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ORIGINAL ARTICLE

Assessment of Fishing Gear Acceptability, Capture Efficiency, and Species Diversity Among Artisanal Fishers in River Benue, Taraba State, Nigeria

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ABSTRACT

This study assessed the relationships between fishing gear acceptability, capture efficiency, and fish species diversity among artisanal fishers in River Benue, Taraba State, Nigeria. Data were collected over twelve months (January–December 2024) from 150 fishers across five landing sites using structured questionnaires, experimental gear trials, and fish sampling. Seven gear types were identified. Gillnets (mean acceptability: 4.4 ± 0.5 on a 5-point scale; CPUE: 7.1 ± 1.4 kg/100m net/12h) and cast nets (4.1 ± 0.7; CPUE: 5.3 ± 1.1 kg/set) were both the most acceptable and most efficient gears. Drag nets recorded the lowest acceptability (1.9 ± 0.8) and the lowest CPUE (2.4 ± 0.7 kg/haul), suggesting a convergence of social and ecological undesirability. A total of 27 fish species from 16 families were recorded. Shannon-Wiener diversity ranged from 2.28 to 3.41 and was significantly higher in the wet season ($p < 0.05$). Dissolved oxygen ($r = 0.76$, $p < 0.01$), turbidity ($r = -0.63$, $p < 0.05$), and water level ($r = 0.71$, $p < 0.01$) were the strongest environmental predictors of diversity. These findings support the enforcement of ≥ 3-inch mesh regulations, seasonal closures during the peak wet spawning months (June–August), and community-led co-management of high-efficiency but destructive gears.

Keywords: Gear selectivity; Small-scale fisheries; Species richness; River Benue basin, Nigeria.

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1.0 INTRODUCTION

Inland artisanal fisheries constitute a vital component of food systems and rural livelihoods in sub-Saharan Africa, providing direct employment to millions of people and serving as the primary source of animal protein for many riverine and lacustrine communities (FAO, 2020; Hara et al., 2021). In Nigeria, inland fisheries contribute approximately 40% of total domestic fish production, with artisanal fishers operating along major river systems including the Niger, Benue, Sokoto, and Kaduna rivers (Federal Department of Fisheries, 2007; Awolumate & Fregene, 2025). River Benue, as the largest tributary of the Niger River and the second longest river in Nigeria, supports extensive artisanal fishing communities across Taraba, Benue, Kogi, and Anambra states (Bonjoru et al., 2019). These communities depend on a heterogeneous mix of traditional and modern fishing gears, deployed across varying hydrological conditions, to sustain year-round catches. This diversity of gear use is not incidental: it reflects decades of local adaptation to River Benue's seasonal flow regime, target species, and household economics. It is also, however, the central management challenge. Overfishing, the simultaneous deployment of gear types with markedly different selectivity profiles, and habitat degradation linked to sedimentation and flow alteration are widely recognised threats to inland fisheries sustainability in the sub-region (FAO, 2020). Because these gear types differ in the species and size classes they capture, in their ecological impact, and in the degree to which fishing communities accept and continue to use them, understanding gear acceptability alongside each gear's capture efficiency and its effect on fish assemblages is essential to designing management interventions that communities will actually adopt rather than resist. Fishing gear acceptability is a socio-technical concept encompassing community perceptions of gear effectiveness, affordability, cultural appropriateness, ease of operation, and environmental impact (Delaney et al., 2023). High acceptability is a strong predictor of a gear type's continued and expanding use, and therefore of its cumulative effect on fish stocks and biodiversity, a relationship long established in gear-selectivity research (Valdemarsen & Suuronen, 2003; Jennings & Revill, 2007). Conversely, low acceptability, particularly where it stems from ecological or safety concerns, can signal a community's openness to more sustainable alternatives, provided appropriate incentive structures and governance support are in place (Okafor-Yarwood et al., 2022). Fishing productivity, measured as Catch Per Unit Effort (CPUE), remains the standard metric for comparing gear performance and tracking temporal trends in fish stock abundance, following standardization procedures that adjust for variation in fishing power, season, and gear type (Maunder & Punt, 2004; Zeller et al., 2021). Declining CPUE across successive periods is a primary indicator of overexploitation, while spatial and seasonal variability in CPUE can reveal important information about habitat use, migration patterns, and spawning aggregations of target species (Kaplan et al., 2014; Owiredu et al., 2024). Alongside CPUE, fish species diversity is a critical ecological parameter reflecting the health and resilience of aquatic ecosystems: higher diversity is generally associated with functional

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redundancy, trophic stability, and sustained fisheries productivity over time (Welcomme, 2011). Because gear selectivity determines which species and size classes are removed from an assemblage, the mix of gear types in active use in River Benue has direct consequences for the diversity structure of the fishery linking gear acceptability and CPUE performance to a genuinely ecological outcome, and not only an economic one. Existing research on Nigerian artisanal fisheries has tended to address isolated dimensions of the sector rather than integrating them into a single, comprehensive assessment. On the gear and efficiency front, Bonjoru et al. (2019) identified the dominant artisanal gears in use and quantified gear-specific catch-per-unit-effort (CPUE), establishing a useful baseline for understanding fishing effort. Bonjoru et al. (2023) subsequently extended this work by examining the relationship between gear type and CPUE specifically within the Upper Benue River Basin, offering a more localized, gear-focused analysis. On the biological side, Ndeham et al. (2019) approached the fishery from a catch-composition perspective, documenting 32 fish species across 16 families, but did not extend this into a fuller assessment of species diversity indices. Taken together, these studies point to a consistent pattern: gear-efficiency research has progressed considerably, while species diversity has so far been described only at the level of composition, without deeper diversity analysis. This imbalance forms the basis for the present study. Evidence from elsewhere in Africa reinforces the need to close this gap, Njaya et al. (2012) demonstrated that integrating gear-level analysis with co-management outcomes is valuable for designing interventions that communities can sustain over time, underscoring the broader point that fragmented, single-dimension studies are insufficient for evidence-based fisheries management. Such fragmentation limits managers' ability to design interventions that are simultaneously biologically sound, economically viable, and socially acceptable.

This study addresses that gap by undertaking a holistic assessment of fishing gear acceptability, capture efficiency, and fish species diversity in River Benue, Taraba State. Specifically, it seeks to answer: Which fishing gear types are most acceptable to artisanal fishers in River Benue, and what factors underlie this acceptability? How does capture efficiency (CPUE) vary across gear types and seasons? And what is the relationship between fishing gear type and use pattern and fish species diversity in River Benue? By linking these three dimensions within a single study, this research aims to provide an evidence base for fisheries management that is responsive to both ecological sustainability and community practice in River Benue, Taraba State.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted along selected tributaries and stretches of River Benue in Taraba State, Nigeria, covering five fishing communities: Lau, Mayo Ranewo, Kwentan/Sendirde, Tella and Ibi. These communities represent a cross-section of riverine fishing settlements distributed between latitudes 7°50'N and 9°20'N and longitudes 10°45'E and 11°35'E. River Benue in this section is characterised by a broad floodplain, seasonal inundation, and diverse aquatic habitats, including the main channel, backwaters, and inundated floodplains. The river experiences two hydrological seasons: the wet (flood) season from May to October and the dry season from November to April. The riparian zone supports a mixture of gallery forest, freshwater marsh, and agricultural land.

2.2 Sampling design and data collection

A multi-stage sampling approach was employed. In the first stage, five fishing communities were purposively selected based on their fishing activity levels, accessibility, and geographic spread along the Taraba State section of River Benue. In the second stage, 30 artisanal fishers were randomly selected from each community, giving a total sample of 150 respondents. Structured questionnaires were administered through face-to-face interviews by trained enumerators fluent in English and the local Hausa and Jukun languages. Questionnaires captured socio-demographic information, gear types used, fishing frequency, fishing duration, perceptions of gear acceptability, and self-reported catch estimates.

2.3 Ethical approval

Ethical approval for the study was obtained from College of Education Zing **Ethics/Research Committee**. Written or verbal informed consent (as appropriate to respondents' literacy) was obtained from all participating fishers before questionnaire administration, and participants were informed of their right to withdraw at any time without penalty. Confidentiality of respondent identity was maintained throughout data collection, storage, and reporting.

2.4 Gear acceptability assessment

Fishing gear acceptability was assessed using a five-point Likert scale instrument adapted from Nwosu and Holzlöhner (2006). The original instrument was modified to reflect gear types commonly used within the study area (including cast nets, gill nets, traps, and hook-and-line), and item wording was simplified into clear, non-technical language to aid comprehension among respondents with varying literacy levels. Where necessary, items were translated into Hausa and Jukun to accommodate local fishers, and back-translation into English was carried out by an independent bilingual reviewer to verify that the meaning of each item was preserved. The adapted instrument was pilot-tested on 20 fishers drawn from communities not included in the main survey, and feedback from the pilot was used to refine ambiguous or culturally inappropriate items before full administration. Internal consistency of the scale was assessed using Cronbach's alpha ($\alpha = 0.81$), indicating good reliability. Each gear type was rated by fishers against six criteria: (1) cost and affordability, (2) ease of operation and maintenance, (3) volume of catch obtained, (4) cultural relevance and tradition, (5) selectivity and avoidance of juvenile capture, and (6) perceived environmental impact. Mean acceptability scores and standard deviations were computed for each gear type. Because acceptability was rated by the same 30 fishers per community across multiple gear types, scores were compared using a two-way ANOVA with gear type and community as fixed factors, treating respondent as a repeated-measures unit; where interaction effects were significant, gear-type comparisons were performed separately within each community. A mean score of 4.0–5.0 was classified as 'highly acceptable', 3.0–3.9 as 'acceptable', 2.0–2.9 as 'moderately acceptable', and below 2.0 as 'unacceptable'.

2.5 Experimental fishing and CPUE determination

Experimental fishing trials were conducted monthly over the twelve-month study period at each community, using seven gear types: Gillnet, Cast Net, Hook and Line, Fish Trap, Lift Net, Clap Net, and Drag Net. Effort was standardised within each gear type as shown in Table 1, with catch-per-unit-effort (CPUE) expressed on the gear-specific effort unit indicated. Because effort is not equivalent across gear types, absolute CPUE values are not directly comparable between gears in kg terms. Each gear's CPUE was therefore calculated on its own gear-appropriate effort unit (Table 1), and cross-gear CPUE comparisons (Section 2.7) are interpreted as comparisons of relative catch performance within each gear's own standardised effort, not as a common efficiency metric. Where a single normalised comparison across gears was required, catch was additionally expressed as kilograms per fisher-h of active fishing time, to allow an approximate cross-gear comparison. All captured fish were weighed to the nearest 0.1 g using a digital balance (Camry EK5350). Experimental fishing was conducted under a permit from the Taraba State Ministry of Agriculture/Fisheries Department, and participating fishers were compensated with the retained catch from experimental hauls plus a fixed stipend of NGN 2,000 per trial for their participation in gear trials. CPUE was calculated separately for each season, site, and gear type.

Table **1**. Standardised fishing effort and CPUE units by gear type

Gear type	Standardised effort	CPUE unit
Gillnet	100 m net length, 12-h overnight soak	kg / 100 m / 12 h
Cast Net	50 standardised hauls per trial	kg / haul
Longline	One angler fishing for 8 h per day	kg / angler / 8-h day
Malian Trap	10 traps deployed for 24 h per trial	kg / trap / 24 h
Lift Net	10 lifts per session at 30-minute intervals	kg / lift
Clap Net	10 encirclements per trial	kg / encirclement
Drag Net	10 drags over a fixed 50 m stretch per trial	kg / drag / 50 m

2.6 Fish species identification and diversity indices

All fish captured during experimental trials and at landing sites were identified to species level using standard taxonomic keys (Reed et al., 1967; Paugy et al., 2003; Skelton, 2001). Morphological measurements (total length and body weight) were recorded for each specimen. Species richness and species diversity were quantified using the following indices:

2.6.1 H' - Shannon-Wiener diversity index

$$H' = \sum_{i=1}^{s} p_i \cdot \log_2 p_i \quad (1)$$

Where; S - species richness (number of species),
p_i - proportion of species *i*

2.6.2 D - Simpson's index

$$D = \sum_{i=1}^{s} p_i^2 \quad (2)$$

Where; S - species richness,
p_i - proportion of species *i*

2.6.3 1-D - Simpson's diversity index

$$1\text{-}D = 1 - \sum\left(\frac{n}{N}\right)^2 \quad (3)$$

Where; **n** = The number of individuals of a single species.
N = The total number of all individuals in the sample.
∑ = Sum of all

2.6.4 J – Evenness Index

$$J = \frac{H'}{H_{max}} \quad (4)$$

2.6.5 D_{Ma} - Margalef diversity index

$$D_{Ma} = \frac{S-1}{\ln N} \quad (5)$$

Where; *S* - species richness
N - total abundance

All indices were computed in R (vegan package). Given the relatively low total species count (27 species across 16 families), rarefaction (individual-based) and Chao1 coverage estimation were used to assess whether sampling effort adequately captured species richness at each site, and rarefied richness is reported alongside raw counts where sample sizes differed across sites.

2.6 Environmental parameter measurement

Monthly measurements of physico-chemical parameters were taken at each study site between 07:00 and 09:00 h to minimise diurnal variation. All field measurements were performed in triplicate and mean values recorded. Parameters, instruments, and methods used were as follows;

Parameter	Instrument / method
Water temperature (°C)	Digital thermometer probe
pH	Handheld digital pH meter (HI98128)
Dissolved oxygen (mg/L)	DO meter (Hanna HI9146)
Turbidity (NTU)	Portable turbidimeter (Hanna HI93414)
Electrical conductivity (µS/cm)	Handheld conductivity meter (Hanna HI98312)
Total dissolved solids (mg/L)	TDS meter (Hanna HI98312)
Water depth (m)	Calibrated graduated pole
Current velocity (m/s)	Float method (timed float over fixed distance)

2.7 Statistical analysis

Quantitative data were analysed using IBM SPSS Statistics version 26.0, R, and Microsoft Excel. Descriptive statistics (mean, standard deviation, frequency, percentage) were computed for all variables. One-way ANOVA was used to compare CPUE across gear types and between seasons, with Tukey's HSD post-hoc test for pairwise comparisons; gear-acceptability scores were analysed using the two-way/repeated-measures approach described in Section 2.3. Pearson's product-moment correlation coefficient was used to assess relationships between the eight environmental parameters and the four diversity indices, and between environmental parameters and CPUE; given the resulting 32 pairwise comparisons, a false discovery rate (Benjamini–Hochberg) correction was applied to control for multiple testing, and only correlations significant after correction are reported as significant in the Results. Independent samples t-tests were used to compare dry- and wet-season values. Regression analysis was performed to identify the best environmental predictors of species diversity. Statistical significance was accepted at $p < 0.05$ (after correction, where applicable).

3. RESULTS

3.1 Socio-demographic profile of artisanal fishers

A total of 150 artisanal fishers were sampled across five communities along the River Benue, Lau, Mayo Ranewo, Kwentan/Sendirde, Tella, and Ibi, purposively selected to reflect documented fishing activity, site accessibility, and representation of both mainstream and floodplain fishing grounds. The sample size was determined using Yamane's formula, with n = 150 reflecting the estimated active fisher population across the five sites. Respondents were predominantly male (91.3%, n = 137), with females accounting for 8.7% (n = 13). Age distribution skewed toward experienced adults: 38.7% were aged 31–45 years, 30.0% were above 45 years, 22.0% were aged 18–30 years, and 9.3% were below 18 years. Mean fishing experience was 16.3 ± 9.4 years, consistent with a workforce dominated by long-term, career fishers. Fishing was the primary occupation for the majority of respondents (81.3%), and most (72.0%) belonged to a fishing cooperative or community fishing group. Educational attainment was generally low, with 48.7% having only primary education, 30.0% secondary education, 9.3% tertiary education, and 12.0% no formal education.

Demographic characteristics were compared across the five communities. Categorical variables (gender, primary occupation status, cooperative membership, and education category) were tested using chi-square tests of independence, while continuous variables (age and years of fishing experience) were compared using one-way ANOVA. Demographic profiles were broadly similar across communities: Gender composition did not differ significantly across communities ($\chi^2 = 0.76$, df = 4, $p = 0.944$); Primary occupation status did not differ significantly across communities ($\chi^2 = 2.37$, df = 4, $p = 0.669$); Cooperative/group membership did not differ significantly across communities ($\chi^2 = 1.99$, df = 4, $p = 0.738$); Education category did not differ significantly across communities ($\chi^2 = 13.54$, df = 12, $p = 0.331$); Age did not differ significantly across communities ($F(4, 145) = 0.61$, $p = 0.656$); Years of fishing experience did not differ significantly across communities ($F(4, 145) = 0.19$, $p = 0.943$).

Table **2**. Socio-demographic characteristics of artisanal fishers across study communities

Variable	Category	n	%	Mean ± SD	X^2	df	p-value	Dec.
Gender	Male	137	91.3	-	0.76	4	0.944	N.S
	Female	13	8.7	-				
Age (years)	18–30	33	22.0	-	0.61	4, 145	0.656	N.S
	31–45	58	38.7	-				
	45–55	45	30.0	-				
	>55	14	9.3	-				
Educational qualification	Primary	73	48.7	-	13.54	12	0.331	N.S
	Secondary	45	30.0	-				
	Tertiary	14	9.3	-				
	No formal education	18	12.0	-				
Occupation	Fishing (primary)	122	81.3	-	2.37	4	0.669	N.S
	Other	28	18.7	-				
Cooperative membership	Yes	108	72.0	-	1.99	4	0.738	N.S
	No	42	28.0	-				
Years of fishing experience		-	-	16.3 ± 9.4	0.19	4, 145	0.943	N.S

N.S = not significant at $p < 0.05$.

3.2 Fishing gear types and acceptability

Table 3 shows that seven fishing gear types were identified across the study communities, with usage varying considerably. Gillnets were the most widely used gear (35.3% of fishers), followed by cast nets (26.7%), longlines (16.0%), Malian traps (10.0%), lift nets (5.3%), clap nets (4.0%), and drag nets (2.7%). Acceptability ratings broadly tracked usage patterns. Gillnets recorded the highest overall acceptability score (4.4 ± 0.5), rated highly for catch volume and versatility. Cast nets ranked second (4.1 ± 0.7), favoured for ease of use and cultural familiarity, while longlines were rated third (3.8 ± 0.8), valued primarily for their selectivity and low environmental impact. Malian traps received a moderate acceptability score (3.5 ± 0.9), particularly valued by older fishers who cited tradition as a key factor. Lift nets and clap nets recorded identical, comparatively low acceptability scores (2.6 ± 1.0 each), reflecting shared concerns among fishers over limited catch efficiency relative to effort. Drag nets received the lowest acceptability score of all gear types (1.9 ± 0.8) and were classified as "unacceptable" in three of the five communities, primarily due to concerns over destruction of riverbed habitats and the capture of undersized fish and non-target species.

Acceptability scores differed significantly among gear types ($F(6, 143) = 18.90$, $p < 0.001$). Tukey's HSD post-hoc comparisons were used to identify which gear types differed significantly from one another, with grouping letters presented in Table 3.

3.3 Capture efficiency (CPUE)

Table 4 presents mean catch per unit effort (CPUE) by gear type across the two seasons. Because effort was recorded in gear-specific units, net length for gillnets, number of drags for drag nets, hauls for cast nets, angler-days for longlines, lifts for lift nets, operations for clap nets, and trap-days for Malian traps absolute CPUE values are not directly comparable across gear types. Formal inferential comparison was therefore restricted to within-gear, across-season contrasts, and the between-gear figures reported below are presented descriptively as an indicative, rather than statistically ranked, ordering of relative productivity. Descriptively, gillnets recorded the highest mean CPUE (7.1 ± 1.4 kg/100 m net/12 h), followed by drag nets (5.8 ± 1.5 kg/10 drags), cast nets (5.2 ± 1.1 kg/50 hauls), longlines (3.6 ± 0.9 kg/angler/day), lift nets (3.1 ± 0.8 kg/10 lifts), clap nets (2.9 ± 1.0 kg/10 operations), and Malian traps (2.1 ± 0.6 kg/trap/day). A two-way ANOVA was used to test the effects of gear type, season, and their interaction on CPUE (gear × season interaction: $F = 3.41$, $df = 6, 196$, $p = 0.003$). Wet season CPUE was significantly higher than dry season CPUE for every gear type ($p < 0.05$) in all within-gear seasonal comparisons), consistent with expected seasonal flooding effects on fish availability and catchability. Because effort units differ by gear, these seasonal contrasts were evaluated within each gear type separately rather than pooled across gears. Despite recording the second-highest descriptive CPUE, drag nets were associated with the highest proportion of juvenile fish in the catch (41.8% across all sites and seasons combined; Table 4), raising concerns about recruitment overfishing associated with this gear type.

Table **3**. Fishing gear types, usage frequency, and community acceptability scores

Gear Type	Users (%)	Mesh Size (mm)	Acceptability Score	Category	Tukey Group	Primary Target Species
Gillnet	35.3	25–76	4.4 ± 0.5	Highly Acceptable	a	Clarias, Citharinus
Cast Net	26.7	25–50	4.1 ± 0.7	Highly Acceptable	a	Oreochromis, Synodontis
Longline	16.0	–	3.8 ± 0.8	Acceptable	b	Heterotis, Lates
Malian Trap	10.0	15–25	3.5 ± 0.9	Acceptable	b	Clarias, Tilapia spp.
Lift Net	5.3	15–20	2.6 ± 1.0	Mod. Acceptable	c	Mixed species
Clap Net	4.0	20–30	2.6 ± 1.0	Mod. Acceptable	c	Mixed species
Drag Net	2.7	10–15	1.9 ± 0.8	Unacceptable	c	Mixed/juveniles

Table **4**. Mean CPUE (kg/unit effort) of fishing gears by season

Gear Type	Wet Season CPUE	Dry Season CPUE	Overall Mean	Juvenile % in Catch	Within-Gear Seasonal p
Gillnet	8.3 ± 1.6	5.7 ± 1.1	7.1 ± 1.4	6.2%	< 0.001
Drag Net	7.1 ± 1.7	4.3 ± 1.2	5.8 ± 1.5	41.8%	< 0.001
Cast Net	6.2 ± 1.3	4.0 ± 0.9	5.2 ± 1.1	12.4%	< 0.001
Longline	4.2 ± 1.0	2.8 ± 0.7	3.6 ± 0.9	3.1%	< 0.001
Lift Net	3.7 ± 0.9	2.3 ± 0.6	3.1 ± 0.8	18.6%	< 0.001
Clap Net	3.4 ± 1.1	2.2 ± 0.8	2.9 ± 1.0	22.3%	< 0.001
Malian Trap	2.5 ± 0.7	1.6 ± 0.4	2.1 ± 0.6	9.8%	< 0.001

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Table 5. Two-way ANOVA showing gear type, season, and gear × season interaction on CPUE

Source of Variation	SS	df	MS	F	p
Gear type	582.11	6	97.02	80.44	< 0.001
Season	167.41	1	167.41	138.80	< 0.001
Gear × Season interaction	24.66	6	4.11	3.41	0.003
Error	236.40	196	1.21		
Total	1010.58	209			

3.4 Fish species composition and diversity

A total of 27 fish species belonging to 16 families were recorded across all study sites and sampling periods. The most diverse families were Cichlidae (4 species), Mochokidae (4 species), Bagridae (3 species), and Characidae (3 species). The ten most abundant species by weight were *Clarias gariepinus* (18.6%), *Oreochromis niloticus* (13.9%), *Synodontis schall* (10.8%), *Citharinus citharus* (9.4%), *Heterobranchus bidorsalis* (7.2%), *Labeo senegalensis* (6.3%), *Distichodus rostratus* (5.1%), *Mormyrus rume* (4.7%), *Coptodon zillii* (4.2%), and *Alestes baremoze* (3.8%); the remaining species collectively accounted for 16.0% of total catch weight. Shannon–Wiener diversity (H′) ranged from 2.28 (dry season, Kwentan/Sendirde) to 3.41 (wet season, Lau). Simpson's diversity (1−D) ranged from 0.78 to 0.94, and evenness (J′) ranged from 0.72 to 0.89, indicating a relatively even species distribution, particularly during the wet season. Species richness was highest at Lau (S = 23) and lowest at Kwentan/Sendirde (S = 16). Margalef's richness index (d) ranged from 3.18 to 5.02. Wet season diversity indices were consistently and significantly higher than dry season values at all sites (t = 4.21–5.76, $p < 0.001$), reflecting the influx of floodplain species during inundation.

Table **6**. Fish species diversity indices by site and season at River Benue, Taraba State

Site	S		H′		1−D		J′		d		N	
	(Wet)	(Dry)	(Wet)	(Dry)	(Wet)	(Dry)	(Wet)	(Dry)	(Wet)	(Dry)	(Wet)	(Dry)
Lau	23	18	3.41	2.74	0.94	0.87	0.89	0.81	5.02	3.96	1,842	1,204
Mayo Ranewo	21	16	3.18	2.51	0.91	0.84	0.86	0.79	4.61	3.52	1,697	1,098
Kwentan/Sendirde	19	16	2.96	2.28	0.89	0.78	0.83	0.72	4.18	3.18	1,543	987
Tella	19	15	2.92	2.41	0.88	0.80	0.83	0.76	4.12	3.24	1,488	952
Ibi	20	17	3.07	2.48	0.90	0.82	0.85	0.78	4.36	3.42	1,612	1,031

S = species richness; H′ = Shannon–Wiener diversity index; 1−D = Simpson's diversity index; J′ = Pielou's evenness; d = Margalef's richness index; N = total number of individuals sampled.

3.5 Environmental determinants of species diversity and CPUE

Monthly physico-chemical measurements recorded a mean water temperature of 27.4 ± 2.8 °C, pH of 7.1 ± 0.6, dissolved oxygen of 6.2 ± 1.4 mg/L, turbidity of 68.4 ± 42.6 NTU, and electrical conductivity of 148.3 ± 36.2 µS/cm (Table 6). The high variability in turbidity (SD = 42.6 on a mean of 68.4 NTU) reflects the strong wet–dry seasonal contrast in suspended sediment load rather than measurement inconsistency.

Table **7**. Physico-chemical parameters of the study area (monthly measurements)

Parameter	Mean ± SD	Unit
Water temperature	27.4 ± 2.8	°C
pH	7.1 ± 0.6	–
Dissolved oxygen	6.2 ± 1.4	mg/L
Turbidity	68.4 ± 42.6	NTU
Electrical conductivity	148.3 ± 36.2	µS/cm

Values are mean ± SD across all monthly sampling occasions and sites.

Pearson correlation analysis revealed that dissolved oxygen was the strongest positive correlate of species diversity (r = 0.76, $p < 0.01$), followed by water level (r = 0.71, $p < 0.01$) and water temperature (r = 0.58, $p < 0.05$). Turbidity exhibited a significant negative correlation with species richness (r = −0.63, p < 0.05). Gillnet CPUE was positively correlated with water depth (r = 0.69, $p < 0.01$) and negatively correlated with turbidity (r = −0.54, $p < 0.05$), while longline CPUE showed a positive relationship with turbidity (r = 0.48, $p < 0.05$), consistent with its lower reliance on visual detection by target species in clearer water.

Table **8.** Pearson correlation coefficients between environmental variables, species diversity/richness, and gear-specific CPUE

Response Variable	Predictor Variable	r	p
Species diversity	Dissolved oxygen	0.76	< 0.01
Species diversity	Water level	0.71	< 0.01
Species diversity	Water temperature	0.58	< 0.05
Species richness	Turbidity	−0.63	< 0.05
Gillnet CPUE	Water depth	0.69	< 0.01
Gillnet CPUE	Turbidity	−0.54	< 0.05
Longline CPUE	Turbidity	0.48	< 0.05

r = Pearson correlation coefficient. Significance levels is ($p < 0.05$ or $p < 0.01$).

Multiple regression analysis identified dissolved oxygen, turbidity, and water level as the best combined predictors of Shannon–Wiener diversity ($R^2 = 0.72$, $F(3, 19) = 16.3$, $p < 0.001$), together explaining 72% of the variance in diversity across sites and sampling occasions.

Table **9.** Multiple regression for predictors of Shannon–Wiener diversity (H′)

Model	R^2	F	df	p-value
Predictors: dissolved oxygen, turbidity, water level → Shannon–Wiener diversity (H′)	0.72	16.3	3, 19	< 0.001

4. DISCUSSION

The predominance of male fishers (91.3%) recorded in this study is consistent with reports from other Nigerian riverine fisheries and reflects entrenched gender norms that assign physically demanding aquatic work to men (Tafida et al., 2014; Abdulraheem, 2021; Adam et al., 2025). No gender-disaggregated data were collected in this study, for example, on women's roles in fish processing and marketing relative to active fishing, or on gender-specific gear preferences and this is noted as a scope limitation rather than inferred from broader gender norms alone. The comparatively high mean fishing experience of 16.3 ± 9.4 years suggests that artisanal fishing in these River Benue communities is a long-established, multigenerational occupation with strong intergenerational knowledge transfer, although this study did not directly measure generational transmission, and this interpretation should therefore be treated as inferential rather than demonstrated. This has practical implications for management design: community-endorsed practices are likely to be more effective than top-down regulatory approaches that overlook indigenous knowledge and existing social structures. The high acceptability scores recorded for gillnets and cast nets (4.4 ± 0.5 and 4.1 ± 0.7, respectively) reflect both their practical advantages and their deep cultural integration into fishing communities along the River Benue. Similar patterns were documented by Nwosu & Holzlöhner (2006) for riverine communities in the Cross River basin and by Okafor-Yarwood (2015) for communities along the Niger River. The very low acceptability of drag nets (1.9 ± 0.8), placing them in the 'unacceptable' category, is a particularly noteworthy finding, made more serious by the fact that drag nets also produced the highest juvenile catch of any gear type (41.8%; Section 3.3). Acceptability differed significantly among gear types overall ($F(6, 143) = 18.90$, $p < 0.001$), with Tukey's HSD grouping drag nets

together with lift nets and clap nets in the lowest-acceptability category (Table 2). Together, these findings suggest that regulatory prohibition of drag nets would be justified on ecological grounds, and that the existing community-level opposition to the gear could be leveraged to build grassroots enforcement mechanisms.

The high CPUE recorded for gillnets (7.1 ± 1.4 kg/100 m net/12 h) confirms their status as the most productive gear type in this system, consistent with reports from other West African river systems, including the Volta in Ghana (Welcomme, 2011) and the Logone in Cameroon (Lévêque et al., 2008). This high productivity is most plausibly attributable to the wide stretched mesh-size range used for gillnets in this fishery (25–76 mm; Table 2), which allows fishers to target a broad size and species range. Gear-deployment factors such as set location within the channel (main channel versus margin) and typical soak time likely also influence CPUE but were not captured by the present sampling design, and their contribution to the high gillnet catch rate cannot be separated from the mesh-size effect on the basis of the data collected here. The high CPUE for drag nets, despite their low acceptability, illustrates a fundamental challenge in artisanal fisheries management: gear that is ecologically destructive may remain in use because it delivers high short-term returns to individual fishers (Javaid et al., 2017). The 41.8% juvenile composition recorded in drag net catches is alarming and, if sustained, will compromise long-term stock viability (Dammannagoda, 2018). The two-way ANOVA reported in Section 3.3 detected a significant main effect of gear type on CPUE ($F(6, 196) = 80.44$, $p < 0.001$; Table 3), confirming that catch rates differ substantially by gear. Because effort was recorded in gear-specific units, however, this effect is best interpreted as confirming that gear identity accounts for a large and significant share of variance within the model, rather than as a formally ranked, pairwise comparison of absolute catch rates across gears; the descriptive ordering in Table 3a, gillnets, drag nets, and cast nets recording the highest CPUE values, well above Malian traps, clap nets, and lift nets should accordingly be read as indicative rather than as statistically confirmed pairwise differences. Even on this cautious reading, the scale of the gear effect indicates that any gear-based management measure should be expected to have a correspondingly large effect on total harvest. The significant seasonal differences in CPUE recorded across all gear types, with wet season values consistently higher (Table 3), are attributable to the hydrological dynamics of the river (Boucek & Rehage, 2015; Wanjari et al., 2026). During the wet season, rising water levels submerge floodplains, creating extensive nursery habitat and abundant food resources that trigger lateral fish migration out of the main channel (Sarkar et al., 2020). Contrary to a purely spatial reading of this pattern, the prevailing flood-pulse literature emphasises that fish generally disperse across the inundated floodplain during high water, occupying a far larger wetted area than during the dry season, rather than becoming more concentrated. The higher wet-season CPUE observed here is therefore better explained by elevated fish activity, feeding, and catchability during flooding, driven by greater food availability and more accessible near-shore habitat for fishers than by any increase in fish density per unit area. Conversely, it is during the dry season, as floodwaters recede, that fish become progressively concentrated into the shrinking main channel and residual pools, a pattern well documented for large tropical river systems (Junk et al., 1989; Welcomme, 2011). The 27 species from 16 families recorded in this study represent a moderate level of diversity typical of the middle reaches of large West African rivers. The dominance of Clarias gariepinus, Oreochromis niloticus, and Synodontis schall in the catch is characteristic of disturbed tropical freshwater systems, where stress-tolerant taxa tend to outcompete habitat-specialist species (Clements & Newman, 2003; Lévêque et al., 2008).

The consistently higher diversity indices recorded during the wet season, with Shannon–Wiener H′ reaching 3.41 at Lau, reflect the ecological enrichment associated with floodplain connectivity, a pattern often described as the flood-pulse advantage (Bayley, 1991; Wantzen et al., 2008; Welcomme, 2011; Giurgiu, 2020). The markedly lower dry season diversity ($H' = 2.28$ at Kwentan/Sendirde) signals a contraction of available habitat and potential localised stress on fish communities during low-water periods.

The identification of dissolved oxygen, turbidity, and water level as the principal environmental predictors of species diversity ($R^2 = 0.72$; Table 8) aligns with established principles of freshwater ecology (Mogaka, 2024; Ge et al., 2025). Dissolved oxygen is a non-negotiable requirement for fish metabolism, and its strong positive correlation with diversity ($r = 0.76$, $p < 0.01$) reflects the importance of maintaining aerobic conditions throughout the water column (Tellier, 2021). The negative effect of turbidity on species richness ($r = -0.63$, $p < 0.05$) is consistent with findings for other tropical African rivers and may reflect reduced feeding efficiency in visual predators, together with direct physiological stress from gill clogging in sensitive species (Welcomme, 2011). The positive association between longline CPUE and turbidity ($r = 0.48$, $p < 0.05$), however, suggests that catfish species, which hunt chemosensorily rather than visually, may actually benefit from turbid conditions that reduce predation risk on their preferred invertebrate prey (Reustle & Smee, 2020; Fitzgibbon, 2020; Zanghi & Ioannou, 2025). Taken together, these findings point to the need for an integrated, ecosystem-based approach to fisheries management in the River Benue, one that addresses gear selectivity, seasonal fishing pressure, and the environmental conditions that sustain fish diversity and productivity simultaneously. Reliance on piecemeal regulation of individual gear types, without addressing this broader ecological context, is unlikely to achieve sustainable outcomes.

Limitations

This study has several limitations that should be considered when interpreting its findings. First, sampling covered a single annual wet–dry cycle across five communities; inter-annual variation in hydrology, fish recruitment, and fishing pressure was therefore not captured, and the reported seasonal patterns should be confirmed over multiple years before being treated as a stable baseline. Second, gear use, acceptability scoring, catch composition, and fishing effort were all recorded through fisher self-report rather than independent verification, which may introduce recall or social-desirability bias, particularly around use of the least-accepted gear types. Third, physico-chemical parameters were sampled monthly at each of the five sites (Section 3.5), which limits the resolution at which environmental drivers of diversity and CPUE can be linked to shorter-term hydrological events occurring between sampling occasions. Finally, no experimental gear trials (e.g., controlled comparison of mesh sizes under matched effort) were conducted; the CPUE and juvenile by-catch findings are therefore observational and should be treated as a basis for, rather than a substitute for, targeted gear-selectivity trials.

Conclusion

This study assessed fishing gear acceptability, capture efficiency, and fish species diversity among 150 artisanal fishers across five River Benue communities in Taraba State, Nigeria. Its central finding is a direct conflict between short-term productivity and long-term sustainability: drag nets, despite recording the second-highest descriptive catch per unit effort of the seven gear types documented, were the least acceptable gear to fishing communities and produced by far the highest proportion of juvenile fish in the catch (41.8%), presenting a clear and immediate threat to stock recruitment. Gillnets and cast nets were both among the most productive and the most community-accepted gear types, reflecting their practical and cultural integration into the fishery. A total of 27 fish species from 16 families were recorded, and diversity was consistently and significantly higher during the wet season, underscoring the dependence of this fishery on seasonal floodplain connectivity. Dissolved oxygen, turbidity, and water level were identified as the principal environmental drivers of species diversity ($R^2 = 0.72$); CPUE, by contrast, was related to individual environmental variables only through univariate correlations (Table 7) and was not modelled jointly against them in this study.

These findings establish an important site-level baseline for fisheries management in the River Benue corridor and point to three specific, data-linked interventions: (i) Prohibit or phase out drag net use, given both its classification as 'unacceptable' in three of five study communities and its disproportionate capture of juvenile fish (41.8% of catch); existing community opposition to this gear provides a practical basis for locally led enforcement. (ii) Establish a minimum stretched mesh size for gillnets, to be set once length-at-maturity (Lm) data are available for *Clarias gariepinus* and *Oreochromis niloticus*, the two dominant species in the catch since such biological reference points were not measured in the present survey and a defensible mesh-size threshold cannot be derived from catch-composition data alone. (iii) Introduce a seasonal closure timed to the peak flood months, to be defined from local hydrological records at a finer temporal resolution than the wet/dry season classification used here, so that the closure protects spawning and floodplain nursery use rather than simply the period of highest catchability; this should be supported by community-based monitoring of catch composition and juvenile proportion by gear type, allowing the effectiveness of the closure and mesh-size measures to be tracked directly against the indicators already established in this study (CPUE by gear, percentage juveniles in catch, and diversity indices).

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