHOKIDAE	*Micralestes*	*M. acutidens*	875	0.3
				281547	100

Table 4: Abundance and Percentage Distribution of Fishes in Gurara Reservoir, Kaduna State.

Diversity index March,17-,2018	
Taxa_S	12
Dominance_D	0.2564
Simpson_I-D	0.7436
Shannon_H	1.581
Evenness_e^H/S	0.4048
Margalef	1.144
Equitability_J	0.6361

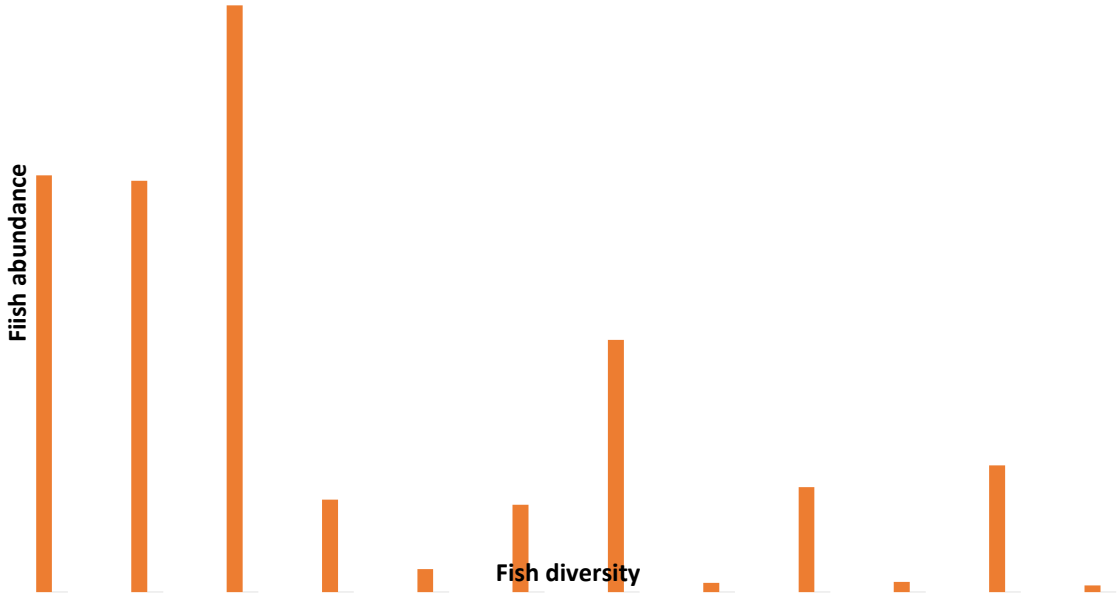


Figure 2: Fish Diversity and Abundance of Gurara Resevour

Fisheries in the Reservoir are multispecies stock in nature, which demonstrates important dynamic variation in terms of size composition and distribution. There are 8 Families with 12 species of fishes noticed during the study. These lacks of high availability of other commercially valued species may be caused by overfishing or alterations in the environmental conditions of the Reservoir, like persistence seasonal flooding during rainy seasons from the tributaries which negatively will affect the reproductive ecology of the various fish species in the Reservoir Ladu *et a*l,(2013); Ekundayo,(2014). Tilapia (*Cichlidae*) which is little in size compared to other families like *Clariidae* and *Mormyridae* constituted 67% of total fish caught in Gurara reservoir. The dominance of *S. galilaeus* in this study and the low population of species like *C. gariepinus* and *M. rume* may be due to the fact that in fisheries, aggressive and competitively dominant fish are often the first to be over fished and are often in the habit of preventing subordinate fishes from taking baits as observed by Mc Clanahan *et al.* (2010). The dominance of Tilapia may also be connected to it Prolific reproductive nature, which allows it to populate water, bodies especially where the population of aggressive and carnivorous species that could control its population has declined. Study also shows that M. *rume* and other low percentage species were seen rarely at the Gurara reservoir, this confirm the characteristics of those fish adaptive to where there are macrophytes acting as shelter and provide available food generated by the decaying vegetation Silvano and Begossi,(1998). Some of these species are been threatened. The conditions responsible for these threatened species either may vary because of overfishing due to the demand or affected by macrophyte due to ecosystem degradation cause by the persistent floods from riparian communities as reported by Ekundayo, (2014). Since the reservoir is situated on the plains of kuku hills on the Jos Plateau with numerous tributaries forming linkages for entrance of common fishes. *Mormyrus* and *clarias* bio-ecology of inhabiting shallows lakes and rivers and solitary inhabit could be an environmental reasons for finding them newly within the past two years during these continuous seasonal flooding. Bene, (2005). The list of species composition of fishes caught in the sampling stations and fish distribution by number per family and their percentages (%).This study is in line with fish families observed by many fisheries workers and researchers, who reported these fishes to constitute the major fisheries of the inland waters in Nigeria. This is due to their ability to adapt to various water conditions (Akinyemi, 2002). The fish with the highest species distribution and abundance in the Study is the Cichlid. The high occurrence of Cichlid could be due to the

environment in which they are found. The Cyprinidae family was the next most abundant family. This is because of their ability to utilize a wide range of foods in the lower tropic level as herbivores as well as their fecundity and prolific nature (Akinyemi, 2002). The dominance of the Cichlids in the present study could be attributed to their prolific breeding pattern and good parental care. This compares favourably with the works of Opa, Osinmo on African reservoir where Cichlids are known to dominate (Komolafe and Adewomo, (2008) Similarly, the present study agrees with the report of Mohammed and Omoregie (2004) and Adesulu and Sydenham, (2007) that fresh water systems in Nigeria were dominated by the family Cichlidae. The Cichlids were the most diversified (3-species) dominated by *Oreochromis niloticus*. This is in contrast with the work of Kamolefe and Arawomo (2008) on Osinmo Reservoir, Osun State that recorded Cichlids, as the most diversified in Kangimi Lake with 5-species representation. The family Mochokidae, Alestidae, Characidae and Mormyridae were poorly represented. Most of these species requires large body of water to thrive well. The relatively low level of abundance of other fish species in the reservoir might be attributed to high level of pollution because the reservoir is directly flooded with mine tailings in the rainy season and is also excessively loaded with nutrients which might have adverse effect on the fish species as reported by Dell' Anno *et al.* (2002) and Lawal and Komolafe (2012) in this habitat.

Species Diversity

The Shannon-wiener index (H') for the fish species from Gurara reservoir within the period of study were within the range of 1.5 to 3.5 as posited by Magurran (2004). 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). Also, Emmanuel and Modupe (2010) 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 Species heterogeneity index ($1 - D$), reported for the station and months for Gurara reservoir compare favourably with those reported for Igbesa and Iba tributaries of River Ore by Emmanuel and Modupe (2010). There is great diversity from Gurara reservoir since $1 - D$ is close to 1. There is also a greater diversity in Gurara reservoir than Lakes Oguta, Oyan, Dadin Kowa, Tiga, Asa and Opi as reported by Yem *et al.* (2011). According to Colwell (2009), H' and $1 - D$ will not rank communities in the same manner but will increase as richness increases, given a pattern of evenness, and rises as evenness increases, given a particular richness. The species richness index (d) of Gurara reservoir is lower than those reported for three tributaries of the Anambra River by Odo *et al.* (2009). This is attributable to the difference in number of species encountered hence Anambra river is richer in species than Gurara reservoir. This measure is however not sensitive to environmental disturbance hence, it cannot be absolutely concluded that this value differs for both areas which are in different ecological zones. Species equitability index across the station as well as months reveals that the distribution of species or fish population is even since the values are close to one. The values are also close to those reported by Emmanuel and Modupe, (2011) for River Ore but greater than those reported for the Anambra River by Odo *et al.* (2009).

Conclusion

The Gurara Reservoir has the potential of being rich in terms of icthyofauna if an appropriate strategy such as balancing the foraging (F) and carnivorous (C) population ratio is undertaken. The dominant fish family is the Cichlidae while, *Tilapia zilli* and *Oreochromis niloticus* were the dominant species. Although, *Oreochromis niloticus* has been documented as the dominant species in some African Reservoirs (Olaniran, 2003), the Reservoir in the present study has an unbalance population of foragers to carnivorous species. If the Reservoir can be stocked with large numbers of effective predators (carnivorous species) to check the prolific breeding activity of members of the family Cichlid as recommended by Ofori-Danson *et al.* (1993) and Ofori-Danson & Antwi (1994), then the Reservoir can be rich in ichthyofauna with high species diversity.

Conclusively, anthropogenic activities such as sand mining, logging and waste disposal into the water was observe in all the stations studied. These have negative impacts on the quality of the water as well as fish faunal diversity. Poor management of the fishery resources in Gurara reservoir ought to be address in order to make the reservoir produce fish

sustainably and to ensure that fish species continue to exist in the reservoir. It is hope that the information gathered will be useful for future planning and management of the fisheries resources of Gurara reservoir, Kaduna State. Nigeria.

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