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ORIGINAL RESEARCH ARTICLE

Itchthyofaunal Composition, Abundance, and Diversity Indices in Zobe Reservoir of Katsina State, Nigeria

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ABSTRACT

Capture fishery is one of the dependable sources of fish protein and livelihood. This study investigated Ichthyofaunal diversity in Zobe reservoir for a period of twelve months (March 2020 to February 2021). Individual fishermen catch was used throughout the study period, where each of the five (5) Landing sites was visited twice monthly for catch assessment survey. Fish samples were randomly collected from 5 canoes/fishermen per sampling unit and catches examined. Thirteen (13) fish species (*Clarias gariepinus, Oreochromis niloticus, Schilbe mystus, Synodontis membranaceous, niloticus, Bagrus docmac, Bagrus bayad, Alestes dentex, Tilapia Mozambique, Clarias anguilaris, Momyrus rume, Sarotherodon galileus, Alestes nurse and Tilapia zilli)* belonging to eight genera from 7 families were observed. *Oreochromis niloticus* of the family Cichlidae was the most dominant species constituting 34.7%, 35.6%, 24.8%, 26.99%, and 27.3%, for Raddawa, Tabobi, Gada, Garhi, and Makera respectively, of the total catch in each fishing station of the reservoir. Diversity indices estimated from all the five stations include Shannon's index of diversity index (H'); with a monthly range of 1.81 to 2.34, Simpson's dominance index (C); 0.10 to 0.78, Simpson's index (1-D); 0.10 to 0.78, Species evenness index (E); ranging from 0.596 to 1.00, species richness of Margalef's index (d); 1.40 to 1.53, and reciprocal of Simpson's index (D'); 1.29 to 9.96. Fish species are highly diverse with good species richness and evenness. This study validated the fisheries resources for commercial activity and fishery management of the reservoir. Therefore, stakeholders should utilize optimally and commercially the fishery resources for job creations.

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INTRODUCTION

Capture fishery is one of the dependable and cheaper animal protein sources (FDF-Federal Department of Fisheries, 2008) and employment opportunities (State of Fisheries and Aquaculture - SOFIA, 2020).

Overexploitation, among other anthropogenic effects, as well as poor management strategies of the water bodies, contributed adversely to the reported decline of Nigeria's Fisheries resources (Lawson and Olusanya, 2010). According to UNESCO (2010) nearly thirty years, fish supply from natural waters has been declining at alarming rates due to illegal fishing. The freshwater fish of Nigeria is exploited artisanally and commercially (Olaosebikan and Raji, 2004). Knowledge of the Ichthyofaunal composition, abundance, and diversity of the water bodies is necessary before designing any management strategy (Sogbesan and Kwaji, 2018). Proper management of aquatic resources requires investigating the fisheries status, compositions, and stock assessment so as to correlate between the number of fish, selectivity of fishing method and gears, and the resulting catch that is sustainable in the long term. This is to maximize the quantity of yield exploitation on a timely basis without risking the biological or economic viability of the fishery resources from the ecosystem (Yusuf and Abdulkarim, 2015).

The biodiversity of fish fauna has been studied in other reservoirs by various scientists (Ita, 1983 and Reed, 1967; Ita 1987; Lawson and Olusanya, 2010; Emmanuel *et al*., 2013; Ahmad *et al*., 2014; Adaka *et al*., 2014; Ekundayo *et al*., 2014; Peter *et al*., 2015; Nafiu *et al*., 2017).

However, there is still a shortage of information on fish species and their distributions in many reservoirs in Nigeria (Ladu and Okaeme, 2000; Raji and Ovie, 2007; Ahmad *et al.,* (2014); Kwaji and Sogbesan, 2015; and Sogbesan and Baka, 2017).

No model based study carried out in Zobe reservoir for lengthy period up to twelve month. Hence, this study aimed to validate the finding of Ahmad *et al.,* (2014) by using diversity indices models, large sample size, and covers all seasons so as to account for more information, identify the different fish species and their diversity/distribution in the Zobe reservoir.

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METHODOLOGY

Study Area

Zobe reservoir is an earth-filled structure with a height of 19 meters and a total length of 2,750 m. The reservoir coordinated; Latitude [12° 20' 34.62N to 12° 23' 27.48N] and Longitude [7° 27' 57.12E to 7° 34' 47.68E] in part of Dustin-ma and Matazu Local Government area of Katsina State. The southern part of the reservoir is bounded by many villages that include; Marke, Makera, and Tsakko. By the southeast are Tuga and Kuka-Damisa, whilst by the north are Garhi, Badole, Daguda, Katsalle and Tabobi remotes. The reservoir is 4,500ha with volume capacity of 177, 000, 000.00m^3 metres of water. Irrigation and municipal water supplies are basic mandates for Zobe reservoir (SRRBDA, 1981). The reservoir was created for local irrigation of 8,000 hectares, hydroelectric power generation and water supply. Zobe reservoir has two main tributaries; River Karaduwa and River Gada (SRBDA, 1981).

Experimental Design

The study was conducted in five (5) major fishing spots/stations of Zobe Reservoir;- [*(A)* Tabobi, *(B)* Makera, *(C)* Garhi, *(D)* Gada, and *(E)* Raddawa (Figure 1)] for better representation of the fishery of the study area. Fish samples were randomly collected from 5 canoes/fishermen crew per sampling unit twice monthly (Stamatopoulos, 2004) from March, 2020 to February, 2021.

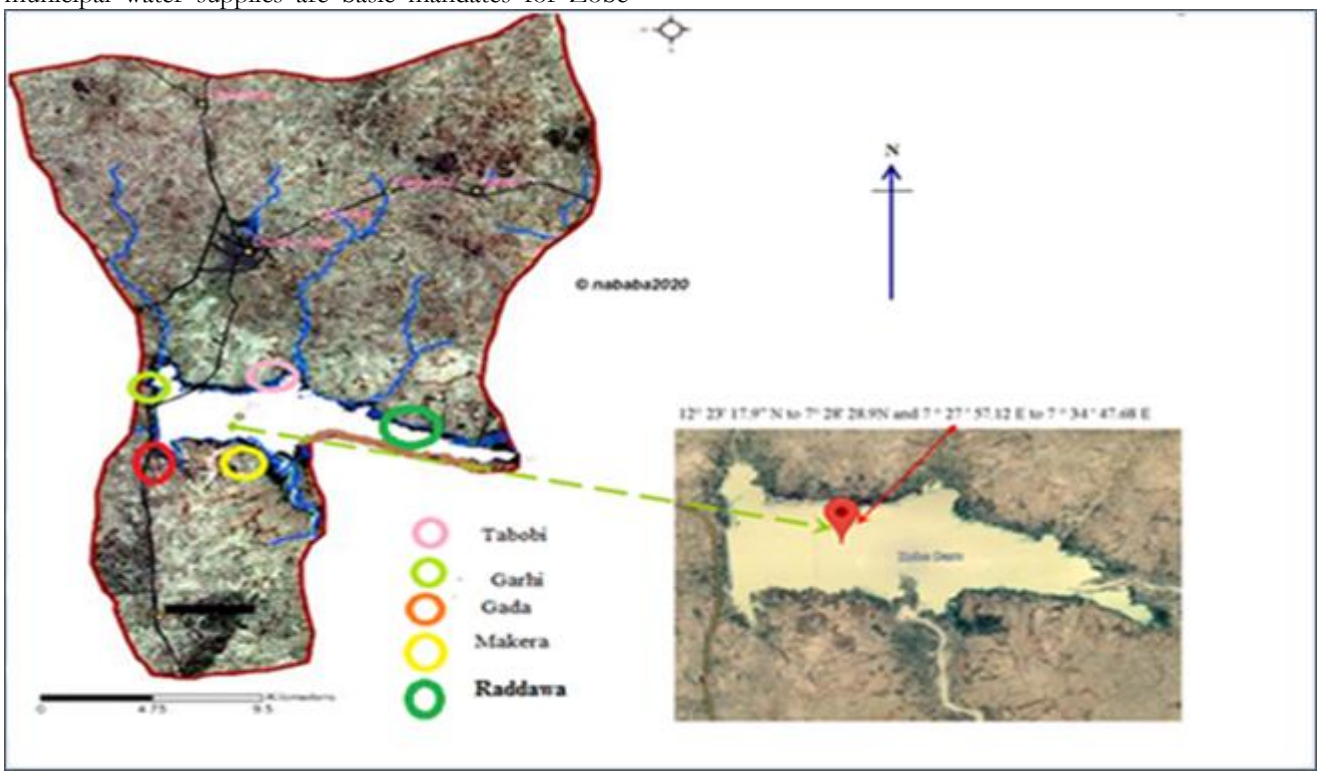

Figure 1: Map of the study area with sampling units marked (ng.geoview.info>zobe_reservoir)

Catch Assessment Survey

Individual fishermen catches were used throughout the period of the study. Each of the five (5) Landing sites was visited on weekly basis twice monthly for 12 months for the catch assessment survey. Fish samples were randomly collected from the landing sites from 5 canoes/fishermen per sampling unit. Fish catches of each of the sampled fisherman were taken at random, i.e. every second landed canoe/fisherman until the tenth comes.

Fish Species Identification

Fish species collected from fishermen were identified by using Key identification guides by Olaosebikan and Raji (2004) as well as (Reed *et al.,* 1967). Nevertheless, personal communications on the identification and local naming with the most experienced fishers at the reservoir were also used.

Diversity, Abundance, and Similarity Indices of the Fish Species

The following models were used to estimate the diversity, abundance, evenness, and similarities among the sample species.

Simpson's Index: $D = \frac{\sum_{i=1}^{q} ni(ni-1)}{N(N-1)}$ Simpson (1949)

Where;

N= total number of individuals encountered

ni = number of individuals of ith species enumerated for i=1……q

q = number of different species enumerated.

Simpson's reciprocal Index = $\frac{1}{d}$ ……...ii

Simpson's index of diversity = $1 - d$ ……iii

Shannon Weiner Index: $H = -\sum_{i=1}^{s} pi \ln pi$ ……v

Gabriel *et al.* (2014)

Where:
pi = the proportion of individuals in the ith species
s = the total number of species
ln = natural logarithm
i = ith species

Renkonen Index of Similarity

The Renkonen similarity index (P), is a percentage of similarity or dissimilarity between two populations centered on proportional abundance of entities of combined species (Renkonen, 1938).

Renkonen Index of Similarity =Pi = ni/∑ni

Where ni = a given population of a particular specie ith

Statistical Analysis

Descriptive statistics with the aid of Microsoft excel package (2010 version) was used for data analysis using various indices expressed above.

RESULTS

Fish Species Composition

A total of thirteen (13) fish species of seven (7) families were observed during this study. Two (2) species, *Bagrus bayad* and *Bagrus docmac*, represented the family Bagridae, another two, *Clarias gariepinus* and *Clarias anguilaris* represented the family Clariidae, hitherto, the family Cichlidae was represented by *Oreochromis niloticus* and *Tilapia zilli* (Table 1). The results show that the family Alestiidae was represented by *Alestes.nurse*, and *Alestes dentex*, whereas the families Mormyridae, Schilbeidae and Mochokidae were represented by *Mormyrus rume*, *Schilbe mystus* and *Synodontis membranaceus*, respectively (Table1).

Table 1: Fish Species Composition in Zobe Reservoir

S/N	Family	Species Name	Local Name	Fishing Stations					Total
				Raddawa	Tabobi	Gada	Garhi	Makera	
1.	Bagridae	*Bagrus bayad*	Ragon ruwa	673	405	788	1101	1173	4140
2.	Bagridae	*Bagrus docmac*	Ragon ruwa	874	620	927	1104	1431	4956
3.	Clariidae	*Clarias gariepinus*	Tarwada	104	61	154	114	133	566
4.	Clariidae	*Clarias anguillaris*	Tarwada	18	6	68	22	26	140
5.	Cichlidae	*Oreochromis niloticus*	Karfasa	82	68	166	91	115	522
6.	Cichlidae	*Tilapia zilli*	Buku/ Karfasa	215	12 1	327	268	302	1112
7.	Cichlidae	*Sarotherodon galilaeus*	Karfasa	256	143	663	663	1033	2758
8.	Cichlidae	*Tilapia mossambique*	Karfasa	51	13	97	119	103	383
9.	Momyridae	*Momyrus rume*	Lafsha	3	0	0	0	4	7
10.	Schilbidae	*Schilbe mystus,*	Ramfai	47	73	132	226	268	746
11.	Alestidae	*Alestes nurse*	Kawara	34	4	39	35	46	158
12.	Alestidae	*Alestes dentex*	Tatar	147	214	278	294	488	1421
13.	Mochokidae	*Synodontis membranaceous*	Kurungu	24	14	98	53	127	316
TOTAL				**2528**	**1742**	**3737**	**4090**	**5249**	**17225**

Fish Species Abundance in Zobe Reservoir

Relative abundance of fish species in Zobe reservoir showed that all the species were present in all the sampling stations except for Clarias anguilaris which was merely absent in Tabobi, Gada, and Makera (Table 2)

Table 2: Abundance of Fish Species in Zobe Reservoir (%)

		C.g	O.n	Sy.m	S.me	B.d	B.b	A. d	T.m	C.a	M.r	S.g	A.n	T.z	TT
Fishing Stations	**RD**	26.62	34.68	4.11	0.71	3.24	8.51	10.12	2.02	0.12	1.86	1.35	5.82	0.95	100
	TB	23.25	35.59	3.50	0.34	3.90	6.95	8.21	0.75	0.00	4.19	0.23	12.29	0.80	100
	GD	21.09	24.81	4.12	1.82	4.44	8.75	17.74	2.60	0.00	3.53	1.04	7.44	2.62	100
	GR	26.92	26.99	2.79	0.54	2.23	6.55	16.21	2.91	0.00	5.53	0.86	7.19	1.30	100
	MK	22.35	27.26	2.53	0.50	2.19	5.75	19.68	1.96	0.076	5.11	0.88	9.30	2.42	100
	TT	23.867	28.571	3.263	0.807	3.010	7.11	15.90	2.21	0.040	4.30	0.911	8.19	1.82	100

Where: RD: Raddawa, TB: Tabobi, GD: Gada, GR: Garhi, MK: Makera and TT: Total. Where C.n, O.n, Sy.m, S.me, B.d, B.b, A. d, T.m, C.a, M.r, S.g, A.n, and T.z, stands for; Clarias gariepinus, Oreochromis niloticus, Schilbide mystus, Synodontis membranaceous, Bagrus docmac, Bagrus bayad, Alestes dentex, Tilapia mozambique, Clarias anguelaris, Momyrus rume, Saratherodon galileus, Alestes nurse and Tilapia zilli, respectively.

Relative Distribution of Fish Species in Zobe reservoir

Fish species distribution of Zobe reservoir for the study period is presented in (Table 3). The percentage contribution of each species was estimated which indicated that Oreochromis niloticus had the highest percentage among the species found in the reservoir except for Gada where Clarias gariepinus happen to be the highest. In other hand, Clarias anguilaris was found to have the lowest proportions with as low as zero in Tabobi, Gada, and Garhi respectively.

Table 3: Relative Distribution of Fish Species in Zobe Reservoir

Fishing Stations	C.g	O.n	Sy.m	S. me	B.d	B.b	A. d	T.m	C.a	M.r	S.g	A.n	T.z	TT
RD	16.26	17.64	18.38	12.86	15.71	17.44	9.28	13.32	42.86	6.30	21.52	10.35	7.60	14.57
TB	9.79	12.5	10.78	4.29	13.03	9.81	5.185	3.40	0.00	9.79	2.53	15.06	4.43	10.04
GD	19.03	18.71	27.21	48.57	31.80	26.52	24.04	25.33	0.00	17.69	24.68	19.56	31.01	21.54
GR	26.59	22.28	20.14	15.72	17.43	21.74	24.04	31.07	0.00	30.30	22.15	20.69	16.77	23.58
MK	28.33	28.87	23.59	18.57	22.03	24.49	37.46	26.89	57.14	35.93	29.11	34.34	40.19	30.26
TT	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Where: RD: Raddawa, TB: Tabobi, GD: Gada, GR: Garhi, MK: Makera, and TT: Total. Where C.n, O.n, Sy.m, S.me, B.d, B.b, A. d, T.m, C.a, M.r, S.g, A.n, and T.z, stands for; Clarias gariepinus, Oreochromis niloticus, Schilbide mystus, Synodontis membranaceous, Bagrus docmac, Bagrus bayad, Alestes dentex, Tilapia mozambique, Clarias anguelaris, Momyrus rume, Saratherodon galileus, Alestes nurse and Tilapia zilli, respectively

Fish Species Diversity and Richness Indices in Zobe Reservoir

Various models were used to test for the fish species diversity, evenness, dominance, and richness in Zobe reservoir for the studied period Table 4. The Shannon-Weiner index 'H ranged from minimum of 1.53 in Raddawa and maximum of 2.56 in Makera stations respectively. Dominance index Tabobi has the least index and Makera has the highest of 0.78 as shown in table 4. For the species richness Tabobi and Raddawa has the highest while Makera recorded the lowest. Similarly, evenness index was highest in Makera and lowest in Tabobi.

Table 4: Species Richness and Diversity Indices in Zobe Reservoir

Indices	Fishing Stations				
	Raddawa	**Tabobi**	**Gada**	**Garhi**	**Makera**
Shannon's Index (H')	1.87	1.53	2.51	2.37	2.56
Species Evenness Index (E)	0.73	0.60	0.98	0.92	1.00
Simpson's Dominance Index (C)	0.22	0.10	0.34	0.49	0.78
Simpson's Index (1- d)	0.22	0.10	0.34	0.49	0.77
Reciprocal of Simpson's index (D')	4.66	9.96	2.91	2.05	1.29
Species Richness of Margalef's index (d)	1.53	1.61	1.46	1.44	1.40

Species Similarity Index

Renkonen's Similarity index was used to determine the magnitude of similarity between all the fishing stations as well as dissimilarity. The results from this study showed that all the five (5) fishing stations were greater than the critical level (50%) of similarity. The comparison degree between the fishing stations are presented in (Table 5)

Table 5: Species Similarity Index of Renkonen's Number (%) of the Five Fishing stations from Zobe Reservoir

Fishing stations	Fishing Spots	Raddawa	Tabobi	Gada	Garhi	Makera
	Raddawa		89.52	84.28	87.34	82.25
	Tabobi			81.55	83.71	83.91
	Gada				89.67	90.84
	Garhi					92.93
	Makera					

DISCUSSION

Fish Species Composition and Diversity in Zobe Reservoir

The Ichthyofauna of Zobe reservoir found during this study appears to be richer than 12 species reported by Ahmad et al. (2014) from the same reservoir, and twelve fish species identified in Dogon Ruwa by Oguntade et al. (2014) and Allison and Okadi (2013). The family Cichilids, Clariids, Alestids and Bagrids are the four most abundant fish families in all the fishing stations at Zobe reservoir. From this study, the species Oreochromis niloticus happened to be the most dominant amongst the total species. This is in line with the work of Sogbesan and Barka (2017); Ja'afaru and Abubakar (2015); Dan-Kishiya et al. (2012); Adeyemi et al., (2010); Abubakar (2006) and Abiodun and Miller (2005) whose individual reports showed that the family Cichlidae was the most dominated species in Njoboliyo Lake, Dadin Kowa Dam, Gombe; lower Usuma Reservoir, Gbedikere Lake, Lake Geriyo and

Lake Geronyo, respectively. Their reports firther indicated that Oreochromis niloticus was the most abundant fish species of the said reservoirs.

Findings of this stuidy revealed a low species richness in the study area compared to eighty one (81) species observed by Odiko et al., (2010) in River Ovia of Edo State, fourty five (45) fish species observed by Meye and Ikomi (2008) at Urie creek and twenty six (26) species observed by Ja'afaru and Abubakar (2015) from Dadin Kowa Dam, Gombe State. The dominance aptitude of the family cichlids could be ascribed to their capacity to frequent spawning about three to four times on annually [Sogbesan and Barka, 2017; Bankole et al., 1994; and Reed et al., 1967]. Higher wet season than dry season catches and species composition was also been reported by Sogbesan and Barka (2017) in Njoboliyo Lake and Ja'afaru and Abubakar (2015) in Dadin Kowa Dam, Gombe State and Kwaji and Sogbesan (2015) at Lake Ribadu. However, this result is contrary with the finding of Meye and Ikomi (2008) who reported higher catch/yield at dry season than rainy season species composition in Urie creek at Igbide in Delta State, Nigeria. The reason for the higher wet season catches may be attributed to the increase in fish food supply (Productivity) and consequently the increase in reproduction especially by the family Clariidae (Reed et al., 1967). For instance, Clarias gariepinus which formed the second most abundant species in this study is a member of this family Clariidae. Nevertheless, the ability of the fishermen at raining season to access deeper parts of the fishing grounds with their crafts due to an increase in water depth and amplified space which are otherwise inaccessible during the dry season, which is in addition to reasonable improvement of water quality parameters during wet season.

Diversity Indices of fish fauna in Zobe Reservoir

The Shannon-wiener index (H') for the fish species in Zobe reservoir for the study period were closer to 1.5 to 3.5 which reported by (Gabriel et al., 2014) from Gubi Dam, Bauchi State. However, the calculated indices in this study was greater than those reported by Offem et al., (2011) 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). Correspondingly Emmanuel et al., (2013) observed H' value ranging from 1.869 and 2.015 in three tributaries of River Ore, and they are lower than what is reported in this study. Disparity in ecological zones could be a major cause of these differences. Howevert, the H' values recorded in this study indicates a good spread of species diversity in Zobe reservoir.

The Species evenness index (E) from this work revealed that fish species in Zobe reservoir were evenly distributed compared to other reservoirs such as River Ore as reported by Emmanuel et al., (2013). Similarly, this study observed that, fish species in Zobe reservoir were well diverse. Nevertheless, there was greater fish diversity in Zobe reservoir than Lakes Oguta, Oyan, Dadin Kowa, Tiga, Asa and Opi as well as Ajiwa reservoir [(Ita, and Padogari, (1987); Ja'afaru, and Abubakar, (2015); Nafiu, (2006)]. According to Colwell (2009), H' and Simpson's index of diversity cannot be used to fecund populations in the same manner but will increase as richness increases.

The species richness of Margalep's index (d) of Zobe reservoir was higher than those observed by Dan-kishiya et al., (2012) for Lower Usuma Reservoir, Bwari, Nigeria. This might be as a result of difference in the number of species observed in the reservoir. However, this measure cannot be sensitive to environmental disorder as such, it cannot be concluded that this value differs for both areas which are in different ecological zones. Species equitability index (E) in for all the five stations reveals that the distribution of species or fish population was even. Likewise, the result of this work is similar to that of Emmanuel et al., (2013) but greater than those (indices) reported by Odo et al., (2009) in Anambra River.

The species similarity index of Renkonen's number across the five (5) fishing stations of the reservoir (Nababa et al., 2019) was above 50 which is an indication that the species are similar in all the fishing spots. This is a clear representation of the spatial distance between the studied sample stations as those with more proximity tend to have more similar fish species distribution.

CONCLUSION

The species of fish in Zobe reservoir were highly diverse with good species evenness and richness. Oreochromis niloticus, Clarias gariepinus, Alestes dentex, and Bagrus bayad were the four most dominant species in the reservoir. The results from this study showed that the reservoir was rich in many species of commercial importance, and the diversity index also indicated that the species were readily available for optimum exploitation in a commercial way. This study validated the fisheries resources for commercial activity and fishery management of the reservoir. Therefore, stakeholders should utilize optimally and commercially the fishery resources for more job creations.

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