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Seasonal variation in fish distribution and physico-chemical parameters of wetland areas in Oyo State, Nigeria

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ABSTRACT

A study was conducted to assess the physico-chemical characteristics and fish distribution of wetland areas of Oyo State. The results revealed incidence of pollution as a result of agricultural pollution mainly due to use of agrochemicals. The water pH, Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were below the World Health Organization (WHO) and FEPA permissible limit in all the locations with the exception of Ajinapa where 5.0, 226.8 mg/l and 372.6 mg/l were recorded for pH, BOD and COD respectively. The level of agrochemical usage varied significantly ($p < 0.05$) among the locations examined with Ajinapa (Orire LGA) having the highest rate (65.0%) while papa-Eleye (Oluyole L.G.A) had the lowest (15.0%). A total of 16988 individuals, 11 fish species belonging to 7 families were found in 11 locations with *Oreochromis niloticus* (30.6%) and *Clarias gariepinus* (20.8%) dominating the catches. From the result, it is clear that high level of pollution in Ajinapa (Orire LGA) location is traceable to the use of agrochemical and therefore there is a need to take appropriate measure to preserve the aquatic life.

Keywords: Water pollution, wetland, fish biodiversity, Agrochemicals.

INTRODUCTION

Wetlands are among the must productive environments. They provide tremendous economic benefits to mankind through fishery production, maintenance of water tables for agriculture, water storage and flood control, timber production, waste disposal and water purification and recreational opportunities (Contreras-Espinosa and Warner, 2004). Wetlands also provide critical habitats for water fowls and other birds as well as for countless mammals, reptiles, amphibians, fish and invertebrate species, many of which are threatened with extinction (Ita, 1994).

Human activities, mainly associated with urbanization and industrialization, have resulted in increasing pollution of wetlands (Omitoyin and Ajani, 2007). Water pollution interacts with the aquatic environment (Biney et al., 1987; Svenson et al., 1995; Abdelimeguid et al., 2002). Hence, FAO (2004) shows that inland fish stocks are under threat from environmental change and impacts. Various studies have shown that various human activities have led to increase in pollution level in wetland areas and these have impacted negatively on physical and chemical factors in wetland environment, consequently affecting the biological diversity in these environments (Ajani and Omitoyin, 2004; Contreras-Espinosa and Warner, 2004). However, for sustainable management of wetland areas, there is need for detailed study of the influence of anthropogenic activities on wetland areas by assessing the variations in aquatic biodiversity of these environments in relation to the pollution induced by human activities and state of the physicochemical parameters of the wetlands.

This study is therefore conducted to assess the physico-chemical characteristics of wetland areas of Oyo State and sustenance of its fish resources in relation to agricultural activities in these areas.

MATERIALS AND METHODS

Study area

Oyo State is located in the southwestern part of Nigeria, within 2°31′ - 5°30′ E and 6° 45′ – 9°15′ N (Ayeni, 1994) (Figure 1). A wide variety of crops are grown throughout the State depending on the vegetation, soil and agroclimatic factors prevailing in the area and there has been a wide spread use of agrochemicals to boost agricultural production. The State is largely drained by all season river systems, which flows southwards namely: Ogun, Osun, Oba, Ona, Ofiki and Imosa rivers that allows for capture and culture fisheries. Oyo State is blessed with a lot of water, big river, man made lakes, swamp, flood plains, tributaries and streams. However, among the popular ones are Okpoma, Iganna, Ilero, Irawo, Ago-Are, Oja-owode, Ago Amodu, Sepeteri, Lakes 1 and II, Sepeteri FDF, Igboho, Kishi and Igbeti.

Eleven (11) local government areas were purposely selected on the basis of their participation in the Fadama project from thirty-three local government areas in the State, the most active location out of three locations in each local government areas were selected from eleven (11) local government areas. The summary of the study location is presented in table 1.

Sampling design

Surface water samples for two wet seasons (May-October) and two dry seasons (November-April) from the study sites (11 Local Government Areas) were collected by dipping plastic container of 1.5 ml to about 6-10 cm below the surface film. The plastic containers were mouth sealed with cellotape and carried to the laboratory where they were stored in a refrigerator (5 °C) before the commencement of analysis. The parameters analyzed includes pH, turbidity, Chemical Oxygen Demand (COD) Biological Oxygen Demand (BOD), Total Dissolved Solid (TDS), chloride, total hardness, carbonate and bicarbonate, calcium, nitrite-nitrate phosphorus and conductivity.

pH was measured by the use of Hanna instrument pH 211-micro processor pH-meters. The nitrate-nitrate concentration was measured colorimetrically using brucine sulphate-sulphanilic acid diazotization according to the method of Murphy and Riley (1962). Also, turbidity, calcium, sulphate, carbonate and bicarbonate were measured following AOAC (2000) methods. While total hardness was measured using APHA (1998) methods. The orgentometric method was used in determining chloride using the formula,

$$\text{Chloride} = \frac{(A - B) \text{ x } N \text{ x } 35.450}{\text{ml of sample used}}$$

Where,
A = sample litre, B = Blank litre and N = 0.0141

Biological Oxygen Demand (BOD) was carried out by measuring the amount of dissolved oxygen present in the samples before and after incubation in the dark at 20 °C for five days. The samples were diluted and then aerated. Dilution was carried out by using dilution water prepared from phosphate (PO_4), buffer solution, magnesium sulphate ($MgSO_4$) solution, calcium chloride ($CaCl_2$) solutions, Iron III chloride (Fe_3Cl_3) solution and distilled water. Iron of phosphate buffers, magnesium sulphate calcium chloride and iron III chloride solution were added to the distilled water. The samples were measured into the BOD bottle in duplicates. The five-day BOD was computed from the dissolved oxygen values using the formula.

$$BOD = \frac{(DO_O - DO_d) \text{ x Volume of BOD bottle}}{\text{M1 samples used}}$$

Where,
BOD = Biological Oxygen Demand
DO_O = Dissolved Oxygen found in the dilutions of the samples on the initial day.
DO_d = Dissolved Oxygen found in the dilutions of the samples on the final day.

Chemical Oxygen Demand (COD) was determined by adding mercury sulphate, 5 ml concentrated sulphuric acid (H_2SO_4) to 5 ml of samples and 25 ml of potassium permanganate was added. The mixture was refluxed for 2 hours and allowed to cool: the solution was titrated against ammonium sulphate solution using ferroin as indicator.

$$\text{COD (ppm)} = \frac{(a - b)\ N \times 800}{S}$$

Where,
N = Normality of ferrous ammonium sulphate, a-b = Volume (ml) of ferrous ammonium sulphate used in titration of Blank (a) and of sample efficient (b)
S = Volume (ml) of sample water
COD = Chemical Oxygen Demand

Fish from the study sites were sampled using gill nets (mesh size: 9 inches length: 6 m), cast nets (mesh size: 9 inches), hook (size: 2 inches and lines. The fish species were identified to the lowest taxonomic level using Idodo-Umen (2003). Species were counted for number of individuals. The sampling is done bimonthly for two dry (November-March) and two wet (April- October) seasons (FAO, 2004) between 2004 and 2006.

Data analysis

The species diversity indices were calculated:

1) Margalef's value (d) = $\frac{S - 1}{\log_e N}$

Where, d = Margalef's value
S = number of species
N = number of individuals

2) Shannon – Wiener Index $H_{(s)} = P_i \log_2 P_i$ or $H_{(s)} = 3.322 P_i \log_{10} P_i$

Where, s = total species number
Pi = total proportion of each species in each sample

3) Measure of evenness J = $\frac{H_{(s)}}{H_{(s)}\ max}$

Statistical Analysis

Spatial and temporal flows in species diversity and physicochemical parameters were subjected to basic statistical analysis such as range, means, standard deviation and probability levels. 11 X 11 X 2 factorial analysis was used to find level of significance between seasons and sampling sites in fish species distribution/abundance. The level of inter-correlation among the variables was determined using regression analysis between the physicochemical variables and biological data so as to identify sources of variation in the water quality and fish productivity. All these were done using STATISTICA for windows XP 2000 on PC (Linear version).

RESULTS

Physico–chemical quality of Wetland Area in Oyo State

The general characteristics of study sites are presented in table 1.

The mean physico–chemical parameters of the study sites during the wet and dry seasons are presented in table 2. The number of individuals sampled and diversity parameters for each sample site of wetland area in Oyo State is presented in table 3.

The water was acidic and slightly alkaline during the sampling period with pH range of 5.00-8.23. The mean pH values ranged from 5.00 ± 0.2 in Ajinapa to 7.95 in Ogbere Tioya during the dry season while in wet season the mean pH values varied between 6.12 ± 0.2 in Ajinapa to 8.23 ± 0.6 in Ogbere Tioya during the wet seasons.

The mean calcium ion concentration varied between 0.46 ± 0.2 mg/l in Olowu and 2.32 ± 1.2 mg/l in Ogbere Tioya during the wet seasons but during the dry seasons, the mean value of calcium ion ranges between 0.48 ± 0.2 mg/l in Olowu and 1.90 ± 1.2 mg/l in Ogbere Tioya.

The mean values of sulphate ions in all the locations during the dry season varied from 0.169 ± 0.1 mg/l in Ejioku to 32.09 ± 3.7 mg/l in Ajinapa while in wet season the mean values of sulphate ranging between 0.368 ± 0.03 mg/h in Ejioku 32.31 ± 0.03 mg/l in Ajinapa. The total hardness of water during the dry season ranging between 0.43 ± 0.3 mg/l in Ogbere Tioya and 0.990 ± 0.1 mg/L in Owode while it varied from 1.000 ± 0.1 mg/l in Araromi to 1.670 ± 0.1 mg/L in Owode during the wet seasons.

Spatial and seasonal variation in fish assemblage

A total of 16,988 individuals representing 11 species belonging to 7 families were captured from Wetland Area in Oyo State. Cichlidae was the most widely distributed family in all the locations with four species (*O. niloticus*, *Tilapia zillii*, *Sarotherodon melanotheron* and *Sarotherodon galilaeus*) recorded throughout the sampling period. It had the highest species composition with 50.13% during the sampling period. The highest number of fish individual was obtained in Papa-Eleye with 3,646 and 6,023 samples recorded in wet and dry seasons while the lowest number of individual was observed in Ajinapa with 597 (dry) and 542 (wet) recorded. In all the sites, a distinct seasonal variation was observed with more families and species recorded in the dry seasons than the wet seasons.

Factorial analysis of variation in the species distribution among the 11 sites and seasons showed significant seasonal variation ($P < 0.05$) in species distribution with more species recorded in dry season. Also a significant variation ($P< 0.05$) was recorded in species distribution among the 11 sites; species distribution in Papa-Eleye was significantly higher than that of the other sites.

The species diversity index values obtained in all the sites showed wide variations with Margalef's diversity values ranging from 0.15 (Ajinapa) to 2.15 (Papa-Eleye). Equitability measure values ranged from 0.20 to 1.00 while Shannon-Wiener information function values varied from 0.75 to 2.50.

Seasonal variation showed that the Shannon – Wiener index ranged from 0.92 to 1.55 in dry season while the values varied between 0.84 and 1.30 in wet season.

The Mean Equitability values ranged from 0.48 to 0.60 (dry seasons) and 0.42 to 0.58 (wet seasons).

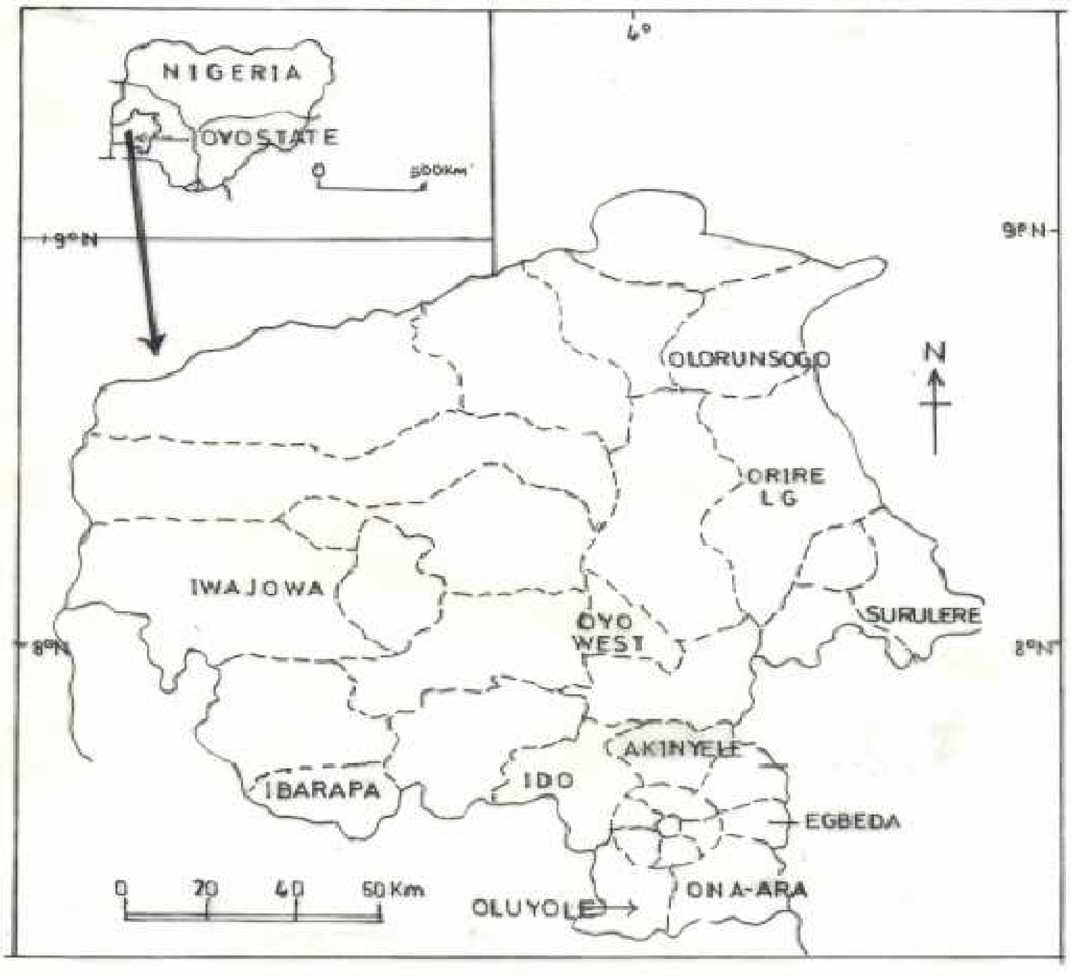

Figure 1: Map of Oyo State showing the eleven local governments of the study area.

Table 1: General characteristics of study sites.

S/N	Designations	L .G .A	Locations	Description of location	Major human activities	Levels of fishing	Use of Agrochemicals
1.	LG1	Akinyele	Tola	A government lake, (pade dam) belonging to OYSADEP exists in the L.G.A	Artisanal fishing, crop farming, livestock & Aquaculture.	Active	Active
2.	LG2	Egbeda	Ejioku	Asejire water Dam bordering it towards the East	Artisanal fishing, crop farming, livestock & Aqua-culture	Active	Active
3.	LG3	Ibarapa	Olowu	A reservior (lake) at Ayete Dam, constructed by OYSADEP as well as big rivers for artisanal fisheries	-As above-	Active	Active
4.	LG4	Iddo	Araromi	There is Akufo farm settlement with big rivers & towards the east is Eleyele Dam. (Eleyele catchment Area), and towards the west is river Omi.	Crop farming Artisanal fishing, aquaculture & livestock	Active	Active
5.	LG5	Iwajowa	Elekokan	Man made lake (Reservoir) at Iganna and big Rivers all over the L.G.A like River ofiki, Oyan and Opara.	- As above-	Active	Active
6.	LG6	Oluyole	Papa Eleye	There are running streams that joined Ogbere river	-As above-	Active	Active
7.	LG7	Olorunsogo	Owode	Dam (Lake) at the HQ of the L.G.A Igbeti which belongs to OYSADEP.	-As above-	Active	Active
8.	LG8	Orire	Ajinapa	A big reservoir (lake) – odo-oba Dam borders the L.G.A to the East.	-As above-	Active	Active
9.	LG9	Oyo west	New Iyaji	Erelu water works (Reservoir) is located in the L.G.A and there are running streams	-As above-	Active	Active
10.	LG10	Ona Ara	Ogere Tioya	River "Ogbere" a perennial	-As above-	Active	Active
11.	LG11	Surulere	Oko	No reservoir but there are running streams	Crop farming and Livestock	Non active	Active

Active = intensive usage/intensive activities; LG = Local Government; L.G.A. = Local Government Area; S/N = Serial Number

Table 2: Physico-Chemical Parameters (mean ± SD) of water in the study site during the wet and dry seasons (Aug & Sept.) and (Feb. & March) 2004-2006 respectively.

Species	Seasons	LG_1	LG_2	LG_3	LG_4	LG_5	LG_6	LG_7	LG_8	LG_9	LG_{10}	LG_{11}
Turbidity (NTU)	Wet	0.15±0.001^{d}	0.40±0.01^{c}	12.00±1.0^{c}	13.50±13.0^{c}	13.85±1.66^{bc}	14.05±1.8^{ab}	16.00±0.9^{a}	15.85±1.6^{a}	15.00±1.3^{a}	13.00±1.3^{ab}	16.80±1.8^{a}
	Dry	10.00±0.1^{f}	11.00±4.0^{e}	14.00±1.2^{d}	15.00±0.2^{cd}	16.00±0.1^{c}	17.00±0.6^{b}	19.00±0.7^{a}	18.00±0.6^{ab}	17.00±0.1^{b}	16.00±0.6^{c}	19.00±0.7^{a}
Conductivity (µs/cm)	Wet	1.03±0.1^{ef}	2.00±0.1^{c}	100.20±11.0^{d}	124.3±16.3^{bc}	125.0±9.9^{c}	143.0±11.0^{b}	158.45±13.1^{a}	158.35±13.0^{a}	129.1±12.4^{b}	124.4±11.3^{b}	158.70±13.2^{a}
	Dry	80.00±1.3^{g}	95.50±1.9^{f}	143.2±26.1^{d}	129.2±17.1^{e}	158.5±36.6^{cd}	116.3±11.3^{e}	151.5±16.7^{cd}	186.4±16.3^{a}	163.4±13.2	136.5±13.6^{e}	171.3±11.8^{b}
pH	Wet	7.93±0.1^{b}	7.84±0.3^{b}	7.53±1.0^{b}	7.45±0.6^{b}	2.20±0.02^{a}	7.30±0.81^{b}	7.13±0.1^{b}	6.12±0.2^{c}	7.12±0.4^{b}	8.23±0.6^{a}	6.97±0.9^{bc}
	Dry	7.70±0.82^{a}	7.64±0.63^{a}	7.21±0.51^{f}	7.26±0.42^{f}	7.07±0.41^{a}	7.18±0.39^{ab}	6.73±0.23^{b}	5.00±0.20^{c}	6.67±0.26^{b}	7.95±0.81^{a}	6.72±0.26^{b}
Calcium ion (mg/l)	Wet	1.84±0.01^{c}	0.91±0.03^{d}	0.82±0.02^{d}	0.72±0.02^{d}	2.20±0.02^{a}	1.15±1.01^{cd}	1.80±1.03^{c}	0.85±0.03^{ab}	2.27±1.6^{ab}	2.32±1.2^{a}	1.16±1.3^{cd}
	Dry	1.60±1.0^{ab}	0.69±0.4^{d}	0.46±0.2^{f}	0.48±0.2^{f}	1.90±0.1^{a}	0.84±0.1^{c}	1.40±1.3^{b}	0.55±0.3^{e}	1.90±1.2^{a}	1.90±1.2^{a}	0.86±0.3^{c}
Magnesium (mg/l	Wet	2.15±0.01^{a}	1.95±1.0^{ab}	1.25±1.3^{c}	1.05±1.2^{cd}	0.90±0.04^{d}	2.30±0.1^{a}	1.75±0.1^{b}	1.70±0.1^{b}	1.30±0.2^{bc}	1.25$^{0.3}$c	2.00±0.2^{a}
	Dry	1.85±1.6^{a}	1.75±1.1^{ab}	0.95±0.9^{e}	0.85±0.7^{f}	0.57±0.3^{g}	1.90±1.0^{a}	1.55±1.3^{c}	1.45±1.6^{d}	0.80±0.2^{f}	0.99±0.4^{e}	1.70±1.6^{ab}
Chloride (mg/l)	Wet	30.12±1.0^{cd}	30.10±1.3^{cd}	19.50±2.0^{d}	16.00±1.3^{dc}	32.75±1.6^{c}	15.80±0.2^{de}	13.50±1.2^{e}	698.5±0.3^{a}	19.70±1.3^{d}	63.20±1.1^{b}	24.10±1.3^{bc}
	Dry	25.20±1.1^{d}	25.20±1.3^{d}	14.40±0.9^{f}	10.80±0.8^{g}	28.80±1.7^{c}	10.80±0.9^{g}	18.00±1.3^{e}	694.80±72.1^{a}	4.40±0.1^{b}	57.60±1.1^{b}	18.00±0.9^{e}
Sulphate (mg/l)	Wet	0.410±0.01^{c}	0.368±0.03^{e}	4.10±1.3^{cd}	4.21±1.1^{cd}	5.92±2.0^{c}	3.64±0.2^{b}	5.36±0.2^{d}	32.31±0.1^{g}	3.80±0.1^{b}	6.10±0.1^{e}	9.21±0.2+f
	Dry	0.212±0.01^{f}	0.169±0.1^{f}	3.90±0.3^{d}	3.80±0.4^{d}	5.71±1.3^{c}	3.43±1.3^{d}	5.20±7.1^{c}	32.09±3.7^{a}	3.43±1.3^{d}	5.71±1.2^{c}	8.84±2.3^{b}
Carbonate (mg/l)	Wet	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	Dry	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bicarbonate (mg/l)	Wet	146.20±15.0^{bc}	136.60±12.3^{c}	81.90±1.2^{de}	91.20±0.9^{de}	103.50±1.3^{d}	94.90±0.1^{de}	150.20±12.5^{b}	621.80±0.1^{a}	47.30±1.1^{e}	127.00±11.3^{cd}	160.00±15.5^{b}
	Dry	103.70±13.7^{d}	97.60±4.9^{e}	42.70±2.1^{g}	42.70±2.0^{g}	97.60±3.7^{e}	50.90±2.2^{f}	109.80±16.1^{d}	579.50±27.9^{a}	42.70±6.3^{g}	122.00±11.3^{b}	115.90±19.7^{c}
Phosphate (mg/l)	Wet	0.115±1.0^{bc}	0.125±0.01^{e}	1.560±0.1^{ab}	0.750±0.1^{bc}	0.928±1.0^{b}	1.50±1.3^{jk}	0.670±0.2^{h}	3.450±0.11	0.315±1.3^{cd}	0.091±1.2^{a}	0.890±0.1^{ij}
	Dry	0.085±0.01^{e}	0.093±0.03^{e}	0.977±0.04^{b}	0.111±0.06^{d}	0.127±0.01^{d}	0.886±0.03^{bc}	0.495±0.09^{c}	2.770±1.3^{a}	0.012±0.01^{g}	0.048±0.02^{f}	0.414±0.06^{c}
Nitrate (mg/l)	Wet	11.508±1.0^{d}	10.605±0.2^{d}	16.810±1.0^{d}	8.120±1.3^{e}	5.70±1.6^{ef}	7.205±0.2^{de}	195.80±11.0^{a}	104.120±1.7^{b}	36.550±1.3^{c}	10.206±1.1^{d}	11.530±0.6^{d}
	Dry	9.102±1.1^{e}	8.405±1.0^{e}	12.915±6.7^{d}	4.018±2.1^{f}	3.608±1.0^{f}	4.305±0.9^{f}	17.548±1.3^{b}	84.091±1.0^{a}	16.482±6.3^{c}	9.708±0.3^{e}	8.528±1.00^{e}
Total Hardness (mg/l)	Wet	1.500±0.01^{ab}	1.380±1.2^{b}	1.000±0.1^{d}	1.000±0.1^{d}	1.210±0.3^{c}	1.750±0.1^{a}	1.670±0.1^{a}	1.455±0.3^{ab}	1.400±0.1^{ab}	1.241±0.2+c	1.350±0.2^{b}
	Dry	1.000±0.1^{a}	0.890±0.01^{b}	0.500±0.02^{e}	0.450±0.01^{e}	0.710±0.03^{d}	1.00±0.01^{a}	0.990±0.1^{b}	0.755±0.2^{d}	0.805±0.1^{c}	0.43±0.3^{f}	0.725±0.1^{e}
BOD (mg/l)	Wet	3.70±1.2^{f}	3.90±1.0^{f}	166.50±10.0^{c}	123.50±13.2^{d}	192.40±11.3^{ab}	124.00±9.0^{d}	190.0±11.0^{ab}	200.60±15.1^{a}	185.50±13.7^{b}	150.0±11.0^{cd}	19.80±1.6^{e}
	Dry	126.50±21.0^{g}	130.80±11.0^{f}	196.20±13.0^{cd}	143.50±15.1^{e}	202.60±21.0^{d}	104.3±15.3^{h}	216.3±23.7^{b}	226.80±37.9^{a}	209.30±21.0^{c}	187.4±19.00^{d}	214.9±16.8^{b}
COD (mg/l)	Wet	12.30±1.6^{e}	15.70±1.3^{e}	280.50±17.3^{bc}	266.30±19.4^{cd}	328.50±22.8^{b}	245.70±13.3^{d}	355.7±21.0^{ab}	366.20±30.6^{a}	352.0±28.6^{ab}	281.5±23.8^{bc}	357.9±28.0^{ab}
	Dry	240.50±20.0^{f}	260.00±11.0	314.60±41.0^{e}	297.40±16.8^{cd}	368.90±16.3^{ab}	279.80±18.0^{d}	384.6±21.0^{a}	386.40±18.0^{a}	372.6±19.3^{ab}	308.5±18.0^{c}	377.8±16.0^{ab}

ND = Not Detectable; Sg: ($p < 0.05$) between the mean of wet and dry season and between the locations; *Mean values followed by the superscript in each row are not significant different ($p < 0.05$)

Table 3: Number of individuals sampled and diversity parameters for each samples site of Wetland area in Oyo State.

Species	LG_1		LG_2		LG_3		LG_4		LG_5		LG_6		LG_7		LG_8		LG_9		LG_{10}		LG_{11}	
	Dry	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**
Oreochromis niloticus	263	222	291	261	401	321	342	274	381	219	1644	1113	190	160	160	120	408	364	420	320	299	192
Tilapia zillii	87	87	92	90	138	138	122	123	54	66	324	319	56	48	30	30	126	126	151	159	66	60
Sarotherodon melanotheron	87	75	156	102	143	102	111	90	92	78	308	276	43	33	55	45	94	72	81	60	82	75
Sarotherodon galilaeus	67	45	78	66	83	63	67	57	47	36	215	198	77	57	47	36	91	71	64	54	52	42
Parachanna obscura	55	45	66	51	49	38	46	35	48	38	253	100	58	48	31	19	57	47	71	63	46	35
Gymnarchus niloticus	66	50	64	48	63	54	48	36	62	49	256	211	43	17	52	0	38	38	48	44	40	36
Lates niloticus	108	115	72	96	44	32	58	38	63	46	159	138	41	36	19	18	36	26	46	36	43	21
Clarias gariepinus	98	86	83	65	72	59	111	98	176	149	1803	305	157	102	102	95	196	156	281	211	762	502
Heterobranchus bidorsalis	138	130	142	136	169	159	188	168	87	67	533	626	103	96	46	36	79	68	98	78	203	191
Chrysichthys nigrodigitatus	45	39	42	36	25	18	16	16	29	24	368	228	0	0	0	0	39	26	0	18	0	0
Synodontis membranaceus	42	36	38	25	28	18	29	19	36	29	160	132	8	0	0	0	22	11	0	8	0	0
Richness	0.26	0.17	0.40	0.15	0.25	0.30	0.32	0.29	0.34	0.39	0.42	0.41	0.32	0.30	0.30	0.28	0.41	0.34	0.35	0.39	0.35	0.28
Evenness	0.49	0.45	0.50	0.46	0.51	0.46	0.49	0.43	0.53	0.51	0.60	0.58	0.49	0.44	0.48	0.42	0.55	0.53	0.54	0.50	0.49	0.46
Shannon Diversity (H*)	1.10	1.00	1.10	0.97	1.25	1.15	1.05	0.95	1.30	1.22	1.55	1.30	1.35	1.10	0.92	0.84	1.15	1.00	1.10	1.00	0.97	0.93

DISCUSSION

The pH range recorded during the period of study could be considered as being within the limit for aquatic life survival in water with the exception of pH of 5.00 from Ajinapa, which is below the limit. The low level of pH is known to increase the toxicity of sulphides and cyanides. (Dupress and Hurer, 1984). The pH of the environment into which a pollutant is deposited may influence the chemical form, the solubility and its toxicity to exposed biota (Sheehan, 1984). Hodson et al. (1978) reported that a decrease in pH of 1 unit from any reference (pH 6-10) resulted in an increase of lead by a factor of 2:1 in the blood of exposed rainbow trout. pH changes can drastically affect the structure and function of the ecosystem both directly and indirectly. It could lead to increasing concentration of really metals in the water through increased leaching from sediments (Ajao, 1989). Ovie and Adedeji (1990) stated that low pH creates a stress situation in most organisms resulting in a decrease in metabolic rates. The nitrate and phosphate level in Ajinapa are higher than permissible limit standard of FEPA (1991). Although nitrate is an essential nutrient but at higher concentration, it becomes toxic and capable of disturbing the aquatic environment. Input of phosphate into a river or stream comes from erosion, agrochemicals, detergents and the draining of wetlands (Vannote et al., 1980).

The conductivity values of dry and wet seasons are within the medium. The conductivity of natural water is a measure of its ability to convey an electrical current and in general the greater the concentration of ions in natural water, the larger the conductivity (Boyd and Lichtokoppler, 1979). High conductivity is synonymous with high nutrient content as asserted by Egborge (1970). Oladimeji and Wade (1984), who in their studies noted that conductivity was highest in the areas with use of agrochemical.

Turbidity in dry and wet seasons of the location studied is beyond the WHO standard with the exception of Tola and Ejioku in wet seasons. This implies that the turbidity of Tola and Ejioku are within the tolerance level while the others values are beyond the tolerance level. The bicarbonate level was highest in the rainy seasons than in the dry seasons because of the intensive use of agrochemicals. The highest level of bicarbonate in Ajinapa could be due to run off of agrochemicals into the river or streams and this agrees with the report of Ovie and Adedeji (1990).

The level of total hardness of water in all locations during dry and wet seasons showed that the level of total hardness is below permissible limit (FEPA, 1991). However, the desirable level of total hardness for fish culture generally is 20 mg/l (Boyd and Lichtokopper, 1979) hence, fish growth in these locations may be impaired.

The BOD was observed to be higher in dry and wet season beyond the FEPA permissible limit standard with the exception of Tola and Ejioku in wet seasons. Unpolluted, natural waters will have a BOD of 5 mg/l or less. Aysel et al. (2005) also reported that excessive fertilizer entering water bodies might affect the BOD that is a threat to survival of fish. Thus the role of fertilizers as pollutant must be taken seriously too, as they are likely to cause problems to aquatic organisms. COD exhibited the same trend as that of BOD in dry and wet seasons.

The high level of COD indicated that there was decomposition of organic and inorganic compounds in the water, which is as the result of agrochemicals usage that requires high level of oxygen. Similar observation was made by Wooton (1992), who stated that low oxygen concentrations in water were often caused by presence of decaying organic matter and agrochemicals, which generates toxic gases such as hydrogen sulphide and methane.

The number of species recorded during the study was below the number reported by Akinyemi (1987). This might be due to increase in level of human activities in the areas over time. This also agreed with observation of Omitoyin and Ajani (2007) that various anthropogenic activities along the same lakes especially users of agrochemicals among others are responsible for loss of biodiversity in some of the lakes/dams in Oyo State.

High level of fish biodiversity in terms of abundance and distribution observed in Papa-Eleye may be linked to low intensity of agricultural activities in this area. Ajinapa had the lowest distribution and abundance of fish species in all the locations in Oyo State; this may not be unconnected to high level of agricultural activities in this area. This is in line with observation of UNCTAD (2002) that uses of agrochemicals and other activities that lead to environment degradation have been threatening biodiversity all over the world. The highest biomass was observed during the dry seasons and this may be linked to low level of water that facilitate catches and this agreed with the observation of Omitoyin and Ajani (2007) that the highest catch of fish during the dry seasons at Asejire and Eleyele lakes of Oyo State was due to low level of water. The spatial and seasonal differences recorded in fish species diversity and richness may be connected with the prevailing ecology conditions such as the level of pollution in the study sites and depth of investigation. In modern day aquatic ecological studies, having good knowledge of the various environmental factors in relation to patterns of distribution and abundance of aquatic life is one of the most pressing issues. This study shows that fish abundance and distribution are vulnerable to variation in the physical and chemical factors of their environment especially where these factors are limiting.

Conclusion

This study established that some of the physico-chemical parameters of the water at wetland areas were higher than FEPA's limit for industrial and agricultural discharge. In the two years of survey, it was found that the water and fish samples from Ajinapa in Surulere Local Government area of Oyo State received highest levels of pollution. Also a survey of physico-chemical parameters is the locations in Oyo State revealed that the high level of Biological Oxygen Demand and Chemical Oxygen Demand indicated decomposition of organic and inorganic compound in the water. Distribution and abundance of fish species depend mainly on the series of complex interactions between components of the environment. Agricultural pollutions through the use of agrochemicals are among the major primers mechanism that are responsible for biodiversity loss of Ajinapa location. These interacting are seasons induced depending on the prevailing conditions of the environment. There is need to enforce sticker treatment regimes and emissions standards in order to reverse the observed increase in water pollution. The ecosystem of the wetland areas should be monitored at least once every four years and the polluted aquatic ecosystem should be bioremediated.

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