ISSN: 2347-5129
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.352
IJFAS 2015; 3(1): 410-414

www.fisheriesjournal.com
Received: 23-07-2015
Accepted: 22-08-2015

Dienye HE
Department of Fisheries,
University of Port
Harcourt.P.M.B.5323.

Correspondence
Dienye HE
Department of Fisheries,
University of Port
Harcourt.P.M.B.5323.

Species Diversity of Macrophytes of the New Calabar River, Niger Delta, Nigeria

Dienye HE

Abstract
Survey of macrophytes from the New Calabar River was conducted to quantify the species diversity. The macrophytes studies were conducted between December and May 2014 along the edge and in the middle of the River. Ten families of macrophyte were recorded representing 12 species. Cyperaceae had the highest species with three species while the remaining had one specie each. The result of this study showed that *Rhynchospora corymbosa* had the highest abundance (richness), followed by *C.difformis* while the species lowest abundance (richness) was *Eichhornia crassipes, Nymphaea lotus* was the lowest in evenness (distribution) followed by *Aneilema beniniense* and *Platostoma africana* having the same level of distribution. *Aspilia africana* had the highest evenness. The diversity indices indicated that *Rhynchospora corymbosa* had the highest taxa value 65, Shannon Weinner 4.01, Simpsons 0.98 and Margalef 7.60 while *Eichhornia crassipes* recorded the lowest taxa of 17, Shannon Weinner had 2.72, Simpsons 0.92 and Margalef 2.30 respectively for macrophytes. The biotic indices of Margalef's species richness, Shannon - Wiener information function, evenness and Simpson's Dominance were fairly distributed in the River. This showed that the macrophytes in the study area were stable.

Keywords: Macrophytes, Specie diversity, classification, distribution, New Calabar River.

Introduction
Aquatic macrophytes were defined as plants with photosynthetic parts that are permanently or temporarily submerged or floating in water and visible to the human eye (Cook, 1990) [5]. Macrophytes constitute a diverse assemblage of taxonomic groups and appears in many shapes and sizes, some grow completely under water while some have leaves that float on the water surface. They are critical to our aquatic environment and many people misunderstand the importance of these macrophytes in our water bodies. Macrophytes are often separated in four categories based on their habitat of growth; floating unattached, Floating attached Submerged and Emergent depending on the position of plant relative to water surface and substrate. (Puijalon *et al*. 2008) [20]

Aquatic macrophytes are important in many aquatic environment especially water lands, slower moving water in streams, rivers and in shallow areas of lakes. Their presence has been found to be beneficial to the basins, fisheries and pastoralism. Despite the considerable interest in research and development of the fisheries of Nigerian waters in recent years. Little effort has been directed at the associated non-fish resources (aquatic macrophytes). The present tendency to destroy completely these resources without adequate knowledge of their ecology, population, dynamics and socio-economic importance may spell down to other dependent aquatic resources (Ita *et al.,* 1985). [12] Macrophytes are important components of the aquatic ecosystem because they enhance the physical structure of habitats and biological complexity which increases biodiversity within the littoral zones (Esteves, 1998, Wetzel, 2001, Pelicice *et al*. 2008). [9, 26, 18] In addition both live and dead materials (detritus) from aquatic macrophyte may serve as food resources for aquatic and terrestrial organisms Lopes *et al*. (2007).[13]

Macrophytes play a significant role in the hydro ecosystem by providing breeding substrate for organisms including fish, aquatic insects and zooplankton and many of them serve as food for fishes (Ratusshnyale, 2008) [21]. However in most rivers and lakes the excessive growth of macrophytes may provoke some negative effects (Bini *et al.,* 2005) [4] and it develops in to explosively large population only when the environment is altered Aquatic macrophytes constitute an important role in aquatic ecosystem. Macrophytes contribute to the general fitness and diversity of a healthy aquatic environment (Flint and Madsen, 1995). [10] It is

against this background the current study investigated the diversity of macrophytes in the New Calabar River

Materials and Methods

Study area

The study area is a section of the New Calabar River as shown in Figure1. The New Calabar River lies between longitude 006º53 53086'E and latitude 04º53' 19.020'N in Choba, Rivers State, Nigeria. The entire river course is situated between longitude 7º60'E and latitude 5º45'N in the coastal area of the Niger Delta and empties into the Atlantic Ocean. The New Calabar River region has an annual rainfall between 2000-3000mm (Abowei 2000) [1].

The new Calabar River is a black water type (Research Planning Institute 1985)[22] located in Rivers State, Nigeria lies on the Eastern arm of the Niger Delta and empties into some creeks and coastal lagoon bordering the Atlantic Ocean. At the source at Elele-Alimini, the water is fresh and acidic but brackish and tidal at the mouth. Aluu is the upstream part of the river where the river is fresh and tidal. The climate of the area is characterized by a dry season during November to March and wet season during April to October with monthly average rainfall of 25.4mm (Erondu, 1983) [8]. The New Calabar River is among the important water resources in the Niger Delta region of Southern Nigeria; it is in the vicinity of the rapidly expanding oil city of Port Harcourt in Rivers State, Southern Nigeria. Most communities within this area are directly dependent on the river for their agricultural, recreational, and sometimes, domestic water supplies. The river is subjected to effluent discharge from Industries sited along its banks. Also, surface run-off resulting from soil erosion, lumbering activities, forestry operations, dredging activities, and domestic sewage inputs may lead to wide scale contamination of the river. A total of five different stations which includes: Rumuokparali, Choba bridge, Aluu (Arac Center), Ogbodo (Isiokpo), Elibrada (Emuoha) and were established as shown

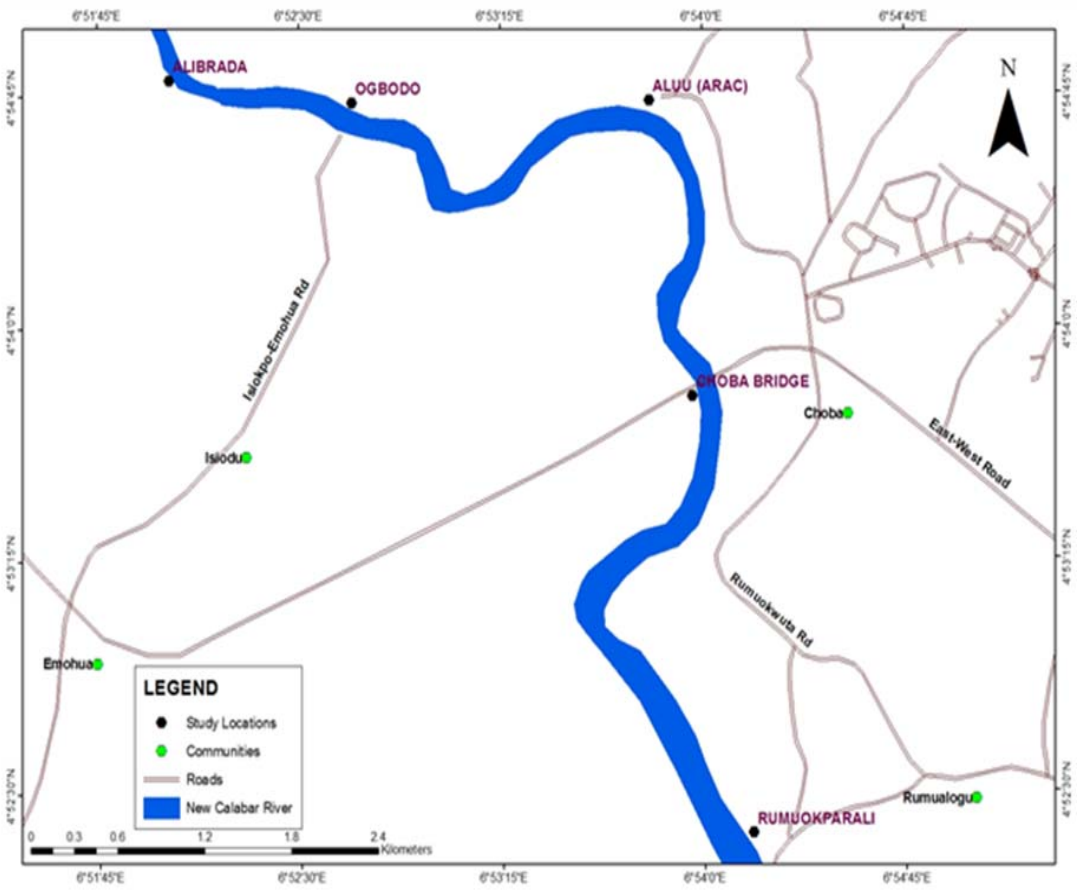

Fig 1: Map of the study area showing the different sampling Stations of the New Calabar River

Sampling of the New Calabar River

Station 1: Rumuokparali Station 1 lies between longitude 6°54.17E and latitude 4°52.37N, with a distance of 551.09meters to Choba Bridge. Heavy dredging activities is been carried out, the river harbor pipes layed for dredging and domestic effluents is emptied into the river. A market is located close to the river which houses an abattoir where in which all waste goes into the river

Station 2: Choba Bridge Station 2 lies between longitude 6°53.95E and latitude 4°53.78N is in Choba village and close to it is an extension base of Wilbros Nigeria Limited (WNL) oil serving industry. The distance from form this station to Aluu is 224.25meters and the activities here include the building and repair of oil pipelines as well as dredging activities as well as fishing activities.

Station 3: Aluu (ARAC) Station 3 lies on longitude 6°53.79E and latitude 4°54.73N with a distance of 213.53meters to Ogbodo in Isiokpo. The Station is also used mainly for dredging activities as well as for domestic and recreational; activities. It is also a narrow creek linking the discharge point of the farming activities within the African Regional Aquaculture Center in the river.

Station 4: Ogbodo (Isiokpo) Station 4 is the upper part of the river which lies between longitude 6º52.01E and latitude 4°54.80N. The Station is mainly used for dredging activities as well as for domestic purposes like fishing by the inhabitants, recreational activities are sometimes carried out. It has a short distance of 71.8meters to Elibrada in Emuoha.
Station 5: Elibrada (Emuoha) Station 5 lies on longitude 6°52.01E and latitude 4°54.80N in Emuoha village where Ogbodo rivers empties into, there is dredging activities in this river and villagers around carry out fishing activities. It is also used for recreational activities by neighboring villages. The distance of this Station to Rumuokparali is 510.97 meters.
The sampling was done once in a month from December 2013 to May 2014 which covers a period of six months (three months of dry season and three months of wet season).

Macrophytes collection and identification
Aquatic macrophytes constitute a significant component of the aquatic ecosystem and they are of considerable ecological and economic importance. Macrophytes found along the edge of the river were easily collected in Stations 1 to 5 while the ones in the middle of the river were collected with a boat using a 1m by 1m square quadrant. The samples were collected at a depth of 15cm. After collection, samples were washed then tagged for easy identification and further analysis following Akobundu and Agyakwa (1987) [3].

Data Analysis
Analysis of Variance (ANOVA) was done by computer software. It was used to ascertain significant variations of parameters within different sites of the New Calabar River. The mean values gotten from the sampling of macrophytes were used to enumerate the:

- Species diversity
- Species abundance
- Specie distribution

Shannon-Weiner diversity index
(H^1)= -E [(ni/N) x in (ni/N)] (Shannon and Weaver, 1963)[24]
Where:
H^1=Diversity index, in=the total number of individuals belonging to the ith species=total number of individuals for the site and ln=the natural log of the number.
Simpson diversity (1-Δ) =1-E n (n-1)/N (N-1) Where:
N=the total number of organisms of all species, and n=the total number of organisms of a particular species
Margalef-value is the measure of species richness.It is expressed as d=S-1/lnN, Where:
d=Margalef value,S=number of species collected in a sample and N=total number of individuals in the sample.
Menhinicks Index (D) =S/√N Where:
S=Number of species in a population and N=Total number of individuals in S species
Pielous index measures how evenly the species are distributed in a sample community. It is expressed as:J=1/Hmax (Pielou,1969)[19] Where:
J=Diversity eveness or Equitability index. H1=calculated Shannon-Weiner diversity index. (Shannon-Weiner) Hmax+in S S=total number of species in a population in=natural log of number
Simpson dominance index(C) =Σ (n/N) 2 (Ogbeibu, 2005) [17]
Where:
N=the number of species in the ith species and N=total number of individuals

Results
The samples of the macrophytes collected in the sampling stations of the New Calabar River were classified as shown in table 1 into ten families made up of 12 different species. From the result family Cyperaceae recorded the highest number of species with 3 species, while other nine families' recorded one specie each. The zonation of the different species of macrophytes in the study area into floating, submerged and emergent is shown in table 2. Among the 12 species samples ten were grouped as emergent, two species grouped as floating and none was grouped as submerged during the sampling period. The diversity indices as shown in Table 3 indicated that *R.corymbosa* recorded the highest taxa value of 65, followed by *C.difformis* while the *E. crassipes* had the lowest taxa value of 17.The result of dominance indices revealed that *E.crassipes* had the highest value 0.07, followed by *N.lotus, P.africana, T.cordifolia* and *L.decurrens* with 0.04 and the lowest value of 0.01 was recorded for *R.corymbosa*. The estimated Shannon H values ranged from 0.92 to 4.01 with highest value recorded for *R.corymbosa* 4.01.followed by *C.difformis* 3.96 and *C.iria* 3.78 while the lowest value of 0.92 was recorded for *E.crassipes*. The estimate of evenness values in table 3 ranged from 0.80 recorded for *A.africana* to 0.92 recorded for *N.lotus*. The estimated Margalef indices was recorded for *R.corymbosa* 7.60 followed by *C.difformis* 7.56 and the lowest value of 2.30 was recorded for *E.crassipes* and *C.iria* 3.78 to 2.72 E.crassipes while the Simpson has highest value of 0.98 *R.corymbosa*, followed by *C.iria* 0.97 and lowest in 0.92 *E.crassipes*.

Table 1: Classification of Macrophytes Species from New Calabar River

Family	Specie	Common name
Cyperaceae	*Cyperus difformis*	Small flower umbrella
	Rhynchospora corymbosa	Matamat
	Cyperus iria	Rice flat sedge
Nymphaeceae	*Nymphea lotus*	Water lily
Poaceae	*Sacciolepsis africana*	Wild rice
Commelinaceae	*Aneilema beniniense*	Aneilema
Lamiaceae	*Platostoma africanum*	Asirisiri
Asteraceae	*Aspillia africana*	Wild sunflower
Tiliaceae	*Triumfetta cordifolia*	Burweed
Pontederiaceae	*Eichhornia crassipes*	Water hyacinth
Onagraceae	*Ludwigia decurrens*	Water primrose
Athyriaceae	*Diplazium sammatti*	

Table 2: Zonation of Macrophytes of the New Calabar River

SPECIE	EMERGENT	
Cyperus difformis	+	
Rhynchospora corymbosa	+	
Cyperus iria	+	
Nymphea lotus		+
Sacciolepsis africana	+	
Aneilema beniniense	+	
Platostoma africanum	+	
Aspillia africana	+	
Triumfetta cordifolia		
Eichhornia crassipes		+
Ludwigia decurrens	+	
Diplazium sammatti	+	

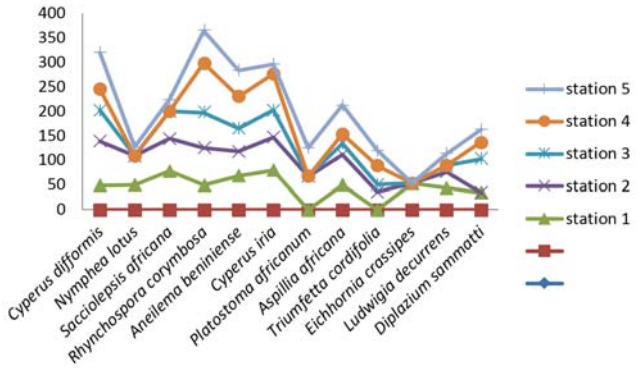

Fig 2: Mean values for macrophytes in the different Stations

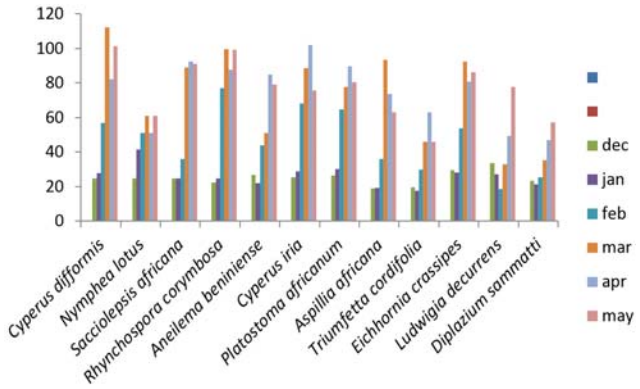

Fig 3: The mean value for macrophytes across the month

Table 3: Diversity Indices of Macrophytes in the New Calabar River

	Cyperus difformis	*Nymphea lotus*	*Sacciolepsis africana*	*Rhynchospora corymbosa*	*Aneilema beniniense*	*Cyperus iria*	*Platostoma africanum*	*Aspillia africana*	*Triumfetta cordifolia*	*Eichhornia crassipes*	*Ludwigia decurrens*	*Diplazium sammatti*
taxa_s	64	24	40	65	30	50	27	39	31	17	29	38
Individual	4320	1207	2504	4538	1648	3217	1721	1918	1099	1022	1019	1417
Dominance_D	0.02	0.04	0.03	0.01	0.03	0.02	0.04	0.03	0.04	0.07**	0.04	0.03
Shanno-Wiennner Index (H	3.96	3.09	3.52	4.01**	3.3	3.78	3.19	3.45	3.29	2.72*	3.22	3.52
Simpson_1-D	0.97	0.95	0.96	0.98**	0.96	0.97	0.95	0.96	0.95	0.92*	0.95	0.96
Evenness_e^H/S	0.82	0.92**	0.84	0.85	0.90	0.87	0.90	0.80*	0.86	0.89	0.86	0.89
Margalef Index (D	7.56	3.24	4.98	7.60**	3.91	6.06	3.49	5.02	4.28	2.30*	4.04	5.09

*Lowest calculated value, ** Highest calculated value

Discussion

Daddy *et al*. (1993) [2, 6] reported that in the herbarium of Kainji and Jebba Lake 13 different aquatic macrophytes families which constituted 31 species. Family Poaceae recorded the highest with 14 species while other families were represented by one specie each. This is in contrary to this findings while Dienye (2005) [7] reported that in Oyan lake in Ogun State with reference to Akiro Station 13 Families were recorded, Cyperaceae and Poaceae recorded the highest species of four each respectively followed by Mimosaceae with two species while others 10 Families had one specie each. This is in agreement with this result. Vipin *et al*. (2012) [25] reported seven Families in River Narmada India. Family *Najadaceae* recorded the highest specie of two while other Families had one specie each. Ikenweiwe (2005) [11] also classified macrophytes of Oyan Lake into 10 Families and nine species respectively. Family Poaceae and Cyperaceae ranked the commonest with two species each while other families were represented by one species each. Roger *et al*. (2010) [23] recorded 37 macrophytes in Itaipu Reservoir, Brazil belonging to 34 Families. The families with the highest number of species were Poaceae, followed by Cyperaceae.

Species of macrophytes were grouped by Obot and Ayeni (1987) [15, 16] 31 species were grouped as marginal flora zone, 15 species were grouped as submerged with four species as both floating and marginal. Dienye (2005) [7] sampled 20 species in Oyan lake, three were grouped as floating, two as submerged while the remaining 15 species were grouped under emergent. This finding shows that in the zonation of macrophytes emergent species ranked the highest which is in line with this result. Among all macrophytes species in the study area five species, *C.difformis, R.corymbosa*, *A.beniniense, A.africana* and *C.iria* were found in all the sampling Station followed by *D.sammatti, L.decurrens* and *T.cordifolia. P.africana* and *N.lotus* were found in two Stations but *E.crassipes* was the least distributed and was found only in Station 1(Rumuokparali) this could be attributed to the water quality (pH) as a result of the discharge of abattoir waste close to the station.

Species diversity is the effective number of different species that are represented in a collection of individuals and the result of the study shows that *R.corymbosa* of the Family Cyperaceae with the highest number of the collection of individuals has the highest species diversity and the lowest individual value is *E.crassipes* of the Family Pontederiaceae which is in contrary to the report of Dienye (2005) [7] who recorded Family Azollaceae with specie *Azolla africana* at the highest while the lowest is *Ceratophyllum demersum* of the Family Ceratophyllaceae. The result of this study showed that *R.corymbosa* had the highest abundance (richness), followed by *C.difformis* while the species lowest abundance (richness) was *E.crassipes* in the samples in the study area.

The evenness is the distribution of species sampled among species in the community. *N.lotus* was the lowest in evenness followed by *A.beniniense* and *P.africana* having the same level of distribution. *A. africana* had the highest evenness In the study of ecology of macrophytes of Jebba lake carried out by Adesina *et al*. (1993) [2] *Vossia cuspidata* has the highest calculated value while *Ceratophyllum demersum*, *Teprosa bracholata*, *Nymphaea lotus* and *Setaria pumila* has the lowest distribution. Dienye (2005) [7] reported that *Fimbristylis ferruginea* had the highest distribution while *L.decurrens* had the lowest distribution. More macrophytes were found in the sampling site during the wet season as compared to the dry season this could be due to the amount of rainfall and run off water. The biotic indices of Margalef's species richness, Shannon - Wiener information function, evenness and Simpson's Dominance were fairly distributed in the Stations. This showed that the macrophytes in the study area were stable.

Conclusion

The study has provided baseline information on the diversity of macrophytes of the New Calabar River. A total of 12 species of macrophytes representing 10 families were encountered, the family Cyperacea had the highest families

while the remaining families were represented by one species each. The diversity was very low due to the dredging activities and other anthropogenic activities in the river. The industrial activities in the New Calabar River should be checked as it affects the macrophytes and aquatic life. Macrophytes in the river when properly checked helps as substrate ground, feeds and habitat for aquatic animals, hence there is need to monitor the growth of the macrophytes of this river at regular intervals.

References

1. Abowei JFN. Aspect of the fisheries of the lower Nun River.Ph.D. Dissertation, University of Port Harcourt, 2000, 248.
2. Adesina GO, Daddy F, Aina E. Studies of the ecology of aquatic macrophytes and association littoral vegetation of Jebba Lake. In: NIFFR Annual Report, 1993, 28-31.
3. Akobundu IO, Agyakwa CW. A handbook of West African Weeds. International Institute of Tropical Agriculture, Ibadan, 1987, 521.
4. Bini LM, Oliveria LG, Souza DC, Cavalho P, Pinto MP. Patterns of the aquatic macrophytes cover in Cachoeira dourada Reservior Brazil. Journal of fish Biology 2005; 65(1):19-24.
5. Cook CDK. Aquatic Plant Book. SBP Academic, The Hague, Netherlands, 1990, 110-112.
6. Daddy F, Adesina GO, Bankole NO, Isah U, Owotunse S. Flora and fauna resources associated with Kainji, Jebba, Shriroro and Wuya water bodies in: NIFFR annual report, 1993, 25-27.
7. Dienye HE. Survey of Aquatic plants of Oyan Lake (Akiro Station) Ogun State. B.Sc. Project, University of Agriculture Abeokuta Ogun State, 2005, 41.
8. Erondu ES. Tidal and seasonal influence on the physico-chemical conditions of the New Calabar River at Aluu. M. Tech, thesis of Rivers State University of Science and Technology, Port Harcourt, 1983, 123.
9. Esteves; F. A Fundmentous de limnologia, Interciencia, Rio. De Janaro, Brazil. 1998; Vol 5:36-37Pp.
10. Flint, N. A and Madsen J. D. The effect of temperature and day length on the germintion of *Potamogeton nodosus* tubers.Journal of Freshwater Ecology 1995;10:125-128Pp.
11. Ikenweiwe NB. Limnology and plankton abundance in relation to fish production in Oyan Lake South-Western Nigeria. A Ph.D. thesis in the Department of Aquaculture and Fisheries Management. University of Agriculture. Abeokuta, 2005, 238.
12. Ita EO, Sado EK, Balogun JK, Pandogari A, Ibitoye B. Inventory survey of Nigeria Inland waters and their Fisheries resources in: preliminary checklist of inland water bodies in Nigeria with special reference to ponds, lakes, reservoir and major rivers. Kainji Lake Research Institute Technical Report Series, 1985, 14-51.
13. Lopes,C.A; Benedito-Cecilio,E. and Martinelli, L. A. Variability in the carbon isotopes signature of *Prochilidus lineatus.*2007
14. Margalef R. Diversity and stability: A practical proposal and a model of interdependence. Brookhaven Symposium on Biology 1967; 22:25-37.
15. Obot EA. Echinochloa stagnina, a potential dry season livestock fodder for arid regions. Journal of Arid Environment. 1987; 12:175-177.
16. Obot EA, Ayeni JSO. A handbook of common aquatic plants of the Kainji Lake Basin, Nigeria. Kainji Lake Research Institute/ Saolog printing production Ilorin, 1987, 65.
17. Ogbeibu AE. Biostatistics: a practical approach to research and data handling. Mindex Publishing Company Limited, Benin City, Nigeria, 2005, 264.
18. Pelicice, F.M; Thomas, S.M and Agostinhno, A.A. Simple relationship to predict attributes of fish assemblages in patches of submerged macrophytes.Neotrop.Khthyol.2008;6:543-550Pp
19. Pielou EC. An introduction to mathematical ecology. John Wiley New York, 1969, 286.
20. Puijalon S, Boumo TJ, Van Groenedael J, Bormette G. Clonal plasticity of aquatic plants species submitted to mechanical stress: escape versus Resistance strategy. Annals of Botany 2008; 102:989-996.
21. Ratusshnyale AA. The role of aquatic macrophytes in hydro ecosystem of the Kuibysheu reservoir. Journal of Agriculture and Environmental Science. 2008; 4(1):01-08.
22. Research Planning Institute, (RPI). Research Planning Institute, Inc. Columbia, U.S.A. Environmental baseline studies for the establishment of control criteria and standards against petroleum related pollution in Nigeria. Report No RPI/R/84/4/15-7, 1985.
23. Roger PM, Fernando AF, Thaisa SM, Priscillia C, Marcio JS, Sidinei MT. Aquatic macrophytes in the large, sub-tropical Itaipu Reservior, Brazil, 2010, 1437-1451.
24. Shannon CE, Weaver E. The mathematical theory of communication. University of Illinois, Urban Press III inois, 1963, 177.
25. Vipin V, Salma Y, Shilpa B, Ankit K. Distribution of macrophytes in river Narmada near water intake point. Journal of Natural Science Research. 2012; 5:54-5
26. Wetzel, R. G. Limnology: Lake and river ecosytem. Academic, San Diego, California, U.S.A.2001; 234Pp.