

Demographic Structure and Level of Exploitation of the Small Pelagic *Pellonula leonensis* Boulenger, 1916 (Pisces; Clupeidae) Fishery in the Aghien lagoon, West Africa

Assi Sonan Romuald (Corresponding author), Boussou Koffi Charles, Konan Koffi Félix,
Aliko N'Guessan Gustave, Bony Kotchi Yves

Department of Environment, Jean Lorougnon Guédé University, POB 150 Daloa, Côte
d'Ivoire.

Gourène Germain

Department of Sciences and Environment Management, Nangui Abrogoua University, 02 POB
801 Abidjan 02, Côte d'Ivoire.

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Abstract

Demographic structure and level of exploitation of *Pellonula leonensis* in the Aghien lagoon were examined by applying length-weight relationship (LWR), Condition factor, Von Bertalanffy model, Mortality parameters, Exploitation rate, Recruitment pattern and Beverton and Holt analysis. Fish population were sampled monthly during one year between June 2014 and May 2015 from artisanal and experimental captures in the Aghien Lagoon. Except LWR and the condition factor, studied parameters were provided by the FiSAT II package. The negative allometric growth ($b = 2.61$) was reported for *Pellonula leonensis*. Mean values of the condition factor (CF) vary significantly from one month to another (Anova, $p < 0.05$). Concerning growth parameters, results indicated that the asymptotic length (L_{∞}) has been estimated at 126.84 mm SL , growth coefficient (K) was 0.67 year⁻¹ and growth performance index (Φ') was 2.03. Growth modelization revealed 4 cohorts for *Pellonula leonensis*. The estimates of the total (Z), natural (M) and fishing (F) mortalities were 1.87, 0.92 and 0.95 year⁻¹ respectively. The recruitment pattern was continuous throughout the year with two Gauss curve. The exploitation rate obtained ($E = 0.51$) was close to $E_{0.1}$ ($E_{0.1} = 0.55$), thus indicating that the *P. leonensis* stock is in an optimum state of exploitation.

Keywords: demographic structure, level of exploitation, *Pellonula leonensis*, Aghien lagoon

1. Introduction

In Côte d'Ivoire, fish represents 70% of the animal protein consumed and its consumption level is between 11 and 14 kg per inhabitant per year (FAO 2008). National fish consumption is between 250000 and 300000 T per year for an average local production of 80000 T (FAO, 2014). Of the fishery resources landed, particularly, fish called “small pelagic” and “semi-pelagic” have a proportion of 80 to 90% (FAO, 2008). They play a role as a “food safety net” (Gaoussou, 2011). According Yao (2008), the species *Pellonula leonensis* has a considerable contribution in these groups of fish called “small pelagic” and “semi-pelagic”. *P. leonensis* is the subject of special fisheries in lagoons and main Côte d'Ivoire lakes (Yao *et al.*, 2015). For these authors, the production of this fish is quite important with average monthly catches estimated at 11 T in Lake Taabo. Kon *é et al.* (2011), note that this species of fish is of considerable economic interest in the locality of Kossou where it is marketed in dry form. This small pelagic belonging to the family Clupeidae is a fish known in Côte d'Ivoire under the vernacular name of “*mimi la go*”. It is remarkable by its first pre-pelvin shield of identical size to the following eccussions without ascending arms and located after the origin of the pectoral (Froese and Pauly, 2017). In the vast majority of continental and estuarine environments in West Africa, *P. leonensis* is responsible for the most targeted fish species in commercial fisheries (Uneke *et al.*, 2010). For better stock management and conservation of the species, a thorough knowledge of population dynamics is needed. Indeed, knowledge of the parameters of growth and exploitation is indispensable for the study of population dynamics. Research has been conducted on the species *P. leonensis*. These studies relate in particular to the length-weight relationship and population parameters of the species in Lake Taabo (Kon *é et al.*, 2014), The reproduction in the Bandama River (Kraidy *et al.*, 2014) and the diet in the Buyo Dam (Kouam *é et al.*, 2006). This study aims to analyze the demographic structure and estimate the exploitation level of *P. leonensis* in the Aghien lagoon, West Africa.

2. Material and Methods

2.1 Study Area

Aghien Lagoon is situated on the Ivorian coast of Atlantic Ocean, northern of Ebrie Lagoon, between latitudes 5°22'N and 5°26'N and longitudes 3°49'W and 3°55'W (Figure 1). This lagoon is separated by from the Atlantique Sea by the Potou Lagoon and the Ebrie Lagoon. The Aghien and Potou Lagoons communicate through a natural channel (Koffi *et al.*, 2014). The Aghien Lagoon could reach 11 m deep (Guiral and Ferhi, 1989). This lagoon has a surface area of 20 km² for a perimeter of 40.72 Km. Three rivers Me, Djibi and B *á* *é* are effluents of Aghien Lagoon and is almost exclusively continental all year long. This gives to the hydrosystem a fluvial character (Koffi *et al.*, 2014). Located in an estuarine zone, the ichthyological diversity of this lagoon is strongly influenced by species of marine and continental origin. The result is a very diverse fish community with intense fishing activity (B *é* *dia et al.*, 2009; Traor *é et al.*, 2014).

2.2 Data Collection

Pellonula leonensis data was obtained from the monthly samplings carried out during the period of June 2014 to May 2015. Samples are from artisanal and experimental fisheries at the Aghien lagoon. Fishes were collected using gill nets (10 to 40 mm stretch mesh). Fish specimens were identified following Paugy *et al.* (2003a), Paugy *et al.* (2003b), Sonnenberg and Busch (2009), Fricke *et al.* (2018), as well as Froese and Pauly (2018). For all specimens collected, the standard length (*SL*) was measured to the nearest millimeter using an ichthyometer. The total weight (*W*) of all fish was recorded to the nearest gram using an electronic balance. According Chikou (2006), standard length (*SL*) was used to avoid errors due to tail fins accidentally damaged during intra or interspecific fighting during capture and specimen conservation.

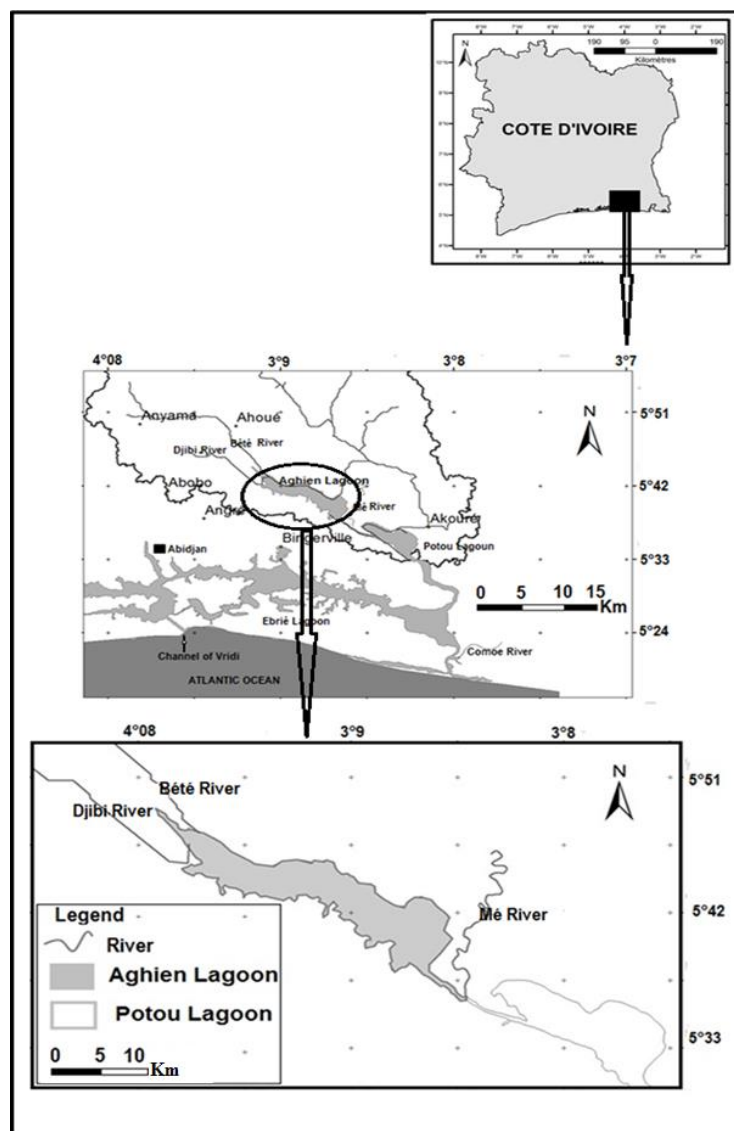


Figure 1. Location of the Aghien Lagoon

2.3 Statistical Analysis of Data

2.3.1 Length-Weight Relationship (LWR)

The length-weight relationship was estimated using the following equation (Froese, 2006):

$$W = aL^b$$

Where, W represents the body weight (g), L is the length of fish (mm), a is the intercept of the regression and b is the regression coefficient or the allometric growth coefficient.

The parameters a and b of the length-weight relationship were estimated by the least-squares method based on logarithms: $\text{Log } W = \text{Log } (a) + b \text{ Log } (L)$.

The value of b gives information on the kind of growth of fish: the growth is isometric if $b = 3$ (Naeem *et al.*, 2010) and the growth is allometric if $b \neq 3$ (negative allometric if $b < 3$ and positive allometric if $b > 3$) (Konan *et al.*, 2007).

A Student's t-test was used for comparison b value obtained in the linear regression with isometric value (Konan *et al.*, 2007).

2.3.2 Condition Factor

The condition factor (CF) was determined by using the following equation (Gomiero and Braga, 2005):

$$CF = (W/SL^b) \times 100$$

Where, W is the whole body weight, SL is the Standard length of fish, b = the value obtained from the length-weight equation.

2.3.3 Growth Parameters

Analysis and processing of length data were conducted using the ELEFAN (Electronic Length Frequency Analysis) together with FAO-ICLARM Stock Assessment Tools (FiSAT II) (Gayanilo *et al.*, 2002). It was assumed that the growth of *Pellonula leonensis* conforms to the Von Bertalanffy growth model. The growth model used is as follow:

$$L_t = L_\infty (1 - e^{-k(t-t_0)}).$$

Where L_t is the length at age t ; L_∞ is the asymptotic length; K is the growth coefficient and t_0 is the theoretical age at which the length is zero.

The reliability of growth parameters was tested applying the growth performance index (Φ') according to the method of Pauly and Munro (1984), as follows:

$$\Phi' = \text{Log}_{10} K + 2 \text{Log}_{10} L_\infty.$$

The age of the fish at zero length was obtained by the equation of Pauly (1979):

$$\text{Log}_{10}(-t_0) = -0.392 - 0.275 \text{Log}_{10} L_\infty - 1.038 \text{Log}_{10} K.$$

The potential longevity or approximate maximum age (t_{max}) of *P. leonensis* was calculated

using Pauly and Munro's formula (1984):

$$t_{max} = 3/K.$$

2.3.4 Mortality Parameters and Exploitation Rate

The total mortality coefficient (Z), was estimated using the linear length-converted catch curve method incorporated in FiSAT, using the final estimates of L_{∞} , K and the length distribution data for the specie (Gayanilo and Pauly, 1997). Assuming constant recruitment and constant mortality the length converted catch curves takes the form:

$$\ln(N_i/dt_i) = a + Z_i.$$

Where N is the number of fish in length class i , dt_i is the time needed for the fish to grow through length class i , t_i age of the mid-length of length class i corresponding to the mid length of class i , and where Z , with sign changed, is an estimated total mortality. The von Bertalanffy growth parameters derived as described in the previous section were used as input data for the estimation.

The natural mortality (M), was estimated using Pauly's (1980) empirical equation:

$\log(M) = -0.0066 - 0.279\log(L_{\infty}) + 0.6543\log(K) + 0.4634\log(T)$; where T is the annual mean of habitat temperature (in degrees Celsius). The indicated value is equal here to 28.39 °C.

The temperature used for this study was measured in-situ monthly during the period from June 2014 to May 2015.

Fishing mortality (F) was derived as the difference between of total mortality coefficient (Z) and natural mortality (M):

$$F = Z - M \text{ (Abowei et al., 2010).}$$

Following the estimations of Z , M and F , the exploitation ratio E , was obtained from:

$$E = F/Z = F / (F+M) \text{ (Pauly, 1985).}$$

The exploitation rate indicates whether the stock is lightly ($E < 0.5$) or strongly ($E > 0.5$) exploited, based on the assumption that the fish are optimally exploited when $F = M$ or $E = 0.5$ (Gulland, 1971).

2.3.5 Size at First Capture

The catch-curve analysis was extended to an estimation of probabilities of capture by backward projection of the number (N) that would be expected if no selectivity had taken place (Sparre, 1987). From the analysis, the size at which 50% of a fish population is likely to be caught by fishing gear (L_{50} or L_c) was estimated. By analogy, L_{25} and L_{75} were estimated.

2.3.6 Recruitment Pattern

The recruitment pattern was obtained from the estimated growth parameters by backward projection of length-frequency data, as done in ELEFAN, onto the time axis (Moreau and

Cuende, 1991). This type of back-calculation allows identification of the number of seasonal pulses of recruitment that have been generated by the population represented in the length frequency data (Gayaniño *et al.*, 2002). Input parameters were L_{∞} , K and t_0 . Recruitment pattern was presented in terms of the percentage of recruitment versus time (months).

2.3.7 Estimation of Relative Yield (Y'/R) and Biomass Per Recruit (B'/R)

The relative yield per recruit (Y'/R) and biomass per recruit (B'/R) were estimated according to Beverton and Holt (1966) using the Knife-edge selection.

Beverton and Holt (1966) method as modified by Pauly and Soriano (1986) were used to predict the relative yield per recruit (Y'/R) and relative biomass per recruit (B'/R) of the species to the fisheries. Y'/R was computed following the formula below:

$$Y'/R = E U^{M/K} (1 - (3U/1+m) + (3U^2/1+2m) - (U^3/1+3m)).$$

Where $U = 1 - (L_c / L_{\infty})$ is the fraction of growth to be completed by the fish after entry into the exploitation phase; $m = (1 - E) / (M / K) = (K / Z)$ and $E = F / Z$ is the fraction of mortality of the fish caused by the fishermen.

The predicted values were obtained by substituting the input parameters of L_c/L_{∞} and M/K in the FiSAT II package.

The relative biomass per recruit (B'/R) was estimated from the relationship:

$$B'/R = (Y'/R) / F.$$

2.3.8 Estimation of the Biological Reference Points (E_{max} ; $E_{0.1}$; $E_{0.5}$)

Yield per-recruit (Y'/R) and biomass per-recruit (B'/R) analysis to obtain reference points and evaluate the exploitation status of the specie was conducted. From the analysis, the maximum allowable limit of exploitation (E_{max}) giving maximum relative yield-per-recruit was estimated. The exploitation rate ($E_{0.1}$) at which the marginal increase in relative yield-per-recruit is 10% as well as the exploitation rate corresponding ($E_{0.5}$) to 50% of the unexploited relative biomass per-recruit were estimated.

Except the Length-weight relationship and the condition factor, all the parameters evaluated during this study are made using the FiSAT II package. This software is the most frequently used to estimate fish population parameters (Al-Barwani *et al.*, 2007), because of relatively simple application, requiring only length frequency data. In addition, the only necessary and sufficient condition for the use of the FiSAT II package, for a species, is to have data of frequency distributions of lengths of at least 100 fish distributed over 10 to 20 length classes (Ahouanssou, 2011).

3. Results

3.1 Variation of the size of *Pellonula Leonensis*

In this study, a total of 884 *Pellonula leonensis* were sampled in the Aghien lagoon for length frequency data. The standard lengths were measured of *P. leonensis* captured varying from 38

to 118 mm and of 78.04 ± 15.41 mm average (Figure 2). The average size of *P. leonensis* varied significantly from one month to another (Anova, $p < 0.05$). However, mean sizes of *P. leonensis* varied only slightly from December ($SL = 77.68$ mm) to Mars ($SL = 74.25$ mm) (Anova, $p > 0.05$). The smallest average size is obtained in July ($SL = 71.20$ mm) and the largest in October ($SL = 80.40$ mm), June ($SL = 80.92$ mm), April ($SL = 83.63$ mm) and November ($SL = 89.17$ mm).

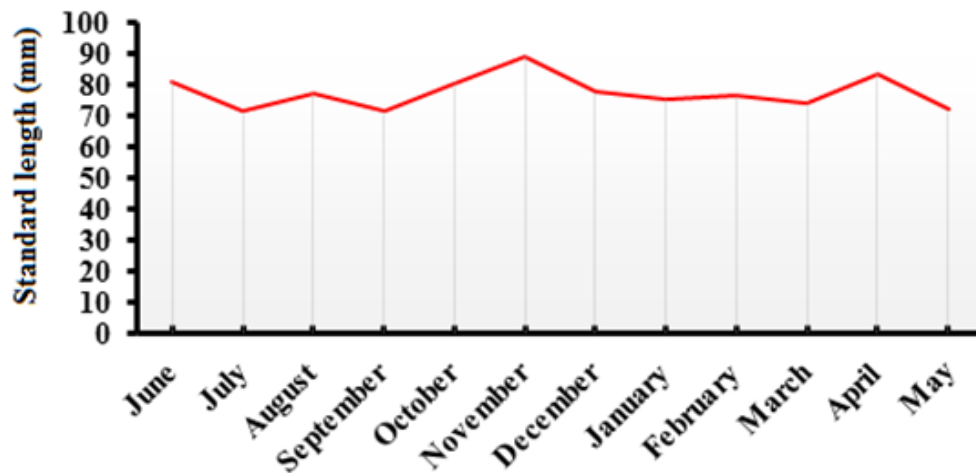


Figure 2. Monthly variation of the standard length of *P. leonensis* at the Aghien lagoon during the period of June 2014 to May 2015

3.2 Length-Weight Relationship

The value of $\text{Log}(a) = -4.25$ and $b = 2.61$ were better fitter at $r^2 = 0.71$ (Figure 3; Table 1). The allometric coefficient ($b = 2.61$) was significantly lower to 3 ($p > 0.05$), indicated that growth was negative allometric for *P. leonensis*.

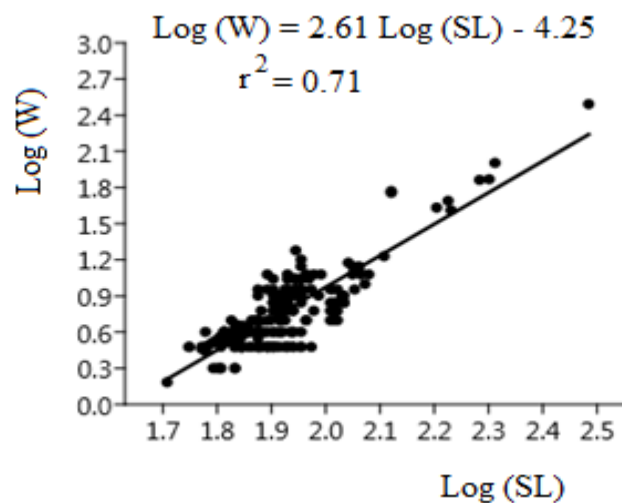


Figure 3. Graph of length-weight relationship of *P. leonensis* from the Aghien Lagoon

Table 1. Standard length (*SL* in mm) and length-weight relationship (*LWR*), parameters for *P. leonensis* from the Aghien Lagoon

Specie	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>b</i>	<i>SE (b)</i>	<i>r</i> ²	Growth type
<i>P. leonensis</i>	884	38	118	78.04 ±15.41	2.61	0.106	0.71	A-

3.3 Condition Factor

Mean values of the condition factor of *P. leonensis* vary significantly from one month to another (Anova, $p < 0.05$) (Figure 4). The highest values are obtained May ($CF = 1.55$), April ($CF = 1.45$) and February ($CF = 1.28$). The lowest average values are obtained in October ($CF = 0.61$) and September ($CF = 0.55$).

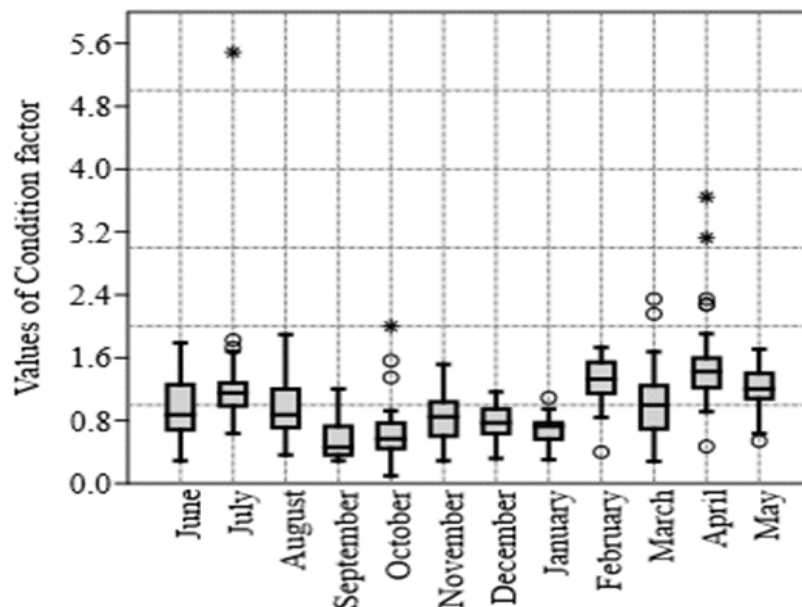


Figure 4. Monthly condition factor evolution of *P. leonensis* at the Aghien lagoon during the period of June 2014 to May 2015

3.4 Growth Parameters

Growth curves indicated that captured fish belonged to 4 cohorts for *Pellonula leonensis* (Figure 5). The value of the adjustment index *Rn* is 0.20. The asymptotic length of *P. leonensis* (L_{∞}) was 126.84 mm SL while the performance growth index (Φ') was 2.03. The growth coefficient (*K*) and the potential longevity (t_{max}) were respectively 0.67 year^{-1} and 4.47 years. The age at zero length was estimated as -0.45 year, which gave the von Bertalanffy growth equation for this species as:

$$L_t = 126.84 (1 - e^{-0.67(t + 0.45)}).$$

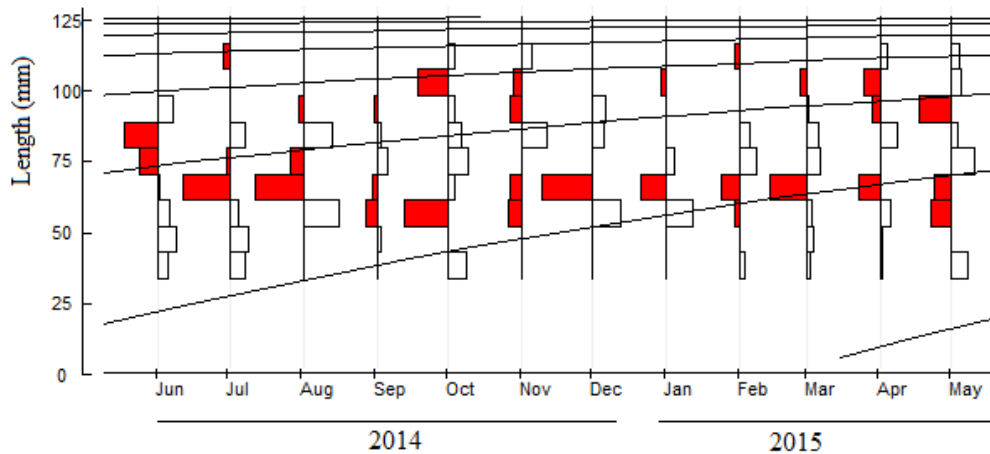


Figure 5. *P. leonensis* length frequency and fitted von Bertalanffy growth curves ($L_{\infty} = 126.84$ mm SL, $K = 0.67$ year⁻¹, $t_0 = -0.45$ year) for the Aghien Lagoon.

3.5 Mortality Parameters and Exploitation Rate

The estimated Z value and linearized regression parameters obtained from the length curve are reported in Table 2.

Total mortality coefficient (Z) obtained by the length converted catch curve was 1.87 year⁻¹ for 1.33 – 3.16 years of age (Figure 6; Table 2). The natural mortality (M) at 28.39 °C was 0.92 year⁻¹ while the fishing mortality (F) was 0.95 year⁻¹. Exploitation rate (E) for *Pellonula leonensis* in the Aghien Lagoon was 0.51.

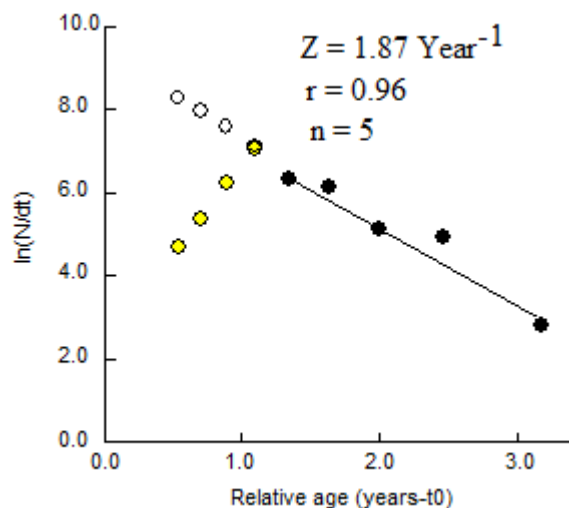


Figure 6. Linearized capture curve of *P. leonensis* at the Aghien lagoon during the period June 2014 to May 2015

Table 2. Estimation of the total mortality coefficient (Z) of *P. leonensis* at the Aghien lagoon during the period of June 2014 to May 2015

Intercept (a)	Slope (b)	Z (year ⁻¹)	Age class	CI of Z	R^2	Z/K	M/K
9.02	-1.87	1.87	(1.33-3.16)	1.03-2.70	0.94	2.79	1.37

3.6 Size at First Capture

The length at first capture (L_{50} or L_c) i.e. the length at which 50% of the *Pellonula leonensis* species are vulnerable to capture was estimated at 57 mm SL (Figure 7). The logistics model selection also showed that 25% of fish at 51.94 mm SL and 75% of fish at 62.06 mm SL were caught.

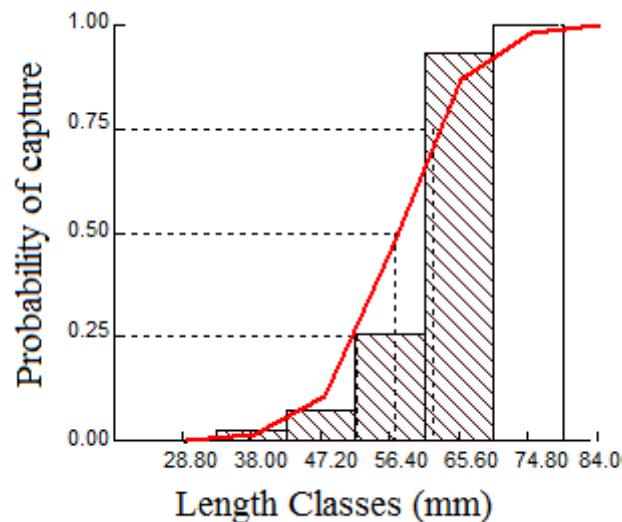


Figure 7. Probability of capture of *P. leonensis* from Aghien Lagoon

3.7 Recruitment Pattern

The recruitment pattern showed that *Pellonula leonensis* was recruited in the fishery continuously throughout the year with two Gauss curve (Figure 8; Table 3). Monthly values of recruitment percentages for *P. leonensis* are shown in Table 3. The two periods of intense recruitment of the specie to the Aghien lagoon are from April to May and October to November.

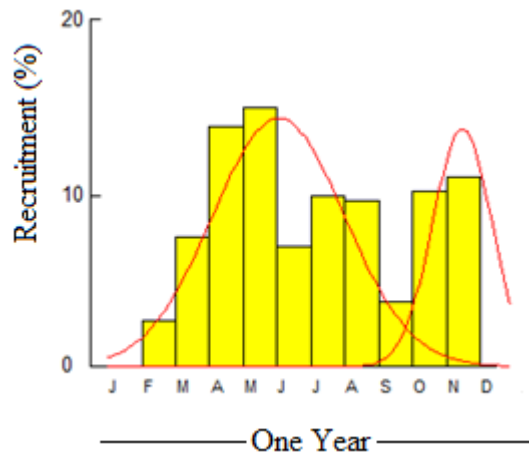


Figure 8. Recruitment pattern of *P. leonensis* sampled in Aghien Lagoon

Table 3. Monthly values of recruitment percentages

Specie	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
<i>P. leonensis</i>	0.00	2.56	7.49	13.84	14.93	6.92	9.95	9.55	3.72	10.01	10.95	0.00

Jan: January; Feb: February; Mar: March; Jun: June; Aug: August; Sept: September; Oct: October; Nov: November; Dec: December.

3.8 Yield and Biomass Per Recruit and Biological Reference Points

The relative Y'/R and B'/R analysis were estimated using $L_c/L_\infty = 0.44$ and $M/K = 1.37$ as input for knife-edge selection procedure (Figure 9). The different colors correspond to relative yields (Figure 9 a) and relative biomasses (Figure 9 b) per recruit. The red zones delineate the optimal values of relative yields and relative biomasses per recruit. The values of relative yield per recruit and relative biomass per recruit based on exploitation rates are shown in Table 4.

The relative yield per recruit (Y'/B) increases to a maximum then decreases while the curve of the relative biomass gradually decreases with the increase of the level of exploitation (Figure 9 c). The maximum allowable limit of exploitation level (E_{max}) that gives the maximum relative Y'/R ($E_{max} = 0.63$) was greater than the exploitation rate ($E = 0.51$).

The exploitation level ($E_{0.1}$) at which the marginal increase in relative yield per recruit is 10% of its value at $E = 0$ was 0.55 whereas the exploitation level ($E_{0.5}$) which corresponds to 50% of the relative B'/R of an unexploited stock was 0.34. The current exploitation rate ($E = 0.51$) is almost equal to $E_{0.1}$, but it is greater than $E_{0.5}$.

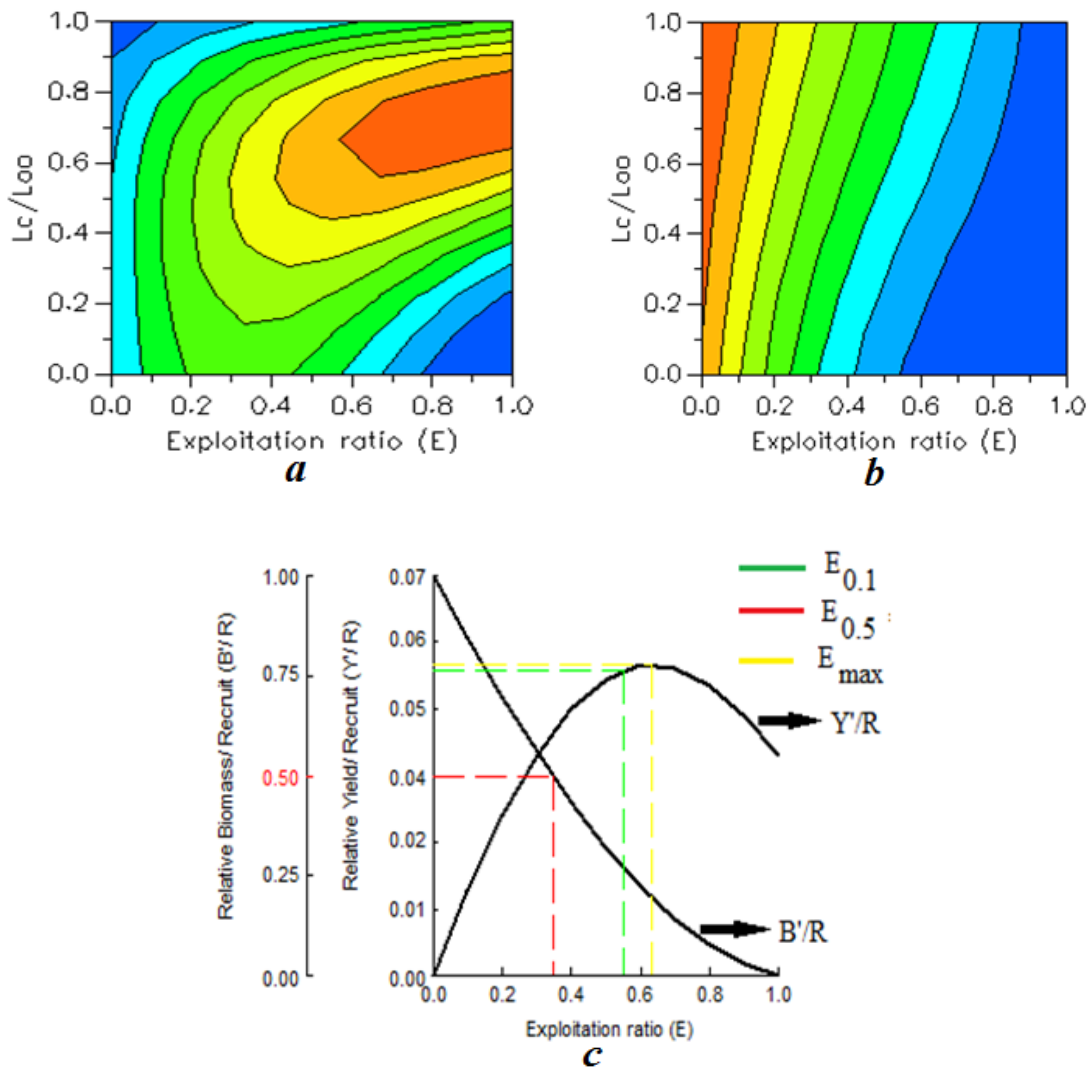


Figure 9. Relative yield-per-recruit (Y'/R) and biomass-per-recruit (B'/R) curves for *P. leonensis* from Aghien lagoon using knife-edge procedure

Table 4. Values of relative yield per recruit and relative biomass per recruit based on exploitation rates for *P. leonensis* from the Aghien Lagoon

E	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
Y'/R (g)	0.015	0.028	0.037	0.043	0.045	0.044	0.040	0.033	0.024	0.017
B'/R (g)	0.823	0.659	0.511	0.380	0.267	0.174	0.101	0.048	0.016	0.000

4. Discussion

4.1 Structure in Size

The population structure of *Pellonula leonensis* in the Aghien lagoon indicates that the average monthly size of fish varies significantly. The higher average sizes obtained in October, June, April and November could be explained by the fact that during these months, the food resources are more available to the growth of *P. leonensis* at the Aghien lagoon. Indeed, L'évêque (1999) states that a fish species is maintained in a long-term environment to the extent that it finds a set of conditions that allow it among others to grow and reproduce. In addition, these months correspond to the rain and flood season at the Aghien lagoon (Ettien, 2010). During this period trophic conditions become more favorable for growth because of the better availability of food resources. The average size obtained at the Aghien lagoon (mean = 71.2 mm LS) is higher than that recorded by Koné *et al.* (2014) in Lake Taabo (mean = 32.59 mm LS).

4.2 Length-Weight Relationship

The negative allometric growth ($b = 2.61$) obtained for *Pellonula leonensis* in the Aghien lagoon corroborates the results of Ecoutin and Albaret (2003) which obtained the same type of growth for the species in the Ebrié lagoon. However, the type of growth observed in this study differs from that of Koné *et al.* (2014) indicate positive allometric growth, with a value of $b = 3.24$ for *P. leonensis* in Lake Taabo. This difference between the values of the allometric coefficient b could be explained by differences in the environmental factors, the physiological conditions of the fish at the time of sampling (gonad development and nutrient conditions), food competition in the ecosystems and to the different size ranges observed as underlined by Froese (2006) ; Kalhoró *et al.* (2014).

4.3 Condition Factor

The average values of the condition factor of *Pellonula leonensis* at the Aghien lagoon vary significantly from one month to another. Analysis of this parameter revealed that low average KC values are recorded in the months of September and October. According to Kingdon and Allison (2009), September and October correspond to the reproductive period of *P. leonensis* in the Niger Delta. In addition, Edoukou *et al.* (2017) ; Djadji *et al.* (2013) note that during the breeding season, fish feed less and begin to tap into their reserves to meet energy requirements. This could explain the low condition factor values of *P. leonensis* obtained in September and October at the Aghien lagoon.

4.4 Growth Parameters

Concerning the growth parameters according to the von Bertalanffy model, the determination was based on the electronic analysis of the size frequencies. The adjustment of the von Bertalanffy equation to the available size frequencies is expressed by an index (R_n) which can vary between 0 and 1 according to Pauly (1987). For the population of *Pellonula leonensis* exploited at the Aghien lagoon, the value of R_n obtained ($R_n = 0.20$) is included in this range. This indicates that the current method used best fits and that the estimated

parameters are reliable. Growth coefficient analysis ($K = 0.67$) reveals that *P. leonensis* has a tendency to grow more rapidly towards asymptotic length (Branstetter, 1987). In addition, based on the K value, Jutagate and De Silva (2003) note that this fish species is a long-lived species. The growth performance index ($\Phi' = 2.03$) recorded during the present study is close to those of Bédia (2015) obtained for another Clupeidae *Ethmalosa fimbriata* in the Aghien lagoons ($\Phi' = 2.71$) and Potou ($\Phi' = 2.64$). In addition, Pauly and Munro (1984); Pérez-Bote and Roso (2012) indicated that species within the same family are expected to have similar values of growth performance index.

4.5 Mortality Parameters and Exploitation Rate

This study shows that, in *Pellonula leonensis* at the Aghien lagoon, the natural mortality rate ($M = 0.92 \text{ year}^{-1}$) is equal to the fishing mortality rate ($F = 0.95 \text{ year}^{-1}$). This result indicates an optimum exploitation status for *P. leonensis* stock (Gulland, 1971). This result is confirmed while considering the analysis of Beverton and Holt's model (1966). Indeed, this analysis revealed a value of $E_{0.1}$ of 0.55 identical to the value of the exploitation rate E ($E = 0.51$). Otherwise, in Lake Taabo (Bandama Basin, Ivory Coast), Koné *et al.* (2014) reported in the same species a natural mortality ($M = 2.55 \text{ year}^{-1}$) greater than the fishing mortality ($F = 0.93 \text{ year}^{-1}$). They also pointed out that the *P. leonensis* stock is under exploited in Lake Taabo with an exploitation rate of 0.27. This difference in the stock status of the two populations in the two environments could be justified by the mathematical expression of the exploitation rate. In fact, the natural mortality of *P. leonensis* in Lake Taabo is much higher than that of the species at the Aghien lagoon. The exploitation level of the species was higher than $E_{0.5}$ ($E_{0.5} = 0.34$) for which the stock is reduced by 50% of its unexploited biomass. This result indicates that the current exploitation of *P. leonensis* in the Aghien lagoon may not ensure the durability of the biomass of the species.

4.6 Recruitment Pattern and Probabilities of Capture

Recruitment of *Pellonula leonensis* shows two Gauss curves. This observation is consistent with Pauly's (1982) assertion that tropical fish exhibit double annual recruitment. This result translates two breeding periods per year for *P. leonensis* in the Aghien lagoon. Recruitment is continuous throughout the year but is marked by significant peaks. The periods of intense recruitment coincide with the rainy seasons when the trophic conditions become favorable for the growth of young individuals of the studied species. In fact, the strategy for tropical fish would be to match the larval emergence period to a time when the environmental factors are more likely to survive the larvae. For example, the reproductive biology of *P. leonensis* (Koné *et al.*, 2011) reveals that the monthly variation of the gonad index peaks in April in Lake Kossou (Côte d'Ivoire) and another in October in the Niger Delta (Kingdom and Allison, 2009). The diagnosis of *Pellonula leonensis* fishing at the Aghien lagoon through the L_c / L_∞ ratio ($L_c / L_\infty = 0.44$) reveals that catches are dominated by small individuals (Moreau and Cuende, 1991).

5. Conclusion

This study suggests that for optimal exploitation of *Pellonula leonensis* at the Aghien lagoon, it would be necessary to increase the size of the first capture and maintain the current exploitation rate (Figure 10).

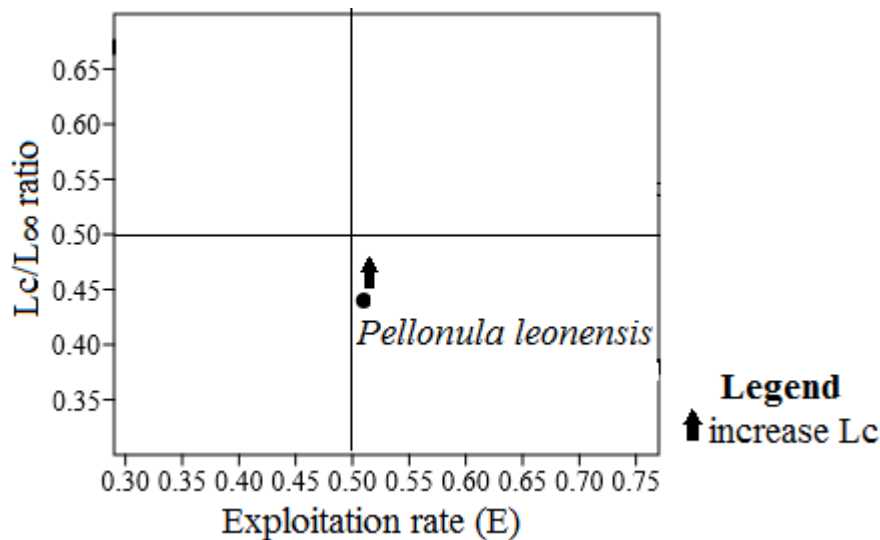


Figure 10. Schematization of the intervention on L_c and E for optimal exploitation of *P. leonensis* at the Aghien lagoon. L_c : The length at first capture; L_∞ : The asymptotic length

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