Research Journal of

# Environmental Sciences

ISSN 1819-3412

Academic
Journals Inc.

www.academicjournals.com

Research Journal of Environmental Sciences 4 (3): 271-279, 2010
ISSN 1819-3412


# The Ecological Impact of Anthropogenic Activities on the Predatory Fish Assemblage of a Tidal Creek in the Niger Delta, Nigeria

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**Abstract:** An investigation of the predatory fish assemblage of Buguma Creek, Niger Delta, Nigeria was conducted during flood tides between November 2004 and June 2006, to assess the ecological impact of anthropogenic activities, namely: vibrations due to pedestrian bridge crossing, dumping of domestic wastes and regular cutting of mangrove. Three stations 1, 2 and 3 were selected from downstream of the point of intense anthropogenic activities, the point of intense anthropogenic activities and its upstream. Twenty taxa comprising 1116 individuals were recorded of which total number of taxa and individuals present at stations 1, 2 and 3 were 13(458), 13(151) and 18(507). There were no significant changes in the water quality parameters that could be attributed to the anthropogenic activities. However, the low density of station 2 could be attributed to the joint impact of vibrations due to pedestrian bridge crossing, dumping of domestic wastes and regular cutting of mangrove. Spatially, the high species density of station 1 is attributable to its least perturbed condition, while the significantly higher diversity of station 3 could be attributed to its upstream status.

**Key words:** Anthropogenic activities, predatory fish assemblage, tidal creek, Niger Delta

## INTRODUCTION

Tidal creeks provide habitats, such as channel salts, intertidal mudflats, mangroves, salt flats, rocky shores and rocky reefs in some areas (Semeniuk *et al*., 1982). These habitats typically support marine species, including transient visitors and permanent residents. However, the biota of these waterways is less well documented than their wave documented counterparts (Dadrymple *et al*., 1992; Connolly *et al*., 1996). The importance of mangrove as nurseries has been one of the reasons advanced to support its conservation and management (Sheridan and Hays, 2003). Many countries in Africa, Latin America and Asia are now estimated to have lost at least 50% of their original mangrove area (Burke *et al*., 2001). There have been warnings, that supportive data have not been collected and that fish and decapods use of mangroves may not be the same in all areas of the globe (Chong *et al*., 1990).

Fish communities of tropical rivers respond to environmental changes imposed by human interference (Obeng, 1981; Victor and Tetteh, 1988).

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Studies on West African running waters have mainly been conducted in large rivers. Although, limited information is available on fish of Nigerian coastal waters (Fagade and Olaniyan, 1972; Wright, 1986; Chindah and Osumkpe, 1994; Chindah and Tawari, 2001), no investigation has examined fish communities from the view point of impact of anthropogenic activities.

The purpose of this study is, firstly, to present a general account of the water quality and predatory fish species composition and diversity at a point of intense anthropogenic activities (pedestrian bridge crossing, dumping of domestic wastes and regular cutting of mangrove) and secondly, to give a comparative account of the same ecological characteristics upstream and downstream of the intense anthropogenic activities, with a view to identifying significant changes attributable to the anthropogenic activities

The Buguma Creek is located Southeast of the Niger Delta between longitude 6° 47'E and 6° 59'E and latitude 4° 36'N and 4° 59'N (Fig. 1) in Asari-Toru Local Government Area

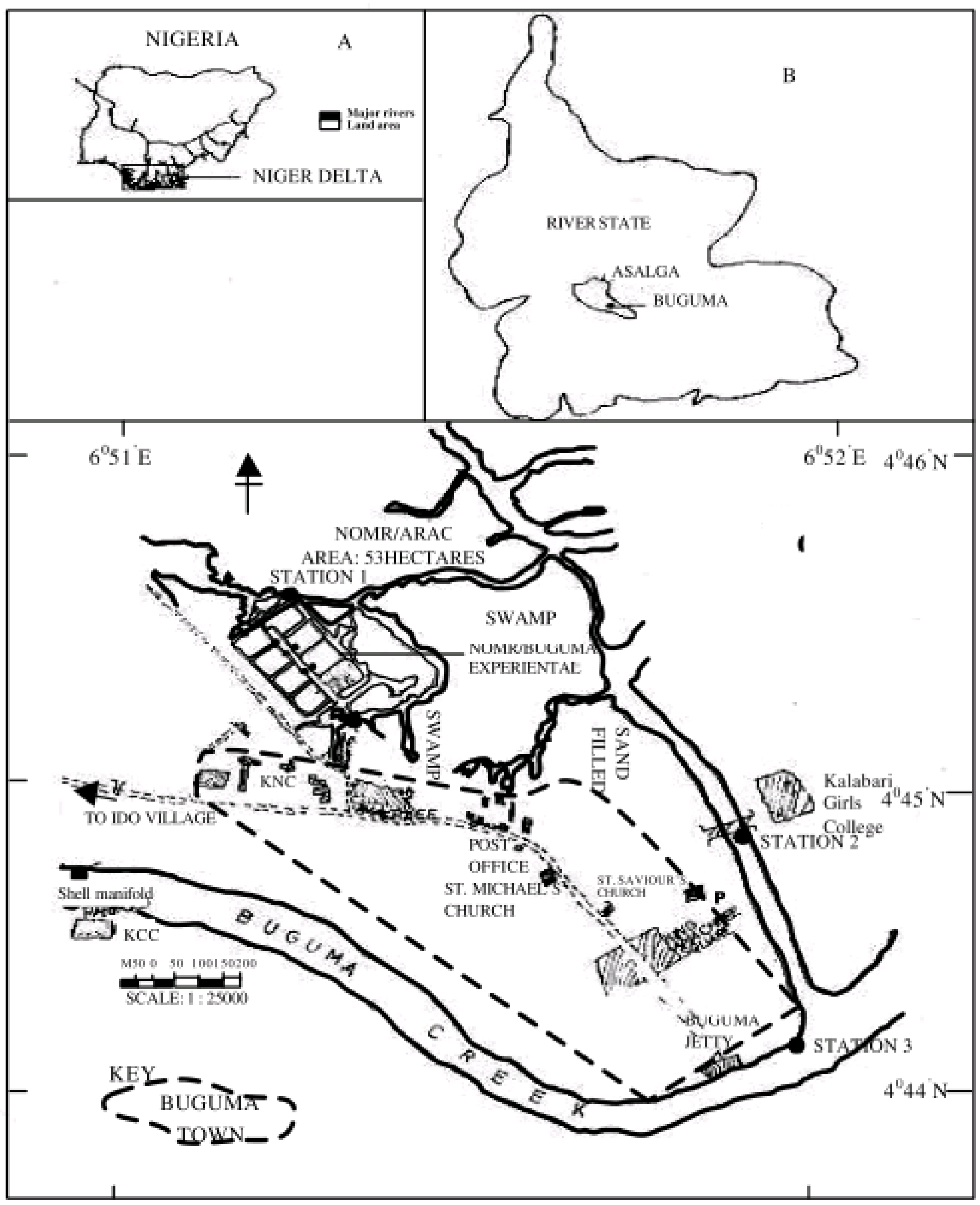


Fig. 1: Map of the study area: A: Nigeria showing Niger Delta, B: Rivers state showing Buguma, C: The study creek showing study stations

of Rivers State. The Buguma Creek system consists of the main creek channel and associated interconnecting creeks, which interconnect and surround Buguma and Ido communities. The Buguma Creek serves as a source of tidal water for Nigerian Institute for Oceanography and Marine Research/Buguma Brackish Water Experimental Fish Farm, which was constructed between 1963 and 1966 under the auspices of the FAO. The New Calabar River brings the salty ocean water as tidal flows diurnally to the fish ponds (Dublin-Green and Ojanuga, 1988). Three sampling stations were chosen: the point of intense anthropogenic activities (station 2), its upstream (station 3) and its downstream (station 1). The descriptions of the stations are as follows:

Station 1 was the least perturbed portion of the creek. It is located 2.54 km downstream of the point of intense anthropogenic activities (station 2). Activities associated with this station are aquaculture activities in the pond area by NIOMR staff, picking of periwinkles from intertidal portions of the creek by Buguma and Ido indigenes, setting of trap nets for *Tilapia* sp., *Periopthalmus* sp. and crabs by artisanal fishers. The substratum is composed basically of mud.

Station 2 is the point of intense anthropogenic activities. It is located northeast of Buguma, where a 96.5 m long pedestrian bridge is sited. Associated with this bridge is dumping and burning of domestic wastes, cum continuous cutting of mangrove. Canoe landing is also a common practice in this station.

## MATERIALS AND METHODS

Water and fish samples were collected monthly from November, 2004 to June 2006 at flood tides. Sampling was conducted between 08: 00 and 17: 00 h in each sampling day within 6 h, depending on the flow and ebb of tide.

Physico-chemical analysis of water was based on Lind (1979) and APHA *et al*. (1985). The fish samples were collected basically by the use of biated hooks and lines with hundred hooks in a set of seven (7) with different size per set (No.1, 6, 7, 8, 9, 10 and 12) per sampling station. The fish samples were ice-packed after capture, kept chilled under ice-blocks in a plastic cooler and immediately transported to the laboratory. In the laboratory, fish specimens were sorted and identified to the species level using the keys and descriptions of Schnieder (1990).

The modified diversity programme of Ludwig and Reynold (SPDIVERS.BAS) was used in computing all diversity indices (Ogbiebu, 2005). The SPSS 11.0 statistical package was used in all statistical computations involving measures of central tendency and dispersion, the parametric One Way Analysis of Variance (ANOVA) and Duncan Multiple Range (DMR) test (Ogbeibu, 2005). The Microsoft Excel was used for the graphical presentation and correlation analysis.

## RESULTS

Among the thirty-two physical and chemical parameters investigated, only water temperature, transparency, water level and total suspended solids were significantly different ($p<0.05$) among the stations (Table 1).

Twenty taxa comprising 1116 individuals were recorded during the study. The total number of taxa and individuals present at stations 1, 2 and 3 were 13(458), 13(151) and 18(507) (Table 2). The family Sciaenidae was the most important at the three stations, contributing 83, 78 and 67% for stations 1, 2 and 3, respectively (Fig. 2).

Table 1: Summary of the physical and chemical parameters of the buguma creek study stations (November, 2004-June, 2006)

| Parameters | Station 1<br>$\bar{X}$ ±SE (min-max) | Station 2<br>$\bar{X}$ ±SE (min-max) | Station 3<br>$\bar{X}$ ±SE (min-max) | Statistical significance |
|---|---|---|---|---|
| Air temp. (°C) | 28.95±0.84 (24-36) | 29.53 ± 0.87 (24-36) | 30.05 ± 0.74 (24-34) | p>0.05 |
| Water temp. (°C) | 28.89±0.49 (25-33) B | 29.37±0.41 (26-32) A | 29.58±0.36 (27-32) A | p<0.05 |
| Transparency (m) | 1.04±0.0626 (0.62-1.50) B | 0.66±0.039 (0.37-0.95) C | 1.20±0.101 (0.42-2.20) A | p<0.001 |
| Turbidity (NTU) | 19.84±3.73 (4-75) | 26.79±4.66 (4-80) | 21.79±2.25 (3-37) | p>0.05 |
| Water level (m) | 1.18±0.019 (0.62-1.95)C | 0.676±0.149 (0.38-0.95) B | 1.95±0.112 (0.85-2.65) A | p<0.001 |
| TDS (mg $L^{-1}$) | 10919.2±1025.1 (3003-16620) | 13096.4±1026.9 (1343-17948) | 14808.8±499.9 (10110–19150) | p>0.05 |
| TSS (mg $L^{-1}$) | 263.32±25.06 (78-432) B | 317.58±26.39 (35467) A | 363.68±19.83 (263-498) A | p<0.05 |
| TS (mg $L^{-1}$) | 11182.5±1047.7 (3081-17052) | 13414.0±1050.5 (1378-18415) | 15172.5±205.90 (10373-19648) | p>0.05 |
| Flow velocity (m $sec^{-1}$) | 0.061±0.0082 (0.02-0.18) | 0.051±0.0047 (0.03-0.09) | 0.055 ± 0.0047 (0.020.09) | p>0.05 |
| Salinity ( ‰) | 12.32±1.01 (3-18) | 14.42±1.07 (0-20) | 15.95±0.69 (11-21) | p>0.05 |
| Chlorinity (mg $L^{-1}$) | 6822.9±560.5 (1662-9972) | 7989.3±590.6 (0-11080) | 8020.96±384.7 (6094-11634) | p>0.05 |
| Specific gravity | 8.95±0.79 (2-14) | 10.58±0.79 (0-14) | 11.74±0.51 (8-16) | p>0.05 |
| Electrical conductivity (µS $cm^{-1}$) | 18801.9±942.4 (4550-32340) | 22109.6±1831.2 (2035-34190) | 24307.9±1449.9 (16285-35910) | p>0.05 |
| pH | 6.859±0.096 (6.37-8.03) | 6.87±0.0993 (6.27-7.79) | 6.893±0.0901 (6.30-7.72) | p>0.05 |
| Alkalinity (mg $L^{-1}$ $CaCO_3$) | 15.87±2.61 (6-56) | 13.42±1.661 (5.5-36) | 14.0±1.061 (6-34) | p>0.05 |
| Dissolved oxygen (mg $L^{-1}$) | 2.279±0.374 (0.9-6.6) | 2.079±0.227 (1.0-5.2) | 2.211±0.334 (0.7-5.6) | p>0.05 |
| THC (mg $L^{-1}$) | 0.010±0.000 (0.01-0.01) | 0.010±0.000 (0.01-0.01) | 0.010±0.000 (0.01-0.01) | p>0.05 |
| BOD (mg $L^{-1}$) | 1.042±0.295 (0.10-4.50) | 1.04±0.189 (0.20-3.80) | 1.02-0.273 (0.00-4.20) | p>0.05 |
| COD (mg $L^{-1}$) | 6.921±1.07 (2.06-18.0) | 7.822±1.022 (2.11-19.60) | 7.316±0.744 (2.43-14.0) | p>0.05 |
| EDTA hardness (mg $L^{-1}$ $CaCO_3$) | 210.5±25.82 (64-528) | 198.9±21.12 (112-456) | 207.79±19.19 (124-436) | p>0.05 |
| Calcium (mg L) | 36.979±9.229 (8.82-200.4) | 38.138±10.006 (12.83-216.4) | 37.124±10.539 (14.43-222.8) | p>0.05 |
| Magnesium (mg $L^{-1}$) | 170.81±20.899 (55.18-428.3) | 160.81±15.349 (89.55-352.72) | 172.01±13.83 (98.35-304.73) | p>0.05 |
| Iron (mg $L^{-1}$) | 0.799±0.334 (0.01-6.02) | 0.824±0.368 (0.01-6.12) | 0.874±0.404 (0.01-6.78) | p>0.05 |
| Zinc (mg $L^{-1}$) | 0.102±0.025 (0.01-0.42) | 0.099±0.031 (0.01-0.44) | 0.106±0.028 (0.01-0.41) | p>0.05 |
| Lead (mg $L^{-1}$) | 0.093±0.03 (0.01-0.53) | 0.109±0.032 (0.01-0.51) | 0.157±0.41 (0.01-0.61) | p>0.05 |
| Cadmium (mg $L^{-1}$) | 0.036±0.004 (0.01-0.10) | 0.039±0.0074 (0.01-0.10) | 0.051±0.0096 (0.01-0.11) | p>0.05 |
| Chromium (mg $L^{-1}$) | 0.14±0.079 (0.01-1.49) | 0.153±0.0784 (0.01-1.37) | 0.175±0.0756 (0.01-1.27) | p>0.05 |
| Nickel (mg $L^{-1}$) | 0.2995±0.1479 (0.01-2.71) | 0.324±0.1531 (0.01-2.73) | 0.2193±0.0912 (0.01-1.50) | p>0.05 |
| Mercury (mg $L^{-1}$) | 0.010±0.00 (0.01-0.10) | 0.010±0.00 (0.01-0.10) | 0.010±0.00 (0.01-0.10) | p>0.05 |
| Nitrate (mg $L^{-1}$) | 1.933±0.547 (0.01-7.90) | 2.284±0.677 (0.01-9.38) | 2.346±0.648 (0.01-9.25) | p>0.05 |
| Phosphate (mg $L^{-1}$) | 0.297±0.104 (0.03-2.08) | 0.2822±0.0952 (0.050-1.89) | 0.274±0.0867 (0.01-1.72) | p>0.05 |
| Sulphide (mg $L^{-1}$) | 9.965±1.1135 (2.10 – 20.00) | 11.066± 1.1289 (5.20 – 22.40) | 9.861 ± 1.0736 (2.90 – 20.00) | p>0.05 |

*p<0.05 = Significant; *p<0.001 = Highly significant; *p>0.05 = Not significant. Similar letters indicate means that are not significantly different from each other

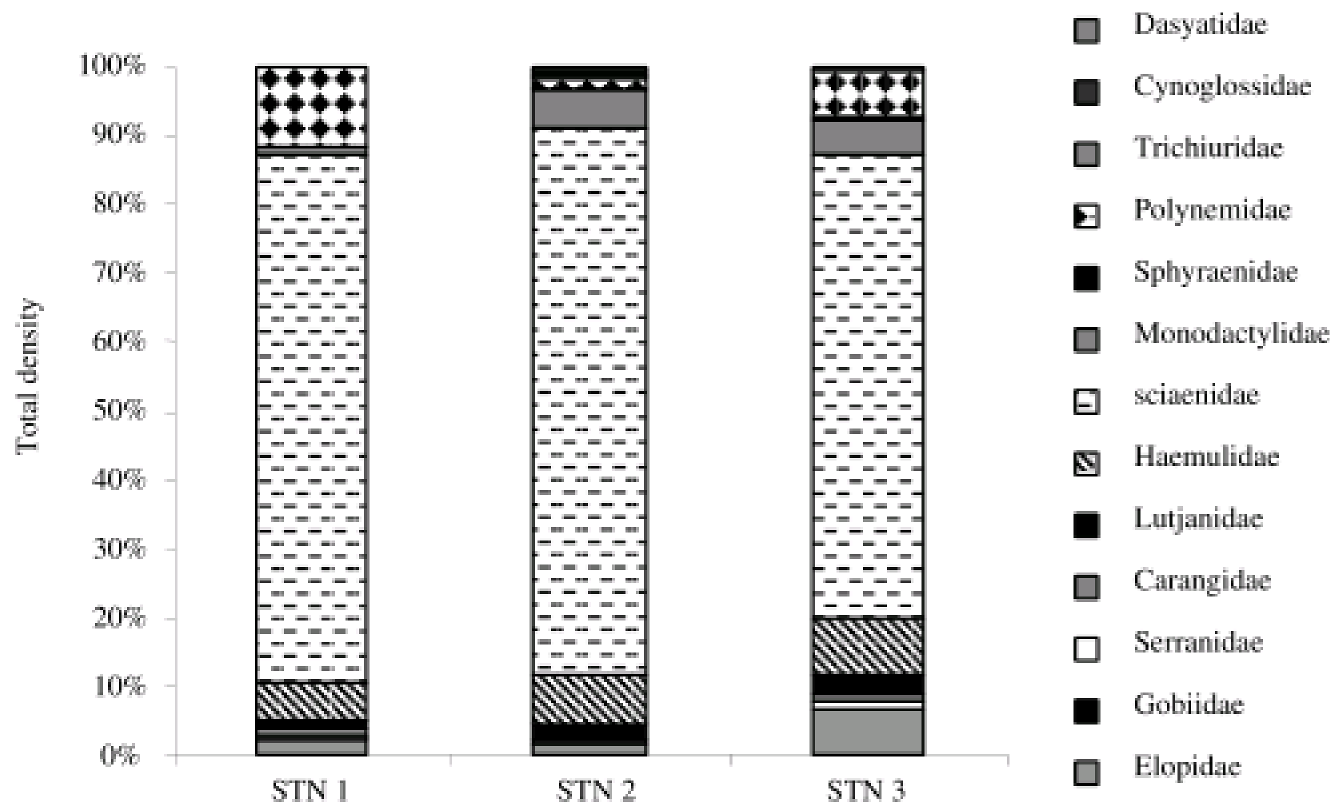


Fig. 2: Spatial variation in the relative contribution of fish families to the overall density at the study stations, Nov, 2004-June 2006

The family Elopidae, represented by *Elops lacerta* occurred only in station 3. The family Ariidae, represented by *Arius gigas* had its highest abundance in station 3 and lowest in station 2. The family Gobiidae, represented by *Gobius* sp. occurred only in station 1. The family of Serranidae, represented by *Epinephelus aeneus* had its highest abundance in station 3 and was absent in station 2. The family of Carangidae, represented by *Caranx latus* had its highest abundance in station 3 and lowest in station 2. The family Lutjanidae was represented by *Lutjanus agennes* which occurred only in station 3 and *Lutjanus goreensis* which had its highest abundance in station 3 and least in station 2. The family Haemulidae was represented by *Plectorhynchus macrolepsis* which had highest abundance in station 3 and absent in station 1 and *Pomadasys jubelini* which was well represented and had highest abundance in station 3 and least in station 2.

Sciaenidae, the dominant family represented by three species, *Argyrosomus regius*, *Pseudotolithus* (*Pseudotolithus*) *Senegalensis* and *Pseudotolithus* (*Fonticulus*) *elongatus* which was the dominant taxon had its highest abundance in station 1 and lowest in station 2.

The family Monodactylidae, represented by *Psettias sebae* had its highest abundance in station 3 and least in station 1. The family Sphyraenidae was represented by three species, *Sphyraena afra* which had its highest abundance in station 3 and absent in station 2, *Sphyraena guachancho* and *Sphyraena sphyraena* which were each singly represented in only station 3. The family Polynemidae, represented by *Polydactylus quadrifilis* had its highest abundance in station 1 and lowest in station 2. The family Trichiuridae, represented by *Trichiurus lepturus* occurred as a single individual at all stations. The family Cynoglossidae, represented by *Cynoglossus senegalensis* occurred as a single individual in only station 2. The family Dasyatidae, represented by *Dasyatis margarita* had its highest abundance in station 3 and absent in station 1.

The overall density showed that there was generally no consistent trend in monthly species abundance at the study stations but the least perturbed station 1 had higher densities than stations 2 and 3 (Fig. 3). Species diversity was higher at dry season than wet season.

Table 2: Distribution and Abundance of fishes at three of the study stations, November, 2004-June, 2006

| Taxa | STN 1 | STN 2 | STN 3 |
|---|---|---|---|
| Elopidae | | | |
| *Elops lacerta* | | | 2 |
| Ariidae | | | |
| *Arius gigas* | 19 | 3 | 32 |
| Gobiidae | | | |
| *Gobius* sp. | 2 | | |
| Serranidae | | | |
| *Epinephelus aeneus* | 2 | | 5 |
| Carangidae | | | |
| *Caranx latus* | 4 | 1 | 5 |
| Lutjanidae | | | |
| *Lutjanus agennes* | | | 4 |
| *Lutjanus goreenis* | 5 | 3 | 12 |
| Haemulidae | | | |
| *Plectorhynchus macrolepsis* | | 1 | 4 |
| *Pomadasys jubelini* | 24 | 11 | 37 |
| Sciaenidae | | | |
| *Argyrosomus regius* | 5 | 4 | 3 |
| *Pseudotolithus* (*Pseudotolithus*) *senegalensis* | 4 | 3 | 17 |
| *Pseudotolithus* (*Fonticulus*) *elongatus* | 335 | 111 | 320 |
| Monodactylidae | | | |
| *Psettias sebae* | 5 | 9 | 25 |
| Sphyraenidae | | | |
| *Sphyraena afra* | 2 | | 3 |
| *Sphyraena guachancho* | | | 1 |
| *Spyraena sphyraena* | | | 1 |
| Polynemidae | | | |
| *Polydactylus quadrifilis* | 50 | 2 | 33 |
| Trichiuridae | | | |
| *Trichiurus lepturus* | 1 | 1 | 1 |
| Cynoglossidae | | | |
| *Cynoglossus senegalensis* | | 1 | |
| Dasyatidae | | | |
| *Dasyatis margarita* | | 1 | 2 |
| Total No. of species | 13 | 13 | 18 |
| Density | 458 | 151 | 507 |
| Diversity (H') | 1.0724 | 1.1383 | 1.4933 |
| Evenness (E) | 0.4181 | 0.4438 | 0.5166 |
| Species richness (d) | 1.9586 | 2.3917 | 2.7294 |
| Dominance (C) | 0.5519 | 0.5515 | 0.4165 |

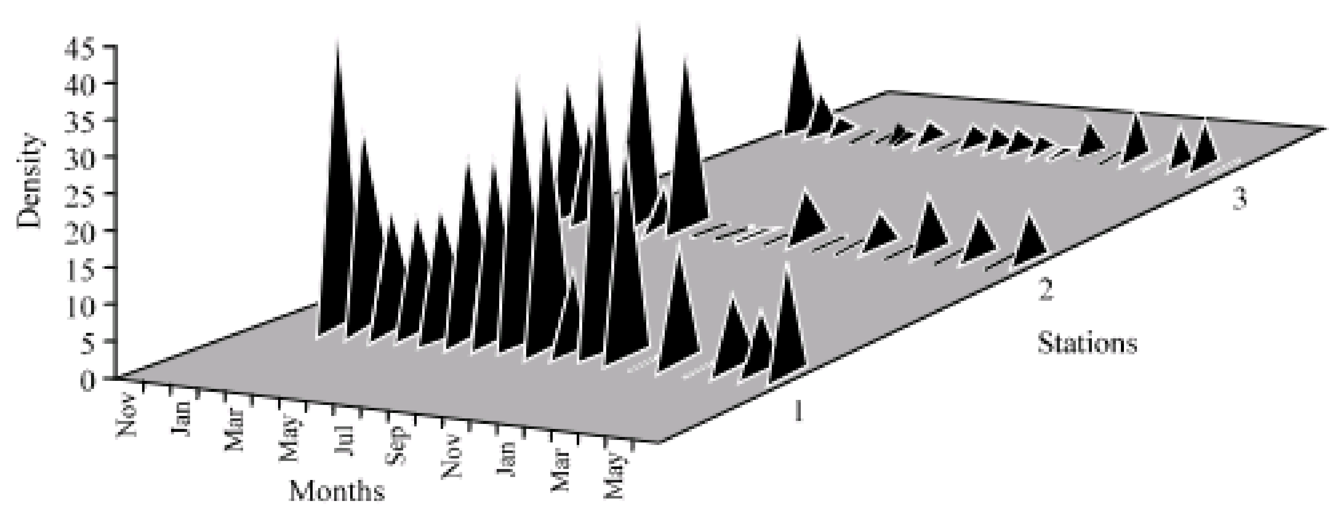


Fig. 3: Spatial and temporal variation in the density of fishes at the study stations, Nov. 2004-June 2006

Shannon Diversity indices (H') was highest in station 3 and lowest in station 1 (Table 2). Hutcheson's t-test performed to detect significant differences in the diversity values showed that station 3 was significantly higher ($p<0.05$) than stations 1 and 2, which

Table 3: Correlation coefficient (r) Values between some environmental variables and fish at three of the sampling stations of buguma creek, Nov 2004-June 2006

| Stations | Water temperature | Water level | Salinity | Dissolved oxygen | pH | Alkalinity | EDTA hardness |
|---|---|---|---|---|---|---|---|
| 1 | -0.269 | 0.277 | -0.266 | -0.171 | -0.319 | -0.427 | -0.172 |
| 3 | 0.184 | -0.323 | 0.211 | 0.096 | 0.309 | 0.454 | 0.163 |
| 4 | -0.239 | 0.026 | -0.449 | -0.313 | -0.076 | -0.271 | -0.064 |

were not significantly different ($p>0.05$). The Evenness index (E) was highest in station 3 and lowest in station 1. Simpson's Dominance index (C) was highest in stations 1 and 2 and lowest in station 3.

At all stations, there was no significant correlation between fish and the environmental factors, water temperature, water level, salinity, dissolved oxygen, pH, alkalinity and EDTA hardness (Table 3).

## DISCUSSION

There is clearly no best method for sampling fishes within mangrove habitats (Faunce and Serafy, 2006) .The baited hook and line fishing is commonly used by fishermen in Buguma because it is productive in catching diversity of species, except that it is unable to catch bottom feeders such as mullets and Tilapia species. Though quite selective by species and to a considerable extent by size, in some situations, line fishing may be most productive. Also, in many of its forms, it can be conducted successfully by a single fisherman (Bagenal, 1978).

The 20 species in 14 families recorded in this study, although excludes the limited number of bottom feeders is comparable to record of similar water bodies. The low habitat diversity limits the number of fish species inhabiting tidal mangrove creek (Krumme *et al*., 2004). Wright (1986) caught only 9 species in the shallow water creeks of a Nigerian mangrove. The higher species number of this study could be due to longer duration of sampling. About 30 species have been reported in the Kaper mangrove in Malaysia (IPIECA,1993). Davies (1988) caught 38 species in Australia. Krumme *et al*. (2004) caught 40 species in small inter-tidal mangrove creeks in Northern Brazil. Compared with other mangrove and estuarine systems, these records are low. A pool of all the species recorded in Lagos lagoon, Nigeria over time revealed 115 species (Oribhabor and Ezenwa, 2005). Other high species record from mangrove and estuarine systems are: 55 species (Beumer, 1978), 83 species (Little *et al*., 1988), 128 species (Kimani *et al*., 1996), 66 species (Laroche *et al*., 1997), 135 species (Tongnunui *et al*., 2002). The variations in species number with different habitats could be due to variations in salinity. The higher in species number of this study could be due to longer duration of sampling.

Although, low number of species was recorded for Buguma Creek, all mangrove and estuarine systems are similar in that, they have relatively few species that are clearly dominant in abundance (Tongnunui *et al*., 2002). Among all the fish species, members of the families Sciaenidae, Polynemidae, Ariidae and Monodactylidae are permanent residents. Members of the families Carangidae, Lutjanidae and Serranidae were temporary residents (These mainly comprised juveniles of large species that lived elsewhere as adults), while members of the families, Elopidae, Gobiidae, Dasyatidae, Cynoglossidae and Sphyraenidae were rare species (species that occured in very low number). Most fishes encountered in this study were sub-adults.

P. (*Fonticulus*) *elongatus* was most dominant because, although it is a marine species, it is able to tolerate a wide range of salinity. Temporally, species diversity and density or abundance was generally higher during the dry months than wet months. This could be attributed to increased salinity due to high incursion of seawater and more availability of food prey during the dry season.

There were no significant changes in the water quality parameters that could be attributed to the investigated anthropogenic activities. Spatially, the highest species density of station 1 is attributable to its least perturbed condition, characterized by less human impact on the mangrove and substrate. The low density of station 2 could be attributed to the joint impact of vibrations due to pedestrian bridge crossing, dumping of domestic wastes and regular cutting of mangrove. The general highest abundance of station 3 could be attributed to the dominance of species in upstream section from where species migrate to down stream during the flooding and ebbing of tide. The significantly higher diversity in station 3 could be attributed to its upstream status, since fishes migrate from upstream during flooding of tide and relative stability in terms of anthropogenic influence. The higher evenness recorded here justifies this situation, since the higher the evenness, the higher the diversity. Thus, if overall diversity is used as a measure of ecosystem stability, the fishes of this station must be considered more stable than other stations. The higher dominance index (C), confirmed by low evenness values in stations 1 and 2 was caused by the dominance of few taxa, notably Sciaenidae and Polynemidae.

## REFERENCES

APHA, AWWA and WPCF, 1985. Standard Methods for the Examination of Water and Waste Water. 16th Edn., APHA, Washington, DC., USA.

Bagenal, T.B., 1978. Methods for Assessment of Fish Production in Freshwaters. 3rd Edn., Blackwell Scientific Publication, Oxford, London, pp: 365..

Beumer, J.P., 1978. Feeding ecology of four fishes from a mangrove creek in North Queensland, Australia. J. Fish Biol., 12: 475-490.

Burke, L., Y. Kura, K. Kassem, C. Revenga, M. Spalding and D. McAtlister, 2001. Pilot Analysis of Global Ecosystems: Costal Ecosystems. World Resources Institute, Washington DC. USA.

Chindah, A.C. and A. Osuamkpe, 1994. The fish Assemblage of the Lower Bonny River, Niger Delta, Nigeria. Afr. J. Ecol., 32: 58-65.

Chindah, A.C. and C.C.B. Tawari, 2001. Comparative study of different gill net mesh sizes in the exploration of bonga fish (*Ethmalosa fimbriata*) and sardines (*Sardinella eba*) in brass coastal waters, bayelsa state, Nigeria. J. Applied Sci. Environ. Mgt., 5: 17-24.

Chong, V.C., A. Sasekumar, M.U.C. Leh and R. D'Cruz, 1990. Jacent mud flats and inshore waters. Estuar. Coast. Shelf Sci., 31: 703-722.

Connolly, R., D. Brass and A. Dalton, 1996. Fish use of an inundated saltmarsh flat in a temperate Australian estuary. Aust. Ecol., 22: 222-226.

Dadrymples, R.W., B.A. Zaitin and R. Boyd, 1992. Estuarine facies models–conceptual basis and stratigraphic implications. J. Sediment. Res., 62: 1130-1146.

Davis, T.L.O., 1988. Temporal patterns in the fish fauna entering a tidal swamp system in tropical Australia. Environ. Biol. Fish., 21: 161-172.

Dublin-Green, C.O. and A.G. Ojanuga, 1988. The problem of acid sulphate soils in brackish water aquaculture. Nigerian Institute for Oceanography and Marine Research Technical Paper No. 45.

Fagade, S.O. and C.I.O. Olaniyan, 1972. The biology of the west african shad, *Ethmalosa fimbriata* (Bowdich) in lagos lagoon, Nigeria. J. Fish Biol., 4: 519-533.

Faunce, C.H. and J.E. Serafy, 2006. Mangroves as fish habitat: 50 years of field studies. Mar. Ecol. Prog. Ser., 318: 1-8.

IPIECA, 1993. Biological impacts of oil pollution: Mangroves. IPIECA Report Series Vol. 4, International Petroleum Industry Environmental Association, London.

Kimani, E.N., E.O. Mwatha, J.M. Wakwabi, J.M. Ntiba and B.K. Okoth, 1996. Fishes of a shallow tropical mangrove estuary, Gazi, Kenya. Mar. Fresh. Res., 47: 857-868.

Krumme, U., U. Saint-Paul and H. Rosenthal, 2004. Tidal and diel changes in the structure of a nekton assemblage in small intertidal mangrove creeks in Northern Brazil. Aquat. Liv. Res., 17: 215-229.

Laroche, J., E. Baran and N.B. Rasoanandrasana, 1997. Temporal patterns in a fish assemblage of a semi arid mangrove zone in Madagascar. J. Fish Biol., 51: 3-20.

Lind, O.T., 1979. Handbook of Common Methods in Limnology. 2nd Edn., The C.V. Mosby Co., St. Louis, Missouri.

Little, M.C., P.J. Reay and S.J. Grove, 1988. The fish community of an east African mangrove creek. J. Fish Biol., 32: 729-747.

Obeng, I., 1981. Man's Impact on Tropical Rivers. In: Perspectives in Running Water Biology, Lock, M.A. and D.D. William (Eds.). Plenum Press, New York.

Ogbeibu, A.E., 2005. Biostatistics-A Practical Approach to Research and Data Handling. 1st Edn., Mindex Press, Benin City, Nigeria, pp: 276.

Oribhabor, B. and B. Ezenwa, 2005. Inventory of fisheries and fishes of the lagos lagoon, lagos, Nigeria. Trop. Fresh. Biol., 14: 19-36.

Scheider, W., 1990. FAO Species Identification Sheets for Fishery Purposes-Field Guide to the Commercial Marine Resources of the Gulf of Guinea. Food and Agricultural Organization of the United Nations, Rome, ISBN: 9251030480.

Semeniuk, V., P.N. Chalmer and I. Le-Provost, 1982. The marine environments of the dampier archipelago. J. Roy. Soc. West. Aust., 65: 97-114.

Sheridan, P. and C. Hays, 2003. Are mangroves nursery habitat for transient fishes and decapods?. Wetlands, 23: 449-458.

Tongnunui, P., K. Ikejia, T. Yamane, M. Horinouchi and T. Medej *et al*., 2002. Fish fauna of the sikao creek mangrove estuary, trang, Thailand. Fish. Sci., 68: 10-17.

Victor, R. and J.O. Tetteh, 1988. Fish communities of a perturbed stream in Southern Nigeria. J. Trop. Ecol., 4: 49-59.

Wright, J.M., 1986. The ecology of fish occurring in shallow water creeks of Nigerian mangrove swamp. J. Fish Biol., 29: 431-441.