COMPOSITION AND PRODUCTION OF ICHTHYOFAUNA IN GURARA WATER RESERVOIR, KADUNA STATE, NIGERIA

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ABSTRACT
Gurara reservoir and associated works were developed by the Federal Government of Nigeria mainly to increase the natural water at Lower Usuma Dam for onward supply to the Federal Capital Territory. The ichthyofauna status of the reservoir is barely known. This study was undertaken to disclose the fish condition and production rate of the reservoir. Experimental gillnet sampling and fish catches from artisanal fishers were simultaneously assessed over 12 months (June 2014 - May 2015) to determine the fish composition, abundance and estimate the current fish yield of the reservoir. Also, a frame survey was carried out to determine the size and distribution of fishing localities, do a census of fisherfolk, fishing craft, and gears. Altogether, 14 species from 7 families were encountered, and a production rate of 8.83 kg/ha was established. The result also brings to light that the reservoir is low in fish biodiversity and productivity is found to be very low when compared with some other similar water bodies in Nigeria. The reservoir is grossly underexploited and suggestions for sustainable fisheries are proffered.

Keywords: Fish diversity, Gurara Reservoir, Water supply, Kaduna State, Anturu/Igoh, Tunga Mallam, Atara

INTRODUCTION
Gurara water supply reservoir in Kaduna State, Nigeria was created in 2007 after damming River Gurara at its upper reaches. Since then, the reservoir has been attracting several fishers from different parts of the country yet very little is known about the fisheries resources of the reservoir. Dan-kishiya *et al*. (2012) reported that irrespective of the principal objective to which a reservoir is built, the fish yield from such a reservoir could make up a substantial input to a country's total domestic fish production. The effectiveness of their impact would depend largely on passable fish assemblages and proper management of the reservoir fisheries (Mustapha, 2008).

Lawson and Olusanya (2010) connected the fast depletion in productivity of fisheries resources in Nigeria to over exploitation and inadequate management mainly of her coastal waters. For the viability of these resources, an adequate knowledge of the fish species composition and relative abundance of her water bodies must be obvious and actively pursued.

Research on the Nigerian freshwater ecosystem has concentrated more on larger water bodies such as Kainji Lake, Jebba Lake, Lake Chad, etc. The lesser-known water bodies such as Kangimi Reservoir (Balogun, 2005); Ojirami dam (Ovie *et al*., 2009); Kontagora Reservoir (Ibrahim *et al.*, 2009 and NIFFR, 2015); Omi dam (Ovie *et al*., 2011); Usuma Reservoir (Dan-kishiya, 2013), etc. are just beginning to emerge, yet they contribute meaningfully to local fish supply and the country's total domestic fish production. Very flimsy literature on the fish composition and distribution of Gurara reservoir exists. This study, therefore, seeks to authenticate this literature by identifying the fish species status and the production rate of the reservoir as discovered during a one-year survey.

MATERIALS AND METHODS
Gurara Water Reservoir (Figure 1) lies within the Guinea Savannah belt between latitudes 9° 38′ and 9°46′N and longitudes 7°42′ and 7°48′E. The area is part of Kaduna State, Nigeria. The reservoir with a capacity of 880 million cubic metres has a maximum surface area of about 64 square kilometres with an average depth of 13.1 metres. The reservoir was spatially stratified into western, eastern, and southern strata based on geographical inclinations and logistical characteristics as observed by Southwood and Henderson, 2000. In each stratum, a sampling area was randomly created using the method of Olaniran, 2000, and Dan-Kishiya *et al*., 2013.

Fleets of experimental gill-nets consisting of nine nets each measuring 30 meters long and 3 meters deep with mesh sizes ranging between 25 and 175 mm (i.e. 1″, 1½″, 2″, 2½″, 3″, 3½″, 4″, 5″ and 7″) were used for the survey.

The nets were set following standard procedures to cover shoreline, surface, and bottom at the selected sampling areas/stations (SS1, SS2, and SS3) in the reservoir. Fish caught were collected according to the net-mesh size and were sorted into species, counted, weighed, and recorded accordingly. Fish were identified morphologically to species level using keys as provided by Idodo-Umeh, 2003 and Olaosebikan and Raji, 2013.

The fishers' catches were assessed from three chosen landing sites each located within a stratum following the method of Abiodun *et al.*, 2013. As the fisher landed his canoe the content was sorted according to species and counted. The weights of the various species and the gear type used to catch them are noted.

The number of canoes and all fishing equipment used in the three fishing localities (Atara, Anturu/Igoh, and Tunga Mallam) was recorded under a frame survey.

Some water parameters such as water temperature, depth, conductivity, and pH were also monitored using standard procedures. This was to enable the researcher to determine the potential fish yield of the reservoir using the Morpho-Edaphic Index method of Henderson and Welcomme (1974) and compare it with actual yield.

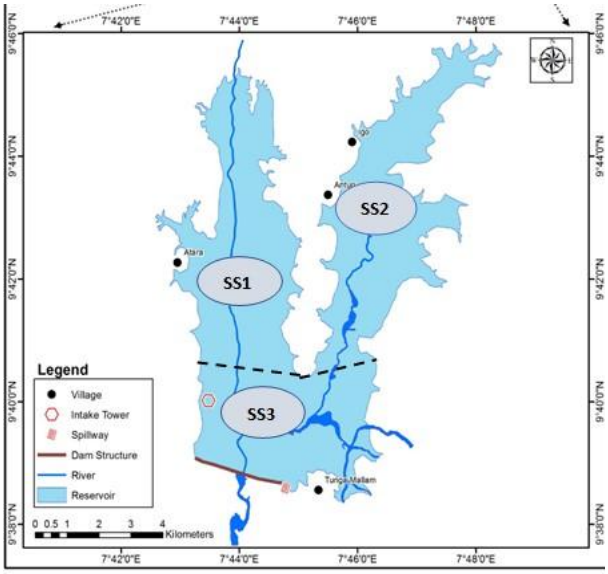

Figure 1: Map of Gurara Reservoir showing Sampling areas/stations SS1, SS2, and SS3

RESULTS

In both the experimental gillnet and artisanal fishers' catches, seven (7) fish families were recorded. However, the number of species recorded in the fishers' catch assessment was fourteen (14) while eleven (11) species were recorded in the experimental gillnetting. These are shown in Table 1.

In terms of species diversity, the families Cichlidae, Mormyridae, and Cyprinidae had three species each. These include *Oreochromis niloticus*, *Hemichromis bimaculatus*, and *Coptidon zillii* for the Cichlid family; *Brienomyrus niger*, *Mormyrus hasselquistii*, and *Petrocephalus bovei* for the Mormyrids; and the Cyprinids include species such as *Raiamas senegalensis*, *Barbus bynni occidentalis*, and *Garra waterloti*.

The family Clariidae – had two species namely; *Clarias anguillaris* and *Clarias buthupogan* while Alestidae, Schilbeidae, and Hepsetidae had one species each vis-à-vis *Micralestes elongatus*, *Schilbe uranoscopus*, and *Hepsetus akawo* respectively.

Table 1: Total Fish Catch by Family/species during Fishers' Catch Assessment Survey

Family	Species	No	No.%	Wt[g]	Wt%	Av. wt [g]
Alestidae	*M. elongatus*	23,233	47.12	12,860	1.07	0.55
Cichlidae	*C. zillii*	9,519	19.31	390,840	32.46	41.06
	H. bimaculatus	46	0.09	510	0.04	11.09
	O. niloticus	5,617	11.39	232,330	19.30	41.36
Clariidae	*C. anguillaris*[1]	678	1.38	52,840	4.39	77.94
	C. buthupogan[1]	10	0.02	180	0.01	18.00
Cyprinidae	*B. occidentalis*	1,054	2.14	48,040	3.99	45.58
	G. waterloti[*]	40	0.08	655	0.05	16.38
	R. senegalensis	1,335	2.71	62,780	5.21	47.03
Hepsetidae	*H. akawo*[1]	2,627	5.33	155,260	12.89	59.10
Mormyridae	*B. niger*[*1]	1	0.002	10	0.0008	10.00
	M. hasselquisti	2,972	6.03	140,180	11.64	35.05
	P. bovei[*1]	6	0.01	70	0.006	11.67
Schilbeidae	*S. uranoscopus*[1]	2,166	4.39	107,500	8.93	49.63
Total		**49,304**		**1,204,055**		

*Not found in the experimental gillnet catches
[1]Carnivorous fish

In terms of number, *Micralestes elongatus* had the highest with 47.12%. This was followed by *Coptidon zillii* with 19.31%. Then *Oreochromis niloticus with* 11.39%; *Mormyrus hasselquistii* with 6.03%; *Hepsetus akawo*, 5.33%, and *Schilbe uranoscopus*, 4.39%. The least in terms of number was *Brienomyrus niger* with 0.002%.

Table 2 shows the Shannon-Weiner index (H) values to be higher in station 2 (1.908) followed by station 1 (1.607) and then station 3 (0.944). The values of evenness (E) varied between 1 and 0. These are shown as 0.416, 0.562 and 0.214 for stations 1, 2 and 3 respectively. Simpson's dominance and diversity indexes complement each other; wherever dominance is less, diversity will be more and vice versa; they both add up to 1. Simpson's index of diversity was found to be higher in station 2 (0.836), station 1 (0.775) and station 3

(0.523). The Shannon-Weiner index, Gibson's evenness, Simpson's indices and Margalef's index didn't differ significantly between the different stations ($p > 0.05$). Hence, fish distribution among the sampling stations in the reservoir could be rightly classified as homogenous.

In terms of catch by weight, Table 1 indicates that *C. zillii* had the highest with 32.46% of the total weight. This was followed by *O. niloticus* (19.30%), *H. akawo* (12.89%); *M. hasselquistii* (11.64%); *S. uranoscopus* (8.93%); *R. senegalensis* (5.21%); and *C. anguillaris* (4.39%). The least in weight was *P. bovei* with 0.006%.

Within the period of study, the average weight of fish caught is 24.42g. The maximum average weight of 77.94 g/fish was attained by *C. anguillaris* only. This was followed by *H. akawo* with 59.10g/fish and *S. uranoscopus* with 49.63g/fish. The least average weight of 0.55g was attained by *A. elongatus* (Table 1).

Table 2: Fish species diversity indexes at different stations of Gurara Reservoir

Assemblage structure index	Sampling stations			
	Station 1	Station 2	Station 3	p-values
Species	9	11	10	
Family	7	7	7	
Individuals	2554	2977	1551	
Shannon-Weiner index (H)	1.607	1.908	0.944	>0.05
Gibson's evenness (E)	0.416	0.562	0.214	>0.05
Simpson's dominance index (D)	0.225	0.164	0.477	>0.05
Simpson's index of diversity (1 – D)	0.775	0.836	0.523	>0.05
Margalef's index (d)	1.402	1.375	1.497	>0.05

Table 3 gives summarized statistical ranges (minimum and maximum), mean and standard error values of some physicochemical parameters of Gurara Reservoir as pooled from all the sampling areas during the entire period of this study.

Table 3: Pooled Summary of Physicochemical parameters of Gurara Reservoir during the study period, June 2014 – May 2015

Physicochemical Parameters	Range	Mean value ± Standard Error
Water depth (m)	5.80 – 33.40	13.06 ± 1.01
Air tempts. (ºC)	23.50 – 29.00	26.12 ± 0.16
Water tempts. (ºC)	23.50 – 29.50	26.17 ± 0.15
Transparency (cm)	45.00 – 195.00	106.36 ± 5.89
Dissolved Oxygen (mg/L)	5.10 – 8.90	7.25 ± 0.11
pH	6.20 – 7.60	6.89 ± 0.05
Electrical Conductivity (µS/cm)	56.00 – 80.00	66.78 ± 0.74
Nitrate-Nitrogen (mg/L)	0.02 – 0.07	0.04 ± 0.00
Phosphate-Phosphorus (mg/L)	0.00 – 0.15	0.07 ± 0.00

Table 4 shows the Pearson (r) correlation coefficient values between the various physicochemical parameters and fish yield by number and weight as computed from data recorded during the study period.

Table 4: Correlation coefficient (r) values between physicochemical parameters and fish yield of Gurara Reservoir, June 2014 – May 2015.

Parameters	Water Depth	Air Tempt	Water Tempt	DO	Transpa-rency	pH	EC	No_3-N	Po_4-P	Fish yield No.	Fish yield Wt (g)
Water Depth	1										
Air Tempt	-0.245*	1									
Water Tempt	-0.327**	0.952**	1								
DO	0.076	-0.750**	-0.662**	1							
Transparency	-0.139	0.435**	0.399**	-0.551**	1						
Ph	0.189	-0.458**	-0.400**	0.533**	-0.810**	1					
EC	-0.487**	-0.287*	-0.260*	0.362**	-0.442**	0.305**	1				
No_3-N	-0.695**	0.067	0.111	0.023	0.091	-0.126	0.575**	1			
Po_4-P	0.035	0.000	-0.034	0.164	-0.022	0.017	0.240*	0.183	1		
Fish yield No	0.001	0.409**	0.371**	-0.434**	0.285*	-0.219	-0.363**	-0.313**	-0.548**	1	
Fish yield Wt(g)	0.678**	0.044	-0.036	-0.182	0.107	-0.047	-0.620**	-0.723**	-0.048	0.356**	1

Figure 2 shows the percentage catch according to mesh size with the smaller mesh sized nets (less than 3") accounting for 94.3 and 86.6 percent by the number and weight respectively, while nets with mesh sizes of 3" and above accounted for 6.7 and 13.4 percent by number and weight respectively.

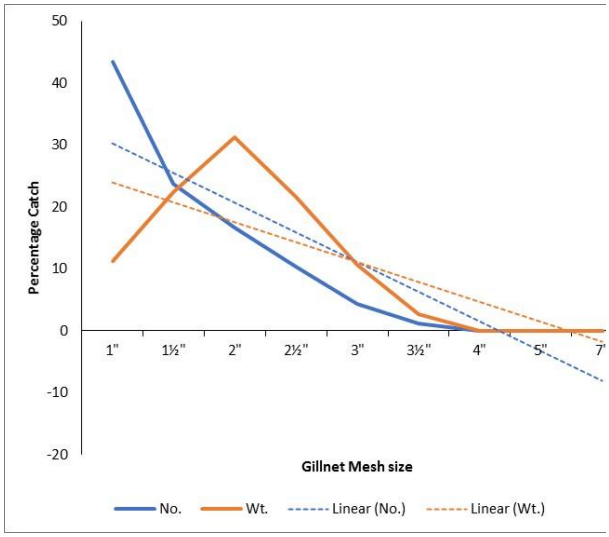

Figure 2: Mesh size selectivity by percentage number and weight of fish-catch in Experimental gill, Nets during the 2-year sampling period

The Frame survey revealed 98 functional fishing crafts in the reservoir with only one motorized. Out of this, an average of 40 is active on every fishing day of about 210 days in a calendar year.

The yield estimates from the reservoir based on the frame and catch assessment data collected during the survey period are computed thus:

$$\frac{\text{40 (Average no. of active fishing craft/day) x 210 (active fishing days) x 6.69 kg/day (Mean daily catch/boat/day)}}{\text{6366.7 ha (total surface area of the reservoir)}} \approx 8.83 \text{ kg/ha.}$$

DISCUSSION

The differences in the total number of fish species recorded under experimental gillnetting and that of the fishers' catch assessment are usually expected given the multiple nature and the variety of fishing gears employed by the artisan fishers. This aligns with the finding of Abiodun *et al*., 2013. The fish species recorded, their relative abundance, and mean weight of each species caught are represented in Table 1.

The low number of family and species is an indication that the reservoir is low in fish biodiversity. The Micralestes, which are known to be small fish species usually with a maximum total length of 60mm, are presumed to be voracious herbivores and widely distributed in tropical freshwaters (Olaosebikan & Raji, 2013). Their high abundance in this reservoir could be attributed to the availability of their food and favourable breeding grounds. Also, 30.79% (by number) and 51.80% (by weight) of the Cichlids confirms their success in the reservoir. Balogun (2005) revealed that the cichlids thrive in natural tropical fresh and brackish waters. However, an imbalance is observed between the foragers and carnivores (F/C) population ratio which is found to be 4.8 and 1.6 in terms of number and weight respectively. Swingle (1950) and Ofori-Danson & Antwi (1994) had recommended at best a ratio of 1:3 – 6. The deviation from this ratio therefore calls for an intervention in the management of the fish population of this reservoir.

The maximum average weight of fish caught (77.94g) reveals that the fish in the reservoir are generally of small-size. This observation is further proven by the poor catches observed at the landing sites in association with the maximum gillnet mesh size (2½″) observed to be commonly used by the fishers of the reservoir. This, according to Abiodun *et al.* (2013), is an indication of growth overfishing. The low fish biodiversity coupled with the small-size nature of fish in the reservoir is linked to low productivity of the reservoir in terms of fish species abundance and diversity which can be improved upon. The higher number of catches in the smaller meshes and the absence of fish in larger meshes further confirm the sizes of fish being caught in the reservoir. The minimum allowable mesh size for gillnet fishing is 3" (Fisheries Act, 2014). Generally, small mesh sizes usually catch small fishes. There was zero catch in the nets with mesh sizes of 4" to 7"; this is an indication of a reservoir with poor fish yield.

The estimated fish yield of 8.83 kg/ha as revealed in this study is considered low when compared to that of other similar water bodies in Nigeria namely; Alau reservoir in Borno State with 155 kg/ha (Bankole and Mbagwu, 2000); Sabke Lake in Katsina State with 178.6 kg/ha (Abiodun *et*

al., 2004) and Egbe dam in Ekiti State with 139.7 kg/ha (Abiodun *et al.*, 2004). The low production per hectare observed, therefore, support the need for enhancement with fish species that will fill the vacant ecological niches of the reservoir if the optimum fisheries potential of the reservoir is to be attained.

CONCLUSION

This study has succeeded in revealing the ichthyofauna status of Gurara reservoir. Fourteen species from seven families are found to be grossly inadequate for such a reservoir. This situation can be improved if an appropriate strategy aimed at balancing the F/C population ratio is undertaken. This, therefore, calls for further study and enhancement of the reservoir to achieve optimum benefit.

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