E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2019; 7(6): 55-60

www.fisheriesjournal.com
Received: 23-09-2019
Accepted: 27-10-2019

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Diversity and abundance of fish species in river Okpokwu, Benue state, Nigeria

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Abstract
The study was carried out to investigate the fish species diversity and abundance in River Okpokwu, Benue State at three stations. The species found include *Heterobranchus longifilis*, *Clarias gariepinus*, *Oreochromis niloticus*, *Tilapia zilli*, *Protoptrus annectens*, *Synodontis budgetti*, *Labeo coubie*, *Alestes baremose*, *Chrysichthys nigrodigitatus*, *Mormyrops rume* and *Malapterirus electricus*. The most abundant species found in both dry and rainy season was *C. gariepinus* (17.00%) followed *T. zilli* (13.90%) while *M. electricus* was the least abundant (4.73%). In conclusion, field observation showed that all the eleven species of fish in River Okpokwu had a seasonal trend in abundance. Therefore, there is a need for the conservation and management of the fisheries resources of River Okpokwu by relevant agencies.

Keywords: Diversity and abundance of fish species, seasonal trend in abundance

Introduction
Relative species abundance describes how common or rare a species is in relative to other species in a given community and usually described for single trophic level (Lawson and Olusanya, 2010) [11]. Species richness and relative abundance are a key element of biodiversity. Lawson and Olusanya (2010) [11] reported that species richness relates to the number of different species in a given area and it is the fundamental unit used to access homogeneity of an environment. They are commonly used in conservation studies to determine the sensitivity of ecosystem and their species. Information generally on fish abundance studies of a river could therefore, be of help in the sustainable management of the aquatic resources. Lawson and Olusanya (2010) [11] also noted that for the sustainability of fish resources, an adequate knowledge of species composition, diversity and relative abundance of the water bodies must be understood and vigorously pursued. Thus, the avoidable decline of fisheries resources in an area due to overexploitation and inadequate management of inland waters could be checked through the availability of relevant information of various parameters of species in the river. According to Suter (2007), [18] species richness and relative abundance studies have been recommended as ecological risk assessment in the aquatic system. Fish abundance studies could also help identify the presence of species of importance and great value to the livelihood of the people living in an area. The study could also reveal species diversity and variation or similarities in the community structure of fish and other aquatic resources in the same river as well as other water bodies. The length-weight relationship is one of the important tools for the management of fisheries resources and it is used to estimate the condition factor. Its importance is pronounced in estimating the average weight at a given length group (Beyer, 1987) [6] and in accessing the relative well-being of the fish population (Bolger and Connoly, 1989) [7]. The study of the condition factor is important to understand the life cycle of fish species and contribute to the maintenance of the ecosystem equilibrium (Haruna and Birchi, 2005) [9]. Condition index may be used to determine the reproductive time of fish species without sacrificing the organism and this could be a valuable tool to develop monitoring programs for the species fishery and culture program (Arellano-Martinez *et al*., 2001) [3].
However, the length – weight parameters of the same species may be different in the population because of the age of the fish, stage of maturation, the fullness of gut, type of food consumed, amount of fat reserve and the degree of muscular development. There are four basic

eating groups of fish; carnivores, herbivores, omnivores and limnivores. Each fish belonging to an individual group needs to be properly placed and fed adequately. Proper feeding practices in fish are a matter of habit. Therefore, the objective of this study, therefore, is to determine fish abundance and diversity of River Okpokwu

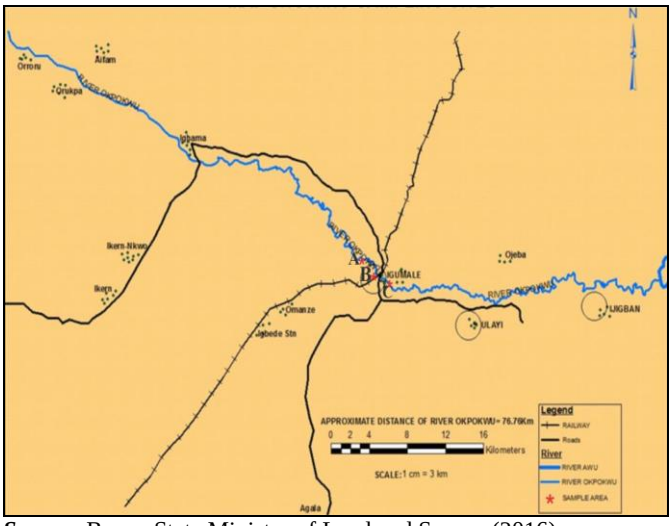
Materials and Methods

Description of Study Area

River Okpokwu transverses Ogbadibo, Ohimini, Okpokwu, and Ado Local Government Areas of Benue State to Ogoja Local Government Area of Cross River State. There is a coal deposit in Owukpa, Ogbadibo Local Government Area which is upstream of River Okpokwu in Igumale, Ado Local Government Area of Benue where the sampling sites are located. The river is used for irrigation, recreation, sewage disposal, laundry, fishing etc.

The study area is the only portion of the river where there are true riparian communities, with human settlements on both banks of the river. The area is located between latitude 6° 48' 0" N and longitude 7° 58' 0" E. It contains mineral and natural resources in commercial quantities such as limestone, kaolin, petroleum and coal (Adadu *et al*., 2019) [1]. The river covers about 76.76km. The climate is characterized by two distinct seasons, the dry season (November – April) and Wet season (May – October).

The three sampling stations (figure 1) were located at Igumale (Station A, known as Madam Ori side, Station B, known as Ogbee side and station C known as Igede side), all in Ado Local Government Area of Benue State. These stations were selected considering the riparian nature and activities of the settlers.



***Source*:** Benue State Ministry of Land and Survey (2016).

Fig 1: Map of River Okpokwu showing the sampling sites

Collection of Fish Samples

The fish specimens used for the study were obtained from fishermen operating along River Okpokwu from May 2015 to April 2017. The fish species were randomly sampled in the mornings between 07.00hr – 10.00hr after landing of catches. These were examined and identified in their fresh state using identification key by Olasebikan and Raji (1998, 2004) [15], Idodo (2003) [10] and Paugy *et al*., (2004) [16]. Length and weight measurements of fish species were taken by means of measuring board and top loading Weighing balance. Both total length and standard length were determined.

Determination of Fish Abundance and Diversity of River Okpokwu

(i) Margalef's Diversity Index (*d*): is a species richness index that measures the diversity in the community structure. This was estimated using the formula as reported by Clifford and Stephenson (1975) [8]

$$d = \frac{(S-1)}{\ln N}$$

Where:
d = Species richness index
S = Number of species in a population
N = Total number of individuals in S species

(ii) 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 reported by Magurran (2004) [12]:

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

Where
ni = number of individuals or quantity of each species (the i^{th} species)
N = total number of individuals for the site

Result

Results of the percentage fish abundance from the three sampling stations in the dry season are presented in Figure 2 while the results of the percentage fish abundance from the three sampling stations in the rainy season are presented in Figure 3.

In dry season, *Heterobranchus longifilis* was most abundant (6.68%) at station C and least abundant (5.44%) at station A. *Clarias gariepinus* was most abundant at station A (19.86%) and least abundant (17.05%) at station B. *Oreochromis niloticus* was most abundant (11.94%) at station C and least abundant (11.82%) at station A. *Tilapia zilli* was most abundant (13.91%) at station C and least abundant (12.49%) at station B. *Protoptrus annectens* was most abundant (7.08%) at station B and least abundant (5.15%) at station C. *Synodontis budgetti* was most abundant (9.12%) at station B and least abundant (8.27%) at station A. *Labeo coubie* was most abundant (9.31%) at station C and least abundant (7.32%) at station B. *Alestes baremose* was most abundant (6.24%) at station B and least abundant (5.37%) at station C. *Chrysichthys nigrodigitatus* was most abundant (10.73%) and least abundant (8.88%) at station B. *Mormyrops rume* was most abundant (8.52%) at station B and least abundant (6.13%) at station C while *Malapterirus electricus* was most abundant (5.67%) at station A and least abundant (4.49%) at station C.

Whereas, in rainy season, *H. longifilis* was most abundant (9.25%) at station C and least abundant (7.51%) at station B. *C. gariepinus* was most abundant (16.64%) at station C but least abundant (14.31%) at station B. *O. niloticus* was most abundant (12.55%) at station C and least abundant (11.73%) at station A. *T. zilli* was most abundant (16.15%) at station B and least abundant (12.88%) at station A. *P. annectens* was most abundant (6.74%) at station C and least abundant (6.52%) at station B. *S. budgetti* was most abundant (8.58%)

at station A but least abundant (7.08%) at station B. *L. coubie* was most abundant (7.58%) at station A and least abundant (6.94%) at station B. *A. baremose* was most abundant (8.30%) at station A and least abundant (7.22%) at station B. *C. nigrodigitatus* was most abundant (9.07%) at station B and least abundant (6.47%), at station C. *M. rume* was most abundant (7.93%) at station C and least abundant (7.65%) at station B. and *M. electricus* was most abundant (4.82%) at station B and least abundant (3.96%) at station C.

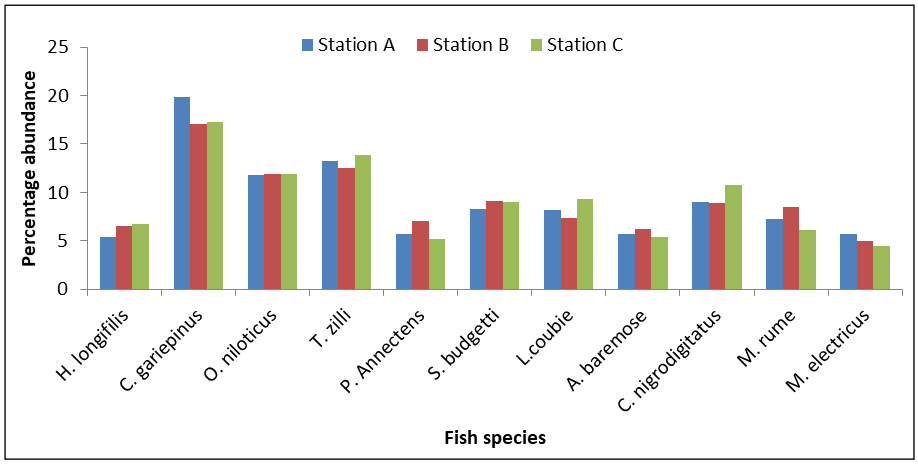


Fig 2: Percentage Fish Abundance of River Okpokwu during the Dry Season

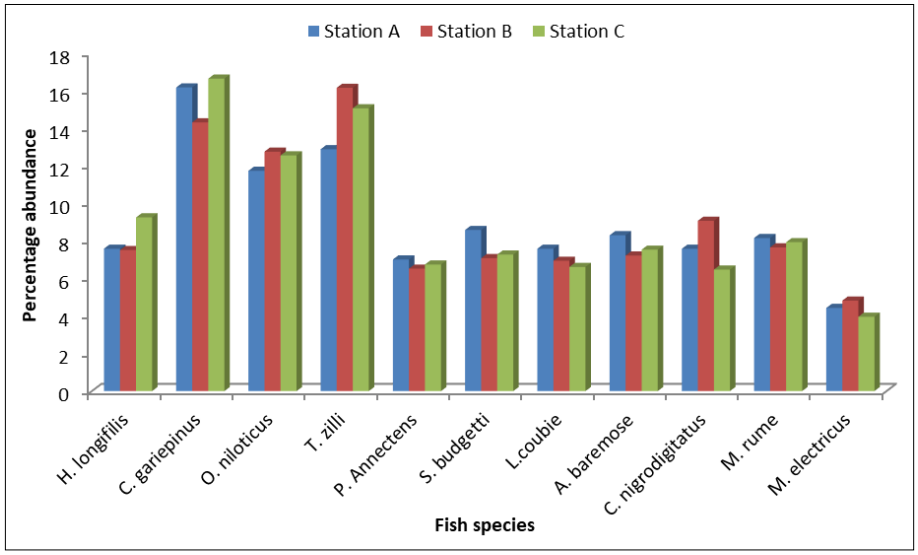


Fig 3: Percentage Fish Abundance of River Okpokwu during the Rainy Season

Results of the overall percentage abundance of fish species during the period of study are presented in Figure 4.

H. longifilis accounted for 7.09%, *C. gariepinus* was 17.00%, *O. niloticus* was 12.10%, *T. zilli*,1.90%, *P. annectens* accounted for 6.31%, *S. budgetti* was 8.27%, *L. coubie* was 7.72%, *A. baremose* was 6.63%, *C. nigrodigitatus* was 8.71%, *M. rume* accounted for 4.73%, while *M. electricus* accounted for 4.73% during the period of study. Generally, *C. gariepinus* was the most abundant (17.00%) while *M. electricus* was the least abundant (4.73%).

Results of the monthly percentage fish abundance of River Okpokwu in the dry season are presented in Figure 5 while the results of the monthly percentage fish abundance of River Okpokwu in the rainy season are presented in Figure 6

In the dry season, in the month of November 2015, *C. gariepinus* was the most abundant (24.46%) while *A. baremose* was the least abundant (5.40%). In December 2015, *C. gariepinus* was the most abundant (16.98%) while *A. baremose* and *M. electricus* were least abundant (4.25% each). In January 2016, *C. gariepinus* was most abundant (14.05%) while *P. annectens* and *M. electricus* were the least abundant (5.41% each). In February 2016, *C. gariepinus* was the most abundant fish species (16.43%) while *M. electricus* was least abundant (4.35%) *C. gariepinus* was most abundant (14.29%) in the month of March 2016 while *H. longifilis* was least abundant (4.91%). In April 2016, *C. gariepinus* was most abundant (16.00%) while *M. electricus* was least abundant (4.00%). In November 2016, *C. gariepinus* was the most abundant species (24.19%) while *M. rume* was the least abundant (5.42%). In December 2016, *C. gariepinus* was most abundant (18.52%) while *M. electricus* was the least abundant fish species (3.24%), in January 2017. *C. gariepinus* was most abundant (15.74%) while *P. annectens* was least abundant (5.58%). In February 2017, *C. gariepinus* was the most abundant species (17.68%) while *M. electricus* was the least abundant (7.64%), in March 2017. *C. gariepinus* was most abundant (18.30%) while *M. electricus* was the least abundant fish species (4.02%) and in April 2017, *C. gariepinus* was most abundant (14.86%) while *M. electricus* was the least abundant (5.14%).

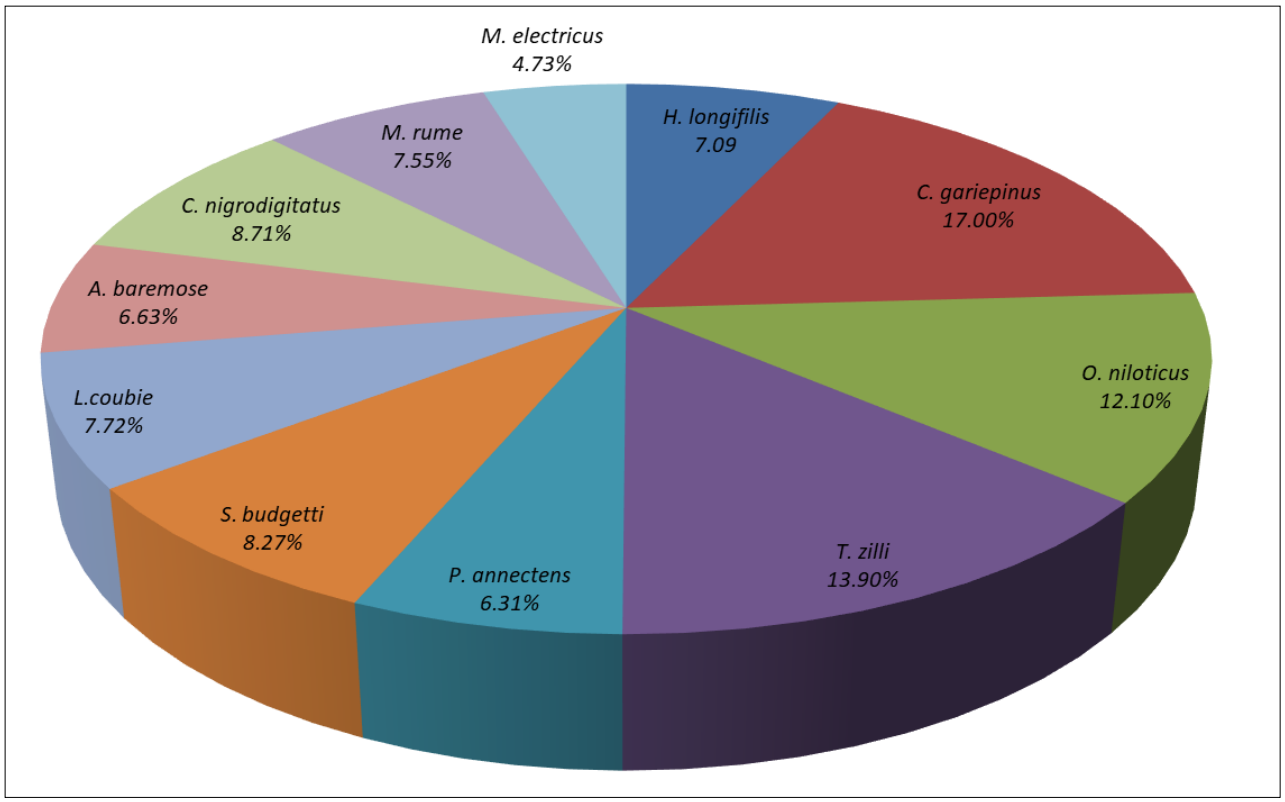


Fig 4: Overall Percentage abundance of fish species from River Okpokwu

Whereas, in the rainy season, in May 2015, *T.zilli* was the most abundant (15.34%) while *M. electricus* was the least abundant (4.76%). In June 2015, *C. gariepinus* was the most abundant species (16.59%) while *H. longifilis* was least abundant (4.74%), in July 2015. *O. niloticus* was most abundant (13.53%) while *M. electricus* was least abundant (5.29%). In August 2015, *T.zilli* was the most abundant fish species (17.65%) while *M. electricus* was least abundant (3.92%). *C. gariepinus* was most abundant (17.28%) in the month of September 2015 while *M. electricus* was least abundant (3.70%). In October 2015, *C. gariepinus* was most abundant (24.64%) while *M. electricus* was least abundant (3.32%). In May 2016, *T. zilli* was the most abundant species (17.13%) while *M. electricus* was the least abundant (4.42%). In June 2016, *C. gariepinus* was most abundant (17.53%) while *M. electricus* was least abundant (4.64%). In July 2016, *O. niloticus* was most abundant (13.33%) while *M. electricus* was least abundant (4.24%). In August 2016, *T. zilli* was the most abundant species (16.77%) while *M. electricus* was the least abundant (4.51%). In September 2016, *T. zilli* was most abundant (17.39%) while *M. electricus* was the least abundant fish species (3.73%) and in October 2016, *C. gariepinus* was most abundant (25.24%) while *M. electricus* and *M. rume* were the least abundant species (4.29% each).

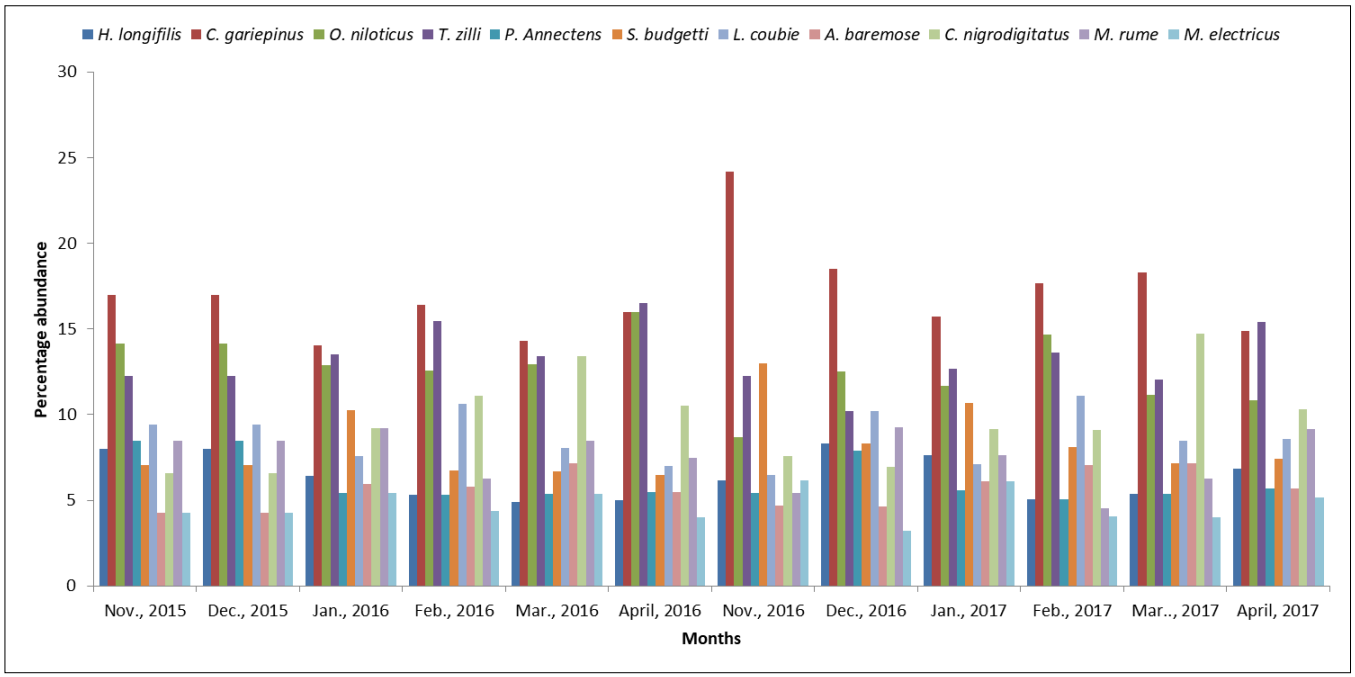


Fig 5: Monthly Percentage of fish abundance in River Okpokwu during the dry season

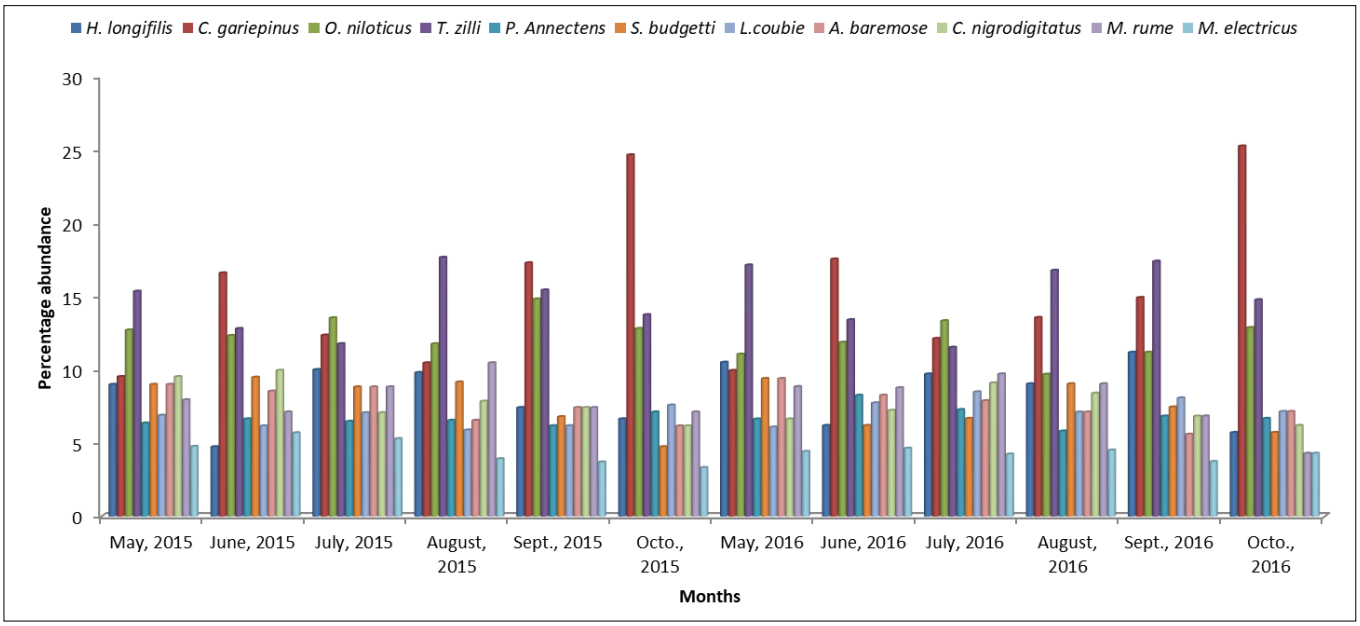


Fig 6: Monthly Percentage of fish abundance in River Okpokwu during the rainy season

Discussion

The fish diversity and abundance of the eleven fish species representing catches from River Okpokwu showed variation within and across seasons during the period of the study. The fish species encountered in the present study is not surprising as they have been encountered elsewhere. Ataguba *et al.* (2014) [4] reported 18 species representing 6 families in Gubi Dam, Bauchi State, Nigeria.

Lawson and Olusanya (2010) [11] carried a study to determine fish species diversity in Igbesa, Itele and Iba tributaries of River Ore in South west Nigeria between June 2007 and May 2008. The study revealed that fish composition comprised 11 species and 10 genera. A total of 103,111 and 96 individuals were caught from Igbesa, Itele and Iba stations respectively. The fish diversity ranges from typical freshwater fishes such as Tilapia and Clarias to brackish species such as *Chrysichthys negrodigitatus.* The abundant group of fish was the Clariids with *Clarias gariepinus* as the dominant species (32.26%) of the population. Their result is in agreement with the result of this study.

The result of this study does not agree with Obi *et al.* (2009) [13] who surveyed fish species in Anambra river basin, Nigeria who reported 52 fish species belonging to 17 families. The dominant species in the Anambra basin belonged to the Characidae (19.5%) and Mochokidae (11.8%) families, species were *Citherinus citherius***,** 9.02% and *Alestis nurse* (7.1%). They suggested this information on the Ichthyofaunal composition in the river will contribute to the sustainable exploitation of the fish resources available there. Also, Allison and Okadi (2009) [2] revealed that 25 species belonging to 14 families made the catches from the Lower Nun River, Niger Delta area of Nigeria in the course of their assessment against the 11 species obtained in this study.

The result of this study is not in alignment with Ayanwale *et al.* (2013) [5] who reported that 8 species family Clariidae and Alestidae were the least abundant consisting of less than 1% of the catch. Their most abundant species were *Tilapia zili*, *Mormyrus rume* and *Sorotherodon galilaeus* recording 33.01%, 29.95% and 26.06% of the catch respectively while the occasional and rare species were *Auchenoglanis occidentalis* (1.01%), *Alestis leciscus* (0.77%) and *Clarias gariepinus* (0.05%). They described the catch in the study as low and ascribed it to the large volume of water during the wet season, noting that available species were dispersed over a wide area which made fishing difficult. According to Offem *et al.* (2011) [14] a high level of water and subsequent flood favored reproductive activities, hence fishes show restricted movement making them less vulnerable to catch. This also does agree with the result of this study as the most catches was during the dry season.

During the study period, there were higher catches in the river during the dry season compared to the rainy season. The higher fish catch in the river during the dry season could be attributed to increasing in fish population density as it might probably be influenced by the availability of food (plankton), migration, presence of low water current, depth of water, among other things. In a similar study, Solomon *et al.* (2012) [17] reported high fish fauna during the wet season in Lower River Niger, Idah in Kogi State. This present work is in contrast with the reported work of Solomon *et al.* (2012) [17]. The month of November marks the beginning of the dry season with its attendant low water level that makes the fish more vulnerable to capture. The present study provided evidence that fluctuations in river flow can influence the seasonal occurrence and distribution patterns of several freshwater fish species. The Seasonal differentiation in the peak in abundance of the eleven fish species, in River Okpokwu could be influenced by the drop in water level and higher light intensity of dry season which could have led to the biological productivity of the river.

Conclusion

In conclusion, the result of the present study revealed that *Clarias gariepinus* were the most abundant fish species in November 2015 accounting for (24.46%), *Tilapia zilli* in April 2016 accounting for (16.50%), *Oreochromis niloticus* in February 2017 accounting for (14.65%), and *Chrysichthys nigrodigitatus* in March 2017 with (14.73%) respectively. Whereas *Malapterirus electricus* was the least abundant fish species caught in August, accounting for (3.24%). The dominant fish species in the rainy season were *Clarias gariepinus* (25.24%)(October, 2016), *Tilapia zilli* (17.65%) (August, 2015), *Oreochromis niloticus* (14.81%) (September, 2015), *Chrysichthyes nigrodigitatus* (9.95%) (June, 2015),

and *Heterobranchus longifilis* (11.18%) (September, 2016), while the least fish species were *Mormyrops rume* (4.29%), and *Malapterirus electricus* (3.32%) respectively. Field observation showed that all the eleven species had a seasonal trend in abundance.

Recommendations

There is a need for the conservation and management of the fisheries resources of River Okpokwu by relevant agencies. The best sustainable strategies for the conservation of the fish species in the study area could be enforcement of fisheries regulations such as banning of obnoxious fishing methods like use of chemicals for fishing, either close area or close season etc, dissemination of conservation information, education of the fishers and other stakeholders about the danger of extinction of the species and the need for its conservation.

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