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RESEARCH ARTICLE

ASSESSING THE CURRENT FISH DIVERSTY AND ABUNDANCE OF A TROPICAL RAINFOREST LENTIC FRESHWATER ECOSYSTEM, SOUTH - EASTERN NIGERIA

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ABSTRACT

This study investigated the fish fauna and species abundance of Oguta Lake in Imo state, Nigeria. Three sampling stations were selected based on factors such as depth, volume of water, accessibility and the various activities taking place in and around the lake. Fish samples were collected from three sampling stations for seven months. Analysis of variance (ANOVA) showed significant difference ($p < 0.05$) in the piscifaunal overall density in the three stations. Six families composed of eleven species were recorded. Cichlidae (52.1%), the most abundant family dominated the samples in the three stations. Cyprinidae (0.5%) was the least family encountered in the study. *Tilapia zilli*, the most abundant species occurred highest in station 3 (13.8%). The highest general diversity (0.885) occurred in station 3 while the least value (0.859) was obtained in station 1. Six fish families collected in this study compared to previous report of Nwadiaro (1989); and the low species abundance reveals that Oguta Lake is experiencing loss of biodiversity in terms of its fishery resources due to anthropogenic activities which affect the composition and structure of fish resident in lakes.

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INTRODUCTION

Fishes are a large group of animals that depend primarily on water for survivial, growth and reproduction (Ugwu and Mgbenka, 2006). Unlike birds and mammals, fish are not a single clade but a paraphyletic collection of taxa, including hagfishes, lampreys, sharks and rays, ray-finned fish, coelacanths, and lungfish (Goldman, 1997). Fishes inhabit both salt and freshwater ecosystems. Their geographic range include lotic waters such as creeks, estuaries, streams, rivers and seas and lentic waters including lakes and ponds. They have adapted to diverse habitats: permanent and temporary rivers, large equatorial lakes, tropical and subtropical rivers, open and closed estuaries found at high elevations and generally requires warmer than 20°C (Fitzsimmons, 2000; Kuton and Kusemiju, 2010). The freshwater food fishes found in Nigeria are about 268 different species (Levesque *et al*., 1992; Odo *et al*., 2009). They inhabit over 34, well-known freshwater bodies (rivers, lakes and reservoirs) which constitute about 12% of Nigeria's total surface area estimated at 94, 185,000 ha (Ita, 1993). Most Nigerians especially Oguta people very much depend on fish for their livelihood.

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Fish which serve as a source of quality protein is known to constitute more than 50% of the animal protein intake in many countries and infact, serves as an important component of the total human food consumption (Shangi, 1981; Avoaja, 2011). Thus fish serve as a source of protein and food in the face of the over increasing population in developing countries (Yem *et al*., 2011). West Africa is very dependent upon imports of fish, whereas much of the demand could be met locally if the fisheries were better managed (Uche, 2014). A prerequisite to effective fish management is knowledge of the fisheries of the inland bodies. This study investigates the fish fauna and species abundance of Oguta Lake for the purpose of planning management strategies for the Lake, especially in a world that is constantly throwing up opportunities and challenges.

MATERIALS AND METHODS

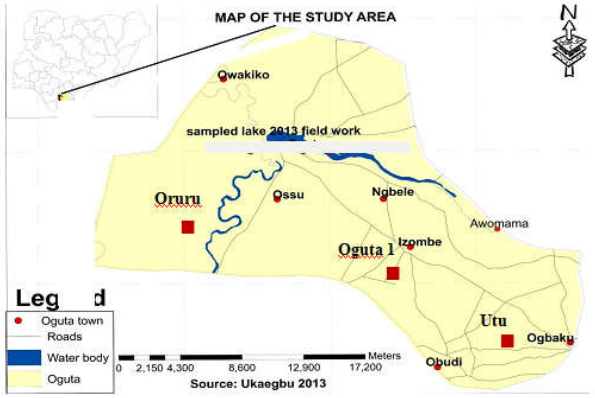
Description of the study area

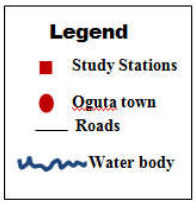
The study was carried out in the Oguta Lake basin, Nigeria (Fig. 1). Oguta Lake, is one of the inland freshwater drainage basins within South-eastern, Nigeria (Nwadiaro, 1989; Francis *et al.,* 2014). It is located between Latitudes 5° 41′ and 5° 44′ North and Longitudes 6° 50′ and 6° 45′ East of Greenwich (Ukaegbu, 2013; Umunnakwe and Aharanwa, 2014). It is the

largest natural Lake in south-eastern Nigeria, with an annual mean temperature and rainfall of 24.7°C and 3,100 mm respectively. It has a surface area of 1.80 km at peak flood and maximum depth of 5.50 m. The lake which is fed mainly by the Njaba and Awbana Rivers, empties itself into the River Niger drainage system through River Orashi (Yem *et al*., 2011). Oguta Lake is located within the rainforest region. The climate is tropical, and majorly controled by rainfall. The lake serves the natives and the environs for domestic, agricultural, economic, transportation and recreational purposes. Human activities occurring at the lake include laundry, washing of cars and motor-cycles, fermentation and sieving of cassava.

Sampling stations

Sampling stations were chosen based on factors such as volume of water, accessibility and the various activities taking place in and around the lake. Three sampling stations were marked at interval of 3 km from each station.





Source: Ukaegbu (2013); Umunnakwe and Aharanwa (2014)

Fig. 1. Map of Oguta Lake showing sampling stations

Station 1: This station is located in Oruru. Human activities that take place here include fishing and sand mining.

Station 2: This station is known as Oguta 1. Activities in this station include navigation, fermentation and sieving of cassava, and bathing.

Station 3: Station 3 is known as Utu. It receives water flow from upstream (Oruru) and links to Orashi River. Fishing is the main human activity taking place in this station.

Data Collection

Fish samples were collected from the three sampling stations (Fig. 1) for a period of seven months (March - September, 2014). Various types of fishing gears such as hooks and line, gillnets and basket traps were used by the fishermen. The gears were set between 16 00 h and 18 00 h. The fishes caught were removed from the fishing gears between 0600 h and 0800 h. Hook - and - line was used during the day. The fish samples were immediately preserved in 10% formalin after which they were transported to the Laboratory. They were rinsed in clean water to remove formalin. Identification and classification of the fish samples to species level was achieved using identification guide/keys such as Holden and Reed (1991), Sikoki and Francis (2007) and Olaosebikan and Raji (2013).

Data analysis

Biological indices such as Margalef's index (d), Shannon-Wiener (H), Evenness or Equitability (E) and Dominance (D) were used to calculate taxa richness, diversity, evenness and dominance. Analysis of variance was used to test for significant difference among the stations. Bellinger's coefficient was used to determine similarity between sampling stations.

RESULTS

Eleven species belonging to six families and three orders were identified from a total of 188 fish samples collected from Oguta Lake (Table 1).

Table 1. Percentage composition of fish families at Oguta Lake, Nigeria

Order	Family	Number of species collected (N)	% N
Osteoglossiformes	Notopteridae	3	1.6
Siluriformes	Cyprinidae	1	0.5
	Clariidae	40	21.3
	Mochokidae	41	21.8
Perciformes	Cichlidae	98	52.1
	Channidae	5	2.7
Total		188	100

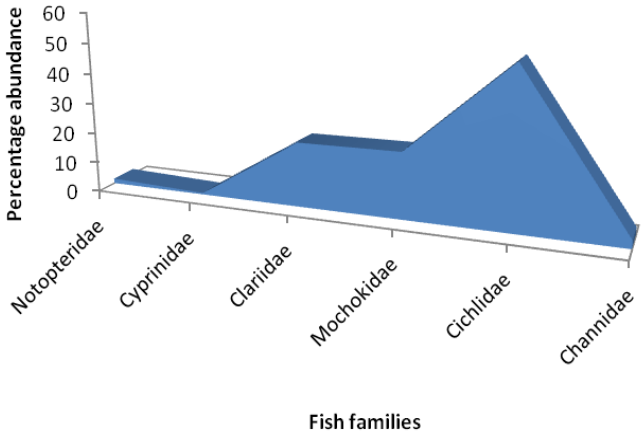


Fig. 2. Percentage composition of fish families at Oguta Lake, Nigeria

The percentage composition of the various families encountered during the study is presented (Fig. 2). The highest family in abundance was Cichlidae (52.1%), followed by Mochokidae (21.8%); Clariidae (21.3%). Channidae and Notopteridae had respective percentage abundance of 2.7% and 1.6% while Cyprinidae had the least abundance of 0.5 percent. Stations 2 and 3 had the higher and equal taxa (10) while station 1 had the least taxa (9) probably due to sand dredging which increases bioavailability of sediment trace metals.

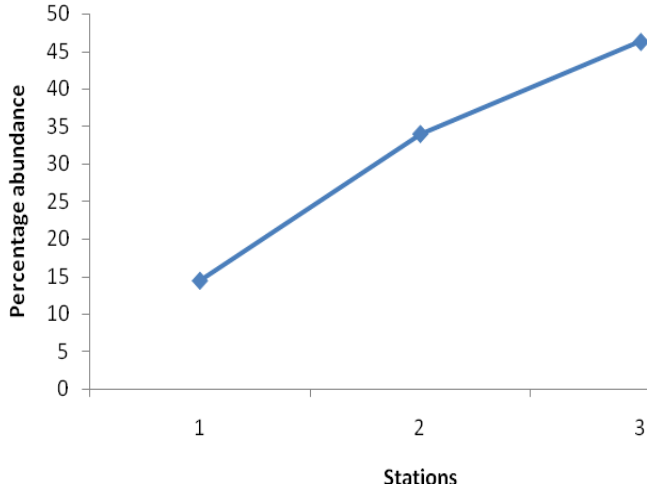


Fig. 3. Abundance of fish at the sampling stations of Oguta Lake, Nigeria

Table 2. Composition and distribution of fish fauna at Oguta Lake

Family	Species	Stations		
		1	2	3
Notopteridae	*Papyrocranusafer*	-	2(3.1)	1(1.1)
Cyprinidae	*Labeosenegalensis*	1(2.7)	-	-
Clariidae	*Clariasgariepinus*	10(27.0)	13(20.3)	17(19.5)
Mochokidae	*Synodontisnigrita*	6(16.2)	13(20.3)	13(14.9)
	Synodontisclarias	2(5.4)	4(6.3)	3(3.4)
Cichlidae	*Sarotherodongalilaeus*	4(10.8)	4(6.3)	11(4.6)
	Tilapia zilli	7(18.9)	15(23.4)	21(24.1)
	Tilapia mariae	3(8.1)	6(9.4)	8(9.2)
	Tilapia melanopleura	2(5.4)	2(3.1)	6(6.9)
	Oreochromisniloticus	2(5.4)	3.(4.7)	4(4.6)
Channidae	*Channachanna*	-	2(3.1)	3(3.4)
Number of species		9	10	10
Number of individuals		37(100)	64(100)	87(100)

Stations 1, 2 and 3 had respective percentage contribution of 19.7, 34.0 and 46.3 percent (Fig. 3). Analysis of variance (ANOVA) showed that the piscifaunal overall density was significantly different ($p < 0.05$) at the three study stations. Table 2 shows the summary of the relative contribution of fish families and main species to the overall faunal density at the different sampling stations. Notopteridae absent in station 1 was most important in station 2 where it contributed 3.1% of the total density. *Papyrocranusafer*, the only representative taxon recorded, occurred most in station 2 (3.1%). It was least in station 3 (1.1%), while it was absent in station 1. The family Cyprinidae was significant in station 1 where it formed 2.7 percent of the total population. It was represented by the taxon *Labeosenegalensis*.

Clariidae was recorded in all the stations. The representative taxon, *Clariasgariepinus* occurred most in station 2 (13, 29.3%). The family Mochokidae contributed 16.2%, 20.3% and 14.9% in stations 1, 2 and 3 respectively. Of the two taxa recorded during the study, *Synodontisnigrita*was most abundant. It had equal abundance in stations 2 and 3 with respective contribution of 20.3 and 14.9 percent. The most abundant family Cichlidae, dominated the three stations. It formed 48.6% in station 1, 46.9% in station 2 and 57.5% in station 3. It was represented by 5 taxa. The important taxon *Tilapia zilli, had the* highest abundance in station 3 (21, 24.1%). It was followed by *Tilapia mariae* (12.5%). Channidae recorded in stations 2 and 3 was absent in station 1. The representative taxon, *Channachanna* occurred in stations 2 and 3, being absent in station 1.

Diversity and Dominance indices

Table 3 presents the result of diversity and dominance indices calculated for three study stations. Margalef's index (d) was highest in station 1 and lowest in station 3. Shannon-Wiener index for diversity was highest in station 3, followed by station 2. Station 1 had the lowest value. Evenness (Equitability) was highest in station 1 and lowest in station 3. Dominance was highest in station 1. The values of Bellinger's coefficient calculated for fish faunal similarities of the sampling stations is shown in Table 4. There was significant difference ($p < 0.05$) between stations 1 and 3. Thus these stations were not similar. Stations 2 and 3 were not significantly different ($p > 0.05$), that is, similar since 3.27 is less than the critical of 3.84.

Table 3. Diversity indices of Oguta Lake with respect to study stations

	Stations		
Diversity indices	1	2	3
Number of taxa	9	10	10
Number of individuals	37	64	87
Taxon richness (d)	2.216	2.163	2.013
General diversity (H)	0.859	0.879	0.885*
Evenness index (E)	0.900	0.879	0.885*
Dominance (D)	0.164	0.159	0.176

* Significant dissimilarity at $p < 0.05$

Table 4. Bellinger's coefficient of similarity of fish fauna in the sampling stations of Oguta Lake

Stations	1	2	3
1			
2	6.00^{*}		
3	8.00^{**}	2.78^{ns}	

** Highly significant difference ($p<0.05$)
* Significant difference ($p<0.05$)
ns No significant difference ($p>0.05$)

DISCUSSION

Out of the 11 taxa obtained in this study, 5 (45.4%) were cichlids, dominated majorly by *Tilapia zilli*. This further confirms the dominance of *Tilapia zilli* among cichlids. Their abundance may be due to phytoplankton availability of food in the lake. Ita (1993) reported that Tilapia feed on algae. Although anthropogenic activities alter icthyofauna of streams (Porto, 2012) and lakes, Ita (1993) reported that hardy species such as Clarias and Tilapia can tolerate fairly polluted waters and therefore become over populated with Clarias feeding on Tilapia fingerlings and Tilapia feeding on algal bloom. Degradable positions covered by eutrophication were not navigable because of luxuriant growths of aquatic plants (Ahiarakwem *et al*., 2012). Such areas must have served as hiding and breeding grounds for cichlids.The total piscine taxa reported in this study was low when compared with 41 species in Asejire Lake (Yem *et al*., 2011) and 32 species in Umudike Water Reservoir (Avoaja, 2011) but higher than 9 species reported by Annune and Bako (1998) in Kubanni Reservoir, Zaria. The low fish abundance in station 1 may be due to sand dredging activities (Agbabiaka, 2010). Dredging destroys spawning, breeding, feeding or growth to maturity grounds of fishes (Ekeke *et al*., 2008) as well as floral and faunal habitats. Lake fisheries, like marine coastal and river fisheries have gone through periods of boom and decrease in catch and have been associated with loss in biodiversity, eutrophication, and alien species invasion (Jia *et al.*, 2013).

The principal taxa namely *Clariasgariepinus, Syndontisnigrita* and *Tilapia zilli*, obtained in this study have been earlier reported in Nigeria waters. It is possible that Oguta Lake is experiencing loss of biodiversity in terms of its fishery resources because Nwadiaro (1989) identified 19 fish families as opposed to 6 families recorded in this study. Two families, recorded in this study, Notopteridae and Channidae, were not reported in the earlier study by Nwadiaro (1989). Their presence may be attributed to migration due to flooding. The 8 families namely Tetraodontidae, Malapteruridae, Centropomidae, Ophiocephalidae, Lepidosirenidae, Carangidae, Pomadasyidae and Mugilidae recorded (Nwadiaro, 1989) were not encountered in the present study. This may be due to anthropogenic perturbations of the lake basin that may influence its suitability for fish productions. Nature and man-made changes could cause alarming decline in catch from inland waters (Kibria and Ahmed, 2005; Akpaniteaku, 2012). The dominance of Cichlidae followed by Mochokidae and Clariidae observed in this study either in number of captured individuals or species is in consonance with the findings of Nwadiaro (1989) who reported the same descending order of dominance observed in this study. The dominance of cichlidae in this study may be attributed to the fact that cichlids have a euryphagic feeding habit which according to Anene (2005) allows for a switch from one diet to another and also disallows inter- and intra- species competition for food.

Cichlids which dominated in the sampling stations had the highest species richness. This agrees with the findings of Ita (1993) who studied inland fishery resources of Nigeria, and Avoaja (2011) who worked in Umudike Water Reservoir. The observations that the number of families seemed to decrease but; with a constitency in the dominant families is indicative of slow rate of anticipated change in the lake system, including effects of climate change and negative impacts of too many anthropogenic activities within the lake (Frances *et al*., 2014).The species diversity and evenness calculated by Shanon - Wiener function differed at the sampling stations. The high diversity in station 3 is indicative of an ecologically stable and favourable environment. The high evenness and low dominance justify this station, since the higher the evenness the higher the diversity, and the lower the dominance (Ogbeibu, 2001). The faunal similarity analysis of the three sampling stations revealed that stations 1 and 2, and stations 1 and 3 were significantly different. Bellinger's coefficient detects significant discontinuities in the horizontal distribution of individual populations (Wallwork, 1970; Ogbeibu, 2001).

Conclusion

Conclusively Oguta Lake has six fish families namely Notopteridae, Cyprinidae, Clariidae, Mochokidea, Cichlidae and Channidae. Cichlidae was the most abundant family while *Tilapia zilli* was the dominant taxon. The least fish abundance in station 1 could be due to human activities like sand dredging.

Recommendations

There is need for proper education and enlightenment on sand dredging and its effects on fish catch. The stream should be adequately and ecologically monitored to ensure effective utilization and sustainable exploitation of the stream and its fishery resources.

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