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Research Article

Effects of Water Pollution in Koluama Area, Niger Delta Area, Nigeria Fish Species Composition, Histology, Shrimp Fishery and Fishing Gear Type

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Abstract: The effect of water pollution in Koluama Area in the Niger Delta region of Nigeria to determine its effects on fish species composition, histology, shrimp fishery and fishing gear type. A total of twenty (20) species belonging to eleven (11) families were recorded. *Strongylura senegalensis, Lagocephalus laevigatus, Tarpon atlantica, Pristis pristis, Galeoides decadatylus* and *Butis koilomatodon* were rare. *Ephippion guttifer, Chaetodipterus goreensis, Sardinella maderensis, Sardinella aurita, Liza falcipinnis, Mugil bananensis, Pentanemus quinquarius, Polydactylus quadrafilis* and *Trichuris lepturis* were common. *Ethmalosa fimbriata, Liza grandisquamis, Sphyraena guachancho, Mugil curema, Sphyraena guachancho* and *Dormitator pleurops* were abundant. None was dominant. The highest number of fish species (16) were recorded in fish town and none was recorded in Kuloma 1 and one (1) was recorded for Kulauma 11. Foroupa, Ekeni, Ejetu and Ikebiri fishing port 1 and 2 recorded 8, 7, 3 and 5 fish species respectively. Artisanal fishing is based on traditional methods of fishing using essentially canoe and different fishing nets which depend on the season and target fish species. Canoes may be motorized or hand-paddled. Common gear types include shrimp traps, drift gill nets, set gill nets, cast nets, seine nets, hook and lines. Lift nets may be use by women folk who target small shrimp species in the creeks and creek lets. Other fishing methods include hand-picking for periwinkles, oysters and other shellfish by women folk and children. Prominent among the fishing devices are *edek*, a type of fish fence used in the creeks; *alot*, a large trap used on sand and mud-banks in the estuaries; and *otunwa,* a barbed spear. Fishers using these devices either operated from their home villages, exploiting the nearby waters, or staged long distance fishing expeditions, during which they lived in distant camps or house-boats. The heavy metals concentration level values are: Cd ($0.013^{a}\pm0.001$), Cr ($2.04^{b}\pm0.01$), Cu ($2.16^{b}\pm0.10$), Pb ($2.20^{b}\pm0.16$) and Zn ($1.03^{ab}\pm0.03$) for *Lagocephalus laevigatus;* Cd ($0.01^{a}\pm0.001$), Cr ($1.60^{b}\pm0.44$), Cu ($1.25^{ab}\pm0.08$), Pb ($1.10^{ab}\pm0.15$) and Zn ($0.50^{b}\pm0.04$) for *Tarpon atlantica* and Cd ($0.02^{ab}\pm0.003$), Cr ($2.35^{ab}\pm0.40$), Cu ($2.60^{a}\pm0.08$), Pb ($2.30^{a}\pm0.45$) and Zn ($1.11^{a}\pm0.17$) for *Pristis pristis.* The presence of heavy metals in the fish samples examined is an evidence of environmental degradation.

Keywords: Fish species composition, histology, Niger Delta, Nigeria, shrimp fishery fishing gear type, water pollution effects

INTRODUCTION

Fisheries play a very significant role in the national economy production. Fish production is regarded as a cheapest source of protein (Sikoki and Otobotekere, 1999). The Kouama area River system is one of the most important river systems in the Niger Delta providing nursery and breeding grounds for a large variety of fish. Fishing in the river is intensified and catch per unit effort is low. Consequent upon speedy industrialization and other human activities, the river is fast becoming degraded. Fishing is carried out indiscriminately with various traditional and modern fishing gears (Sikoki *et al*., 1998). In spite of the importance of fish species composition, fish histology, shrimp fishery and fishing gear type and pollution impact assessment in the River fishery, no attempt had been made to assess these parameters from the study area. Available data on similar or the same water body but different aspects are often scattered in unpublished reports, consultancy and related studies including the work of Ogbo (1982), (Otamiri River); Dokubo (1982), (Sombreiro River); Akari (1982), (Orashi River); Nwandiaro (1989), (Oguta Lake); Orji and Akobuche (1989), (Otamiri River); Chindah and Suamke (1994), (Bonny River), Sikoki and Hart (1999), (Brass River); Abowei (2000), (Nun River) and Ezekiel *et al.* (2002), (Oduhioku Ekpeye flood plain).

The daily life of the people of Koluama in Bayelsa State reflects the daily existence of most people along

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the creeks and rivers in the Niger Delta. It is a life of extreme struggle, with both the vagaries of nature and man-made obstacles. Most times, communities are far removed from another, connected only by the waters that flow along the extensive creeks into the Atlantic Ocean. Since there are no roads, those who live there and want to reach out to their neighbors, go to market or go fishing, must necessarily move on water, by means of slow-moving dug-out canoes, while some of the more illustrious citizens are able to make use of posh speed-boats for their daily endeavors. Koluama 1 and 2 are part of the eight communities in the State affected by the blowout of gas facility owned by Chevron in January, this year, the others being Ezetu I, Ezetu II, Furoupa, Fish Town, Sangana and Ekeni, with a combined population of about 30,000 people. Access to the communities from Yenagoa, the state capital, takes two and half hours ride by speedboat through the creeks. For other boats, the time can be much longer. The journey can be particularly frightening, especially for non-natives not used to water. For the indigenes, there is nothing to worry about as far as riding the waves is concerned. Life in the waters is normal for them. It is a way of life that they were born into.

In the beginning, in spite of the distances they had to cover in the waters, there was peace, harmony and understanding with nature. But things have been drastically altered, especially with the activities of the oil prospecting companies and their manner of operation in the area. They make good money but are hardly interested in giving back to the communities. It is now common to find oil floating on the creeks, not necessarily from the activities of the oil majors but from the enterprise of Niger Delta indigenes who have established local petroleum refineries along the banks of the rivers and creeks. The base of the mangrove forest bordering the creeks is colored by moulds of oil which will require an unprecedented effort to restore to their natural state. The people burst oil pipelines buried by the oil majors and cause spills in an attempt to siphon the crude for illegal bunkering activities and refine some to dispose of at the readily available markets. The business is risky but who cares? How can oil pipelines pass through their houses and they do not benefit from their content? That is what they seem to think.

Many people do not see how the risky bunkering and illegal petroleum refining and, consequently, the degradation on the creeks, can be stopped in the Niger Delta because of the number of people involved on the one hand and the perceived complicity of the Joint Task Force (JTF) stationed in the area on the other. Apart from the inadequate knowledge of the creeks where the business thrives, the JTF operatives are said to be more interested in extorting money from those in the bunkering and illegal petroleum refining than checking their economic sabotage. Therefore, all along the route to Koluama, thick smoke rises at various positions on the river banks, indicative of the existence of local refineries where business is booming.

Plate 1: Chevron Gas Rig Explosion in Koluama communities in the early hours of Monday January 16, 2012 chevron Rig fire search call off for 2 missing workers Daily Time Nigeria. Article| January 20, 2012 - 11:07am | by from the wires

Koluama community gained added prominence on the January 16 this year when the Chevron gas facility at its Atlantic Ocean backward exploded, shaking the very foundation of the structures in the community (Plate 1). The blowout released harmful gas into the atmosphere and caused a huge conflagration that burnt in the sea, with concomitant disaster to the aquatic life. The cries of the people for remedy to their plight attracted President Good luck Ebele Jonathan who, last Monday, personally undertook an aerial inspection of the affected gas platform in the sea and later met with members of the communities.

A spokesman of the eight communities affected, Hon. Nimibofa Ayawei, painted a gloomy picture of the disaster to the president, narrating how the incident occurred and how the inhabitants of the area had been neglected by Chevron, the owner of the facility and government. According to him, in the early hours of Monday January 16, 2012, the residents heard a loud explosion from the K.S. Endeavour (Panama) Rig where Fode Drilling Limited, a company contracted by Chevron Nigeria Limited was drilling gas at the North Apoi Field, west of Funiwa Field, Koluama Clan about 5 nautical miles from the Koluama communities in Southern Ijaw Local Government Area of Bayelsa State. The explosion resulted into a huge gas fire and a massive spill.

The huge flame in the sea which was visible could be sighted from the Koluama River burning uncontrollably and emitting dangerous gases and other toxic chemicals into the environment. The Koluama River directly empties into the Atlantic Ocean and as such, the polluted water is carried into the Koluama Rivers and Creeks and other neighbouring communities in the coast line. Ayawei told the President that the massive explosions shook the foundations of houses in Koluama 1, Koluama 2, Kalaweiama, Opuama, Tamazo, Kiriseighegbene, Abiakiawei and Lobia, among other communities in the Koluama Clan, saying that "we are worried about this development because it was explosions in the course of seismic activities by Shell D'Archy while exploring for oil and gas in the same area that led to the wiping away of ancient Koluama in 1953."

He emphasized that with this incident, the air space and the ocean had been seriously polluted and the current was carrying the dangerous gases and chemicals into the rivers and creeks of the communities within the coastal areas where the incident occurred. The aquatic or marine life has been adversely affected and dead fishes could be seen floating on the water in the ocean, shore, creeks and rivers of the coastal communities in the area. Dark colored pollutants have been seen spreading on the surface of the ocean from the first day and have been impacting seriously on the people and the coastal shoreline. The health implications of this are no doubt overwhelming, he remarked, as the gases released into the environment such as carbon monoxide, sulphur dioxide, etc, most of which are acidic gases, have wide-ranging implications on the populace. The former lawmaker spoke of incidents of various forms of ailments including vomiting, stomach pains, difficulty in breathing, acute asthma, etc, resulting in a couple of deaths which had been reported, stating that people had been moving out of the communities for the fear of the unknown.

In spite of the dangers associated with the situation, no assistance has so far gone to the people. That is why, he said, they were very angry with Chevron which they believed had demonstrated stark insensitivity to their plight. "We therefore feel insulted by the claim of Chevron that the gases emitted from the blowout which burnt were not harmful to human and the environment. We really feel insulted by this claim because if these gases were not harmful, Chevron could not have immediately evacuated its personnel from its oil facilities around the scene of the accident. The above claim was not only inciting but was aimed at preventing the victims of this unfortunate incident from taking drastic actions against the company," the community spokesman added.

They have now put up a list of demand before the President, including shore protection and embankment, reclamation and sand filling of land, canalization, provision of functional health facilities, implementation of the Bayelsa Central Senatorial road/coastal Ring road, provision of concrete walk ways, provision of potable water, quality education for their people and employment, especially with the multinational oil companies operating in their areas. The Managing Director of Chevron, Mr. Andrew Fawthrope, who was present at the occasion, appeared to be loss for words following the bashing he received from the community and managed to say that the blow-out was dying out down to about 3,000 feet and progressing to put the fire out. While appreciating the community as well as staff of Chevron, he spoke of what seemed to the community like a token effort to provide medical assistance, saying that "there will be some community work going on with medical works starting from Wednesday to improve the quality of life."

The Group Managing Director (GMD) of the Nigerian National Petroleum Corporation (NNPC), Mr. Austen Oniwon, remarked that the rig that exploded was one dedicated to gas, adding that though the incident happened, the Corporation would not be discouraged. "It was an accident. We believe that we have learnt a lot of lessons from it. Immediately it happened, we tried everything possible to control and contain it," he said. Oniwon revealed that there were 154 people on the rig when the incident occurred out of which two, a Frenchman and an Indian lost their lives and their corpses never found. He explained that "because it is a blow-out, it is very difficult to quench the fire, but what we are doing now is to drill another well to try and reach the hole and then block it." Oniwon acknowledged that the communities had been "very magnanimous and very patient with us", saying, "in spite of all the devastation the oil spill would have caused them, they have not taken to the streets to demonstrate."

In his remark, the governor of the state, Seriake Dickson, noted that while the people do not have any problem with the exploitation of oil to sustain the national economy, they however want the oil companies to respect the fragile environment of the area as he observed that what happened in these communities was a common occurrence which the people of the Niger Delta had been contending with. "Mr. President, as we all know, what has happened in Koluama is a very familiar event; it is the same story in the Niger Delta, the same story of sacrifice, the same story of inconveniences, the same story of living with risks day by day to be able to produce the mainstay of the economy of our great country.

What has happened in Koulama is the same story in all our communities, countless communities, villages and settlements in Bayelsa State, the Ijaw nation and across the Niger Delta. We have no problem producing what has become the mainstay of our economy but the least we can ask from Mr. President is respect for our environment, protection of our very fragile ecosystem," he declared. Dickson was however furious with the people who burst oil pipelines for the sake of bunkering and illegal refining, stating that his government had set up a task force to try to fight the ugly situation. After listening to the people, President Jonathan promised the provision of relief materials and compensation to those affected, assuring the people of government's commitment to tackling environmental management issues, not only in the Niger Delta but also in the extreme north of the country where he observed there was desert encroachment. Jonathan added that the federal government would collaborate with Bayelsa State government and Chevron to provide relief materials for the people and noted: "In terms of other demands that have been documented, I noticed that many issues have been raised and these are issues we are quite conversant with. I can assure you that we will look into it, the company, the state government and the federal government will continue to address them."

The President told the people that "communities impacted must have some relief, some compensation. That is obvious but the quantum will depend on studies that have been carried out by the company and the federal government," adding that "on my own part, I will reassure you that the federal government is totally committed to the issues bordering on environmental management, from the Niger Delta to extreme north where we have desert encroachment." Besides what Chevron and other government agencies would do, he assured that the federal government through the National Emergency Management Agency (NEMA) would provide some of the relief materials sought by the communities. A study of the effect of water pollution in Koluama Area in the Niger Delta region of Nigeria is aimed at determining its effects on fish species composition, histology, shrimp fishery and fishing gear type.

MATERIALS AND METHODS

The effect of water pollution in Koluama Area in the Niger Delta region of Nigeria to determine its effects on fish species composition, histology, shrimp fishery and fishing gear type from April to May, 2012. A total of seven sampling stations were established: Foroupa (N4 36.004 E5 39.128); Ekeni (N4 41.659 E5 34.451); Ezetu 2(N4 43.333 E5 34.640); Kuluama 1 (N4 28 433 E5 46.248); Koluama 2 (N4 25.805 E5 49.582); Fish Town (N4 24.642 E5 51.128) and Ikebiri fishing port (N4 30.374 E5 50.298). Replicate samples were collected and the mean used for further analysis.

Fish and fisheries: A frame survey of fishing communities was carried out employing the complete census technique (Bankole *et al*., 1994) during the survey, existing landing sites, number of fishers, number of canoe units, types of fishing gear and available aquatic milluscs, mammal and reptiles were enumerated. The basic information was obtained by direct observation and questioning. The number of fishers, canoe units and fishing gear were obtained by direct count. Fishing nets were also counted and estimated by counting drying poles and racks. These estimates were confirmed by direct questioning of the inhabitants of the community. Fish landing figures were obtained indirectly. Catches from fishers were estimated after smoking, where, considerable quantities were caught. These units were weighed and an estimate of the weight of fish landed was obtained. The figures were supplemented cross-checked by obtaining estimates of the fishers earning and having obtained figures for the prices, fishers got for various fish, the weight was deduced. The dry weights obtained were converted to wet weights by a conversion factor of 2.5 to each dry weight (Scott, 1966). An average cost of N600 per kilogram of fish was obtained by direct information from a market survey. This price was used as basis for economic analysis. Direct information obtained from the buying and sale of fish; pricing and short market surveys were also carried out. An estimate of standing stock of fish was made, using the formulae by Henderson and Welcome (1974) as:

$$S = {}^{B}/A \qquad (1)$$

Which expresses the basic interrelationship between annual catch in wet weight, standing stock size (B) and area covered (A).

Fish specimens were obtained from fishers using gill nets, longlines, traps, stakes and local fishponds. Catches were isolated and conveyed in thermos cool boxes to the laboratory. Fish families were identified using monographs, descriptions checklist and keys (Boeseman, 1963; Reed *et al*., 1967; Holden and Reed, 1972; Poll, 1974; Whyte, 1975; Jiri, 1976, Reed and Sydenhan, 1978, Otobo, 1981, Alfred-Ockuya, 1983; Whitehead, 1984 and Loveque *et al*., 1991). Total length and weight of the fish specimens were measured to the nearest centimeter and gramme respectively, to obtain the required data. The weight of each fish was obtained after draining from the buccal cavity and blot drying samples. Age was estimated from the length frequency distribution plot using six hundred fish specimens (600), following the integrated Peterson method (Pauly, 1983). The diagram was repeated six times along the time axis and a single continuous growth curve was flitted. The relative age (in years) and the corresponding modal lengths were determined from the plot. Total length and weight of fish specimens were measured to the nearest centimeter and grammes, respectively, to obtain data on the length-weight relationship. Length-weight and length-breadth relationship of fish specimens were determined using the exponential equation (Roff, 1986):

$$W = al\ b \qquad (2)$$

where, b is an exponent with a value nearly always between 2 and 4, often close to 3. The value b = 3 indicates that the fish grow symmetrically or isometrically (provided its specific gravity remains constant). Values other than 3 indicate allometric growth: If b>3, the fish becomes heavier for its length as it grows larger. The methods used to obtain the growth parameters of the Von Bertalanffy's Growth Formula (VBGF) were: Ford Walfored plot: Lt + 1 were plotted against Lt where Lt + 1 are lengths separated by a year interval. The value of Lt at the point of interception of the regression line with the 450 lines gave L∞.

Graphs of length and weight increment ▲L at age against the original length Lt and Wt. The degree of association between the length and weight was expressed by a correlation coefficient "r". The correlation coefficient could take values ranging between –1 and +1. When "r" is negative, it means that one variable tends to decrease as the other increases; there is a negative correlation (corresponding to a negative value of 'b' in regression analysis). When r is positive, on the other hand, it means that the one variable increases with the one (which corresponds to a positive value of b in regression analysis) (Pauly, 1983).

However, whether the correlation that was identified could have arisen by chance alone, the 'r'value was tested for 'significance'. That is, whether the (absolute) value of "r" was higher than or equal to a critical value of "r" as given in a statistical table. Length-breadth relationship was determined using:

$$M = a\,(TL)j, \tag{3}$$

where,
a = Initial growth constant
J = Growth rate exponent
TL = Total length of fish

Both coefficients were determined by least square regression analysis after logarithmically transforming all data into the from:

$$\text{Log } M = \text{Log } a + J \log TL \tag{4}$$

If J = 1.0 then M growth rate is constant and equal to the initial growth consistent (isometric growth), otherwise there is a negative (J<1.0) or positive (J>1.0) algometric growth.

Length performance index was estimated from the equation (Pauly and Munro, 1984):

$$Ø = \text{Log } k + 2 \log l\infty \tag{5}$$

where, k and l∞ are parameters of VBGR.

Growth performance index Ø1 was estimated from the equation (Pauly and Manro, 1984):

$$Ø1 = \text{Log } k + 0.67 \log W\infty \tag{6}$$

where,
k = A parameter of VBGR
W∞ = The mean weight of very old fish

The points at which the growth curve cuts the length axis on the sequentially arranged time scale gave the length at age counted from the origin. The estimation was derived from Pauly (1983). The total mortality coefficient (Z) was estimated from the formular given by Pauly (1983).

$$Z = \frac{nk}{(n+1)(L\infty - 11/L\infty - I)} \tag{7}$$

where,
n = number of fish in computing the mean length T
1' = smallest of fish that is fully represented in the catch.
K and L∞ are parameters of the VBGF.

An independent estimate of Z was obtained from the Hoeing formula in Ehrhardt *et al*. (1975):

$$Z = 1.45 - 1.01\, Tmax \tag{8}$$

where,
Tmax = Longevity (years)
Natural mortality coefficient (M) was estimated from Taylor's formula in Ehrhardt *et al*. (1975).

$$M = 2.995To + 2.9975K \tag{9}$$

Fishing mortality coefficient (f) was estimated as:

$$E = Z - M \text{ (Gulland, 1971)} \tag{10}$$

The exploitation ratio was estimated using the formula:

$$E = F/Z \text{ (Gulland, 1971)} \tag{11}$$

The Condition Factor (CF) was calculated from the expression

$$CF = \frac{100W}{L3} \tag{12}$$

where,
W = The fresh body weight in (g)
L = Total length in cm

Fish histological study: Fish samples *Lagocephalus laevigatus, Tarpon atlantica and Pristis pristis* were allowed to thaw at room temperature (27°C) and subsequently oven dried at a temperature of 60°C for 48 h. Concentrated nitric acid (20 mL) and perchloric acid (10 mLs) were added to approximately 1 g tissue (dry mass) in a 100ml Erlemeyer flask. Digestion was performed on a hot plate at a temperature of between 200 and 250°C until each solution was clear. The digests were made up to 50 mL each with distilled water and stored in clean glass bottles. Blanks were prepared using the same quantities of mixed acids. Heavy metals were analysed using a spectra A A-10 Varian atomic absorption Spectrophotometer. The atomic absorption Spectrophotometer was standardized using stock standard solutions from the respective metals. Accuracy of the method employed was assessed by the analysis of three replicate samples, which yielded standard deviation less than 5% of Cu, Pb and Zn and 1% Cd. Mean recoveries were in excess of 92%. Blank samples were run with each set of experiments. Analysis of variance (ANOVA) was used to determined significant differences in metal values in various fish species at 5% level of significance.

RESULTS

Fish species composition: Fishing is the main occupation of the inhabitants within the study area. It is carried out at both commercial and subsistence levels. The fish species landed, their relative abundance and distribution in the sampling stations are as presented in Table 1 and 2, respectively. A total of 20 species belonging to 11 families were recorded. Strongylura senegalensis, Lagocephalus laevigatus, Tarpon atlantica, Pristis pristis, Galeoides decadatylus and Butis koilomatodon were rare. Ephippion guttifer, Chaetodipterus goreensis, Sardinella maderensis, Sardinella aurita, Liza falcipinnis, Mugil bananensis, Pentanemus quinquarius, Polydactylus quadrafilis and Trichuris lepturis were common. Ethmalosa fimbriata, Liza grandisquamis, Sphyraena guachancho, Mugil curema, Sphyraena guachancho and Dormitator pleurops were abundant. None was dominant. The highest number of fish species (16) was recorded in fish town and none was recorded in Kuloma 1 and one (1)

Table 1: Fish Species Composition

Family	Species	Common name	Abundance rating
Belonidae	*Strongylura senegalensis* (Val., 1846)		1
Tetradintidae	*Ephippion guttifer* (Bennet, 1830)		2
	Lagocephalus laevigatus (Linn., 1758)		1
Megalopidae	*Tarpon atlantica*	Tarpon	1
Pristidae	*Pristis pristis*	Saw fish	1
Ephippidae	*Chaetodipterus goreensis* (Cuv., 1831)		2
Clupeidae	*Ethmalosa fimbriata* (Bowdich, 1875)	Bonga	3
	Sardinella maderensis (Lowe, 1939)	Sardine	2
	Sardinella aurita (Lowe, 1939)	Sardine	2
Mugilidae	*Liza falcipinnis* [Val,1836]	Mullet	2
	Liza grandisquamis [Val, 1836]	‘’	3
	Mugil bananensis [Pellegrin, 1927]	,,	2
	Mugil curema Val, 1836	,,	3
Sphyraenidae	*Sphyraena guachancho* Cuvier, 1829	Barracudas	3
Polynemidae	*Galeoides decadatylus* (Bloch, 1795)	Threadfins	1
	Pentanemus quinquarius (Linn, 1758)	Shiny nose	2
	Polydactylus quadrafilis		2
Eleotridae	*Butis koilomatodon* [Bleeker, 1849]	Sleepers	1
Elopidae	*Dormitator pleurops* [Boul, 1909]	Lady Fish	3
Trichuridae	*Trichuris lepturis* Linn, 1758		2

Abundance Rating: 1 = Rare; 2 = Common; 3 = Abundant; and 4 = Dominant

Table 2: Fish Species distribution at various sampling stations

Family	species	Foropa	Ekeni	Ejetu	Kulama 1	Kulama11	Fish town	Ikebiri fishing port1 and 2
Belonidae	*Strongylura senegalensis* (Val., 1846)	1	x	x	x	x	x	X
Tetradintidae	*Ephippion guttifer* (Bennet, 1830)	x	1	1	x	x	x	X
	Lagocephalus laevigatus (Linn., 1758)	x	1	x	x	x	x	X
Megalopidae	*Tarpon atlantica*	x	x	x	x	x	1	X
Pristidae	*Pristis pristis*	x	x	x	x	x	1	1
Ephippidae	*Chaetodipterus goreensis* (Cuv., 1831)	x	1	x	x	x	1	X
Clupeidae	*Ethmalosa fimbriata* (Bowdich, 1875)	x	x	x	x	x	2	1
	Sardinella maderensis (Lowe, 1939)	x	x	x	x	x	1	1
	Sardinella aurita (Lowe, 1939)	x	x	1	x	x	1	X
Mugilidae	*Liza falcipinnis*[Val,1836]	x	1	x	x	x	1	X
	Liza grandisquamis [Val, 1836]	2	x	x	x	1	x	X
	Mugil bananensis [Pellegrin, 1927]	1	x	x	x	x	1	X
	Mugil curema Val, 1836	x	1	x	x	x	2	X
Sphyraenidae	*Sphyraena guachancho* Cuvier, 1829	1	1	x	x	x	x	1
Polynemidae	*Galeoides decadatylus* (Bloch, 1795)	x	x	x	x	x	1	X
	Pentanemus quinquarius (Linn, 1758)	1	x	x	x	x	1	X
	Polydactylus quadrafilis	1	x	x	x	x	1	X
Eleotridae	*Butis koilomatodon* [Bleeker, 1849]	x	x	x	x	x	x	1
Elopidae	*Dormitator pleurops* [Boul, 1909]	1	1	x	x	x	1	X
Trichuridae	*Trichuris lepturis* Linn, 1758			1			1	
Total no.		8	7	3	0	1	16	5

Table 3: Concentration values (mg/L) of heavy metals in *Lagocephalus laevigatus,Tarpon atlantica and Pristis pristis* from the study area

		Heavy		Metals		
Fish species	No of samples	Cd	Cr	Cu	Pb	Zn
L laevigatus	60	0.013^{a}±0.001	2.04^{b}±0.01	2.16^{b}±0.10	2.20^{b}±0.16	1.03^{ab}±0.03
T atlantica	45	0.01^{a}±0.001	1.60^{b}±0.44	1.25^{ab}±0.08	1.10^{ab}±0.15	0.50^{b}±0.04
P pristis	57	0.02^{ab}±0.003	2.35^{ab}±0.40	2.60^{a}±0.08	2.30^{a}±0.45	1.11^{a}±0.17

Mean followed by the some superscript are not significantly different at the 5% level was recorded for Kulauma 11. Foroupa, Ekeni, Ejetu and Ikebiri fishing port 1 and 2 recorded 8, 7, 3 and 5 fish species, respectively.

Fishing gear types: Artisanal fishing is based on traditional methods of fishing using essentially canoe and different fishing nets which depend on the season and target fish species. Canoes may be motorized or hand-paddled. Common gear types include shrimp traps, drift gill nets, set gill nets, cast nets, seine nets, hook and lines. Lift nets may be use by women folk who target small shrimp species in the creeks and creek lets. Other fishing methods include hand-picking for periwinkles, oysters and other shellfish by women folk and children. Prominent among the fishing devices are edek, a type of fish fence used in the creeks; alot, a large trap used on sand and mud-banks in the estuaries; and otunwa, a barbed spear. Fishers using these devices either operated from their home villages, exploiting the nearby waters, or staged long distance fishing expeditions, during which they lived in distant camps or house-boats. Many forms of fishing engaged by the fishers include:

- *Onyeama* type of fishing, which entails the use of drift nets, sticks and raffia twines. (otherwise called stationary fishing)
- *Nkoto fishing* entails also use of nets with floaters, twines, sticks, iron in form of anchorage (about 15 in one net) and one boat carries 30-40 nets. Large canoes enhanced with a 15-25 HP engines are sometimes used. Hence can travel far into the ocean manned by 3 people
- *Trap fishing,* In this type of fishing, raffia palm materials are used to weave sixty (60) basket traps, with sticks as anchorage. Twines and canoe is used to set up the traps, including use of smaller sized-nets (2-3 persons can handle this)
- *Hook fishing* of different sizes and 10 packets used per boat, with twines
- *Cast nets and floating nets (momotomo)* and drawing nets used mainly by the women folk
- Male fishers use motorizes fishing around the larger water bodies and near shore areas. Oyster harvesting is mostly carried out by women and children and men who lack the boat infrastructure to engage in other demanding type of artisanal fishing

Exploitation of fish resources in the study area is largely by artisan fishers. These fishers operate in dugout wooden canoes measuring 7-12 m in length and 0.4-1.9 m in width. The boats are hand-paddled and movement is occasionally complimented by the use of sail. Two fishers usually operate each boat. Fishing gears are largely made of long setlines, circling nets and seine nets of different mesh sizes varying between ½", 1", 1½", 2", 2½ and 3" (1.0-5.0 mm). Gears measure 6-12 m in length and 2-4 m in width. Nets are manually operated. They are set and allowed to stay for up to one hour before they are removed with the catch. Catch rates are seasonally dependent and varied from 15-120 kg/day.

Shrimp fishery: Shrimp is one of the leading highly priced sea foods that is harvested by fishers in the study area and associated creeks and creek lets and it is largely accounted for by small scale fishers. This involved numerous rural persons operating motorized and non-motorized boats to catch shrimp. Most of the shrimps caught in the small scale sector are consumed internally. For this reason, scarcely any comprehensive documentation exists on the status of artisanal shrimp fisheries in Nigeria. Gears for shrimping include stake or grass woven traps of different dimension, scoop net. Drag nets are also in use. Fishing with these gears takes place in un-motorized wooden boats, which involved manual rowing with paddles. Single fishers operated in a boat with hand scooping net while shrimping along mud flats and chicoco edges of creek channels and creek lets. One fisher may conveniently employ traps and baskets usually engaged in macrobranchuim fishery. Traps with single and multiple compartments are also used in the sector. Dragnet or hand seine required two operators, each holding the wooden pole (handle) as the net is dragged along in the river channel. Shrimp and other stocks bigger than net mesh size, was retained as water fittered through the net bag. The major representatives in small-scale catches were: *Nematopaleamon hastatus; Penaeus notialis* (Southern pink shrimp); *Parapenaeopsis atlantica* (Guinea shrimp); *Palaemon* sp. (white shrimp); *Macrobrachium* sp and *Periophthalmus koelreuteri* (mudskipper).

Fish Histological study: The heavy metal concentration values of three rare fish species (*Lagocephalus laevigatus, Tarpon atlantica and Pristis pristis)* from the study area are presented in Table 3. The heavy metals concentration level values are: Cd ($0.013^{a}\pm0.001$), Cr ($2.04^{b}\pm0.01$), Cu ($2.16^{b}\pm0.10$), Pb ($2.20^{b}\pm0.16$) and Zn ($1.03^{ab}\pm0.03$) for *Lagocephalus laevigatus;* Cd ($0.01^{a}\pm0.001$), Cr ($1.60^{b}\pm0.44$), Cu ($1.25^{ab}\pm0.08$), Pb ($1.10^{ab}\pm0.15$) and Zn ($0.50^{b}\pm0.04$) for *Tarpon atlantica* and Cd ($0.02^{ab}\pm0.003$), Cr ($2.35^{ab}\pm0.40$), Cu ($2.60^{a}\pm0.08$), Pb ($2.30^{a}\pm0.45$) and Zn ($1.11^{a}\pm0.17$) for *Pristis pristis.*

DISCUSSION

The Eleven fish families recorded in the study area was lower than 29 fish families' records by Abowei and Hart, (2008) in the fresh water reaches of Lower Nun River and fifteen families recorded by Sikoki *et al.* (1998) from same water body., The difference could be attributed to differences in sampling method. Sikoki *et al*. (1998) used gill net of various mesh sizes while, this study used various fishing gears. The physical environment of the fresh water reaches of the lower Nun River may be diverse enough to support more species. Low diversity is a function of low productivity, which has been a common feature of small fresh water rivers (Welcome, 1979). The study area is close to the Atlantic Ocean and should have supported more fish species and families. The reason for the relative low species diversity may be due to the short sampling period, season and industrial activities. Kuluama 1 and 2 recorded the lowest no. of fish species. This could be attributed to under exploitation and industrial activities. Kuluama 1 and 2 are nearer to the chevron offshore plant.

Variations in number of fishers and fishing gear/method employed in different study areas could be attributed to over-estimation of the number of fishers as a result of migration of fishers from one area to another and inaccuracy in estimation of productivity of certain gears and in addition, is complicated by the fact that a fisher may use than one type of gear depending on local conditions which are unpredictable. Abowei and Hart, (2008) reported a mean total biomass of 23.04 of fish per boat, total catch of 37903.6 kg, annual production estimate of 434.81 tones and an estimated standing stock of 2.27 km^2 in the Lower Nun River. This also varied from the results obtained from other studies. Scott (1966) reported that rivers, lakes and swamps of the Niger Delta produced about 2,000 tones of fish per year. Moses (1981) estimated a mean annual catch of 4,791 tones from the cross river over a period of twelve years. Sikoki and Hart (1999) in the Brass River, estimated the total biomass of 160.20 of fish per boat, total catch of 254, 554k g, annual production of 610.93 tones, estimated mean catch per boat of 384.90kg and a standing stock of 1.19 km^2.

The presence of heavy metals in the fish samples examined is an evidence of environmental degradation.

CONCLUSION

- The eleven fish families recorded in the study area was relatively low
- Kuluama 1 and 2 recorded the lowest no. of fish species
- This could be attributed to under exploitation and industrial activities. Kuluama 1 and 2 are nearer to the chevron offshore plant
- The presence of heavy metals in the fish samples examined is an evidence of environmental degradation

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