Bio-Ecological Studies of The Upper River Niger at Lokoja, Kogi State

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***Abstract*: This study was carried out to investigate the bio-ecology of the Upper River Niger at Lokoja, Kogi State. Sampling points were chosen based on the human activities of the area, five sampling points of station 1,2,3,4 and 5 were considered, these areas are Ganaja Village, Gadumo, Adankolo, Kpata market and New Market. Analysis of the water samples for Water temperature, pH, water depth, turbidity and electrical conductivity were determined in situ. Analysis for the various physicochemical parameters were done using the method described by APHA (1998). A total number of 5505 fish were caught, belonging to twenty (20) fish species in 11 fish families. These fish species are Arius gigas, Bagrus bayad macropterus, Bagrus domac niger, Chromidotilapia guntheri, Citharus latus, Gnathonemus tamandua, Heterobranchus longifilis, Heterotis niloticus, Hydrocynus brevis, Hydrocynus lineatus, Malapterurus electricus, Marcusenius brachistius, Mormyrops deliciousus, Mormyrus macrophthalmus, Oreochromis niloticus, Parachanna obseura, Synodontis budgetti, Synodontis courteti, Tilapia guineensis and Tilapia zilli. Significant variation ($p \leq 0.05$) exists between the wet and dry seasons in the physico-chemical parameters of Upper River Niger, Kogi State; electrical conductivity (wet: 0.07, dry: 0.44), total dissolved solids (wet: 57.43, dry: 155.73), sulphate (wet: 0.86, dry: 2.76), sodium (wet: 7.73, dry: 5.11), total hardness (wet: 6.77, dry: 7.68), magnesium (wet: 0.63, dry: 5.49), nitrate (wet: 0.58, dry: 1.32) and temperature (wet: 29.23, dry: 25.50) while no significant variation ($p > 0.05$) exist in the iron (wet: 0.5, dry: 0.65), dissolved oxygen (wet: 6.28, dry: 6.59) and pH (wet: 7.56, dry: 6.99). This study revealed that Upper River Niger at Lokoja is gradually deteriorating, as well as there is reduction in fish species diversity as a result of over exploitation. There is therefore the need for the government to develop policies that will help in the controlled use of the River.**

***Key Word*: Bio-Ecological Studies, Upper River Niger, Physico chemical Parameters.**

I. INTRODUCTION

Fish are important in that they contribute as much as 17% of the world's animal protein. Inland fisheries play an important role in the provision of protein to Nigerians with a high population of about 178.5 million people (FDF, 2007), especially when imported fish is becoming too expensive for low income earners as observed by Olusola and Arawomo (2008).

In Nigeria, studies of fish biodiversity, distribution, abundance and yield of most of the inland lacustrine water bodies have been limited to large sized water bodies (>1,000 ha) which include mainly Kainji, Jebba, Shiroro, Tiga, Bakolori and Goronyo among others as stated by Balogun (2006).

A review of the Nigerian fish fauna reveals that there are about 511 fish families in Nigeria (Ita, 1993). About 34% of these species are restricted to exclusive economic zone (EEZ) while approximately 44% are freshwater fisheries inhabiting water of very low salinity of below 1ppt (part per thousand) or below conductivity of 1000µs/cm.

Fisheries resources are on the decline in Nigeria due to over exploitation and inadequate management of the coastal waters. For sustainability of these resources, an adequate knowledge of species composition, diversity and relative abundance of the water bodies must be understood and vigorously pursued (Lawson, 2010). Biodiversity is often ambiguously misused or overused to describe the population dynamics of a location or community, but in the real sense, it is a measure of the members of species that make up a biological community and is considered to be one of the most important aspects of community organization and structure. Species richness and relative abundance describe key elements of biodiversity.

Lokoja is privileged to be the place where river Niger and river Benue converge. River Niger from its origin in the Guinean highlands in Guinea passed through Mali, Niger, Benin Republic (4 countries) before reaching Nigeria.

The river is a major source of economic activities for inhabitants across the rivers banks and a natural habitat for aquatic animals.

The poor output from local fisher men had become worrisome. Is on this premise this research is to find out the condition factor of the available fish. For effective fisheries, development and management of the Upper River Niger at Lokoja.

In actualizing the aim of the study, null hypotheses were formulated to guide the study:

Ho_1: the fish species of the upper river Niger at Lokoja is not diversified

Ho_2: the fish species of the upper river Niger at Lokoja is not prolific

II. METHODOLOGY

Lokoja is a city in Nigeria. It lies at the confluence of the Niger and Benue rivers and is the capital of Kogi State, located between latitude 7^0 45 N to longitude 6^0 45 E. Most of the town's landscape slopes to the river so that run–off from the town finally ends in the river. Commercial and agricultural activities predominate in the area.

The sampling area is located in River Niger Kogi State. Sampling points were chosen based on the human activities of the area. Five sampling points of station 1,2,3,4 and 5 were considered, showing the map of the study area with their coordinates.

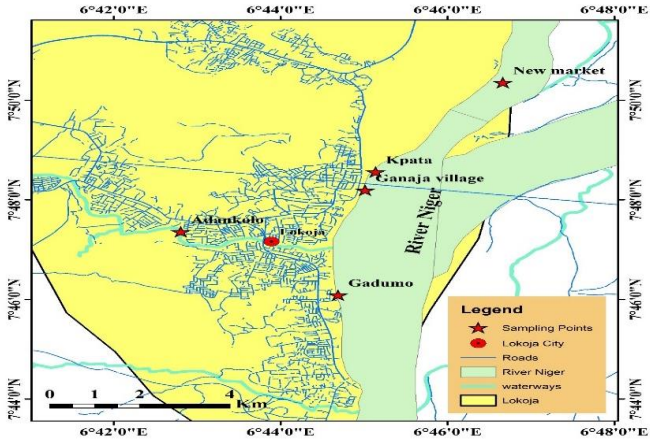

Figure 1: Map of Upper River Niger Showing Sampling Stations

Source: Geography Department Kogi State University Lokoja.

Descriptive statistics was used to determine (means and standard deviations), percentage abundance for individual species and monthly abundance**.** The physico-chemical parameters were subjected to one-way analysis of variance (ANOVA) to determine significant differences at $p \leq 0.05$. Correlation of physico-chemical parameters against fish abundance was performed. *Relative Abundance of Fish:* The species abundance was calculated as the percentage of each species represented in the total catch for each sampling point. Catch data was averaged within monthly time intervals and expressed as average monthly catches for the water body as described by Alphonse and Rudi (1995). The relative abundance was calculated as follows:

$$\text{Relative abundance} = \frac{\text{Frequency of species x 100}}{\text{Frequency of all species}} \quad \ldots\ldots (1)$$

III. RESULTS AND DISCUSION

Some Fish Species Composition of Upper River Niger, Lokoja

A total number of 5505 fish were caught, belonging to twenty (20) fish species, 11 fish families. These fish species are *Arius gigas*, *Bagrus bayad macropterus*, *Bagrus domac niger*, *Chromidotilapia guntheri*, *Citharus latus*, *Gnathonemus tamandua*, *Heterobranchus longifilis*, *Heterotis niloticus*, *Hydrocynus brevis*, *Hydrocynus lineatus*, *Malapterurus electricus*, *Marcusenius brachistius*, *Mormyrops deliciousus*, *Mormyrus macrophthalmus*, *Oreochromis niloticus*, *Parachanna obseura*, *Synodontis budgetti*, *Synodontis courteti*, *Tilapia guineensis* and *Tilapia zilli* (Table 1) while the families are Arridae (4.58%), Bagridae (8.90%), Channidae (5.65%), Characidae (10.23%), Cichlidae (20.05%), Citharinidae (5.01%), Clariidae (5.52%), Malapteruridae (3.58%), Mochokidae (10.79%), Mormyridae (21.09%) and Osteoglossidae (4.61%) (Table 1). Family Mormyridae has the highest domination while Malapteruridae has the lowest. Cichlidae and Momyridae has the highest number of fish species having four species each while the families with the lowest fish species are Arridae, Channidae, Citharinidae, Clarridae, Malapteruridae, Osteoglossidae have one specie each.

Table 1: Fish Species found at the Confluence of Rivers, Lokoja.

Family	Fish Species	Total Number (%)
Arridae	Arius gigas	252 (4.58)
		252 (4.58)
Bagridae	Bagrus bayad macropterus	208 (3.78)
	Bagrus domac niger	282 (5.12)
		490 (8.90)
Channidae	Parachanna obseura	311 (5.65)
		311 (5.65)
Characidae	Hydrocynus brevis	324 (5.88)
	Hydrocynus lineatus	239 (4.34)
		563 (10.23)
Cichlidae	Chromidotilapia guntheri	184 (3.34)
	Oreochromis niloticus	404 (7.34)
	Tilapia guineensis	256 (4.65)
	Tilapia zilli	260 (4.72)
		1104 (20.05)
Citharinidae	Citharus latus	276 (5.01)
		276 (5.01)
Clariidae	Heterobranchus longifilis	304 (5.52)
		304 (5.52)
Malapteruridae	Malapterurus electricus	197 (3.58)
		197 (3.58)
Mochokidae	Synodontis budgetti	258 (4.69)
	Synodontis courtteti	336 (6.10)
		594 (10.79)
Mormyridae	Gnathonemus tamandua	343 (6.23)

	Marcusenius brachistius	249 (4.52)
	Mormyrops deliciousus	262 (4.76)
	Mormyrus macrophthalmus	307 (5.58)
		1161 (21.09)
Osteoglossidae	Heterotis niloticus	254 (4.61)
		254 (4.61)
	Total	5506

Fish Species Diversity

The diversity indices of the fish species in Upper part of River Niger at Lokoja was determined using simpsons index diversity. Bearing in mind the number of species present with the abundance of each specie and the total fish counted. The formula is: SID=1-D

Where D is the measure of diversity computed as follows:

$$D = \frac{n_1(n_1 - 1) + n_2(n_2 - 1) + n_3(n_3 - 1) + n_4(n_4 - 1) + n_x(n_x - 1)}{N(N - 1)}$$

In this formula, n_1 is the count of the first specie, n_2 is the count of the second species and so on down to n_k. Nis the total number of organisms of all species counted, k is the number of species and D is diversity.

The Simpson diversity index of the 20 fish species ranges from 0.94 to 0.95. The least Simpson index were observed in Jul., Aug, sept., Dec., Jan., with (0.94) while the highest index of 0.95 were observed in Oct., Nov., Feb.,

The Shannon index for the fish species showed that all the fish occurred in high number with Shannon index of more than one (1). The highest Shannon index of 2.97 was observed in nov., other fish species that have Shannon index of ≥2 were observed in Jul., Aug., Sept., Oct., Dec., Jan., Feb. The measurement of how evenly distributed the fish species was observed in Nov. the most evenly distributed fish species with an evenness value of 0.97, followed by Aug (0.96) Feb (0.96) Oct (0.95) Jul (0.94) Sept (0.94) Jan (0.94) and the least was in Dec (0.91).

Table 2: Diversity Indices of Fish Species in Upper Part of River Niger, Lokoja.

Months	Dominance_D	Simpson_1-D	Shannon_H	Evenness_e^H/S
July	0.06 (0.06 - 0.06)	0.94 (0.94 - 0.94)	2.93 (2.88 - 2.94)	0.94 (0.89 - 0.95)
August	0.06 (0.06 - 0.06)	0.94 (0.94 - 0.94)	2.91 (2.86 - 2.91)	0.96 (0.92 - 0.97)
September	0.06 (0.05 - 0.06)	0.94 (0.94 - 0.95)	2.94 (2.89 - 2.94)	0.94 (0.90 - 0.95)
October	0.05 (0.05 - 0.06)	0.95 (0.94 - 0.95)	2.95 (2.91 - 2.95)	0.95 (0.91 - 0.96)
November	0.05 (0.05 - 0.06)	0.95 (0.94 - 0.95)	2.97 (2.94 - 2.97)	0.97 (0.95 - 0.98)
December	0.06 (0.06 - 0.06)	0.94 (0.04 - 0.94)	2.91 (2.88 - 2.92)	0.91 (0.89 - 0.93)
January	0.06 (0.05 - 0.06)	0.94 (0.94 - 0.95)	2.94 (2.88 - 2.94)	0.94 (0.89 - 0.95)
February	0.05 (0.05 - 0.06)	0.95 (0.94 - 0.95)	2.95 (2.91 - 2.96)	0.96 (0.91 - 0.97)

Mean Monthly Occurrence of Fish Species in Upper River Niger

The monthly occurrence of the fish species in the Upper River Niger, Lokoja is presented in table 3. The highest occurrence of fish species was in the month of December (22.76%, 1253 fishes) followed by November (18.11%, 997 fishes) and October (12.57%, 692 fishes) while January (8.23%, 453 fishes) had the least number of fish occurrence. Comparison of the fish species that occurred most revealed that *O. niloticus* had the highest occurrence of 7.34% (404 fishes), followed by *G. tamandua* (6.23%, 343 fishes) and *S. courteti* (6.10%, 336 fishes). *C. guntheri* had the least occurrence of 3.34% (184 fishes) (Table 3). The study revealed that 15 fish species had their highest occurrence in the month of December i.e. *A. gigas* (26.59%), *G. tamandua* (20.99%), *H. longifilis* (30.26%), *H. niloticus* (24.80%), *H. brevis* (28.09%), *M. branchistius*(28.51%), *M. deliciousus* (24.43%), *O. niloticus* (29.70%), *P. obseura* (25.08%), *S. budgetti* (23.26%), *S. courteti* (27.68%) and *T. guineensis* (19.92%) while 5 of the fish species occurred most in November i.e. *C. guntheri* (25.54%), *H. lineatus* (25.52%), *M. electricus* (21.83%), *M. macrophthalmus* (20.20%) and *T. zilli* (23.08%) (Table 4.4). Majority of the fish species had their least occurrence in the month of January and February during the dry season. *C. guntheri* (4.35%), *C. latus* (8.70%), *O. niloticus* (6.19%), *P. obseura* (7.07%), *T. guineensis* (7.42%) and *T. zilli* (6.15%) had their least occurrence in January while *A. gigas* (7.94%), *H. longifilis* (5.26%), *M. deliciousus* (6.44%), *S. budgetti* (5.04%), *S. courteti* (5.06%) had their least occurrence in February (Table 3).

Table 3: Monthly Occurrence of Fish Species in River

Fish Species	July	August	September	October	November	December	January	February	Total
Arius gigas	27 (10.71)	20 (7.94)	21 (8.33)	22 (8.73)	48 (19.05)	67 (26.59)	27 (10.71)	20 (7.94)	**252 (4.58)**
Bagrus bayad macropterus	23 (11.06)	25 (12.02)	28 (13.46)	10 (4.81)	39 (18.75)	47 (22.60)	12 (5.77)	24 (11.54)	**208 (3.78)**
Bagrus domac niger	12 (4.26)	36 (12.77)	28 (9.93)	48 (17.02)	43 (15.25)	74 (26.24)	17 (6.03)	24 (8.51)	**282 (5.12)**
Chromidotilapia guntheri	21 (11.41)	20 (10.87)	10 (5.43)	20 (10.87)	47 (25.54)	40 (21.74)	8 (4.35)	18 (9.78)	**184 (3.34)**
Citharus latus	34 (12.32)	24 (8.70)	25 (9.06)	43 (15.58)	32 (11.59)	64 (23.19)	24 (8.70)	30 (10.87)	**276 (5.01)**
Gnathonemus tamandua	54 (15.74)	13 (3.79)	28 (8.16)	56 (16.33)	58 (16.91)	72 (20.99)	39 (11.37)	23 (6.71)	**343 (6.23)**
Heterobranchus longifilis	20 (6.58)	27 (8.88)	38 (12.50)	32 (10.53)	57 (18.75)	92 (30.26)	22 (7.24)	16 (5.26)	**304 (5.52)**
Heterotis niloticus	37 (14.57)	33 (12.99)	18 (7.09)	30 (11.81)	37 (14.57)	63 (24.80)	14 (5.51)	22 (8.66)	**254 (4.61)**
Hydrocynus brevis	29 (8.95)	24 (7.41)	30 (9.26)	32 (9.88)	54 (16.67)	91 (28.09)	34 (10.49)	30 (9.26)	**324 (5.88)**
Hydrocynus lineatus	23 (9.62)	14 (5.86)	38 (15.90)	38 (15.90)	61 (25.52)	19 (7.95)	15 (6.28)	31 (12.97)	**239 (4.34)**
Malapterurus electricus	18 (9.14)	25 (12.69)	13 (6.60)	36 (18.27)	43 (21.83)	18 (9.14)	18 (9.14)	26 (13.20)	**197 (3.58)**
Marcusenius branchistius	31 (12.45)	0 (0.00)	8 (3.21)	45 (18.07)	31 (12.45)	71 (28.51)	29 (11.65)	34 (13.65)	**249 (4.52)**
Mormyrops deliciousus	17 (6.49)	31 (11.83)	32 (12.21)	33 (12.60)	46 (17.56)	64 (24.43)	22 (8.40)	17 (6.49)	**262 (4.76)**
Mormyrus macrophthalmus	30 (9.77)	36 (11.73)	24 (7.82)	34 (11.07)	62 (20.20)	46 (14.98)	33 (10.75)	42 (13.68)	**307 (5.58)**
Oreochromis niloticus	56 (13.86)	32 (7.92)	30 (7.43)	33 (8.17)	75 (18.56)	120 (29.70)	25 (6.19)	33 (8.17)	**404 (7.34)**
Parachanna obseura	38 (12.22)	29 (9.32)	25 (8.04)	30 (9.65)	56 (18.01)	78 (25.08)	22 (7.07)	33 (10.61)	**311 (5.65)**
Synodontis budgetti	35 (13.57)	16 (6.20)	26 (10.08)	41 (15.89)	40 (15.50)	60 (23.26)	27 (10.47)	13 (5.04)	**258 (4.69)**
Synodontis courteti	27 (8.04)	22 (6.55)	31 (9.23)	49 (14.58)	67 (19.94)	93 (27.68)	30 (8.93)	17 (5.06)	**336 (6.10)**
Tilapia guineansis	35 (13.67)	20 (7.81)	38 (14.84)	25 (9.77)	41 (16.02)	51 (19.92)	19 (7.42)	27 (10.55)	**256 (4.65)**
Tilapia zilli	33 (12.69)	24 (9.23)	37 (14.23)	35 (13.46)	60 (23.08)	23 (8.85)	16 (6.15)	32 (12.31)	**260 (4.72)**
Total	600 (10.90)	471 (8.55)	528 (9.59)	692 (12.57)	997 (18.11)	1253 (22.76)	453 (8.23)	512 (9.30)	5506

Physicochemical Parameters of Upper River Niger at Lokoja, Kogi State

A total of eleven (11) physicochemical parameters were observed in the upper part of River Niger at Lokoja, Kogi State. Of these parameters, dissolved oxygen and nitrate were the two parameters that tends to be uniform across the months of sampling.

- *Temperature*

The temperature of the Upper River Niger ranges from 14.90 to 38.60℃ with an overall temperature of 27.36℃. The lowest temperature of 14.9℃ was in the month of December while the highest temperature of 38.60℃ was in the month of August. Significant variation ($p \leq 0.05$) exist in the average monthly temperature with February having the highest monthly temperature of 31.38℃ while January had the least with 22.40℃ (Table 4a).

- *Dissolved Oxygen*

Dissolved oxygen (DO) level in Upper River Niger ranges from 3.40 to 10.50 mg/l. The highest DO of 10.50 mg/l was observed in January while the lowest DO of 3.40 mg/l was observed in December (Fig. 24). The DO didn't differ significantly ($p>0.05$) across the months. The average monthly DO was highest in February with 7.23±1.37 mg/l while the least was in September with 6.05±0.49 mg/l (Table 4a).

- *Electrical Conductivity*

The electrical conductivity (EC) ranges from 0.03 to 0.26 µS/cm with the lowest EC of 0.03 µS/cm observed in September and October while the highest EC of 2.86 µS/cm was observed in January (Table 4). The average monthly EC revealed that January had the highest EC of 0.76 µS/cm which was similar to February (0.59 µS/cm) but significantly different from what was observed in the months of July to December (Table 4a).

Table 4a: Mean monthly Physicochemical Parameters of Upper River Niger at Lokoja, Kogi State

Months	Temperature (°C)	Dissolved Oxygen (mg/l)	Electrical Conductivity (µS/cm)	**pH**
July	28.88±1.32 (25.20 - 30.40)^{b}	6.28±0.15 (6.10 - 6.50)^{ab}	0.07±0.04 (0.05 - 0.14)^{c}	6.84±0.42 (5.90 - 8.50)^{a}
August	29.36±2.66 (20.20 - 38.60)^{b}	6.28±0.15 (6.10 - 6.50)^{ab}	0.07±0.04 (0.05 - 0.14)^{c}	8.02±4.80 (5.70 – 9.40)^{a}
September	29.28±1.34 (23.40 - 31.00)^{b}	6.05±0.49 (5.10 - 6.50)^{b}	0.09±0.05 (0.03 - 0.15)^{c}	6.85±0.32 (6.30 - 7.70)^{a}
October	29.40±1.85 (23.20 - 35.40)^{b}	6.51±0.75 (5.40 - 8.20)^{ab}	0.08±0.05 (0.03 - 0.15)^{c}	8.53±5.11 (5.20 – 13.70)^{a}
November	28.67±1.38 (27.30 - 35.10)^{b}	6.41±0.31 (6.10 - 7.20)^{ab}	0.06±0.03 (0.04 - 0.14)^{c}	6.80±0.40 (6.30 - 8.20)^{a}
December	19.54±3.44 (14.90 - 29.60)^{d}	6.43±1.9 (3.40 - 9.80)^{ab}	0.34±0.41 (0.10 - 1.16)^{bc}	7.21±0.61 (6.50 - 8.80)^{a}
January	22.40±3.63 (16.90 - 37.10)^{c}	6.3±1.87 (3.40 - 10.50)^{ab}	0.76±1 (0.13 - 2.86)^{a}	6.92±0.59 (5.20 - 8.40)^{a}
February	31.38±4.24 (26.50 - 38.40)^{a}	7.23±1.37 (4.30 - 8.80)^{a}	0.59±0.41 (0.12 - 1.17)^{ab}	7.04±0.62 (6.10 - 8.30)^{a}
Total	**27.36±4.68 (14.90 - 38.60)**	**6.44±1.11 (3.40 - 10.50)**	**0.26±0.47 (0.03 - 2.86)**	**7.28±4.31 (5.20 – 13.70)**
p Value	0.000*	0.455ns	0.000*	0.699ns

* - Significant at p≤0.05. Means along the same column with different alphabet(s) are significant at p≤0.05.

- pH

The pH of Upper River Niger ranges from 5.20 to 13.7 with an overall pH of 7.28 (Fig. 26). The highest monthly pH of 8.53 was observed in October, followed by August (8.02). No significant difference (p>0.05) in the pH across the months of sampling (Table 4a).

- Total Dissolved Solids

The total dissolved solids (TDS) of the water body ranges from 17 – 873mg/l with the lowest TDS of 17 mg/l observed in November while the highest TDS of 873mg/l was observed in January (Fig. 27). Comparison of the average monthly TDS revealed significant difference (p≤0.05) with December and January significantly different from the other months having an average monthly TDS of 200.9±215.04 mg/l and 188.7±242.11 mg/l respectively (Table 4b). The overall TDS of the water body is 106.58±146.91 mg/l.

- Total Hardness

The total hardness of the water in Upper River Niger ranges from 3.71 to 9.81 mg/l. The lowest total hardness value of 3.71 mg/l was observed in December while the highest total hardness value of 9.81 mg/l was observed in January. Comparison of the total hardness level across the months revealed significant difference (p≤0.05) with January, November, July, December and February have total hardness level significant from August, September and October. An overall total hardness level of 7.22 mg/l was observed (Table 4b).

- Iron

The iron (Fe) level of the water body ranges from 0.04 to 9.07 mg/l. the lowest Fe level of 0.04 mg/l was observed in the month of September while the highest Fe level of 9.07 mg/l was observed in January. Mean monthly Fe level was highest in January (1.84±2.88 mg/l) which was significantly different with the Fe level in the other months. December had the least average

Table 4b: Mean monthly Physicochemical Parameters of Upper River Niger at Lokoja, Kogi State

Months	Total Dissolved Solids (mg/l)	Total Hardness (mg/l)	**Iron (mg/l)**
July	55±27.45 (40.00 - 107.00)^{b}	7.72±0.52 (7.05 - 8.35)^{ab}	0.58±1.24 (0.06 - 4.10)^{b}
August	55±27.45 (40.00 - 107.00)^{b}	7.13±0.94 (5.25 - 8.31)^{b}	0.33±0.47 (0.06 - 1.62)^{b}
September	57.8±21.71 (43.00 - 100.00)^{b}	6.12±1.2 (4.64 - 8.11)^{c}	0.29±0.42 (0.04 - 1.43)^{b}
October	61.9±32.53 (20.00 - 131.00)^{b}	6.11±0.86 (4.63 - 7.46)^{c}	0.79±0.9 (0.11 - 3.10)^{b}
November	56±28.45 (17.00 - 127.00)^{b}	7.65±0.82 (6.25 - 8.80)^{ab}	0.28±0.15 (0.10 - 0.61)^{b}
December	200.9±215.04 (95.00 - 773.00)^{a}	7.19±1.59 (3.71 - 8.83)^{ab}	0.25±0.12 (0.07 - 0.42)^{b}
January	188.7±242.11 (69.00 - 873.00)^{ab}	8.19±1.44 (5.25 - 9.81)^{a}	1.84±2.88 (0.11 - 9.07)^{a}
February	177.3±210.2 (77.00 - 773.00)^{ab}	7.7±0.52 (7.05 - 8.25)^{ab}	0.25±0.11 (0.10 - 0.43)^{b}
Total	**106.58±146.91 (17.00 - 873.00)**	**7.22±1.23 (3.71 - 9.81)**	**0.57±1.24 (0.04 - 9.07)**
p Value	0.026*	0.000*	0.048*

monthly Fe level of 0.25±0.12 mg/l which was not significant from February (0.25±0.11 mg/l), November (0.28±0.15 mg/l) and September (0.29±0.42 mg/l) (Table 4b).

- *Sulphate*

The overall sulphate level in Upper River Niger is 1.81 mg/l, it ranges from 0.16 to 8.21 mg/l with the lowest sulphate level of 0.16 mg/l observed in September while the highest sulphate level of 8.21 mg/l (Fig. 30). The average monthly sulphate level revealed that January (3.92±1.92) had the highest sulphate level which was not significant from what was observed in December (3.46±2.24 mg/l) and February (2.94±0.93 mg/l) and significantly different ($p \leq 0.05$) from the other months. October (0.74±0.61 mg/l) and November (0.71±0.45 mg/l) had the least sulphate level (Table 4c).

- *Sodium*

Sodium level observed in Upper River Niger significantly vary ($p \leq 0.05$) among the months. The sodium level ranges from 1.17 to 17.60 mg/l. The highest sodium level of 17.60 mg/l was observed in November while the least was observed in February. The average monthly sodium level was highest in November (9.52±4.43 mg/l) while the least was observed in January (3.42±1.74 mg/l) and February (3.44±1.80 mg/l) (Table 4c).

- *Magnesium*

An overall magnesium level of 3.06 mg/l was observed in the Upper River Niger. The magnesium level ranges from 0.22 to 9.42 mg/l with the highest Mg+ of 7.42 mg/l observed in December while the least Mg+ level of 0.22 mg/l observed in September. Monthly average Mg+ level revealed that January had the highest Mg+ level of 7.19 mg/l while the least average monthly Mg+ was in the month of September. Significant difference ($p \leq 0.05$) exist across the months (Table 4c).

Table 4c: Seasonal Variation in the Physicochemical Parameters of Upper River Niger at Lokoja, Kogi State

Seasons	Wet Season	Dry Season	Total	p Value
Electrical Conductivity (µS/cm)	0.07±0.01 (0.03 - 0.15)	0.44±0.10 (0.04 - 2.86)	0.26±0.05 (0.03 - 2.86)	0.000*
Total Dissolved Solids (mg/l)	57.43±4.21 (20 - 131)	155.73±30.84 (17 - 873)	106.58±16.42 (17 - 873)	0.002*
Iron (mg/l)	0.5±0.13 (0.04 - 4.1)	0.65±0.25 (0.07 - 9.07)	0.57±0.14 (0.04 - 9.07)	0.567ns
Dissolved Oxygen (mg/l)	6.28±0.08 (5.1 - 8.2)	6.59±0.24 (3.4 - 10.5)	6.44±0.12 (3.4 - 10.5)	0.212ns
Sulphate (mg/l)	0.86±0.07 (0.16 - 1.96)	2.76±0.31 (0.24 - 8.21)	1.81±0.19 (0.16 - 8.21)	0.000*
Sodium (mg/l)	7.73±0.43 (2.6 - 13.2)	5.11±0.58 (1.17 - 17.6)	6.42±0.39 (1.17 - 17.6)	0.001*
Total Hardness (mg/l)	6.77±0.18 (4.63 - 8.35)	7.68±0.19 (3.71 - 9.81)	7.22±0.14 (3.71 - 9.81)	0.001*
Magnesium (mg/l)	0.63±0.04 (0.22 - 1.55)	5.49±0.46 (0.45 - 9.42)	3.06±0.36 (0.22 - 9.42)	0.000*
Nitrate (mg/l)	0.58±0.04 (0.29 - 1.62)	1.32±0.30 (0.22 - 7.48)	0.95±0.15 (0.22 - 7.48)	0.016*
Temperature (°C)	29.23±0.17 (20.20 - 38.60)	25.50±0.53 (14.90 - 38.40)	27.36±0.30 (14.90 - 38.60)	0.000*
pH	7.56±0.55 (5.20 - 62.00)	6.99±0.05 (5.20 - 8.80)	7.28±0.28 (5.20 - 62.00)	0.308ns

ns – Not significant $p>0.05$, * - Significant at $p \leq 0.05$.

An overall nitrate level of 0.95 mg/l was observed in the study. Nitrate level ranges from 0.22 to 7.48 mg/l (Fig. 33). January (2.72±2.90 mg/l) had the highest nitrate level which was significantly different ($p \leq 0.05$) from the other months. The least nitrate level of 0.57 mg/l was observed in both July and August (Table 4c).

Seasonal Physicochemical Parameters of Upper River Niger at Lokoja, Kogi State

Comparison of the seasonal variation in the physic-chemical parameters of Upper River Niger, Kogi State revealed that significant variation ($p \leq 0.05$) exist in the electrical conductivity (wet: 0.07, dry: 0.44), total dissolved solids (wet: 57.43, dry: 155.73), sulphate (wet: 0.86, dry: 2.76), sodium (wet: 7.73, dry: 5.11), total hardness (wet: 6.77, dry: 7.68), magnesium (wet: 0.63, dry: 5.49), nitrate (wet: 0.58, dry: 1.32) and temperature (wet: 29.23, dry: 25.50) of the river while, no significant variation ($p>0.05$) exist in the iron (wet: 0.5, dry: 0.65), dissolved oxygen (wet: 6.28, dry: 6.59) and pH (wet: 7.56, dry: 6.99). All the physicochemical parameters measured were observed to be higher in the dry season than in the wet season except sodium, temperature and pH (Table 5).

Correlation of Physicochemical Parameters with Abundance of Fish Species of Upper River Niger at Lokoja

The effect of physicochemical on the abundance of fish species were assessed and presented in table 10a. Electrical conductivity was positively correlated to TDS (0.89), Fe (0.58), sulphate (0.92), total hardness (0.58), Mg (0.91) and nitrate (0.79) and negatively correlated to sodium (-0.90) and the distribution of *T. zilli* (-0.56).

Table 5: Seasonal Variation in the Physicochemical Parameters of Upper River Niger at Lokoja, Kogi State

Seasons	Wet Season	Dry Season	Total	p Value
Electrical Conductivity (µS/cm)	0.07±0.01 (0.03 - 0.15)	0.44±0.10 (0.04 - 2.86)	0.26±0.05 (0.03 - 2.86)	0.000*
Total Dissolved Solids (mg/l)	57.43±4.21 (20 - 131)	155.73±30.84 (17 - 873)	106.58±16.42 (17 - 873)	0.002*
Iron (mg/l)	0.5±0.13 (0.04 - 4.1)	0.65±0.25 (0.07 - 9.07)	0.57±0.14 (0.04 - 9.07)	0.567ns
Dissolved Oxygen (mg/l)	6.28±0.08 (5.1 - 8.2)	6.59±0.24 (3.4 - 10.5)	6.44±0.12 (3.4 - 10.5)	0.212ns
Sulphate (mg/l)	0.86±0.07 (0.16 - 1.96)	2.76±0.31 (0.24 - 8.21)	1.81±0.19 (0.16 - 8.21)	0.000*
Sodium (mg/l)	7.73±0.43 (2.6 - 13.2)	5.11±0.58 (1.17 - 17.6)	6.42±0.39 (1.17 - 17.6)	0.001*
Total Hardness (mg/l)	6.77±0.18 (4.63 - 8.35)	7.68±0.19 (3.71 - 9.81)	7.22±0.14 (3.71 - 9.81)	0.001*
Magnesium (mg/l)	0.63±0.04 (0.22 - 1.55)	5.49±0.46 (0.45 - 9.42)	3.06±0.36 (0.22 - 9.42)	0.000*
Nitrate (mg/l)	0.58±0.04 (0.29 - 1.62)	1.32±0.30 (0.22 - 7.48)	0.95±0.15 (0.22 - 7.48)	0.016*
Temperature (°C)	29.23±0.17 (20.20 - 38.60)	25.50±0.53 (14.90 - 38.40)	27.36±0.30 (14.90 - 38.60)	0.000*
pH	7.56±0.55 (5.20 - 62.00)	6.99±0.05 (5.20 - 8.80)	7.28±0.28 (5.20 - 62.00)	0.308ns

ns – Not significant p>0.05, * - Significant at p≤0.05.

Total dissolved solids was positively correlated to sulphate (0.98), magnesium (1.00), nitrate (0.68) and *M. deliciousus* (0.57) while negatively correlated to sodium (-0.94), temperature (-0.66) and *T. zilli* (-0.56).

Iron was positively correlated to nitrate (0.86) and negatively affect the distribution of *B. bayad macropterus* (-0.66), *T. guineensis* (-0.56) and *C. guntheri* (-0.50).

Dissolved oxygen was positively correlated to magnesium (0.50) and negatively correlated to sodium (-0.51).

Sulphate was positively correlated to sodium (0.50), total hardness (0.98) and magnesium (0.78) and negatively correlated to sulphate (-0.93), temperature (-0.67) and *T. zilli* (-0.62).

Sodium was positively correlated to temperature (0.50), *H. lineatus* (0.50) and T. zilli (0.67) and negatively correlated to total hardness (-0.94) and Magnesium (-0.64).

Total hardness was positively correlated to magnesium (0.51) and nitrate (0.51) and negatively correlated to pH (-0.54).

Magnesium was positively correlated to nitrate (0.68) and *M. brachistius* (0.52) and negatively correlated to temperature (-0.60) and *T. zilli* (-0.55).

Nitrate was negatively correlated to temperature (-0.72) and *T. zilli* (-0.58).

Temperature was negatively affected the distribution of the following species; *S. budgetti* (-0.64), *S. courteti* (-0.63), *G. tamandua* (-0.54), *C. latus* (-0.57), *M. deliciousus* (-0.58), *M. brachistius* (-0.59), *A. gigas* (-0.71), *H. brevis* (-0.74), *P. obseura* (-0.53), *H. longifilis* (-0.64) and *O. niloticus* (-0.60).

The correlation of the fish species against themselves revealed positive interaction among the fish species in Upper River Niger (Table 6b). The fish species exhibit positive correlation and positively support their distribution in the water body, an indication that most of the fish species are not carnivorous.

Table 6a: Correlation of Physicochemical Parameters of Upper River Niger at Lokoja, Kogi State

	EC	TDS	Fe	DO	SO3	Na+	TH	Mg	NO3	Temp	pH
EC	1.00										
TDS	0.89*	1.00									
Fe	0.58*	0.31	1.00								
DO	0.46	0.46	-0.19	1.00							
SO3	0.92*	0.98*	0.44	0.34	1.00						
Na+	-0.90*	-0.94*	-0.40	-0.51*	-0.93*	1.00					
TH	0.58*	0.47	0.36	0.28	0.50*	-0.30	1.00				
Mg	0.91*	1.00*	0.32	0.50*	0.98*	-0.94*	0.51*	1.00			
NO3	0.79*	0.68*	0.86*	-0.10	0.78*	-0.64*	0.51*	0.68*	1.00		
Temp	-0.43	-0.66*	-0.38	0.27	-0.69*	0.50*	-0.27	-0.60*	-0.72*	1.00	
pH	-0.30	-0.26	0.00	0.05	-0.31	0.09	-0.54*	-0.28	-0.21	0.18	1.00

EC- Electrical conductivity, TDS – total dissolved solids, Fe – Iron, DO – dissolved oxygen, SO3 – Sulphate, Na+ - sodium, TH – total hardness, Mg – Magnesium, NO3 – Nitrate, Temp – Temperature, pH – pH. * - Strong negative or positive correlation.

Table 6b: Correlation of Physico-chemical Parameters Against Fish Species in Upper River Niger.

\	EC	TDS	Fe	DO	SO3	Na+	TH	Mg	NO3	Temp	pH
SB	-0.21	0.14	-0.07	-0.26	0.09	0.01	-0.15	0.07	0.10	-0.64*	0.02
SC	-0.16	0.22	-0.22	-0.14	0.15	-0.02	-0.11	0.16	0.07	-0.63*	0.00
GT	-0.14	0.14	0.03	-0.12	0.08	0.00	0.02	0.09	0.12	-0.54*	-0.08
HN	-0.31	0.13	-0.47	-0.04	0.02	0.07	-0.01	0.07	-0.20	-0.47	0.09
CL	-0.06	0.37	-0.26	0.11	0.25	-0.27	-0.17	0.30	-0.02	-0.57*	0.18
MD	-0.24	0.16	-0.36	-0.22	0.09	0.05	-0.24	0.09	-0.02	-0.58*	0.07
MM	-0.01	0.14	-0.31	0.34	0.05	0.11	0.37	0.15	-0.07	-0.12	-0.15
BBM	-0.22	0.14	-0.66*	-0.05	0.07	0.13	0.07	0.11	-0.25	-0.34	-0.40
BDN	-0.21	0.20	-0.39	0.01	0.09	-0.07	-0.37	0.13	-0.11	-0.47	0.36
MB	0.25	0.57*	0.01	0.32	0.47	-0.48	0.09	0.52*	0.23	-0.59*	0.02
HL	-0.41	-0.44	-0.36	0.08	-0.49	0.50*	-0.24	-0.43	-0.45	0.43	-0.16
AG	0.00	0.38	-0.22	-0.08	0.31	-0.11	0.19	0.33	0.16	-0.71*	-0.26
HB	0.08	0.48	-0.24	-0.01	0.41	-0.25	0.08	0.42	0.18	-0.74*	-0.18
PO	-0.13	0.29	-0.45	0.07	0.19	-0.04	0.12	0.24	-0.09	-0.53*	-0.18
TG	-0.30	0.07	-0.56*	-0.15	0.00	0.13	-0.13	0.02	-0.27	-0.36	-0.42
Hlon	-0.17	0.25	-0.36	-0.19	0.18	-0.03	-0.15	0.18	0.01	-0.64*	-0.08
ON	-0.14	0.28	-0.40	-0.04	0.19	-0.03	0.12	0.23	-0.04	-0.60*	-0.22
CG	-0.34	-0.03	-0.50*	0.09	-0.13	0.29	0.13	-0.05	-0.26	-0.22	-0.09
TZ	-0.56*	-0.57*	-0.48	0.03	-0.62*	0.67*	-0.15	-0.55*	-0.58*	0.50*	-0.20
ME	-0.30	-0.33	-0.16	0.31	-0.41	0.38	-0.02	-0.31	-0.29	0.36	0.35

SB – *Synodontis budgetti*, SC – *Synodontis courtteti*, GT – *Gnathonemus tamandua*, HN – *Heterotis niloticus*, CL – *Citharus latus*, MD – *Mormyrops deliciousus*, MM – *Mormyrus macrophthalmus*, BBM – *Bagrus bayad* macropterus, BDN – *Bagrus domac* niger, MB – *Marcusenius brachistius*, HL – *Hydrocynus lineatus*, AG – *Arius gigas*, HB – *Hydrocynus brevis*, PO – *Parachanna obseura*, TG – *Tilapia guineensis*, HLon – *Heterobranchus longifilis*, ON – *Oreochromis niloticus*, CG – *Chromidotilapia guntheri*, TZ – *Tilapia zilli*, ME – *Malapterurus electricus*. * - Strong negative or positive correlation.

Table 6c: Correlation of Fish Species of Upper River Niger at Lokoja, Kogi State.

	SB	SC	GT	HN	CL	MD	MM	BBM	BDN	MB	HL	AG	HB	PO	TG	Hlon	ON	CG	TZ	ME
SB	1.00																			
SC	0.92*	1.00																		
GT	0.95*	0.83*	1.00																	
HN	0.77*	0.79*	0.67*	1.00																
CL	0.87*	0.83*	0.79*	0.86*	1.00															
MD	0.78*	0.94*	0.60*	0.77*	0.74*	1.00														
MM	0.34	0.58*	0.40	0.46	0.30	0.54*	1.00													
BBM	0.49	0.68*	0.37	0.73*	0.51*	0.76*	0.59*	1.00												
BDN	0.72*	0.87*	0.54*	0.77*	0.82*	0.93*	0.48	0.60*	1.00											
MB	0.79*	0.74*	0.83*	0.65*	0.90*	0.54*	0.38	0.33	0.62*	1.00										
HL	0.15	0.26	0.26	-0.06	-0.06	0.20	0.53*	0.22	0.12	0.01	1.00									
AG	0.83*	0.93*	0.76*	0.83*	0.77*	0.87*	0.64*	0.81*	0.74*	0.72*	0.12	1.00								

HB	0.83*	0.93*	0.73*	0.82*	0.84*	0.89*	0.56*	0.78*	0.81*	0.78*	0.06	0.98*	1.00							
PO	0.79*	0.89*	0.72*	0.92*	0.82*	0.84*	0.67*	0.86*	0.77*	0.72*	0.16	0.96*	0.94*	1.00						
TG	0.73*	0.76*	0.66*	0.71*	0.67*	0.72*	0.39	0.86*	0.57*	0.53*	0.34	0.80*	0.79*	0.84*	1.00					
Hlon	0.83*	0.95*	0.67*	0.81*	0.79*	0.98*	0.51*	0.82*	0.88*	0.62*	0.17	0.93*	0.95*	0.90*	0.82*	1.00				
ON	0.83*	0.88*	0.76*	0.93*	0.83*	0.83*	0.58*	0.85*	0.73*	0.72*	0.09	0.96*	0.94*	0.99*	0.86*	0.90*	1.00			
CG	0.64*	0.79*	0.64*	0.78*	0.58*	0.75*	0.88*	0.77*	0.67*	0.50*	0.47	0.82*	0.74*	0.88*	0.69*	0.75*	0.83*	1.00		
TZ	0.13	0.23	0.23	0.05	-0.08	0.18	0.56*	0.32	0.07	-0.08	0.96*	0.14	0.03	0.22	0.38	0.15	0.15	0.56*	1.00	
ME	0.11	0.25	0.22	0.09	0.03	0.18	0.71*	0.00	0.26	0.11	0.69*	0.10	0.02	0.16	-0.07	0.06	0.06	0.56	0.68*	1.00

* - Strong negative or positive correlation.

SB – Synodontis budgetti, SC – Synodontis courtteti, GT – Gnathonemus tamandua, HN – Heterotis niloticus, CL – Citharus latus, MD – Mormyrops deliciousus, MM – Mormyrus macrophthalmus, BBM – Bagrus bayad macropterus, BDN – Bagrus domac niger, MB – Marcusenius brachistius, HL – Hydrocynus lineatus, AG – Arius gigas, HB – Hydrocynus brevis, PO – Parachanna obseura, TG – Tilapia guineensis, HLon – Heterobranchus longifilis, ON – Oreochromis niloticus, CG – Chromidotilapia guntheri, TZ – Tilapia zilli, ME – Malapterurus electricus.

Series of factors were observed to affect the fish distribution in Mekong River ranging from over hydrological alteration, over exploitation of fish as well as introduction of exotic species. Water pollution was the most serious threat to fishes in the Upper Mekong (Kang *et al.*, 2009). Huang *et al.* (2011) observed that anthropogenic activities such as habitat alteration, overfishing, pollution and soil erosion have severely reduced the fish biodiversity in Poyang Lake Basin. Other factors such as the construction of dams, sand excavation as well as heavy metals pollution are of significant threat to fish diversity and ecosystem functioning in the area. Goren and Ortal (1999) reported that the range of fish species in a system is the product of evolutionary processes, such as speciation, extinction and colonization from other systems, all of which occur over time spans. They also stated that changes in aquatic ecosystems can alter the distribution of fish species as well as influence their evolution. Linde-Arias *et al.* (2008) stated that inland waters and freshwaters biodiversity constitute an essential natural resources and changes in this aquatic ecosystems can alter the fish assemblages and this can be used as good indicators of ecological health as demonstrated by the Index of Biotic Integrity for conservation of streams and rivers.

Some studies reported that sand extraction can damage the habitat required by fish for feeding, migration and reproduction (Zhong and Chen 2005; Huang and Gong 2007; Zhang and Huang 2008), this can also lead to increased turbidity of the waters (Yu and Sun 2006). Also, some studies reported that severe soil erosion and water losses due to a combination of high temperatures and precipitation, mountainous and hilly terrain, as well as various large scale construction activities (Li *et al.*, 2008a; Liang *et al.*, 2010) have led to alteration and loss of habitat which caused a great decline in fish resources (Zhong and Chen 2005) in different parts of the world.

Therefore, the low fish diversity in the Upper River Niger at Lokoja is as a result of anthropogenic activities including habitat alteration, overfishing, pollution and soil erosion. Among these, hydrological alterations of physical habitat through dam construction, sand excavation and heavy metal pollution are the most significant threats. Freshwater habitats are being subjected to unprecedented levels of human disturbance worldwide. Increased water demand for irrigation, industrial and domestic use already threatens freshwater resources in many parts of the world (Szöllosi-Nagy *et al.*, 1998). Species dependent on these freshwater habitats are in danger of disappearing.

Effect of Physico-chemical Parameters on Fish Composition and Biodiversity

Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent (Wang *et al*., 2002). Generally, pH between 7 to 8.5 is ideal for biological productivity. Fishes can become stressed in water with a pH ranging from 4.0 to 6.5 and 9.0 to 11.0 and death is almost certain at a pH of less than 4.0 or greater than 11.0 (Ekubo and Abowei, 2011). The pH of an aquatic system is an important indicator of the water quality and the extent of pollution in the watershed areas. The pH range of 6.84 to 8.53 observed in this study reflect a suitable environment for aquatic life.

Obtaining sufficient oxygen is a greater problem for aquatic organisms than terrestrial ones, due to the low solubility of oxygen in water and solubility decreases with factors like: increase in temperature, increase in salinity, low atmospheric pressure, high humidity, high concentration of submerged plants, plankton blooms. Oxygen depletion in water leads to poor feeding of fish, starvation, reduced growth and more fish mortality, either directly or indirectly (Bhatnagar and Garg, 2000). As a general rule, concentrations of DO above 5 mg/L are considered supportive of aquatic life, while concentrations below this are potentially harmful. The dissolved oxygen observed in this study is within the acceptable limit for aquatic life (U.S. EPA, 2000).

The temperature range observed in this study is within the acceptable limit. These values are within the temperature range for maximal growth rate, efficient food conversion, best condition of fish (South African Water Quality Guidelines, 1996).

High concentrations of total dissolved solids have several negative effects, such as decreasing the amount of light that can penetrate the water, thereby slowing photosynthetic processes which in turn can lower the production of dissolved oxygen, high absorption of heat from sunlight, thus increasing the temperature which can result to lower oxygen level low visibility which will affect the fish' ability to hunt for food; clog fish gills; prevent the development of egg and larva.

Nitrates are a form of nitrogen and a vital nutrient for growth, reproduction, and the survival of organisms. The nitrate level in this study is within the recommended level. Santhosh and Singh (2007) described the favourable range of 0.1 mg/L to 4.0 mg/L in fish culture water.

In this study, the correlation of physicochemical parameters against fish species abundance revealed significant effect of some of these factors on fish distribution. Temperature negatively affected the distribution of the following species; *S. budgetti, S. courteti, G. tamandua, C. latus, M. deliciousus, M. brachistius, A. gigas, H. brevis, P. obseura, H. longifilis and O. niloticus*.Total dissolved solids positively and negatively affected the distribution of *M. deliciousus* and *T. zilli* respectively. Magnesium positively and negatively affected the distribution of *M. brachistius* and *T. zilli* respectively. Iron negatively affect *B. bayad macropterus*, *T. guineensis*, *C. guntheri* and*H. lineatus* positively affected by sodium. Electrical conductivity and sulphate affects negatively the distribution of *T. zilli* while sodium affects it positively. In general, temperature, total dissolved solids, magnesium, iron, sodium and electrical conductivity significantly affected fish distributions and assemblage composition ($P<0.05$). Similar observation was reported by Petts (2000) who stated that these environmental factors also affected fish distributions and assemblage composition.

IV CONCLUSIONS

1. A total of 20 fish species belonging to 11 families were found in the Upper River Niger, Lokoja, Kogi State. These fish species are *Arius gigas*, *B. bayad macropterus*, *B. domac niger*, *C. guntheri*, *C. latus*, *G. tamandua*, *H. longifilis*, *H.niloticus*, *H. brevis*, *H. lineatus*, *M. electricus*, *M. brachistius*, *M. deliciousus*, *M. macrophthalmus*, *O. niloticus*, *P. obseura*, *S. budgetti*, *S. courteti*, *T. guineensis* and *T. zilli.*
2. The highest occurrence of fish species was in the month of December (22.76%, 1253 fishes) while January (8.23%, 453 fishes) had the least number of fish occurrence.
3. *O. niloticus* (7.34%) was the most abundant fish species in Upper River Niger, Lokoja, Kogi State.
4. Temperature, total dissolved solids, magnesium, iron, sodium and electrical conductivity were the physic-chemical parameters that affects the water quality, fish distribution and assemblage at the Upper River Niger, Lokoja, Kogi State.

V. RECOMMENDATIONS

1. The need to set up community-based committee to help pay attention in keeping pollution levels under control in this valuable, recreational and commercial water body through regular monitoring for its continued sustainability for human needs and the freshwater ecosystem is recommended.
2. The Kogi State government should develop policies that will restrict the type of fishing gear to be used in order to control over exploitation of the fish in the Upper River.
3. More individuals should be involved in culture fisheries by raising ponds where fish can be raised in order to reduce the stress and over exploitation on the River.
4. Further research should be carried out on some other fish species available in the water body.

REFERENCE

[1] APHA (2005) Standard Method for the Examination of Water and Waste Water.22nd edition. American Public Health Authority, Water Environmental Federation, Washinton D. C. 1280

[2] Araoye, P.A. (2008). Physical Factors and their Influence on Fish Species Composition in Asa Lake, Ilorin, Nigeria. International Journal of Tropical Biology, 57(1-2): 167-175.

[3] Balogun, J. K. (2006). Basic Fisheries Biology and Management for tertiary Institutions. Ayo-Sule (NIG) Printers & Publishers, Zaria, Nigeria.

[4] Bellingham, K. (2012). Physicochemical Parameters of Natural Waters: Stevens water monitoring systems. http://www.stevenswater.com/index.aspx

[5] Bhatnagar A., and Garg S. K. (2000). Causative factors of fish mortality in still water fish ponds under sub-tropical conditions. Aquaculture, 1, (2), 91-96.

[6] Ekubo A. A., and Abowei J. F. N. (2011). Review of some water quality management principles in culture fisheries, Research Journal of Applied Sciences, Engineering and Technology, 3, (2), 1342-1357.

[7] Federal Department of Fisheries (FDF) (2007). Fisheries Statistic of Nigeria, fourth edition 1995-2007. 49.

[8] Goren M, Ortal R (1999) Biogeography, diversity and conservation of the inland water fish communities in Israel. Biol Conserv 89:1–9.

[9] Huang, L.L., Wu, Z.Q. and Li, J.H. (2011). Fish fauna, biogeography and conservation of freshwater fish in Poyang Lake Basin, China. Environmental Biology of Fishes, 96:1229-1243.

[10] Ita, E .O. (1993). Inland Fishery Resources of Nigeria. Central Institute of Freshwater Aquaculture Occasional Paper, 20: 120-126.

[11] Kang, B., He, D., Perrett, L., Wang, H., Hu, W., Deng, W. and Wu, Y. (2009). Fish and fisheries in the Upper Mekong: current assessment of the fish community, threats and conservation. Reviews in Fish Biology and Fisheries, 1-16. http://dx.doi.org/10.1007/s11160-009-9114-5.

[12] Lawson O.E. (2010): Fish Diversity in Three Tributaries of River Ore, South-West, Nigeria. Journal of Fish Science, 2(6): 524-531.
[13] Linde-Arias AR, Incaio AF, Novo LA, de Alburquerque C, Moreira JC (2008) Multibiomarker approach in fish to assess the impact of pollution in a large Brazilian river, Paraiba do Sul. Environ Pollut 156:974–979.
[14] Mustapha, M.K. (2008). Assessment of the Water Quality of Oyun Reservoir, Offa, Nigeria, using Selected Physico-chemical Parameters. Turkish Journal of Fisheries and Aquatic Sciences, 8, 309-3 19.
[15] Olusola B. D. and Arawomo (2008). Field Guide to Nigeria Freshwater Fishes. Federal College of Freshwater Fisheries Technology Publication. Decency Printers, Ilorin, Nigeria. 110.
[16] Ramachandra, T. V. and Malvikaa, S. (2007). Ecological Assessment of Lentic Water Bodies of Bangalore. ENVIS Technical Report: 25. http://ces.iisc.ernet.in/biodiversity.
[17] Santhosh B. and Singh N. P. (2007). Guidelines for water quality management for fish culture in Tripura. ICAR Research Complex for NEH Region, Tripura Center, Publication no. 29.
[18] South African Water Quality Guidelines. (1996). Agricultural Water Use: Aquaculture. Department of Water Affairs and Forestry of South Africa, Pretoria, (2nd Ed.), Vol. 6, pp. 185.
[19] Ude, E.F., Ugwu, L.L.C., Mgbenka, B.O. and Nwani, C.D. (2011). Trends in nitrate-nitrogen, Nitrite-Nitrogen and phosphorus concentration in Eboyi River, Nigeria. Continental. Journal of Fisheries and Aquatic Science, 5(1): 1-7.
[20] U.S.EPA. (United State Environmental Protection Agency). (2000). Ambient aquatic life water quality criteria for dissolved oxygen (saltwater). Cape Cod to Cape Hatteras, EPA/822/R-00/12.
[21] Wang W., Wang A., Chen L., Liu Y. and Sun R. (2002). Effects of pH on Survival, Phosphorus Concentration, Adenylate Energy Charge and Na+-K+ ATPase Activities of Penaeus chinensis Osbeck Juveniles. Aquatic Toxicology, 60, pp. 75-83.
[22] Zhong YX, Chen S (2005) Effects of sand excavation on fish in Poyang Lake. Jiangxi Fishery Sci Technol 101:15–18 (in Chinese).