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ENVIRONMENTAL PARAMETERS AND THE DYNAMICS OF FISH RESOURCES IN LEKKI LAGOON, SOUTH-WEST, NIGERIA.

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ABSTRACT

This study accessed the effects of environmental parameters on the dynamics of fish resources in Lekki lagoon, Nigeria. The catch data of fish species were estimated from commercial landings between January and June, 2016 in nine (9) distinct sampling stations. Collected fish species were identified using standard identification guide while the physico-chemical parameters of the lagoon were determined using standard procedures. Data collected were subjected to univariate indices (Berger- Parker dominance, Simpson's diversity, Richness index, Shannon's indicies), and multivariate analysis, using PRIMER software. This study recorded 40 species of 25 families during the period of study; Chrysicththys nigrodigitatus contributed the highest (23.09%) catch while Erpetoichthy calabaricus contributed the least (0.023%) catch.. Margalef diversity and Pielou evenness indices were highest in Station VI (2.934, 0.785 respectively) while Shannon-Wienner index and Simpson's index of dominance were both highest in Station II (2.621 and 0.899 respectively), while, the least values of Margalef diversity, Pielou evenness were recorded in Stations I (0.352), III (0.5517), IV (0.833) and IX (0.706). Multivariate analysis showed that environmental gradient and fish abundance was significantly ($p < 0.42$) correlated with pH, electrical conductivity, sulphate, phosphate, nitrate, alkalinity and salinity in the lagoon. Distance-based linear model (DistLM) indicated the strong (r^2=98.50%) correlation environmental variables related to fish abundance.

Key words: Fish resources, Lagoon, Environmental parameters, Coastal waters, Multivariate analysis

INTRODUCTION

Coastal waters are important natural resources, valued for their ecological richness as well as for the many human activities they support (Abdul and Adekoya, 2016). As the interface between terrestrial environments and the open ocean, coastal waters encompass many unique habitats, such as estuaries, coastal wetlands, sea-grass, meadows, coral reefs, mangrove and kelp forests, and upwelling areas (USEPA, 2006). These waters support many fish species for at least part of their life cycle, offering some of the most productive fisheries habitats in the world and support many other organisms with high public visibility (e.g., marine mammals, corals, and sea turtles) or unique ecological significance e.g. submerged aquatic vegetation (USEPA, 2006).

Water bodies in Nigeria harbor a variety of fish species that serve as food (Akinsanya, 2015). Nigeria also has a large area of natural aquatic habitats that provides important spawning and feeding grounds for a large number of freshwater and brackish water fishes (Kusemiju *et al*. 1993; Meye and Ikomi, 2008; Emmanuel, 2009; Babatunde, 2010). Lekki lagoon is one of the largest lagoons in West Africa and an important source of freshwater fish production in Lagos and Ogun State of Nigeria (Emmanuel and Chukwu, 2010).The geography and hydrology of various part of Lagos lagoon complex in which Lekki lagoon is one have been described by several workers which include Ikusemiju (1973) as cited by Adesalu and Nwankwo (2010).The water has been described as estuary because of its relatively low salinity throughout the year as a result of high influx of freshwater from several rivers, such as Rivers Oshun, Oni, Mosafejo, etc. (Abdul *et al*., 2015).According to Ogamba *et al.* (2004), the unique nature of estuaries is due to the exchange of materials between the habitat types (marine and freshwater) which make it a recruitment sanctuary for many organisms.

Fishes are important components of tropical fresh and brackish water ecosystems in Nigeria (King and Etim, 2004). They are ecologically and commercially important food and they are widely exploited. They are

also abundant and easily affordable for individual that earn low-income (Abdul, 2009). The estuaries in the south western part of Nigeria make a substantial contribution to the fishery of the country and the livelihoods of the fisherfolks.

In recent years, a number of events affecting water quality have resulted in increased public concern about surface water quality (Chindah *et al.,* 2003). Anthropogenic activities encourage discharge of untreated animal waste, such as releases from sewage and septic tanks, run-off from agricultural lands, laundering into water bodies. Consequently, these have negative effects on the quality and health status of the water bodies (Costanza, 2012). This study was carried-out to establish how current environmental parameters of Lekki Lagoon affect its fish resources.

MATERIALS AND METHODS

DESCRIPTION OF THE STUDY AREA

The study was conducted in Lekki lagoon (Figure 1) which supports a major fishery in Nigeria. Lekki lagoon located in Lagos State, Nigeria. It lies between longitudes 4^0 12' N – 4^0 34' N and latitudes 6^0 18' SE – 6^0 40' SE and has a surface area of about 247 sqkm with a maximum depth of 6.4m. A large portion of the lagoon is shallow and less than 3.0 m deep (Kusemiju, 1973, Emmanuel and Chukwu, 2010) The Lekki lagoon is part of an intricate system of waterways made up of lagoons and creeks that are found along the coast of South-Western Nigeria from the Dahomey border to the Niger Deltas stretching over a distance of about 200km. It is fed by the River Oni discharging to the North- Eastern and the Rivers Osun and Saga discharging into the North-Western parts of the lagoon (Akinsanya, 2015).

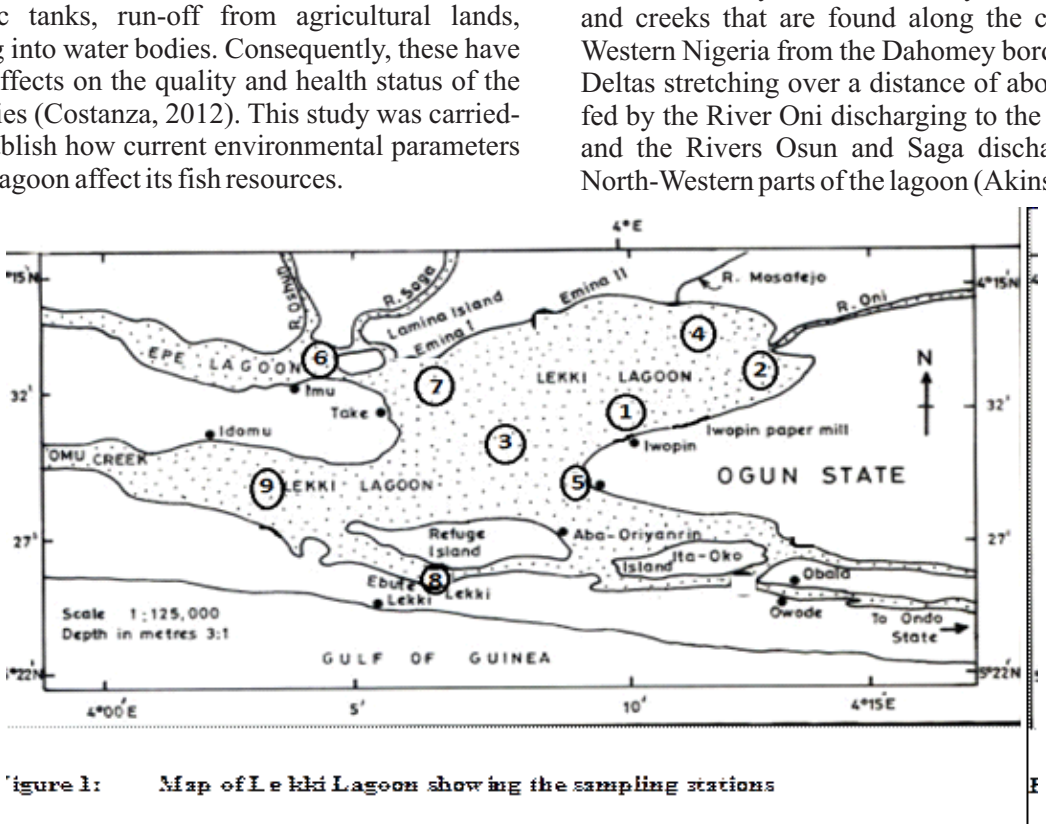


Figure 1: Map of Lekki Lagoon showing the sampling stations

Fish Sampling Procedure

The study area was divided into nine (9) sampling stations: The brush park area in Iwopin ($4^0$17'E, $6^0$56'N), River Oni ($4^0$14'E, $6^0$56''N), open water ($4^0$16'E, $6^0$55'N), River Mosafejo ($4^0$20'E, $6^0$56'N), River Imeki ($4^0$15'E, $6^0$49'N), River Osun ($4^0$06'E, $6^0$12'N), River Emina ($4^0$08'E, $6^0$54'N), Ebute-Lekki ($4^0$07'E, $6^0$46'N) and Yuboye ($4^0$14'E, $6^0$57'N).

Commercial catches of fishermen per Station were randomly assessed and sorted into different species using the catalogue of Raji and Olaosebikan (2013). The number , length and weight of the fish were measured. Samples of each fish were taken and preserved in 10% formalin for further identification in the laboratory.

Multivariate tools in PRIMER-E V7 plus PERMANOVA were further used to classify the fishes into cluster groups based on environmental parameters.

Fish community structure analysis

Fish community structure was analysed using univariate indicies (**Berger- Parker dominance,** Simpson's diversity, Richness index (RI), Shannon's indices) to express the degree of uniformity, diversity and richness in the distribution of individuals among taxa in the study area

Environmental Parameters

Environmental parameters (Surface water temperature, dissolved oxygen, pH, transparency, electrical conductivity), were monitored *in-situ* with meters while

nitrate, phosphate, sulphate TSS, alkalinity and BOD were analyzed *ex-situ* using standard methods according to APHA, (1998)

RESULTS

Seasonal distribution of fish species

Table 1 shows the seasonal distribution of fish species in Lekki Lagoon.The most diverse group was the Cichlidae family (*C. zillii, T. mariae, H. fasciatus* and *S. galilaeus*). *C. nigrodigitatus* was the most abundant in the dry and wet seasons. *E. calabaricus* (265.67kg) and *P. bucholzi* w the least abundant in the dry season and wet season respectively

Fish distribution and abundance in Lekki lagoon

Table 2 shows the fish distribution and abundance in terms of numbers and weight between January and June, 2016 in Lekki lagoon. Forty fish species belonging to 25 families were recorded during the study period. The least number (18) of fish species was recorded in Station I while all species were present in Staions IV and VI. *Coptodon zillii, Tilapia mariae, Polydactylus quadrifilis, Elops lacerta, Hepsetus odoe*; *Chrysichthys nigrodigitatus, Chrysichthys auratus* and *Mugil cephalus* were all present in all Stations. Also, the most abundant fish species in terms of numbers, was *C.nigrodigitatus* (2007155) and the least was *Pantodon bucholzi* (2750).

Table 1: Temporal distribution and relative abundance of fish species

		Dry Season		Wet Season	
	Fish species	**Total**	**Average Catch (kg)**	**Total**	**Average Catch (kg)**
1.	*Caranx hippos*	5027 (0.145)	1675.67	17237 (0.326)	0.323
2.	*Trachinotusteraia*	3747 (0.108)	1249	7694 (0.146)	2564.667
3.	*Scomberoidescommersonnianus*	2132 (0.062)	710.67	5228 (0.099)	1742.667
4.	*Coptodon zillii*	617634 (17.851)	205878	848764 (16.101)	282921.3
5.	*Tilapia mariae*	35748 (1.033)	11916	48262 (0.915)	16087.33
6.	*Hemichromis fasciatus*	982 (0.028)	327.33	2476 (0.047)	825.3333
7.	*Sarotherodon galilaeus*	31147 (0.900)	10382.33	45017(0.85)	15005.67
8.	*Channa obscura*	21606 (0.624)	7202	37216 (0.706)	12405.33
9.	*Pomadsys jubelini*	7244 (0.209)	2414.67	4188 (0.079)	1396
10.	*Polydactylus quadrifilis*	21320 (0.616)	7106.67	11156 (0.211)	3718.667
11.	*Sphyraena barracuda*	6046 (0.175)	2015.33	10346 (0.196)	3448.667
12.	*Psettias sebae*	1290 (0.037)	430	3220 (0.061)	1073.333
13.	*Ichthyborus monody*	4929 (0.142)	1643	8866 (0.168)	2955.333
14.	*Periophithamus barbarous*	1304 (0.038)	434.67	2886 (0.055)	962
15.	*Ctenopoma kingsleyae*	1658 (0.0480)	552.67	2653 (0.050)	884.3333
16.	*Polypterus senegalus*	2219 (0.064)	739.67	6443 (0.122)	2147.667
17.	*Erpetoichthys calabaricus*	797 (0.023)	265.67	2495 (0.047)	831.6667
18.	*Elops lacerta*	112974 (3.265)	37658	168485 (3.196)	56161.67
19.	*Papyrocranus afer*	33315 (0.963)	11105	48132 (0.913)	16044
20.	*Xenomystus nigri*	9202 (0.266)	3067.33	14321 (0.272)	4773.667
21.	*Heterotis niloticus*	4426 (0.128)	1475.33	96957 (1.839)	32319
22.	*Mormyrus rume*	38525 (1.113)	12841.67	70412 (1.336)	23470.67
23.	*Hyperopisus bebe occidentalis*	13681 (0.395	4560.33	25846 (0.490)	8615.333
24.	*Gymnarchus niloticus*	16189 (0.468)	5396.33	23220 (0.441)	7740
25.	*Pantodon bucholzi*	1133 (0.033)	377.67	1617 (0.031)	539
26.	*Pellonula leonensis*	494959 (14.306)	164986.33	1029120 (19.523)	343040
27.	*Sadinella maderensis*	554233 (16.019)	184744.33	321854 (6.106)	107284.7
28.	*Ethmalosa fimbriata*	51585 (1.491)	17195	164169 (3.114)	54723
29.	*Hepsetusodoe*	29079 (0.840)	9693	54325 (1.030)	18108.33
30.	*Brycinus macrolepidotus*	43015 (1.243)	14338.33	68654 (1.302)	22884.67
31.	*Brycinus longipinnis*	8966 (0.259)	2988.67	16645 (0.316)	5548.333
32.	*Chrysichthys nigrodigitatus*	862576 (24.931)	287525.33	1144579 (21.713)	381526.3
33.	*Chrysichthys auratus*	61891 (1.789)	20630.33	87198 (1.654)	29066
34.	*Schilbe mystus*	79955 (2.311)	26651.67	113161 (2.147)	37720.33
35.	*Schilbe intermedius*	28109 (0.812)	9369.67	65137 (1.236)	21712.33
36.	*Synodontis schall*	15245 (0.441)	5081.67	31042 (0.589)	10347.33
37.	*Mugil cephalus*	123529 (3.570)	41176.33	241357 (4.579)	80452.33
38.	*Cynoglossus senegalensis*	17611 (0.509)	5870.33	32614 (0.619)	10871.33
39.	*Citharichthys spilopterus*	10881 (0.314)	3627	38654 (0.733)	35296.33
40.	*Macrobranchium vollenhovenii*	83989 (2.428)	27986.33	349742 (6.635)	116580.7
	Total Monthly catch (kg)	**3459898**	**1153289**	**5271388**	**1779541**

Table 2: Spatial distribution and relative abundance of fish species in Lekki lagoon

	STATIONS									
Species	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**Total**
Caranx hippos	-	1675(0.75)	1536(0.07)	2814(0.30)	96(0.01)	429(0.07)	11265(1.70)	4322(0.24)	127(0.03)	**22264**
Trachinotusteraia	-	1604(0.71)	802(0.04)	2772(0.30)	53(0.003)	312(0.05)	4047(0.61)	1726(0.08)	125(0.03)	**11441**
Scomberoides commersonnianus	-	514(0.23)	475(0.02)	1045(0.11)	68(0.004)	4424(0.75)	556(0.08)	224(0.01)	54(0.01)	**7360**
CoptodonzillI	94760(32.8)	41317(18.3)	403680(19.4)	60115(6.47)	278880(16.)	111062(18.77)	142322(21.5)	281951(15.35)	52311(12.0)	**1466398**
Tilapia Mariae	10206(3.54)	3002(1.34)	20352(0.98)	9387(1.01)	5376(0.32)	18174(3.07)	3212(0.48)	4121(0.22)	10180(2.35)	**84010**
Hemichromis Fasciatus	-	816(0.36)	621(0.03)	318(0.03)	55(0.003)	1526(0.26)	43(0.01)	33(0.001)	46(0.01)	**3458**
Sarotherodon Galilaeus	26160(9.07)	18442(8.21)	19(0.001)	25166(2.7)	96(0.01)	6281(1.06)	-	-	-	**76164**
Channa Obscura	-	20203(8.99)	2352(0.11)	9823(1.06)	1248(0.07)	24480(4.14)	-	-	716(0.17)	**58822**
Pomadsys Jubelini	-	-	1488(0.072)	526(0.06)	864(0.05)	1534(0.26)	2713(0.41)	2893(0.16)	1414(0.33)	**11432**
Polydactylus Quadrifilis	2682(0.93)	666(0.30)	5328(0.25)	5292(0.56)	240(0.01)	4665(0.79)	4973(0.75)	7212(0.39)	1418(0.33)	**32476**
Sphyraena Barracuda	288(0.10)	13(0.01)	2784(0.13)	215(0.02)	288(0.02)	3015(0.51)	8787(1.32)	827(0.05	175(0.04)	**16392**
Psettiassebae	-	-	1296(0.06)	586(0.06)	48(0.002)	158(0.03)	36(0.01)	1185(0.06)	1201(0.28)	**4510**
Ichthyborus Monody		1294(0.58)	912(0.04)	833(0.09)	42(0.002)	7187(1.21)	1594(0.24)	418(0.02)	1515(0.35)	**13795**
Gobius Schlegelli	-	67(0.03)	1488(0.07)	374(0.04)	816(0.05)	1401(0.23)	-	-	44(0.01)	**4190**
Ctenopoma Kingsleyae	-	400(0.18)	1296(0.06)	754(0.08))	240(0.01)	1221(0.21)	102(0.02)	-	298(0.07)	**4311**
Polypterus Senegalus	-	56(0.02)	1632(0.08)	2307(0.24)	1008(0.06)	2145(0.36)	-	-	1514(0.35)	**8662**
Erpetoichthys Calabaricus	-	724(0.32)	1153(0.06)	400(0.04)	227(0.01)	430(0.07)	-	-	358(0.08)	**3292**
Elopslacerta	23984(8.32)	9113(4.06)	42192(2.0)	11716(1.3)	31296(1.8)	34234(5.79)	42099(6.35)	59554(3.24)	27271(6.30)	**281459**
Papyrocranusafer	3442(1.19)	342(0.15)	864(0.04)	9030(0.97)	-	19032(3.22)	32615(4.92)	16122(0.88)	-	**81447**
Xenomystusnigri	3972(1.38)	231(0.10)	-	470(0.05)	-	614(0.10)	10412(1.57)	7824(0.43)	-	**23523**
Heterotisniloticus	438(0.15)	1488(0.66)	144(0.01)	5021(0.54)	-	94292(15.94)	-	-	-	**101383**
Mormyrusrume	14328(4.97)	2004(0.89)	2832(0.14)	13288(1.43)	-	25713(4.43)	35232(5.31)	11458(0.62)	4082(0.94)	**108937**
Hyperopisusbebe	716(0.25)	176(0.08)	-	8134(0.88)	-	10444(1.77)	11995(1.81)	8043(0.44)	19(0.004)	**39527**
Gymnarchus niloticus	8266(2.87)	127(0.06)	336(0.02)	9692(1.0.4)	-	17822(3.01)	1194(0.18)	1819(0.10)	153(0.04)	**39409**
Pantodon Bucholzi	-	242(0.11)	110(0.01)	838(0.09)	98(0.01)	1238(0.21)	71(0.01)	151(0.01)	2(0.0004)	**2750**
Pellonula Leonensis -	0	-	110220(5.3)	83219(8.9)	655795(38.93)	8182(1.38)	1112(0.17)	442230(24.08)	223321(51.8)	**1524079**
SadinellaMaderensis	-	-	537024(25.8)	80252(8.64)	156144(9.27)	3123(0.53)	9(0.001)	98523(5.37)	1012(0.23)	**876087**
Ethmalosa Fimbriata	-	-	17811(0.86)	14030(1.51)	100804(5.98)	1092(0.18)	23652(3.56)	56364(3.07)	2001(0.46)	**215754**
Hepsetusodoe	336(0.13)	4042(1.80)	3072(0.15)	16891(1.82)	2976(0.18)	11817(1.20)	19224(2.90)	22132(1.21)	2914(0.67)	**83404**
Alestes Macropidotus	-	6741(3.00)	9888(0.48)	18290(1.97)	768(0.05)	12400(2.10)	34223(5.16)	29230(1.59)	129(0.03)	**111669**
Alestes Longipinnis	-	1332(0.59)	2016(0.10)	4751(0.51)	2640(0.16)	3121(0.53)	8429(1.27)	3144(0.17)	178(0.04)	**25611**
Chrysichthys Nigrodigitatus	72500(25.1)	35729(15.9)	686928(33.0)	383345(41.3)	135648(8.05)	49240(8.32)	50343(7.59)	572282(31.16)	21140(4.88)	**2007155**
Chrysichthys Auratus	13868(4.81)	23552(10.4)	30505(1.47)	35143(3.78)	1056(0.06)	2324(0.39)	1218(0.18)	36283(1.98)	5140(1.19)	**149089**
Schilbemystus	-	2396(1.07)	13150(0.63)	28163(3.03)	16896(1.00)	19249(3.25)	44251(6.67)	49871(2.72)	19140(4.42)	**193116**
Schilbe Uranoscopus	-	917(0.41)	4752(0.23)	13982(1.51)	3032(0.18)	10998(1.86)	16982(2.56)	20862(1.14)	21721(5.02)	**93246**
Synodontisschall	3920(1.36)	10085(4.49)	3039(0.15)	21021(2.26)	-	8222(1.39)	-	-	-	**46287**
Mugilcephalus	7736(2.68)	15992(7.12)	84000(4.04)	11633(1.25)	28176(1.67)	20742(3.51)	106376(16.04)	76220(4.15)	14011(3.24)	**364886**
Cynoglossus Senegalensis	-	1020(0.45)	6384(0.31)	1100(0.12)	2640(0.16)	3099((0.52)	21768(3.28)	9212(0.50)	5002(1.16)	**50225**
Citharichthys Spilopterus	-	3279(1.46)	2832(0.14)	1899(0.20)	1680(0.10)	10468(1.77)	14127(2.13)	3047(0.17)	12203(2.82)	**49535**
Macrobranchium Vollenhovenii	788(0.27)	15046(6.70)	75360(3.62)	34161(3.68)	255264(15.5)	35741(6.04)	8222(1.24)	7118(0.39)	2031(0.47)	**433731**
Total	**288390**	**224647**	**2080673**	**928796**	**1684558**	**591651**	**663204**	**1836401**	**432966**	**8731286**

Diversity of Fish Species in Lekki Lagoon.

Table 3 shows the fish species diversity, richness and evenness across the nine stations in Lekki lagoon. Station IV and Station VI had the highest number of fish species (40), followed by Station III (32), Station II and IX (35), StationV and VII (33) and Station VIII (32). Station I had the least number of fish species (18). Margalef diversity was high in Station VI (2.934) and the least Station I (1.367). The Pielou evenness index was highest in Station VI (0.4531) while the least was recorded in Station III (0.1728). Shannon-Wienner indices recorded in Station I to Station IX were 2.129, 2.621, 1.882, 2.386, 1.833, 2.897, 2.69, 2.122 and 1.887 respectively. The Simpson's index of dominance recorded the highest index in Station IX (0.2944), and the least was in Station VI (0.08608).

Table 3: Diversity of fish species in Lekki lagoon

Diversity indices/ stations	I	II	III	IV	V	VI	VII	VIII	IX
Number of species	18	35	38	40	33	40	33	32	35
Number of individuals	288390	224647	2080673	928796	1684558	591651	663204	1836401	432966
Margalef species richness (d)	1.352	2.759	2.543	2.838	2.232	2.934	2.387	2.149	2.62
Pielou's evenness index (J)	0.699	0.737	0.517	0.647	0.524	0.785	0.769	0.612	0.531
Shannon diversity index (H')	2.019	2.621	1.882	2.386	1.833	2.897	2.69	2.122	1.887
Simpson dominance index	0.803	0.899	0.78	0.803	0.779	0.914	0.9	0.813	0.706

Key: I=Brushpark, II=River Oni, III= Open water, IV= River Mosafejo, V= Imeki, VI= River Osun, VII=Emina, VIII=Ebute Lekki, IX=Yuboye

Temporal Physical and Chemical Environmental Parameters of Lekki Lagoon

Table 4 shows the seasonal physical and chemical environmental parameters of Lekki lagoon. Surface water temperature ranged between 28.603 ± 0.29 ºC in dry season and 28.81± 0.15 ºC in wet season. The pH in Lekki lagoon during the dry season was 7.487 ± 0.96 and it was 6.69 ± 0.89 in the wet season. Depth ranged between 1.8567 ± 0.45m in dry season and 2.876 ± 0.50m in wet season. The transparency in Lekki lagoon during the dry season was 0.691 ± 0.33m and 0.514 ± 0.315m was recorded in the wet season. Electrical conductivity ranged between (258.232 ± 53.313 μScm^{-1}) in dry season and 529.522 ± 115.67 μScm^{-1} (in wet season). Sulphate in Lekki lagoon during the dry season was 83.079 ± 5.148mg/l and 32.499 ± 7.99mg/l in the wet season. The phosphate ranged between 0.021 ± 0.008mg/l in dry season and 0.034 ± 0.009mg/l in wet season. Alkalinity ranged between 2.128 ± 0.34mg $CaCO_3$/l in dry season and 1.467 ± 0.099mg $CaCO_3$/l in wet season. Dissolve oxygen ranged between 6.387 ± 0.089mg/l in dry season and 7.104 ± 0.207mg/l in wet season. The salinity in Lekki lagoon during the dry season was 0.401 ± 0.236ppt and 0.324 ± 0.036ppt in the wet season. Nitrate ranged between 2.042± 0.241mg/l in dry season and 5.985 ± 0.498mg/l in wet season. Total suspended solid in Lekki lagoon during the dry season was 0.072 ± 0.030mg/l and 0.148 ± 0.092mg/l in the wet season. Biological oxygen demand ranged between 1.822± 0.146mg/l in dry season and 2.681± 0.2481mg/l in wet season. Total dissolved solid in Lekki lagoon during the dry season was 105.084 ± 24.654mg/l and 357.929 ± 87.940mg/l in the wet season. Seasonal means values of pH, depth, transparency, electrical conductivity, sulphate, alkalinity, dissolved oxygen, salinity, nitrite and total suspended solid showed no significant ($p>0.05$) difference while there were significant ($p<0.05$) difference in the values of surface water temperature, biological oxygen demand and total dissolved solid during the study in the lagoon.

Mean values with the same superscript across the row are not significantly ($P> 0.05$) difference.

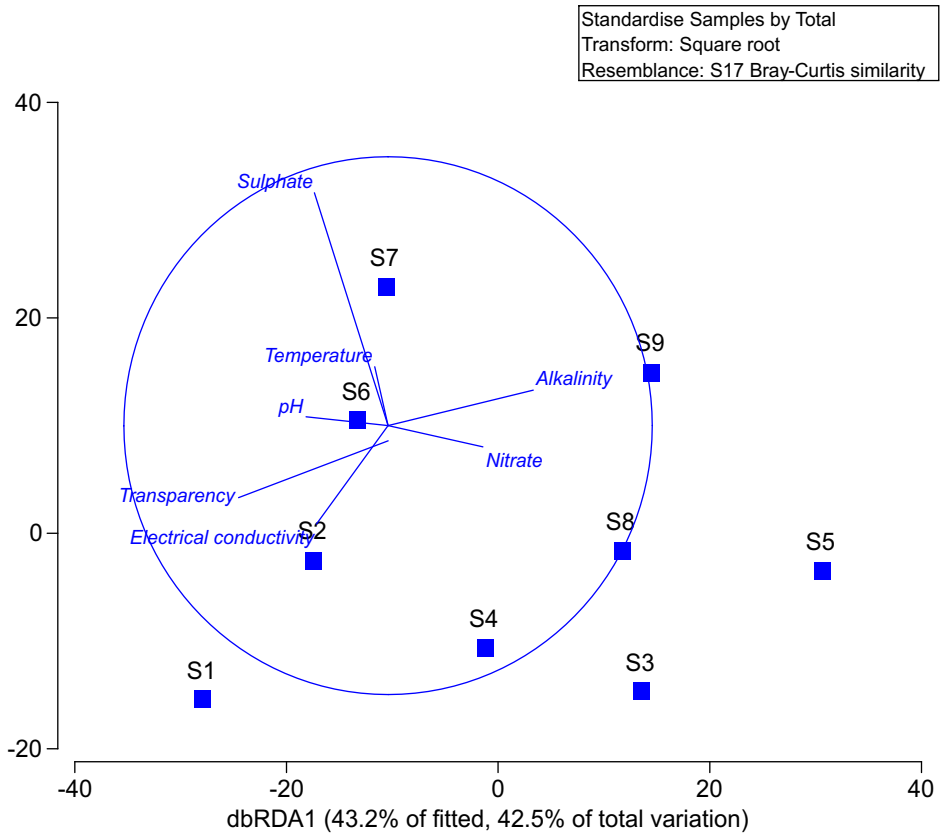
Multivariate analysis between the fish abundance and environmental parameters

Multivariate analysis between showed that fish abundance was significantly ($p < 0.42$) correlated with the environmental gradients such as pH, electrical conductivity, sulphate, phosphate, nitrate, alkalinity and salinity in the lagoon. Meanwhile, distance-based linear model (DistLM) indicated the strong

(r^2=98.50%) correlation when temperature, pH, transparency, electrical conductivity, sulphate, phosphate, nitrate, alkalinity, dissolved oxygen and total solid suspended were related with fish abundance (Figures 2 and 3). Distance – based redundancy analysis (dbRDA) plot of best two relationships were 64.1% and 62.8% of the total variation for fish abundance and environmental variables.

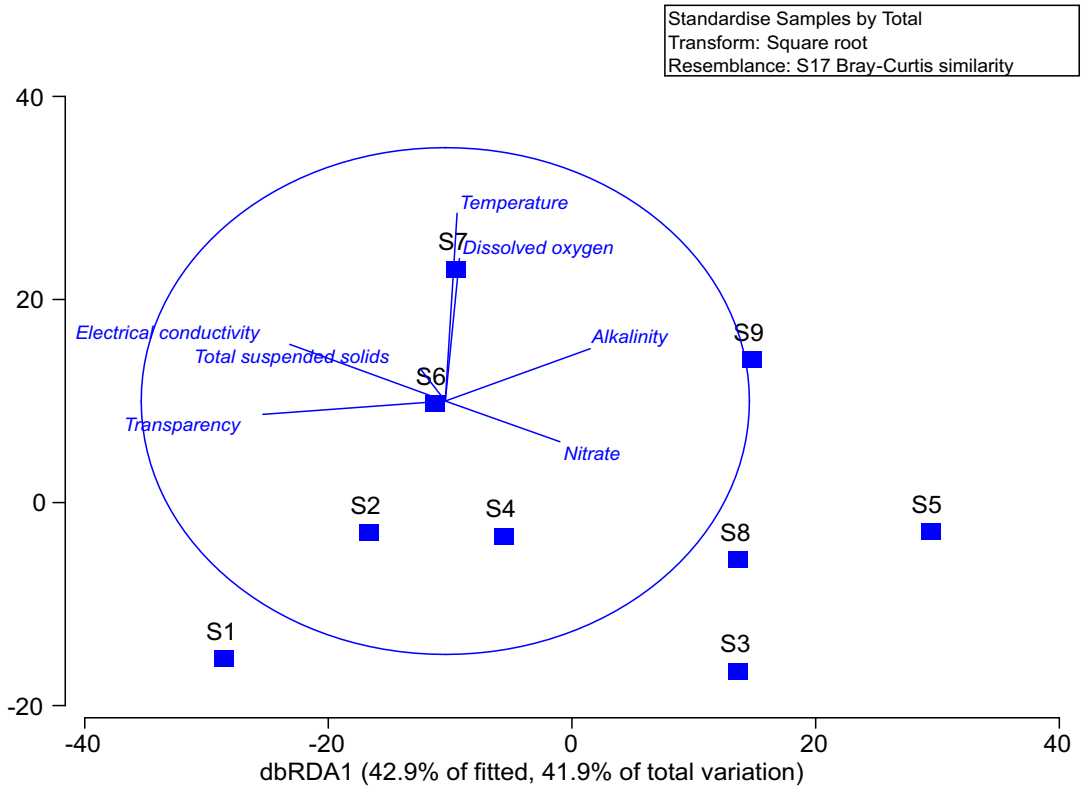
Table 4: Seasonal physical and chemical water parameters of Lekki lagoon

Water Parameter		Wet season (mean±se)
Temperature		28.81±0.15
pH	7.487±0.96	6.69±0.89
Depth	1.8567±0.45	2.876±0.50
Transparency	0.691±0.33	0.514±0.315
Electrical conductivity	258.232±53.313	529.522±115.67
Sulphate	32.499±7.99	83.079±5.148
Phosphate	0.021±0.008	0.034±0.009
Alkalinity	1.467±0.099	2.128±0.34
Dissolve oxygen	6.387±0.089	7.104±0.207
Salinity	0.324±0.036	0.4012±0.236
Nitrate	2.042±0.241	5.985±0.498
Total suspended solid	0.072±0.030	0.148±0.092
Biological oxygen demand	1.822±0.146	2.681±0.248
Total dissolved solid	105.084±24.654	357.929±87.940



Key: 1=Brushpark, 2=River Oni, 3= Open water, 4= River Mosafejo, 5= Imeki, 6= River Osun, 7=Emina, 8=Ebute Lekki, 9=Yuboye

Figure 2: Distance-based redundancy analysis plot of the best relationship between environmental parameters and fish distribution & abundance.



Key: 1=Brushpark, 2=River Oni, 3= Open water, 4= River Mosafejo, 5= Imeki, 6= River Osun, 7=Emina, 8=EbuteLekki, 9=Yuboye.

Figure 3: Distance-based redundancy analysis plot of the second best relationship between environmental parameters and fish distribution and abundance.

DISCUSSION

From this study, it was found that the high number of fish species recorded in lekki lagoon indicated the nutrient rich nature of the lagoon. The significant high diversity of fish species was also an ind As observed in this study, the 40 fish species from 25 families and 10 orders recorded is lower than the 81 species from 40 families and 14 orders recorded by Emmanuel (2010) also in Lekki lagoon. The decline in fish composition could be as a result of anthropogenic activities such as fishing pressure and pollution. The fish composition recorded in this study is higher than the 11 species from 10 families and 10 orders recorded by Lawson and Olusanya (2010) in River Ore and 25 species from 16 families recorded by Soyinka and Kassem (2008) in Ologe lagoon.

Fish species such as *P. bulcholzi, S. commersionanus, H. odoe, P. sebae, P. quadrifilis, I. monody* and *E. calabaricus* were observed to be rare as a result of their low abundance during the study. Similar low abundance of *E. calabaricus* and *H. odoe* were recorded by Lawson and Olusanya (2010) in Ore River. On the other hand, *C. nigrodigitatus, P. leonensis* and *C. zillii* were found to be the three most predominant fish species. Bolarinwa et al. (2015) also recorded a predominance of *C. nigrodigitatus* and *C. zillii* in the coastal waters of Ondo State. During this study, higher fish abundance was recorded during the wet season. This observation is similar to what was reported by authors such as Odulate (2010) in Ode-Omi coastal marine waters of Ogun State and Bello-Olusoji et al. (2010) in Asejire Dam.

Environmental parameters of Lekki lagoon, as observed in this study, revealed that they were good predictors of fish species presence and their adaptation in the lagoon.

It also shows that they all fell within the recommended range for survival of tropical fish species. According to Brown and Kusemiju (2002), Onyema (2008) and Emmanuel and Chukwu (2010), rainfall pattern in the tropics creates the dry and wet seasonal experienced in West Africa. The salinity in Lekki lagoon showed peculiar trend in that wet season salinity was higher than dry season. It could be as a result of the intrusion of the ocean into underground water which was transported by hydraulic gradients in the direction of the lagoon as reported by Waljeski and Williams (2004) and high influx of freshwater from the adjoining rivers. This and more factors accounted for the variations in the environmental parameters observed seasonally in this study,.

According to Odulate et al. (2014), aquatic environmental variables are key factors that influences the abundance, distribution, survival, reproduction, growth performance and over all biological production of fish species. This have created a need for a good understanding of threshold effects along environmental gradients that may cause abrupt changes in fish species distribution and their abundance (Roni et al., 2008). Findings from this study showed that the selected Stations were significantly ($p<0.05$) different in their fish distribution and abundance. This could be attributed to the heterogeneity of the selected stations in terms of water quality parameters. pH, conductivity, sulphate, phosphate, nitrate, alkalinity and salinity, and when combined, had positive significant correlation with fish abundance. This may in turn alter fish species feeding, breeding strategies, life traits and biotic interactions, for individual fish species (Trigal and Degerman, 2015). Olaosebikan et al. (2015) observed similar positive significant ($p<0.05$) correlation of notobranchiid fish abundance with water conductivity. Dubey et al. (2012), also observed that the habitat variables such as conductivity, DO, pH, alkalinity, and salinity were most strongly correlated with the fish community composition of the Ganga River Basin, India. Also, the model showed a good reliability (r^2 =0.985 and 0.984 respectively) between the combined temperature, pH, transparency, conductivity, sulphate, nitrate and alkalinity, and that combining temperature, conductivity, nitrate, alkalinity, dissolved oxygen and total suspended solids in relation to fish distribution and abundance accounting for 64.1% and 62.8% of the total variation respectively.

CONCLUSION

Findings of this study showed that the physico-chemical parameters of the lagoon favoured the abundance of the fish species present. Therefore, understanding factors that influence fish assemblage structure is important not only for accumulating basic ecological information, but also to predict the effects of environmental change on the integrity of these communities. This information will help in planning future conservation activities towards sustainability of the aquatic resources of Lekki Lagoon.

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