Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.3, No.5, 2013 

# Biodiversity and Abundance of Fish and Plankton of Nguru Lake, Northeastern, Nigeria.

Mohammad Mustapha Abubakar (corresponding Author)
Department of Biological Sciences, Federal University Dutse, Saminu Murtala Yakasai
Department of Chemistry, Federal University Dutse

**Abstract**
Aspects of ecology and fisheries of Nguru lake were studied for a period of twelve months between May 2006 and April 2007.Nguru Lake, which is part of the Hadejia-Nguru wetlands is a natural lake, with an area of about 58,100 hectares and depth of between 1.5m to 8m. There is scarcity of information on the biodiversity of the lake .Therefore this work was aimed at determining the composition, abundance and distribution of phytoplankton, zooplankton, and fish of Nguru Lake. The phytoplankton of Nguru lake consists of twenty five species of algae from four divisions, namely Chlorophyta,Cyanophyta, Bacillariophyta and Dinophyta. Some algae such as Zygnema sp, Microcystis sp, Chlorella sp and Anabaena sp occur throughout the year, while others occur seasonally. All the phytoplankton studied showed significant seasonal and spatial variation ($P<0.05$).The zooplankton of Nguru lake is made up of four groups, Cladocera (41%), Copepoda (24%), Rotifera (27%) and Protozoa (18%).There is a total of 16 species, with Moina sp and Keratella sp dominating the fauna. The zooplankton showed significant seasonal and spatial variation ($P<0.05$). Twenty four species of fishes belonging to thirteen families were recorded.The family Cichlidae dominated the fishes with 64%.The families Claridae and Osteoglossidae constituted 6% each, while the family Malapteruridae was the least with only 0.17%.The mean weight of fish caught per day was 540.17kg, from three landing sites, with 14 fishermen operating averagely from each site.
**Key Words**: Biodiversity, Fish, Plankton, Ramsar site.

## 1. Introduction

Water is a primary natural resource, and its availability has played a vital role in the evolution of human settlements. In the course of the development of human societies, the dependence on water had been followed in several ways, depending on the climatic peculiarities of the different geographical regions of the earth.

Water use by man ranges from purely social needs, such as recreation, religious worship, regional/cultural identification and nature conservation through vital needs such as drinking, cooking, laundry, bathing, waste disposal and education to economic needs such as irrigation, fisheries, animal production, electric power generation and navigation. For most of these uses man depends mainly on freshwater available in inland lakes and rivers, which constitute less than 50% of the total amount of the water in the biosphere (Wetzel 1983). There is an urgent need to conserve the quality and quantity of water resources. In conserving water quality for multipurpose use, a holistic approach is recommended (UNEP, 1985) in which all-immediate and potential interests in the water basin are considered simultaneously. Experience has shown that only an ecologically healthy fresh water ecosystem fulfils this goal and the ecology of the flora and fauna of the ecosystem best measure this.

**N**guru Lake is part of the Hadejia-Nguru wetlands, it is formed from discharge from two river systems (Hadejia and Jama'are rivers), and it is about 58,000ha in size, with a mean depth of 1-8m. The lake is a wetland of international importance, it is a Ramsar site.

The last documented study on the biodiversity of the lake was carried out by HNWCP (1997). So it becomes important to have information on the current biodiversity of the lake. This paper therefore reports on the fish and plankton diversity and abundance of the lake. It is believed that the data gathered from this work would provide baseline information on developing its fisheries potential.

### 1.1 Materials and Methods

Sampling was conducted monthly, for a period of twelve months, from five sampling stations selected after a preliminary study.

**1.1.2. Experimental Fish Sampling**

A fleet of gill-nets consisting of nine multifilament nets of 25.4, 38.1, 50.8, 63.5, 76.2, 88.9, 101.6, 127.0 and 177.8mm stretched meshes were used to catch the fish. Each net measured 30m long and 3m deep, with 210/3 twine used for the first eight meshes and 210/6 for the 177.8mm. Nets were set approximately 2 hours before sunset and lifted 2 hours after sunrise. The fish caught in each net were removed and kept in large bowls. Each fish was weighed and measured for standard and total lengths.

**1.1.3. Frame Survey**

These involved total counts of fish landing sites, and fishermen operating in the lake with records of fishing gear used.

**1.1.4. Catch Assessment Survey**

The actual counts of fish caught by the local fishermen and their weights were carried out. The total weight of fish caught by each fisherman was taken with a spring balance. All fishes were also identified.

**1.1.5. Collection of Plankton**

Sample of plankton were collected using plankton net of mesh size 70um (microns). The net was tied to a metal rod, and immersed into the water, towed for a fixed distance, and hauled out of the water. The water (containing plankton) that was collected in the plastic bottle at the end of the net was emptied into sample bottles and preserved with 4% formalin, for zooplankton and Lugol's solution, for phytoplankton (Vollenweder, 1974, Wetzel and Likens, 1979). The volume of water that passed through the net was then estimated by using the following formula:

$$V=\pi r^2 d$$

Where V = volume of water filtered by the net, = radius of the mouth of the net and d = length of the haul (Downing and Rigler, 1982).

**1.1 6. Plankton Enumeration**

On coming to the laboratory, the phytoplankton samples were condensed by centrifuging 100ml of the sample to10mI. The concentrated sample was taken for enumeration with Sedgwick-Rafter counting chamber. Identification was done to species level, using keys in Prescott (1970) and Lund (1995). Zooplankton samples were similarly condensed and enumerated. Identification to species level was done using keys in Jeje and Fernando (1982). Fish identification was done using keys in Leveque *et al.,* (1992).

Data collected were subjected to analysis of variance (ANOVA), Pearson's product moment correlation coefficient, and Shannon-Weiner and Evenness indices.

**1.1.7 Results**

The phytoplankton of Nguru Lake consists of four genera, with twenty five species. The phytoplankton is dominated by the *Chlorophyta* which makes up 46% of the total algae. The *Cyanophyta* constituted 29% and the *Bacillariophyta* contributes 22% of the population, while the *Dinophyta* makes up only 2% of the phytoplankton. The *Chlorophyta* is dominated by *Chlorella vulgaris, Zygnema sterile*, and *Ankistrodesmus falcatus* which are most abundant and occur throughout the study period. The *Cyanophyta* are made up of *Anabaena circinalis*, *A. flos-aque* and *Gomphosphaeria sp.* occurring in all the sampling stations, all year round. None of the members of *Bacillariophyta* and *Dinophyta* is present throughout the year. There was highly significant ($p<0.001$) in both spatial and seasonal variation of phytoplankton.

A Shannon-Weiner index of 5.32, 3.89 and 4.67 for stations 1, 2 and 3 respectively indicates that these stations have a relatively higher diversity index and are therefore not polluted. While indexes of 2, 92 and 2.11 for stations 4 and 5 respectively show that these stations are slightly polluted.

Four groups of zooplankton consisting of Cladocera, Copepoda, Rotifera and Protozoa were observed. A total of 12 species of zooplankton were present at Nguru Lake. The zooplankton show, highly significant ($p<0.001$) seasonal and spatial variation.

Shannon-Weiner index of 5.76, 4.14 and 5.02 for stations 1, 2 and 3 respectively indicate that these stations have relatively high species diversity and therefore are not polluted. But stations 4 and 5 with indexes of 2.96 and 1.98 respectively have relatively lower species diversity suggesting possible pollution.

The results of the mean weight of fishes are presented in figure 1. A total of twenty four fish species belonging to 13 families were identified. The family *Cichlidae* dominated the fishes of Nguru Lake with 64%. The families *Claridae*

 

and *Osteoglosidae* constituted 6% each, while the family *Malapteruridae* was the least with 0.17%. According to their weights, the family *Cichlidae* had 53.87% followed by *Osteoglosidae* with 18.57% and *Claridae* had 6.17%. Nguru Lake had three main fish landing sites at Garbi, Gashua road and Dabar Magini with an average of 14 fishermen everyday. The fishing gears used were mainly gillnets and detachable basket traps with non-return valve. The mean weight of fish caught from the lake per day was 540.17kg. The seasonal distribution of fishes in Nguru Lake is not significantly different.

**1.1.8. Discussion**

The changes in algal composition in this case may be explained by zooplankton grazing, since the records of algal biomass observed showed significant correlation with the zooplankton population. This is supported by Barlow *et al.*, (2006) who stated that phytoplankton is a stable food supply for zooplankton and pelagic fish. It has long been recognized that zooplankton grazing can be an important loss factor for phytoplankton in lakes (Kerfoot *et al.*, 1988). Observations by Odhiambo and Gichuki (1998) revealed that the algae of Lake Baringo were dominated by the *Chlorophyta* and the *Cyanophyta* and that the lake is in a state of gradual deterioration of water quality. These factors are applicable to Nguru Lake in the case of the present study.

The richness of *Cladocera* in Nguru Lake is relatively high; this may be attributed to the abundance of aquatic macrophytes, particularly *Typha* sp in the water, which hampers the rate of predation by fish. As it was suggested by Sarnelle (1992) that fish prefer open waters to feed on zooplankton. This is further collaborated by Kemdirim (2000), Jeppesen *et al.*, (2001) and Havens (2002) who observed that the absence of *Cladocera* and the low numbers of *Copepoda* could be due to the effects of fish predation, which was found to be the major factor structuring zooplankton assemblages in several studies.

The distribution of zooplankton in Nguru Lake is peculiar, in that there is significant spatial variation in the distribution. Sampling station 5 had the least number of individuals, probably because the site is liable to drying up during some months of the year. Low values in station 3 may be attributed to its shallow nature. Station 1 is open water with less aquatic macrophytes, making the zooplankton there vulnerable for fish predation. This point is buttressed by Balarabe (2000) who observed that the nature and distribution of aquatic macrophytes may influence the distribution patterns of zooplankton within the two ponds he studied.

The zooplankton of Nguru Lake is directly proportional to the abundance of phytoplankton. This is further explained by the observations of Abubakar and Balarabe, (2008) who reported the same observations in the same lake.

It is obvious from the results that Nguru Lake showed fish abundance in terms of number and weight, and there was also relatively high species diversity. The mean catch of 12.86kg per fisherman is an indication of high productivity, which is also higher than the 5.8kg observed by Henderson and Welcomme (1974) for 31 African Lakes. The fish diversity of 13 fish families and 24 different fish species is also higher than fish diversities observed from small lakes such as Bakalori, Goronyo and Tiga, (Ita 1979). Kangimi (Balogun and Auta, 2001), Dan-Zaria, (Lamai and Kolo, 2003), Doma, (Mohammed and Omoregie, 2004).

The dominance of fish family *Cichlidae* in Nguru Lake compares favorably with dominance of the cichlids in Lakes Kainji, Tiga, Bakalori, Kangimi and other African Lakes (Ita *et al,*. 1982, Balogun and Auta, 2001, Mohammed and Omoregie, 2004 and Balogun, 2005). The order *Cichlidae, Bagridae, Characidae* and *Cyprinidae reported* for Lakes Kainji, Tiga and Bakalori (Balogun, 2005) is in contrast to the order of *Cichlidae, Claridae*, *Osteoglosidae* and *Mormyridae observed* in Nguru Lake. The fishes caught in the lake did not show significant seasonal variation. This is consistent with the observation of Balogun (2005), who recorded no significant variation in the mean catch of fish families caught in Zaria reservoir

**References**

Abubakar, M.M. and Balarabe, M.L. (2008) Effect of physicochemical factors and phytoplankton on the abundance of zooplankton in Nguru lake, North eastern Nigeria. *Biological and environmental Sciences journal for the tropics* **5** *(1):* 110- 112.

Balarabe M.L (2000) Effect of limnological characteristics on Zooplankton composition and distribution in Dumbi and Kwangila ponds, Zaria, Nigeria (Unpublished) PHD thesis Department of Biological science ABU Zaria.

Balogun, J.K. (2005). Fish distribution in Kainji domestic water supply reservoir. A case study of Kangimi reservoir, Kaduna state, Nigeria. *Journal of Applied Sciences* **1:** 50-56

Balogun,J.K. and Auta, J.(2001). Fisheries resources and development potential of Lake Kangimi, Kaduna

state, Nigeria. *Nigerian Journal of Biological Sciences* **1**:.50-56.

Barlow, R., Louw, D., Balarin, M. and Alheit, J.(2006). Pigment signatures of phytoplankton composition in the northern Benguela ecosystem during spring. *African journal of Marine science,* **28***(3&4)*: 479-491.

Downing, J.A and F.H. Rigler (1982) *A Manual of Methods for the assessment of secondary productivity in fresh waters (2nd ed.)* Blackwell scientific publications, oxford, UK.

Havens K.E. (2002) Zooplankton structure and potential food web interactions in the plankton of a subtropical chain of lakes. *Scientific world* **8:** 926 –942.

Henderson, H.F. and R.L. Welcome (1974). The relationship of yield to morpho-edaphic index and numbers of fishermen in African inland fisheries. C.I.F.A. Conference paper. 19.

HNWCP(1997) Biodiversity study on the Hadejia-Nguru wetlands. Hadejia-Nguru Wetlands Conservation Project. Nguru, Nigeria.

Ita, E.O. (1979). Some perspective in reservoir fishery management and development. The Kainji Experience. International Conference on Kainji Lake and River Basin Development in Africa, 2, New-Bussa, Nigeria. 266-277.

Jeje, C.Y. and C.K. Fernando(1986) *A practical guide to the identification of Nigeria Zooplankton:* Kainji Lake Institute.

Jeppensen E, Jensen J, Skovgaard H and Havidt (2001) change in the abundance of planktivorous fish in lake, skanderborg during the past two centuries- palaeoecological approach. *Palaeogeography, Palaeochimatology, Palaeoecology* **172***:* 143-152.

Kawo,A.H.(1996) Laboratory investigation on the effect of some physical and chemical factors on the total microbial population in relation to eutrophication and purification of Salanta river.Kano. Msc. Thesis B.U.K. Kano Nigeria. 22.

Kemdirim, E.C. (2000) Diel Rhythm of plankton and physio-chemical parameters in Kangimi Reservoir, Kaduna State, *Journal of Aquatic Sciences,* **15***(1)* 35-39.

Kerfoot, C.W., Levitan, C. and DeMott, W.R.(1988). Daphnia-phytoplankton interactions: density dependent shifts in resource quality. *Ecology* **69** : 1806-1825

Lamai, S.L. and R.J. Kolo (2003). Biodiversity and abundance of fish and plankton of Dan-Zaria dam, Niger state, Nigeria. *Journal of Aquatic sciences* **18** *(2)* 141-148.

Leveque, C.D. Paugy, and G.G Teugels (eds) *Fauene des poisons d'eaux douces et saumatres de L'Afrique de I'Ouest (Tome)* ORSTOM et MRAC Tervuren and Paris. 902.

Lund, J.W.G (1995) A Sedimentation technique for counting algae and other organisms. *Hydrobiologia* **3***:*390-394.

Mohammed, S.U. and Omoregie (2004). A preliminary investigation into the fisheries potential of Doma Lake, Nassarawa state, Nigeria. *Journal of Aquatic sciences* **19** *(2): 59-64*

Odhiambo, W. and J. Gichuki(1998). Seasonal dynamics of the phytoplankton community in relation to environment in Lake Baringo, Kenya. (Impact on the lake's resource management*). African Journal of Tropical Hydrobiology and Fisheries* **8***:*. 36-47.

Prescott, G.W. (1970) *How to know the freshwater algae*. W.M.C Brown Co. Inc. Dubuque, Lowa, USA.

Sarnelle O. (1992) Nutrient Enrichment and grazer effect on phytoplankton in lakes. *Ecology.* **73**: 551-556.

UNEP (1992). Chemical pollution. A global overview. UNEP. Geneva.

Vollenweider, R.A.(1974) *A manual on methods for measuring primary production in aquatic environments*. IBP Handbook no. 12. Blackwell Scientific Publications, London.

Wetzel,R.G. and Likens, G.E. (1979) *Limnological analysis*. W.B. Saunders Philadelphia. 357.

 

Table 1 – ANOVA For Phytoplankton Of Nguru Lake

| Source | DF | Cyanophyta | Chlorophyta | Bacillariophyta | Dinophyta |
|---|---|---|---|---|---|
| Year | 1 | 4.78* | 0.67NS | 0.16NS | 0.30NS |
| Season | 1 | 32.16** | 30.29** | 24.32** | 43.28** |
| Station | 4 | 11.27** | 28.37** | 30.29** | 41.81** |
| Year x Season | 1 | 0.00NS | 0.20NS | 0.20NS | 0.01NS |
| Year x Station | 4 | 2.61* | 0.74NS | 0.75NS | 11.83** |
| Season x Station | 4 | 1.78NS | 1.57NS | 1.61NS | 3.96* |
| Year x Season x Station | 4 | 0.2NS | 0.12NS | 0.09NS | 0.43NS |

***-Significant, **-Highly Significant, NS – Not Significant**

Table 2. Mean distribution of Zooplankton in Nguru Lake and the diversity indices of the stations.

| **Cladocera** | **Site 1** | **Site 2** | **Site 3** | **Site 4** | **Site 5** | Total |
|---|---|---|---|---|---|---|
| *Moina micrura* **Kutz** | 111 | 212 | 31 | 41 | 12 | 407 |
| *Ceriodaphnia cornuta* **Sars** | 91 | 230 | 52 | 81 | 22 | 476 |
| *Simocephalus serrulatus* **Koch** | 82 | 171 | - | 41 | - | 294 |
| *rnayella mondi* **Sars** | 72 | 111 | - | - | - | 183 |
| *Monella excisa* **Kutz** | - | 81 | - | - | - | 81 |
| *Alona monacantha* ***Sars*** | - | 72 | 21 | - | - | 93 |
| **Copepoda** | | | | | | |
| *Tropodiaptomus incognitos* ***D&G*** | - | 51 | 12 | - | - | 63 |
| *Thermocyclops neglectus* **Sars** | 112 | 101 | - | - | - | 213 |
| *Macrocyclops albidus* **Imhof** | 131 | - | - | - | - | 131 |
| *Afrocyclops gibsoni* **Kutz** | 72 | 101 | - | 73 | - | 246 |
| **Rotifera** | | | | | | |
| *Brachionus patulus* **Muller** | 91 | 172 | 71 | 82 | 33 | 449 |
| *Keratella quadrata* **Hauer**. | 141 | 192 | 42 | 103 | 31 | 509 |
| *Kellicottia longispina* **Kellicott** | 22 | 41 | - | - | - | 63 |
| **Protozoa** | | | | | | |
| *Paramecium sp.* | - | - | 32 | 11 | 10 | 53 |
| *Colpidium campylum* **Sars** | - | - | - | 51 | 22 | 73 |
| Mean No. of individuals(N) | 911 | 1362 | 253 | 561 | 20 | 621.4 |
| No. of species (S) | 10 | 12 | 7 | 8 | 6 | 43 |
| Shannon-Weiner index(D) | 5.76 | 4.14 | 5.02 | 2.96 | 1.98 | 3.97 |
| Evenness index(E) | 0.96 | 0.906 | 0.944 | 0.66 | 0.50 | 0.794 |

 

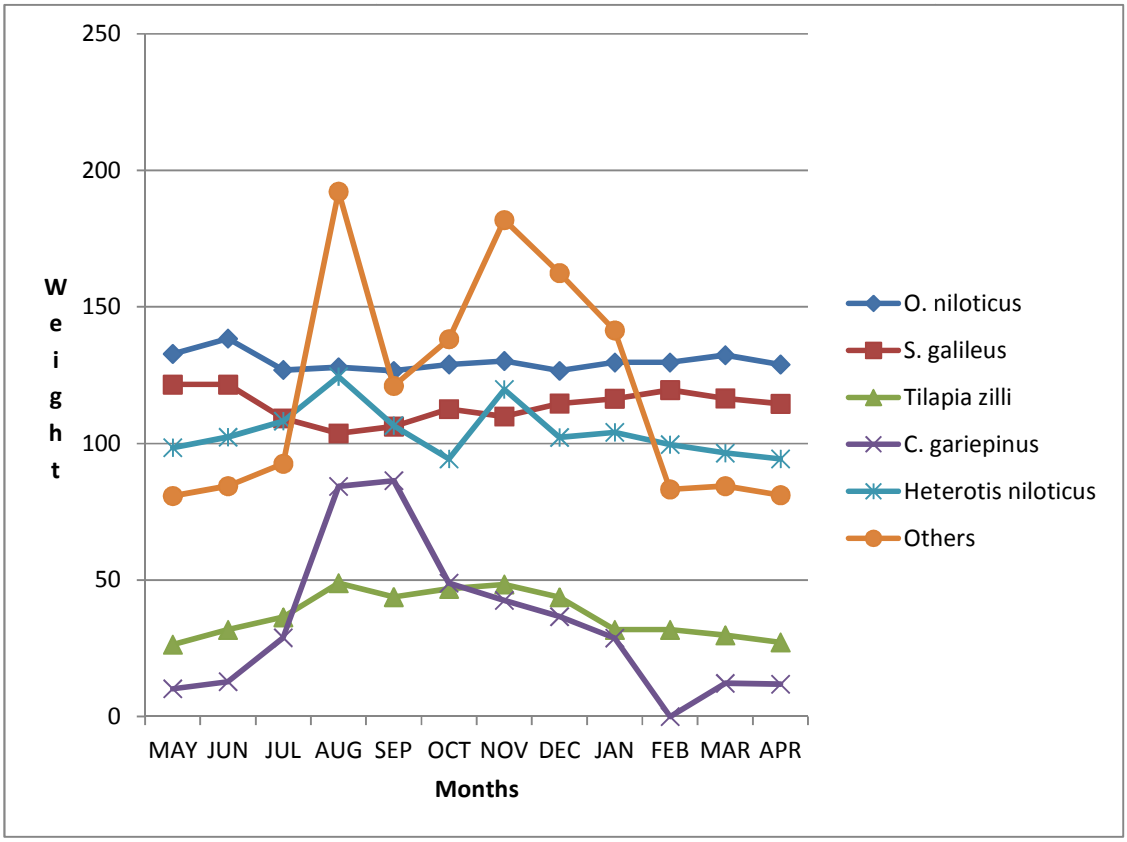


Fig. 1. Mean weight of fish in Nguru Lake

This academic article was published by The International Institute for Science, Technology and Education (IISTE). The IISTE is a pioneer in the Open Access Publishing service based in the U.S. and Europe. The aim of the institute is Accelerating Global Knowledge Sharing.

More information about the publisher can be found in the IISTE's homepage: http://www.iiste.org

## CALL FOR PAPERS

The IISTE is currently hosting more than 30 peer-reviewed academic journals and collaborating with academic institutions around the world. There's no deadline for submission. **Prospective authors of IISTE journals can find the submission instruction on the following page:** http://www.iiste.org/Journals/

The IISTE editorial team promises to the review and publish all the qualified submissions in a **fast** manner. All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Printed version of the journals is also available upon request of readers and authors.

### IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar