Benthic Macrofauna of the Mgbuoshimini Axis of Elechi Creek, Bonny Estuary, Nigeria: Baseline for Ecological Monitoring

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Abstract
Benthic macrofaunal composition, abundance, were investigated in the Mgbuoshimini axis of Elechi Creek, Bonny Estuary, Rivers State, Nigeria, before construction of a proposed abattoir. Four stations were sampled bimonthly from April 2023 to February 2024. Sediment was collected with a 16 × 16 cm Van Veen grab and washed through a 0.5-mm sieve, the material retained was placed in labeled containers and fixed with 10 % formalin to which eosin was added. Three replicate benthic samples were collected at each station. Samples were sorted and all organisms were identified using appropriate keys and enumerated. Fifteen species belonging to five phyla and eleven families were recorded. Annelida had the highest number of species with 53% of species, followed by Arthropoda (20%), Mollusca (13%), Echinodermata (7%) and Chordata (7%). Polychaeta accounted for ca 98% of the relative abundance of benthos in the area. Seven polychaete taxocene were recorded from all stations and subjected to Analysis of variance (ANOVA) while Boccardia sp was found at only one station and not carried through. ANOVA did not give significant spatial differences Notomastus sp (p=0.416), Polydora sp (p=0.202) Nephtys hombergi (p=286) and Streblospio sp (p=0.437). However, there were significant differences between stations for Capitella capitata (p=0.001), Nereis diversicolor (p=0.009) and Lumbrineris sp (p=0.005). The results demonstrate spatial and temporal structuring of the benthic community and provide a baseline of polychaete taxocene for assessing ecological change that may be associated with the proposed abattoir during construction and operation.

Keywords: *Benthic macrofauna; Polychaeta; Baseline; Elechi Creek; Bonny Estuary*

Introduction

Estuarine creeks of the Niger Delta provide important ecological and socioeconomic functions, including fisheries, transportation, nutrient cycling and habitat provision. Their shallow, sediment-rich environments also receive contaminants from domestic discharges, industrial activities, petroleum-related operations, dredging, waste disposal and slaughterhouse activities.

Benthic macrofauna are important components of estuarine ecosystems and respond to changes in sediment characteristics, organic enrichment, oxygen availability, salinity and contaminants. They are useful in environmental assessment because they are closely associated with sediments, have limited mobility and respond to cumulative environmental pressures. Changes in their abundance and composition can therefore complement physicochemical measurements and provide an

integrated indication of ecological condition (Umesi & Daka, 2004; Olomukoro & Dirisu, 2014; Edegbene et al., 2021).

The Niger Delta contains numerous estuarine creeks exposed to multiple anthropogenic pressures. In Elechi Creek and neighbouring systems, previous studies have documented changes in physicochemical conditions and benthic assemblages (Obire et al., 2003; George et al., 2009; Uyi, 2013; Daka et al. 2018). Pollution-tolerant taxa may become dominant where organic enrichment and sediment disturbance increase, while sensitive or habitat-specific taxa may decline.

The Mgbuoshimini axis is of particular interest because of existing slaughter-related activities and the proposed construction of a new abattoir. Establishing environmental conditions before construction is essential for distinguishing pre-existing impairment from impacts that may arise during construction and subsequent operation. Establishing the benthic community before construction is necessary for subsequent ecological impact assessment. Furthermore, benthic organisms can serve as biological indicators (Edegbene et al., 2021). Biological indicators are employed in environmental legislation to monitor, manage, and conserve freshwater environments in order to assess the health of these ecosystems (Edegbene et al., 2021).

This study therefore characterized benthic macrofaunal composition and abundance, evaluated temporal and spatial variation in dominant taxa.

Materials and Methods

Study area and sampling design

The study was conducted in a brackish wetland of Bonny estuary at Mgboushimini (Elechi Creek). The creek lies Southwest of Port Harcourt between longitude 04˚46'743"N and 007˚00'557"E; 04˚48'217"N and 006˚48'989"E. It is protected from strong wave actions prevalent in the main Bonny River Channel and the current flow velocity is minimal. Vegetation in the area is characteristically mangrove, with the dominant types being red mangrove (*Rhizophora racemosa*), white mangrove (*Avicennia africana*) and black mangrove (*Laguncularia racemosa*). The area is also inhabited by other plants (e.g. fern-*Achrostichum aureum* and grass-*Paspalum varginatum*). Animals found in the area include (mud skipper *Periophthalmus* sp., fidder crabs *Uca tangeri* and Periwinkles). The vegetation of the head water and stream banks are intact, and had been referred to as un-degraded stream systems (Wilcox, 1980) (Chindah, 1993). Four (4) stations were identified as follows for sampling (Figure 1). Station 1: Old Abattoir, Station 2: Proposed Location of New Abattoir, Station 3: Downstream of ST 2 (Alhaji Jetty, before Agip company) and Station 4. Upstream of ST 1.

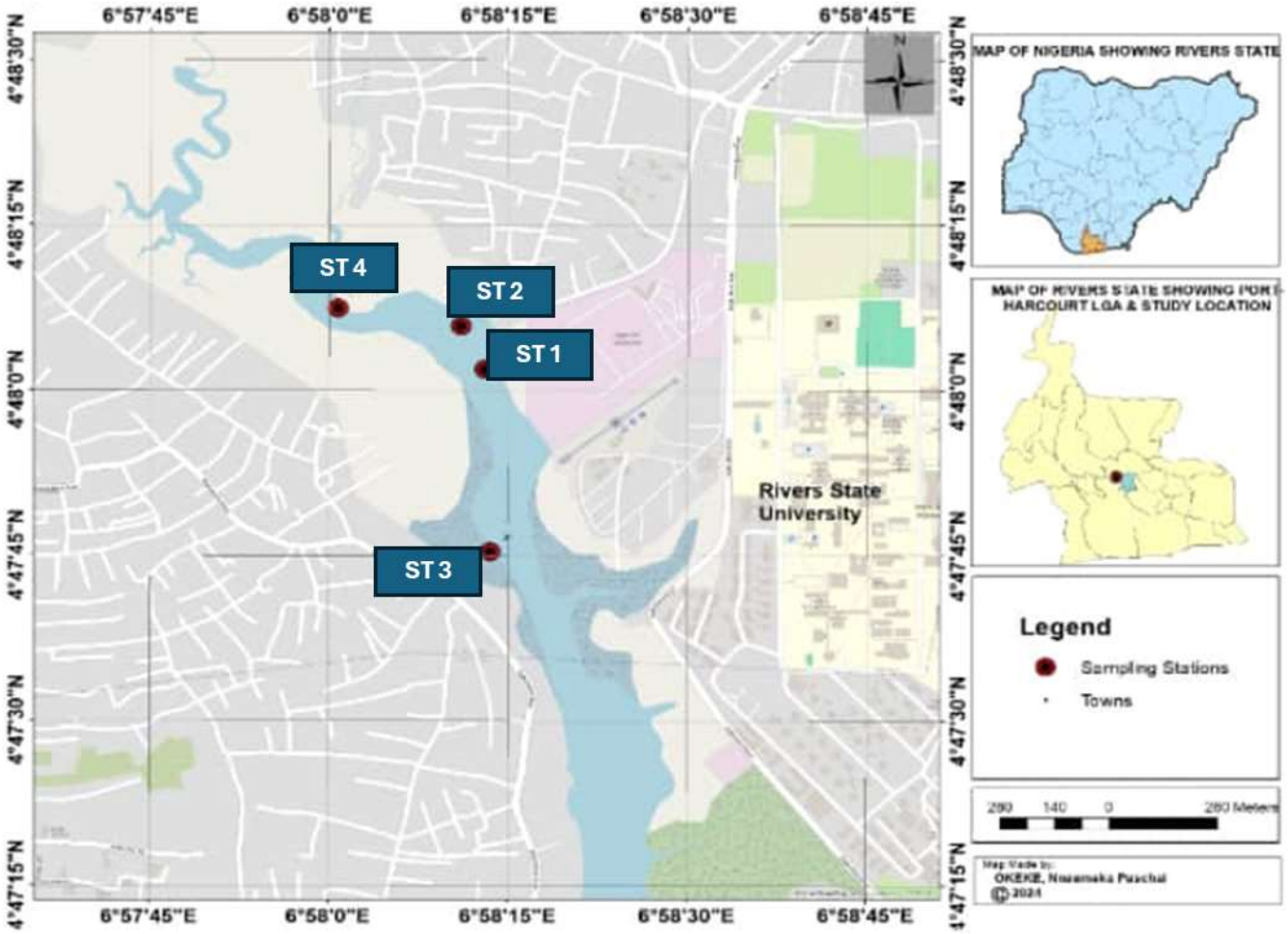


Figure 1. Map showing the Sampling Stations in Elechi Creek of the Bonny Estuary

Benthic macrofaunal collection and identification

The sediment collection was done using a Van Veen Grab. Triplicate samples were taken from each station bimonthly from April 2023 to February 2024. The sediment was collected and emptied into a wide plastic basin. A sub-sample of each sediment from each zone were transferred into labeled polythene bag and foil paper for further analysis in the laboratory. The remaining sample were washed through a 1mm, 0.5mm and 0.35mm mesh size sieves to a clean and clear state to obtain benthic macrofauna. The material retained by the sieves were placed in a container and preserved with 10% formalin against the volume of brackish-water mixture and stained in Eosin to facilitate sorting in the laboratory.

Statistical analysis

Analysis of Variance (ANOVA) was used to assess spatial and temporal variation in abundance, followed by Tukey mean separation where appropriate.

Results

A total of 15 species from 5 phyla of benthic macroinvertebrates (Annelida, Echinodermata, Arthropoda, Mollusca and Chordata) were reported from the 4 stations in Elechi Creek (Table 1). The relative abundance of major taxa shows that polychaeta was the predominant group accounting for ca 98%o overall (Fig 2). Subsequent analysis therefore focused on the temporal and spatial differences in the abundance of polychaete genera/species. While temporal variations described distribution patterns, spatial variations included statistical inferences.

Table 1: Checklist of benthic fauna identified from Elechi Creek over the study period

PHYLUM	CLASS	SPECIES	ST1	ST2	ST3	ST4
Annelida	Polychaeta	*Polydora capensis*	+	+	+	+
		Streblospio sp	+	+	+	+
		Boccardia sp	-	-	-	+
		Nereis diversicolor	+	+	+	+
		Nephtys hombergii	+	+	+	+
		Lumbrineris spp	+	+	+	+
		Capitella capitata	+	+	+	+
		Notomastus sp	+	+	+	+
Echinodermata	Holothuroidea	*Holothuria sp*	+	+	+	+
Arthropoda	Insecta	*Chironomus ablabiesmia*	-	+	-	-
Crustacea*	Malacostraca	*Talitri spp*	-	-	+	+
		Cumaceans	+	+	+	-
Mollusca	Bivalvia	*Tellina spp*	+	+	+	+
	Gastropoda	*Tympanotonus fuscatus*	-	-	-	+
Chordata	Pisces**	*Myrophis plumbeus*	-	-	-	+

*Subphylum; ** Superclass

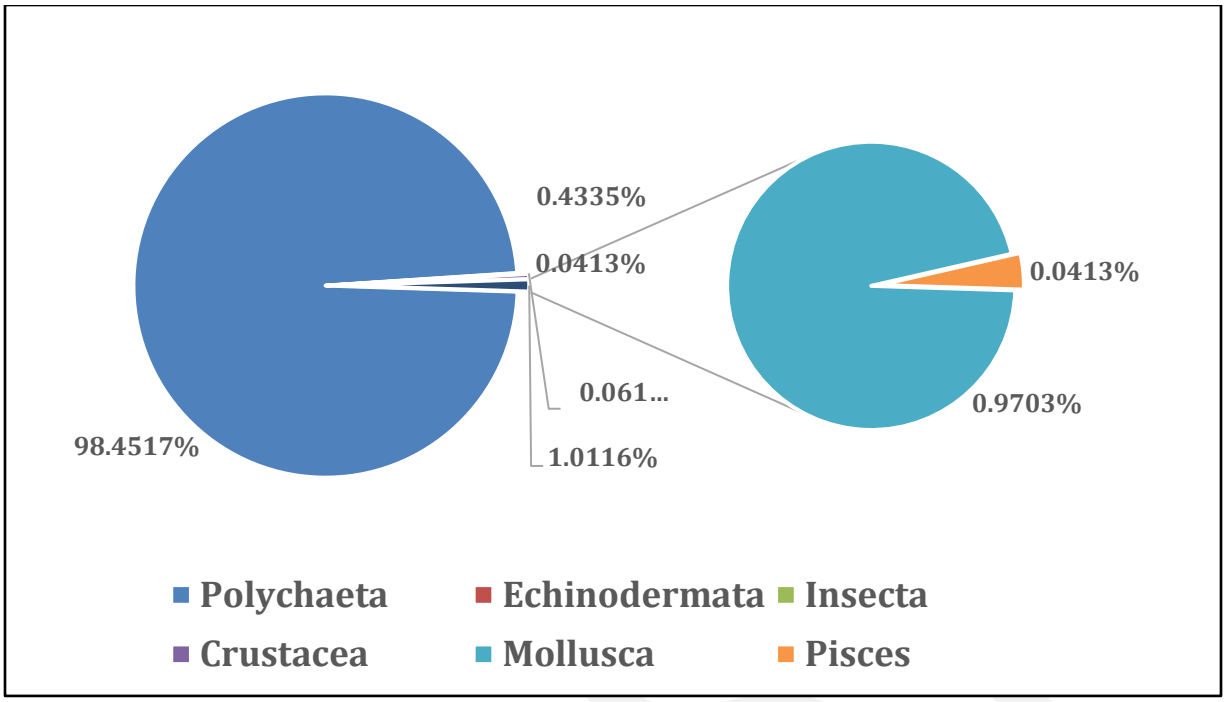


Figure 2: Relative abundance of major taxa in the benthos of Elechi Creek

Abundance of *Lumbrineris* spp was highest in the month of April and lowest in June (Fig 3). Mean abundance for stations was highest at stations ST3 and lowest at stations ST1 (Fig 4). Analysis of variance (ANOVA) showed significant difference between stations, ($p<0.0=0.005$). Tukey pairwise comparison for stations showed that ST3>ST4= ST2= ST1.

Mean abundance of *Capitella capitata* was highest in the month of February and lowest in December (Fig 5). Mean abundance for stations was highest at stations ST4 and lowest at stations ST3 (Fig 6). Analysis of variance (ANOVA) showed significant difference between stations($p=0.001$). Tukey pairwise comparison for stations showed that ST4>ST2 = ST1 = ST3.

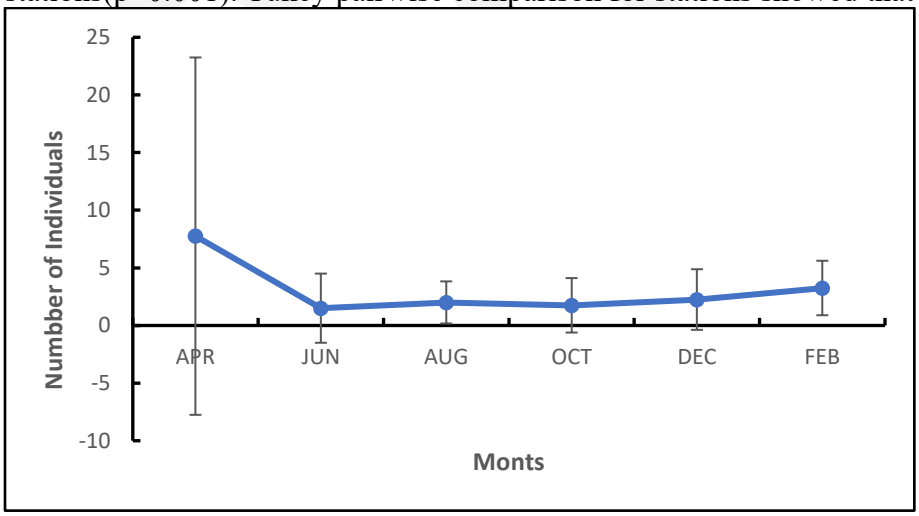


Figure 3: Temporal Abundance of *Lumbrineris sp* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

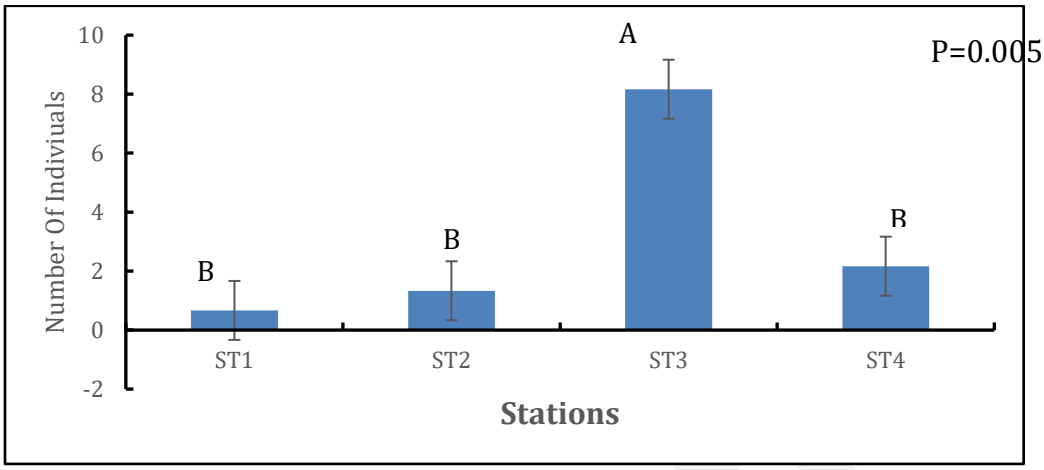


Figure 4: Spatial Abundance of *Lumbrineris sp* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

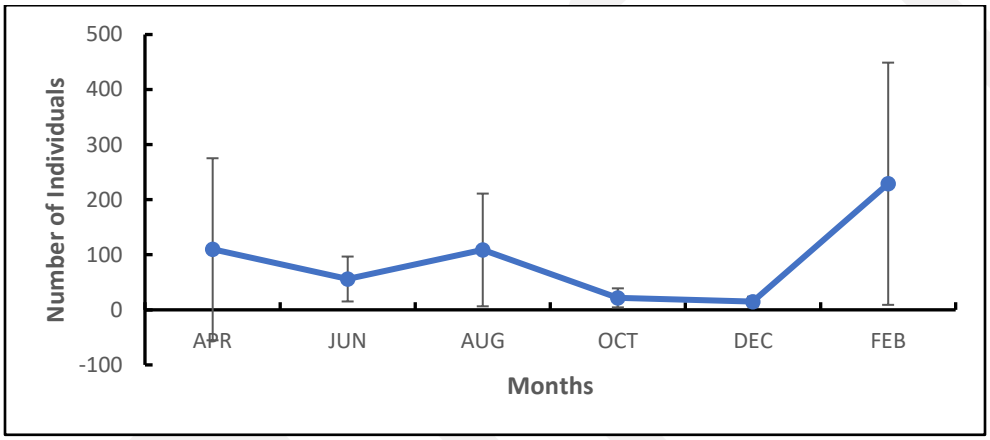


Figure 5: Temporal Abundance of *Capitella capitata* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

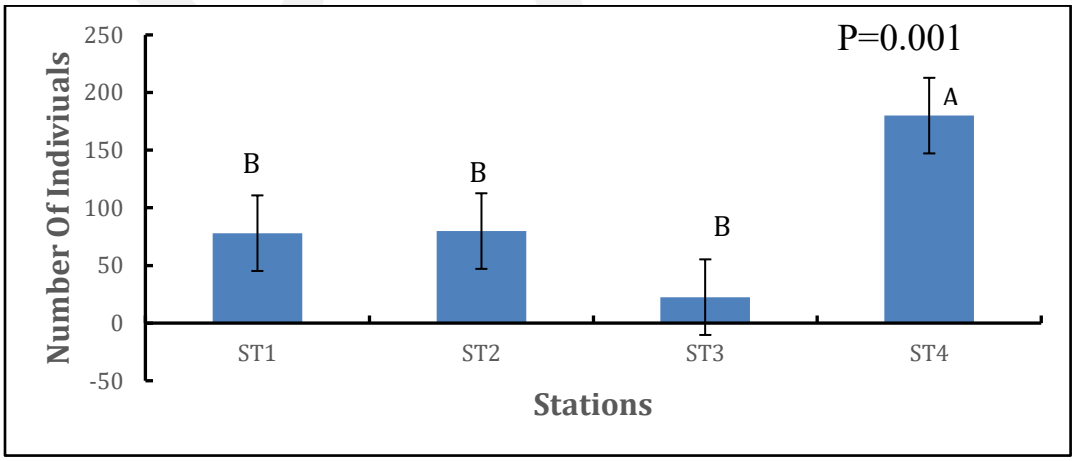


Figure 6: Spatial Abundance of *Capitella capitata* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek

Mean abundance of ***Notomastus spp*** was highest in the months of August and October, the lowest was observed in December (Fig 7). Mean abundance for stations was highest at stations ST1 and lowest at stations ST3.and there was no significant difference (P=0.416). between stations (Fig 8).

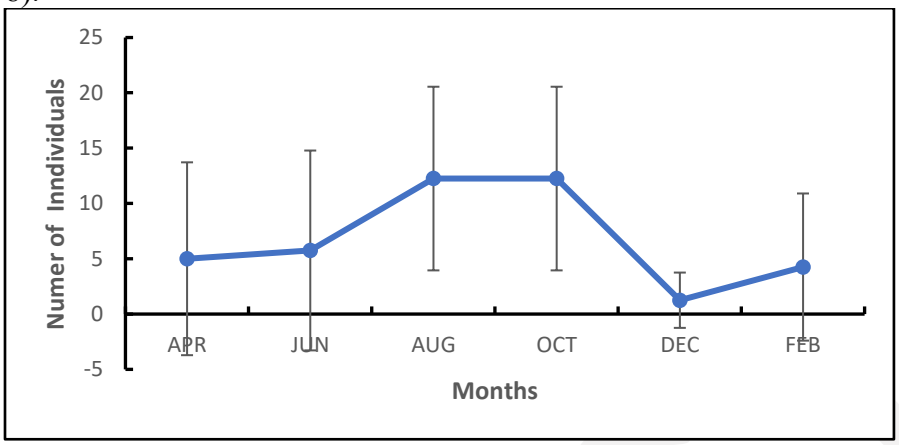


Figure 7: Temporal Abundance of *Notomastus sp* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

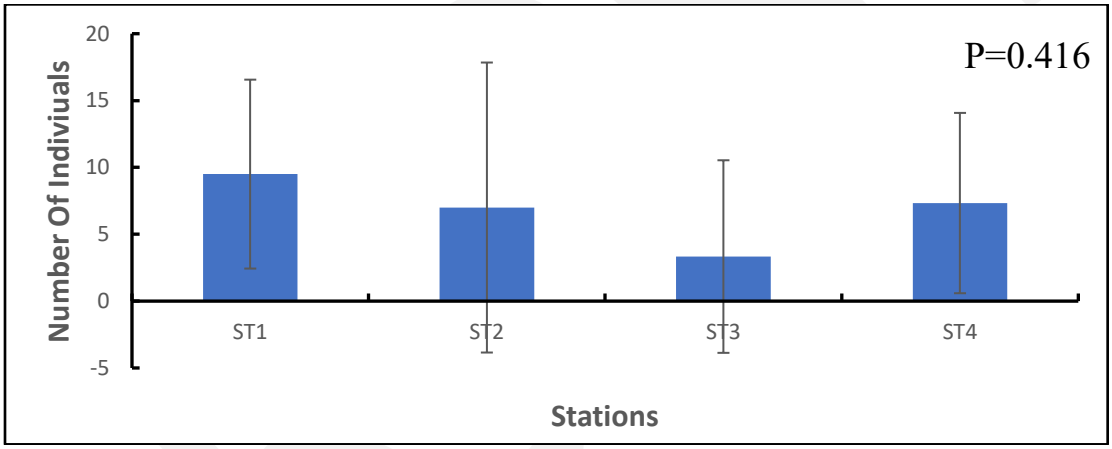


Figure 8: Spatial Abundance of *Notomastus sp* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

The month of April had the highest Mean abundance of *Nephtys hombergi*, while the lowest was observed in the months of August, October and December (Fig 9). For stations, ST3 had the highest mean abundance, the lowest occurred at stations ST4 but ANOVA showed no significant difference between stations (Fig 10).

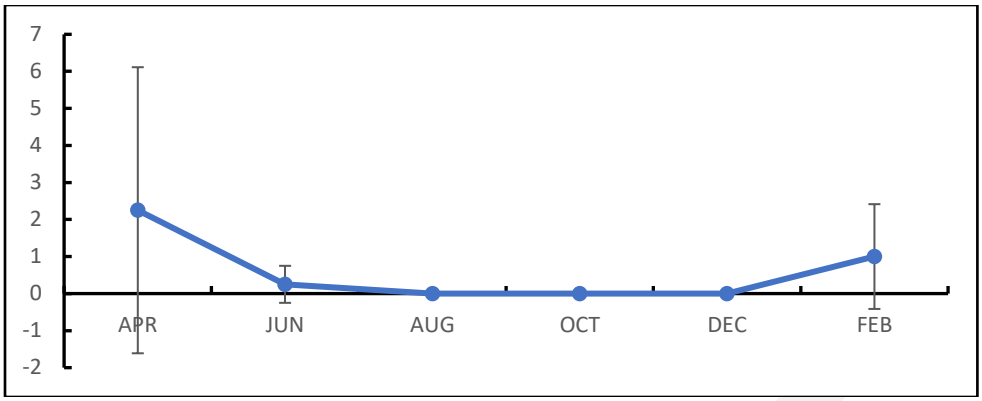


Figure 9: Temporal Abundance of *Nephtys hombergi* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

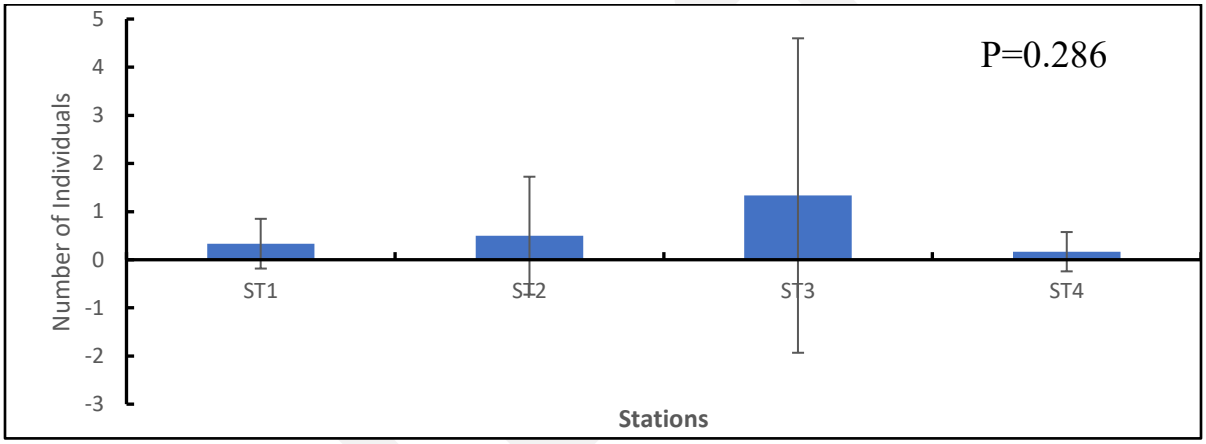


Figure 10: Spatial Abundance of *Nephtys hombergi* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

The month of October had the highest mean abundance of ***Polydora sp***, the lowest occurred in the month of August (Fig 11). ST 3 had the highest mean abundance, the lowest occurred at stations ST4 (Fig 10) there was no significant difference (p=0.202) stations (Fig. 12).

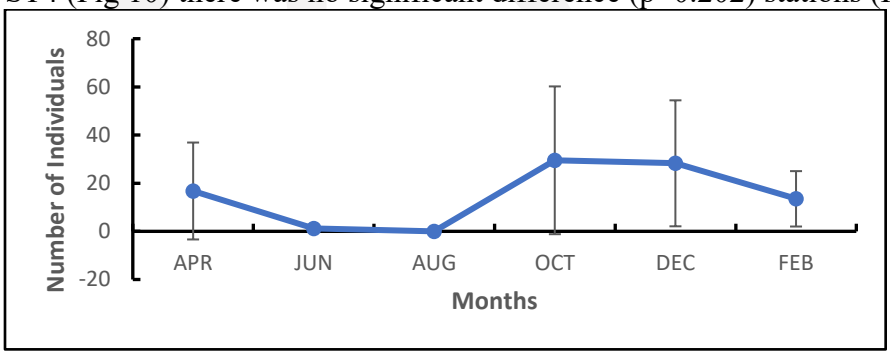


Figure 11: Temporal Abundance of *Polydora sp* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

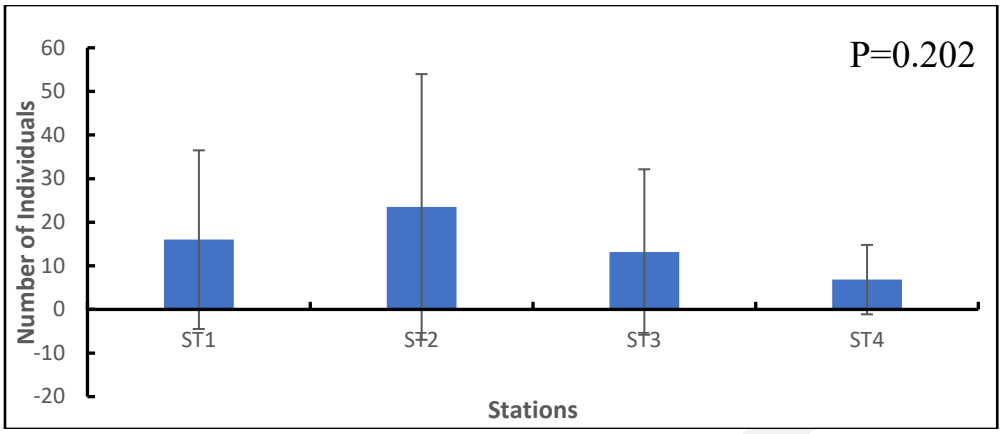


Figure 12: Spatial Abundance of *Polydora sp* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

For *Streblospio sp*, the month of December had the highest Mean abundance, while the lowest occurred in the month of June (Fig 13). ST2 had the highest mean abundance, the lowest occurred at stations ST4 (Fig 14); ANOVA) showed no significant difference between stations (p=0.437).

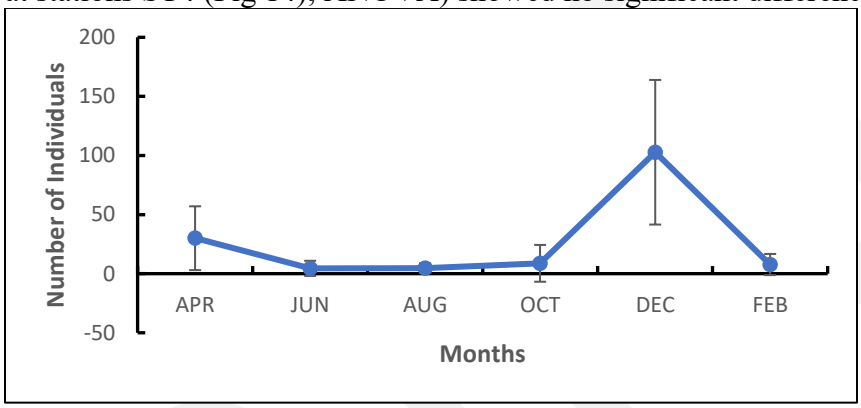


Figure 13: Temporal Abundance of *Streblospio sp* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

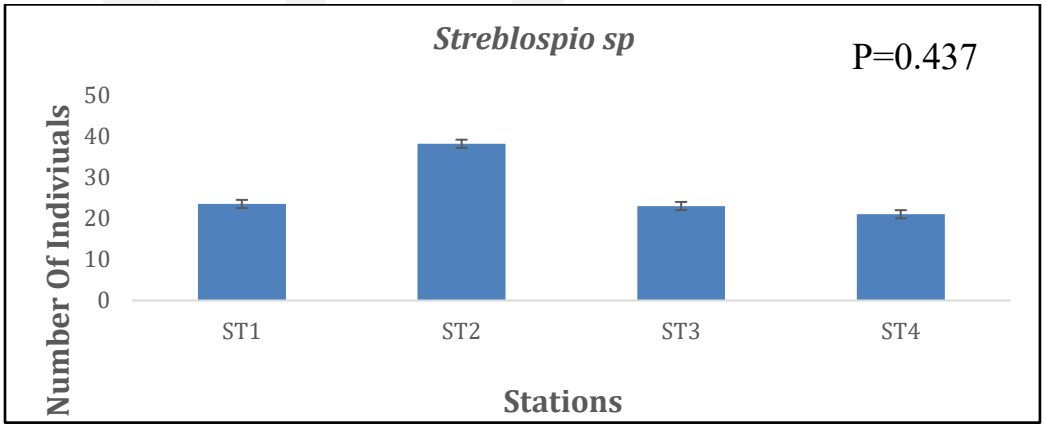


Figure 14: Spatial Abundance of *Streblospio sp* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

The highest Mean abundance of ***Nereis diversicolor*** was obtained in the month of October while the lowest occurred in the month of April (Fig 15). For stations, ST3 had the highest mean

abundance, the lowest occurred at stations ST1 (Fig 16). Analysis of variance (ANOVA) showed significant difference between stations(p=0.009). Mean separation by Tukey pairwise comparison showed that ST3 = ST4; ST3 > ST2 = ST1 (Fig. 16).

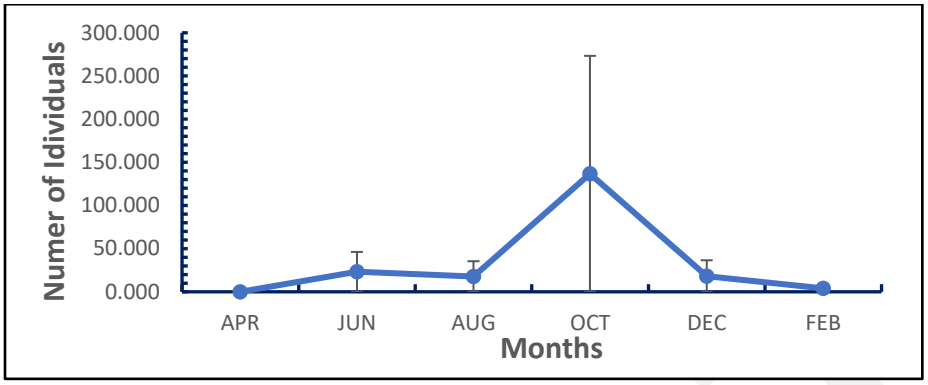


Figure 15: Temporal Abundance of *Nereis diversicolor* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

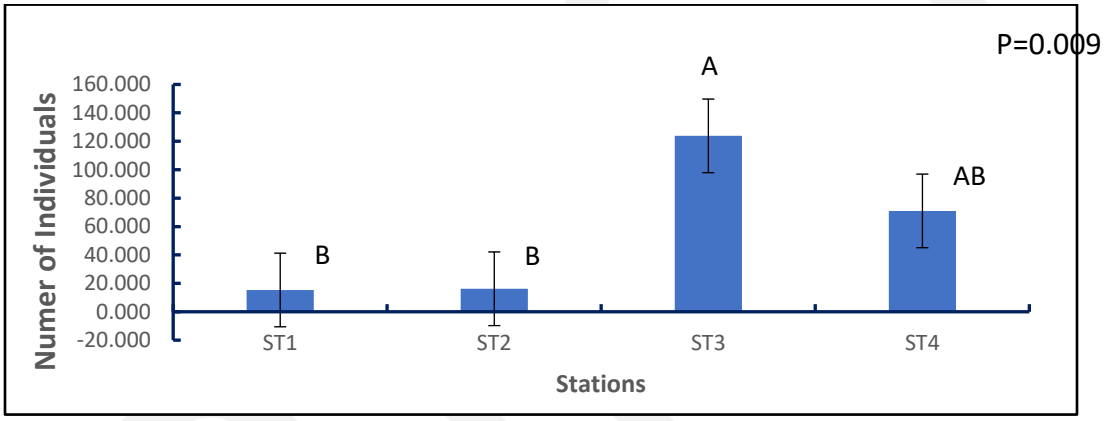


Figure 16: Spacial Abundance of *Nereis diversicolor* (Mean± S.D) from April 2023 to January 2024 in Elechi Creek.

Discussion

The dominance of Annelida, particularly polychaetes, is consistent with the importance of polychaetes in estuarine soft-bottom habitats. The five phyla and eleven families recorded demonstrate that the creek supports a heterogeneous benthic assemblage, but the abundance patterns of individual taxa reveal substantial spatial and temporal structuring. This study did not vary greatly from some other studies in Niger Delta region. Zabbey (2002) in his study on the Woji creek reported thirty taxa belonging to twenty families and five classes, George *et al.,* (2009) also in their study on the Okpoka creek, recorded Nineteen species belonging to twelve families, six classes and four phyla while Daka et al. (2018) reported twenty-one families, six classes and four phyla from the intertidal area of Elechi creek. Anyanwu *et al*., (2018) reported twenty-one species belonging to twenty-one families, six classes and four phyla in the Okpoka creek.

The strong abundance of *Capitella capitata* is ecologically important. The source project identifies C. capitata as one of the most abundant taxa and notes particularly high abundance at ST4. Capitella is widely recognised as a taxon capable of persisting in organically enriched sediments, making its distribution potentially useful for tracking environmental change. The strong temporal

response also suggests that seasonal conditions modify the expression of organic enrichment and habitat suitability.

The composition of benthic communities in relation to tropic groups and species distribution could be related to sediment particle size (Snelgrove and Butman, 1994). Stations ST3, ST1 and ST2 in the creek recorded more silt-clay fraction. This could be responsible for the high numerical abundance recorded at these stations. Spatial variation in the composition of benthic communities along estuarine gradients could also be associated to changes in salinity, depth, sediment grain size and organic content (Day *et al*, 1967).

Streblospio spp. showed an especially strong December peak and was most abundant at ST2, the proposed/new slaughter station. *Polydora* spp. also showed marked temporal changes, peaking in October and showing its highest station mean at ST2. These patterns indicate that benthic response cannot be interpreted from station location alone; seasonality and changing sediment/water conditions

Daka et al. 2018 reported *Capitella capitata* in his studies on the Elechi creek. *Capitella capitata* also had a strong positive relationship with conductivity, total dissolved solids and salinity, this suggest that high salinity did not affect the abundance of this organism.

The findings of this study are particularly valuable because they represent conditions before construction of the proposed abattoir. The baseline establishes the existing ecological state against which future changes can be evaluated. Repeated monitoring of the same stations, sampling months and methods will allow future investigators to determine whether construction or operation is associated with shifts in abundance, dominance or diversity.

Conclusion

The Mgbuoshimini axis of Elechi Creek supported a benthic community of 15 species from five phyla and eleven families, dominated by polychaetes. The results establish that polychaeta can be used for detecting/monitoring ecological changes during and after the development of the proposed abattoir.

Acknowledgements

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