International Journal of Fisheries and Aquaculture Research
Vol.10, No.2, pp.28-50, 2024
Print ISSN: ISSN 2397-7507,
Online ISSN: ISSN 2397-776
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development UK

Shellfish Species Abundance and Diversity in River Donga, Taraba, Nigeria

*** Flourizel Igbani [1]; Mbanefo Onwumelu[2]; Tubasen Vyonma Stephen**

[1&3]Department of Fisheries and Aquaculture, Faculty of Agriculture and Life Sciences, Federal University Wukari, KM 200 Katsina-Ala Road, PMB 1020 Wukari, Taraba State, Nigeria.

[2]Department of Fisheries and Aquatic Resources Management, College of Natural Resources and Environmental Management, Michael Okpara University of Agriculture, Umudike, P.M.B. 7267, Umuahia, Abia, Nigeria.

*igbani@fuwukari.edu.ng

doi: https://doi.org/10.37745/ijfar.15/vol10n22850 Published October 27, 2024

Citation: Igbani F., Onwumelu M., and Stephen T.V. (2024) Shellfish Species Abundance and Diversity in River Donga, Taraba, Nigeria, *International Journal of Fisheries and Aquaculture Research*, Vol.10, No.2, pp.28-50

Abstract: *A twenty-four (24) week investigation was carried out in River Donga, to determine the shellfish species abundance and diversity. The section of the River was sampled and human activities were considered in the choice of sampling stations. A total of five (5) individual species of shellfish were identified; they comprise of five (5) families, five (5) genera and three (3) orders; including one (1) terrestrial (land) snail (Anixa zebuensis); the highest caught individual species was H. pomatia (1,072) species, while the least caught individual species was C. obeyensis (1) species. A total of 1,305 species of shellfish were caught. Analysis of variance (ANOVA) was used to test for the significant difference occurring in various physicochemical parameters between stations. Pearson's Correlation was used to test the relationship between physicochemical parameters and shellfish composition of the river at P<0.01 significant level. The highest temperature value (27.11 ± 0.05^b) was recorded in station B; the least value (26.98 ± 0.03^a) was recorded in station A. The mean pH values were slightly acidic; the highest pH value (6.57 ± 0.08^a) was recorded in station A and the least value (6.29 ± 0.1^b) was recorded in station C. The highest Dissolve Oxygen value (6.06 ± 0.03^b) was recorded in station C and the least value (5.94 ± 0.05^a) was recorded in station B. Electrical Conductivity, the highest value (16.05 ± 0.03^b) was recorded in Station C and the least value (15.85 ± 0.02^a) was recorded in station B. The highest turbidity value (34.32 ± 0.15^b) was recorded in station C; the least value (33.95 ± 0.03^a) was recorded in station B. The highest total dissolved solid value (0.29 ± 0.01^a) was recorded in station B; the least (0.26 ± 0.01^a) was recorded in station A. The river was described as slightly productive in terms of its shellfish richness. It was recommended that the physicochemical characteristics of the researched ecosystem is adequate for species survival. Nevertheless, it is paramount that the monitoring of human activities and the conservation of its natural resources are considered to aid sustainable diversity for food sovereignty and security to better the lives of the aquatic species in the ecosystem amidst anthropogenic activities and climate change.*

Keywords: shellfish biodiversity, abundance, conservation, management, anthropogenic activities

International Journal of Fisheries and Aquaculture Research
Vol.10, No.2, pp.28-50, 2024
Print ISSN: ISSN 2397-7507,
Online ISSN: ISSN 2397-776
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development UK

INTRODUCTION

Fish is one of the affordable sources of quality protein that is available worldwide for human consumption (Olugbojo and Ayoola, 2015). It is one of the main food components of humans for many centuries and still constitutes an important part of the diet of many countries (Eze *et al.,* 2011). Fishes are consumed for their high nutrient values in terms of high protein retention in its body, low level of cholesterol and presence of essential amino acids. Fish is also an important source of income for fisher folk and fish farmers and its cultivation is a source of employment in developing countries (Felix *et al.,* 2018).

Shellfish are a major but cheap protein source for human consumption as well as source of income for coastal towns and villages of the Niger Delta environment. Nigeria's shrimp fisheries, both industrial and artisanal, are a major source of both direct and indirect employment (Okayi *et al.*, 2013). Shellfish have been found out to be of very great commercial importance in Nigeria territorial waters and the exploitation has been on the increase due to increasing population and demand for protein sources by man (Bankole, 2007). Nwosu (2007) reported that there has been significant reduction of the natural stock of shrimps in Nigerian coastal waters (probably due to environmental degradation which is detrimental to the abundance and life cycle of the shrimp species) while Deekae and Abowei (2010) stated that the unfriendly fishing methods of local fishers who use poisons and chemicals are affecting the shrimp catch.

The two largest species of *Macrobrachium* in Nigeria waters are *M. vollenhovenii* and *M. macrobrachion* both of which are found in fresh and brackish waters. They are universally accepted as food organisms and support a substantial number of local fisheries (William, 2006). Oyekanmi (2000) reported that *Macrobrachium species* accounted for up to 60% of the prawn landings from Lagos Lagoon and that *M. vollenhovenii* are usually absent from clear water rivers which are generally acidic, extremely transparent, lack of mollusc's fauna and show little seasonal change in level.

Flourizel, defined biodiversity as the biological variation/forms of species in their ecological environments due to genetic factors over time; it could be genetic interactions or environmental (natural or man-made) influence/threats that creates their differences/kinds or types (Igbani, 2022). Igbani and Uka (2019) reported that biodiversity should not be construed as a simple umbrella covering a mosaic of heterogeneous activities but should represent a composite entity 'shaped by the interactions (Krishnamurthy, 2003).

Biodiversity and its conservation are regarded as one of the major issues of enabling sustainable use of natural resources. Maintaining biodiversity is important because it is not always possible to identify which individual species are critical to aquatic ecosystems sustainability. Many fish species may provide genetic material and may serve as ecological indicators. Aquatic conservation strategies support sustainable development by protecting biological resources in ways that will preserve habitats and ecosystems (Jenkis and Williamson, 2003).

Recent evidence has shown over exploitation and decline in the stock size of some species (Ama-Abasi *et al.*, 2004). Fish diversity is also threatened by anthropogenic activities such as dredging, deforestation and organic pollution. Previous belief that artisanal fisheries have little impact on fish abundance and diversity has been disproved by recent studies (Njiru *et al.*, 2004; King, 2007; Silvano *et al.*, 2009).

Aim and Objectives of the Study

Aim of the Study

This study is aimed at assessing the shellfish species diversity and abundance in River Donga, Taraba State.

Objectives of the Study

The specific objectives of this study are to:

i. Estimate shellfish species abundance in River Donga.
ii. Estimate shellfish species diversity in River Donga.
iii. Determine the physico-chemical parameters of River Donga.

Shellfish are aquatic invertebrate that are used for food and typically either have a hard exterior or an exoskeleton, or belong to a group of invertebrate that typically are characterized by this shell. Taxonomy is the theory and practice of classifying organisms. In Fisheries science, the taxonomy of aquatic animals could be studied as two major components i.e. shellfish taxonomy and finfish taxonomy. The shellfish taxonomy includes two highly diversified phyla which is phylum Arthropoda and phylum Mollusca. The fresh water crabs, Lobsters, fresh water clams belongs to the same phylum which is Arthropoda and snails belongs to the phylum Mollusca. (Candolle, 1813).

Igbani and Ikponmwen (2023) researched on the plankton and benthos distribution of river Donga in Taraba State, Northeast, Nigeria. They reported highest temperature value (29.0 ± 1.36^{0}C) in station A (Shisha) and least value (27.9 ± 0.6^{0}C) in section B (Nyankwala); highest dissolve oxygen (8.08 ± 0.22 mg/L) in station B (Nyankwala) and least value (7.32 ±0.5 mg/L) in station A (Shisha); the stated that the mean pH value were slightly acidic: highest pH value (6.71 ± 0.62) in station A (Shisha) and least value (6.27 ± 0.27) in station C (Nikanaki), highest electric conductivity value (16.07 ± 0.25) in station C (Nikanaki) and least value (15.58 ± 0.52) in station A (Shisha), highest total dissolve solid value (0.36 ± 0.38 ppm) in station C (Nikanaki) and least value (0.24 ± 0.32 ppm) in station A (Shisha), highest turbidity value (33.25 ± 6.15 cm) in station A (Shisha) and least value (32.08 ± 4.54 cm) in station B (Nyankwala). They stressed that the river was slightly productive and rich in plankton and benthos as some fish species eggs were recorded.

Amos *et al.* (2020) researched on assessment and identification of fish species abundant and endangered in river Donga, Taraba State, Nigeria. They recorded a total number of 39 fish species and reported the most abundant fish species as *Oreochromis niloticus* (9.18%) while the least was the *Hyperopsus bebe* and *Labeo barbusbynni* (0.19% each) and the most endangered fish species was *Gymnarchus niloticus* (21.28%), the least was *Malapterurus electricus* (0.53%). They stressed that the causes of endangered fish species were the use of poison as the highest (30.94%) while the list was the size of fishing gear (1.1%). They advised that the use of crude methods in fishing collection/harvesting should be discouraged.

Deekae *et al*. (2016) researched on foods of the brackish river Prawn, *Macrobrachium macrobrachion* (Herklots 1851) from Ekole creek, Bayelsa State, Nigeria. They examined prawn species juveniles, young adults and adults, the young adults constituting majority of the population. They reported sizes of specimen ranged from 3.40-10.50cm which weighed between 0.5-18.3g with males generally larger than the females, the males ranged from 3.40-10.50cm and weighed between 69g and 18.30g while the female range from 3.50-9.10cm and weighed between 0.5g and 10.10g. They stated that the values obtained from the length/weight relationship (LWR) of *M. macrobrachion* showed a positive correlation between total length and weight (r = 0.94). They stressed that the condition factor, K of the Prawn provides information on the physiological state of the prawn in relation to it welfare; this showed that the species is in good condition in Ekole River, Bayelsa State, Nigeria.

Egwali *et al*. (2018) researched on the composition and abundance of shellfish, they recorded a total of 1583 individual shellfish species comprising of eight (8) families which were grouped into three. Five (5) families; grapsidae, gecarcinidae, ocypodidae, portunidae and xanthidae made up crabs group, while one (1) family; palaemonidae made up prawn group and two (2) families; penaeidae and pandalidae made up shrimps group. They also reported composition and abundance of Pandalus spp (50.29%) as the higest in abundance, followed by *Nematopalaemon hastatus* (29.21%) and *callinectes amnicola*. Williams (2006) stated that shellfish species are universally accepted as food organisms and support a substantial number of local fisheries. Besides, the prawn; *Nematopalaemon hastatus*, is the major constituent and an essential food condiment in almost all local dishes to area, in south east, southsouth and further north in Nigeria (Okayi *et al*., 2013).

Zabbey (2007) stated that the composition of 'bycatch' observed during shrimping ranged from jellyfishes to finfish and occasionally gastropod molluscs. Bycatch may be defined as anything the fisherman does not intend to catch and may include the turtles, fish, crabs, sharks, weed and seabed debris (Eayrs, 2005).

Soundarapandian (2012) studied the diversity of commercially important crabs from Arukkattuthurai to Pasipattinum, where they found 12 species of crabs, the most dominant of which was *P. pelagicus*. However, differences in the number of species were caused by many factors such as the habitat (bay or coastal areas), geographical distribution of the crabs, season, fishing gear used to collect the samples (Kunsook 2011), exploitation rate and physical factors such as temperature, salinity, transparency depth and pH (Varadharajan and Soundarapandian, 2012).

Kunsook *et al*. (2014) found that 70% of crabs are in the juvenile stage. Moreover, Tianpru and Samakphan (2014) investigated the species diversity of marine animals in the bay and found a total of 36 species. Importantly, they found many animals in the juvenile stage, including arthropods (95%), chordates (4%) and molluscs (1%), in both seagrass beds.

Nazeef *et al.* (2021) researched on the fish species biodiversity of Dadin-Kowa reservoir: current status. They reported a total number of 28 fish species, 14 families and the family Cichlidae was dominant with *Oreochromis niloticus*; the most abundant while the family Malapterurudae was the least (0.09%). They stressed that the reservoir has a rich ichthyofaunal composition which is facing challenges of structural collapse unless if management strategies are fully adopted.

Andrew *et al.* (2017) researched on the seasonal analysis of water quality in two settlements of Wukari local government area, Taraba state, Nigeria. They investigated on temperature, turbidity, suspended solid, total dissolved solids (TDS), conductivity, pH, phosphate, chloride, alkalinity, hardness, chemical oxygen demand (COD), dissolved oxygen (DO) and biological oxygen demand (BOD). Kumar *et al.* (2021), researched on physicochemical characteristics of Akshar Vihar pond in Bareilly, U.P. They recorded air temperature (17.03-36.03^{o}C), water temperature (17.97-35.97^{o}C), transparency (17.93-36.03 cm), pH (6.77-8.63), dissolved oxygen (6.40-9.97 mg/l), free CO2 (0-18 mg/l), carbonate alkalinity (0-67 mg/l), bicarbonate alkalinity (155.58-433.13 mg/l), chloride (4.52-5.92 mg/l), calcium (65.78-82.34 mg/l), magnesium (158.60-538.83 mg/l), total hardness (380-480 mg/l), BOD (1.23-1.80 mg/l) and COD (3.97-8.83 mg/l). They reported a positive relationship of air temperature with water temperature (0.864), dissolved oxygen with BOD (0.869), magnesium with both total hardness (0.915) and COD (0.866). They also observed a negative relationship of water temperature and pH at (-0.913). Nwagba *et al.* (2022), worked on the seasonal variation and physicochemical characteristics of Omeremaduche River, Abia state, Niger Delta, Nigeria. They reported that the mean value of pH, water-temperature, DO, BOD, phosphate and nitrate during the wet season were 6.91, 27.3, 5.86mg/l, 0.38 and 4.18 respectively, while mean value of the physicochemical characteristics during the dry season were 6.68, 26.8, 7.22mg/l, 5.44mg/l, 0.25mg/l and 3.09mg/l respectively. They also stated that, there was a significant difference in seasonal variation in DO, BOD, Nitrate and Phosphate, while no significant difference in pH and water-temperature.

MATERIALS METHODS

Study Area

Location

River Donga is one of the promising tributaries of River Benue in Taraba State. This river transport rainwater with huge amounts of sediments through the town. Donga town is one of the oldest LGA in the State. It is roughly located between latitude 10^{0}03’00” E and longitude 7^{0}43’00”N (Fig. 1.1). It is bounded with Kurmi Local Government Area by east, Wukari Local Government Area by the South, Gassol Local Government Area to the North, Bali Local Government to the Northeast and Tkum Local Government Area to the West. It has an area of 3,121 km^{2} and a population of 134,111 at the 2006 census (Anderson *et al* 2006). Its river basin covers an area of 11,355km2. River Donga is characterized by several minor catchments of about 1,135,498 hectares (Adelalu, 2018). These Sub Basins include among others Ntum, Luggungo, Mbasoand Ngo. Its sources are from Tsabga hill, which has an altitude range of 4,500 – 5,000 meters above sea level (Adebayo and Bashir, 2005). It flows southwest to other parts of the State with a volumetric flow remaining considerable even in the low water period (Adebayo and Bashir, 2005). This makes these area water resources potential for socio-economic development. However, if not properly harness can boost vulnerability of such area to flooding (Adelalu, 2018).

EXPERIMENTAL PROCEDURE

Collection of Shellfish Species Samples

The Shellfish species were collected once a week from the month of July to December 2023 in three (3) sampling stations. Shellfish species were collected from the landing sites at low and high tides. The shellfish specimens collected were preserved in an iced packed chest box in the field and later transferred to the Laboratory, for sorting and identification (Lawal-Are, 2009).

Identification of Shellfish Species

The collected shellfish species were identified to species level using identification keys provided by my lecturer (FAO. 1981; Igbani and Uka, 2019).

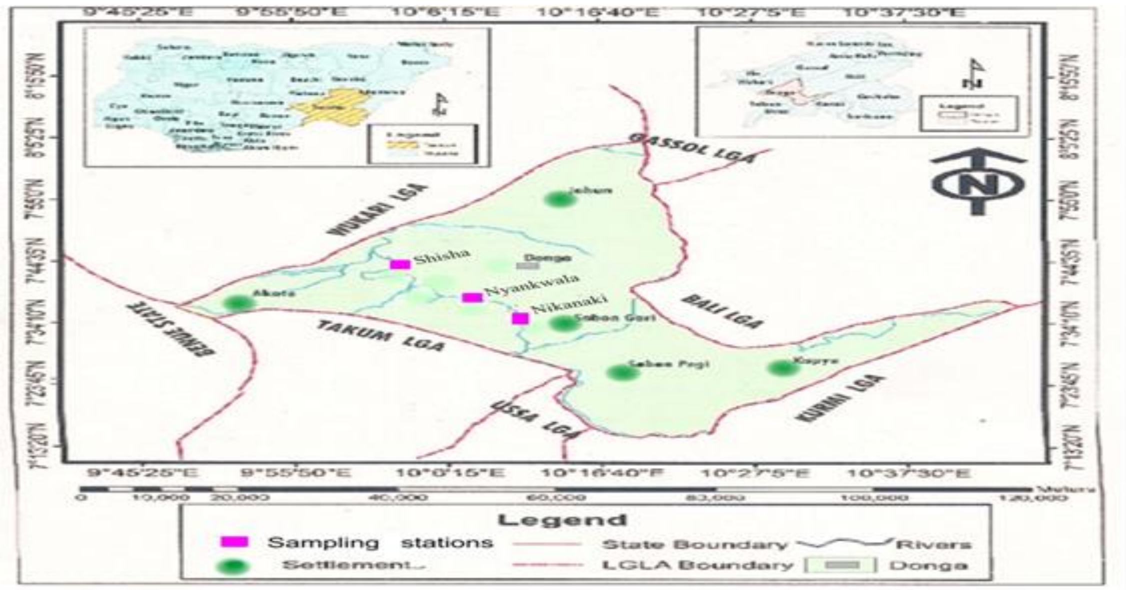

Figure 1: Map showing sampling stations in River Donga.

Determination of Species Abundance and Diversity

Shellfish species abundance and diversity were determined using Shannon diversity calculator Index with the formula thus:

Diversity (D) = $1 - \Sigma (n/N)^2$

Where "N" is the total number of stated species residing in the same area and "n" is the abundance of the i – th species in the area. (Shannon and Simpson, 2024).

Species Abundance can be determined using the formula as follows;

Abundance: $d = (s - 1)/\text{In } N$

Where;

d = Margalef richness index or species abundance index,

S = Number of species in the population,

N = Total number of individual in the species,

In = Logarithm (Margalef, 1958; Antai and Joseph, 2015).

Abundance was determined by relative abundance method which involves counting the total number of fish species caught per sample site per time which were recorded and the relative abundance score of the species were estimated, thus: 1-50(Rare/R); 51-100 (Few/F); 101-200 (Common/C); 201-400 (Abundant/A) and > 400(Dominant/D) (Allison *et al.,* 2003; Igbani and Uka, 2019).

Determination of Physicochemical Parameters:

Water Temperature

Temperature was determined in-situ using mercury in glass thermometer. This was done by lowering the thermometer bulb into the water below for about 2 to 5 minutes and taking it stable reading (APHA. 2005).

Dissolved Oxygen

Dissolved Oxygen (DO) was determined in-situ using DO meter (Luton DO-5509 Model). This was done by lowering the DO meters probe into the water for about 2 to 5 minutes and taking it stable reading (APHA. 2005).

Power of Hydrogen (pH)

Power of Hydrogen was measured in-situ with a pH meter (HANNA 3100 Model). This involved probing the electrode of the pH into the water for about 3 to 5 minutes and taking it stable reading (APHA. 2005).

Turbidity

Turbidity was measured in-situ with secchi disc, this was done by lowered slowly the secchi disc down into the water and when the disc is no longer visible, the length of the line lowered was measured and then recorded (APHA. 2005).

Electrical Conductivity (EC)

Conductivity of water was measured in-situ with EC meter (DDS-307 Model). This was done by lowering the EC meter into the water below for about 2 to 5 minutes and taking its stable reading (APHA. 2005).

Total Dissolved Solid (TDS)

Total dissolved solid was measured in-situ with TDS meter (HANNA 3100 Model). This was done by lowering the TDS meter into the water below for about 3 to 5 minutes and taking it stable reading (APHA. 2005).

Data Analysis:

Microsoft Excel (2007) was be used for Data analysis for the percentage abundance of the shellfish species, mean and standard error of the physicochemical parameters of the sampled stations, while version 3 of PAST Software Design will be used to determine the shellfish species diversity (Shannon Diversity index) and richness (Margalef) of the shellfish community composition in each sample stations. Pearson’s Correlation was used to test the relationship between physicochemical characteristics and shellfish composition of the river at p=0.01 significant level.

RESULTS

Identification Of Shellfish Species

A total number of five (5) individual species of shellfish were identified (table 4.1). The species identified comprises a total number of five (5) individual species, five (5) families, five (5) genera and three (3) orders; the highest individual caught was *L. bernardanus* recorded (1,072) species and the lowest was *C. obeyensis* recorded (1) species.

Abundance And Distribution Of Shellfish Species

A total number of 1,305 individual species of shellfish were caught along River Donga. The Margalef species richness index or species abundance index (d) were recorded; shellfish recorded in the sampled stations A, B and C were (0.65, 0.32 and 0.33) respectively (table 4.2); station A has the highest score (0.65) and the least was recorded in station B (0.32); the most abundance species of shellfish identified was *L. bernardanus*; the least was *C. obeyensis.*

Diversity Of Shellfish Species

Shellfish species diversity (Table 4.3) showed a total of 5 shellfish species belonging to 5 families, 3 orders and 5 genera. The species diversity amongst the families found in the river during the research work were reported using Shannon and Simpson diversity index. The shannon diversity index has the highest (1.820), simpson diversity index is the least (0.691).

Table 4.1 Shellfish Species Identification In River Donga

S/N	Species	Families	Orders	Total Number Of Species Caught
1.	*Cardosima armatum*	Gecarcinidae	Decapoda	**146**
2.	*Homarus americanus*	Nephropidae	//	**2**
3.	*Cambarus obeyensis*	Cambaridae	//	**1**
4.	*Mercenaria mercenaria*	Veneridae	Venerida	**84**
5.	*Lanistes bernardianus*	Ampullariidae	Architaenioglossa	**1072**
TOTAL				**1305**

SHELLFISH SPECIES IDENTIFIED IN RIVER DONGA.

Plate 1: Scientific Name: *Cardosima armatum* (Herklots,1851)
Family: Gecarcinidae
Order: Decapoda
Common Name: Fresh water crab
Local Name (Hausa): Kagua

Plate 2: Scientific Name: *Homarus americanus* (H. Milne-Edwards, 1837)
Family: Nephropidae
Order: Decapoda
Common Name: American Lobster
Local Name (Hausa):

Plate 3: Scientific Name: *Mercenaria mercenaria* (Schumacher, 1817)
Family: Veneridae
Order: Venerida
Common Name: Fresh water clam
Local Name (Hausa): Maciscira

Plate 4: Scientific Name: *Cambarus obeyensis* (Hobbs and Shoup, 1947)
Family: Cambaridae
Order: Decapoda
Common Name: Obey crayfish
Local Name (Hausa): Jatalambe

International Journal of Fisheries and Aquaculture Research
Vol.10, No.2, pp.28-50, 2024
Print ISSN: ISSN 2397-7507,
Online ISSN: ISSN 2397-776
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development UK

Plate 5: Scientific Name: *Lanistes bernardanus* (Morelet, 1860)
Family: Ampullariidae
Order: Architaenioglossa
Common Name: Fresh water snail
Local Name (Hausa): Kodi

Tables 4.2: Shellfish species Abundance in River Donga

S/N	Species	Families	Orders	Sites			Total Species Caught
				A	**B**	**C**	
1.	*Cardosima armatum*	Gecarcinidae	Decapoda	**49**	**49**	**48**	**146**
2.	*Homarus americanus*	Nephropidae	//	**2**	**0**	**0**	**2**
3.	C. obeyensis	Cambaridae	//	**1**	**0**	**0**	**1**
4.	*Mercenaria mercenaria*	Veneridae	Veneridae	**32**	**29**	**23**	**84**
5.	*Lanistes bernardanus*	Helicidae	Stylommatophora	**376**	**348**	**348**	**1,072**
Total Abundance				**460**	**426**	**419**	**1,305**
Total number of species				**5**	**3**	**3**	
Total number of individual species				**460**	**426**	**419**	
Margalef species richness index				**0.65**	**0.32**	**0.33**	

Table 4.3: Shellfish species Diversity in River Donga (Shannon and Sampson)

	Total Individual species	Shanon Diversity Index	Simpson Diversity Index
Cardosima armatum	146	1.820	0.691
Homarus americanus	2		
Mercenaria mercenaria	84		
Cambarus obeyensis	1		
Lanistes bernardanus	1072		

International Journal of Fisheries and Aquaculture Research
Vol.10, No.2, pp.28-50, 2024
Print ISSN: ISSN 2397-7507,
Online ISSN: ISSN 2397-776
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development UK

Table 4.4 Composition of Shellfish Species in River Donga

S/N	Species	Total Individual Catch	Weekly Total Catch 1	2	3	4	5	6	7	8	9	10	11	12
1	*Cardosima armatum*	**146**	1	2	0	0	0	4	0	16	14	8	20	10
2	*Homarus americanus*	**2**	0	0	0	0	0	0	0	0	0	0	0	0
3	*Mercenaria mercenaria*	**84**	0	2	1	0	1	0	0	0	5	3	8	10
4	*Cambarus* obeyensis	**1**	0	0	0	0	0	0	0	0	0	0	0	0
5	*Lanistes bernardanus*	**1,072**	23	32	32	39	46	22	21	49	46	49	67	48
		1,305	**24**	**36**	**33**	**39**	**47**	**26**	**21**	**65**	**65**	**60**	**95**	**68**

Total Catch

S/N	Species	Total Individual Catch	Weekly Total Catch 13	14	15	16	17	18	19	20	21	22	23	24
1	*Cardosima armatum*	**146**	14	3	4	2	3	8	13	4	3	6	5	6
2	*Homarus americanus*	**2**	0	0	0	0	0	0	0	0	0	0	1	1
3	*Mercenaria mercenaria*	**84**	9	11	5	5	4	1	2	2	2	3	4	6
4	*Cambarus* obeyensis	**1**	0	0	0	0	0	0	0	0	0	0	0	1
5	*Lanistes bernardanus*	**1,072**	82	72	79	54	52	33	40	36	38	32	37	43
	Total Catch	**1,305**	**108**	**86**	**88**	**61**	**59**	**42**	**55**	**42**	**43**	**41**	**47**	**57**

4.2 Fish Species Composition of River Donga per Sampled Station

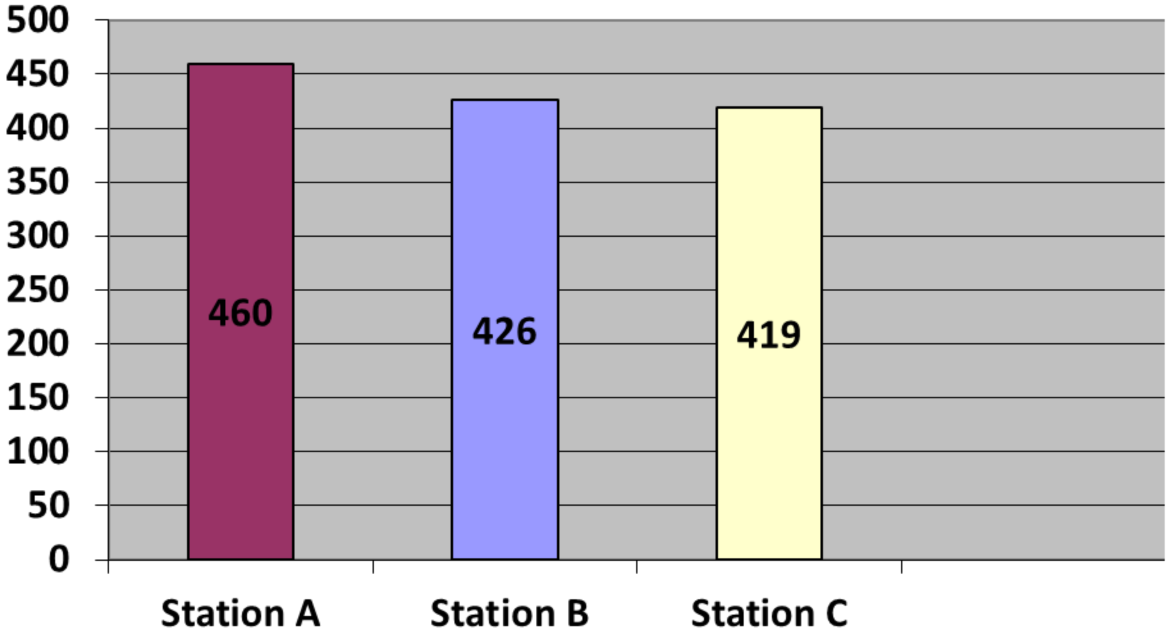

Figure 4.1: Bar Chart Showing Shellfish Species Station Composition

Mean Value of Physicochemical Parameters among Stations

Mean values of physicochemical parameters were presented in (Table 4.6), Mean water temperatures were between (26.98 ± 0.03^a) to (27.11 ± 0.05^b). The temperature values were below the acceptable limits (29ºC-30ºC) set by World Bank Range for freshwater aquaculture (Ronald *et al*., 1999), the highest temperature was (27.11 ± 0.05^b) were recorded in station B, and the least (26.98 ± 0.03^a) were recorded in station A.

The mean values of dissolved oxygen ranged between (5.94 ± 0.05^a) to (6.06 ± 0.03^b), station C recorded the highest (6.06 ± 0.03^b), while station B recorded the lowest (5.94 ± 0.05^a); all the DO values were within the acceptable limits (>5.0-6.0 Mg/l) set by World Bank Range for freshwater aquaculture (Ronald *et al*., 1999).

The pH mean values were slightly acidic, ranging from (6.29 ± 0.1^b) to (6.57 ± 0.08^a); the highest values (6.57 ± 0.08^a) were recorded in station A, while the lowest values (6.29 ± 0.1^b) were recorded in station C. all the pH values were within the acceptable limits (6.5-9.0) set by World Bank Range for freshwater aquaculture (Ronald *et al*.,1999).

Electrical conductivity mean values were recorded from (15.85 ± 0.02^a) to (16.05 ± 0.03^b); the highest value (16.05 ± 0.03^b) was recorded in Station C and the least values (15.85 ± 0.02^a) was recorded in

station B; the acceptable threshold for electrical conductivity is 100 – 500 µS/cm (freshwater fish culture) and 500 – 1,000 µS/cm (shrimp and prawns culture).
The turbidity mean values range from (33.95±0.03[a]) to (34.32±0.15[b]); the highest values (34.32±0.15[b]) were recorded in station C and lowest value (33.95±0.03[a]) were recorded in station B; the acceptable threshold for turbidity is <50 NTU (freshwater fish culture) and <20 NTU (shrimp and prawns culture).
The TDS mean values range from (0.26±0.0.01[a]) to (0.29±0.01[a]); the highest values (0.29±0.01[a]) were recorded in station B and the lowest values (0.26±0.01[a]) were recorded in station A; the acceptable threshold for total dissolved solid is <500 mg/l (freshwater fish culture) and <1,000 mg/l (shrimp and prawns culture).

Pearson Correlation of Shellfish Species with Physicochemical Parameters with Stations

There was a negative and positive correlation with some of the physicochemical parameters and shellfish species in the sampled stations (Tables 4.6 to 4.11). Temperature and dissolved oxygen showed negative physicochemical parameters and species correlation in all the stations, except with *L. bernardanus* in station C (Table 4.6 and 4.8), pH showed negative correlation in all the stations except station A which was positive (Table 4.7), turbidity showed positive correlation in all the stations, except with *H. americanus* in station A (Table 4.9), conductivity showed positive correlation in all the stations, except station B and with *H. americanus* in station C (Table 4.10), while TDS showed negative correlation in all the stations except station B and *M. mercenaria* showed positive correlation in station B (Table 4.11).

4.5 Mean Value within Station of Physicochemical Parameters @ (P<0.01)

Stations	Temperature(^{0}C)	pH	DO(Mg/l)	Turbidity(cm)	EC (µS/cm)	TDS (ppm)
A	26.98±0.03[a]	6.57±0.08[a]	5.96±0.04[a]	33.98±0.04 [a]	15.89±0.05[a]	0.26±0.01[a]
B	27.11±0.05 [b]	6.36±0.1 [b]	5.94±0.05[a]	33.95±0.03 [a]	15.85±0.02[a]	0.29±0.01[a]
C	27.06±0.09 [b]	6.29±0.1 [b]	6.06±0.03[b]	34.32±0.15 [b]	16.05±0.03[b]	0.28±0.01[a]

Means within the rows with different superscripts differ significantly @P<0.01.

Table 4.6 Pearson Correlation of shellfish Species with Temperature With Stations

	C. armatum	*H. americanus*	*M. mercenaria*	*C. obeyensis*	*L. bernardanus*	Temperature A	Temperature B	Temperature C
C. armatum	1	-0.032	0.394	.a	0.421*	-0.506*	-0.329	-0.001
H. americanus	-0.032	1	0.14	.a	-0.086	-0.217	-0.227	-0.246
M. mercenaria	0.394	0.14	1	.a	0.747**	-0.748**	-0.533**	-0.015
C. obeyensis	.a	.a	.a	.a	.a	.a	.a	.a
L. bernardanus	0.421*	-0.086	0.747**	.a	1	-0.546**	-0.464*	0.096
Temperature A	-0.506*	-0.217	-0.748**	.a	-0.546**	1	0.627**	0.214
Temperature B	-0.329	-0.227	-0.533**	.a	-0.464*	0.627**	1	0.748**
Temperature C	-0.001	-0.246	-0.015	.a	0.096	0.214	0.748**	1

*Correlation is significant at P<0.05 level (2-tailed); **Correlation is significant at P<0.01 level (2-tailed); (.a) cannot be computed because at least one of the variables is constant.

Table 4.7 Pearson Correlation of Shellfish Species with Hydrogen Ion Conc. pH with Stations

	C. armatum	*H. americanus*	*M. mercenaria*	*C. obeyensis*	*L. bernardanus*	(pH) A	(pH) B	(pH) C
C. armatum	1	-0.032	0.394	.a	0.421*	0.153	-0.239	-0.181
H. americanus	-0.032	1	0.140	.a	-0.086	0.275	0.378	0.372
M. mercenaria	0.394	0.140	1	.a	0.747**	0.449*	-0.300	-0.354
C. obeyensis	.a	.a	.a	.a	.a	.a	.a	.a
L. bernardanus	0.421*	0.689	0.747**	.a	1	0.335	-0.411*	-0.451*
(pH) A	0.153	0.193	0.449*	.a	0.335	1	0.517**	0.481*
(pH) B	-0.239	0.068	-0.300	.a	-0.411*	0.517**	1	0.909**
(pH) C	-0.181	0.074	-0.354	.a	-0.451*	0.481*	0.909**	1

*Correlation is significant at P<0.05 level (2-tailed); **Correlation is significant at P<0.01 level (2-tailed); (.a) cannot be computed because at least one of the variables is constant.

Table 4.8 Pearson Correlation of Shellfish Species With Dissolved Oxygen with Stations

	C. armatum	*H. americanus*	*M. mercenaria*	*C. obeyensis*	*L. bernardanus*	(DO) A	(DO) B	(DO) C
C. armatum	1	-0.032	0.394	.a	0.421*	-0.329	-0.375	-0.309
H. americanus	-0.032	1	0.140	.a	-0.086	-0.061	-0.063	-0.362
M. mercenaria	0.394	0.140	1	.a	0.747**	-0.481*	-0.494*	-0.555**
C. obeyensis	.a	.a	.a	.a	.a	.a	.a	.a
L. bernardanus	0.421*	-0.086	0.747**	.a	1	-0.451*	-0.481*	-0.443*
(DO) A	-0.329	-0.061	-0.481*	.a	-0.451*	1	0.986**	0.896**
(DO) B	-0.375	-0.063	-0.494*	.a	-0.481*	0.986**	1	0.913**
(DO) C	-0.309	-0.362	-0.555**	.a	-0.443*	0.896**	0.913**	1

*Correlation is significant at P<0.05 level (2-tailed); **Correlation is significant at P<0.01 level (2-tailed); (.a) cannot be computed because at least one of the variables is constant.

Table 4.9 Pearson Correlation of Shellfish Species with Turbididty with Stations

	C. armatum	*H. americanus*	*M. mercenaria*	*C. obeyensis*	*L.bernardanus*	Turbidity A	Turbidity B	Turbidity C
C. armatum	1	-0.032	0.394	.[a]	0.421*	0.526**	0.402	0.368
H. americanus	-0.032	1	0.140	.[a]	-0.086	-0.007	0.019	0.004
M. mercenaria	0.394	0.140	1	.[a]	0.747**	0.311	0.255	0.514*
C. obeyensis	.a	.a	.a	.a	.a	.a	.a	.a
L. bernardanus	0.421*	-0.086	0.747**	.[a]	1	0.326	0.212	0.429*
Turbidity A	0.526**	-0.007	0.311	.[a]	0.326	1	0.868**	0.778**
Turbidity B	0.402	0.019	0.255	.[a]	0.212	0.868**	1	0.755**
Turbidity C	0.368	0.004	0.514*	.[a]	0.429*	0.778**	0.755**	1

*Correlation is significant at P<0.05 level (2-tailed); **Correlation is significant at P< 0.01 level (2-tailed); (.a) cannot be computed because at least one of the variables is constant.

International Journal of Fisheries and Aquaculture Research
Vol.10, No.2, pp.28-50, 2024
Print ISSN: ISSN 2397-7507,
Online ISSN: ISSN 2397-776
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development UK

Table 4.10 Pearson Correlation of Shellfish Species with Electric Conductivity with Stations

	C. armatum	*H. americanus*	*M. mercenaria*	*C. obeyensis*	*L. bernardanus*	Conductivity (µScm¯2) A	Conductivity (µScm¯2) B	Conductivity (µScm¯2) C
C. armatum	1	-0.032	0.394	.a	0.421*	0.565**	-0.39	.427*
H. americanus	-0.032	1	0.140	.a	-0.086	0.075	0.347	-0.379
M. mercenaria	0.394	0.140	1	.a	0.747**	0.518**	-0.352	0.300
C. obeyensis	.a	.a	.a	.a	.a	.a	.a	.a
L.bernardanus	0.421*	-0.086	0.747**	.a	1	0.498*	-0.490*	0.260
Conductivity (µScm¯2) A	0.565**	0.075	0.518**	.a	0.498*	1	-0.350	0.086
Conductivity (µScm¯2) B	-0.390	0.347	-0.352	.a	-0.490	-0.350	1	-0.362
Conductivity (µScm¯2) C	0.427*	-0.379	0.300	.a	0.260	0.086	-0.362	1

*Correlation is significant at P<0.05 level (2-tailed); **Correlation is significant at P<0.01 level (2-tailed); (.a) cannot be computed because at least one of the variables is constant.

Table 4.11 Pearson Correlation of Shellfish Species with Total Dissove Oxygen with Stations

	C. armatum	*H. americanus*	*M. mercenaria*	*C. obeyensis*	*L. bernardanus*	(TDS) A	(TDS) B	(TDS) C
C. armatum	1	-0.032	0.394	.a	0.421*	-0.366	0.094	-0.525
H. americanus	-0.032	1	0.140	.a	-0.086	-0.299	-0.512*	-0.137
M. mercenaria	0.394	0.140	1	.a	0.747**	-0.596	-0.016	-0.484
C. obeyensis	.a	.a	.a	.a	.a	.a	.a	.a
L. bernardanus	0.421*	-0.086	0.747**	.a	1	-0.440	0.027	-0.197
(TDS) A	-0.366	-0.299	-0.596	.a	-0.440	1	0.210	0.504*
(TDS) B	0.094	0.512*	-0.016	.a	0.027	0.210	1	0.290
(TDS) C	-0.525	-0.137	-0.484	.a	-0.197	0.504*	0.290	1

*Correlation is significant at P<0.05 level (2-tailed); **Correlation is significant at P<0.01 level (2-tailed); (.a) cannot be computed because at least one of the variables is constant.

DISCUSSION

A total of 1,305 individual species of shellfish were caught along River Donga during the period of these research. The abundance and diversity of shellfish species were recorded in (table 4.3) (Egwali *et al*., 2018); also recorded one (1) terrestrial species (African Zebu snail, *Anixa zebuensis:* Camaenidae) and reported that they were very abundant in the bank of the aquatic ecosystem which some researchers reported them as aquatic species which they are not (Rosales *et al*., 2020). This showed that the shellfish diversity were low, although some species were more abundant than others. There is no existing research work carried out along this river on shellfish species abundance and diversity for direct comparison. The results showed highest individual species of shellfish recorded was *H. monatia* and the least was *C. obeyensis*. Base on these research *H. monatia* is more abundant than *C. obeyensss* due to the effect of human activities along the river (Egwali *et al*., 2018; Akpan *et al*., 2019).

The physicochemical parameters showed that water temperature; dissolve oxygen; power of hydrogen; electric conductivity; turbidity; total dissolve solid mean values were ($26.98{\pm}0.03^a$ to $27.11{\pm}0.05^b$); ($6.29{\pm}0.1^b$ to $6.57{\pm}0.08^a$); ($5.94{\pm}0.05^a$ to $6.06{\pm}0.03^b$); ($15.85{\pm}0.02^a$ to $16.05{\pm}0.03^b$); ($33.95{\pm}0.03^a$ to $34.32{\pm}0.15^b$); ($0.26{\pm}0.01^a$ to $0.29{\pm}0.01^a$) respectively (Igbani and Ikponmwen, 2023).

CONCLUSION

The said River Donga could be described to be poor in shellfish species as there were few species represented in the aquatic ecosystem, considering the period of sampling; in spite of the anthropogenic activities going on and fishing gear types in the ecosystem. The research revealed that shellfish species were present, with some pollution tolerant species, such as *H. pomatia*, *C. armatum*; *M. mercenaria* species: this showed that there is a point source of pollution with regard to human activities. The results of the present investigation compared with literature values of other rivers in Nigeria, revealed that there is fluctuation in the physicochemical characteristics of the ecosystem and the activities around the river has significant effects on the water quality as indicated by the variations in physicochemical characteristics; species distribution and abundance.

RECOMMENDATIONS

In view of the above findings, it is recommended that:
The results in shellfish species abundance and diversity could be used by microbiology, agriculture, aquaculture, zoology, biochemistry, hydrobiology, fisheries students and scholars.
The results on physicochemical parameters could be used as a base line for aquatic threshold and fresh water culture indicator.
The shellfish species identified could serve as identification keys by microbiology, agriculture, aquaculture, zoology, biochemistry, hydrobiology, fisheries students; scholars and experts.

REFERENCES

Adelalu T.G. (2018). Rainfall analysis and flood hazard vulnerability assessment along major tributaries to River Benue in Taraba. Unpublished PhD. dissertation submitted to Department of Geography, School of Environmental Science, Modibbo Adama University of Technology, Yola, in partial fulfillment of the requirement for the award of Doctorate degree (Ph.D.) in Climatology.

Akpan, A. U., EGWALI, E. C., Esenowo, I. K. and Akpabio, E. K. (2019). Preliminary Study On The Composition And Abundance Of Shellfish (Decapoda: Crustacea) In Uta Ewa Estuary, Ikot Abasi Local Government Area, Akwa Ibom State, Nigeria. *Animal Research International*, 16(1): 3198 – 3206.

Ama-Abasi, D., Holzloehner, S. and Enin, U. (2004).The dynamics of the exploited population of *Ethmalosa fimbriata* (Bowdich, 1825, Clupeidae) in the Cross River Estuary and adjacent Gulf of Guinea. *Fish. Res. 68:* 225-235.

Amos, J.T., Ali J.A. and Abubakar, A.K. (2020). An Assessment and Identification of Fish Species Abundance and Endangered in River Donga Taraba State, Nigeria. *Direct Research Journal of Agriculture and Food Science.* DOI: https://doi.org/10. 26765/DRJAFS92819109, ISSN: 2354-4147; 8(2):62-66.

APHA (American public Health Association) (2005). Standard methods for the examination of water and waste water. 23rd edition. *American public Health Association Inc*, New York. 1193pp.

Bankole, M.Y. (2007). Some Aspects of The Reproductive Biology of Freshwater Prawn (*Macrobrachiumvollenhovenii*) and Brackish Water Prawn (*Macrobrachiummacrobrachion*). M.TECH Thesis, The Federal University of Technology Akure, Nigeria, 14-17.

Candolle, (1813) Shellfish Species Taxonomy *Systemic Zoology of Science.*

Deekae, S.N. and Abowei, J.F.N. (2010). *Macrobrachium macrobrachion*(Herklots, 1851) Length-Weight Relationship and Fulton's Condition Factor in Luubara Creek, Ogoni Land, Niger Delta, Nigeria. Int J Anim VetAdv; 2(4):155-162.

Deekae, S.N., Ansa, E.J. and Davidson, E.B. (2016). Foods of the Brackish River Prawn, Machrbrachium Machrobrachion, (Herklots, 1851) from Ekole Creek, Bayelsa State, Nigeria. *Continental Journal of Applied Sciences, DOI:10.57/cjapplsci.2016.11.1.11.26,* ISSN: 1597-9928., 11(2):11-26.

Eayrs, S. A. (2005) Guide to Bycatch Reduction in Tropical Shrimp-Trawl Fisheries. Food and Agricultural Organization (FAO) of the United Nations, Rome, Italy, 231-239.

Egwali, E.C., Akpan, A.U., Esenowo, I.K. and Akpabio E.K. (2018). The Composition and Abundance of Shellfish (Decapoda: Crustacean) in Uta Ewa Estruary, IKOT Abasi Local Government Area, Akwa Ibom State, Nigeria. *Prceeding of 6thNSCB Biodiversity Conference;* Uruilyo 2018 (125-130pp).

Eze, E. l., Echezona, B. C. and Uzodinma, E. C. (2011). Isolation and identification of pathogenic bacteria associated with frozen mackerel fish (Scomber scombrus) in a humid tropical environment. *African Journal of Agricultural Research*, 6(7), 1918–1922.

FAO. (1981) Species Identification Sheets.Food andAgricultural Organization of the United Nations, (Volume VI).Department of Fisheries and Oceans.Canada, 7-35.

Felix, A. I., Robert, U. O., Christopher, C. E., Christian, U., & Christiana, O. I. (2018). Economic of small holder fish farming to poverty alleviation in the Niger Delta region of Nigeria. *Turkish Journal of Fisheries & Aquatic Sciences*, 19(4), 313–329.

Igbani, F. (2022). The Almighty God is the Originator of Biodiversity. In: The Term Biodiversity.Genesis1: 20 – 30. https:/www.Researchgate.net/publication/363231406. THE_ALMIGHTY_GOD_IS_THE_ ORIGINATOR_OF_ BIODIVERSITY full Text File, 1pp.

Igbani, F. and Ikponmwen, E.G. (2023). Plankton and Benthos Distribution of River Donga, Taraba State, Noerth East, Nigeria. *International journal For Research in Agricultural And Food Science. Green Publication*, ISSN: 2208-2719, 9(2):1-16.

Igbani, F. and Uka, A. (2019). Fish diversity, abundance and fishing activities in the upper Ekole River, Bayelsa State, Niger Delta, Nigeria. *International Journal of Fisheries and Aquatic Studies* 2019; 7(5): 122-129.

Jenkins, M.D. and Williamson, (2003). Biodiversity and the ecosystem approach in agriculture, forestry and fisheries proceedings. Food and Agriculture Organization of the United Nations. Rome, Italy, pp. 100-116.

King, M. (2007). *Fisheries Biology, Assessment andManagement (2nd Ed).*Blackwell Publishing Ltd, Australia. 382 pp.

Krishnamurthy K.V. (2003). Text Book of Biodiversity, Science Publishers, Inc., Enfield, New Hampshire-03784, United States of America.

Kunsook, C. (2011). Assessment of stock and movement pattern of blue swimming crab Portunuspelagicus (Linnaeus, 1758) for sustainable management: case study in Kung Krabaen Bay, PhD diss. Chulalongkorn University; Chanthaburi Province.

Kunsook, C., Gajaseni, N. and Paphavasit, N. (2014b). A Stock assessment of the blue swimming crab Portunus pelagicus (Linnaeus, 1758) for sustainable management in Kung Krabaen Bay, Gulf of Thailand. Tropical Life Science Research. 2014b; 25(1):41–59.

Margalef, R. (1968). Perspective in Ecological Theory, Uni. of Chicago Press, 1968, 112.

Margalef, R., (1958). Information theory in ecology. *General Systems, vol.3, pp. 36*-71.

Nazeef, S., Ja'afar, A., Abubakar, K.A. and Kabiru, M. (2021). Fish species biodiversity of Dadin-Kowa reservoir: Current Status. *World Journal of Advanced Research and Reviews, DOI: 10.30574/wjarr, eISSN: 2581-9615 CODEN (USA): WJARAI, 11(02): 100-111.*

Njiru, M., Nzungi, P., Getabu, A., Wakwabi, E., Othina, A., Jembe, T., Wekesa, S. 2004. Are fisheries' management measures in Lake Victoria successful? The case of Nile perch and Nile tilapia fishery.*Afr. J. Ecol. 45:* 315-323.

Nwosu F. (2007). The Problem of By Catch Associated with Industrial Shrimping: Implications for Inshore Demersal Fisheries in the Niger Delta. In: Zabbey (Ed.), Small Scale Shrimp Fisheries in Nigeria. Centre for Environment, Human Rights and Rural Development (CEHRD), Eleme, Rivers State Cehrd/Tech/Conserv/01/2007, 32-48. OA Fisheries Technical Paper 428. ISSN 0429-9345.

Okayi, R. G, Solomon, S. G, Ataguba, A. G, Chukwudi, O. P. and Mbata, F. U (2013). Indigenous knowledge of shrimps and prawn species and fishing of the Benue and Niger River (middle – belt savannah) – Nigeria. *Agriculture and Biology Journal of North America* 4(3). 221-226.

Olugbojo, J. A. and Ayoola, S. O. (2015). Comparative studies of bacteria load in fish species of commercial importance at the aquaculture unit and lagoon front of the University of Lagos. *International Journal of Fisheries and Aquaculture*, 7(4): 36–46.

Oyekanmi, F. B. (2000) Nutritional Value and Flesh Yield of Some Crustaceans in Southwest Nigeria. M. TECH. Thesis, The Federal University Of Technology, Akure, Nigeria, 2000, 11-23.

Shannon, C.E. and Weaver, W. (1963). *The mathematical theory of communication 1949.* Urbana, IL: University of illinos Press.

Silvano, R.A.M., Ramires, M. and Zuanon J. 2009.Effects of fisheries' management on fish communities in the floodplain lakes of a Brazilian Amazonian Reserve.*Eco.Freshw.Fish.18:* 156-166.

Tianpru, P. and Samakphan, L. (2014). Species diversity of bycatch from blue swimming crab trap fishery at Kung Krabaen Bay, Chanthaburi Province. Undergraduate diss. Rambhai Barni Rajabhat University; [Google Scholar].

Varadharajan, D., and Soundarapandian, P. (2012). Commercially important crab fishery resources from Arukkattuthurai to pasipattinam, South east coast of India. Journal of marine Science Reserve and Development. 2(4):1–6.

William, N. S. (2006). Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), U. S. Fish and Wildlife Service Biological Reports (U.S. Army Corps of Engineers) (2006): 82 (11.47): TR EL-82– 4. 10, 47.

Zabbey, N. (2007). Small scale shrimp fisheries in Nigeria Centre for Environment, Human Rights and Development, Eleme, Rivers State. Technical Report, CEHRD/TESH/CONSERV/01/ (2007): 64pp.

Appendix VIII: Terrestrial (Land) Snail Surviving Along The Aquatic Ecosystem

Scientific Name: *Anixa zebuensis* (Broderip, 1841)
Family: Ariolimacidae
Order: Pulmonata
Common Name: Zebu snail
Native Name: Kubewa