International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:10, No:5, 2016

Fish Diversity of Two Lacustrine Wetlands of the Upper Benue Basin, Nigeria

D. L. David, J. A. Wahedi, Q. T. Zaku

Abstract**—**A study was conducted at River Mayo Ranewo and River Lau, Taraba State Nigeria. The two rivers empty into the Upper Benue Basin. A survey of visual encounter was conducted within the two wetlands from June to August, 2014. The fish record was based entirely on landings of fishermen, number of canoes that land fish was counted, types of nets and baits used on each sampling day. Fishes were sorted into taxonomic groups, identified to family/ species level, counted and weighed in groups by species. Other aquatic organisms captured by the fishermen were scallops, turtles and frogs. The relative species abundance was determined by dividing the number of species from a site by the total number of species from all tributaries/sites. The fish were preserved in 2% formaldehyde solution and taken to the laboratory, were identified through keys of identification to African fishes and field guides. Shannon-Wieiner index of species diversity indicated that the diversity was highest at River Mayo Ranewo than River Lau. Results showed that at River Mayo Ranewo, the family Mochokidae recorded the highest (23.15%), followed by Mormyridae (22.64%) and the least was the family Lepidosirenidae (0.04%). While at River Lau, the family Mochokidae recorded the highest occurrence of (24.1%), followed by Bagridae (20.20%), and then Mormyridae, which also was the second highest in River Lau, with 18.46% occurrence. There was no occurrence of Malapteruridae and Osteoglossidae (0%) in River Lau, but the least occurrence was the family Gymnarchidae (0.04%). According to the result from the t-test, the fish composition was not significantly different ($p \leq 0.05$).

Keywords**—**Diversity Index, Lau, Mayo Ranewo, Wetlands.

I. Introduction

SPECIES richness and relative species abundance describe key elements of diversity. Biodiversity is a measure of the numbers of species that make up a biologic community and is considered to be one of the most important aspects of community organization and structure. Species richness is the number of different species in a given area and is the fundamental unit in which to assess the homogeneity of an environment and is commonly used in conservation studies to determine the sensitivity of ecosystems and their resident species, while relative species abundance describes how common or rare a species is relative to other species in a given community and are usually described for a single trophic level [1].

D. L. David is with the Department of Biological Sciences, Taraba State University Jalingo, Nigeria (phone: +234 766 267 678; e-mail: delphinedavid64@gmail.com)
J. A. Wahedi is with the Department of Biological Sciences, Adamawa State University Mubi, Nigeria (e-mail: wajasini@yahoo.com)
Q. T. Zaku was with the Department of Biological Sciences, Adamawa State University Mubi, Nigeria (e-mail: queenzaku@yahoo.com)

Estimating the true number of species in an area, 'S', usually called species richness by ecologists, is one of the basic statistics used to ascertain biological diversity. To estimate species richness, one would naturally consider the observed count of species, S_0, from a given sample. However, it is clear that S_0 is a lower bound for the true number of species. For S_0 to accurately estimate S, the researcher must actually observe every species. If the researcher can only sample a few plots from the area, then S_0 is likely to be smaller than S. Even if a census of the area is done it is likely that some species will be missed because of human error, environmental fluctuations that affect observations, or very small species detection probabilities [2].

According to [3], species richness, evenness, and diversity are all used in the study of biology and can be used to compare different populations. Species richness is simply the number of species present in an area. Species evenness refers to the proportion that each species comprises of the whole. The Shannon-Wieiner species evenness Diversity Index is calculated by taking the number of each species, the proportion each species is of the total number of individuals, and sums the proportion times the natural log of the proportion for each species. Since this is a negative number, we then take the negative of the negative of this sum. The higher the number, the higher is the species diversity. In an ideal situation, one should compare populations that are of the same size in the numbers of individuals.

The formula is as:

$$H' = -\sum_{i=1}^{s} \text{pi In pi}$$

where H` is the species diversity index, s is the number of species, and pi is the proportion of individual, of each species belonging to the ith species of the total number of individuals.

According to [4], species diversity of fishes is measured by:

$$\text{Species Diversity} = \frac{\text{Number of species}}{\sqrt{\text{Total Number of individuals}}} \text{ x } 100$$

Tarabastate is characterized by abundant surface water which includes ponds and rivers, which includes rivers Benue, Taraba and Donga and their tributaries. The state has about 500,000 hectares of water body and 142 natural ponds. Therefore, the rural communities in the State especially those along the river Benue use fishery as an important local resources [5]. The high surface water resource makes fishing the second most important human economic activity after crop farming in Taraba State. The types of fish caught in these

rivers include Tilapia (*Oreochromis niloticus*), Mudfish (*Clarias anguillaris*), Nile perch (*Lates niloticus*), Silver catfish (*Bagrusbayad*), Silverside (*Alestes macroleptilotus*), Butter fish (*Schilbemystus*), Tiger fish (*Hydrocynus forskahlii*), Catfish (*Synodontis nigrita*), Osteoglosid (*Heterotis niloticus*), Sailfins (*Polypterus senegalus*), Electric fish (*Malapterurus electricus*), African lungfish (*Protopterus annectens*), Trunkfish *(Mormyrus rume*) [5].

The biodiversity and conservation of fish in the aquatic ecosystem have attracted the attentions of various workers [6]-[8].

The East African Great Lakes (Victoria, Malawi and Janganyika) are the centre of biodiversity of many fish, especially cichlids (they harbor more than two-thirds of the estimated 2000 species in the family) [9]. The West African coastal rivers region covers only a fraction of West Africa, but harbors 322 of West African's fish species, with 247 restricted to this area and 129 restricted even to smaller ranges. The central rivers fauna comprises 194 fish species with 119 endemics and only 33 restricted to small areas [10].

At 32,000 species, fish exhibit greater species diversity than any other group of vertebrates [11]. Mbinkar [12], recorded 64 species of fish belonging to 18 families at Kiri and Gyawana Lakes in Adamawa State Upper Benue Basin of Nigeria. 48 species of fish belonging to 13 families and 45 species of fish belonging to 16 families were caught in Kiri Lake during 2004/2005 respectively, 36 species belonging to 16 families and 28 from 15 families were identified in Gyawana Lake. Emmanuel and Modupe [1] conducted a study to determine fish species diversity in Igbesa, Itele and Iba tributaries of River Ore in South West Nigeria. The fish composition comprised 11 species from 10 families and 10 genera. A total of 103, 111 and 96 individuals were caught from Igbesa, Itele and Iba stations respectively. The fish diversity ranged from typically freshwater fishes such as *Tilapia* and *Clarias* to brackish species such as *Chrysichthys nigrodigitatus.* The most abundant group of fish was the Clariids. The dominant species, *Clarias gariepinus* consisted of 32.26% of the population, *Heterotis niloticus,* a rare and least abundant species was 0.32%. Fingerlings, juveniles and sub-adults were among the catch, smallest being *Tilapia mariae,* while the largest was *Heterotis niloticus.* The indices of diversity included (d)=0.155, 0.257 and 0.196; H=2.015, 1.899 and 1.896; and E=0.740, 0.659 and 0.600 respectively for tributaries at Igbesa, Itele and Iba. Estimates from these indices were indication of low fish species composition and richness and unevenness in the population of fish in River Ore. Odo et al. [13], estimated 52 fish species belonging to 17 families from Anambra River, Nigeria. Soyinka et al. [14], gave a report on seasonal distribution and richness of fish species in the Badagry Lagoon, South West Nigeria, 37 species distributed among 21 families of fish were reportedly caught from the lagoon.

There is no available record on the fish species diversity and composition of these two wetlands, which drains directly and empties into the upper Benue Basin. For sustainability of this resource, knowledge of species diversity and relative abundance of her water bodies must be understood and pursued. It is a bid to contribute to filling some of these gaps in knowledge that the study being proposed here was conceived.

II. Materials and Methods

River Mayo Ranewo lies in latitude 8°47' to 8°53'N and 10°55'E to 10°55'E. It is a source of water to people in the settlement which is covered by short grasses (Sub-sudan vegetation). Fishing is the major occupation of people living in Mayo Ranewo, but they also engage in activities like farming, knitting nets and knitting mats.

River Lau lies in latitude 8°56'N to 9°40'N and longitude 11°5'E to 11°4'E having a total land mass of 1,700km^2. The area is covered by short grasses. The river is known for good supply and abundance of fish. The occupation of inhabitants is mainly fishing and farming [5].

III. Methods/ Data Collection Techniques

Fish composition was determined by visual survey at landings of fishermen at River Mayo Ranewo and River Lau. Survey and accountability on each sampling day was conducted between June and August 2014 at the two wetlands. The numbers of canoes that land fish were counted, and the type of nets used by fishermen was recorded. Fish were sorted into taxonomic groups, identified to family species level, counted and weighed in groups by species.

In the laboratory, the fish were preserved in 2% formaldehyde solution. The identification of species was carried out by using field guides to Nigerian fresh water fishes [15], and illustrated key as, West African Fresh Water Fish [16], Fish and Fisheries of Northern Nigeria [17], and the illustrated key to the fishes of lake Kainji [18].

IV. Statistical Analysis

The species and number of individuals were recorded to calculate the species diversity and abundance at each river site. Shannon-Wieiner index and evenness index was used to evaluate species diversity [19].

V. Results

About 2791 species of fish was collected from River Mayo Ranewo during the period of the study. The family Mochokidae recorded the highest 646 (23.15%), followed by Mormyridae 632 (22.64%). Elsewhere, Schilbeidae recorded about 481 (17.23%), Bagridae 365 (13.08%), Cyprinidae 212 (7.60%), Clariidae 151 (5.41%), and Characidae 149 (5.34%). Few species of Gymnarchidae and Osteoglossidae 4 (0.14%) each, Malapteruridae and Channidae 3 (0.11% each) were also recorded. The family Lepidosirenidae recorded the least value of 1 (0.04%), as shown in Table I.

In River Lau, the total number of fish species collected was 2253. Similar trend was seen for the family Mochokidae where it recorded the highest occurrence of 543 (24.1%), followed by Bagridae 455 (20.20%), and then Mormyridae, with about 416 (18.46%) occurrence. There was no occurrence

of Malapteruridae and Osteoglossidae (0%) in River Lau. But the least occurrence was the family Gymnarchidae 1 (0.04%), as shown also in Table I.

TABLE I
SPECIES COMPOSITION AND ABUNDANCE OF FISH FROM RIVER MAYO RANEWO AND RIVER LAU

Family	No. of Species in River M/Ranewo	%Occurrence	No. of Species in River Lau	%Occurrence
Bagridae	365	13.08	455	20.20
Clariidae	151	5.41	86	3.82
Cyprinidae	212	7.60	170	7.55
Characidae	149	5.34	87	3.86
Citharinidae	16	0.57	13	0.58
Channidae	3	0.11	2	0.09
Cichlidae	106	3.80	62	2.75
Distichodontidae	18	0.64	3	0.13
Gymnarchidae	4	0.14	1	0.04
Lepidosirenidae	1	0.04	3	0.13
Malapteruridae	3	0.11	0	0.00
Mochokidae	646	23.15	543	24.10
Mormyridae	632	22.64	416	18.46
Osteoglossidae	4	0.14	0	0.00
Schilbeidae	481	17.23	412	18.29
TOTAL	**2791**	**100.00**	**2253**	**100.00**

A total of 5,044 species of fish was collected from the two wetlands (River Mayo Ranewo and River Lau). River Mayo Ranewo had the highest number of specimens, occurrence with about 2,791 (55.33%), while River Lau had about 2,253 (44.67%). The family Mochokidae had the highest occurrence in both wetlands (646 and 543 for River Mayo Ranewo and River Lau respectively). Although, there were few species of Malapteruridae (3), and Osteoglossidae (4) in River Mayo-Ranewo, none of the two species occurred in River Lau (0) as shown in Fig. 1.

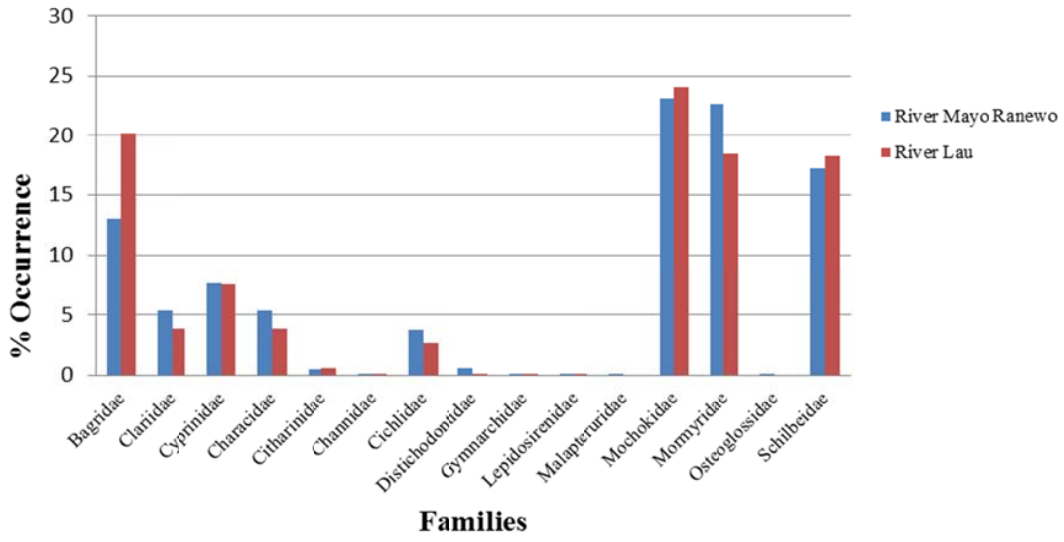

Fig. 1 Comparison of Fish Species Abundance according to Their Families in River Mayo Ranewo and River Lau

The comparison of the fish species occurrence in the two rivers showed a significant higher occurrence in River Mayo Ranewo than River Lau as indicated in Fig. 1. Mochokidae occurred highest in the two rivers, and Mormyridae also showed a significant occurrence in the two rivers, but Malapteruridae and Osteoglossidae occurred only in River Mayo Ranewo (Fig. 1).

The diversity index of fish species from River Mayo Ranewo and River Lau indicated a higher diversity of fish species in River Mayo Ranewo than River Lau. Although the number appeared in negative, the higher the number of species and their evenness, the higher the diversity as shown in Table II.

TABLE II
DIVERSITY INDEX OF THE FISH SPECIES FROM RIVER MAYO RANEWO AND RIVER LAU

	RIVER MAYO RANEWO				RIVER LAU			
SPECIES	**Number**	**Pi**	**InPi**	**PiInPi**	**Number**	**Pi**	**InPi**	**PiInPi**
Clarias garienpinus	101	0.0375	-1.4259	-1.3884	65	0.0288	-1.5406	-1.5118
Clarias anguillaris	26	0.0096	-2.0177	-2.0081	17	0.0075	-2.1249	-2.1174
Heterobranchus bidorsalis	24	0.0089	-2.0506	-2.0417	4	0.0017	-2.7695	-2.7678
Bagrus bayad	114	0.0423	-1.3736	-1.3313	136	0.0603	-1.2196	-1.1593
Bagrus docmac	30	0.0111	-1.9546	-1.9435	53	0.0235	-1.6289	-1.6054
Clarotes laticeps	49	0.0182	-1.7399	-1.7217	96	0.0426	-1.3705	-1.3279
Auchenoglanis biscutatus	102	0.0379	-1.4213	-1.3834	73	0.0324	-1.4894	-1.457
Auchenoglanis occidentalis	14	0.0052	-2.2839	-2.2787	0	0.00	0.00	0.00
Clarotes macrocephalus	0	0.00	0.00	0.00	1	0.0004	-3.3979	-3.3975
Chrysichthys longifilis	39	0.0144	-1.8416	-1.8272	61	0.0027	2.5686-	-2.5659
Chrysichthys nigrodigitatus	17	0.0063	-2.2006	-2.1943	35	0.0155	-1.8096	-1.7941
Gymnarchus niloticus	4	0.0014	-2.8538	-2.8524	1	0.0004	-3.3979	-3.3975
Schilbe mystus	215	0.0798	-1.0979	-1.0181	158	0.0701	-1.1542	-1.0841
Silaurido nauritus	249	0.0925	-1.0338	-0.9413	254	0.01127	-0.9480	-0.8353
Physallia pellucida	13	0.0048	-2.3187	-2.319	0	0.00	0.00	0.00
Eutropius niloticus	4	0.0014	-2.8538	-2.8524	0	0.00	0.00	0.00
Labeo senegalensis	178	0.0661	-1.1797	-1.1136	165	0.0732	-1.1354	-1.0622
Labeo coubie	34	0.0126	-1.8996	-1.887	5	0.0022	-2.6575	-2.6553
Alestes nurse	85	0.0315	-1.5016	-1.4701	38	0.0168	-1.7746	-1.7578
Alestes baremose	42	0.0156	-1.8068	-1.7912	45	0.0199	-1.7011	-1.6812
Hydrocynus forskahlii	22	0.0081	-2.0915	-2.0834	4	0.0017	-2.7695	-2.7678
Heterotis niloticus	4	0.0014	-2.8538	-2.8524	0	0.00	0.00	0.00
Malapterurus electricus	3	0.0011	-2.9586	-2.9575	0	0.00	0.00	0.00
Citharinus citherus	16	0.0059	-2.2291	-2.2232	13	0.0057	-2.2441	-2.2384
Channa obscura	3	0.0011	-2.9586	-2.9575	2	0.0008	-3.0969	-3.0961
Distichodontus rostratus	118	0.0438	-1.3585	-1.3147	3	0.0013	-2.8860	-2.8847
Mormyrus rume	228	0.0847	-1.0721	-0.9874	115	0.00510	-1.2924	-1.2414
Hyperopisus bebe	53	0.0196	-1.7077	-1.6881	48	0.0213	-1.6716	-1.6503
Mormyrups deliciosus	14	0.0052	-2.2839	-2.2787	8	0.00035	-2.4559	-2.4524
Mormyrus macrophthalmus	102	0.0379	-1.4213	-1.3834	81	0.0359	-1.4449	-1.409
Gnathonemus thamandua	21	0.0078	-2.1079	-2.1001	16	0.0071	-2.1487	-2.1416
Marcuseniusa badii	98	0.0364	-1.4388	-1.4024	76	0.0337	-1.4723	-1.4386
Petrocephalus bane	111	0.0412	-1.3851	-1.3439	72	0.0319	-1.4962	-1.4643
Marcusenius psittacus	5	0.0018	-2.7447	-2.7429	0	0.00	0.00	0.00
Protopterus annecterus	1	0.0003	-2.5228	-2.5225	3	0.0013	-2.8860	-2.8847
Tillapi azilli	40	0.0148	-1.8297	-1.8151	16	0.0071	-2.1487	-2.8847
Tillapia dageti	10	0.0037	-2.4317	-2.428	7	0.0031	-2.5086	-2.5055
Tillapia galilee	14	0.0052	-2.2839	-2.2787	20	0.0088	-2.0555	-2.0467
Hemichromis fasciatus	8	0.0029	-2.5376	-2.5347	4	0.0017	-2.7695	-2.7678
Oreochromis niloticus	34	0.0126	-1.8996	-1.887	14	0.0062	-2.2076	-2.2014
Tillapia membrenaceus	0	0.00	0.00	0.00	1	0.0004	-3.3979	-3.3975
Synodontis clarias	131	0.0486	-1.3133	-1.3619	44	0.0195	-1.7099	-1.6904
Synodontis eureptus	0	0.00	0.00	0.00	11	0.0048	-2.3187	-2.3139
Synodontis filamentous	18	0.0066	-2.1804	-2.187	0	0.00	0.00	0.00
Synodontis gabroni	0	0.00	0.00	0.00	1	0.0004	-3.3979	-3.3975
Synodontis gambiensis	284	0.1055	-0.9767	-0.8712	399	0.1770	-0.7520	-0.575
Synodontis membranaceus	47	0.0174	-1.7594	-1.7768	16	0.0071	-2.1487	-2.1416
Synodontis nigrita	0	0.00	0.00	0.00	2	0.0008	-3.0969	-3.0961
Synodontis schall	66	0.0245	-1.6108	-1.6353	70	0.0310	-1.5086	-1.4776
TOTAL	**2791**	**1.0393**		**83.9772**	**2253**	**0.9738**		**88.3425**

Note: $H^1 = 83.9772$; $H^2 = 88.3425$; $N^1 = 2791$; $N^2 = 2253$Var $(H^1) = 5083.6$Var $(H^2) = 5847.66$

VI. DISCUSSION

From the result, fish species diversity comprised of 44 species in 15 families at River Mayo Ranewo and 42 species in 15 families at River Lau. This species abundance and composition of fish showed a relatively higher species richness and evenness in River Mayo Ranewo compared to River Lau. Generally, the species abundance and composition of the fish from the two lacustrine wetlands showed a

relatively higher species richness and evenness when compared to some research made in other parts of Nigeria. Emmanuel and Modupe [1], presented 310 individuals comprising of 10 families and 11 species of fish present at River Ore in Ogun State, located at South West, Nigeria. Findings from the Badagry, Lagoon. Soyinka et al. [14], gave a report on seasonal distribution and richness of fish species in South West, Nigeria, 37 species were distributed among 21 families of fish caught from the Lagoon. However, this study showed relatively low species richness when compared with [13], which reported an estimate of 52 fish species belonging to 17 families from Anambra River, Nigeria. Mbinkar [12] compared the diversity of two lakes in the Upper Benue Basin, Adamawa State, Nigeria, where the author recorded 57 species in 16 families at Kiri Lake and 40 species in 16 fish families at Gyawana Lake. However, given the relative abundance of each species among the two rivers, the family Mochokidae has the highest abundance and the second most abundant was the Bagridae. The least abundannce of fish were the families Gymnarchidae and Lepidosirenidae. Smith and Pontius [2] assumed that abundance of a given species has a poisson distribution, and that catchment volume is a significant richness of fish assemblages in Wetlands.

The diversity index of fish species from the two rivers indicated a higher diversity of fish species in River Mayo Ranewo than River Lau. This could be influenced by the disturbances visibly seen such as catchment, local fish harvest and the removal of water for domestic and commercial purposes coupled with the downstream migration of fish in search for food, shelter, spawning and farming activities around the River Lau.

VII. Conclusion

This study was aimed at knowing the fish species diversity and abundance at the two lacustrine wetlands of the Upper-Benue Basin Nigeria in Taraba State. The results showed that there were more species abundance in River Mayo Ranewo than River Lau, but were not significantly ($p \leq 0.05$) different based on t-test. The family Malapteruridae and Osteoglossidae were restricted to only River Mayo Ranewo but not in River Lau.

This study could serve as a baseline data in assisting relevant bodies in the management and conservation of fisheries resources of these water bodies. Observation suggests that government should take immediate action through public awareness and education to regulate fishing activities such that adequate numbers of fishermen should be licensed to fish in a particular water body, together with their gear and craft nets, and that the minimum mesh size regulation should be effectively enforced to minimize overfishing. Urbanization of farm activities within and around the water bodies to conserve the resources of our natural waters will ensure that most fish species are conserved.

Acknowledgment

The authors wish to acknowledge Mr. Bilyaminu Barau, Taraba State University, for the statistical analysis.

References

[1] L. O. Emmanuel and O.O. Modupe, Fish diversity in three tributaries of River Ore, South West, Nigeria. *World Journal of Fish and Marine Sciences*,2010, 2(6): 524-531. ISSN 2078-4589.

[2] C. D. Smith and J.S. Pontius, Jack Knife estimator of species richness with S-plus *Journal of Statistical Software*, 2006, Vol 15, Issue 3, Ppl-12.http://www.jstatsoft.org/.

[3] Nolan, K.A. and J.E. Callahan (2005). Beachcomber Biology: The Shannon-Wieiner Species Diversity Index. Pp 334-308. In: O'Donell, M.D (Ed.) *Tested Studies for Laboratory Teaching,* Volume 27. Proceedings of the 27th workshop/ conference of the Association for Biology Laboratory Education (ABLE).

[4] Bakawale, S. and R.R. Kanhere (2013). Study on the fish species diversity of the River Narmada in Western zone. *Research Journal of Animal, Veterinary and Fishery Sciences*, Vol. 1(6): 18-20. ISSN 2320-6535.

[5] Oruonye, E.D. (2014). The challenges of Fishery Resource Management Practices in Mayo Ranewo Community in Ardo Kola Government Area (LGA), Taraba State, Nigeria. *Global Journal of Science Frontier Research*: D Agriculture and Verterinary, Volume 14, Issue 3, Version 1.0: pp 14-24.

[6] Thiel, R., A. Sepulveda, R. Kafemann and W. Nellen (2006). Environmental factors as forces structuring the fish community of the Elbe estuary. *Journal of Fish Biology,* 46(1): 47-49.

[7] Waltham, N.J and R.M. Connolly (2007). Artificial waterway design affects fish assemblage in urban estuaries. *Journal of Fish Biology,* 71(6): 1613-1629.

[8] Jordan, S.J., M.A. Lewis, L.M. Harwell, and L.R. Goodman (2010). Summer fish communities in Northern Gulf of Mexico estuaries: Indices of ecological condition. *Ecological indicators,* 10(2): 504- 515.

[9] Farias, I.P. (2000) Total Evidence; Molecules, Morphology and the phylogeneticsof Cichlid Fish, *Journal of Experimental Zoology*, 288:76-92.

[10] Moritz, T. and K.E. Linsenmair (2001). West African fish diversity-distribution patterns and possible conclusions for conservation strategies *(In: Africa Biodiversity: Molecules, Organisms, Ecosystems, Springer, 2001).*

[11] Gheerbrant, E. and J.C. Rage (2006). Paleobiogeography of Africa: How distinct from Gondwana and Laurasia? *Palaeogeography, Palaeoclimatology, Palaeoecology,* Vol. 241.

[12] Mbinkar, D.L. (2007). *Evaluation of the conservation significance of two lacustrine wetlands of the Upper Benue basin, Nigeria.* Unpublished Ph.D. Thesis, Department of Biological Sciences, Ahmadu Bello University, Zaria. 215pp.

[13] Odo, G.E., N.C. Didigwu and J.E. Eyo (2009). The fish fauna of Anambra river basin, Nigeria: species abundance and morphometry. *Rev. Biol. Trop. (Int. Journal of Trop. Biol.,* 57(1-2): 177-186. ISSN-0034-7744.

[14] Soyinka, O.O., M.P. Kuton and C.I. Ayo-Olalusi (2010). Seasonal distribution and richness of species in the Badagry Lagoon, South-west, Nigeria. *Estonian Journal of Ecology.*, 59(2): 147-157.

[15] Olaosebikan, B.D. A. and Raji (1998). *Field guide to Nigerian Freshwater Fishes*. Decency Printers and Stationaries Ltd. 106pp.

[16] Holden, M. and W. Reed (1991). *West African freshwater fish*. Longman GroupLtd. UK. 68pp.

[17] Reed, W., J. Burchard, A.J. Hopson, J. Jenness and I. Yaro (1967). Fish and fisheries of Northern Nigeria. Published by the Ministry of Agriculture, Northern Nigeria. Printed by Gaskiya Corporation, Zaria, Northern Nigeria. 226pp.

[18] Lewis, D.S.C. (1974). *An illustrated key to the fishes of Lake Kainji.* ODA London. 106pp.

[19] Shannon, C.E. and W. Weiner (1963). *The Mathematical Theory of Communication*. U. Illinois, Urbana, Illinois. pp 117.