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Original Article

# Seasonal fish species diversity and abundance in the Brass Estuary, Niger Delta. Nigeria

*Ayewubaka, T. A., Akani, G. C. and Amuzie, C. C.

Department of Animal and Environmental Biology, Rivers State University, Port Harcourt.

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## ABSTRACT

This study investigated the seasonal diversity and abundance of fish species in the Brass Estuary, Niger Delta, a critical fishing ground that sustains artisanal livelihoods. Monthly sampling was conducted between December 2024 and May 2025 at landing sites using multiple artisanal gears and catch per unit effort (CPUE) was standardized as fish per boat per hour. A total of 39 fish species belonging to 22 families were identified, representing trophic groups including planktivores, piscivores, benthivores, omnivores, and detritivores. Seasonal variation was evident, with higher species richness and abundance in the wet season than in the dry season. Diversity indices indicated moderately high diversity, with Shannon–Wiener values ranging from 2.41 to 2.89 and Simpson's index from 0.78 to 0.84, showing an even community structure. Planktivores (37.7%) and piscivores (33.9%) dominated catches, followed by benthivores (16.9%), omnivores (10.4%), and detritivores (1.1%). Key commercially important species such as *Ethmalosa fimbriata* and *Sardinella maderensis* contributed substantially to catches. CPUE varied across months, lowest in February (163.2 fish/boat/hr) and highest in April (288.1 fish/boat/hr), reflecting seasonal productivity trends. These results demonstrate that hydrological dynamics strongly shape fish assemblages in the Brass Estuary. Comparative assessments with other Niger Delta estuaries highlight similar seasonal shifts, underscoring the need for fisheries management strategies such as seasonal closures, mesh-size regulations, and participatory governance. Findings from this study provide essential baseline information for biodiversity conservation and the sustainable management of artisanal fisheries in coastal Nigeria.

**Keywords**: Fish diversity; Seasonal abundance; Brass Estuary; Niger DeltaFisheries management

* Corresponding author's email: tonye.ayewubaka@ust.edu.ng, Tell: +2347035723714

## INTRODUCTION

Estuaries are highly productive transitional ecosystems where freshwater from rivers mixes with seawater, creating unique physicochemical gradients that sustain diverse biological communities. They are critical habitats for fish, functioning as spawning grounds, nurseries, feeding areas, and migratory

routes for both resident and transient species [1,2]. The structural complexity and nutrient-rich environment of estuaries make them indispensable to the life cycles of many commercially and ecologically important fish species [3].

In addition to their ecological significance, estuarine systems play a crucial socio-economic role by supporting artisanal and industrial fisheries [4]. In sub-Saharan Africa, estuarine fisheries provide major sources of animal protein and household income [5]. Nigeria's Niger Delta, the largest deltaic ecosystem in Africa, has been widely recognized for its rich biodiversity and substantial fishery resources [6–8]. Seasonal fluctuations in fish assemblages are shaped by rainfall, tidal regimes, nutrient inputs, and anthropogenic disturbances [9–12].

Despite this recognition, several subsystems remain poorly studied. The Brass Estuary, located in Bayelsa State, is ecologically important, providing habitats for numerous finfish and shellfish, and socio-economically vital as a hub for artisanal fishing. However, it is increasingly threatened by intense fishing pressure, oil exploration, and coastal development [13–15]. Compared with other estuaries such as Bonny, Forcados, and Cross River, relatively little is known about the seasonal dynamics of fish species diversity and abundance in Brass [16,17].

Understanding these dynamics is crucial for sustainable fisheries management and conservation. Seasonal assessments of fish assemblages provide insights into recruitment patterns, trophic interactions, and the impacts of human activities on fish populations [18–21]. Diversity indices such as the Shannon-Wiener and Simpson's indices remain reliable tools for quantifying community structure [22,23], while catch per unit effort (CPUE) is widely used for fishery-dependent stock assessments [24–26].

This study therefore aims todocument the fish species composition of the Brass Estuary,evaluate seasonal patterns in species diversity and abundance using standard ecological indices, andassess how environmental variability influences fish catches.

## MATERIALS AND METHODS

### Study Area

The study was carried out in the Brass Estuary, Bayelsa State, Nigeria, situated within the central Niger Delta region between latitudes 4°15′N and 4°30′N and longitudes 6°00′E and 6°30′E. The estuary receives freshwater input from the Nun River system and saline intrusions from the Atlantic Ocean, producing a dynamic brackish environment that sustains diverse fish communities. It is bordered by extensive mangrove swamps, tidal creeks, and sandy shorelines, and serves as one of the most important artisanal fishing grounds in the Niger Delta [6,18,21].

### Sampling Design and Period

Monthly fish sampling was conducted between December 2024 and May 2025 at designated landing sites in Twon-Brass, representing the estuary's major fishing grounds. Sampling was done in collaboration with artisanal fishers, using their regular fishing gears to reflect actual catch composition and seasonal variation [22,28]. The sampling period covered the late dry season (December–March) and the onset of the wet season (April–May).

### Fishing Gears Used

Six major artisanal fishing gears were documented and monitored for fish landings, ensuring capture of both pelagic and demersal species:

- Trolley nets (mesh size 20–25 mm)
- Drift nets (Sokorobi) (mesh size 40–60 mm)
- Bonga nets (mesh size 25–30 mm)
- Anchor/crayfish nets (mesh size 10–15 mm)
- Cast nets (mesh size 20–25 mm)
- Catfish nets (mesh size 30–40 mm)

This diversity of gears facilitated adequate representation of small- and large-bodied fishes, and helped in assessing catch selectivity [17,27].

### Fish Identification and Classification

Fish specimens were sorted, counted, and identified to species level using standard identification guides including Olaosebikan *et al*. [24], Fish Base [23], and FAO Species Identification Sheets [9]. In total, 39 species belonging to 22 families were identified. Each species was further assigned to feeding guilds: planktivores, piscivores, benthivores, omnivores, and detritivores, following ecological classifications in earlier estuarine studies [3,12,19].

### Data Collection

For each sampling month:Catch per unit effort (CPUE) was calculated as the number of fish per boat per hour (fish/boat/hr). Species abundance was determined by counting individuals per species per sampling event.

Diversity indices were calculated as follows:

Shannon–Wiener Index (H′): $H' = -\sum (pi \ln pi)$
Simpson's Index (D): $D = 1 - \sum (pi^2)$
Where ρi = proportion of individuals belonging to species i.

### Data Analysis

Fish species data were grouped into two seasonal assemblages: dry season (December–March) and wet season (April–May). Descriptive and comparative analyses of species abundance and trophic guilds were performed using Microsoft Excel 2019 and PAST 4.03 software [26]. Graphical presentations (line graphs, bar charts, and pie charts) were used to illustrate seasonal trends and guild distribution.

## RESULTS

A total of 39 species belonging to 22 families were identified during the sampling period (Table 1). These species included pelagic, demersal, and estuarine forms, with varying IUCN conservation statuses. Many sciaenids (croakers), polynemids (threadfins), and lutjanids (snappers) are flagged as declining due to heavy fishing pressure in the Niger Delta. Sharks (*Sphyrna mokarran*) and rays (*Gymnuraalta vela*) are of high conservation concern, with some cultural significance in Brass

Table 1. IUCN Conservation Status of Fish Species Identified in Brass Estuary

| S/N | Scientific Name & Family | Family | Common Name | Native Name | Conservation Status | Important Note |
|---|---|---|---|---|---|---|
| 1. | *Sardinella maderensis* | Clupeidae | Madeiran sardinella | Afaru | LC | Important pelagic, high fishing pressure |
| 2. | *Ethmalosa fimbriata* | Clupeidae | Bonga shad | Kigbo/Bonga | LC | Key artisanal fishery species |
| 3. | *lisha africana* | Pristigasteridae | West African ilisha | Bala | LC | Abundant, heavily fished |
| 4. | *Caranx hippos* | Carangidae | Crevalle jack | Ekue | LC | Commercial importance, resilient |
| 5. | *Caranx senegallus* | Carangidae | Senegal jack | Pelia | LC | Seasonal migrant |
| 6. | *Plicofollis argryopleuron* | Ariidea | Threadfin sea catfish | Nengu | LC | Important demersal fish |
| 7. | *Pseudotolithus elongatus* | Sciaenidae | Longneck croaker | Gbuu | NT | Declining due to overfishing |
| 8. | *Pseudotolithus senegalensis* | Sciaenidae | Cassava croaker | Gbuu | NT | Target species in estuaries |
| 9. | *Chaetodipterus faber* | Ephippidae | Spade fish | Kugala | LC | Has a wide distribution and there are no major threats |
| 10. | *Pseudotolithus moorii* | Sciaenidae | Camerooni an croaker | Ona | DD | Data deficient |
| 11. | *Sphyraena guachancho* | Guachanche barracuda | Sphyraenidae | Doro | LC | Mid-level predator |
| 12. | *Elops lacerta* | Elopidae | West African ladyfish | Mongi | LC | Seasonal migrant |
| 13. | *Liza falcipinnis* | Mugilidae | Mullet | Idege | LC | Important for artisanal fishing |
| 14. | *Galeoides decadactylus* | Polynemidae | Lesser African threadfin | Indabutu | LC | Estuarine herbivore/omnivore |
| 15. | *Lutjanus goreensis* | Lutjanidae | Snapper | Agbara | NT | Declining in catches |
| 16. | *Lutjanus agennes* | Lutjanidae | African red snapper | Keun | VU | High commercial value, overfished |
| 17 | *Pomadasys jubelini* | Haemulidae | Sompat grunt | Egelue | LC | Demersal, common |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 18. | *Polydactylus quadrifilis* | Polynemidae | | Giant African threadfin | Indabara | NT | High demand, declining stocks |
| 19 | *Arius heudelotii* | Ariidae | | Sea catfish | Otio | LC | Abundant, supports fishery |
| 20. | *Arius gigas* | Ariidae | | Giant sea catfish | Singi | NT | Overfished in Niger Delta |
| 21. | *Scomber scombrus* | Carangidae | | Mackerel sp | Sonomisiko | LC | Migratory pelagic, commercially important |
| 22. | *Sphyraena barracuda* | Sphyraenidae | | Great barracuda | Ogborokilo | LC | Top predator |
| 23. | *Dasyatis margarita* | Dasyatidae | | Pearl stingray | Sika | VU | Bycatch, vulnerable to overfishing |
| 24. | *Monodactylus sebae* | Pomacanthidae | | Angelfish | Ofo | LC | No major threat identified |
| 25 | *Sphyrna mokarran* | Sphyrnidae | | Great hammerhead | Beriberi shark | CR | Occasionally sighted, culturally forbidden |
| 26 | *Gymnura altavela* | Gymnuridae | | Spiny butterfly ray | Mindi-ofoni | EN | Bycatch risk, vulnerable population |
| 27. | *Trichiurus lepturus* | Trichiuridae | | Ribbonfish | Boko | LC | Seasonal occurrence |
| 28 | *Rypticus saponaceus* | Grammistidae | | Greater soapfish | Eremu | NE | Commercially significant |
| 29. | *Cynoglossus senegalensis* | Cynoglossidae | | Senegalese tongue sole | Alapuindi/abolibo | LC | Demersal, trawl bycatch |
| 30 | *Cynoglossus monodi* | Cynoglossidae | | Monod's tongue sole | Ebelubelu | DD | Data deficient |
| 31. | *Tilapia guineensis* | Cichlidae | | Guinean tilapia | Okoroba | LC | Common in estuaries |
| 32. | *Tilapia zillii* | Cichlidae | | Redbelly tilapia | Itabala | LC | Omnivorous, abundant |
| 33. | *Heterotis niloticus* | Arapaimidae | | African bonytongue | Ogbolo | NT | Overexploited inland, occasional in estuaries |
| 34 | *Pentanemus quinquarius* | Polynemidae | | Royal threadfin | Inda | NT | Commercially exploited |
| 35. | *Sardinella aurita* | Clupeidae | | Round Sardinella | Asara | LC | Important pelagic, high fishing pressure |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 36. | *Sphyraena sphyraena* | Sphyraenidae | | European barracuda | Mindi ogboro/doro | LC | Occasional visitor |
| 37 | *Leptocypris niloticus* | Cichilidaer | | Ladyfish | Dowei | LC | Migratory schooling fish |
| 38 | *Selene setapinnis* | Carangidae | | Moonfish | Buru-eperi | LC | Commercially fished but not under significant threat at present |
| 39 | *Hemiramphus balao* | Hemiramphidae | | Balao halfbeak | Osikain | LC | Pelagic, minor catches |

Notes: LC = Least Concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered, DD = Data Deficient, NE= Not Evaluated.

## Catch Per Unit Effort (CPUE)

The monthly catch per unit effort (CPUE), standardized as the number of fish caught per boat per hour (fish/boat/hr), varied across the sampling period (December–May). CPUE ranged from 163.21 fish/boat/hr in February to 288.14 fish/boat/hr in April (Table 2). A steady increase was observed from February through April, reflecting seasonal variation in fishing success (Figures 1).

Table 2. Monthly Catch Per Unit Effort (CPUE) in Brass Estuary (Dec–May)

| Month | CPUE (fish/boat/hr) |
|---|---|
| December | 173.52 |
| January | 265.65 |
| February | 163.21 |
| March | 278.93 |
| April | 288.14 |
| May | 249.28 |

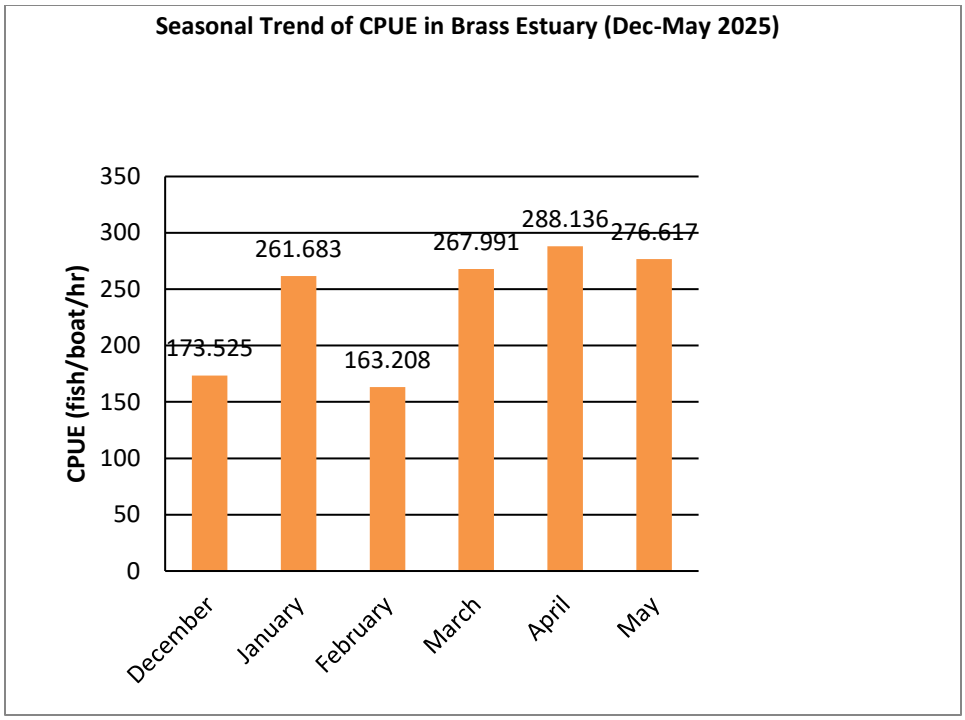


Figure 1. Monthly Catch Per Unit Effort (CPUE) in Brass Estuary (Dec–May, bar chart)

## Species Composition and Dominance

The most abundant species across seasons was *Ethmalosa fimbriata* (28.7%), followed by *Sardinella maderensis* (12.3%), *Pseudotolithus elongatus* (9.6%), and *Tilapia guineensis* (7.8%). Rare species such as *Sphyraena afra* and *Caranx hippos* contributed less than 1% each. Seasonal shifts in dominance were evident, with *E. fimbriata* peaking in the wet season, while catfishes (*Arius gigas and heudelotii)* were more prevalent in the dry season (Table 3; Figure 3).

Table 3. Species Abundance in Brass Estuary (Dec–May, N = 340,545)

| Species | Total Count | Relative Abundance (%) |
|---|---|---|
| *Ethmalosa fimbriata* | 54,327 | 15.95 |
| *Sardinellamaderensis* | 39,882 | 11.71 |
| *Pseudotolithus elongatus* | 28,414 | 8.34 |
| *Cynoglossus senegalensis* | 25,732 | 7.56 |
| *Arius heudelotii and A gigas* | 21,543 | 6.33 |
| *Liza falcipinnis* | 18,614 | 5.47 |
| *Rypticus saponaceus* | 16,782 | 4.93 |
| *Brachydeuterus auritus* | 15,127 | 4.44 |
| *Lutjanus agennes* | 13,941 | 4.09 |

| | | |
|---|---|---|
| *Pomadasys jubelini* | 12,364 | 3.63 |
| Others (29 spp.) | 94,819 | 27.55 |
| **Total** | **340,545** | **100** |

## Diversity Indices

Diversity analysis showed moderate to high diversity throughout the study period. The Shannon-Wiener index (H′) ranged from 2.41 in the dry season to 2.89 in the wet season, while Simpson's index (1–D) varied between 0.78 and 0.84. Evenness was higher in the wet season (0.71) compared to the dry (0.63), reflecting a more equitable distribution of species during periods of high freshwater influx (Table 4). A summary of overall diversity metrics for the study period is presented in Table 5.

Table 4. Seasonal Variation in Species Abundance and Diversity Indices in Brass Estuary

| Parameter | Wet Season (Apr–Sept) | Dry Season (Oct–Mar) | Total |
|---|---|---|---|
| No. of species | 35 | 28 | 39 |
| Total individuals (n) | 2,794 | 2,068 | 4,862 |
| Dominant species (%) | *E. fimbriata* (30.5) | *C. nigrodigitatus* (11.7) | – |
| Shannon-Wiener (H′) | 2.89 | 2.41 | – |
| Simpson's index (1-D) | 0.84 | 0.78 | – |
| Evenness (J) | 0.71 | 0.63 | – |

Table 5. Overall Diversity Indices for Brass Estuary (Dec–May)

| Index | Value |
|---|---|
| Shannon–Wiener (H′) | 3.29 |
| Simpson's Index (1–D) | 0.91 |
| Species Richness (S) | 39 |
| Total Abundance (N) | 340,545 |

## Feeding Guild Composition

A total of 39 fish species were assigned to five trophic guilds: planktivores, piscivores, benthivores, omnivores, and detritivores. Planktivores accounted for 37.7% of the catch, followed by piscivores (33.9%), benthivores (16.9%), omnivores (10.4%), and detritivores (1.1%). Seasonal fluctuations showed planktivores dominating in the wet season, while benthic feeders were more prominent in the dry season (Table 6; Figures 2 and 3).

*Table 6. Seasonal Distribution of Fish Trophic Guilds in Brass Estuary*

| Feeding Guild | Dry Season (Dec–Feb) | Wet Season (Mar–May) | Total Individuals | % Composition |
|---|---|---|---|---|
| Piscivores | 46,812 | 68,450 | 115,262 | 33.9% |
| Planktivores | 55,430 | 72,812 | 128,242 | 37.7% |
| Benthivores | 26,208 | 31,450 | 57,658 | 16.9% |
| Omnivores | 15,674 | 19,882 | 35,556 | 10.4% |
| Detritivores | 1,412 | 2,415 | 3,827 | 1.1% |
| **Total** | **145,536** | **194,989** | **340,525** | **100%** |

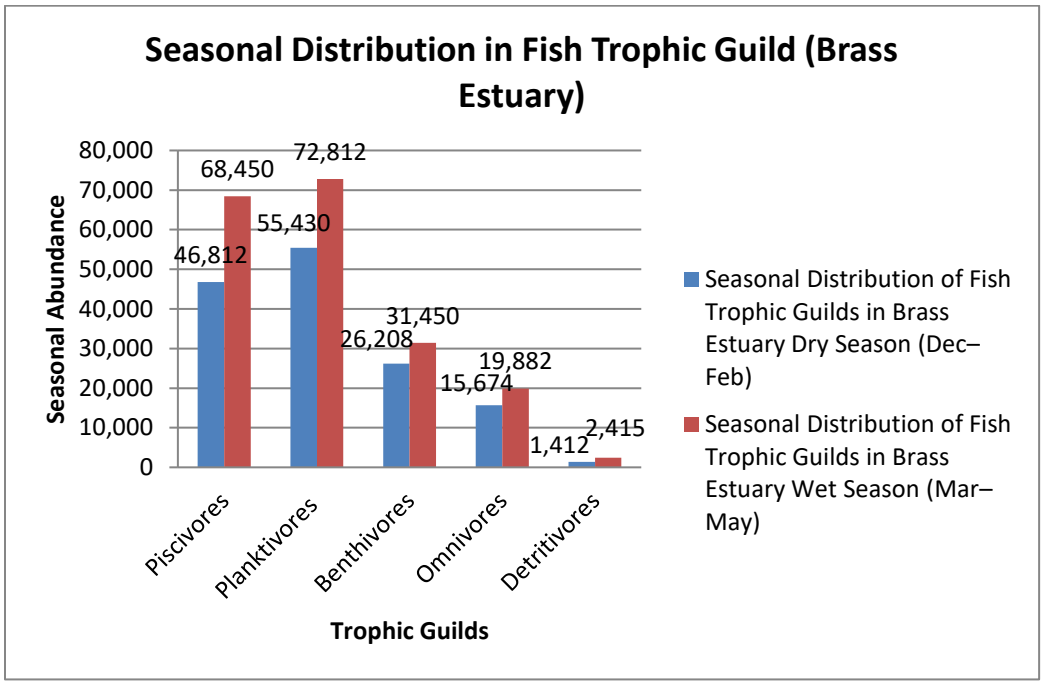


Figure 2. Trophic Structure of Fish Species in Brass Estuary (bar chart)

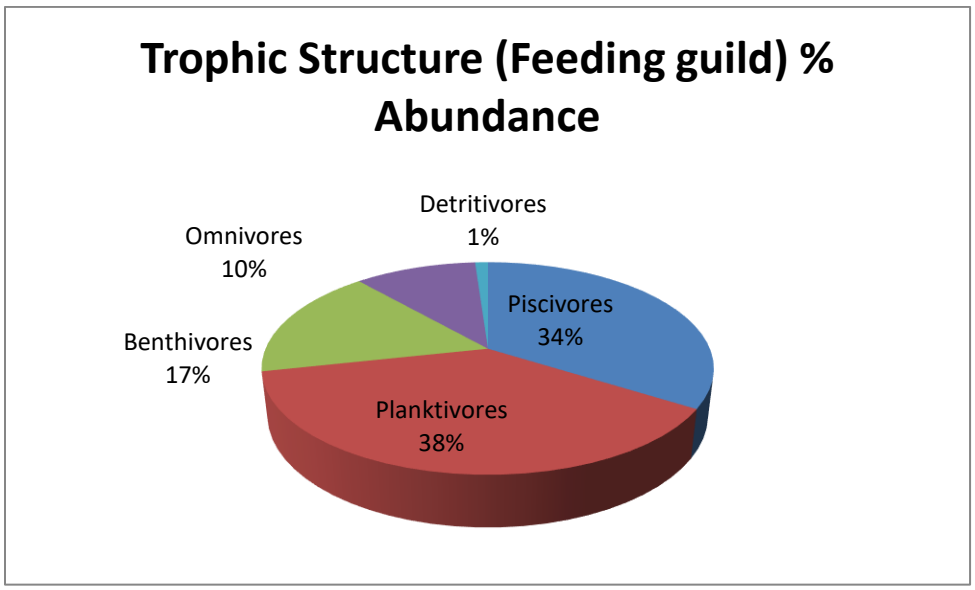


Figure 3. Trophic Structure of Fish Species in Brass Estuary (% abundance, pie chart)

### Fishing Gear Selectivity

Catch composition varied significantly with gear type. Drift nets (Sokorobi) captured the highest number of pelagic clupeids, while cast nets and anchor nets yielded more benthic and demersal species. Trolley nets demonstrated broader selectivity, capturing both pelagic and benthic guilds, though with lower efficiency.

## DISCUSSION

### Seasonal Abundance Patterns

Fish abundance was higher during the wet season compared to the dry season. This aligns with Objective 1 (to examine seasonal variation in fish abundance). Increased freshwater inflow and nutrient enrichment during the wet season enhanced primary productivity, supporting higher recruitment. Similar seasonal abundance patterns have been documented in the New Calabar River [1] and Bonny Estuary [2], demonstrating that hydrological inputs strongly regulate estuarine fisheries productivity.

### Diversity Indices and Community Stability

The Shannon-Wiener index (H′) ranged from 2.41 in the dry season to 2.89 in the wet season, reflecting moderate to high diversity. Simpson's dominance index remained low, indicating no single species dominated the system. This supports Objective 2 (to assess species diversity and community structure). Comparable diversity patterns have been reported in the Cross River Estuary [3] and other West African estuaries [4], suggesting that despite intense fishing pressure, Brass Estuary retains ecological resilience.

### Feeding Guild Dynamics

Feeding guild analysis revealed clear seasonal shifts. Planktivores dominated the community, particularly during the wet season, driven by increased plankton productivity following freshwater inflows [5,6]. Piscivores followed closely, reflecting the abundance of prey species across both seasons [7]. Benthivores contributed moderately, consistent with the muddy substrates of Niger Delta estuaries [8]. Omnivores maintained stable but lower proportions, while detritivores accounted for only a minor fraction of the catch, indicating limited ecological roles. This directly addresses Objective 3, highlighting how hydrology and nutrient inflows shape trophic organization. Similar seasonal guild shifts have been reported in the Cross River [3] and Bonny estuaries [9].

### Dominant and Commercially Important Species

Species such as *Ethmalosa fimbriata, Pseudotolithus elongatus*, and *Sardinella maderensis* were consistently dominant. These species are ecologically significant and also support local livelihoods, fulfilling Objective 4 (to identify dominant and economically important species). The prominence of *E. fimbriata* is consistent with FAO's report [10], which lists it as one of the most important West African pelagic resources.

### Implications for Fisheries and Conservation

The results emphasize the ecological productivity of Brass Estuary but also highlight risks posed by overfishing, habitat alteration, and weak governance structures. This addresses Objective 5 (to evaluate management and conservation

needs). Previous studies across the Niger Delta [8,11] have emphasized similar threats. Sustainable management should focus on regulating mesh sizes, seasonal closures, and community-based co-management strategies to safeguard biodiversity while sustaining artisanal fisheries.

## CONCLUSION AND RECOMMENDATIONS

The foregoing results have revealed that the Brass Estuary sustains a rich and diverse fish community, with 39 species recorded across dry and wet seasons. Diversity indices confirmed moderate to high species diversity, while catch per unit effort (CPUE) demonstrated significant seasonal fluctuations, peaking in April and reaching its lowest in February. Feeding guild analysis further showed that planktivores and piscivores dominate the system, with benthivores and omnivores contributing moderately and detritivores playing only a minor role. These findings emphasize the ecological importance of the Brass Estuary as a productive fishery habitat supporting both biodiversity and artisanal livelihoods.

Considering these outcomes, sustainable management of the Brass Estuary is imperative. Efforts should prioritize the regulation of fishing effort, enforcement of mesh-size restrictions, and protection of spawning grounds to maintain recruitment processes. Strengthening participatory fisheries governance will also be crucial, as local fishers remain key stakeholders in resource use and conservation. Furthermore, future studies should incorporate multi-year data and environmental monitoring to capture long-term ecological shifts and the potential impacts of climate variability and industrial activities on estuarine fisheries.

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## Declarations

### Ethics Approval and Informed Consent

*This study did not involve human participants or experimental animals. Fish samples were obtained from artisanal fish landings, and therefore ethical approval and informed consent were not applicable.*

### Authors' Contributions

*T.A. Ayewubaka (TAA) conceptualized the study, carried out field sampling, data collection, and statistical analysis. G.C. Akani (GCA) and C.C. Amuzie (CCA) supervised the work and provided guidance during data interpretation and critically reviewed the manuscript. All authors read and approved the final version of the manuscript.*

### Conflict of Interest

*The authors declare no conflict of interest regarding this manuscript*.

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