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Fish Species Diversity and Seasonal Abundance of Lake Akata, Benue State, Nigeria

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ABSTRACT

This study investigates the fish species diversity and seasonal abundance of Lake Akata, Benue State, Nigeria. Standard methods were used to analyze monthly and seasonal fish abundance in Lake Akata from (August 2013-July 2015). The fish specimens used for the study were obtained from fishermen operating along Lake Akata. These fishermen use various fishing gears including hand nets, cast nets and gill nets of various standard mesh sizes and canoe were used as fishing craft. Sixteen fish species comprising of a total number of 3525, individuals belonging to 12 families were sampled. The number of fish species caught showed that family Claroteidae was the most dominant (22.26%), while Protopteridae was the least family (4.85%). The dominant fish species was *Oreochromis niloticus* (11.27%), while *Polypterus annectans* was the least fish species (4.85%). The ecological parameters considered in this study include Shannon-Wiener Index (H') and Simpson's index of dominance (1-D), and were calculated according to seasons and stations. The values of Shannon Wiener diversity index (H′) and Simpson's index of dominance (1-D) for the three stations (station A,B and C) studied in the dry season were 4.30 and 0.99 station; 4.32 and 0.99; 4.33 and 0.99, while that of the wet season were 4.63 and 0.99; 4.64 and 0.99; 4.60 and 0.99 respectively.

INTRODUCTION

Water bodies in Nigeria supports an array of aquatic organisms (Atobatele and Ugwumba, 2008). Nigeria's fish production data has reflected that 5,788,474 tonnes of fish had been produced between 2010 and 2015. Year 2014 recorded the highest tonnes of fish produced with 1,123,011 tonnes; the second highest tonnes of fish produced were recorded in 2015 while the least were recorded in 2010 (NBS, 2017). There are over 323 man-made lakes in the country occupying 137,802 hectares of the land (Ita, 1993). Fisheries play important role in the global food supply. Fish provides rich source of protein for the increasing world population especially in the developing countries of Africa, Asia, and the South America (FAO, 2006; Gabriel et al., 2007). The fish yields of most Nigeria inland waters are generally at their maximum level of exploitation and decline (Jamu and Ayinla, 2003). The decline of these fisheries has been attributed to a wide range of causes ranging from inadequate management of the fisheries resources to environmental degradation of the water bodies. Tobor, (1992) reported that the inshore waters of most parts of the West African coast are rich in fish resources in quantities that can support commercial exploitation on a sustainable basis. The need for sustainability of fisheries resources prompted researchers to investigate the potentials of the numerous inland water bodies for fish production in Nigeria (Abdul and Omoniyi, 2007). The abundance of some fishes in abroad and Nigerian waters has been studied: Researchers such as Offem, et al., (2011) reported influence of seasons on water quality, abundance of fish and plankton species of Ikwori Lake, South-Eastern Nigeria. (Ramollo, 2011) reported freshwater fish abundance and distribution in the Orange River, South Africa. Meye. and Ikomi, (2012) reported Seasonal Fish Abundance and Fishing Gear Efficiency in River Orogodo, Niger Delta, Nigeria. (Ikongbeh, et al., 2013) reported Seasonal numerical abundance and determination of size distribution of Chrysichthyes nigrodigitatus from Lake Akata, Benue State, Nigeria, Basavaraja, et al., (2014) reported fish diversity and abundance in relation to water quality of Anjanapura Reservoir, Karnataka, India. Ataguba et al., (2014) reported Fish Species Diversity and Abundance of Gubi Dam, Bauchi State of Nigeria. Adaka et al., (2016) reported diversity and distribution of freshwater fishes in Oguta Lake,South eastern Nigeria

A Lake (from a Latin word "lacus") is a terrain feature (or physical feature) that is considerable inland body of water, not part of the ocean, that is larger and deeper than a pond, and may or may not be moving slowly, and is localized to the bottom of basin (another type of landform or terrain feature) and is fed by a river (Britannica online, 2008).

Lakes are used by humans for many commercial purposes, including fishing, transportation, irrigation, industrial and cooling water supply, receiving waters or waste water effluents, recreation and navigation. Man-made lakes are often constructed for the specific purpose of flood control and hydro-electric power generation (Basavaraja, et al., 2014). There is little published account on the biology of fish species of Lake Akata. It is therefore necessary to carry out a more comprehensive study on the Freshwater Fish Species of this very important recreational lake aimed at good management. The aim of the present study provides information on the fish species diversity and seasonal abundance of freshwater fish species in Lake Akata, Benue State, Nigeria.

MATERIALS AND METHODS

Study area

Figure (i) show the map of the study area Lake Akata, an ox-bow lake of River Katsina-Ala. and sampling stations A, B and C respectively. Generally, three sampling sites were selected for monitoring at regular monthly intervals. Inlet (Station A): is the point where the principal feeders open into the lake. Midpoint (Station B): is the point that gives the maximum depth of the lake. Outlet (Station C): is the point where the overflow occurs. The sampling stations are located between longitudes 9o16´ and 9o17´ E and latitudes 7o11´ and 7o13´ N. The host town, Katsina-Ala is a riverside resort with a unique feature and the scenic beauty of savannah landscape, supplemented by the famous River Katsina-ala with extensive fadama flood plain covered by numerous lakes scattered over the flood plain one of such lake is the Lake Agbo. The flood plain is used for irrigation farming and fishing. The climate is characterized by two distinct seasons, the dry season (November – March) and wet season (April – October).

Sample Collection

The period of this study was from August, 2013 - July, 2015. The fish specimens used for the study were obtained from fishermen operating along Lake Akata. These fishermen use various fishing gears including hand nets, cast nets and gill nets of various standard mesh sizes and canoe were used as fishing craft. Fish species were randomly sampled monthly for two year and usually in the mornings between 07.00hr – 10.00hr.

Laboratory Analysis

Length and weight measurements were taken directly from the landing sites. The total body weight was determined using the mettler tabletop loading electronic weighing balance (model 59174). The total and standard lengths were measured with a meter rule on measuring board according to (Lagler, 1970). Fish samples were collected and identified in the field according to Olaosebikan and Raji, (1998) and FAO, (1992).

Data analysis

Determination of Fish Abundance and Diversity of Lake Akata

Abundance was estimated from the length (cm) and weight (kg) of the total catch of each station for each species over the period of this study. Species diversity can be measured separately either as species richness or evenness or diversity as a whole. Diversity of the species calculated directly with a variety of indices, of which two commonly used are Shannon-Weiner Index (denoted by H´; as given by Shannon and Weiner, 1963) and Simpson s index given by Simpson (1949). Shannon s index has a direct relationship with the species diversity, whereas index of dominance has an inverse relationship. Data collected was analyzed using the following diversity indices:

I Shannon-Wiener diversity index (H'): This measures faunal diversity and gives the degree of uncertainty involved in predicting the species identified from randomly selected individuals. It was calculated using the following equation as given by Shannon and Weiner (1963):

$$H' = -\sum\left[\left(\frac{n_i}{N}\right) \times ln\left(\frac{n_i}{N}\right)\right]$$

Where

ni = number of individuals or amount of each species (the ith species)

N = total number of individuals for the site

ii) Simpson's Index (D): is a measure of dominance and was calculated using the formula of Simpson (1949):

$$D = \sum \frac{n_i(n_i - 1)}{N(N-1)}$$

Where:

ni = number of individuals or amount of each species (i.e., the number of individuals of the ith species) and

N = total number of individuals for the site.

This was then transformed into a measure of species heterogeneity using the complement of D as recommended by Lande (1996):

1-D

RESULTS AND DISCUSSION

Fish abundance and fish species composition

Table (i) shows the seasonal variation in the number of fish caught in Lake Akata from (2013-2015). The 16 fish species caught, which comprised 1018, 1863, and 643 individual specimens at station A, station B, and station C respectively. Table (ii) indicats the percentage seasonal variation of fish caught in Lake Akata from (2013-2015). *Gnathonemus petersii* were the most abundant fish species in October accounting for (11.92%), *Polypterus annectans* in November accounting for (15.97%), Citharinus citharus in December accounting for (13.38%), and Mormyrus rume in January (11.67%) respectively. Where as *Oreochromis niloticus* was the least abundant fish species caught in August, constituting (3.53%). The dominant fish species in the wet season were Oreochromis niloticus (10.94%), *Auchenoglanis occidentalis* (8.26%), *Clarotes laticeps* (7.64%), *Chrysichthyes nigrodigitatus* (7.02%), and Clarias gariepinus (6.97%), while the least fish species were *Citharinus citharus* (4.34%), and *Polypterus annectans* (4.65%) respectively. Figure (ii) reveals the 12 fish families that were recorded in Lake Akata. The most abundant familes were Claroteidae (22.27%), Cichlidae (11.26%) and Citharinidae (10.89%), while the least families were Mochokidae (5.02%) and Protopteridae (4.85%).

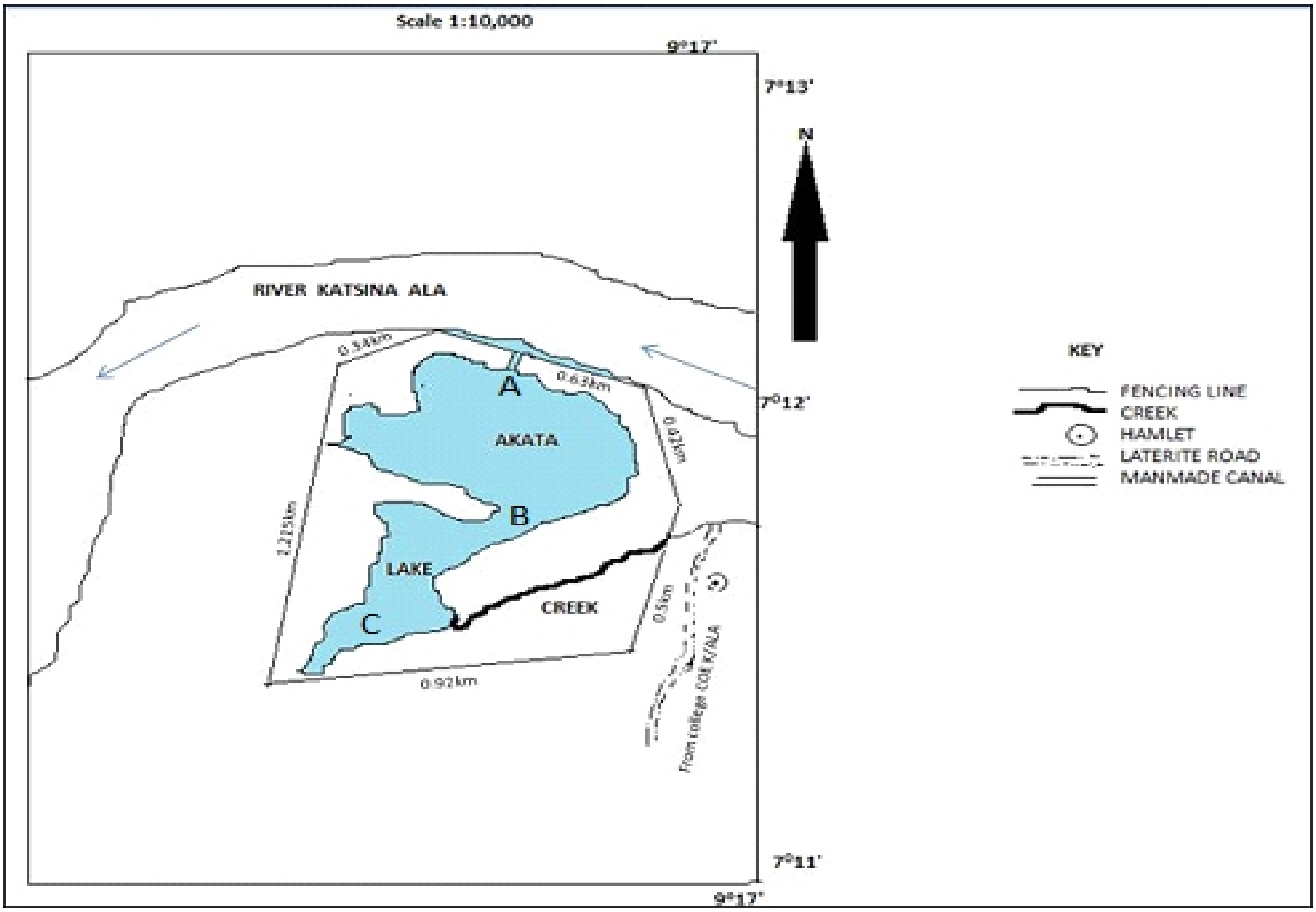

Fig 1: Map of Lake Akata.

Table (ii) shows that *Mormyrus rume* were caught throughout the year in the three stations investigated, but were more abundant from October, November, December and January. These periods accounted for 8.89%, 9.44%, 9.44% and 11.67%, respectively. During this period, the maximum abundance value of *Mormyrus rume* (5.91%) was recorded in station C, while the minimum abundance value (4.78%) was recorded in station B. The dry season (5.23%) species abundance values were higher than wet season (5.01%) values.

Table (ii) depicts that *Clarias gariepinus* were caught throughout the year and more abundant from November, December, February and May which accounted for 9.50%, 12.81%, 7.85%, and 11.16%, respectively. The highest abundance value of *Clarias gariepinus* (7.35%) was recorded in station B, while the lowest abundance value (6.29%) was recorded in station A. The wet season (6.97%) species abundance values were higher than dry season (6.74%) values.

Table (ii) reveals that *Synodontis clarias* was dominant in September (9.60%), November (8.47%), December (11.86%), and January (9.60%) respectively, while the least was (4.52%) in August. The highest abundance value of *Synodontis clarias* (5.91%) was recorded in station C, while the lowest abundance value (4.72%) was recorded in station B. The wet season (5.16%) species abundance values were higher than dry season (4.85%) values.

Table (ii) shows the monthly percentages of *Polypterus annectans* the highest percentage (15.79%) of *Polypterus annectans* was caught in November and good fractions in January (9.94 %) and April (12.28 %) respectively. Whereas, October (5.26%) recorded low percentage. The maximum abundance value of *Polypterus annectans* (5.40%) was recorded in station A, while the minimum abundance value (4.56%) was recorded in station B. The dry season (5.10%) species abundance values were higher than wet season (4.65%) values.

Table (ii) reveals that *Malapterurus electricus* were highest percentage (12.99%), (9.60%) and (11.86%) of *Malapterurus electricus* was caught in November, December and April respectively. Whereas, August (4.52%) recorded low percentage. The maximum abundance value of *Malapterurus electricus* (5.11%) was recorded in station A, while the minimum abundance value (4.67%) was recorded in station C. The dry

Table 1: Seasonal Variation in the Number of Fish Caught in Lake Akata.

Fish species / Month /Season		*Clarias gariepinus*	*Synodontis clarias*	*Polypterus annectans*	*Malapterurus electricus*	*Gnathonemus petersii*	*Hydrocynus forskalli*	*Oreochromis niloticus*	*Lates niloticus*	*Auchenoglanis occidentalis*	*Bagrus docmac*	*Chrysichthyes nigrodigitatus*	*Schilbe mystus*	*Distichodus rostratus*	*Citharinus citharus*	*Clarotes laticeps*	**Total**	**(%)**
Aug	12	17	8	11	8	10	10	14	9	17	13	22	11	26	9	29	**226**	6.41
Sept	17	14	17	12	14	17	12	22	12	18	16	13	12	19	13	25	**253**	7.18
Oct	16	13	11	9	13	23	19	38	21	27	19	21	23	23	17	29	**322**	9.13
Nov	17	23	15	27	23	19	23	50	19	27	23	21	19	23	17	28	**374**	10.61
Dec	17	31	21	15	17	19	21	37	19	31	25	13	17	25	21	23	**352**	9.99
Jan	21	15	17	17	17	19	17	36	15	27	19	19	17	23	13	23	**315**	8.94
Feb	15	19	13	11	13	15	17	36	15	25	15	15	17	21	13	21	**281**	7.97
Mar	13	19	11	11	13	13	15	26	23	31	19	20	13	13	9	17	**266**	7.55
Apr	13	23	17	21	21	17	19	50	19	33	13	13	21	11	11	13	**315**	8.94
May	13	27	17	15	14	19	18	32	19	23	19	19	20	13	14	16	**298**	8.45
Jun	13	20	15	11	11	11	13	30	11	21	25	25	19	13	9	17	**264**	7.49
Jul	13	21	15	11	13	11	13	26	11	21	25	23	9	17	11	19	**259**	7.35
Total	**180**	**242**	**177**	**171**	**177**	**193**	**197**	**397**	**193**	**301**	**230**	**224**	**198**	**227**	**157**	**260**	**3524**	**Total**
(%)	5.11	6.87	5.02	4.85	5.02	5.48	5.59	11.27	5.48	8.54	6.53	6.36	5.62	6.44	4.46	7.38	100.00	
Wet total	**97**	**135**	**100**	**90**	**94**	**108**	**104**	212	**102**	**160**	**130**	**136**	**115**	**122**	**84**	**148**	**1937**	
(%)	5.01	6.97	5.16	4.65	4.85	5.58	5.37	10.94	5.27	8.26	6.71	7.02	5.94	6.30	4.34	7.64	100.00	
Dry total	**83**	**107**	**77**	**81**	**83**	**85**	**93**	185	**91**	**141**	**100**	**88**	**83**	**105**	**73**	**112**	**1588**	
(%)	5.23	6.74	4.85	5.10	5.23	5.35	5.86	11.65	5.73	8.88	6.30	5.54	5.23	6.61	4.60	7.05	100.00	
Station A	53	64	51	55	52	65	58	110	56	96	60	59	56	64	45	74	**1018**	
Station B	89	137	88	85	95	98	107	211	105	152	126	120	104	119	84	143	**1863**	
Station C	38	41	38	31	30	30	32	76	32	53	44	45	38	44	28	43	**643**	

Table 2: Seasonal Variation in the Number of Fish Caught in Lake Akata from (July 2013 – August 2015).

Fish species / Month /Season		*Clarias gariepinus*	*Synodontis clarias*	*Polypterus annectans*	*Malapterurus electricus*	*Gnathonemus petersii*	*Hydrocynus forskalli*	*Oreochromis niloticus*	*Lates niloticus*	*Auchenoglanis occidentalis*	*Bagrus docmac*	*Chrysichthyes nigrodigitatus*	*Schilbe mystus*	*Distichodus rostratus*	*Citharinus citharus*	*Clarotes laticeps*	**Total**	**(%)**
Aug	6.67	7.02	4.52	6.43	4.52	5.18	5.08	3.53	4.66	5.65	5.63	9.82	5.56	11.45	5.73	11.15	**226**	6.41
Sept	9.44	5.79	9.60	7.02	7.91	8.81	6.09	5.54	6.22	5.98	6.93	5.80	6.06	8.37	8.28	9.62	**253**	7.18
Oct	8.89	5.37	6.21	5.26	7.34	11.92	9.64	9.57	10.88	8.97	8.23	9.38	11.62	10.13	10.83	11.15	**322**	9.13
Nov	9.44	9.50	8.47	15.79	12.99	9.84	11.68	12.59	9.84	8.97	9.96	9.38	9.60	10.13	10.83	10.77	**374**	10.61
Dec	9.44	12.81	11.86	8.77	9.60	9.84	10.66	9.32	9.84	10.30	10.82	5.80	8.59	11.01	13.38	8.85	**352**	9.99
Jan	11.67	6.20	9.60	9.94	9.60	9.84	8.63	9.07	7.77	8.97	8.23	8.48	8.59	10.13	8.28	8.85	**315**	8.94
Feb	8.33	7.85	7.34	6.43	7.34	7.77	8.63	9.07	7.77	8.31	6.49	6.70	8.59	9.25	8.28	8.08	**281**	7.97
Mar	7.22	7.85	6.21	6.43	7.34	6.74	7.61	6.55	11.92	10.30	8.23	8.93	6.57	5.73	5.74	6.54	**266**	7.55
Apr	7.22	9.50	9.60	12.28	11.86	8.81	9.64	12.59	9.84	10.96	5.63	5.80	10.61	4.85	7.01	5.00	**315**	8.94
May	7.22	11.16	9.60	8.77	7.91	9.84	9.14	8.06	9.84	7.64	8.23	8.48	10.10	5.73	8.92	6.15	**298**	8.45
Jun	7.22	8.26	8.47	6.43	6.21	5.71	6.60	7.56	5.70	6.98	10.82	11.16	9.60	5.74	5.73	6.54	**264**	7.49
Jul	7.22	8.68	8.47	6.43	7.34	5.70	6.60	6.55	5.70	6.98	10.82	10.27	4.55	7.49	7.01	7.31	**259**	7.35
Total	**180**	**242**	**177**	**171**	**177**	**193**	**197**	**397**	**193**	**301**	**230**	**224**	**198**	**227**	**157**	**260**	**3524**	100
(%)	5.11	6.87	5.02	4.85	5.02	5.48	5.59	11.27	5.48	8.54	6.53	6.36	5.62	6.44	4.46	7.38	100.00	
Wet total	**97**	**135**	**100**	**90**	**94**	**108**	**104**	212	**102**	**160**	**130**	**136**	**115**	**122**	**84**	**148**	**1937**	
(%)	5.01	6.97	5.16	4.65	4.85	5.58	5.37	10.94	5.27	8.26	6.71	7.02	5.94	6.30	4.34	7.64	100.00	
Dry total	**83**	**107**	**77**	**81**	**83**	**85**	**93**	185	**91**	**141**	**100**	**88**	**83**	**105**	**73**	**112**	**1588**	
(%)	5.23	6.74	4.85	5.10	5.23	5.35	5.86	11.65	5.73	8.88	6.30	5.54	5.23	6.61	4.60	7.05	100.00	
Station A	5.21	6.29	5.01	5.40	5.11	6.39	5.70	10.81	5.50	9.43	5.89	5.80	5.50	6.29	4.42	7.27	100.00	
Station B	4.78	7.35	4.72	4.56	5.10	5.26	5.74	11.33	5.64	8.16	6.76	6.44	5.58	6.39	4.51	7.68	100.00	
Station C	5.91	6.38	5.91	4.82	4.67	4.67	4.98	11.82	4.98	8.24	6.84	7.00	5.91	6.84	4.35	6.69	100.00	

season (5.23%) species abundance values were higher than wet season (4.85%) values.

Table (ii) depicts that *Gnathonemus petersii* were caught throughout the year but were more abundant from September, October, November, and December. These periods accounted for (8.81%), (11.92%), (9.84%) and (9.84%) respectively. Whereas, August (5.70%) recorded low percentage. The maximum abundance value of *Gnathonemus petersii* (6.39%) was recorded in station A, while the minimum abundance value (4.67%) was recorded in station C. The wet season (5.58%) species abundance values were higher than dry season (5.35%) values.

Table (ii) indicates that *Hydrocynus forskalli* were caught throughout the year and more abundant from October, November, December and May which accounted for (9.64%), (11.68%), (10.66%) and (9.14%) respectively. Whereas, August (5.08%) recorded low percentage. The highest abundance value of *Hydrocynus forskalli* (5.74%) was recorded in station B, while the lowest abundance value (4.98%) was recorded in station C. The dry season (5.86%) species abundance values were higher than wet season (5.37%) values.

Table (ii) depicts that *Oreochromis niloticus* was the dominant species in October (9.57%), November (12.59%), December (9.32%), January (9.07%) and, May (8.06%), but the least (3.53%) in August. The highest abundance value of *Oreochromis niloticus* (11.82%) was recorded in station C, while the lowest abundance value (10.81%) was recorded in station A. The dry season (11.65%) species abundance values were higher than wet season (10.94%) values.

Table (ii) shows that *Lates niloticus* was most numerous in October (10.88%) and also well represented in November (9.84%), December (9.84%) and March (11.92%) but had low percentage abundance in August (4.66%). The maximum abundance value of *Lates niloticus* (5.64%) was recorded in station B, while the minimum abundance value (4.98%) was recorded in station C. The dry season (5.73%) species abundance values were higher than wet season (5.27%) values.

Table (ii) reveals that *Auchenoglanis occidentalis* was most numerous in October (8.97%) and also well represented in November (8.97%), December (10.30%), and April (10.96%) but had low percentage abundance in August (5.65%). The maximum abundance value of of *Auchenoglanis occidentalis* (11.46%) was recorded in station 'C', while the minimum abundance value (4.61%) was recorded in station 'B'. The dry season (28.2%) species abundance values were higher than wet season (11.71%) values.

Table (ii) indicates that *Bagrus docmac* was most numerous in November (9.96%) and also well represented in December (10.82%), and January (8.23%) the minor components of the fish species caught in April and August constitute (5.63%). The maximum abundance value of *Bagrus docmac* (6.84%) was recorded in station C, while the minimum abundance value (5.89%) was recorded in station A. The wet season (6.71%) species abundance values were higher than dry season (6.30%) values.

Table (ii) depicts that *Chrysichthyes nigrodigitatus* were caught throughout the year and more abundant from June, July, and August which accounted for (11.16%), (10.27%), and (9.82%), respectively. The least components of the fish species caught in April and December constitute (5.80%). The highest abundance value of *Chrysichthyes nigrodigitatus* (7. 00%) was recorded in station C, while the lowest abundance value (5.80%) was recorded in station A. The wet season (7.02%) species abundance values were higher than dry season (5.54%) values.

Table (ii) shows that *Schilbe mystus* were caught throughout the year but were more abundant from April, May, October, and November. These periods accounted for (10.61%), (10.10%), (11.62%) and (9.60%) respectively. Whereas, July (4.55%) recorded low percentage. The highest abundance value of *Schilbe mystus* (5.91%) was recorded in station C, while the lowest abundance value (5.50%) was recorded in station A. The wet season (5.94%) species abundance values were higher than dry season (5.23%) values.

Table (ii) reveals that *Distichodus rostratus* was most numerous in August (10.45%), September (8.37%), October (10.13%), November (10.13%), December (11.01%) and also well represented in February (9.25%), but had low percentage abundance in April (4.85%). The maximum abundance value of *Distichodus rostratus* (6.84%) was recorded in station C, while the minimum abundance value (6.29%) was recorded in station A. The dry season (6.61%) species abundance values were higher than wet season (6.30%) values.

Table (ii) indicates the monthly percentages of Citharinus citharus, the highest percentage (13.38%) of Citharinus citharus was caught in December and good fractions in October (10.83%) and November (10.83%).Whereas, March, April and August (5.73%) recorded low percentage. The maximum abundance value of Citharinus citharus (4.51%) was recorded in station B, while the minimum abundance value (4.35%) was recorded in station C. The dry season (4.60%) species abundance values were higher than wet season (4.34%) values.

Table (ii) depicts that Clarotes laticeps was dominant in August (11.15%), September (9.62%), November (10.77%) and December (8.85%) respectively. The minor components of the fish species caught in April constitute (5.00%). The maximum abundance value of Clarotes laticeps (7.68%) was recorded in station B, while the minimum abundance value (6.69%) was recorded in station C. The wet season (7.64%) species abundance values were higher than dry season (7.05%) values. Field observation showed that all the sixteen species had a seasonal trend in abundance. Oreochromis niloticus Auchenoglanis occidentalis, Clarotes laticeps and Clarias gariepinus were the most abundant followed by Bagrus docmac, Distichodus rostratus, and Chrysichthyes nigrodigitatus.

The ecological parameters considered in this study were Shannon-Wiener Index and Simpson's index of dominance (D). The value of Shannon Wiener diversity index (H′) and Simpson's index of dominance (D) were calculated according to seasons and stations. Seasonal differentiation in the richness and diversity indices of fish species revealed higher values for the dry season samples than wet indicating larger food chains, which may be due to availability of food.

Table (iii) shows seasonal fish diversity index of fish species from the three stations in Lake Akata, the highest dry season Shannon Weinner diversity index (4.32) was recorded in station B, while the lowest Shannon Weinner diversity index (4.30) was recorded in station A. The maximum wet season Shannon Weinner diversity index (4.64) was recorded in station B, while the minimum Shannon Weinner diversity index (4.60) was recorded in station C. The Simpson's index of dominance (D) for fish in the both seasons were (0.99) across the stations. The fish diversity and abundance of the sixteen fish species caught from Lake Akata showed variation within and across seasons during the period of the study. The slight differences in the period of peak abundance for the sixteen species studied in Lake Akata and those obtained from other lakes could be due to the difference in the geo-hydrological factors of the two water bodies especially the flooding regime, rain distribution pattern and the nature of the water body. More individuals were caught in rainy seasons than in dry. (Ikongbeh et al., 2013) reported seasonal abundance of *Chrysichthyes nigrodigitatus* from Lake Akata Benue state; they were numerically more abundant in Wet season than in the dry season. Adaka et al., (2016) reported diversity and distribution of freshwater fishes in Oguta Lake, Southeastern, Nigeria which is in agreement with the observation of the present study. The month of April marks the beginning of the rainy season. In the peak of rainy season the River flood, and merges with the lake. The seasonal differentiation in the peak in abundance of the sixteen fish species, in Lake Akata could be influenced by rise in water level of the lake, this helps in the biological productivity of the lake with optimal light penetration. Other reasons could be due to availability of food, spawning rates, breeding grounds, coupled with shelter, presence of current, vegetation, depth of water, temperature, dissolved nutrients, dissolved oxygen, salinity and low predation. In a similar study (Solomon et al., 2012) reported Fish fauna in lower River Niger at Idah in Kogi State and the results obtained was in agreement with that of the present study. The monthly abundance mostly exhibiting peaks in the dry months. The month of November marks the beginning of the dry season. This was attributed to low water level in the dry season that makes the fish more vulnerable to capture. During the dry season period the lake is cut-off from the river due to reduction in the water level. The present study provided evidence that fluctuations in river flow can influence the seasonal occurrence and distribution patterns of several freshwater fish species especially in Lake Akata. Fisheries resources are on the decline in Nigeria inland water bodies due to over exploitation and inadequate management of inland waters. Sustainability of these resources requires adequate attention and knowledge of the species composition, diversity and relative abundance of the resources (Lawson and Olusanya, 2010). In recent times, fish populations and species sizes have dwindled and this situation is traceable to non rational and unsustainable exploitation of the resource. This phenomenon can also be attributed to fish migration, natural barrier and habitat diversity such as stones, marginal vegetation, as well as overhanging vegetation and woody debris. The values of diversity indices obtained in the present study are higher than those reported by Offem et al., (2011) for fish of the Ikwori Lake in South Eastern Nigeria in the rainy season. In a similar study (Ataguba et al., 2014) reported diversity indices from Gubi dam, Bauchi State,Nigeria, the values were lower than those in the present study. The difference can be attributed to disparity in ecological zones. The values for H' in both seasons and stations indicates a good spread of species diversity in Lake Akata. The average diversity function calculated by Shannon-Wiener Diversity index, was higher for the wet season than dry for all species studied, revealing that wet season samples were more diversified and stable. The Species heterogeneity index (1 – D), reported for the seasons and stations for Lake Akata compare favourably with those reported for Oguta Lake by Adaka et al., (2016). There is great diversity from Lake Akata since 1 – D is close to 1. There is also a greater diversity in Lake Akata than Lakes Oguta, Oyan, Dadin Kowa, Tiga, Asa and Opi as reported by Yem et al. (2011). Simpson index gives the evenness of species distribution; the higher evenness in species distribution of fish species may be an indication that the plankton population supports the growth of most of the fish species observed (Lawson and Olusanya, 2010). Shannon-Weaver diversity index varied but did not vary significantly between seasons which are characteristics of unstable fish species population. This situation is traceable to use of agro-chemicals during farming season along the lake might have contributed to low species diversity. Therefore there is need for the conservation and management of the fisheries resources of Lake Akata by relevant agencies. The best sustainable strategies for the conservation of the species are to disseminate conservation information, educate the fishers and other stakeholders about the danger of extinction of the species and the need for its conservation (Adaka et al., 2016). It is advisable to reverse the trend in fish decline and biodiversity loss by undertaking a re-stocking, fish ranching, close season and area, regulation of mesh sizes; ban the use of agro chemicals along the lake and its adjourning flood plains. This study provides important information on the formulation of management plan and policies decision for the lake, so as to enhance sustainable fish production of the lake to boost its productivity.

CONCLUSION

In conclusion, the result of the present study revealed that fish species were caught throughout the year but were more abundant from April, May, June, October, November and December. The seasonal pattern observed in the fish fauna of Lake Akata reflects the response of the hydrological changes in the habitat which ultimately influences the entire ecosystem as have been reported in other tropical lakes. Changes in fish community, directly or indirectly affect other components of the lake ecosystem including physical, chemical and biological characteristics. Habitat loss, over fishing, global warming, Climate change, Coastal development and environmental degradation has seriously affected fish fauna inhabiting various water bodies. Conservation of fish diversity assumes top most priority under changing circumstances of gradual habitat degradation. Therefore, a sustainable strategies needs to explore more fish species, utilization and save fish community of this lake. The study will provide future strategies for development and fish conservation.

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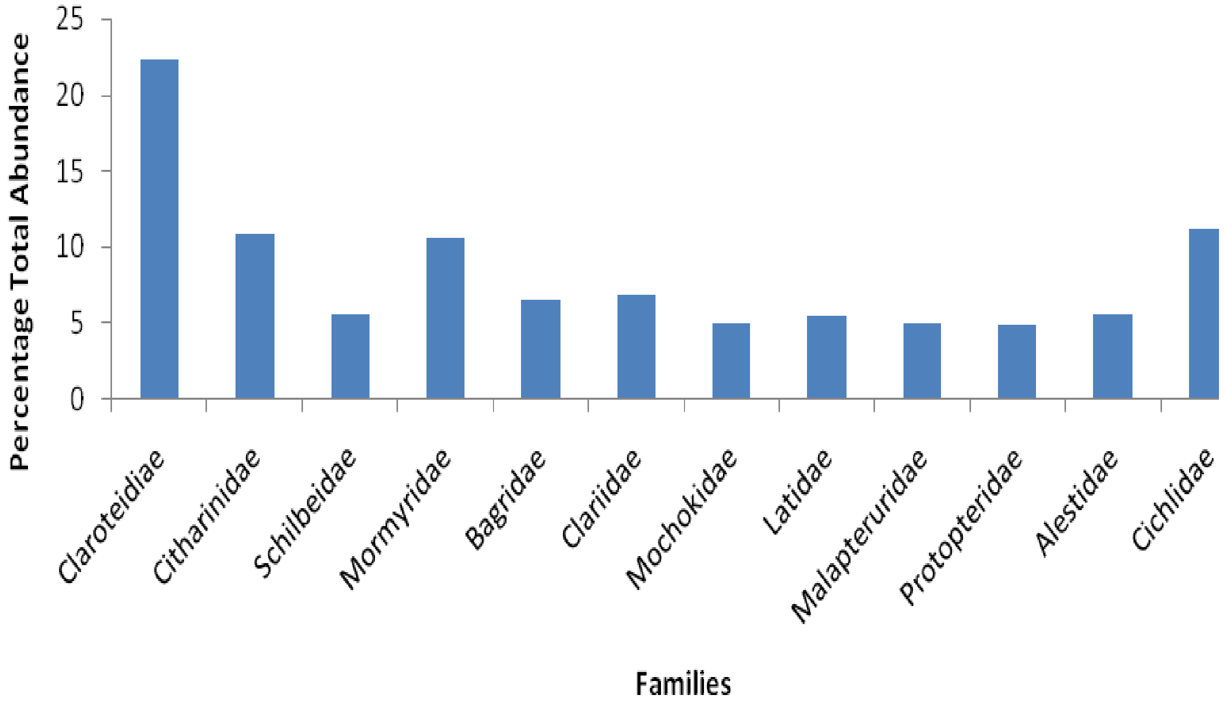

Fig 2: Percentage Abundance of Fish Families from Lake Akata (July2013 – August 2015).

Table 3: Fish Diversity Indices from Akata Lake (August 2013 – July 2015).

Indicies	Fish					
	Station A		Station B		Station C	
	Dry	Wet	Dry	Wet	Dry	Wet
Shannon-Wiener diversity index (H')	4.30	4.63	4.32	4.64	4.33	4.60
Simpson's Index (1-D)	0.99	0.99	0.99	0.99	0.99	0.99

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