FISHERIES STATUS AND FISHING GEARS OF A WEST AFRICAN ARID ZONE LAKE

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ABSTRACT

The lake Alau fisheries of the North East zone of Nigeria, Maiduguri contains relatively low fish species exploited artisanally by 365 fishers in all the sampled stations. Station 4 has the highest mean number of fishers (275 ± 21.30) while station 2 has the least mean number (35 ± 9.30). A total of one thousand, eight hundred and thirty one (1831) fish specimens were sampled. The major fish species were from the families; Characidae, Cichlidae, Mochokidae, Schilbeidae, Mormyridae, Cyprinidae, Clariidae, Bagridae, Centropomidae, Polypteridae and Osteoglossidae. The most dominant family observed was the Cichlidae. The species composition recorded was 28 in all the studied stations. Heterotis niloticus was dominant with mean number of 40.4 ± 1.1.28 and percentage composition of 11.2 %. Sex ratio of 1 male to 0.95 female was recorded for Heterotis niloticus. Multi gears fishing were observed. The percentage composition of fishing gears observed were in the order of clap net (33 %), cast net (20 %), gill net (20 %), long line (11 %), Mali trap (15 %) and seine net (1 %). There was a steady increase in number of fishers employing nets of various kinds. Lake Alau fisheries can be rated as over fished due to the pressure of fishers and the quality of their catches.

Keywords: Arid zone, Fisheries resources, Fishing gears, *Heterotis niloticus*

INTRODUCTION

The tropical freshwater fish fauna of Nigeria contains many fish species exploited commercially or artisanally. The fish fauna of Nigeria waters has been studied more in comparison to those of other tropical nations. Fish landing from capture fisheries has over the years been recording a tremendous decline with no regards to the ever increasing world population (Anpe, 2001).

Much work has been reported on fish composition and fisheries of many tropical water, for example South America waters (Lowe McConnell, 1994 and Junk, 1984) and Africa inland waters (Welcome, 1974, 1979) among others. For the African lakes, Cambray (1990) reported that many of these studies were centered on the exploitable adults and relatively large fish species.

Status on the biological and economic importance of lake fisheries includes those of Okedi (1971), Oguzie (1982) and Beadle (1981). A combination of circumstances makes these fishes uniquely vulnerable to over exploitation due to habitat degradation or simply poor management. Ochumba and Manyale (1992) observed that freshly caught fish are the most delicious, a treaty for royalty among the fishing tribes, and secondly, a strong consumers preference, which make them the most valuable prized fishes.

In Nigeria, Onwuka (2001) reported that the issues of increased fish production among the artisanal fishers have been of great concern to the government, local organization and fisheries experts globally. The fish products in lake Alau, Borno State of Nigeria, play important role in meeting fish protein need of Borno State and some other states in the country contributing above 25 % of the total domestic fish supply in Nigeria.

Fishery management requires a good knowledge of fishing gears. There is great divergence in the efficiency of different forms of fishing gear, in their adaptability to certain conditions, and in their desirability for specific job (Eyo and Akpati, 1995).

Traditional fishing arts have been developed over the years to adapt to local body conditions; the species of fish desired and targeted size. The most successful fishing methods of an area or a region are those that have stood the test of time (Eyo and Akpati, 1995).

There have been very few studies on aspects of the fisheries of lake Alau. These studies were limited to the preliminary investigation on the fisheries and catch assessment survey (Bankole, 1994), parasites of *Clarias gariepinus* (Idowu, *et. al.,* 2002) and limnological characteristics (Idowu, 2004), physico-chemical characteristics (Idowu, *et. al.,* 2004) of the lake.

Lake Alau is one of the major tourist attraction sites of Borno State and is held in great esteem both by tourist and the indigenes. Also being the largest and nearest water body to Maiduguri metropolitan that supplies domestic water to various localities, the management of the Borno River Basin Development Authority were able to create some visible fisheries impact around the water body with good roads for easy access by tourist, fishers and their patronizers (CBDA, 1984).

MATERIALS AND METHODS

The Study Area: Lake Alau was created in 1985 by damming river Ngadda about 22 km from Maiduguri, along Maiduguri – Bama road. It is located between latitude 13^0N and 14^0N and longitude 12^0E and 13^0E. It has a total surface area of 56 km^2. Being located in the North-East arid zone, the climate is Sahelian with three distinct seasons. The rainy season starts from July to October, cold dry harmattan winds from November to February and a very hot dry season with extreme temperature of about 42 ^{0}C from March to June. It has a mean depth of 10 m, with an effective storage capacity of 54,000 cm^3 (CBDA, 1986; Bankole, 1994; Idowu, *et. al,* 2002 and Idowu, 2004). The water temperature values ranged from 23 ^{o}C to 27 ^{o}C, depth varied from 2.85 m to 17.23 m, water current was between 19.62 cm/sec and 26.71 cm/sec, Secchi disc transparency ranged from 0.26 m to 0.42 m, pH varied from 6.59 to 7.29, conductivity was between 118.41 homs/cm and 131.45 homs/cm, free CO_2 ranged from 2.55 mg/l to 3.06 mg/l, Biochemical oxygen demand (BOD) are between 4.30 mg/l and 5.31 mg/l and nitrate-nitrogen concentration are between 30.30 mg/l and 47.0 mg/l. Generally, the physico-chemical characteristics of lake Alau fall within the productive values for tropical lakes. This strongly indicates that the lake is unpolluted.

Assessment of Fisheries Status and Fishing Gears: The study was carried out for over a 12 month period running from September 2001 to August 2002. The lake was demarcated into five stations. The stations were sampled twice monthly for ichythyofauna. Sampling was by (a) direct observations and record of the fish species, fishers and fishing gears used and (b) constructed interviews of the fishers at their landing sites. All the fish species landed were counted and recorded. Selected fish species were preserved in ice and labeled for laboratory identification and analysis (Bankole, *et al.,* 1994). Identification of the fish species was according to Reed, *et al*. (1967), Trewaves, *et al.* (1972) and Teugels, *et al.* (1992). Voucher specimens preserved in normalized 10 % formalin were deposited in the Museum of Natural History, Department of Zoology, University of Nigeria. The fish assemblage structure, species abundance and percentage composition were calculated. Species richness (Odum, 1971; Peck and Forsyth, 1982) and diversity index (Shannon, 1948) were also calculated.

RESULTS

The total number of fish specimen studied was 1831 out of which 375 were from Station 1, 365 from station 2, 374 from station 3, 373 from Station 4 and 353 from 5. The highest fish population was recorded in the months of January and February. The sex ratio during the study period was 1 male to 0.95 female. Twelve fish families were identified from the five stations thus: Characidae, Cichlidae, Mochokidae, Schilbeidae, Mormyridae, Cyprinidae, Clariidae, Bagridae, Centropomidae, Polypteridae, Malapteruridae and Osteoglossidae (Table 1). The percentage composition of the fishes family indicated that the cichlids were the most abundant followed by the clariids in all the stations sampled.

Table 1: Percentage composition of each family per station

FAMILY	STATION				
	1	2	3	4	5
Cichlidae	17	17	16	16	17.2
Clariidae	14.4	14	13	11	14.7
Morymyridae	10	12.6	11	10.7	13
Characidae	8.5	11	1	4.8	4.5
Mochokidae	9.3	7.9	11	9.7	9.1
Osteolgossidae	8	7	11	14.7	14
Schilbeidae	7	6.7	7.5	5.4	6.2
Bagriidae	6.4	6	5	7	4.2
Cyprinidae	5	5.1	4.3	5.6	7.6
Malapteruridae	5.9	5.1	4	6.7	2.8
Polypteridae	4.8	3.9	5.9	4.3	2.8
Centropomidae	3.7	2.8	4	4.3	2.8

The family Centropomidae had the least percentage composition in all the stations. A total of 28 centropomid fish species were recorded from all the stations. Table 2 showed the mean abundance and the percentage composition of each species as pooled from all the sampled stations. *Heterotis niloticus* dominated the overall catch with the highest mean value of 40.4 ± 12.78 with the percentage composition of 11.2 %. This was followed by *Hemichromis fasciatus* (18.6 ± 0.59 mean abundance and 5.1 percentage composition). Other records were *Sarotherodon galilaeus* (18.2 ± 2.05 mean abundance and 5.0 percentage composition), *Malapterus electricus* (18.0 ± 5.87 mean abundance and 5.0 percentage composition), *Polypterus senegalensis* (16.0 ± 4.47 mean abundance and 4.4 percentage composition), *Schilbe mystus* (14.6 ± 3.58 mean abundance and 4.0 percentage composition), *Clarias macromytax* (13.6 ± 2.07 mean abundance and 3.6 percentage composition), *Lates niloticus* (13.4 ± 2.41 mean abundance and 3.7 percentage composition) among others. The least species was *Hyperopsis bebe* (5.60 ± 1.51 mean abundance and 1.5 percentage composition). Homogeneous distribution of fish in all the sampled stations was observed (Table 3). The families Clariidae, Cichlidae and Morymyridae had the highest number of genera and species (four species each) while Mochokidae and Characildae had three species, Schilbeidae, Bagridae and Cyprinidae had two species and Centropomidae, Polypteridae, Malapteruridae and Osteoglossidae had only one species. Table 4 shows the assemblage parameters of the fish families in relation to stations. Diversity index of 0.64 was calculated for stations 2 and 5, 0.63 for station 1 and 0.62 for stations 3 and 4. The species richness was highest in station 5 (4.38). Other records were station 4 (4.28), stations 3 and 1 (4.27) and station 2 (4.30). The Shannon's index showed that stations 1 and 4 had 1.04, followed by 1.03 in station 3 and station 5 had the least value of 0.998.

Table 2: Means Abundance and percentage composition of fish species in lake Alau

Species	Means Abundance	% Composition
Heterosis niloticus	40.4 ± 12.78	11.2
Hemichromis fasciatus	18.6 ± 0.59	5.1
Sarotherodon galilaeus	18.2 ± 2.05	5
Malapterus electricus	18.0 ± 5.87	5
Polypterus senegalensis	16.0 ± 4.47	4.4
Schilbe mystus	14.6 ± 3.58	4
Clarias macromytax	13.6 ± 2.07	3.6
Lates niloticus	13.4 ± 2.41	3.7
Bagrus bayad	13.2 ± 2.28	3.6
Mormyrus delicious	13.2 ± 2.17	3.6
Synodontis nigrita	12.8 ± 2.17	3.5
Clarias gariepinus	12.6 ± 3.13	3.4
Oreochromis niloticus	12.0 ± 2.51	3.3
Mormyrus rume	12.0 ± 2.45	3.3
Clarias anguillaris	12.0 ± 2.0	3.3
Labeo couble	11.8 ± 5.40	3.3
Alestes nurse	11.6 ± 5.03	3.2
Gnathonemus petersii	11.4 ± 3.91	3.1
Synodontis filamentus	11.4 ± 2.97	3.1
Tilapia zilli	10.0 ± 4.69	2.8
Synodontis batensoda	10.0 ± 1.41	2.8
Europius niloticus	9.20 ± 0.84	2.5
Heterobranchus bidorsalis	8.80 ± 3.19	2.4
Alestes dentex	8.60 ± 4.04	2.4
Labeo senegalenis	8.60 ± 3.13	2.4
Chrysicthys awatus	8.20 ± 2.49	2.3
Hydrocynus forskali	6.0 ± 3.08	1.7
Hyperopisus bebe	5.60 ± 2.51	1.5

The fishing gears identified during the study period included baited and unbaited Malian traps which constitute about 15 % of the total gears recorded. Clap net had the highest percentage occurrence of 33 %. Seine nets were found to have the least occurrence of 1 %. Figure 1 shows the percentage number of fishing gears recorded in lake Alau. Fish were caught more by clap nets during the dry and the flood seasons. The total number of fishers observed per station varies drastically. Station 4 has the highest number of fishers (275) and fishing boat (155) followed by Station 1 which had 60 fishers and 50 fishing boats (Table 5). Fishing intensity was high during the non flooding periods than the flooding periods. Among the fishers both genders were involved in the fisheries with the male gender dominating the pre and fish harvesting sectors and the female gender dominating the post harvest preservation and marketing sectors.

DISCUSSION

The species richness of each of the stations studied in Lake Alau compares favourably with those of Tiga reservoirs (Bankole, 1991), Tatabu flood plain (Daddy, *et al.,* 1991) and lake Busumtwi, Ghana (Whyte, 1975). In an earlier report, Bankole (1994) recorded 19 fish species in lake Alau. Our report of 28 fish species for the lake is an improvement over the 19 species recorded for 1994 and may be attributed to the sampling techniques adopted and the duration of sampling. Lake Alau showed a preponderance of cichlid species. In each of the station there were more cichlid than fishes from other families. Four species *Sarotherodon galilaeus. Hemichromis fasciatus, Oreochromis niloticus* and *Tilapia zilli* were

Table 3: Species distribution per station in Lake Alau

SPECIES	STATION				
	1	2	3	4	5
CICHLIDAE					
Sarotherodon galilaeus	+	+	+	+	+
Hemichromis fasciatus	+	+	+	+	+
Oreochromis niloticus	+	+	+	+	+
Tilapia zilli	+	+	+	+	+
MORMYRIDAE					
Mormyrus delicious	+	+	+	+	+
Mormyrus rume	+	+	+	+	+
Gnathonemus petersii	+	+	+	+	+
Hyperopisus bebe	+	+	+	+	+
MOCHOKIDAE					
Synodontis batensoda	+	+	+	+	+
Synodontis nigrita	+	+	+	+	+
Synodontis filamentus	+	+	+	+	+
CLARIIDAE					
Clarias macromytax	+	+	+	+	+
Clarias anguillaris	+	+	+	+	+
Clarias gariepinus	+	+	+	+	+
Heterobranchus bidorsalis	+	+	+	+	+
CHARACIDAE					
Alestes dentex	+	+	+	+	+
Alestes nurse	+	+	+	+	+
Hydrocynus forskali	+	+	+	+	+
SCHILBEIDAE					
Schilbe mystus	+	+	+	+	+
Europius niloticus	+	+	+	+	+
BAGRIDAE					
Bagrus bayad	+	+	+	+	+
Chrysicthys awatus	+	+	+	+	+
CYPRINIDAE					
Labeo couble	+	+	+	+	+
Labeo senegalenis	+	+	+	+	+
CENTROPOMIDAE					
Lates niloticus	+	+	+	+	+
POLYPTERIDAE					
Polypterus senegalensis	+	+	+	+	+
MALAPTERURIDAE					
Malapterus electricus	+	+	+	+	+
OSTEOGLOSSIDAE					
Heterosis niloticus	+	+	+	+	+

evenly distributed in all stations. Their abundance is attributed to their adaptation to lentic aquatic environmental qualities, productivity of the lake and changes in hydrological regime of the lake (Idowu, *et al.,* 2004). Dun (1989) reported that cichlids apparently requires swam habitat with plenty of organic matters for swamping and feeding of fry. They must have abundant food to thrive upon as the tendencies for most cichlids to breed early during the floods at the margin of the advancing water have been demonstrated (Dun, 1989). Their prolific breeding status couple with parental care can also contribute to the dominance of cichlids in the lake.

Table 4: Assemblage parameters of the fish families in relation to stations in lake Alau

STATIONS	DIVERSITY INDEX $M/N^{½}$	SPECIES RICHNESS	SHANNON INDEX
1	0.63	4.27	1.04
2	0.64	4.30	1.02
3	0.62	4.27	1.03
4	0.62	4.28	1.04
5	0.64	4.38	0.98
Pooled data	0.28	3.68	1.03

In terms of relative abundance and species composition and *Heterotis niloticus* clearly dominated other fish species. The vast reed vegetation that is found along the fringes of the lake affords these species a good breeding and nursery ground as well as cover from predators. The *Clarias* species that were found includes *Clarias gariepirius, C. anguillaris* and *C. macromystax*, their sizes were found to be smaller due to the mesh size selection of the fishing gears. The relative abundance and species percentage composition of *Hyperopisus bebe* was very low when compared with other species. King (1989) and Udoidiong and King (2000) reported the ability for mormyrids to adapt to fluctuations of hydrometeorological variables accounted for their occurrence and that their success could also be attributed to presence of suitable habitats.

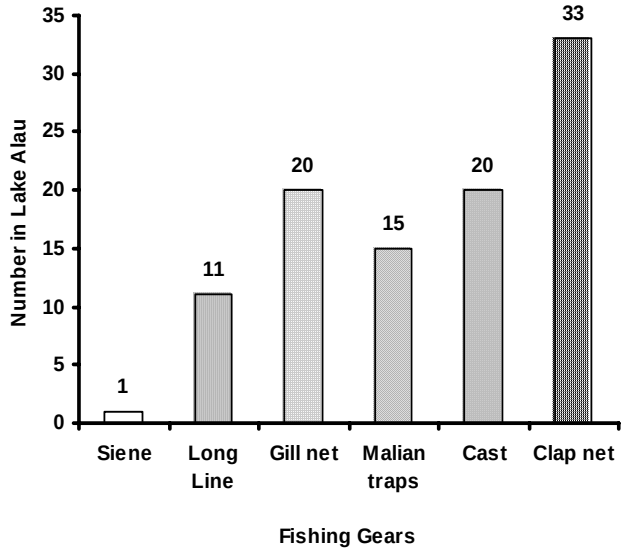

Figure 1;The number of fishing gears in lake Alau

Table 5: Mean number of fishers and fishing boats observed at each station in lake Alau

STATION	NUMBER OF FISHERS	NUMBER OF FISHING BOAT
1	60 ± 3.7	50 ± 1.52
2	35 ± 4.25	15 ± 1.02
3	55 ± 4.25	50 ± 2.50
4	275 ± 10.30	155 ± 11.25
5	55 ± 2.20	30 ± 1.25

Species richness and diversity was observed to increase in all stations. There were no significant differences ($P > 0.05$) between the calculated values in all the stations. This may be attributed to increased living space leading to increased number of microhabitats. According to Odum (1971) and Udoidiong and King (2000) diversity is higher in old communities than newly established ones. Lake Alau, over the past twenty has attended the status of being classified as a lake with old communities. The impacts of high fishing levels on the species are mentioned in Bankole, *et. al* (1994). Generally, there has been decline in abundance of medium and large fish species due to the high fishing effort. The fisheries of lake Alau can be considered over-fished. Over fishing has brought about changes in species composition and this have important implication for the fisheries.

From this study, it was observed that the family *Clariidae, C. gariepirius, C. anguillaris* and *C. macromystax* which were highly valued has been greatly reduced and has been replaced by less valued herbivorous species of cichlids. Estes (1979), Meido and Carracsco (2000) observed that heavy exploitation could lead to shift in maturity of many species. The same situation was observed in this study. Increase in the number of fishers exploiting the fish resources of the lake led to reduction in catch per unit effort.

Visual observation of the catches from the fishers revealed that juveniles caught were wasted by the fishers using gears with small mesh size. Eyo and Akpati (1995) reported that fishing-out has negative consequences and was capable of killing the fishery. Furthermore, the numbers of the fishers fishing in the lake far exceeded the FAO recommendation for tropical lakes. Station 4 has the highest number of fishers (275) when compared to other stations studied. Fishers had no license, thus the fishery was open to all and no management regulations were enforced.

The dominance of the clap net as the major gear in all stations that it is the easiest and the cheapest gear that could be afforded by the fishers whose livelihood depend on these resources. The implication of this is that harvest will be greater than the natural rate at which these species can replenish themselves. There was no fish management programme through restocking of over exploited species. Significant increase in yield can be obtained from lake Alau fishery, if gears with large mesh sizes are introduced and enforced and small mesh gears banned as a rehabilitative measure. Furthermore, the restocking and introduction of new species into the lake should be considered.

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