AQAUTIC BIODIVERSITY STUDY

For

MM PORT FZE PROJECT ESIA

INTRODUCTION

Meliora Methanol FZE, Federal Ocean Terminal (FOT), Onne Port Complex, Oil & Gas Free Zone, Onne, Eleme LGA, Rivers State intent to establish Port Terminal facility from concept to design and to engineering, construction in line with the Nations and International Guidelines. Aquatic biodiversity studies were considered to be an important area of focus in undertaking the environmental and social impact assessment for the proposed project. Recent dry season data on Aquatic Biology (fieldwork 18-21 January 2022) from the approved EIA of the Upgrade Of Onne Multipurpose Terminal (Berth 9-11) Project, FOT Onne, Eleme LGA, Rivers State ICTS (2022) was considered as valid in the approval of the Terms of Reference and Scope of Work for this Study. Additional one-season (wet season) work was therefore approved to augment and close gaps in the existing data to describe the baseline aquatic biodiversity conditions of the proposed project area.

Scope of Study

The scope of work is in tandem with that approved TOR by regulators for the ESIA of MM Port FZE project and includes:

- Delineation of ten (10) sampling stations and two (2) control stations for wet season. This entails additional Stations and Control for broader coverage than the dry season data for which five (5) stations (inclusive of a Control) were sampled.
- Field survey, sample collection and laboratory analysis.
- Data analyses and report writing

Fieldwork approach/Sampling

The field survey and sample collection for aquatic biodiversity for wet season was done between July 4th to 5th July 2023, with continuation for fish sampling on 10th and 19th July 2023. Twelve (12) stations were sampled for aquatic biology and fisheries study. Five (5) stations were be located within the proposed quay area, five (5) stations located on waterbody on both side of flow channels, while two (2) control stations were located approximately 4 km away from the proposed project area. The sampling stations/codes and their coordinates recorded during the fieldwork are presented in Table 1 and plotted in Figure 1.

Table1: Geographical coordinates of sampling stations

S/No	Station Code	Depth (meters)	Distance from bank (meters)	WGS 84	
				LATITUDE (N)	LONGITUDE (E)
1	SW1	4.8	150	4°39'39.2"N	7°08'50.5"E
2	SW2	4.3	140	4°39'55.9"N	7°08'24.5"E
3	SW3	6.5	170	4°40'02.8"N	7°08'10.1"E
4	SW4	4.0	130	4°40'07.0"N	7°07'47.2"E
5	SW5	3.5	110	4°40'14.6"N	7°07'28.8"E
6	SW6	6.0	200	4°39'59.6"N	7°09'14.7"E
7	SW7	8.7	210	4°40'29.6"N	7°09'22.3"E
8	SW8	4.9	140	4°40'28.9"N	7°07'00.7"E
9	SW9	5.2	150	4°40'24.7"N	7°06'45.7"E
10	SW10	6.5	600	4°39'30.0"N	7°08'03.6"E
11	SWC1	9.2	600	4°36'38.0"N	7°10'35.3"E
12	SWC2	7.9	900	4°42'44.4"N	7°05'39.9"E

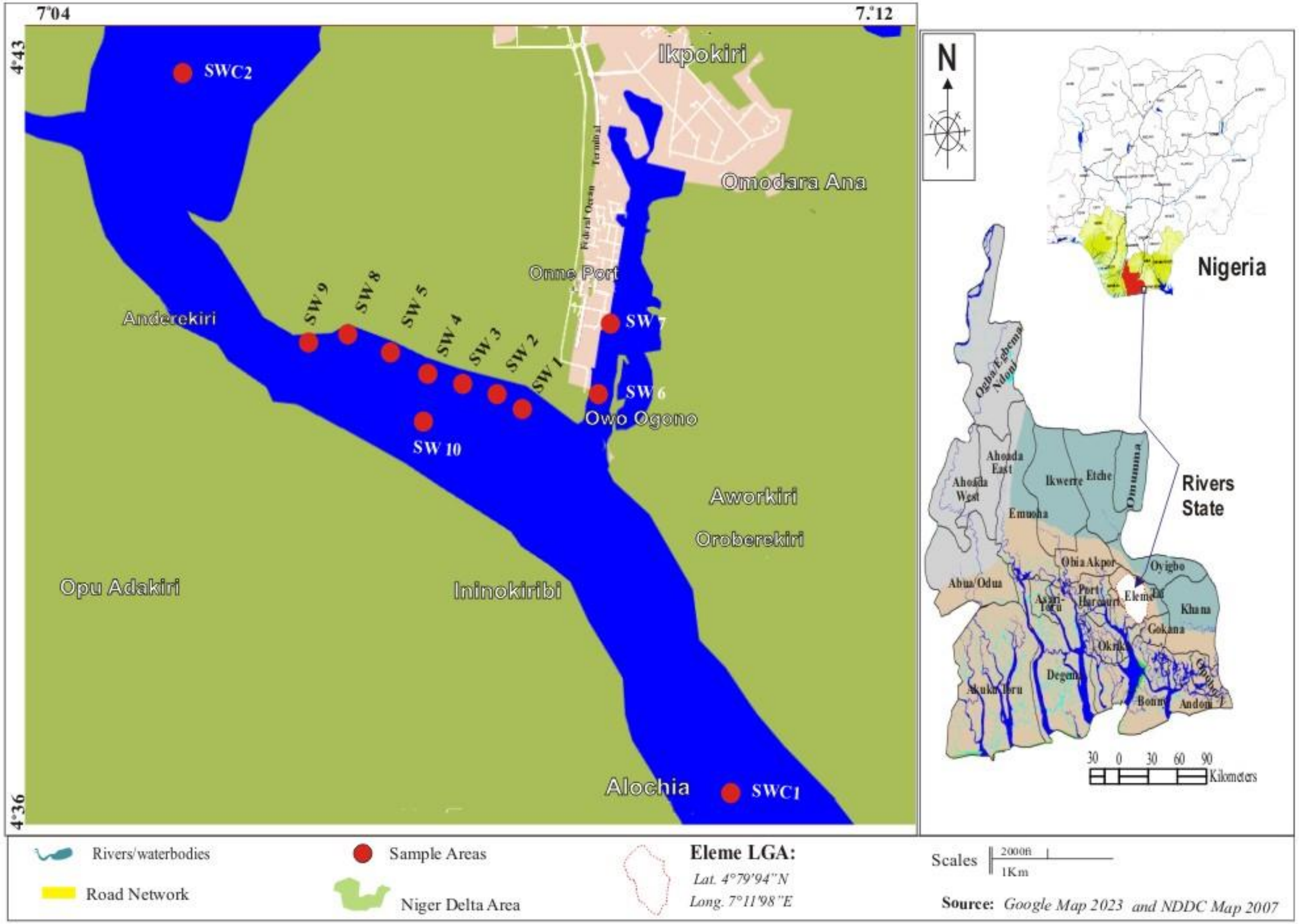

Figure 1: Sampling stations

Sample Collection and Analysis

Plankton

Plankton samples were collected with the aid of plankton net. This was done by towing plankton net (Plate 1A) for five minutes and the materials in the collection bottle was then transferred into sample containers and preserved in 5 % formaldehyde-water mixture, and stained with eosin. In the laboratory, samples were made up to a uniform volume of 50 ml. Following a thorough agitation and homogenization, 1 ml sub-samples were taken using a Pasteur pipette and transferred to a Bogorov counting chamber for observation under a binocular compound microscope. The organisms were simultaneously identified and enumerated. phytoplankton were identified with the aid of a binocular microscope using appropriate keys (Durans and Leveque, (1980), Suthers, (2008), Kadiri, 1988). For zooplankton samples, keys from Barnes, (1980), Suthers, (2008), Newell and Newell, (1977) were used as guide for the identification and classification.

Benthos

A Van-Veen grab was used for the collection of sediment / benthos samples (Plate 1B). The sediment sample was collected and emptied into a plastic bucket. This was washed through a 0.5 mm mesh size sieve and the materials retained in the sieve were placed in plastic containers and fixed with 5 % formalin-water mixture and carefully packaged for laboratory analysis. In the laboratory, the organisms were sorted, identified to the lowest possible taxonomic level using Keys by Day (1967), Fauchald (1977); and individuals of each taxonomic group were counted and recorded.

Fisheries

Physical observation of fishing activities was undertaken to capture types of fishing gear and catch assessment. The use of Cast and Seine nets is common and suitable fishing gears used within the region. The use of cast net at all sampling stations will produce representative data among all station for comparison. Emmanuel *et al.* (2008) reported that cast net was not species specific. The circumference of the cast net used was 8.2m while the mesh size was 10mm; the net was made of nylon. Data from fish sampled directly at each sampling station with ten (10) cast net throws (Plate 2A). Samples were also purchased from other fisherfolks who used cast nets, seines (Plate 2B) or hooks. All samples collected were placed in labelled polythene bags and placed in ice-cooled boxes for transportation to the laboratory where they were immediately frozen until analyzed. All samples collected were placed in labelled polythene bags and placed in ice-cooled boxes for transportation to the laboratory where they were immediately frozen until analyzed. Fish were individually identified and morphometric measurements (length and weight) were obtained.

Floating Aquatic Macrophytes

Floating aquatic macrophytes were studied by visual assessment in the field.

Data Analysis

Several statistics were used as measures of the attributes of community structure of the phytoplankton, zooplankton, and benthos samples. Diversity indices used to characterize species abundance relationships take the following into account (Ogbeibu 2019): ‘’the total number of species encountered in the sample, expressed as richness; how the species abundance (e.g., the number or individuals, biomass cover etc) are distributed among the species, usually expressed as evenness. Richness indices characterize species richness, while Evenness indices characterize evenness, but Diversity indices combine both species richness and evenness into a single value and therefore more informative in ecological studies.’’ The indices measured in this study were species richness (Margalef, d) diversity (Shannon-Weiner H’) and equitability (Pielou, J’) and dominance (Simpson λ). These were used as indicators of the health status of the habitat .The formulae used for the calculation of the various indices are as follows (Pielou, 1975, Heip et al., 1988, Magurran, 1991):

- Margalef index: $d = (S-1) / \log N$
- Shannon-Weiner Index: $H' = - \Sigma_i p_i \log(p_i)$
- Pielou Evenness: $J' = H'/H'_{max} = H' / \log S$
- Simpson Index $\lambda = \Sigma pi^2$

These were computed using the Plymouth Routines of Multivariate Experimental Research (PRIMER) software.

Length-weight relationship studies of fishes are considered as an important tool for understanding of fish. Variation from the general length-weight relationship is indicative of the overall condition and such changes in condition have been usually analysed by means of a condition factor. Fishes with condition factor value above 0.56 are considered as in good condition (Bennet, 1970)

Fish morphometric measurements were used for the calculation of Condition Factor. The Fulton's condition factor (K) of the fish was estimated from the relationship:

- $K = W/L^3 * 100$

  Where:

  K = condition factor

  W = fish weight (g)

  L = Fish total length (cm)

The relationship between the length (L) and weight (W) of fish was expressed by the equation (Pauly, 1983).

$W = aL^b$

Where:

W = weight of fish in (g)

L = total length (TL) of fish in (cm)

a = constant (intercept)

b = the length exponent (slope)

The "a" and "b" values were obtained from a linear regression of the length and weight of fish. When b is equal to three (3), isometric pattern of growth occurs but when b is not equal to 3, allometric pattern of growth occurs, which may be positive if >3 or negative if <3 (Nehemia *et al*., 2012).

Log-transforming the equation was applied: $\text{Log } W = a + b \text{ Log } L$

A: **Plankton net after towing**

B: Lowering grab for sampling of benthos

Plate 1: Sampling for Plankton and Benthos

A: Fish Sampling - Study Team using Cast Net

	
Crews with cast net	
	
Wind-sail boating to fishing location	**Crew with seine net**
B: Other Fishing Crews observed during fieldwork	

Plate 2: Fish Sampling

RESULTS AND DISCUSSION

Phytoplankton

The abundance and distribution of Phytoplankton community within the study area are presented in Table 2A for dry season and 2B for Wet season. In the Dry season, four major algal groups were represented namely, Bacillariophyceae (Diatoms), Chlorophyceae (Green algae), Cynaophyceae (Bluegreen bacteria) and Pyrrophyceae. The diatoms had more genera and the highest relative abundance (58%), followed by Chlorophyceae (31%), while the lowest were Cyanophyceae (7%) and Pyrrophyceae (4%) (Fig.3A). The diatom genera recorded were *Cymbella*, *Melosira* and *Tabelleria sp.* The Chlorophyceae was represented by *Netrium digitus* and *Micrasterias sp.* whil Cyanophyta were *Snewella sp* and *Anabaena sp*.; and Pyrrophyta were *Ceratium sp* and *Peridinium sp*. The phytoplankton diversity indices Shannon-Wiener diversity ranged between 2.25 and 2.45, while Margalef species richness Simpson's dominance was between 0.89 and 0.91, Evenness ranged from 0.82 to 0.98 respectively.

In the wet season, a total of five genera (*Coscinodiscus, Cerataulina*, *Gyrosigma*l, *Nitzschia, and Synedra*) were recorded and all (100%) were diatoms (bacillariophyceae). The abundance values ranged from 11 cells/ml at SWC8 to 125 cells/ml at SW3 (Table 2). The ranges of the indices of community structure are as follows: Margalef, 0.42 (SW8) to 1.29 (SW10); Shannon-Weiner, 0.47 (SW8) to 1.36 (SW6); Pielou, 0.67 (SW7) to 0.98 (SW6); Simpson, 0.24 (SW10) to 0.70 (SW8). The dominance of diatoms is a common pattern of phytoplankton relative composition in the Bonny estuary (Ejiowhor *et al*., 2018; Daka *et al.* 2019A).

Table 2A: Composition, Abundance and Community Indices of Phytoplankton (Dry Season, January 2022)

TAXA	SW1	SW2	SW3	SW4	SWC1
BACILLARIOPHYCEAE					
Cymbella hydrida	10	14	11	8	10
Cymbella lacustris	8	12	16	10	4
Cymbella striate	14	8	11	13	12
Melosira various	11	13	10	8	14
Melosira distans	18	6	12	11	17
Tabellaria fenstrata	6	9	11	8	6
CHLOROPHYCEAE					
Netrium digitus	11	13	10	8	14

Micrasterias radiate	18	6	12	11	17
Micrasterias denticuata	6	9	11	8	6
PYRROPHYCEAE					
Peridinium cinatum	2	0	1	6	4
Ceratum hirudinella	0	0	2	4	3
CYANOPHYCEAE					
Anabaena sp.	8	5	7	8	6
Snewella rosea	3	0	3	0	1
No of Genera (S)	12	10	13	12	13
Abundance (N)	115	95	117	103	114
Margalef Richness (d)	0.87	1.98	2.52	2.37	2.53
Pielou Evenness (J')	0.94	0.98	0.94	0.99	0.92
Shannon (H')	2.34	2.25	2.42	2.45	2.37
Simpson (λ)	0.11	0.11	0.09	0.09	0.11

Table 2B: Composition, Abundance and Community Indices of Phytoplankton (Wet Season – July 2023)

TAXA	**SW1**	**SW2**	**SW3**	**SW4**	**SW5**	**SW6**	**SW7**	**SW8**	**SW9**	**SW10**	**SWC1**	**SWC2**
BACILLARIOPHYCEA												
Coscinodiscus sp	10	6	8	5	0	7	12	9	2	3	11	8
Cerataulina pelagica	0	0	0	0	0	0	0	0	0	2	0	0
Gyrosigma sp	7	3	59	17	20	5	2	0	14	4	1	4
Nitzschia sp	0	0	26	2	12	4	0	2	20	8	1	0
Synedra sp	1	3	32	7	22	4	2	0	11	5	4	2
No of Genera (S)	3	3	4	4	3	4	3	2	4	5	4	3
Abundance (N)	18	12	125	31	54	20	16	11	47	22	17	14
Margalef Richness (d)	0.69	0.80	0.62	0.87	0.50	1.00	0.72	0.42	0.78	1.29	1.06	0.76
Pielou Evenness (J')	0.78	0.95	0.87	0.82	0.97	0.98	0.67	0.68	0.86	0.93	0.69	0.87
Shannon-Weiner (H')	0.85	1.04	1.21	1.14	1.07	1.36	0.74	0.47	1.20	1.50	0.96	0.96
Simpson (λ)	0.46	0.38	0.34	0.38	0.35	0.27	0.59	0.70	0.33	0.24	0.48	0.43

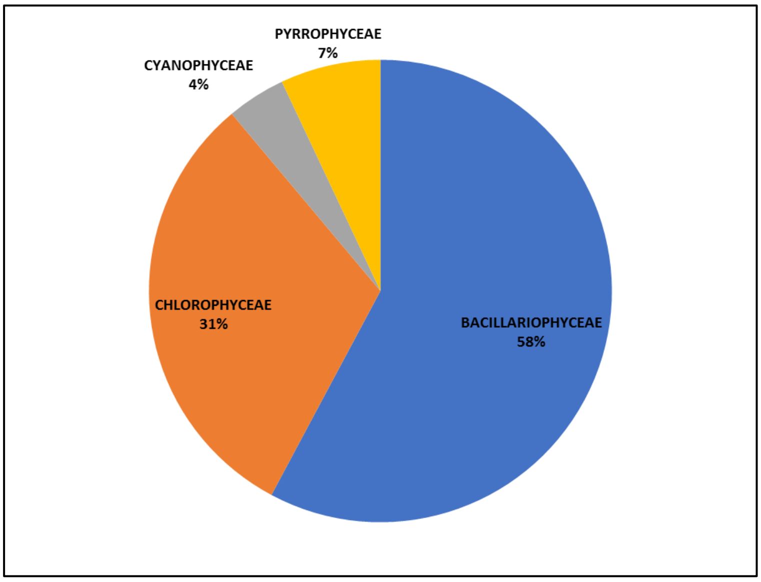

Figure 2A: Relative Abundance of Phytoplankton Taxa (Dry Season, January 2022)

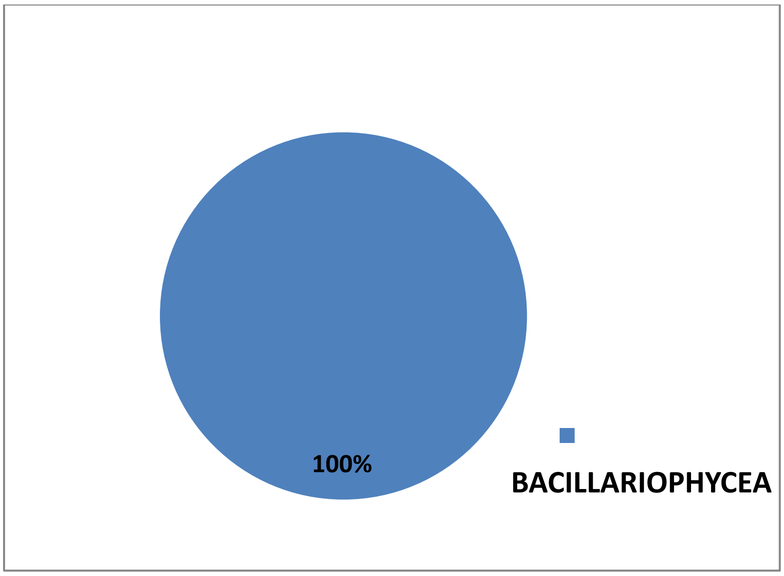

Figure 2B: Relative Abundance of Phytoplankton Taxa (Wet Season, July 2022)

Zooplankton

The composition, abundance and distribution of zooplankton community in the study area are presented in Table 3A for dry season and Table 3B for wet season. In the dry season, the zooplankton community was represented by five major taxa, namely, Copepoda, Cladocera, Rotifera, Ostracoda and Decapoda. The Copepoda had the highest number of species as well as relative abundacne (81%), followed by Cladocera (10%) and Rotifera (5%) (Fig. 3A). Amongst the copepods, *Metridia lucens*, *Calamus finmarchicus* and *Anomalocere patersoni* were recorded in all sampling stations. The Cladocera, *Peniclia arirosteris* and Rotifera

Rotaria citria were observed in only two stations. Shannon-Wiener diversity and Margalef richness ranged between 1.68 - 2.21 and 1.76 - 2.63, respectively.

The zooplankton in the wet season consisted of predominantly of copepods with thirteen genera, and accounted for 98.16% of the abundance (Table 3B, Figure 3B). The other taxa were decapoda (1.78%) and amphipoda (0.06%). Nauplius, *Paracalanus parvus, Tortanus* sp, *Pseudocalanus newmani* and *Oithona* sp were the most widely distributed copepods. The amphipoda was represented by a single genus (*Gammarus*) while the decapods recorded were brachyuran crab zoea, *Scyllarus* sp and *Alpheaus* sp. Abundance values ranged from 57 individuals/ml at SW4 to 559 individuals/ml at SW3 7. Shannon-Weiner diversity index ranged from 1.30 (10) to 2.07 (SW5) while Margalef index was 0.70 (SW9) to 1.68 (SW8). The Pielou Evenness measure ranged from 0.81 (SW10) to 0.99 (SW9) while the Simpson's dominance ranged from 0.14 (SW5) to 029 (SW4). The dominance of the class Copepoda is a common trend in zooplankton of in the Bonny estuary (Miebaka and Daka, 2013, Daka et al. 2019B).

Table 3A: Composition, Abundance and Community Indices of Zooplankton (Dry Season, January 2022)

TAXA	SW1	SW2	SW3	SW4	SWC1
COPEPODA					
Metridia lucens	5	2	8	4	11
Calamus finmarchicus	3	5	7	8	10
Acartia longiremis	0	1	4	7	9
Anomalocere patersoni	2	4	3	6	12
Pseudocalamus elongatus	0	2	4	8	14
CLADOCERA					
Peniclia arirosteris	**0**	**0**	**0**	**2**	**1**
Evadne nordmanni	**0**	**1**	**0**	**1**	**3**
Podonpolyphemides	**1**	**0**	**0**	**3**	**4**
ROTIFERA					
Rotaria citria	0	0	2	0	1
Rotaria rataria	2	1	0	2	1
DECAPOD CRUSTACEA					
Crab (larva)	0	0	2	0	1
Shrimp (larva)	2	1	0	2	1
OSTRACODA					
Conchocia spinirastris	0	0	0	2	0

TAXA	SW1	SW2	SW3	SW4	SWC1
No of Genera (S)	6	8	7	11	12
Abundance (N)	15	17	30	45	68
Margalef Richness (d)	1.85	2.47	1.76	2.63	2.61
Pielou Evenness (J')	0.94	0.9	0.94	0.92	0.84
Shannon-Weiner (H')	1.68	1.87	1.82	2.21	2.09
Simpson (λ)	0.21	0.18	0.18	0.13	0.15

Table 3B: Composition, Abundance and Community Indices of Zooplankton (Wet Season – July 2023)

	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SWC1	SWC2
COPEPODA												
Nauplius	87	92	10	13	81	76	117	102	0	12	59	31
Acartia tonsa	0	2	0	0	0	0	0	1	0	0	0	0
Calanus finmarchicus	44	53	0	0	58	42	82	56	0	0	32	18
Pseudocalanus newmani	73	80	0	24	39	66	79	81	19	30	37	22
Paracalanus parvus	67	32	28	5	77	63	80	67	18	4	46	37
Parvocalanus sp	11	4	0	0	4	9	17	9	0	0	7	9
Temora sp	0	0	3	0	24	3	0	0	0	0	2	0
Tortanus sp	43	27	20	0	55	49	76	44	14	20	51	19
Oithona sp	71	52	15	13	61	34	89	72	22	0	46	44
Halicyclops fosteri	0	0	0	0	0	0	0	0	0	2	0	0
Corycaeus sp	0	0	0	0	18	7	0	12	0	0	0	0
Euterpina sp	0	0	16	0	7	0	0	7	0	0	0	0
DECAPODA												
Brachyuran crab zoea	4	0	0	0	0	12	17	7	0	0	3	0
Scyllarus sp	0	0	0	2	0	0	0	0	0	0	2	0
Alpheaus sp	0	0	12	0	0	0	0	0	0	0	0	0
AMPHIPODA												
Gammarus sp	0	0	0	0	0	0	2	0	0	0	0	0
No of Genera (S)	8	8	7	5	10	10	9	11	4	5	10	7
Abundance (N)	400	342	104	57	424	361	559	458	73	68	285	180
Margalef Richness (d)	1.17	1.20	1.29	0.99	1.49	1.53	1.26	1.63	0.70	0.95	1.59	1.16
Pielou Evenness (J')	0.90	0.85	0.93	0.85	0.90	0.87	0.89	0.84	0.99	0.81	0.84	0.95
Shannon-Weiner (H')	1.88	1.77	1.81	1.37	2.07	2.01	1.96	2.01	1.37	1.30	1.94	1.85
Simpson (λ)	0.16	0.19	0.18	0.29	0.14	0.15	0.15	0.15	0.26	0.32	0.16	0.17

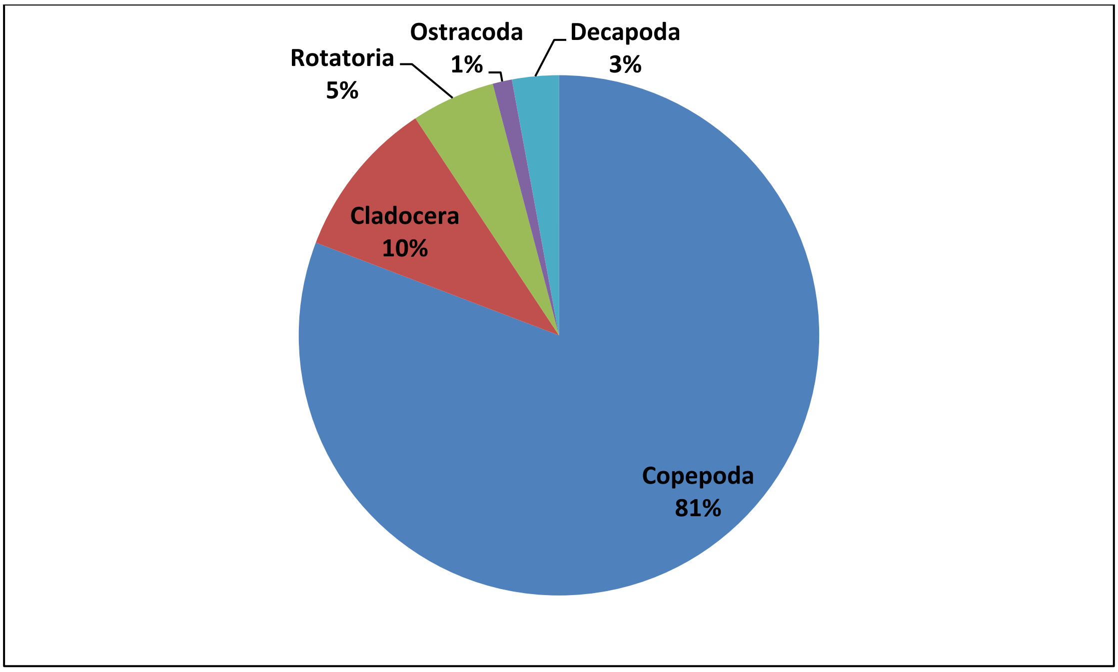

Figure 3A: Relative Abundance of Zooplankton Taxa (Dry Season, January 2022)

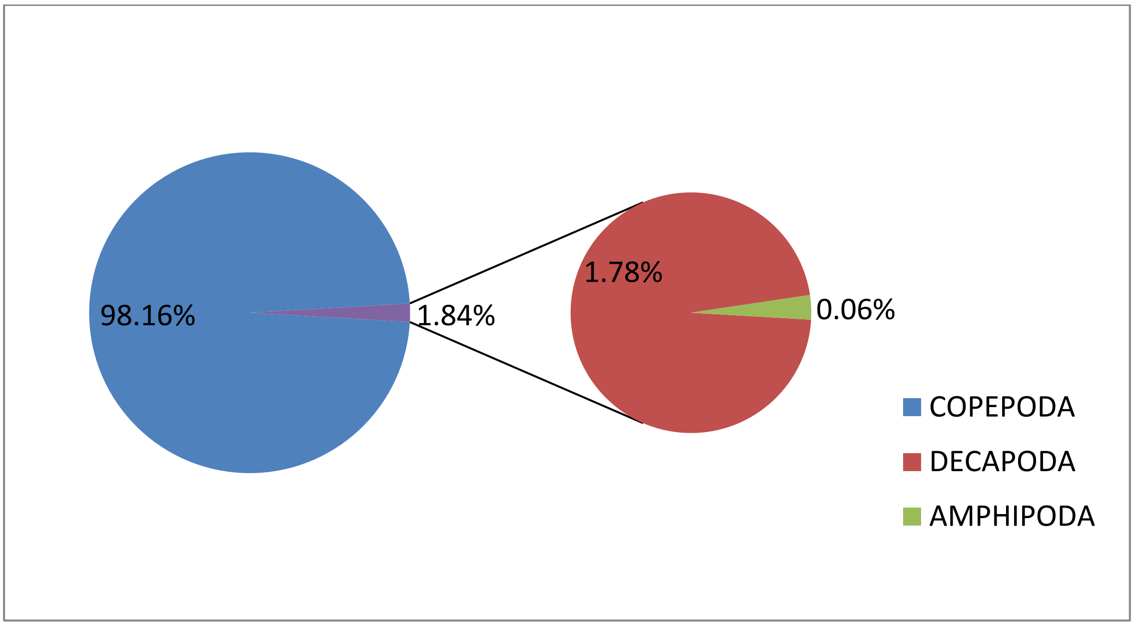

Figure 3B: Relative Abundance of Zooplankton Taxa (Wet Season – July 2023)

Benthos

Table 4A presents species composition, distribution, and relative abundance of benthos recorded during the dry season whereas wet season is presented in Table 4B. In the dry season, only 6 species representing two Phyla (Annelida and Mollusca) were recorded. The class Polycheata dominated with four genera and relative abundance, of 96%. The Margalef richness ranged between 0.63 – 1.29 while Shannon-Wiener ranged between 1.02 to 1.39.

In the wet season, the benthos consisted of predominantly of polychaetes, with eight genara being widely distributed in all stations (apart from three stations that were azoic) (Table 4B). Polychaeta accounted for 50% of the relative abundance (Figure 4B). Crustaceans were observed in five stations accounting for 23% while other taxa were Oligochaeta (16%), Insecta (7%), Mollusca (3%) and Pisces (1%). The counts of benthic organisms ranged from 0 at SW5, SW9 and SW10 to 39 at SW4. Benthic community indices were not calculated for SW5, SW9 and SW10 (azoic); however, in the other sampling stations Shannon-Weiner diversity index ranged from 0.69 (SWC1) to 1.96 (SW4) while Margalef index was 1.03 (SW3) to 2.52 (SWC2). The Pielou Evenness measure and Simpson's dominance were (0.76-SW2 to 1.0-SW6 and SWC1) and (0.15-SW3 to 0.43-SW3) respectively. The low diversity of the benthic macro-invertebrates could be attributed disturbance by human activities such as dredging/sweeping of the waterways to increase draft for vessels.

Table 4A: Composition, Abundance and Community Indices of Benthic Fauna (Dry Season, January 2022)

TAXA	**SW1**	**SW2**	**SW3**	**SW4**	**SWC1**
POLYCHAETA					
Nereis diversicolar	5	7	11	10	14
Neathes sp	3	5	4	8	11
Martphysa sp	0	0	2	4	6
Notomastus sp	0	0	0	2	2
MOLLUSCA					
Tellina sp.	0	0	1	0	2
Melampus sp.	0	0	0	1	0
No of Genera (S)	3	3	5	6	6
Abundance (N)	16	24	35	49	68
Margalef Richness (d)	0.72	0.63	1.13	1.29	1.19
Pielou Evenness (J')	0.93	0.94	0.76	0.77	0.78
Shannon-Weiner (H')	1.02	1.03	1.23	1.38	1.39
Simpson (λ)	0.38	0.38	0.35	0.32	0.31

Table 4B: Composition, Abundance and Community Indices of Benthic Fauna (Wet Season – July 2023)

TAXA	SWI	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SWC1	SWC2
POLYCHAETA												
Cossura spp	0	15	0	8	0	1	0	0	0	0	0	3
Cirriformia spp	0	3	0	0	0	0	0	0	0	0	0	1
Eunice spp	0	0	4	0	0	0	0	5	0	0	1	1
Glycera spp	0	1	1	4	0	0	0	1	0	0	1	1
Nephtys spp	7	0	0	0	0	0	0	0	0	0	0	1
Nereis spp	0	0	0	0	0	0	0	0	0	0	0	3
Polydora spp	0	0	0	0	0	0	0	0	0	0	0	1
Arenicola sp	0	1	0	0	0	0	0	0	0	0	0	0
OLIGOCHAETA												
Naididae	0	1	0	9	0	1	0	4	0	0	0	5
Lumbriculidae	0	1	0	0	0	0	0	0	0	0	0	0
INSECTA												
Chironomid larva	1	1	2	5	0	0	0	0	0	0	0	0
MOLLUSCA												
Buccinum (Gastropod)	0	0	0	2	0	0	0	0	0	0	0	0
Bivalve	0	0	0	2	0	0	0	0	0	0	0	0
CRUSTACEA												
Cumacean	7	7	0	4	0	1	0	0	0	0	0	0
Talitri spp	0	4	0	5	0	1	0	1	0	0	0	0
PISCES												
Fish	1	0	0	0	0	0	0	0	0	0	0	0
No of Genera (S)	4	9	3	8	0	4	0	4	0	0	2	8
Abundance (N)	16	34	7	39	0	4	0	11	0	0	2	16
Margalef Richness (d)	1.08	2.27	1.03	1.91		2.16		1.25			1.44	2.52
Pielou Evenness (J')	0.77	0.76	0.87	0.94		1.00		0.84			1.00	0.89
Shannon-Weiner (H')	1.07	1.67	0.96	1.96		1.39		1.16			0.69	1.86
Simpson (λ)	0.39	0.26	0.43	0.15		0.25		0.36			0.50	0.19

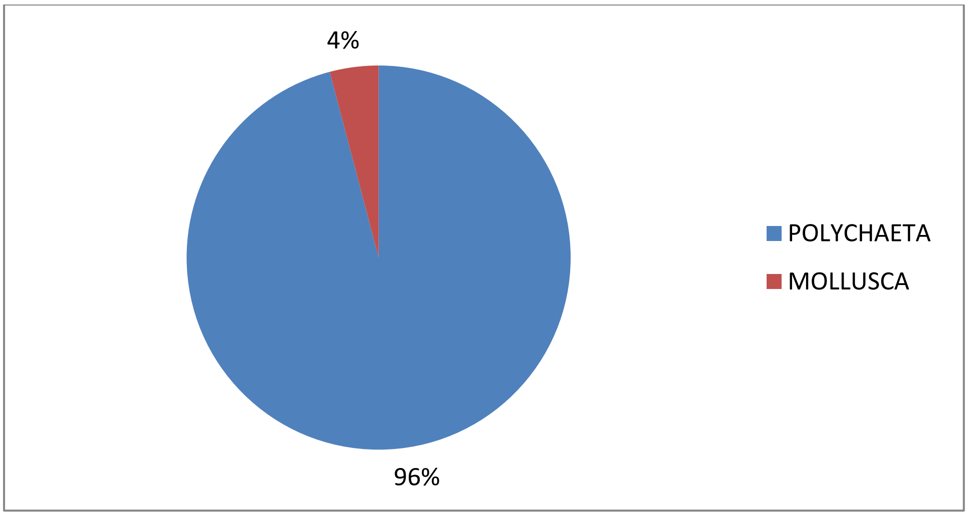

Figure 4A: Relative Abundance of Taxa in the Benthos (Dry Season, January 2022)

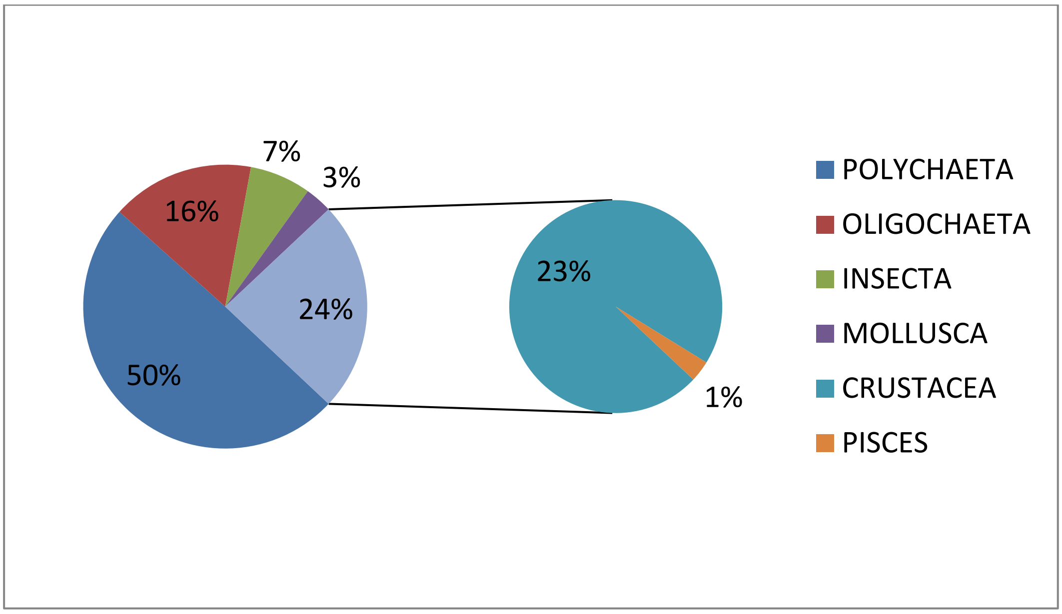

Figure 4B: Relative Abundance of Taxa in the Benthos (Wet Season – July 2023)

Fish and Fisheries

Fishing is also major occupation of the communities in the project area. Fishing methods include cast net, hook and line, seine and traps. It is mostly conducted from dug-out hand pulled wooden canoes, sometimes powered by low horsepower outboard engines. These are typical gears used by artisanal fishermen in the Niger Delta.

A checklist of fin-fishes reported during the dry season is presented in Table 5A (and Plates 3 and 4), while those observed in the wet season are presented in Table 5B (and Plates 5 to 19). Ten species from eight families were reported in the finfish assemblage of the area during the dry season (Table 5A) while fifteen species from eleven families were observed in the wet season. Clupeidae had two species in dry and wet season. Although *Sardinella maderensis* was reported to be common in both seasons, *Ethmalosa fimbriata* and *Sardinella aurita* wee the dominant ones in dry and wet seasons respectively. Other families reported in both seasons and the number of species were Cichlidae (1 dry, 2 wet), Mugilidae (1 dry, 2 wet), Haemulidae (1 dry, 2 wet). Lutdjaniae and Bagridae were also reported I in both seasons with 1 species. Sciaenidae and Gobiidae were reported only in the dry season, while Serranidae, Gerreidae, Carangidae, Alestidae and Tetraodontidae were observed in the wet season samples. The types of fish caught may depend on season and tidal cycle, dominance of bonga fish in the landed catches from the dry season is attributable to season. Bonga fish is a marine fish that move inshore of estuaries in the dry season when salinity is usually elevated due to low precipitation and high evaporation.

Shellfishes caught during the study are presented in Table 6 and Plates 20 to 21. These were the giant tiger shrimp (*Penaus monodon*), swimming crab, (*Callinectes amnicola*) and lizard mantis (*Lysiosquilla hoevenii*)**.**

Table 5A: Composition of fish reported during the study (Dry Season – January 2022)

Family	**Scientific name**	**Common Name**	**Local (Okrika) Name**	**Abundance Score**	**IUCN Red List Status**	**CITES**
Clupeidae	*Ethmalosa fimbriata*	Bonga	Kigbo	Dominant	LC (2019)	NE
	Sardinella maderensis	Sardine fish	Songu	Abundant	VU (2014)	NE
Sciaenidae	*Pseudotolithus enlongatus*	Bobo Croaker	Ona	Abundant	LC (2020)	NE
	Pseudotolithus epipercus	Guinea Croaker	Ona	Common	LC (2020)	NE
Mugilidae	*Mugil cephalus*	Mullet	Beme	Common	DD (2019)	NE
Bagridae	*Chrysichthys nigrodigitatus*	Marine catfish	Aga	Common	LC (2019)	NE
Lutjanidae	*Lutjanus goreensis*	Snapper	Agbara	Common	LC (2013)	NE
Haemulidae	*Pomadasys jubelini*	Spotted Grunt	Owolo	Common	LC (2018)	NE
Cichlidae	*Sarotherodon melanotheron*	Tilapia	Omoda	Abundanta	LC (2020)	NE
Gobiidae	*Porogobius scheligelii*	Goby	Ikinji	Rare	LC (2019)	NE

DD = Data Deficient; LC = Least Concern; NT=Near Threatened; VU = Vulnerable; NE=Not Evacuated

Table 5B: Composition of fish observed during the study (Wet Season – July 2023)

Family	Scientific name	Common Name	Local (Okrika) Name	Abundance Score	IUCN Red List Status	CITES
Cichlidae	*Sarotherodon melanotheron*	Black-chin tilapia	Omoda	Abundant	LC (2019)	NE
	Coptodon guineensis	Guinean tilapia	Atabala	Abundant	LC (2019)	NE
Haemulidae	*Pomadasys jubelini*	Sompat grunt	Owolo	Abundant	LC (2013)	NE
	Plectorhinchus macrolepis	Biglip grunt	Olokpo	Common	LC (2013)	NE
Mugilidae	*Mugil cephalus*	Striped mullet	Beme	Common	DD (2019)	NE
	Neochelon falcipinnis	Sickle-fin mullet	Gbulu	Common	DD (2013)	NE
Lutjanidae	*Lutjanus agennes*	African red snapper	Agbara	Common	DD (2011)	NE
Clupeidae	*Sardinella maderensis*	Madeiran sardinella	Songu	Common	VU (2014)	NE
	Sardinella aurita	Round sardinella	Asara	Dominant	LC (2012)	NE
Serranidae	*Epinephelus aeneus*	White grouper	Orom	Common	NT (2016)	NE
Gerreidae	*Eucinostomus melanopterus*	Flagfin mojarra	Otubulu	Rare	LC (2010)	NE
Carangidae	*Caranx hippos*	Crevalle jack	Okwe	Common	LC (2018)	NE
Bagridae	*Chrysichthys nigrodigitatus*	Bagrid catfish	Aga	Rare	LC (2019)	NE
Alestidae	*Brycinus nurse*	Nurse tetra	Ogein	Rare	LC (2013)	NE
Tetraodontidae	*Sphoeroides pachygaster*	Blunthead puffer	Ibupu	Rare	LC (2011)	NE

DD = Data Deficient; LC = Least Concern; NT=Near Threatened; VU = Vulnerable; NE=Not Evacuated

Table 6: Composition of shellfish observed during the study (Wet Season – July 2023)

Family	**Scientific name**	**Common Name**	**Local (Okrika) Name**	**Score**	**IUCN Red List Status**	**CITES**
Portunidae	*Callinectes amnicola*	Swimming crab	Ipa	Abundant	NE	NE
Penaeidae	*Penaeus monodon*	Giant tiger prawn	Ipoli	Abundant	NE	NE
Lysiosquillidae	*Lysiosquilla hoevenii*	Lizard mantis	Siko	Common	NE	NE

NE=Not Evacuated

Plate 3: ***Ethmalosa fimbriata***

Plate 4: ***Pseudotolithus epipercus***

Plate 5: ***Coptodon guineensis***

Plate 6: ***Sarotherodon melanotheron***

Plate 7: ***Pomadasys jubelini***

Plate 8: ***Plectorhinchus macrolepis***

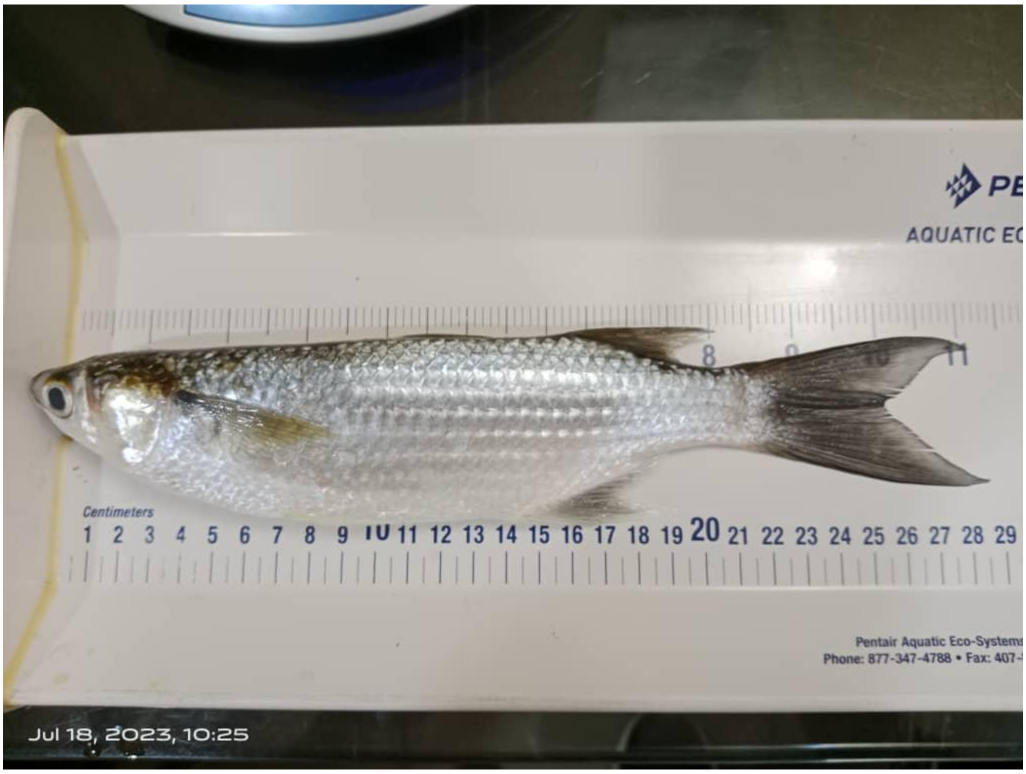

Plate 9: ***Mugil cephalus***

Plate 10: ***Neochelon falcipinnis***

Plate 11: ***Eucinostomus melanopterus***

Plate 12: *Lutjanus agennes*

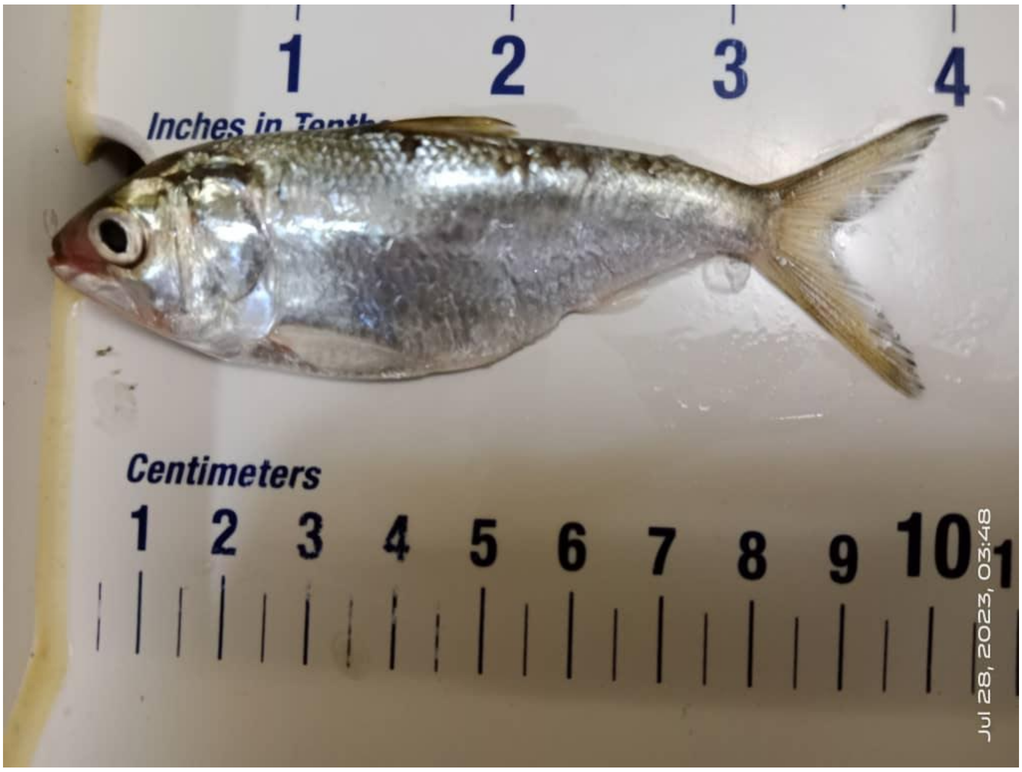

Plate 13: *Sardinella maderensis*

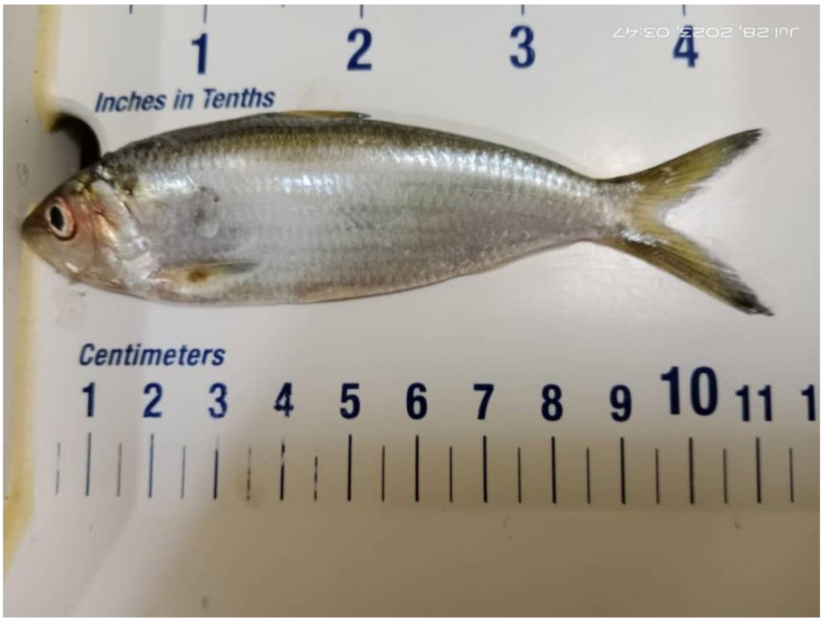

Plate 14: ***Sardinella aurita***

Plate 15: ***Epinephelus aeneus***

Plate 16: ***Caranx hippos***

Plate 17: ***Chrysichthys nigrodigitatus***

Plate 18: ***Brycinus nurse***

Plate 19: ***Sphoeroides pachygaster*** **(in red box)**

Plate 20: ***Callinectes amnicola***

Plate 21: ***Penaeus monodon***

Plate 22: ***Lysiosquilla hoevenii***

The Fulton's condition factors of the fish showed that the lowest and highest mean values of a mean values of 0.81 and 2.13 for *Neochelon falcipinnis* and *Sarotherodon melanotheron* respectively (Table 7). According to Bennet (1970), Fulton's condition factor of 0.56 is considered as well-being benchmark value of a fish; hence fishes with condition factor values above the well-being benchmark were considered to be in good condition.

The length-weight relationship of some fish determined by regression following log-log transformation is presented in Figure 5. The equations derived showed that the mugilids fish exhibited negative allometric growth pattern while the cichlids exhibited positive allometry.

Table 7: Statistical Summary of Condition Factors of some Fish Species (July 2023)

Species	Mean	SD	Min	Max	N
Lutjanus agennes	1.49	0.13	1.30	1.84	68
Pomadasys jubelini	1.34	0.10	1.16	1.63	41
Sarotherodon melanotheron	2.04	0.13	1.73	2.29	33
Coptodon guineensis	2.13	0.18	1.85	2.55	32
Neochelon falcipinnis	0.81	0.11	0.67	1.06	9
Mugil cephalus	0.82	0.10	0.71	0.95	5
Epinephelus aeneus	1.17	0.17	1.00	1.41	4
Caranx hippos	1.38	0.07	1.30	1.45	3
Plectorhinchus macrolepis	2.03				1
Eucinostomus melanopterus	1.49				1
Sardinella aurita	1.24				1
Chrysichthys nigrodigitatus	0.93				1

Floating Aquatic Macrophytes

No floating aquatic macrophytes were observed in any of the sampling stations. This is not surprising as species common in the Niger Delta such as *Nymphaea lotus*, *Eichonea crassipes* are known to be intolerant of saline water are not reported in the Bonny estuary.

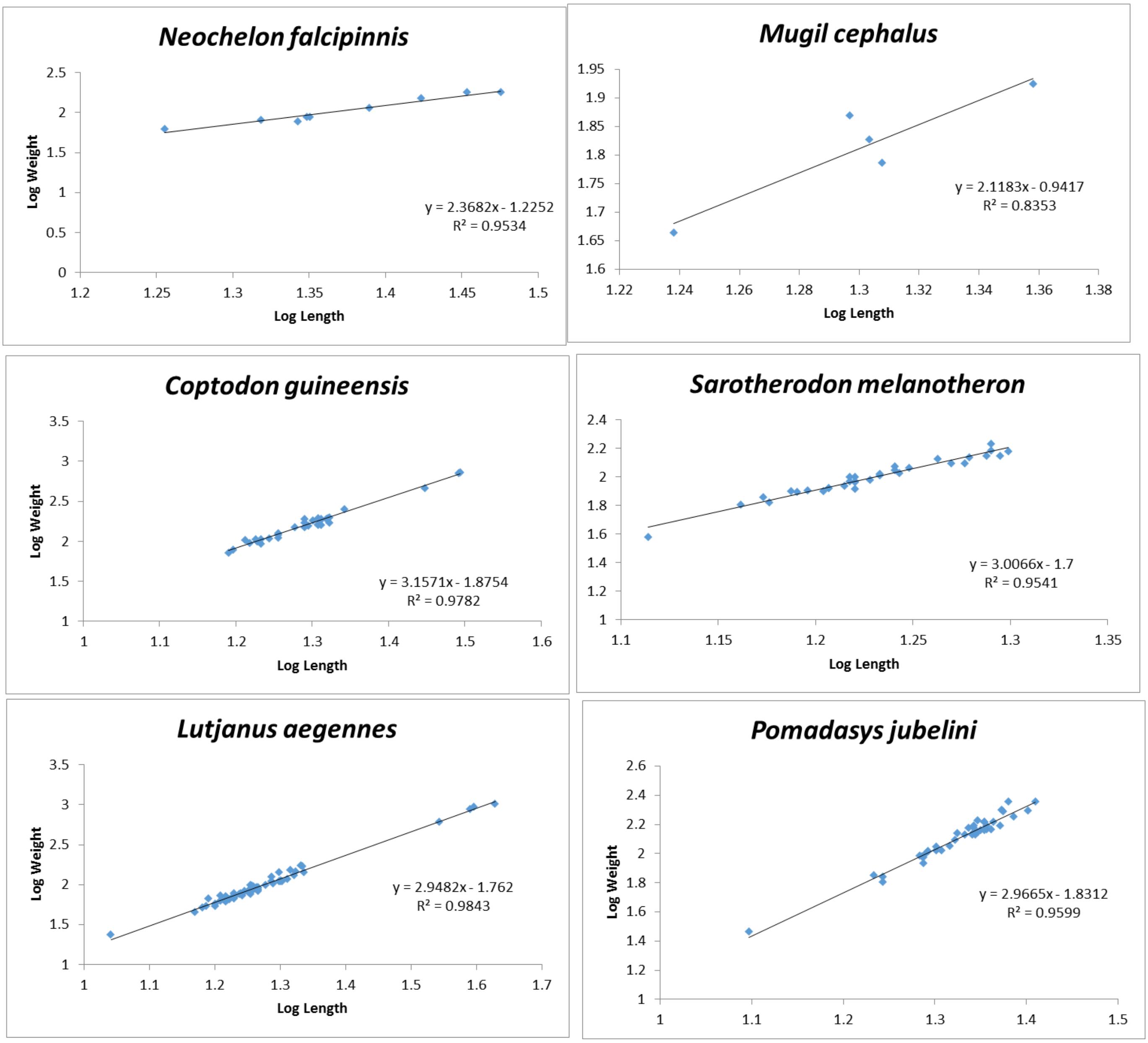

Figure 5: Length –Weight Relationships of some fish in the study area (July 2023)

Conservation Status

The spatial boundaries of the project port facility at the federal ocean terminal at Onne, Eleme Local Government Area of Rivers State do not fall within any national legally protected area or an internationally recognized area. Nigeria presently has 11 sites designated as Wetlands of International Importance (Ramsar Sites), with a surface area of 1,076,728 hectares spreading across the six geopolitical regions in Nigeria. (https://www.ramsar.org/news/nine-new-ramsar-sites-in-nigeria). It is not an aquatic critical or sensitive fish habitat. There are no endemic species; the IUCN status of the fish were mostly Least Concern (LC) or Data Deficient (DD) except for *Sardinella maderensis* which is globally Vulnerable (V) and *Epinephelus aeneus* as near threatened(NT). All the species recorded fall in the Not Evaluated (NE) category in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). All the shell fishes observed were NE for both IUCN and CITES.

Ecosystem Services of the Onne axis of the Bonny Estuary

Fisheries provisioning services is one of the most important ecosystem services provided by river/estuaries. Fishing is major occupation of the communities in the area, albeit done at artisanal and subsistence levels. Fishes are reasonably priced and are a major source of income to the resident and itinerant fisherfolks. There are no species that support recreational fisheries, or culturally important fisheries. The ecosystem services of plankton and benthos are support services premised on their ecological roles in the ecosystem.

Key Stressors/Threats to Aquatic Biodiversity and Ecosystem Function

Several human activities including oil and gas exploration, dredging, invasive plant infestation and wetland reclamation in addition to increased exploration, population growth and weak governance have led to increase case of water pollution/contamination and fish migration of the Niger Delta (Adekola and Mitchell, 2011, Izah 2018) thus becoming threats to aquatic biodiversity and ecosystem function. According to Dirisu and Edwin-Wosu indiscriminate harvest of fisheries, unregulated navigations, illegal activities of crude oil products and transportation activities pose some threats to the estuary sustainability. Major anthropogenic influences that could affect aquatic biodiversity and ecosystem function in the proposed project area are Port operations, movement of marine vessel and dredging. Some illegal fishing with toxic chemicals is also reported to be an occasional occurrence.

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