Temporal Turnover Outweighs Spatial Differences in The Fish Assemblage of a Peri-Urban Tidal River During the Early Rainy Season: The Egbelu Reach of The New Calabar River, Niger Delta, Nigeria

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Abstract
Tidal rivers that pass through growing Niger Delta towns sustain artisanal fisheries, but surveys rarely collect fish and water quality data at the same places and times. We sampled three stations on the Egbelu reach of the New Calabar River, Rivers State, Nigeria, each month from May to July 2026. On every visit we measured eleven physico-chemical variables and caught fish with gill nets, cast nets and hooks. Salinity, conductivity and total dissolved solids differed among stations ($p < 0.001$), while only temperature and pH changed from month to month. Dissolved oxygen (6.50–6.80 mg L^{-1}) and BOD_5 (2.50–2.80 mg L^{-1}) pointed to well-oxygenated water with modest organic loading. We caught 1,533 fish belonging to 20 species and 11 families. Cichlidae made up 28.6% of individuals, Clupeidae 16.0% and Alestidae 11.4%, and Sarotherodon melanotheron was the most abundant species (12.5%). Every species turned up at every station, diversity was almost the same everywhere ($H' = 2.91–2.93$; $J' = 0.97–0.98$), and Bray–Curtis similarity was above 92%. Sampling month, on the other hand, explained 81% of the variation in assemblage composition (PERMANOVA, pseudo-$F = 11.04$, $p = 0.028$), against only 4% for station ($p = 0.861$). Mugil cephalus, Neochelon falcipinnis, Elops lacerta and other marine-associated species declined from May to July, as Brycinus spp., Hemichromis fasciatus and Chrysichthys nigrodigitatus became more common. In the early rainy season, then, the assemblage changed far more over time than across space, and monitoring of the reach should follow the seasonal cycle rather than add stations.

Keywords: *ichthyofauna; estuarine fish assemblage; temporal turnover; PERMANOVA; water quality; Niger Delta*

1. Introduction

Freshwater and estuarine fishes are in decline around the world. Habitat change, pollution, altered flows and overharvesting seldom act in isolation, and together they tend to do more damage, or at least less predictable damage, than any one of them would alone (Reid et al.,

2019; Dudgeon, 2019; Birk et al., 2020). Tidal rivers are caught in the middle of this. They connect freshwater catchments with the sea and provide nursery and feeding grounds for many species. In the tropics they also tend to flow through fast-growing settlements that depend on them for food and transport and use them to carry away waste (Elliott et al., 2007; Tickner et al., 2020). Not all fish use these rivers in the same way. Some species spend their whole life cycle in the estuary. Others come in from the sea, either as juveniles or to feed, and freshwater species move downstream when river flow increases (Elliott et al., 2007; Potter et al., 2015). The balance among these groups shifts with salinity, discharge and season, so the fish community of a tidal river can look quite different from one month to the next. Making sense of any single survey therefore means knowing when it was done, not only where.

The New Calabar River is a tidal blackwater river in the eastern Niger Delta. It begins as a freshwater stream near Elele-Alimini, runs south past Aluu, Choba and Ogbogoro, and grows steadily more brackish before it meets the Bonny estuary near Bakana (Dienye & Woke, 2015; Nwibani et al., 2025). People living along its banks fish in it and draw domestic water from it. It also receives effluents, abattoir waste and urban runoff, and dredging and sand mining disturb its bed (Imachrist et al., 2024; Nwibani et al., 2025). Heavy metals have been found in its water, sediment and fish (Davies & Ekperusi, 2021), and sand extraction from rivers is known to change bed habitat and turbidity in ways that matter to fish (Koehnken et al., 2020).

The fish of the New Calabar River have been studied before. Ibim et al. (2016) compared its upper and lower reaches, Dienye et al. (2018) recorded 26 species in cast-net catches, Olopade and Dienye (2018) looked at how cichlids were distributed, and Olopade et al. (2019) reported 28 species from 15 families caught in gill nets. Most of these studies relied on a single gear or focused on a single family, and few of them measured water quality at the same stations and on the same days as the fishing. No survey has yet been published for the Egbelu reach, which lies in the peri-urban corridor of Obio/Akpor Local Government Area.

We set out to do three things: (i) describe how physico-chemical conditions in the Egbelu reach varied between stations and between months in the early rainy season; (ii) document the species composition, abundance, family structure and diversity of the fish assemblage; and (iii) test whether the assemblage differed more among stations or among months. The answer to the third question has direct consequences for how the reach should be monitored.

2. Methodology

2.1. Study area

The work was done on the Egbelu reach of the New Calabar River in Obio/Akpor Local Government Area, Rivers State, Nigeria (Fig. 1). The climate is humid tropical. The rainy season is long, usually lasting from about March to October, and annual rainfall often exceeds 2,000 mm. The reach is tidal and oligohaline, and its banks are a mix of houses, small landing sites and secondary vegetation. We fixed three stations with a handheld GPS receiver so that together they covered the gradient of tidal influence and human activity along the reach: Station 1 (upstream; 4.8499° N, 6.9238° E), Station 2 (midstream; 4.8470° N, 6.9296° E) and Station 3 (downstream; 4.8438° N, 6.9355° E). Stations 1 and 2 were about 0.72 km apart and Stations 2 and 3 about 0.74 km apart, so the stations covered roughly 1.5 km of river.

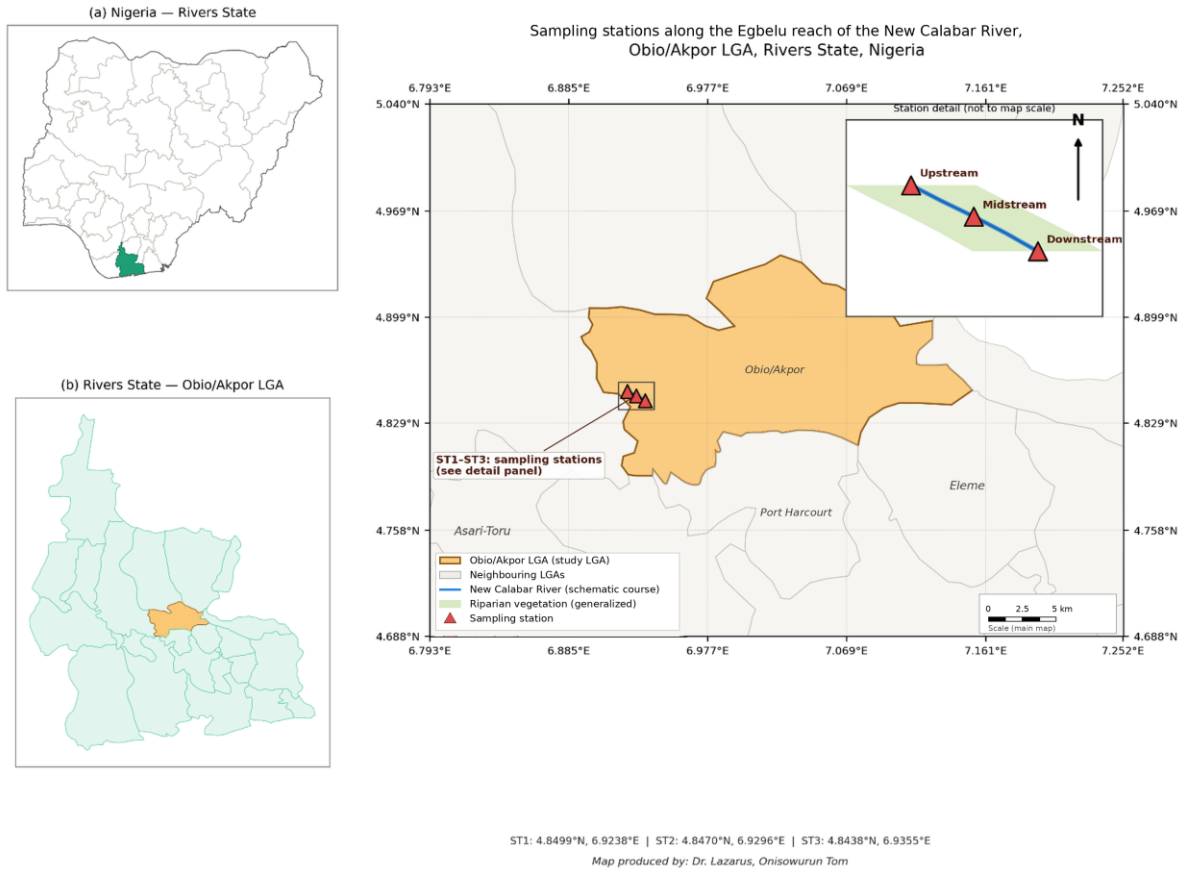


Fig. 1. Location of the study area: (a) Nigeria, showing Rivers State; (b) Rivers State, showing Obio/Akpor Local Government Area; (c) the Egbelu reach of the New Calabar River with sampling Stations 1–3 (ST1–ST3). The station detail panel is not drawn to the map scale.

2.2. Sampling design

We visited each station once a month for three months in a row (May, June and July 2026), a period that spans the early to middle rainy season. Water was sampled in triplicate on each visit and fish were caught on the same day, so each catch could be paired with water quality from the same place and time. The water quality data came from a single field campaign that also served companion studies of the plankton and benthic macroinvertebrates of the reach (Wala et al., in preparation). We report them in full here so that this paper stands on its own.

2.3. Physico-chemical analysis

Temperature, pH, dissolved oxygen (DO) and electrical conductivity (EC) were measured on site with a calibrated multi-parameter water quality meter (APHA, 2017). Salinity was read with a hand-held refractometer. Total dissolved solids (TDS) were taken from the conductivity meter and checked gravimetrically. Turbidity was measured with a nephelometric turbidimeter (APHA, 2017, Method 2130 B), and current velocity with a portable flow meter, with the float method used as a cross-check. Nitrate was determined by cadmium reduction (APHA, 2017, Method 4500-NO_3^- E) and phosphate by the ascorbic acid method (Murphy & Riley, 1962), and both were read on a UV–visible spectrophotometer. Five-day biochemical oxygen demand (BOD_5) was measured after incubation using the azide modification of the Winkler method (APHA, 2017).

2.4. Fish sampling and identification

Local artisanal fishers helped us sample with three gears that are in everyday use on the river (Bagenal, 1978). At each station we set two multi-mesh gill nets (each 30 m long and 2 m deep; 25–76 mm stretched mesh) in the late afternoon and lifted them the next morning after a soak of about 10 h. This gave 120 m^2 of net and a nominal gill-net effort of 1,200 m^2 h per station per visit. Cast nets (3–4 m diameter; 15–25 mm stretched mesh) were thrown 5–10 times at each station on each visit. Baited hook lines carried about 10–20 hooks (sizes 6–10) and were fished for about 2–4 h. Active fishing was done early in the morning (about 06:00–09:00) and late in the afternoon (about 16:00–18:00), and we recorded the effort for each gear at each station on every visit. Fish were sorted and counted in the field. Any specimen that could not be named with confidence was fixed in 10% formalin and checked in the laboratory. We identified fish using Idodo-Umeh (2003), Paugy et al. (2003), Olaosebikan and Raji (2013) and, for marine and estuarine taxa, Schneider (1990), and checked scientific names against FishBase (Froese & Pauly, 2024).

2.5. Data analysis

We tested differences in each physico-chemical variable among stations and among months with one-way analysis of variance (ANOVA). When the ANOVA was significant ($p < 0.05$), means were separated with Tukey's honestly significant difference test (Tukey, 1949). Some variables gave identical readings in every replicate and month at a station. Because their within-station variance was zero, we did not test them among stations.

For each station, catches from the three months were added together to give the total abundance (n) of each species. Percentage relative abundance was calculated as $\%RA = (n_i / N) \times 100$, where n_i is the number of individuals of species i and N is the total number of fish at that station or in the whole data set. Species were assigned to families following FishBase, and for each family we calculated the number of species, the number of individuals and its percentage share of the pooled catch. We described community structure at each station, and for the pooled catch, using species richness (S), the Shannon–Wiener index, $H' = -\Sigma\, p_i \ln p_i$ (Shannon & Weaver, 1949), Simpson's dominance index, $D = \Sigma\, p_i^2$, with its complement ($1 - D$) and reciprocal ($1/D$) (Simpson, 1949), Pielou's evenness, $J' = H'/\ln S$ (Pielou, 1966), and Margalef's richness, $d = (S - 1)/\ln N$ (Margalef, 1958). The same indices were worked out for each month from catches pooled across stations. Similarity in composition between stations was measured with the Bray–Curtis coefficient on untransformed abundances (Bray & Curtis, 1957). To look at dominance and diversity together, we drew rank–abundance (Whittaker) plots, ranking species from most to least abundant and plotting their abundance on a logarithmic scale (Whittaker, 1965). To find out whether station or month mattered more for assemblage composition, we ran a two-factor permutational multivariate analysis of variance (PERMANOVA; Anderson, 2001) on Bray–Curtis dissimilarities among the nine monthly station catches (Appendix Table A1). There was one catch per station and month, so the model was additive and the station × month interaction could not be estimated. Significance was assessed by exhaustive restricted permutation (216 permutations), with station labels permuted within months and month labels within stations. We repeated the analysis on square-root-transformed abundances to make sure the most abundant species were not driving the result. Univariate tests and diversity indices were run in PAST (Hammer et al., 2001) and R version 4.3 (R Core Team, 2023), and the PERMANOVA in Python 3 with NumPy and SciPy (Virtanen et al., 2020). We took $p < 0.05$ as significant.

2.6. Ethical statement

All fish came from the routine catches of licensed local artisanal fishers using gear they already use on the river, and no experimental procedures were carried out on live animals. Specimens

kept for identification were humanely euthanised before fixation. Because the study relied entirely on routine fishery catches, we did not seek separate approval from an institutional animal ethics committee.

3. Results

3.1. Physico-chemical conditions

Throughout the study the reach was warm, close to neutral and well oxygenated (Table 1). Temperature hardly differed among stations (27.67–27.77 °C; $p = 0.600$), but it rose from 27.50 °C in May to 28.00 °C in July ($p < 0.001$). July was warmer than both earlier months, and May and June did not differ from each other (Tukey HSD, $p = 0.055$). pH also increased over time, from 7.03 in May to 7.13 in July ($p = 0.001$); June fell in between and could not be separated from either month. pH was slightly higher at Station 2 (7.15) than at the other two stations (7.05). Salinity, EC and TDS differed significantly among stations ($p < 0.001$) but not among months. Salinity was lowest at Station 1 (0.45 ppt), highest at Station 2 (1.88 ppt) and intermediate at Station 3 (1.68 ppt). Conductivity and TDS followed the reverse pattern. Both were more than twice as high at Station 1 (9,700 µS cm^{-1} and 4,850 mg L^{-1}) as at Stations 2 and 3, which were similar to each other. Station 2 recorded the highest DO (6.80 mg L^{-1}), turbidity (18.00 NTU), current velocity (0.35 m s^{-1}), nitrate (0.90 mg L^{-1}), phosphate (0.25 mg L^{-1}) and BOD_5 (2.80 mg L^{-1}). Station 1 had the lowest value of each, and Station 3 fell in between. For these six variables the readings were identical in every replicate and month at a given station, so we report the station differences descriptively rather than testing them; their monthly means did not differ ($p = 1.000$). Monthly trends for all variables appear in Appendix Fig. A1

Table 1. Spatial (station) and temporal (month) variation in physio-chemical parameters of the Egbelu reach of the New Calabar River, May–July 2026.

Parameter	Station (spatial)				Month (temporal)			
	Station 1	Station 2	Station 3	*p*	May	June	July	*p*
Temperature (°C)	27.77 ± 0.22[a]	27.67 ± 0.25[a]	27.67 ± 0.25[a]	0.600	27.50 ± 0.00[a]	27.60 ± 0.15[a]	28.00 ± 0.00[b]	<0.001
Salinity (ppt)	0.45 ± 0.04[a]	1.88 ± 0.07[b]	1.68 ± 0.07[c]	<0.001	1.27 ± 0.66	1.35 ± 0.68	1.40 ± 0.68	0.914
pH	7.05 ± 0.04[a]	7.15 ± 0.04[b]	7.05 ± 0.04[a]	<0.001	7.03 ± 0.05[a]	7.08 ± 0.05[ab]	7.13 ± 0.05[b]	0.001
EC (µS cm^{-1})	9700 ± 173[a]	4133 ± 109[b]	4200 ± 87[b]	<0.001	5867 ± 2725	6017 ± 2763	6150 ± 2813	0.977
TDS (mg L^{-1})	4850 ± 87[a]	2063 ± 52[b]	2073 ± 22[b]	<0.001	2933 ± 1363	3007 ± 1383	3047 ± 1428	0.985
DO (mg L^{-1})	6.50 ± 0.00	6.80 ± 0.00	6.70 ± 0.00	n.t.	6.67 ± 0.13	6.67 ± 0.13	6.67 ± 0.13	1.000
Turbidity (NTU)	15.00 ± 0.00	18.00 ± 0.00	16.00 ± 0.00	n.t.	16.33 ± 1.32	16.33 ± 1.32	16.33 ± 1.32	1.000
Current velocity (m s^{-1})	0.30 ± 0.00	0.35 ± 0.00	0.32 ± 0.00	n.t.	0.32 ± 0.02	0.32 ± 0.02	0.32 ± 0.02	1.000
Nitrate (mg L^{-1})	0.80 ± 0.00	0.90 ± 0.00	0.85 ± 0.00	n.t.	0.85 ± 0.04	0.85 ± 0.04	0.85 ± 0.04	1.000
Phosphate (mg L^{-1})	0.20 ± 0.00	0.25 ± 0.00	0.22 ± 0.00	n.t.	0.22 ± 0.02	0.22 ± 0.02	0.22 ± 0.02	1.000
BOD_5 (mg L^{-1})	2.50 ± 0.00	2.80 ± 0.00	2.60 ± 0.00	n.t.	2.63 ± 0.13	2.63 ± 0.13	2.63 ± 0.13	1.000

Values are mean ± SD (n = 9 per station: three months × triplicate samples; n = 9 per month: three stations × triplicate samples). p values are from one-way ANOVA. Within the station columns and within the month columns, means sharing a superscript letter do not differ significantly (Tukey HSD, α = 0.05); monthly letters are shown only for the two variables with a significant monthly effect. n.t., not tested: readings were identical in every replicate and month at each station, so within-station variance was zero and a station ANOVA is undefined; these station values are reported descriptively. EC, electrical conductivity; TDS, total dissolved solids; DO, dissolved oxygen; BOD_5, five-day biochemical oxygen demand.

3.2. Composition and abundance

We caught 1,533 fish in all, from 20 species and 11 families (Table 2). The largest catch came from Station 1 (539 individuals), followed by Station 2 (522) and Station 3 (472). Cichlidae was both the richest and the most abundant family, with five species and 28.6% of all individuals. It was followed by Clupeidae (three species; 16.0%), Alestidae (three species; 11.4%) and Mugilidae (two species; 9.8%) (Fig. 2). Each of the other seven families had a single species, and between them they accounted for about a third of the catch.

Sarotherodon melanotheron was the most abundant species at every station, making up 11.5–13.6% of station catches and 12.5% of the total. Next came *Chrysichthys nigrodigitatus* (8.7%),

Sardinella maderensis (7.2%), *Mugil cephalus* (5.7%) and *Caranx hippos* (5.0%). No other species reached 5% of the total. Even the scarcest, *Brycinus macrolepidotus*, contributed 3.2% (49 individuals). Species ranked in much the same order at all three stations (Fig. 3).

Table 2. Abundance (*n*) and percentage relative abundance (%RA, in parentheses) of fish species at three stations on the Egbelu reach of the New Calabar River (May–July 2026 pooled).

Species	Family	Station 1	Station 2	Station 3	Total
Brycinus longipinnis	Alestidae	24 (4.45)	19 (3.64)	23 (4.87)	66 (4.31)
Brycinus macrolepidotus	Alestidae	19 (3.53)	17 (3.26)	13 (2.75)	49 (3.20)
Brycinus nurse	Alestidae	21 (3.90)	22 (4.21)	16 (3.39)	59 (3.85)
Caranx hippos	Carangidae	27 (5.01)	25 (4.79)	25 (5.30)	77 (5.02)
Coptodon dageti	Cichlidae	26 (4.82)	27 (5.17)	22 (4.66)	75 (4.89)
Coptodon guineensis	Cichlidae	22 (4.08)	22 (4.21)	24 (5.08)	68 (4.44)
Coptodon zillii	Cichlidae	20 (3.71)	22 (4.21)	13 (2.75)	55 (3.59)
Hemichromis fasciatus	Cichlidae	20 (3.71)	17 (3.26)	13 (2.75)	50 (3.26)
Sarotherodon melanotheron	Cichlidae	67 (12.43)	60 (11.49)	64 (13.56)	191 (12.46)
Chrysichthys nigrodigitatus	Claroteidae	47 (8.72)	49 (9.39)	38 (8.05)	134 (8.74)
Ethmalosa fimbriata	Clupeidae	27 (5.01)	25 (4.79)	24 (5.08)	76 (4.96)
Ilisha africana	Clupeidae	23 (4.27)	17 (3.26)	19 (4.03)	59 (3.85)
Sardinella maderensis	Clupeidae	38 (7.05)	39 (7.47)	33 (6.99)	110 (7.18)
Bostrychus africanus	Eleotridae	20 (3.71)	22 (4.21)	20 (4.24)	62 (4.04)
Elops lacerta	Elopidae	21 (3.90)	25 (4.79)	18 (3.81)	64 (4.17)
Lutjanus agennes	Lutjanidae	21 (3.90)	22 (4.21)	21 (4.45)	64 (4.17)
Monodactylus sebae	Monodactylidae	22 (4.08)	18 (3.45)	19 (4.03)	59 (3.85)
Mugil cephalus	Mugilidae	33 (6.12)	28 (5.36)	26 (5.51)	87 (5.68)
Neochelon falcipinnis	Mugilidae	23 (4.27)	22 (4.21)	18 (3.81)	63 (4.11)
Pseudotolithus elongatus	Sciaenidae	18 (3.34)	24 (4.60)	23 (4.87)	65 (4.24)
Total (N)		**539**	**522**	**472**	**1533**

Station percentages are relative to the station total; the final column is relative to the grand total ($N = 1{,}533$). *Neochelon falcipinnis* (syn. *Liza falcipinnis*). Monthly catches by station are given in Appendix Table A1.

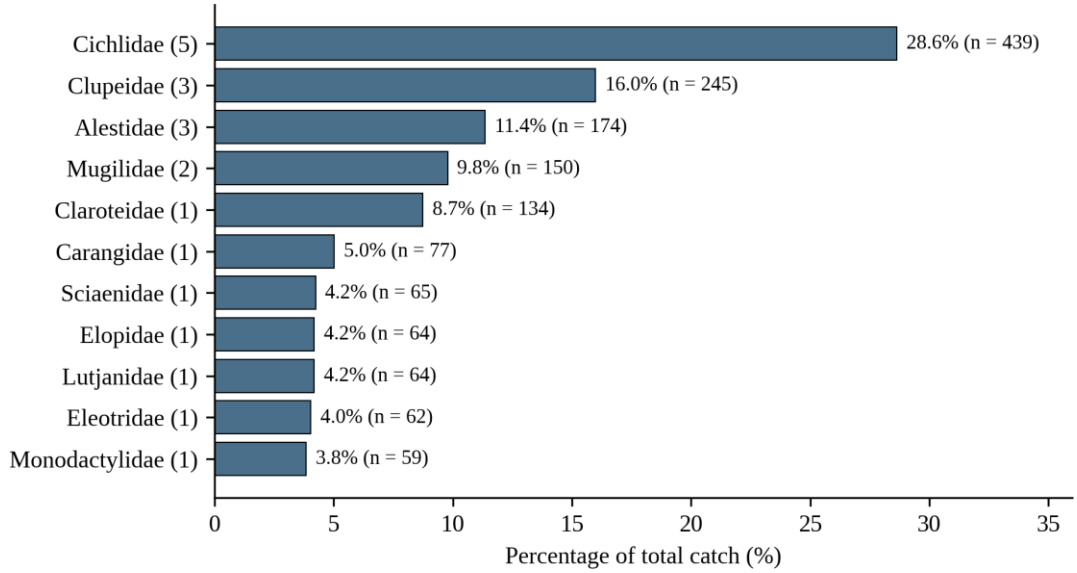


Fig. 2. Family composition of the fish catch (Stations 1–3 and May–July pooled). Numbers in parentheses after family names are the number of species; bar labels give the percentage of the total catch and the number of individuals.

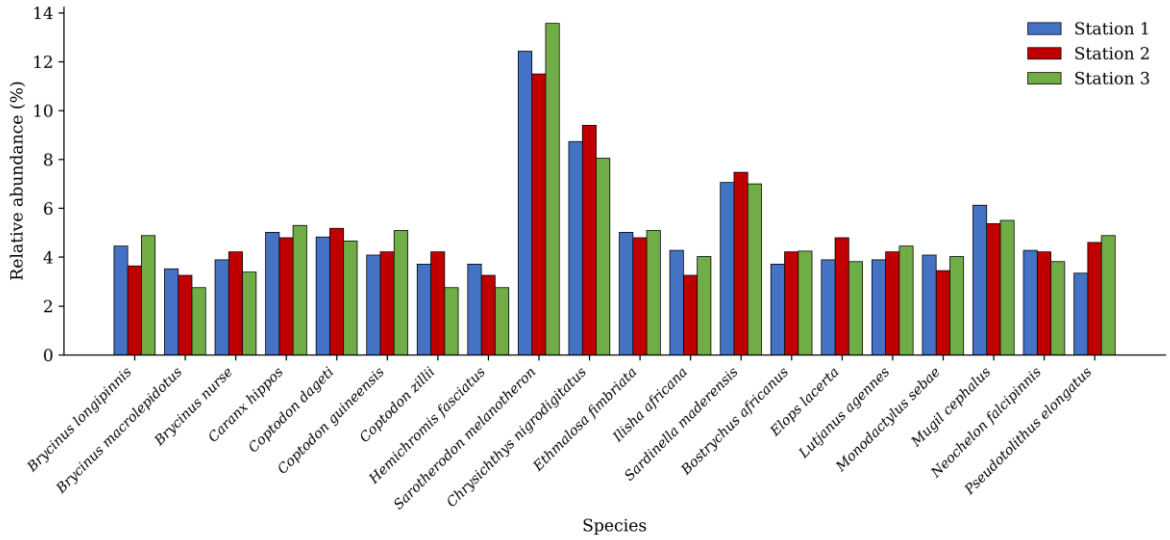


Fig. 3. Percentage relative abundance of fish species at the three sampling stations on the Egbelu reach of the New Calabar River.

3.3. Diversity and similarity among stations

All 20 species were caught at each station, so richness did not vary (Table 3). Diversity and evenness were high and practically the same at every station: H′ ranged from 2.907 to 2.925, J′ from 0.970 to 0.976 and Simpson's 1 − *D* from 0.939 to 0.941. Station 3 had the lowest H′ and J′ and the highest dominance (*D* = 0.061), although its slightly smaller catch gave it the highest Margalef richness (*d* = 3.086). Bray–Curtis similarity was 94.6% between Stations 1 and 2, 92.4% between Stations 2 and 3, and 92.0% between Stations 1 and 3. In other words, the three stations held almost the same assemblage.

Rank–abundance curves were shallow at all three stations (Fig. 4). After the leading species, *S. melanotheron*, abundance fell off gradually from rank to rank without any sharp break, which is what one would expect when no single species dominates the catch. At Station 3 the tail of

the curve dropped a little more steeply, because several species there were represented by fewer than 20 individuals.

Table 3. Community diversity indices of the fish assemblage at three stations on the Egbelu reach of the New Calabar River.

Index	Station 1	Station 2	Station 3	Pooled
Number of species (*S*)	20	20	20	20
Number of individuals (*N*)	539	522	472	1533
Shannon–Wiener (H′)	2.922	2.925	2.907	2.922
Simpson's dominance (*D*)	0.059	0.059	0.061	0.059
Simpson's diversity (1 − *D*)	0.941	0.941	0.939	0.941
Simpson's reciprocal (1/*D*)	16.915	17.092	16.384	16.905
Pielou's evenness (J′)	0.976	0.976	0.970	0.975
Margalef's richness (*d*)	3.021	3.036	3.086	2.590

H′ was computed with natural logarithms. Pooled values are for all stations and months combined.

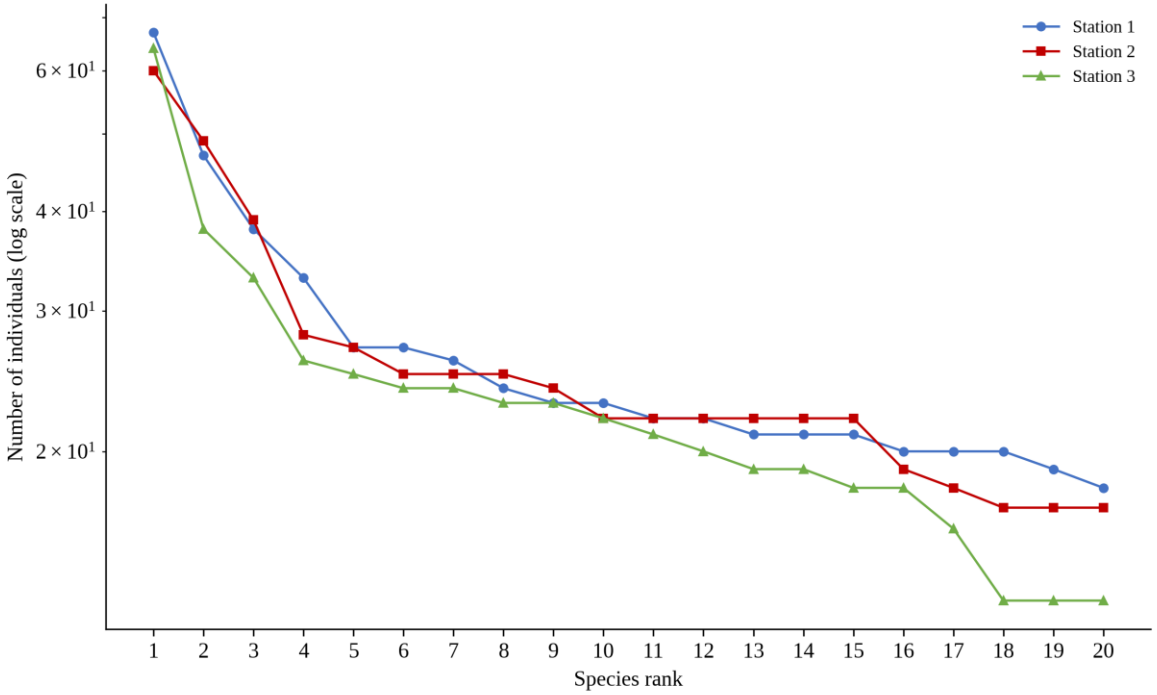


Fig. 4. Rank–abundance (Whittaker) plots of the fish assemblage at each sampling station. Species are ranked from most to least abundant; abundance is shown on a logarithmic scale.

3.4. Monthly change in the assemblage

The picture over time was very different. The assemblage changed markedly from one month to the next (Fig. 5; Appendix Table A1). Sampling month accounted for 81.0% of the total variation in Bray–Curtis dissimilarity (PERMANOVA, pseudo-$F_{2,4}$ = 11.04, p = 0.028), whereas station accounted for just 4.3% (pseudo-$F_{2,4}$ = 0.59, p = 0.861). Square-root-transformed abundances gave the same result (month R^2 = 0.82, p = 0.028; station R^2 = 0.04, p = 0.861). The total catch went up from 510 fish in May to 551 in June and then dropped to 472 in July. Diversity was highest in June (H′ = 2.914; J′ = 0.973) and lower in May (2.806; 0.937) and July (2.813; 0.939), when a handful of species took a bigger share of the catch.

Which species dominated was not the same at the start and the end of the study. In May the catch was led by *S. melanotheron* (84 individuals) and *M. cephalus* (53), and *Sardinella maderensis*, *Elops lacerta* and other estuarine and marine-associated species were well represented. By July, *M. cephalus* had dropped to 7 individuals, *Neochelon falcipinnis* from 27 to 6, *E. lacerta* from 31 to 9, *Monodactylus sebae* from 23 to 8 and *Pseudotolithus elongatus* from 28 to 11. Over the same months *Hemichromis fasciatus* rose from 6 to 35 individuals, *Brycinus macrolepidotus* from 10 to 30, *Brycinus nurse* from 13 to 32 and *C. nigrodigitatus* from 33 to 60, which made it the most abundant species in July. *Coptodon dageti* and *C. guineensis* increased sharply between May and June and remained high in July. A few species, among them *Ethmalosa fimbriata*, *Coptodon zillii* and *Brycinus longipinnis*, changed very little.

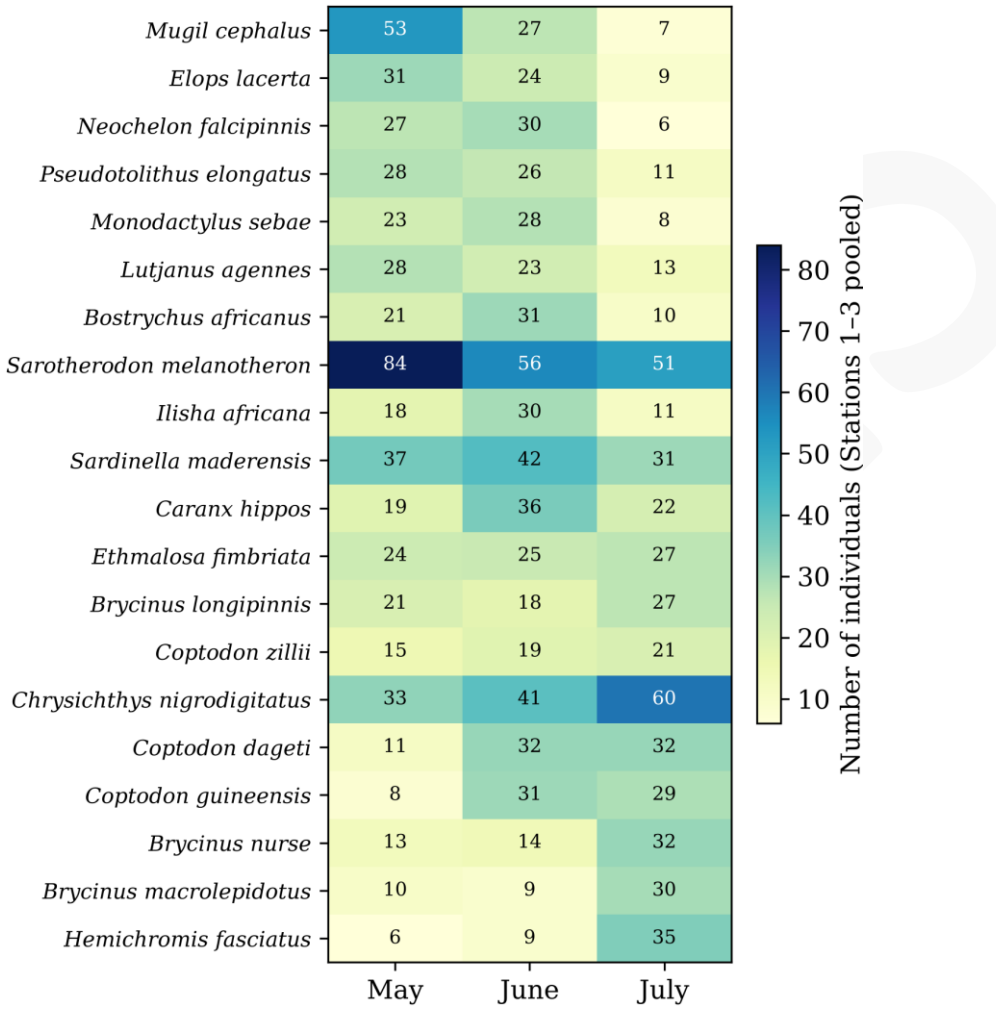


Fig. 5. Monthly catch of each fish species (Stations 1–3 pooled), May–July 2026. Species are ordered from those that declined most strongly over the study (top) to those that increased most (bottom).

4. Discussion

4.1. Water quality setting

During the early rainy season, conditions on the Egbelu reach were good for fish. Dissolved oxygen stayed between 6.50 and 6.80 mg L^{-1} and BOD_5 remained below 3 mg L^{-1}, which suggests the water was well aerated and carried only a modest organic load. These oxygen levels are higher than the 3.91–4.53 mg L^{-1} that Nwibani et al. (2025) reported for the Choba–

Ogbogoro stretch of the same river, and they sit at the top of the 3.8–6.8 mg L^{-1} range that Imachrist et al. (2024) recorded around Ogbogoro. Nitrate (0.80–0.90 mg L^{-1}) and phosphate (0.20–0.25 mg L^{-1}) were likewise lower than the 1.62–3.62 and 0.36–0.58 mg L^{-1} reported upstream by Nwibani et al. (2025). Some of this difference may come from season, station placement or method, but our data give no sign of acute nutrient enrichment in this reach during the study. All three stations were oligohaline, well below the 5–8 salinity band that Telesh and Khlebovich (2010) describe as a critical transition for estuarine biota. A reach like this can be used both by freshwater fishes and by euryhaline marine species, which matches the mixed assemblage we found. Less easy to explain is why Station 1 combined the lowest salinity with the highest conductivity. In estuaries, conductivity rises mainly with sea salts, so a station that is fresher yet more conductive points to an extra, non-marine source of dissolved ions nearby, such as effluent, leachate or groundwater seepage. Measurement limits may also play a part. Salinities below about 2 are close to the resolution of hand-held refractometers, whereas a conductivity of 9,700 µS cm^{-1} would equal a practical salinity of about 5 if it came from sea salts alone. Settling the question would need data on ionic composition and conductivity-based salinity, and it deserves attention in future work on the reach. Imachrist et al. (2024) reported conductivity values of a similar order near Ogbogoro and attributed the poorer conditions there partly to dredging.

4.2. Assemblage composition

The 20 species we recorded are a subset of those known from the wider river. Olopade et al. (2019) found 28 species in 15 families in gill-net catches over six months, and Dienye et al. (2018) recorded 26 species in 11 families from cast nets. The simplest explanation for our lower richness is that we sampled for a shorter time and caught fewer fish. Even so, the families that dominated our catch are the same ones that dominate earlier surveys. Cichlidae was the richest family both in Olopade et al. (2019) and in our study, and Alestidae, Clupeidae and Mugilidae each had two or three species in both. That *S. melanotheron* led the catch fits what is known of this euryhaline tilapia, which is common in West African lagoons and brackish rivers and copes with a wide range of salinity (Paugy et al., 2003). Olopade and Dienye (2018), however, found *Coptodon guineensis* to be the most abundant cichlid in the New Calabar River, and *M. cephalus* has been reported as the dominant species in landings from the nearby Bonny River (Olopade et al., 2017). Differences of this kind are to be expected when, as here, several species have similar abundances, because a small change in timing, gear or station placement can alter which one comes first.

4.3. Spatial uniformity and what it mean

What stands out most in the spatial data is how little the assemblage changed from station to station. Every species occurred everywhere, Bray–Curtis similarity was above 92%, and the diversity indices differed only in the second decimal place. Several things probably explain this. The stations are within 1.5 km of one another on a reach that the tide mixes twice a day, and most of the species we caught are mobile. Pooling three gears and three months at each station also evens out differences that a single gear or visit might pick up, and it makes it more likely that every species will be recorded at every station. Within the range we observed, then, the clear station differences in salinity and conductivity left no detectable mark on the fish assemblage. High evenness is not automatically a sign of a healthy system. Transitional waters are naturally variable and the organisms living in them are adapted to stress, so community indices often change little even when human pressure is real (Elliott & Quintino, 2007). Diversity indices also squeeze a lot of information into one number and may not register when one species replaces another (Magurran, 2004). Our monthly results show this clearly: H′

moved by only about 0.1 between months, yet the identity of the dominant species changed considerably.

4.4. Temporal turnover through the early rainy season

The clearest ecological signal in the data is the fall in mullets, ladyfish, croaker, moony and snapper between May and July, alongside the rise in alestids, cichlids and the silver catfish. Month was the only factor that explained a significant share of the variation in composition. Most of the species that declined are estuarine or marine-associated fishes that use tidal rivers for feeding and as nurseries, while most of those that increased are freshwater or freshwater-affiliated species (Paugy et al., 2003; Potter et al., 2015). This is what one would expect as freshwater discharge builds through the rainy season. Stronger flows can carry freshwater species downstream and push marine-associated species towards the sea. In many tropical rivers the flood period is also when freshwater fishes spawn and their young recruit (Junk et al., 1989), so the sharp rise in *H. fasciatus* and *Brycinus* spp. in July may reflect recruitment as well as movement. Surface salinity did not change significantly between months, so salinity measured at the surface during daytime sampling cannot explain the turnover on its own. Discharge, tidal phase, bottom salinity and food supply may matter more, and we measured none of them. Still, the pattern is clear enough to carry a practical lesson. A survey of this reach done in May would describe a noticeably different fish community from one done in July, and any comparison over time or between rivers has to allow for that.

4.5. Limitations and management implications

The study covered only three months of one rainy season, so it says nothing about dry-season conditions or differences between years. With a single catch per station and month, the PERMANOVA could not test the station × month interaction and relied on a limited number of distinct permutations, so its result should be taken as indicative rather than conclusive. Catch per unit effort was not standardised across gears, which makes it harder to compare our abundances with those of other studies. We also did not record length and weight, so size structure and condition could not be assessed. Olopade et al. (2019) found that gill nets in this river catch mostly small fish and recommended a minimum mesh of 25 mm, and size data would let our catches be checked against that recommendation. Within these limits, the results give the first baseline for the Egbelu reach and show that its fish assemblage is diverse and supports both freshwater and marine-associated species. For management, they make a case for year-round monitoring with standardised effort, for adding length–frequency data, and for treating the reach as a seasonal corridor for mullets and other marine-associated species. Dredging, sand mining and effluent discharges have already been documented elsewhere on the river (Davies & Ekperusi, 2021; Imachrist et al., 2024; Nwibani et al., 2025). Against that background, protecting the habitat that makes this seasonal exchange possible is likely to do more for the fishery than managing any single station.

5. Conclusion

In the early rainy season of 2026, the Egbelu reach of the New Calabar River held a diverse and even fish assemblage of 20 species from 11 families, dominated by cichlids and led by *Sarotherodon melanotheron*. Although salinity and conductivity differed among stations, the assemblage was almost identical at all three. Change over time was far stronger. Month explained 81% of the variation in composition, as estuarine and marine-associated species declined from May to July and freshwater-affiliated species increased. Monitoring of this reach should therefore cover the full seasonal cycle, use standardised effort and include size data, so that human impacts can be told apart from the river's natural rhythm.

Declarations

Author contributions. All authors contributed to the conception and design of the study, field sampling, laboratory work, data analysis and preparation of the manuscript. All authors read and approved the final version.

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Data availability. The data supporting this study are available from the corresponding author on reasonable request.

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Appendix

Table A1. Monthly catch (number of individuals) of fish species at three stations on the Egbelu reach of the New Calabar River, May–July 2026.

Species	May			June			July		
	St 1	St 2	St 3	St 1	St 2	St 3	St 1	St 2	St 3
Brycinus longipinnis	7	6	8	7	5	6	10	8	9
Brycinus macrolepidotus	3	4	3	4	3	2	12	10	8
Brycinus nurse	6	4	3	5	6	3	10	12	10
Caranx hippos	8	7	4	12	10	14	7	8	7
Coptodon dageti	3	5	3	13	12	7	10	10	12
Coptodon guineensis	3	3	2	9	10	12	10	9	10
Coptodon zillii	5	7	3	8	9	2	7	6	8
Hemichromis fasciatus	1	3	2	3	4	2	16	10	9
Sarotherodon melanotheron	22	30	32	23	15	18	22	15	14
Chrysichthys nigrodigitatus	10	15	8	15	14	12	22	20	18
Ethmalosa fimbriata	8	9	7	9	7	9	10	9	8
Ilisha africana	7	6	5	12	8	10	4	3	4
Sardinella maderensis	11	12	14	15	17	10	12	10	9
Bostrychus africanus	5	7	9	10	12	9	5	3	2
Elops lacerta	10	12	9	8	9	7	3	4	2
Lutjanus agennes	7	9	12	10	7	6	4	6	3
Monodactylus sebae	9	8	6	10	8	10	3	2	3
Mugil cephalus	20	18	15	10	8	9	3	2	2
Neochelon falcipinnis	12	8	7	8	12	10	3	2	1
Pseudotolithus elongatus	6	10	12	7	10	9	5	4	2
Total	**163**	**183**	**164**	**198**	**186**	**167**	**178**	**153**	**141**

St, station.

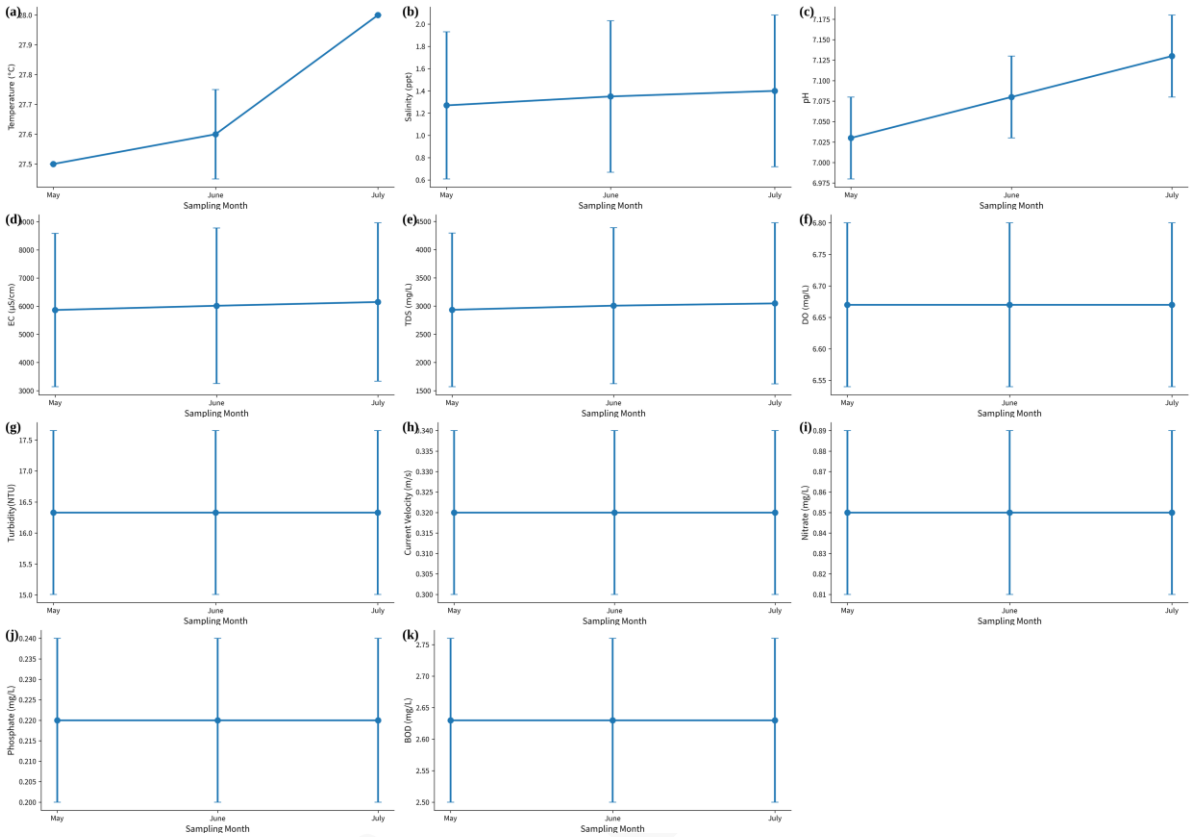


Fig. A1. Monthly variation (mean ± SD across stations) in (a) temperature, (b) salinity, (c) pH, (d) electrical conductivity, (e) total dissolved solids, (f) dissolved oxygen, (g) turbidity, (h) current velocity, (i) nitrate, (j) phosphate and (k) BOD_5 in the Egbelu reach of the New Calabar River, May–July 2026.