Nigerian Journal of Ecology (2015) 14:90-101.

ISSN: 1116-753X

Physico-chemical Characteristics and Fish Abundance in Erelu Reservoir, Oyo State, Nigeria

*[1]Kareem, O.K., [1]Falaye, A.E., [1]Ajani, E.K. and [2]Olanrewaju, A.N.

[1]Department of Aquaculture and Fisheries Management, University of Ibadan
[2]Federal College of Freshwater Fisheries Technology, P.M.B 1060, Maiduguri
*Correspondence Email: kaykaz2007@yahoo.co.uk

(Accepted 17 December 2015)

Abstract

The need to determine quantitative relationship between fishery status and water quality become imperative in order to make informed judgment concerning fishery health and setting environmental quality standards for fishery protection. Hence, the relationship of fish assemblages and water quality in Erelu Lake was investigated. Studies were undertaken for a period of twenty-one months from July 2013 to March, 2015. Fish population were assessed monthly using fleet of gillnets while physico-chemical parameters such as water temperature, dissolved oxygen (DO), biological oxygen demand (BOD), conductivity, pH, transparency, nitrate, nitrite, ammonia, phosphate and heavy metals were monitored following standard methods. Fish community/environment relationships were evaluated using Pearson Correlation Analysis and Canonical Correspondence Analysis (CCA). A total of 6,927 fish representing eight families and 16 species were recorded during this study. All the investigated physico-chemical parameters fell within standard limits for fish production. Analysis of variance revealed non-significant difference between wet and dry seasons for most physic-chemical parameters except dissolved oxygen, transparency, temperature, pH, nitrate and lead ($P<0.05$). Based on CCA, fish abundance was discovered to be strongly correlated with BOD, DO and Conductivity. Fish distribution and abundance in Erelu Lake was therefore influenced by series of complex interactions between environmental variables which were seasonally induced.

Keywords: Fishery health, environmental variables, correlation, Erelu Lake, water quality.

INTRODUCTION

Lakes and surface water reservoirs are the planet's most important freshwater resources and provide innumerable benefits (Dirican, 2015). They have an important economic, social and cultural benefit for the development of a nation through hydroelectric power generation, irrigation, tourism, recreation, research, fishing and aquaculture. The lake provides both renewable and non-renewable resources to its riparian communities. However, significant numbers of these water bodies have been dramatically altered by human activities due to the development of modern technology and rapid industrialization. Dudgeon *et al*., (2006) grouped the main threats under five interacting categories;

over-exploitation, water pollution, flow modification, destruction or degradation of habitat, and invasion by exotic species. The effective and efficient management of the resource base is essential for any nations' economic and social welfare and its environmental quality (Muyodi *et al.*, 2011).

Water quality parameters provide important information about the health of a water body. Its periodical investigations remain an important part of environmental monitoring activities because when water quality is poor, it affects not only aquatic life but the surrounding ecosystem as well. Also, water quality monitoring can help to predict natural processes in the environment and determine human impacts on an ecosystem. Studies have shown that there is entwining relationship between surface water quality and icthyofauna diversity (Mustapha, 2009; Edward *et al.*, 2014). Many fish species or developmental stages of a species can only survive within a certain range of abiotic conditions such as temperature, oxygen, pH, salinity and water currents (Fryer, 1973; Mustapha, 2006, 2009; Edward *et al.*, 2014; Akaahan *et al.*, 2015). Adeyemi *et al*., (2009), thus asserted that changes in the physico-chemical aspect of a water body bring about a corresponding change in the relative composition and abundance of the organisms in that water. A number of studies have been conducted on Southwestern Nigerian lake and reservoirs on the relationship between environmental parameters and fish composition, abundance and distribution (Mustapha, 2006, 2009; Edward *et al.*, 2014), but there is dearth of such documented information on Erelu Lake. Therefore, the relationship between environmental variables and fish abundance in Erelu Lake was investigated.

MATERIALS AND METHODS

Study Area: Erelu Lake is one of the major reservoirs built by Water Corporation of Oyo State in 1961. It is located about 6.4 km from the heart of Oyo town. Oyo town is however, situated in the North of Ibadan, the capital city of Oyo State. Geographically, Erelu Lake is at an altitude of 241.7 meters above sea level and lies within the tropical rainforest zone of southwestern Nigeria between latitudes $7^0$53'0" - $7^0$55'30" N and longitudes $3^0$53'30" - $3^0$56'0" E (Fig. 1). The impoundment area of the dam is 161.07 hectares and the catchment area is 243.46 kilometres (Iroko, 2003). The reservoir was constructed by damming Awon River, and water from the dam is being supplied to the public for domestic purposes in Oyo and neighbouring towns with fish production as an ancillary purpose. Fish fauna found in the reservoir include the following: *Oreochromis niloticus, O. aureus, Raimas senegalensis, Chryschythys nigrodigitatus, Sarotherodon melanotheron, Schilbe mystus, Tilapia marie, T. guinensis, T. zilli, Clarias gariepinus, C. anguillaris, Labeo parvies, Momyrus rume, Heterotis niloticus, Parachanna obscura* and *Barbus pleuropholes* (Falaye et al., 2015). Human activities around the lake include lowland farming along the edges of the dam, irrigation of arable crops by the farmers and migration of fishermen into the area. Settlers around the lake are from various states of Nigeria such as Benue, Kogi, Delta, Ondo, Osun, Ogun and Oyo states.

Field Sampling: Erelu Lake was spatially stratified into upper, middle and lower zones (A, B and C, respectively) based on geographical location and four sampling points were randomly selected in each zone for water sampling. Fleet of gill nets (38.1mm, 50.8mm, 63.5 mm, 76.2mm, 88.9mm, 101.6mm and 127.0mm) each measured 30m long and 3m deep were set randomly at each zone at 1900hours and fish caught retrieved at about 0700hours the following morning. Water and fish sampling were carried out monthly for a

period of 21 months covering July 2013 to March 2015. Surface water temperature, Dissolved Oxygen (DO), conductivity, pH and transparency were determined using water quality kit while Biological Oxygen Demand (BOD), nitrite, nitrate, ammonia, phosphate, lead, zinc, iron, and cadmium were determined in the laboratory using standard methods (APHA, 1998). All the parameters were compared with water quality standards (Boyd and Tucker, 1998; Ali *et al.*, 2000) to determine their suitability for the sustenance of aquatic species in the selected sites.

Fish retrieved were identify to the lowest taxonomic level using monograph and texts (Olaosebikan and Raji, 2013; Idodo-Umeh, 2003). Relative abundance by family and species were recorded every month and pooled at the end of the study.

DATA ANALYSIS:

The data collected were analyzed using descriptive statistic, Analysis of variance (ANOVA) and Pearson Correlation Test (PCT) at $p \leq 0.05$. Also, the influence of physico-chemical variables on fish abundance was determined using Canonical Correspondence Analysis (CCA).

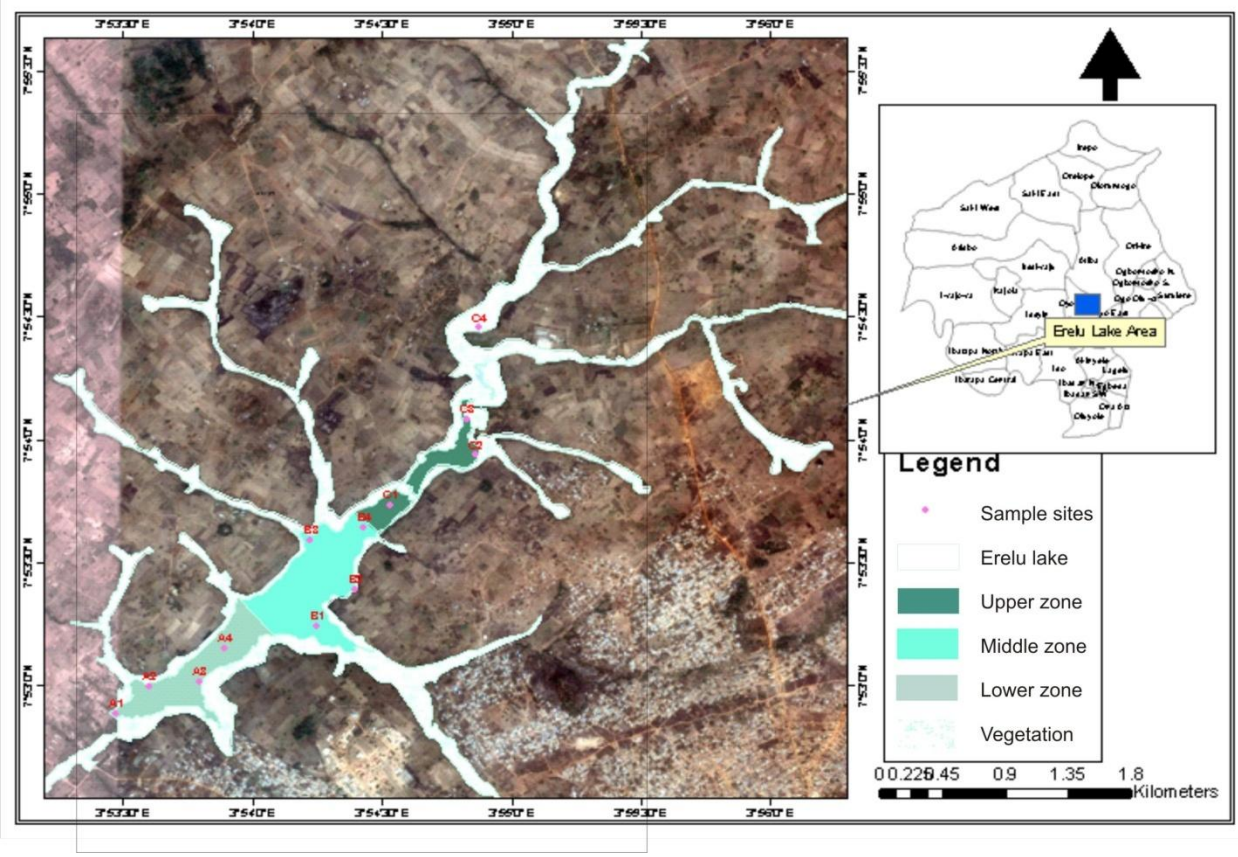

Figure 1: Map of Erelu Lake in Oyo State

RESULTS

A total of 6,927 fish representing eight families and 16 species were captured in the study area (Figure 2). Three families, Cichlidae, Cyprinidae and Clariidae, constituted 72% of the total catches and

were dominated by *Oreochromis. niloticus*, *Raimas. senegalensis*, *Chryschythys. nigrodigitatus, Sarotherodon. melanotheron, Schilbe. mystus* and *Tilapia. marie*. The seasonal mean values of water physicochemical parameters and their correlation analysis were as presented in the tables 1.

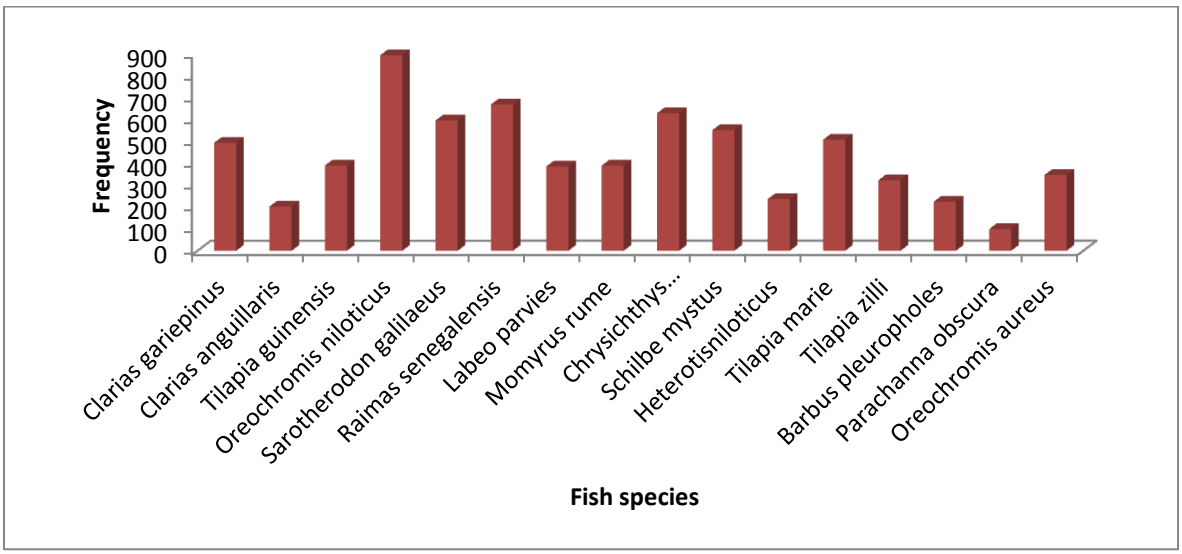

Figure 2: Fish abundance in Erelu Lake from July, 2013 to March, 2015

Dissolved Oxygen (7.53±0.77 mg/l) and Transparency (1.36±0.39 m) were highest in the dry season and was significantly different from ($p<0.05$) the wet season. Also, significant seasonal variations were observed in temperatures, pH and Nitrate. Dry season had relatively lower temperatures, 26.81±1.82^{o}C, than wet season (27.71±1.00^{o}C). However, dry season had the highest pH (7.80±0.70) and Nitrate (0.70±0.05 mg/L), while wet season had the least value of 7.06±1.06 and 0.66±0.07 mg/L, respectively. There was no significant difference at 5% for Biological Oxygen Dissolved, conductivity, nitrite, ammonia, phosphorus and heavy metals in both seasons.

Correlation analysis of the physico-chemical parameters obtained from the Erelu Lake is presented in Table 2. Transparency correlated significantly ($p<0.05$) with surface water temperature ($r = -0.242$), pH ($r = 0.233$), nitrate ($r = 0.187$), lead ($r= 0.362$) and zinc ($r = -0.272$) respectively. The temperature had a negative correlation ($r = -0.138$) with pH, while BOD is positively related ($r = 0.213$) to temperature. However, conductivity showed positive significant relationship with iron ($r = 0.330$) and cadmium($r = 0.144$). Nitrate had a positive significant ($r = 0.146$) correlation with lead only. Similarly, nitrite had a negative significant association ($r = -0.134$; -0.278) with ammonia and phosphate respectively, but positively correlated ($r = 0.173$) with iron. However, Ammonia, pH, phosphate, zinc, iron and cadmium showed no significant correlation with any of the physico-chemical parameters.

Relationship between the environmental variables measured and the abundance of fish populations were analyzed using the Pearson correlation (Table 3). The result revealed that most of the physico-chemical parameters were positively correlated to fish abundance. A positive and strong correlation

(P<0.05) was observed between fish abundance, dissolved oxygen, BOD, conductivity, lead, zinc, iron and cadmium whereas inverse correlation exist between fish abundance, temperature and nitrite. However, transparency, nitrate, ammonia and phosphate were positively correlated with fish abundance.

Table 1: Seasonal Physico-Chemical parameters of Erelu Reservoir between July, 2013 and March, 2015

Variables	Wet season			Dry season			
	Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.	P value
DO (mg/l)	7.03±0.97	4.86	8.93	7.53±0.77	5.42	8.95	< 0.05
BOD(mg/l)	2.56±0.28	1.02	2.83	2.51±0.39	1.25	2.84	> 0.05
Transparency (m)	0.88±0.31	0.59	1.82	1.36±0.39	0.50	2.68	< 0.05
Temperature (^{o}C)	27.71±1.00	23.30	29.60	26.81±1.82	23.50	31.00	< 0.05
Conductivity (hs/cm)	157.79±20.48	123.45	189.2	161.12±19.01	124.44	190.02	> 0.05
pH	7.06±1.06	6.10	8.86	7.80±0.70	5.53	9.36	<0.05
Nitrate(mg/l)	0.66±0.07	0.46	0.85	0.70±0.05	0.58	0.80	< 0.05
Nitrite(mg/l)	0.23±0.02	0.18	0.28	0.23±0.02	0.20	0.27	>0.05
Ammonia(mg/l)	0.23±0.02	0.19	0.30	0.23±0.02	0.19	0.25	> 0.05
Phosphate(mg/l)	0.29±0.04	0.03	0.35	0.29±0.02	0.22	0.35	> 0.05
Lead(mg/l)	1.07±0.63	0.12	1.88	1.41±0.52	0.15	1.78	< 0.05
Zinc(mg/l)	0.23±0.02	0.12	0.27	0.22±0.03	0.12	0.27	> 0.05
Iron(mg/l)	0.13±0.06	0.06	0.24	0.14±0.06	0.05	0.24	> 0.05
Cadmium(mg/l)	0.04±0.01	0.01	0.07	0.04±0.01	0.01	0.06	> 0.05

Legend: *DO* dissolve oxygen, *BOD* biological oxygen demand, *SD* standard deviation, *Min* minimum, *Max* maximum.

Table 2: Correlation matrix of physico-chemical parameters of Erelu Lake

	BOD	Transpa-rency	Temp.	Condu-ctivity	pH	Nitrate	Nitrite	Amm-onia	Phosph-ate	Lead	Zinc	Iron	Cadmium
BOD	1.0000												
Transparency	-0.1263 0.0640	1.0000											
Temperature	0.2133* 0.0016	-0.2425* 0.0003	1.0000										
Conductivity	-0.0302 0.6593	0.1215 0.0748	-0.0394 0.5647	1.0000									
pH	-0.0466 0.4961	0.2332* 0.0005	-0.1384* 0.0421	0.1118 0.1012	1.0000								
Nitrate	-0.0357 0.6017	0.1875* 0.0057	-0.0664 0.3311	0.0229 0.7379	0.0629 0.3578	1.0000							
Nitrite	-0.0072 0.9160	-0.0257 0.7072	0.0368 0.5909	-0.0491 0.4729	-0.0174 0.7998	0.0570 0.4048	1.0000						
Ammonia	0.0096 0.8883	-0.0681 0.3194	-0.0256 0.7083	-0.0498 0.4668	-0.0544 0.4267	0.0305 0.6559	-0.1349* 0.0477	1.0000					
Phosphate	-0.0245 0.7206	0.0483 0.4797	-0.0181 0.7910	-0.0610 0.3726	-0.0537 0.4319	-0.0566 0.4081	-0.2784* 0.0000	-0.0514 0.4525	1.0000				
Lead	0.0049 0.9429	0.3625* 0.0000	0.0537 0.4319	0.1321 0.0525	-0.0339 0.6205	0.1460* 0.0320	0.0753 0.2705	-0.0402 0.5569	0.0468 0.4942	1.0000			
Zinc	-0.1220 0.0736	-0.2729* 0.0000	0.0652 0.3402	-0.0985 0.1491	-0.0844 0.2167	-0.0701 0.3054	-0.0630 0.3572	0.0640 0.3494	0.0325 0.6352	-0.1642* 0.0157	1.0000		
Iron	0.0165 0.8093	0.0975 0.1534	0.0788 0.2486	0.3305* 0.0000	0.0040 0.9539	0.0243 0.7226	0.1735* 0.0107	-0.1005 0.1411	-0.0246 0.7196	0.4574* 0.0000	-0.0386 0.5721	1.0000	
Cadmium	-0.0552 0.4194	-0.0607 0.3747	0.0328 0.6318	0.1445* 0.0337	-0.0623 0.3621	0.0656 0.3371	-0.0639 0.3497	0.0547 0.4235	0.0750 0.2723	-0.0488 0.4751	-0.1324 0.0521	0.1221 0.0733	1.0000

Table 3: Pearson correlation matrix of water quality parameters and fish abundance

Water parameters	Fish abundance
DO (mg/l)	0.315
BOD(mg/l)	0.448
Transparency (m)	0.176
Temperature (^{o}C)	-0.267
Conductivity (µScm^{-1})	0.468
pH	-0.001
Nitrate(mg/l)	0.054
Nitrite(mg/l)	-0.274
Ammonia(mg/l)	0.013
Phosphate(mg/l)	0.039
Lead(mg/l)	0.279
Zinc(mg/l)	0.430
Iron (mg/l)	0.523
Cadmium (mg/l)	0.350

From the CCA diagram in Figure 3, the longer the vector, the greater the influence of water parameters on species distribution. Moreover, the closer any species is to either the vector or to other species, the stronger their relationship. The relative position along the vector indicates the type of effect. Transparency was found to be the most important parameter affecting the distribution of *Mormyrus rume* (MOMYRUM), *Raimas senegalensis* (RAIMSEN), *Schilbe mystus* (SCHMYT), *Sarotherodon melanotheron* (SAROMEL) and *Tilapia marie* (TILAMAR). However, these did not show any significant correlation. *Parachanna obscura (PARAOBS) and Clarias gariepinus (CLARGAR)* showed very little correlation with DO. None of the fish species was strongly influenced by conductivity. Overall, the distribution of most fish species recorded in the Erelu Lake was influenced by DO, BOD, and transparency, but the correlations were inversed with temperature, nitrite and pH.

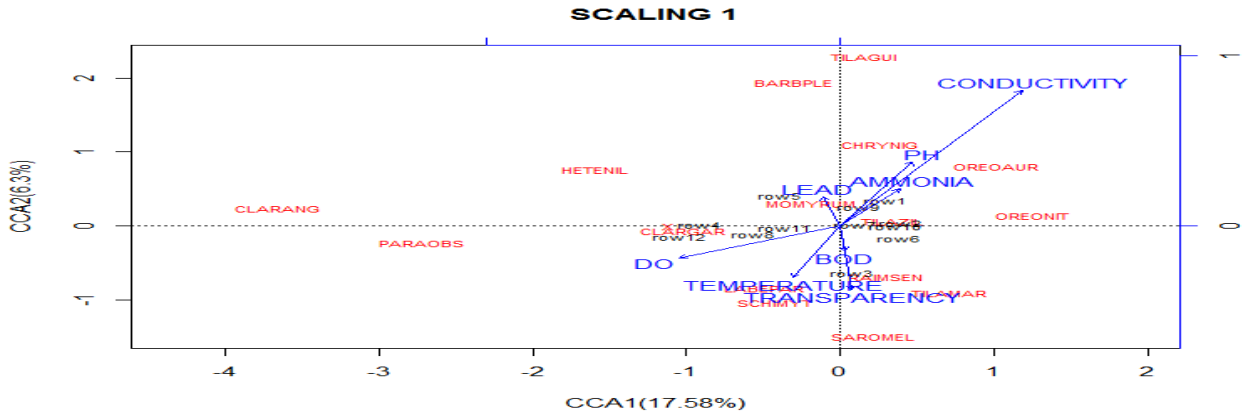

Figure 3: Ordination diagram from the canonical correspondence analysis (CCA) of fish species and environmental parameters.

DISCUSSION

The fish composition and distribution of Erelu Reservoir compared favourably with other similar man-made reservoirs as reported by Balogun (2005) in Kangimi Reservoir, Fapohunda and Godstate (2007) in Egbe Reservoir and Mustapha (2009) in Oyun Reservoir, all in Southwestern Nigeria. The dominance of the members of the family Cichildae in Erelu reservoir was in accordance with Oso and Fagbuaro (2004), Balogun (2005) and Mustapha (2009). The quality of an aquatic ecosystem is dependent on the physical and chemical qualities of water (Ajani, 2000). The range and means of physico-chemical parameters recorded during the period of study could be considered as being within the standard limit recommended for aquatic life survival (Boyd, 1998). Results of variations in all the physical and chemical characteristics of water in Erelu Lake revealed some of the significant ecological tendencies of the lake system. Dissolved oxygen is found to be a maximum of 8.95 mg/L and a minimum of 4.86 mg/L in the Lake. Its mean concentration is above 5 mg/L, which is adequate enough to support aquatic life (Boyd, 1998). This could be attributed to low organic enrichment as emphasized by Ikenweiwe and Otubusin, (2005) and Idowu *et al.,* (2013). The concentration of dissolved oxygen recorded were similar to the range observed in other reservoirs such as Awba (Yakubu, 2004), Oyan (Ikenweiwe and Otubusin, 2005), Moro (Mustapha, 2006) and Oyun (Mustapha, 2009). However, Edward *et al.,* (2014) reported higher values of DO that ranged from 5.10 – 11.24mg/L in Ureje reservoir, Ado Ekiti. Dissolved oxygen is inversely related to water temperature (Ali, 1999) and consequently affects the solubility and availability of nutrients (Lawson, 2011). This was reflected in the strong positive correlation between DO and fish abundance. BOD is a basic index to test for organic pollution in a reservoir or lake. Ovie *et al.,* (2011) observed that the concentration of organic substances in water and their capacity to taking oxygen from water are evaluated by means of biochemical oxygen demand (BOD). The mean BOD value of 2.54±0.33mg/L obtained during this study falls within the recommended limits of <10mg/L set by Boyd (1998). BOD has a strong significant correlation with temperature and fish abundance.

Transparency is a characteristic of water that varies with the combined effect of colour and turbidity. The mean range of secchi disc transparency of 0.50m and 2.80m reflects the depth of light penetration and could probably explain why fish diversity was high in the reservoir. A range of 0.3m to 0.6m secchi disc visibility has been given by Boyd (1979) as adequate for fish production. The mean value of transparency recorded in Lake Erelu compared favourably with the findings of Mustapha (2009) in Oyun (1.62m) and Mustapha (2003) in Moro lake (0.95 m). Lind (2003) observed that a change in light regime may shift the relative abundance of species, hence, the positive correlation with fish abundance. The surface water temperature which varied from 23.3°C to 27.4°C was within the acceptable levels for survival, metabolism and physiology of aquatic organisms (Boyd, 1979). The result also agrees with the findings of Adebisi (1981) in Upper Ogun river, Ikenweiwe and Otubusin (2005) in Oyan lake and Idowu and Ugwumba (2005) in Eleyele reservoir. The fluctuation in water temperature of the lakes according to Toma (2013) depends mainly on the climatic conditions, sampling times, the number of sun-shine hours and is also affected by specific characteristics of water environment such as turbidity, wind force, plant cover and humidity **(**Mahmoud, 2002). The negative correlation found

between fish abundance and temperature revealed that increasing temperature affects fish abundance.

The highest conductivity value of 190µS/cm recorded is within the medium range of 50 - 1500 μScm^{-1}, which according to Egborge (1970) is synonymous with high nutrient content. This observation is corroborated by Stone *et al.*, (2013) who stated that freshwater fish generally thrive over a wide range of electrical conductivity. The medium to high level of conductivity in an area could be ascribed to use of agrochemical as asserted by (Oladimeji and Wade, 1984).The mean conductivity result obtained in this study agrees with the findings of Mustapha (2009) who reported mean conductivity value that ranged from 80.40 – 178.80µS/cm in Oyun reservoir, Offa. However, this result contradicts the findings of Ovie *et al.*, (2011) who conducted preliminary study on limnological stock assessment, productivity and potential fish yield of Omi Dam, Nigeria. The authors found higher mean conductivity value of 229.43µS/cm. pH indicates the alkalinity or acidity of a solution on a scale of 1-14 and it affects many chemical and biological processes in water (Vyas and Bhawsar, 2013). The mean pH value of the lake is adequate for fish production and within the range for inland waters (6.5–8.5), as reported by **(**Boyd, 1998**)**. The lake like other tropical lakes could be described as having water of neutral pH with slight fluctuation to alkaline conditions (Ugwumba, 1990; Idowu and Ugwumba, 2005). This could be attributed to higher water volume, with greater water retention, low decomposition and good buffering capacity of total alkalinity (Mustapha, 2009). The negative correlation of fish abundance with pH is indicated that fish abundance is not influenced by change in pH.

Nitrate and Nitrite is nitrogenous waste product found in water though relatively non-toxic to fish and is not of health hazard except at exceedingly high levels (Boyd, 1998). The range and mean of nitrate observed in this study (0.46–0.85 mg/L; 0.67 mg/L ± 0.06) falls within the optimum range (0.1-3mg/L) suitable for fish production and domestic use as recommended by Boyd (1998). Nitrate was positively correlated with fish abundance in Erelu Lake which shows good nutrient load for use however, nitrite, which is a toxic constituent, exhibited negative correlation. The ammonia and phosphate level found in Erelu Lake during the study period fell with WHO/FEPA and Boyd (1998) range for productive freshwater. The significant influences of ammonia and phosphate on productivity variables confirmed their vital roles in ecosystems processes. The positive correlation between heavy metal and fish abundance indicate that fish thrive well with optimal heavy metals level as present in Erelu Lake. Balogun (2005) also reported positive correlation between fish abundance and heavy metals. Similar observations were made by Muyodi *et al*, (2011) and Lawson (2011) on Lake Victoria and Lagos lagoon, respectively. The distribution of most fish species recorded in the Erelu Lake was influenced by DO, BOD, and transparency, but the correlations were inversed with temperature, nitrite and pH. However, the contribution of all the vectors studied to fish abundance was estimated as 53.68% from the eigene and inertia values calculated. This observation is further supported by the report of terBraak and Verdonschot (1995) that 50.00% eigene value is satisfactory for balanced aquatic ecosystem productivity.

CONCLUSION

The study revealed that all the investigated physico-chemical parameters were within the safe limit for fish production. Also, the physico-chemical

parameters were noticed to significantly correlate with the fish abundance which indicates that the physico-chemistry of the Erelu Lake could affect fish fauna production. Hence, distribution and abundance of fish species in Erelu Lake depend mainly on the series of complex interactions between components of the environment which are seasonally induced. It is recommended that proper management measures should be put in place to ensure good water quality and rich biodiversity for sustainable fisheries development.

REFERENCES

Adebisi, A. A. 1981. The physico-chemical properties and hydrology of a tropical seasonal River- upper Ogun River, *Hydrobiologia 79: 157-165*.

Adeyemi, S. O., Bankole, N. O., Adikwu, I.A. and Akombu, P. M. 2009. Age, growth and mortality of some commercially important fish species in Gbedikere Lake, Kogi State Nigeria. *International Journal of Lakes and Rivers, 2(1): 63 – 69.*

Ajani, E. K. 2000. Effects of biotic and abiotic components of the habitat on fish productivity in Lagos, Nigeria. Ph.D Thesis. University of Ibadan. 260pp.

Akaahan T. J. A., Araoye P. A. and Azua E. T. 2015. Phyisco-Chemical Characteristics and Macro Invertebrates of River Benue at Makirdi, Benue State, Nigeria. *International Research Journal of Education and Innovation (IRJEI) 1 (4): 43 – 54.*

Ali, S.S. 1999. *Freshwater fishery biology*. Naseem Book Depot, Hyderabad, 108-114.

Ali, S. S., Salam, A., Azeem, A., Shafique, M. and Khan, B. A., 2000. Studies on the effect of seasonal variations on physical and chemical characteristics of mixed water from Rivers Ravi and Chenab at union site in Pakistan. *J. Res. B. Z. Univ.Multan,* 2: 1 17

APHA, 1998. *Standard Methods for the Examination of Water and Wastewater*. 20th Edition.,

American Public Health Association, Washington, DC., USA., pp: 1-541.

Balogun, J. K. 2005. Fish distribution in a small domestic water supply reservoir: A case study of Kangimi Reservoir, Nigeria. *Journal of Applied Science and Environmental Management Vol. 9 (1): 93-97.*

Boyd, C.E. 1979. *Water quality in warm water fish ponds*. Craftmaster Printers Inc. Auburn,

Alabama, USA. 353 pp.

Boyd, C. E., 1998. *Water Quality for Pond Aquaculture*. Research and Development Series No. 43. International Center for Aquaculture and Aquatic Environments, Alabama. Agricultural Experiment Station, Auburn University Publisher, Alabama. 183pp.

Boyd C. E. and Tucker C. S. 1998. *Pond Aquaculture Water Quality Management*, Kluwer Academic Publishers, Boston, MA (1998) 700 p.

Dirican, S. 2015. Assessment of Water Quality Using Physico-chemical Parameters of Çamlıgöze Dam Lake in Sivas, Turkey. *Ecologia 5 (1): 1-7.*

Dudgeon, D., Arthington, A. H., Gessner, M. O., Kawabata, Z., Knowler, D. J., Le've‘que, C., Naiman, R. J., Prieur-Richard, A. H., Soto, D., Stiassny, M. L. J., Sullivan, C. A., 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Review 81: 163-182.*

Edward, J. B., Idowu, E. O., Oso, J. A., Kadri, M. I. 2014. Fish productivity of Ado-Ekiti water reservoir in relation to physicochemical characteristics and mopho-edaphic index. *International Journal of Multidisciplinary Research and Development 2014; 1(1): 11-17*

Egborge, A. B. M. 1970. The hydrology and plankton of the River Oshun, Western State, Nigeria. M.Sc Thesis. University of Ibadan, Ibadan, Nigeria. 126 pp.

Falaye,A. E., Ajani, E. K., Kareem, O. K. and Olanrewaju, A. N**.,** 2015: Assessment of Ichthyofaunal assemblage of Erelu Reservoir, Oyo, Nigeria. *Ecologia 5 (2): 43-53.*

Fapohunda, O.O. and Godstate, R., 2007. Biometry and composition of fish species in Owena Reservoir, Ondo State, Nigeria. *Journal of Central European Agriculture*. 8(1): 99-104

Fryer, G. 1973. The Lake Victoria Fisheries: Some facts and fallacies, *Biological Conservation*, vol. 5, pp. 305-308,.

Idodo-Umeh, G. 2003. ‘*’Fresh water fishes of Nigeria. Taxonomy, Ecological Notes, Diet and Utilization*’’, Idodo Umeh Publishers Limited, pp. 232

Idowu, E. O., and Ugwumba, A. A. A. 2005. Physical, chemical and benthic fauna characteristics of a southern Nigerian reservoir. *The Zoologist; 3:15-25.*

Idowu, E. O., Ugwumba, A. A. A., Edward, J. B. and Oso, J.A . 2013.Study of the Seasonal Variation in the Physico-Chemical Parameters of a Tropical Reservoir. *Greener Journal of Physical Sciences Vol. 3 (4), pp. 142-148*

Ikenweiwe, N. B. and Otubusin, S. O. 2005. An evaluation of the pelagic primary productivity and potential fish yield of Oyan Lake, Southern Nigeria. *The Zoologist*; 3:46-67.

Iroko, I. A. 2003. Effect of Erelu Water Dam on Livelihood Activities of Settlers in Atiba Local Government Area of Oyo State.An Unpublished Thesis in the Departmentof Agricultural Extension and Rural Development,University of Ibadan, Nigeria.

Lawson, E. O. 2011. Physico-Chemical Parameters and Heavy Metal Contents of Water from the Mangrove Swamps of Lagos Lagoon, Lagos, Nigeria. *Advances in Biological Research 5 (1): 08-21*

Lind, O. T. 2003. Suspended clay’s effect on lake and reservoir limnology. *Archiv für Hydrobiologie Supplement 139/3 pp327-360.*

Mahmoud, S. A. 2002. Evaluation of toxicity of some pollutant on histological and biochemical features of *Oreochromis niloticus* in River Nile. Ph.D. Thesis, Zagazig University, Zagazig.

Mustapha, M. K. 2009. Fish Fauna of Oyun Reservoir, Offa, Nigeria. *Journal of Aquatic Sciences.* Published by The Association of Aquatic Sciences of Nigeria, University of Jos.

Mustapha, M. K., 2006. Effects of human activities on the biodiversity of a tropical man-madelake. *Nigerian Journal of Pure and Applied Sciences Vol 21: 1960-1968*

Mustapha, M. K. and Omotosho, J. S. 2006. Hydrobiological studies of Moro Lake. *Nigerian Journal of Pure and Applied Sciences. Vol. 21: 1948-1954.*

Mustapha, M.K. 2003. A Pre-impoundment study of the limno-chemical conditions of Oyun Lake in Ilorin, Kwara State, Nigeria. *African Journal of Applied Zoology and Environmental Biology Vol. 5: 44-48.*

Muyodi, F. J., Mwanuzi, F. L. and Kapiyo, R. 2011. Environmental Quality and Fish Communities in Selected Catchments of Lake Victoria. *The Open Environmental Engineering Journal, 4,* 54-65

Oladimeji, A. A. and Wade, J.W. 1984. Effects of Effluents from the sewage treatment plant on the aquatic organisms. *Soil, Air and Water pollution. 23:309-315.*

Olaosebikan, B. D. and Raji, A. 2013. *Field guide to Nigerian freshwater fishes*. Federal College of Freshwater Fisheries Technology, New Bussa, Niger State, Nigeria. Revised edition. 144pp.

Oso, J. A, Fagbuaro, O. 2004. Fish fauna of Ero Reservoir, Ekiti State, South-Western Nigeria. *Journal of Biological and Physical Sciences. 3: 20-23.*

Ovie, S. I., Bwala, R. L. and Ajayi, O. 2011. A preliminary study on limnological stock assessment, productivity and potential fish yield of Omi Dam, Nigeria. *African Journal of Environmental Science and Technology Vol. 5(11), pp. 956-963.*

Stone. N., Shelton, J. L., Haggard, B. E. and Thomforde, H. K., 2013."Interpretation of water analysis reports for fish culture," SRAC Publication no. 4606, Southern Regional Aquaculture Centre (SRAC).

Toma, J. J. 2013. Limnological study of Dokan, Derbendikhan and Duhok lakes, Kurdistan region of Iraq. *Open Journal of Ecology 3 (2013) 23-29*

terBraak, C. J. F. and Verdonschot, P. F. M. 1995. Canonical correspondence analysis and related multivariate methods in aquatic ecology. *Aquatic SciencesVolume 57, Issue 3, pp 255-289*

Ugwumba, A. A A. 1990. Food and feeding ecology of *Oreochromis niloticus*, *Sarotherodon melanotheron* and *Heterotis niloticus* (Pisces: Osteichchytes) in Awba Reservoir, Ibadan, (Ph.D Thesis). University of Ibadan, 395pp.

Vyas, V. and Bhawsar, A. 2013. Benthic community structure in Barna stream network of Naramada river basin. *International Journal of Environmental Biology 3(2): 57-63.*

Yakubu, A. S. 2004. Assessment of water quality and plankton of effluent receiving lower Awba stream and reservoir Ibadan. *African Journal of Applied Zoology and Environmental Biology Vol. 6: 86-94.0*