Aspects of the Growth, Mortality, Population Dynamics, Stock and Exploitation Status of Hepsetus Odoe (Bloch, 1794) of Oguta Lake, Imo State Nigeria

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ABSTRACT

The study investigated aspects of the population dynamics of Hepsetus odoe of Oguta Lake with a view to ascertaining the status of the stock in the lake and providing management strategies for sustainability. A six-month sampling survey was conducted between March and August 2025, during which 5,562 specimens were examined. Sampling was carried out bi-weekly from four designated sampling stations on the lake using a combination of gillnets, seine nets, and cast nets. Data were analyzed using the FiSAT II computer software. Von Bertalanffy growth parameters from length-frequency analysis of the catch data gave the asymptotic length, L∞ as 57.75 cm, growth coefficient, K as 0.15 year-1, the theoretical age, t0 as -0.883 year, and the growth equation as: Lt = 57.75 (1 - e-0.15(t - 0.883)). The result depicts a slow growth rate over a maximum attainable life span of 20 years. Fishing mortality F was 2.25 year-1, natural mortality M was 0.65 year-1, while total mortality estimate Z was 2.90 year-1. The estimated exploitation ratio E of 0.78 was above the recommended sustainable threshold, suggesting overexploitation of the stock and rapidly declining productivity. The selection curve revealed a preponderance of immature size classes with a reduced reproductive capacity in the lake incapable of replenishing the depleted stock. The yield-per-recruit model recommends an optimum exploitation ratio (E) of between 0.40 and 0.50 as ideal in a properly regulated fishery. The present yield of the fishery is estimated at 0.07 - 0.08 t/km2, which shows that the Hepsetus stock of Oguta Lake is depleted. ELEFAN II length frequency graphics identified six age groups (0+ to 5+ years) while the modal length-at-age of the oldest fish (5+ year individuals) was 48.0cm in total length. Regulatory measures such as prescription of mesh size limits, closed fishing seasons, protection of spawning habitats, reduction in fishing effort, and the provision of alternative sources of income for fishermen outside the fishery are advocated for the recovery of the fishery.

Keywords: *Hepsetus odoe, population dynamics, stock status, Oguta Lake, Von Bertalanffy.*

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INTRODUCTION

The African pike (*Hepsetus odoe*) is an important freshwater fish species prevalent in African waters and well known for its predatory behavior. The fish contributes significantly to artisanal inland fisheries of West Africa, particularly in Nigeria where the lake fishery supports the livelihood of several rural fishermen. *Hepsetus odoe* is sold fresh or marketed as smoked fish, a local delicacy that commands high prices. Ecologically, *Hepsetus odoe* plays a vital role in the aquatic ecosystem as an important heterotroph in aquatic food webs (Tossavi, 2025) contributing to nutrient recycling, energy flow and food budget of the aquatic ecosystems (Ogueri et al., 2025a; 2025b). Preliminary trials reveal that *Hepsetus odoe* holds great potentials for aquaculture which have remained largely unexploited such as fast growth rate, good table size, resistance to environmental conditions in culture ponds and resistance to diseases (Tossavi et al. 2025; Ogueri et al., 2025a; 2025b). Julius et al. (2026) reported that several ageing tropical reservoirs in southwestern Nigeria continue to support important native freshwater fish species, including *Hepsetus odoe*, but some of these species occurred at relatively low and consistent abundance and were considered to have local conservation relevance. Recent studies by Ogueri et al. (2025b), Ma et al. (2026) and Flores-Iwasaki et al. (2026) reported that several factors including aquatic pollution, anthropogenic pollutants, deforestation, urbanization, climate change and obnoxious fishing methods threatened the fish communties. Fishing pressure have impacted negatively on the aquatic ecosystem and biodiversity of the corresponding fish stocks of Oguta Lake (Kingdom et al., 2024). Osijaye et al (2025) observed that the *Citharinid* and *Distichodontid* stocks of the lake had been depleted and that the fishermen now operate at a loss in the lake fishery. This menace was attributed to obnoxious fishing methods, habitat distortions, and excessive fishing pressure. Given the foregoing, it has become necessary to ascertain the current stock status of *Hepsetus* in Oguta Lake to provide scientifically robust information for conservation, fisheries management, and the long-term sustainability of the fishery. Stock assessment provides essential information on the biological condition and productivity of exploited fish populations in determination whether a stock is being harvested at sustainable levels.
Therefore, this study is provide updated information on the biological and fisheries status of *Hepsetus* in Oguta Lake. The results will serve as a scientific basis for conservation planning, regulation of fishing activities, sustainable exploitation, biodiversity protection, and long-term management of the Oguta Lake fishery.

MATERIALS AND METHODS

The study area

Oguta Lake (Figure. 1), located in Imo State, is known for its diverse aquatic habitats. The lake's biodiversity provides a rich environment for various fish species, including *Hepsetus odoe*. Oguta Lake is situated in Oguta Local Government Area of Imo State, Nigeria. It is located approximately within latitude 5°:41' and 5°:44' North of the Equator and between longitude 6°:50' and 6°:45' East of Greenwich. Though relatively shallow, the lake is the largest lentic natural water body in the Anambra-Imo River Basin. It covers a surface area of 2.48 km^2 during the peak flood season around October and has an average depth of 5.50m. The Lake, which is linear in shape also serves as a source of navigation, transportation, and tourism, thus, contributing to the socio-economic development of low income rural fishermen and their families.

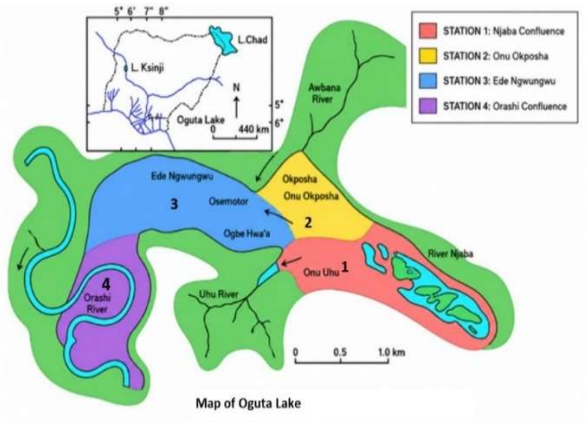

Figure 1: Map of Oguta Lake (Adaka et al., 2016) Showing the Sampling Stations

Sampling stations:

Four sampling stations were established on the lake and designated as follows:
Station 1: Njaba Confluence
Station 2: Onu Okposha
Station 3: Ede Ngwungwu
Station 4: Orashi Confluence
(Station 1: Njaba Confluence, Station 2: Onu Okposha, Station 3: Ede Ngwungwu, Station 4: Orashi Confluence) and GPS Coordinates

GPS Coordinates

Station 1: Latitude: 5.7000271 / N 5' 42' 0.0972
Longitude: 6.8123857 / E 6' 48' 44.5896
Station 2: Latitude: 5.7000261 / N 5' 42' 18.0674
Longitude: 6.8131257 / E 6' 48' 46.5922
Station 3: Latitude: 5.7000271 / N 5' 42' 29.742
Longitude: 6.798328 / E 6' 47' 53.981
Station 4: Latitude: 5.7073883 / N 5' 42' 26.5962
Longitude: 6.794085 / 05E 6' 47' 27.9'
Distance from STN 1 – 2 = 150 metres

Sample collection and identification

Fish samples were collected from the four sampling stations by commissioned fishermen. Sampling took place twice weekly, for 6 months (March 2025 to August 2025), ensuring coverage of both wet and dry seasons. The fish samples were caught by fishermen from the designated stations using different fishing gears, including:

1. Gill nets (mesh sizes: 15–25 mm)
2. Beach Seines net (mesh sizes: 2.3–10 mm)
3. Cast nets (mesh sizes: 15–25 mm)

Fish specimens were identified in the field immediately after capture using standard fish identification keys (Paugy, 2003; Adesulu & Sydenham, 2007; Olaosebikan & Raji, 2015). The total length (cm) of each fish sample was recorded.

Definition of Effort

The gill nets (surface-set and bottom-set nets) were fished simultaneously in each station. The nets were set at dusk and inspected at dawn. The unit of effort was nights of fishing while each station recorded 8 fishing nights each month using the standard gill nets while the Beach Seines and cast nets were operated in the day time, at bi-weekly intervals, equivalent to the same fishing efforts of 8 day-time fishing per month. Catch per unit of effort (CPUE) was thus defined as catch (kg) per night of fishing with standard gear.

Data analysis

Length-frequency data were collected monthly from each sampling station and categorized into 1.0 cm class intervals for further analysis. The data were analyzed using FiSAT II (FAO-ICLARM Stock Assessment Tools) as described by Gayanilo et al. (2005). The growth parameters were estimated using the Von Bertalanffy Growth Model (Dey, 2019):

$$L_{(t)} = L\infty\ (1-e^{-k(t-t0)})$$

Where;

$L_{(t)}$ = Length at time t

$L\infty$ = Asymptotic length or maximum attainable length of the fish

k = Growth curvature or growth coefficient

t = Time

t_0 = Theoretical age or hypothetical age at which the fish length is zero

L ∞ and growth curvature K were estimated using ELEFAN I (Electronic Length Frequency Analysis) in accordance with Zhou (2022). Bhattacharya's length frequency analysis using the ELEFAN II computer graphics was used for age composition analysis of fish population.

Statistical Analysis

Descriptive statistical analytical methods (Njoku, 2014) and ELEFAN11 computer graphical package (FAO, 2006) for fish stock assessment was employed in the analysis of the resulting data. They include bar charts histograms and graphics. The analysis was conducted at a 95% confidence level, with statistical significance declared at $p < 0.05$.

RESULTS AND DISCUSSION

Catch Composition of *Hepsetus odoe* of Oguta Lake

The catch composition of *Hepsetus* stock of Oguta Lake from the four sampling stations of Oguta Lake are summarized in Tables 1 and 2 while Table 3 shows the biometric features of *Hepsetus odoe* in Oguta Lake, estimated from pooled catch data (Table 2).

A total of 5,562 specimens of *H. odoe* were caught from all stations with station 1 (Table 1) contributing the highest number of samples (1,646), followed by station 4 (1318), station 3 (1304), and station 2 (1294). A mean total length of 31.00 cm (Table 3) was observed across the four stations, suggesting a uniform average size distribution throughout the lake. The minimum length recorded was 7.00cm while the maximum was 55.00cm.

Length-frequency Analysis and Age composition of Hepsetus stock of Oguta Lake

Figure 2 presents the length frequency histograms of pooled catch data and the age distribution of *Hepsetus odoe* in Oguta Lake between March and August 2025. ELEFAN II graphical analysis identified six distinct age groups of *H. odoe* in Oguta Lake as presented in Table 4.

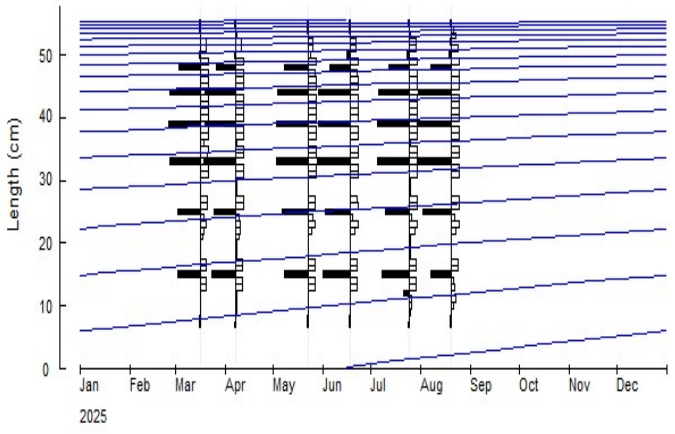

Figure 2: Length Frequency Analysis of *H. odoe* from pooled data using ELEFAN II Computer Graphics.

The age distribution shows a gradual progression in mean total length of cohorts from 14.00 cm in the first year class to 48.00 cm in 6th year age group with accelerated growth rate from 1+ year class up to the 4th year group (3+ year class), which subsequently declined thereafter, up to the 6th year age group (5+ year class), the asymptotic age.

Table 1: Catch Composition Data of *Hepsetus odoe* of Oguta Lake during a 6-month Sampling Period (March – August, 2025).

STATION 1 (Njaba Confluence)							
Size Class (cm)	**Number Per Month**						**Total**
	M	A	M	J	J	A	
0 – 10.9	4	4	4	4	4	4	24
11 – 19.9	18	20	21	22	28	38	147
20 – 29.9	30	35	34	42	46	48	235
30 – 39.9	100	105	112	119	128	143	707
40 – 49.9	72	64	68	73	73	88	438
50 – 59.9	15	13	10	16	17	24	95
Total	239	241	249	276	296	345	1646
STATION 2 (Onu Okposhi)							
Size Class (cm)	**Number Per Month**						**Total**
	M	A	M	A	M	A	
0 – 10.9	4	4	4	4	4	4	24
11 – 19.9	19	25	19	25	19	25	162
20 – 29.9	29	31	29	31	29	31	199
30 – 39.9	85	81	85	81	85	81	525
40 – 49.9	50	49	50	49	50	49	314
50 – 59.9	13	11	13	11	13	11	70
Total	200	201	200	201	200	201	1294
STATION 3 (Ede Ngwungwu)							
Size Class (cm)	**Number Per Month**						**Total**
	M	A	M	J	J	A	
0 – 10.9	4	4	4	6	4	4	26
11 – 19.9	26	26	28	43	38	30	191
20 – 29.9	32	31	32	36	38	36	205
30 – 39.9	86	82	86	93	95	91	533
40 – 49.9	53	44	44	39	43	44	267
50 – 59.9	20	16	14	12	11	9	82
Total	221	203	208	229	229	214	1304
STATION 4 (Orashi Confluence)							
Size Class (cm)	**Number Per Month**						**Total**
	M	21	M	J	J	A	
0 – 10.9	4	4	4	4	4	1	21
11 – 19.9	30	29	27	42	36	29	193
20 – 29.9	35	33	34	36	37	35	210
30 – 39.9	85	89	83	94	91	91	533
40 – 49.9	52	47	44	54	48	46	291
50 – 59.9	15	12	10	13	11	9	70
Total	221	214	202	243	227	211	1318

Table 2: Pooled catch composition data of *Hepsetus odoe* of Oguta Lake

Size Class (cm)	**M**	**A**	**M**	**J**	**Jly**	**Aug**	**Total**
0 – 10.9	16	16	16	18	16	13	95
11 – 19.9	93	100	103	137	131	129	693
20 – 29.9	126	130	133	149	155	156	849
30 – 39.9	356	357	366	397	405	417	2,298
40 – 49.9	227	204	210	218	220	231	1,310
50 – 59.9	63	52	44	53	50	55	317
Total	881	859	872	972	977	1,001	5,562

Mean lengths-at-age groups of *Hepsetus* stock of lake Oguta increased from an annual growth rate of 6.90cm year^{-1} in the first year individual (0+ year class) up to the 3rd year individuals (2+ year class) and declined steadily to a rate of 0.76cm year^{-1} between the 4th year individuals (3+ year group) through the 6th year cohorts (5+ year group. This reflects a typical growth pattern of rapid early growth that slows down as the fish matures. This is consistent with Von Bertalanffy growth model for organic growth (FAO, 2006). The cohort structure of fish stocks in inland waters can vary remarkably depending on many endemic factors, including sampling coverage, fishing intensity of the stock as well as environmental and anthropogenic pollution (Ma et al., 2026; Flores-Iwasaki et al., 2026). Njoku and Ezeibekwe (1996) identified four distinct age groups of 0+ to III+ years in *Liza grandisquamis* with modal lengths ranging between 18.00cm and 34.00cm. Keke et al (2008) identified four distinct age groups in *Distichodus rostratus* of Oguta lake with modal length of 22.00 cm for 1st year group, 32.00 cm (2nd year class), 44.00 cm (3rd year) and 60.00 cm (4th year class). There was a general downward decline in the growth rate of the fish, being rapid in younger age groups and minimal in mature to old age groups. These findings are in tandem with the patterns of organic

growth in fish Wang (2025).

Common feature of the age structure of *Hepsetus odoe* in Oguta Lake is the steady decline in population with age and size with the result that the fish stock comprises of few large individuals and a preponderance of young individuals. This is a common characteristic of a depleted fishery (Ogueri et al., 2025b). The apparent small biomass in population of 0+ year group of modal length of 14.0cm is attributable to gear selectivity of the corresponding fishing gear which allowed the escape of under sized fish (Ogueri et al., 2025b).

Population parameters of *H. odoe* from Pooled data in Oguta Lake

Table 3 summarized the estimated stock population parameters and growth structure of *Hepsetus* stock from combined data in Oguta Lake. The result (Table 4) shows that the asymptotic length L_∞ was 57.75 cm, while the growth coefficient (K) was 0.15 year$^{-1.}$ Njoku & Ezeibekwe (1996) recorded asymptotic length L_∞ of 55.2 cm, curvature parameter (K) of 0.186 cm year^{-1} and age at hatching (t_0) of -0.45 in *Liza grandisquamis* and concluded that the growth coefficient (0.186 year^{-1}) implied a slow growth rate and a fish stock with high longevity. The theoretical age (t_0) was estimated as -0.88years.

Table 3: Biometric data of *Hepsetus odoe* from All Stations

	Station 1	Station 2	Station 3	Station 4	Pooled data
Total	1646	1294	1304	1318	5562
Mean	31.00	31.00	31.00	31.00	31.00
SD	14.29	14.29	14.29	14.29	14.29
Min.	7.00	7.00	7.00	7.00	7.00
Max	55.00	55.00	55.00	55.00	55.00
Range	48.00	48.00	48.00	48.00	48.00

Table 4: Age composition of the Pike, *Hepsetus odoe* of Oguta Lake

Age group (years)	Modal length (cm)	Population
0+ year	14.00	95
1+ year	25.00	693
2+ year	30.20	849
3+ year	38.00	2298
4+ year	44.50	1310
5+ year	48.00	317

Fishing mortality rate (F) as 2.25 year^{-1}, natural mortality rate (M), 0.65 year^{-1} and total mortality rate (Z), 2.90 year$^{-1.}$ Exploitation ratio (E) was estimated as 0.78.

The fishing mortality rate (F) of 2.25 year^{-1} suggests that fishing is the dominant mortality factor in the *Hepsetus* fishery of Lake Oguta. Keke et al (2008) calculated a total mortality coefficient (Z) of 0.530 year^{-1} and fishing mortality rate (F) of 0.378 year^{-1} in *Distichodus rostratus* of Oguta Lake and concluded that this coefficient suggests a moderate fishing pressure.

The estimated exploitation ratio (E) of 0.78 is considered above the recommended threshold in a properly regulated fishery under exploitation and implies that 78% of total mortality of *Hepsetus odoe* is attributable to fishing and suggests a significant fishing pressure capable of depleting the stock. This observation agrees with the findings of other authors. Keke et al., (2008) estimated an exploitation ratio (E) of 0.713 in *Distichodus* stock of Oguta Lake and concluded that the fishery had been overexploited beyond the optimum sustainable yield (MSY), tilting towards over exploitation.

The estimated length at first maturity (L_{m50}) of 38.5 cm shows that half of the *Hepsetus odoe* in the lake reaches sexual maturity at this length.

The probability of capture values (L_{25}, L_{50}, L_{75}) estimated at 25.04 cm, 31.40 cm and 37.77 cm respectively (Table 3) using ELEFAN II Computer Package indicates the lengths at which 25%, 50% and 75% of the fish are likely to be caught, thus providing insights into fishing gear selectivity and its impact on *Hepsetus* population of the lake and necessary regulatory measures for stock conservation. Njoku (2014) and FAO (2006) were of the opinion that the prescription of mesh size limits of nets, and restriction of influx of fishermen entering the fishery serve as important regulatory strategies for revamping a depleted fishery.

The Von Bertalanffy growth equation of the analytical model, which was fitted as $L_t = 57.75\ (1 - e^{-0.15(t - 0.88)})$ (Table 5) provides the expected length at age t, and offers a predictive tool for estimating the fish growth across the lake.

Table 5: Population Parameters of *H. odoe* in Oguta Lake from pooled data

Parameters	Estimated values
Growth coefficient (k)	0.15
Theoretical age (t_0)	-0.883
Asymptotic length ($L\infty$)	57.75
Total mortality (Z)	2.90
Natural mortality (M)	0.65
Fishing mortality (F)	2.25
Length at first Maturity (L_{m50})	38.5
Exploitation rate (E)	0.78
Probability capture (L_{25})	25.04
Probability capture (L_{50})	31.40
Probability capture (L_{75})	37.77
Von Bertalanffy Growth Model	$Lt = 57.75\ (1\text{-}e^{-0.15(t\text{-}0.883)})$
Max. Predicted Age	20 years
Estimated yield	0.07 – 0.08 tkm^2

A yield of 0.07 - 0.08 tkm^{-2} was estimated for *Hepsetus* fishery of Oguta lake. This yield is considered low, suggesting that the fishery is overexploited. This assertion is in line with the findings of other authors. Keke and Njoku (2014) calculated a maximum attainable yield of 1.25 tkm^{-2} for *Distichodus* stock of Oguta lake and concluded that the yield indicated a depleted fishery. Pauly (1983) recommended an exploitation ratio (E) of 0.50 and a yield of 4 – 8 tkm^{-2} in inshore waters for sustainability.

CONCLUSION

This study revealed that *Hepsetus odoe* of Oguta Lake is facing strong fishing pressure, with exploitation levels well above sustainable limits. Growth analysis revealed that the fish is a slow-growing, long-living predator, with maturity reached after several years. Mortality estimates showed fishing mortality far higher than natural mortality, leaving

few large individuals in the population. Recruitment which peaks during the rainy season tend to support stock replenishment, but heavy fishing removes many fish before they reach maturity. The overall picture is that *H. odoe* in Oguta Lake is overexploited, with reduced yield and biomass, and its ecological role as a top predator is threatened. If unchecked, this situation could destabilize the lake's ecosystem and undermine the protein supply for resource-dependent communities.

RECOMMENDATIONS

To ensure the long-term sustainability of *Hepsetus odoe* in Oguta Lake, several management strategies are needed:

i. Regulation of fishing pressure by reducing the exploitation rate to sustainable levels (around E = 0.40–0.50). This can be achieved by enforcing minimum mesh sizes of 25–30 mm to prevent capture of immature fish (Koo & Kwon, 2024).
ii. Introduction of seasonal closures of spawning grounds and peak spawning months to fishing to protect recruitment and ensure successful replenishment of stock (Eklöf et al., 2023).
iii. Promotion of habitat restoration, such as replanting riparian vegetation and prevention of anthropogenic pollutants from domestic and oil-related activities, to improve aquatic ecosystem health (Lee et al., 2026).
iv. Strengthening community participation in fisheries management by involving fishers in monitoring, and enforcement of conservation measures through community participatory approach.
v. Encouragement of aquaculture development as an alternative source of income and job outside the fishery to allow the depleted stock to recuperate over time.

REFERENCES

Adaka, G. S., Nlewadim, A. A., & Udoh, J. P. (2016). Diversity and distribution of freshwater fishes in Oguta Lake, Southeastern Nigeria. *Advances in Life Science and Technology, 46*, 25–32.

Adesulu, E. A., & Sydenham, D. H. J. (2007). *The freshwater fishes and fisheries of Nigeria*. Abeokuta, Nigeria.

Dey, R., Cadigan, N., & Zheng, N. (2019). Estimation of the Von Bertalanffy growth model when ages are measured with error. *Journal of the Royal Statistical Society: Series C (Applied Statistics), 68*(4), 1131–1147. https://doi.org/10.1111/rssc.12340

Eklöf, J. S., Hansen, J. P., Eriksson, B. K., Östman, Ö., Austin, Å. N., Yanos, C., Fredriksson, R., Bergström, U., & Andersson, H. C. (2023). Effects of seasonal spawning closures on pike (*Esox lucius* L.) and perch (*Perca fluviatilis* L.) catches and coastal food webs in the western Baltic Sea. *Fisheries Research, 263*, 106674. https://doi.org/10.1016/j.fishres.2023.106674

Food and Agriculture Organization of the United Nations. (2006). *Stock assessment for fishery management: A framework guide to the stock assessment tools of the Fisheries Management Science Programme (FMSP)* (D. D. Hoggarth & S. Abeyasekera, Eds.; FAO Fisheries Technical Paper No. 487). FAO.

Flores-Iwasaki, M., Mori-Zabarburú, R. C., Hernández-Amasifuen, A. D., Chapa-Gonza, S., Fernández-Jeri, A. B., & Guerrero-Abad, J. C. (2026). Environmental DNA as a tool for freshwater fish conservation: A systematic review and bibliometric analysis. *Water, 18*(2), 215. https://doi.org/10.3390/w18020215

Gayanilo, F. C., Sparre, P., & Pauly, D. (2005). *FAO/ICLARM stock assessment tools II (FiSAT II): User's guide* (Rev. 2; FAO Computerized Information Series [Fisheries], No. 8). Food and Agriculture Organization of the United Nations.

Julius, O. T., Zangaro, F., Massaro, R., Rainò, M., Marcucci, F., Cazzetta, A., Sangiorgio, F., Olasunkanmi, J. B., Specchia, V., Julius, O., Shauer, M., Basset, A. & Pinna, M. (2026). Fish communities and management challenges in three ageing tropical reservoirs in southwestern Nigeria. *Limnological Review, 26*(1), 2. https://doi.org/10.3390/limnolrev26010002

Keke, I. R., Njoku, D. C., & Ejiogu, C. O. (2008). Managing the tropical inland fish stocks when resources are depleted: The case of Oguta Lake Distichodontid fishery in Nigeria. *Journal of Aquatic Sciences, 23*(1), 13–22.

Kingdom, G., Bob-Manuel, G., & Igbani, F. (2024). Assessment of fish fauna in Oguta Lake, Imo State, Niger Delta, Eastern Nigeria. *African Journal of Sciences and Traditional Medicine, 1*(1), 288–308. https://doi.org/10.58578/AJSTM.v1i1.3502

Koo, M., & Kwon, I. (2024). Optimal mesh size of traps for marbled flounder (*Pseudopleuronectes yokohamae*) based on biological and economic factors. *Fisheries Management and Ecology, 31*, e12730. https://doi.org/10.1111/fme.12730

Lee, C. S., Lee, Y. J., Kang, G. T., & Seok, J. E. (2026). Vegetation structure and riparian recovery govern ecological outcomes of restored ponds. *Ecological Indicators, 186*, 114891. https://doi.org/10.1016/j.ecolind.2026.114891

Ma, F., Huang, H., Yang, Q., Altermatt, F., Hong, P., Luo, M., & Wang, S. (2026). Biodiversity and habitat complexity buffer the destabilizing effects of anthropogenic activities on riverine fish communities. *Nature Communications, 17*, 6567. https://doi.org/10.1038/s41467-026-73311-w

Njoku, D. C. (2014). *Descriptive statistics, step-by-step*. Martins Continental Publishers.

Njoku, D. C., & Ezeibekwe, I. O. (1996). Age composition and growth of the large-scaled mullet, *Liza grandisquamis* (Pisces: Mugilidae), Valenciennes 1836, on the New Calabar Estuary, off the Nigerian coast. *Fisheries Research, 26*, 67–73.

Njoku, D. C., & Udoh, J. P. (2014). *Fish biology and taxonomy*. Brighton Graphic Publishers.

Ogueri, C., Adaka, G. S., Bunu, A. J., Nwaka, D. E., Utah, C., Wilfred, P. N., Ekeledo, C. B., Ogah, I., & Adebayo, E. T. (2025a). Stock status of *Brycinus nurse* (Rüppel, 1832) in Oguta Lake, Nigeria for conservation and management strategies. *Global Scientific Research in Environmental Science, 5*(1), 1–5.

Ogueri, C., Adaka, G. S., Utah, C., Ekeledo, C. B., Chinnan, C. U. E., Ezeafulukwe, C. F., Bunu, A. J., Njoku, D. C., & Madu, H. C. (2025b). Stock status of the moon fish, *Citharinus citharus*, for management strategies and conservation in Oguta Lake, Imo State, Nigeria. *Uttar Pradesh Journal of Zoology, 46*(10), 394–403.

Olaosebikan, B. D., & Raji, A. (2015). *Field guide to Nigerian freshwater fishes*. Federal College of Freshwater Fisheries Research Technology.

Osijaye, G. K., Bob-Manuel, G. O., & Igbani, F. (2024). Assessment of fish fauna in Oguta Lake, Imo State, Niger Delta, Eastern Nigeria. *African Journal of Sciences and Traditional Medicine, 1*(1), 288–308. https://doi.org/10.58578/ajstm.v1i1.3502

Pauly, D. (1983). *Some simple methods for the assessment of tropical fish stocks* (FAO Fisheries Technical Paper No. 234). Food and Agriculture Organization of the United Nations.

Paugy, D. (2003). *Hepsetus odoe* (Bloch, 1794). In D. Paugy, C. Levêque, & G. G. Teugels (Eds.), *Poissons d'eaux douces et saumâtres de l'Afrique de l'Ouest* (Tome 2, pp. 156–159). Institut de Recherche pour le Développement.

Tossavi, N. D., Koussovi, G., Gangbazo, D. N. S. K., Aizonou, R., Gandé, G., Zannou, T. B., & Agadjihouèdé, H. (2025). Population structure, weight-length relationships, and parasitism associated with *Hepsetus odoe* (Bloch, 1794) caught in Lake Togbadji in southwest Benin, West Africa. *American Journal of Water Resources, 13*(1), 1–6. https://doi.org/10.12691/ajwr-13-1-1

Wang, Z., Hao, H., Wei, J., Wu, H., Hamid, S. M., Lv, R., Lu, H., & Nie, Z. (2025). Morphology, age, and growth of *Triplophysa strauchii* in Sayram Lake, Xinjiang, China. *Animals, 15*(7), 1039. https://doi.org/10.3390/ani15071039.

Zhou, S., Hutton, T., & Lei, Y. (2022). Estimating growth from length

frequency distribution: Comparison of ELEFAN and Bayesian approaches for red endeavour prawns (*Metapenaeus ensis*). *ICES Journal of Marine Science, 79*(6), 1942–1957.