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Research Article

BIOLOGICAL ASPECTS AND POPULATION DYNAMICS OF *CHRYSICHTHYS AURATUS* (PISCES, CLAROTEIDAE) IN THE OULE RIVER, FORESTED REGION OF GUINEA

***[1,3,4,6]Gildas DJIDOHOKPIN, [1]Hermann Leonce ZINSOU, [1]Demba Aissata SAMOURA, [2]Richard ADANDÉ, [3]Cheick Moussa KEITA, [4]Alpha Oumar KALISSA, [5]Julien DJOSSOU, [6]Edmond SOSSOUKPÈ**

[1]Department of Natural Resources Management, Faculty of Environmental Sciences (FSE), University of N'Zérékoré, N'Zérékoré, Guinea.
[2]Department of Hydrology, Faculty of Environmental Sciences (FSE), University of N'Zérékoré, N'Zérékoré, Guinea.
[3]Department of Biology, Faculty of Technical Sciences (FST), University of N'Zérékoré, N'Zérékoré, Guinea.
[4]Department of Environmental Engineering, Faculty of Environmental Sciences (FSE), University of N'Zérékoré, N'Zérékoré, Guinea.
[5]Department of Physical, Faculty of Technical Sciences (FST), University of N'Zérékoré, N'Zérékoré, Guinea.
[6]Laboratory of Hydrobiology and Wetland Research, Department of Zoology, Faculty of Sciences and Technology, University of Abomey-Calavi, Benin.

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ABSTRACT

The biology and ecology of economically important fish species in Guinea are insufficiently studied. In this study, growth parameters, mortality rates, and the exploitation level were estimated to describe the population dynamics of *Chrysichthys auratus* from the artisanal fishery of the Oulé River. A total of 4,323 specimens were collected between November 2024 and October 2025 and analyzed using the FiSAT II (FAO-ICLARM Stock Assessment Tools) software. The estimated growth coefficient (K) was 0.65 yr^{-1}, while the asymptotic length ($L\infty$) reached 42 cm. Natural mortality (M) was 1.16 yr^{-1}, total mortality (Z) was 2.21 yr^{-1}, and the exploitation rate (E = 0.48) was very close to the optimal exploitation level (E_{opt} ≈ 0.5), suggesting that nearly half of the total mortality is due to fishing. These results indicate that *C. auratus* in the Oulé River is being exploited at an almost optimal level, where the yield is near its maximum sustainable value. However, maintaining or slightly reducing fishing effort (through measures such as regulating mesh size and controlling fishing intensity) is recommended to prevent growth overfishing and ensure the long-term sustainability of this important fish resource.

Keywords: *Chrysichthys auratus*, Artisanal fishery, Growth parameters, Sustainable fisheries, Guinea.

INTRODUCTION

Guinea, often referred to as the "water tower" of West Africa, hosts a diverse network of freshwater systems that are vital for food security and local economies, particularly in rural areas where artisanal fisheries provide a primary source of protein and income. Among the economically important fish species, *Chrysichthys auratus* (Geoffroy Saint-Hilaire, 1809), a demersal freshwater catfish of the Claroteidae family, is widely distributed across West African river systems, including those in Guinea. In Forested Guinea, it is commonly found in the Oulé River, where it plays a key ecological role as both predator and prey within aquatic food webs and holds significant socio-economic importance for local communities. The species' abundance and distribution reflect the health and productivity of freshwater ecosystems in the region, underscoring the need for targeted studies on its biology (Lalèyè *et al*, 2020), growth, mortality, and exploitation

*Corresponding Author: Gildas DJIDOHOKPIN, Department of Natural Resources Management, Faculty of Environmental Sciences (FSE), University of N'Zérékoré, N'Zérékoré, Guinea. Email: gdjidohokpin@gmail.com.

parameters to support sustainable management and conservation efforts.

The biology and ecology of economically important fish species in Guinea remain insufficiently studied. This study was conducted to address this knowledge gap by assessing key biological parameters of *Chrysichthys auratus*, such as growth, mortality, and exploitation rates. These parameters are essential for understanding population dynamics and ensuring sustainable management of fishery resources (Reis & Celal, 2025). For instance, Costa *et al.* (2022) showed that, fish growth is influenced by environmental and biological factors, and understanding it helps estimate optimal capture sizes and assess population health. Mortality encompasses both natural and fishing-related mortality, and its estimation is crucial for determining sustainable yield levels (Maunder *et al.,* 2023). Finally, the exploitation rate reflects fishing intensity and aids in evaluating whether a population is overexploited (Vasilakopoulos *et al.,* 2012). The ELEFAN routine implemented in the FiSAT software, a widely recognized tool for estimating population parameters of finfish and shellfish from length-frequency data, has become a standard approach for growth studies, particularly in tropical and subtropical regions (Al-Barwani *et al.,* 2007; Amin *et al.,* 2008; Ye *et al.,* 2003). The FiSAT method has been widely applied in growth studies, especially in tropical and subtropical countries (Ye *et al.,* 2003; Djidohokpin *et al.,* 2017). In the present study, this method was applied to estimate the growth, mortality, and exploitation parameters of *Chrysichthys auratus* in the Oulé River, providing essential information for understanding its population dynamics and supporting sustainable management.

MATERIALS AND METHODS

Sampling

Fish samples were obtained twice monthly from November 2024 to October 2025. Fish were collected directly from artisanal fishermen landing their catches in the lakeside villages along the Oulé River (Figure 1). After sorting according to genus, the species was identified using books and publications on fish systematic such as: The Fresh and Brackish Water Fishes of Lower Guinea, West-Central Africa (Stiassny *et al.,* 2007); The Guide to identifying the main fish of fishing interest in the upper Niger basin in Guinea (Ricois, 1991); The Fresh and Brackish Water Fishes of West Africa (Lévêque *et al.,* 1992). At each sampling event, samples of *Chrysichthys auratus* taken at random from the catches and used for length measurements yielding 4,323 fish measured during the period of investigation. Measured fish were arranged by length.

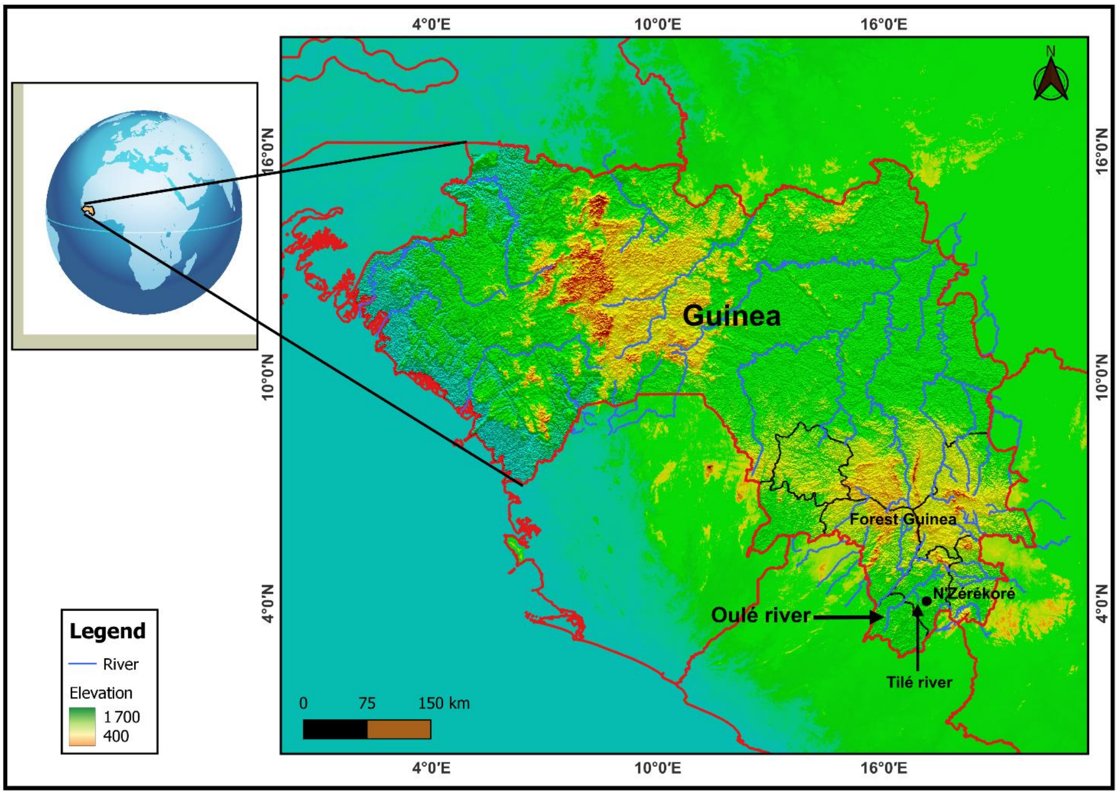

Figure 1. Location map of the Oulé River.

Length and weight measurements

Length measurements taken included total length (TL) and standard length (SL), the latter measured from the tip of the mouth to the end of the hypural bone, with both lengths measured to the lower centimetre. Weight (W) is expressed as fresh weight, measured to the nearest gram.

Estimation of populations parameters

The length frequency data were pooled into groups with 1cm length intervals. Then the data were analyzed using the FiSAT II (FAOICLARM Population Assessment Tools) software (Gayanilo *et al.,* 2005). Growth parameters were investigated by applying the (Von Bertalanffy, 1938) growth function as follows:

$\mathbf{L_t = L_\infty[- \exp(-K(t- t_0))]}$ Eq.1

where Lt is the length at age t, L∞ is the asymptotic length, K is the growth coefficient, and t0 is the hypothetical age at which length is equal to zero.

The growth performance index (φ′) was calculated by the equation of Pauly & Munro (1984) :

$\mathbf{\varphi' = \log_{10}(K) + 2\log_{10}(L_\infty)}$ Eq.2

The total mortality (Z) was calculated according to Beverton & Holt (1956) :

$\mathbf{Z = K * ((L_\infty - \bar{L}) / (\bar{L} - L_0))}$ Eq.3

where $\bar{L}$ is the mean length of fish, and L0 is the length of the first capture.

The natural mortality (M) was calculated using the formula of Pauly (1980):

$\mathbf{\log_{10}(M) = -0.0066 - 0.279*\log_{10}(L_\infty) + 0.6543*\log_{10}(K) + 0.4634*\log_{10}(T)}$ Eq.4

where (T) is the annual mean of habitat temperature (in degrees Celsius)

The fishing mortality coefficient (F) was estimated from total mortality and natural mortality:

$\mathbf{F = Z – M}$ Eq.5

The exploitation rate (E) was computed from the formula of Gulland (1971):

$\mathbf{E = F / Z}$ Eq.6

The estimates of length-at-first-capture (Lc or L50) were derived from probabilities of capture generated from the catch curve analysis. The extrapolated points of the length-converted catch curve were used to approximate the probability of capture for each length group using the running average method to estimate the selection parameter L50 through linear interpolation. Recruitment patterns were generated from the estimated growth parameters by backward projection of length frequency data, as done in ELEFAN, onto the time axis (Moreau & Cuende, 1991). This type of back-calculation usually allows identification of the number of seasonal pulses of recruitment that have been generated by the represented population in the length frequency data (Gayanilo *et al.,* 2002). The relative yield per recruit (Y′/R) and relative biomass per recruit (B′/R) models, developed by Beverton & Holt (1966) and incorporated in FISAT II software (Gayanilo *et al.,* 2005), were used to evaluate the stock of *Chrysichthys auratus.* The virtual population analysis (VPA) based on fish length was used to determine the impact of fishing on the stock as well as the MSY by the Thompson and Bell method (Sparre & Venema, 1992).

RESULTS AND DISCUSSION

A total of 4,323 individuals of *Chrysichthys auratus* were sampled, the results obtained from the analysis of length-frequency data and the estimation of growth, mortality, and exploitation parameters are presented below. The figure 2 shows the variation of the score function as a function of the growth coefficient (K). The maximum score is observed around K ≈ 0.5-0.6 year^{-1}, indicating a moderate growth rate of the stock. The corresponding growth performance index (φ′ ≈ 3.0-3.2) suggests a medium-growth species, typical of tropical fishes. The absence of a sharp peak reflects a certain dispersion in the length-frequency data.

Figure 2. Curve of growth coefficient (K, yr^{-1}) and growth performance index (φ′) of Chrysichthys auratus in the Oulé River estimated using the ELEFAN method.

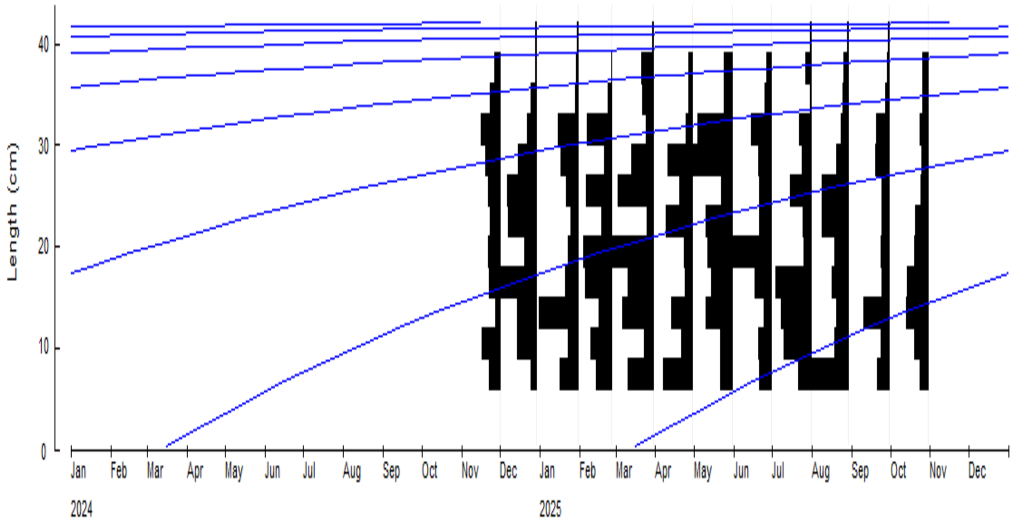

Figure 3. Growth curves fitted by ELEFAN I to length-frequency of *Chrysichthys auratus* in Oulé River (K=0.65 year-1; L∞ =42 cm TL).

The ELEFAN analysis of *Chrysichthys auratus* from the Oulé River (Figure 3) showed distinct length-frequency modes corresponding to successive cohorts, indicating a steady and continuous growth pattern. The von Bertalanffy growth curves provided a good fit to the data, confirming the reliability of the estimated growth parameters (L∞ ≈ 40 cm, moderate K value). The recurrent presence of small individuals throughout the year suggests continuous recruitment typical of tropical freshwater species. The length-converted catch curve (Figure 4) provided an estimate of the total mortality coefficient ($Z = 2.21\ yr^{-1}$) using Pauly's empirical formula at 25 °C, from which the natural mortality ($M = 1.16\ yr^{-1}$) and fishing mortality ($F = 1.05\ yr^{-1}$) were derived. This resulted in an exploitation rate of E = 0.48, indicating that approximately half of the total mortality experienced by the stock is due to fishing activities.

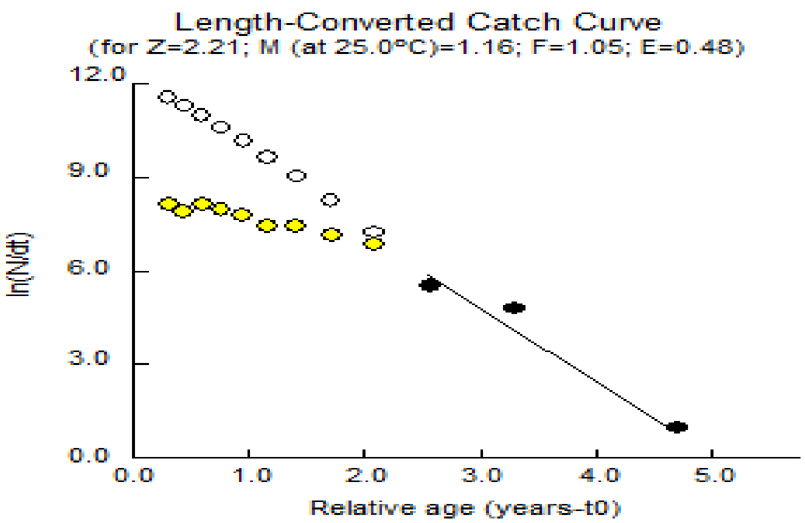

Figure 4. Length-converted catch curve for *Chrysichthys auratus* in Oulé River.

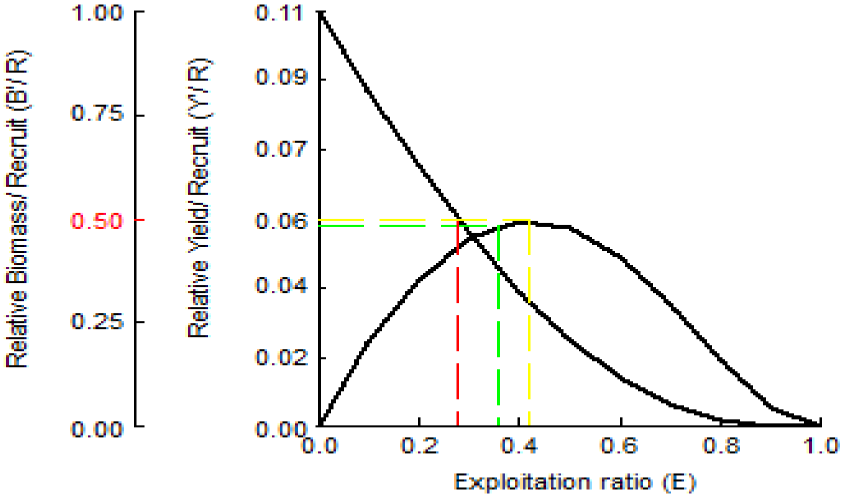

Figure 5. Relative yield-per-recruit and biomass-per-recruit curves for *Chrysichthys auratus* in Oulé River using the selection ogive option. The three dashed right-angled lines correspond to E0.5, E0.1 and Emax, respectively. The probability of capture analysis (Figure 6) showed a 50% capture length ($Lc_{50} \approx 28$ cm), suggesting that most larger individuals are fully vulnerable to fishing gears.

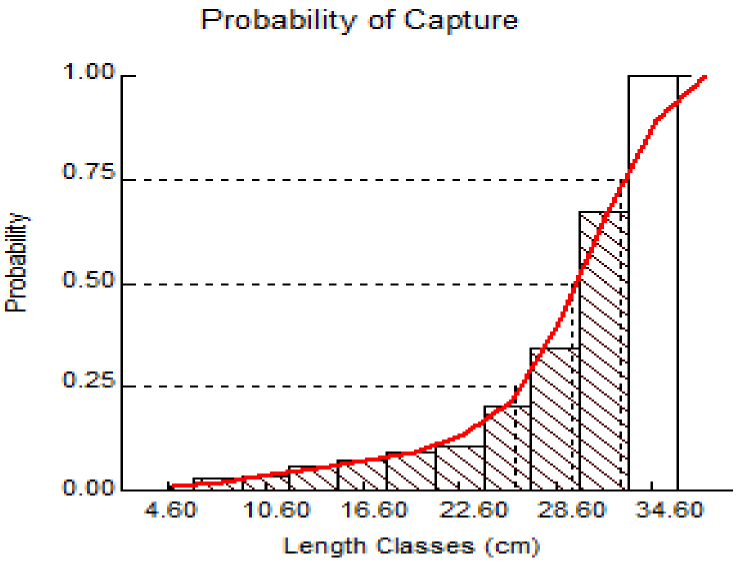

Figure 6. Probability of capture of *Chrysichthys auratus* in Oulé River estimated from the ascending axis of the catch curve.

This exploitation rate was further evaluated using the relative yield-per-recruit (Y′/R) and biomass-per-recruit (B′/R) model (Figure 5). The Y′/R curve increased with the exploitation rate up to a maximum (Emax), after which it declined, while the B′/R curve continuously decreased with increasing effort. The estimated current exploitation rate (E = 0.48) lies between $E_{0.1}$ (the conservative exploitation level) and Emax, and closely coincides with $E_{0.5}$, where the spawning biomass is reduced to 50% of its unexploited level. The recruitment pattern shown in Figure 7 The recruitment pattern of *Chrysichthys auratus* in the Oulé River indicates a nearly continuous recruitment throughout the year, with a main peak occurring between November and February.

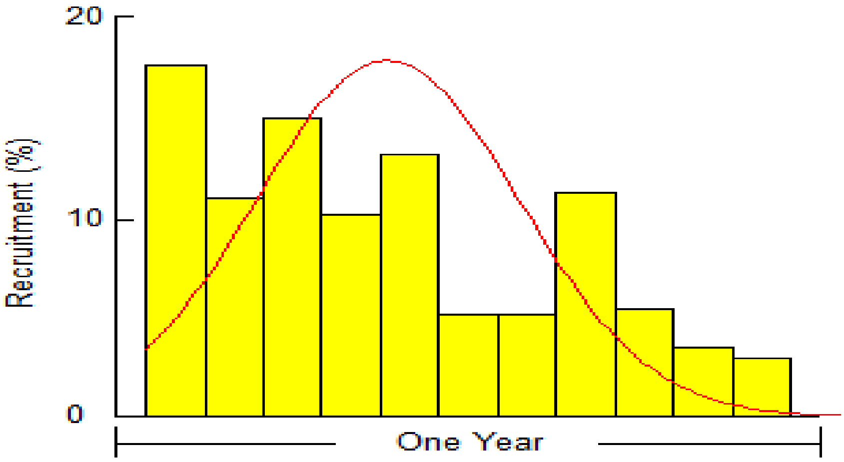

Figure 7. Recruitment pattern of *Chrysichthys auratus* in Oulé River.

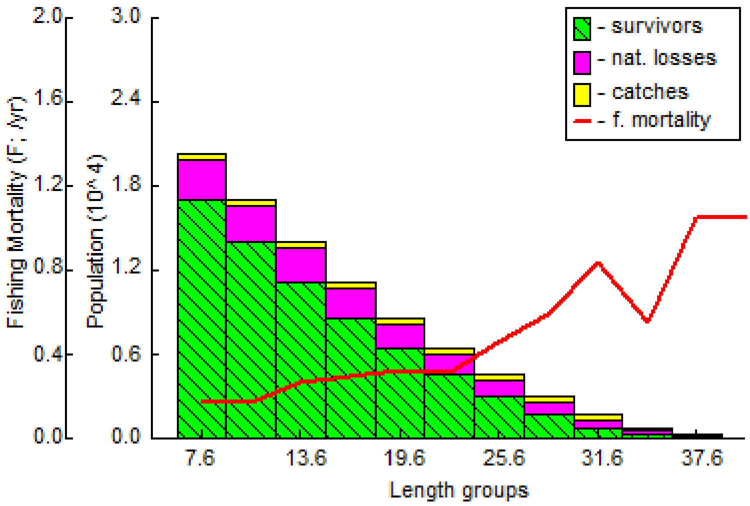

Figure 8. The length-structured VPA for *Chrysichthys auratus* in Oulé River

Figure 8 also shows the fishing pressure on the exploited stock of *Chrysichthys auratus* in the Oulé River. The population *Chrysichthys auratus* in the Oulé River is dominated by smaller individuals, while fishing mortality increases progressively with size and reaches its maximum around 31.6 cm. This pattern indicates that the fishery primarily targets medium- to large-sized individuals, which is generally considered favorable for the sustainability of the stock, provided that fishing pressure remains within moderate limits. Such selectivity allows younger and smaller fish to escape capture and contribute to recruitment, thereby supporting the long-term stability and productivity of the population.

The results of the score function variation with respect to the growth coefficient (K) indicate a relatively stable demographic structure of *Chrysichthys auratus* in the Oulé River. The highest score occurs around K ≈ 0.5-0.6 yr^{-1}, suggesting moderate growth of the stock. This value implies an intermediate growth pattern typical of medium-sized tropical fish species, characterized by rapid juvenile growth followed by a slowdown as the asymptotic length (L_∞) is approached. The corresponding growth performance index (φ′ ≈ 3.0-3.2) supports this interpretation, reflecting a balancé between growth potential and longevity. Similar φ′ values have been reported for *Chrysichthys nigrodigitatus* and *C. auratus* populations in West African inland waters (Ofori-Danson and Ofori-Adu, 2002 ; Ekpo & Udoh, 2013), confirming that *C. auratus* in the Oulé River exhibits typical tropical growth dynamics. The absence of a sharp peak in the score curve suggests moderate dispersion in length-frequency data, possibly linked to seasonal recruitment fluctuations or heterogeneity in the sampling of different size classes. The ELEFAN analysis highlights a relatively stable population structure with the recurrent presence of small-sized individuals (5-10 cm) throughout the sampling period, indicating a continuous recruitment pattern. Such continuous recruitment is a common feature of tropical freshwater fishes inhabiting environments with relatively stable temperature and hydrological conditions year-round (Pauly, 1982; King, 1991). The estimated asymptotic length ($L\infty \approx 40$ cm) and growth coefficient ($K \approx 0.55$ yr^{-1}) suggest that *C. auratus* is a moderately fast-growing species, comparable to related Claroteidae populations from the Niger and Volta river systems (Ayoade, 2011; Ofori-Danson & Ofori-Adu, 2002).

The length-converted catch curve analysis revealed that nearly half of total mortality is due to fishing. The estimated exploitation rate (E = 0.48) indicates that 48% of total mortality results from fishing activities, while the remaining 52% is attributable to natural causes such as predation, disease, or senescence. According to Beverton & Holt (1975), this corresponds to an optimal level of exploitation where yield approaches its maximum sustainable level. This value is also close to the exploitation threshold ($E_opt \approx 0.5$) proposed by Gulland (1971), suggesting that the *C. auratus* stock in the Oulé River is being harvested near the sustainable limit. However, any further increase in fishing effort could shift the population toward overexploitation, emphasizing the need for continuous monitoring and adaptive management. The yield-per-recruit (Y′/R) and biomass-per-recruit (B′/R) models, calculated using FiSAT based on the same dataset, suggest that the stock is moderately to highly exploited, operating near the biological optimum but close to the threshold of overexploitation. Similar exploitation levels have been observed for other tropical freshwater fishes in West Africa, such as *Labeo senegalensis* and *Oreochromis niloticus* (Abowei & Hart, 2009 ; Ofori-Danson *et al.,* 2012). Therefore, maintaining or slightly reducing the current fishing effort is advisable to prevent further depletion of spawning biomass and to ensure the long-term sustainability of the resource.

The analysis of the probability of capture revealed a length at 50% capture (Lc_{50}) of approximately 28 cm, indicating that most larger individuals are fully vulnerable to fishing gear. In the absence of direct data on the length at first maturity (Lm) for the studied population, it was not possible to assess this relationship precisely. However, according to available information for Chrysichthys auratus populations from West African inland waters, particularly those from the Porto-Novo Lagoon and Lake Nokoué (Bénin), sexual maturity is attained between approximately 8 and 19 cm total length (Hounkpè *et al.,* 2023 ; Sparre & Venema, 1998). Therefore, it is likely that most individuals captured in this study ($Lc_{50} \approx 28$ cm) are already mature, suggesting that gear selectivity is relatively appropriate, as it primarily targets mature fish and may help reduce recruitment overfishing.

The recruitment pattern of *C. auratus* in the Oulé River shows nearly continuous recruitment throughout the year, with a main peak between November and February. This extended spawning activity is typical of tropical fishes, as relatively stable environmental conditions (such as temperature, food availability, and hydrological regime) permit multiple spawning events annually (Pauly, 1982 ; King, 1991). The dominant recruitment peak during the onset of the dry season likely reflects favorable conditions for larval survival and early growth. Such continuous recruitment enhances population resilience and supports recovery under moderate fishing pressure. Finally, the population structure of *C. auratus* in the Oulé River is dominated by small-sized individuals, while fishing mortality increases with size and reaches its maximum around 31.6 cm. This indicates that the fishery primarily targets medium to large individuals, which is generally favorable for sustainability if fishing pressure remains moderate. This selective pattern allows younger fish to grow and reproduce before capture, ensuring long-term population stability and productivity.

CONCLUSION

The current study of the population status of *Chrysichthys auratus* in the Oulé River of the Republic of Guinea, based on samples collected from artisanal fishers, shows that the stock is harvested near its sustainable limit. The exploitation rate (E = 0.48) and the length at 50% capture ($Lc_{50} \approx 28$ cm) indicate that the majority of large individuals are fully vulnerable to fishing gear. The population exhibits moderate growth ($L\infty \approx 40$ cm; $K = 0.65$ yr^{-1}) and continuous recruitment, suggesting resilience under current fishing pressure. However, any further increase in fishing effort could lead to overexploitation. Therefore, it is recommended to implement a monitoring program to track changes in exploitation rates, recruitment patterns, population structure, and life-history traits that may reflect harvest-induced effects.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest

ETHICS APPROVAL

Not applicable

FUNDING

This study received no specific funding from public, commercial, or not-for-profit funding agencies.

AI TOOL DECLARATION

The authors declares that no AI and related tools are used to write the scientific content of this manuscript.

DATA AVAILABILITY

Data will be available on request

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