



International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129

P-ISSN: 2394-0506

(ICV-Poland) Impact Value: 5.62

(GIF) Impact Factor: 0.549

IJFAS 2021; 9(6): 120-126

© 2021 IJFAS

www.fisheriesjournal.com

Received: 15-09-2021

Accepted: 18-10-2021

Wadjé Jérôme N'Glouan

Formation Unit and Research of
Nature Sciences, University
Nangui Abrogoua,
02 BP 801 Abidjan 02 –
Côte d'Ivoire

Jean Noel Yapi

Formation Unit and Research of
Nature Sciences, University
Nangui Abrogoua,
02 BP 801 Abidjan 02 –
Côte d'Ivoire

Vincent Kadjo

Formation Unit and Research of
Biological Sciences, University
Péléforo Gon Coulibaly, BP 1328
Korhogo - Côte d'Ivoire

Dofara Soro

Formation Unit and Research of
Nature Sciences, University
Nangui Abrogoua,
02 BP 801 Abidjan 02 –
Côte d'Ivoire

Corresponding Author:

Wadjé Jérôme N'Glouan

Formation Unit and Research of
Nature Sciences, University
Nangui Abrogoua,
02 BP 801 Abidjan 02 –
Côte d'Ivoire

Growth, exploitation and mortality parameters of mangrove oyster *Crassostrea gasar* of Grand-Lahou Lagoon (Côte d'Ivoire)

**Wadjé Jérôme N'Glouan, Jean Noel Yapi, Vincent Kadjo and Dofara
Soro**

DOI: <https://doi.org/10.22271/fish.2021.v9.i6b.2594>

Abstract

This study on growth, exploitation and mortality parameters of the mangrove oyster in the Grand-Lahou Lagoon was conducted from February 2019 to January 2020. Thus, a monthly sampling of 60 oysters coupled with water temperature measurement was carried out. Parameters were determined from the 20 mm size frequencies and integrated into the FiSAT I I software. Oysters from the Grand-Lahou lagoon have an asymptotic length of 142 mm, a growth coefficient (K) of 0.85 year⁻¹, and a growth performance index of 2.234. Total mortality, natural mortality and fishing mortality are 2.26 year⁻¹, 2.01 year⁻¹ and 0.25 year⁻¹, respectively. Survival rate is 0.104 year⁻¹, the exploitation rate (E) 0.11 and longevity (t_{max}) recorded is 3.53 year⁻¹. Oyster recruitment is continuous throughout the year with two peaks, the largest in April and the lowest in October. Results from this study could contribute to the sustainable exploitation of this aquatic resource.

Keywords: Growth, Exploitation, Mortality, *Crassostrea gasar*, Grand-Lahou Lagoon, Côte d'Ivoire

1. Introduction

Coastal and estuarine areas are major ecological and economic importance (Costanza, 1997)^[1]. Among the species which live in these areas are oysters that are of major importance in terms of food (Jouzier 1998)^[2], ecological (Tamburri *et al.*, 2008)^[3] and economic (Baron 1992)^[4]. The species *Crassostrea gasar*, also known as mangrove oysters, is present on most of lagoon coasts of Côte d'Ivoire and is a significant source of protein and income for Ivorian populations, particularly those of coastal areas (Yapi *et al.*, 2016)^[5]. Unfortunately, studies by these authors at the Ebrié and Aby lagoons show growth problems that are likely due not only to uncontrolled exploitation of the stock (Yapi *et al.*, 2016)^[5] but also to a level of water pollution in these lagoons (Scheren *et al.*, 2004)^[6]. In this context, it is therefore appropriate to find other suitable sites meeting the optimum conditions for the sustainability of this species, which is within reach and whose breeding would be of great benefit as regards its contribution to the self-sufficiency of animal proteins. The aim of this study is to study the dynamics of oyster populations of the Grand-Lahou lagoon.

2 Materials and methods

2.1 Study area

The present study was carried out at the level of the lagoon coasts of Grand-Lahou, more precisely between the villages of Groguida and Lahou-Kpanda. Figure 1 shows the geographic location of the sampling area

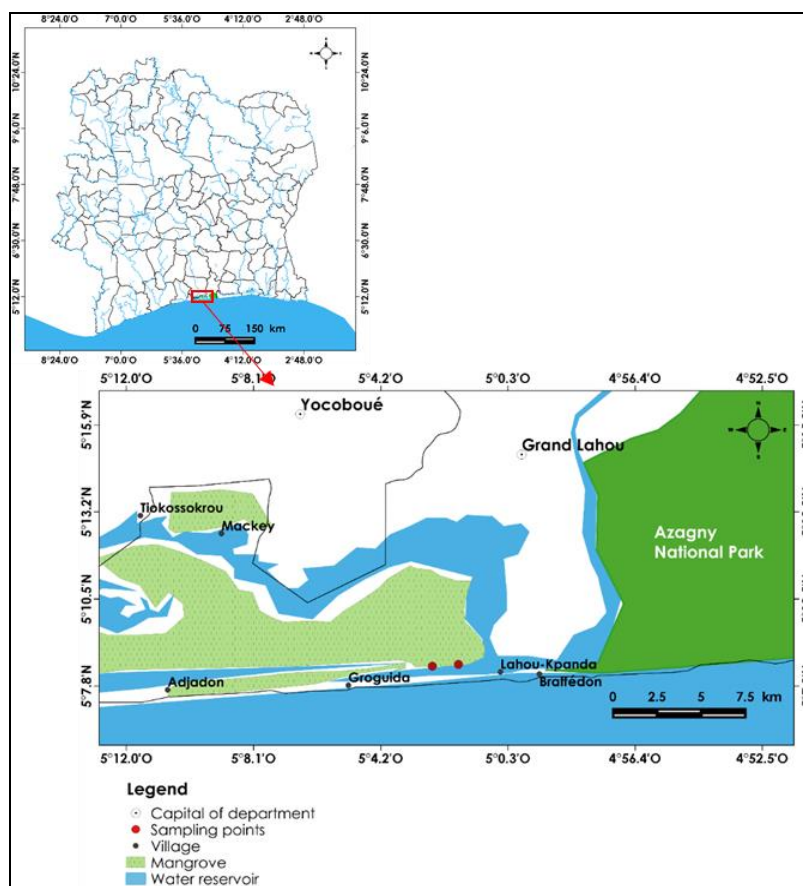


Fig 1: Geographical location of the sampling area

2.2 Sampling and data processing

The study of oyster population dynamics in the Grand-Lahou lagoon required a monthly sampling of 60 oysters over a 12-month period from February 2019 to January 2020. These samples were coupled with the measurement of water temperature at the sampling points. The specimens from these samples were then subjected to linear measurements of the waist using a caliper of maximum size 200 mm and 1 mm graduation. Thus, size classes of 20 mm were established for each month of sampling with these monthly size classes, size frequencies were established to facilitate the study of population structure. Thus, for the study of linear growth, the different size classes were subjected to the Von Bertalanffy equation using FiSAT II software (Gayalino *et al.*, 1996) [7]. This equation is of the following form:

$L_t = L_\infty(1 - e^{-K(t-t_0)})$. In this equation, L_t is the length at time t , L_∞ is the asymptotic length; K is the growth coefficient and t_0 is the age of the oyster assumed at size t_0 . Next, the ELEFAN 1 (Electronic Size Frequency Analysis) routine of the FiSAT II program (FAO ICLARM Stock Assessment Tools) was used to estimate L_∞ and K (Von Bertalanffy, 1938) [8].

2.2.1 Growth Performance Index (Φ')

The growth performance index is used to assess linear growth (Φ'). It is determined from the Pauly and Munro (1984) [9] equation using the formula:

$$\Phi' = \log_{10}(K) + 2\log_{10}(L_\infty)$$

Modal progression is analysed using the method of Bhattacharya (1967) [10]. This method is based on the fact that a distribution, which does not have an empty class, can be transformed into a negative slope straight line, by placing the

center of abscissas classes on the ordinate. The quantity $\Delta \ln N$ were the difference of neperian logarithms of consecutive frequencies in the distribution.

The equation of Bhattacharya (1967) [10] is as follow: $\Delta \ln N = \ln N_{(X+h)} - \ln N_{(X)}$. In this equation $N_{(X+h)}$ is the size of the length class $(X+h)$; $N_{(X)}$ the size of the previous length and class center (X) ; h class interval and X class center.

1.2.2 Longevity (t_{max})

The longevity (t_{max}) of oysters, at which 95% of asymptotic size L_∞ is reached, is estimated through the Pauly equation (Pauly, 1980a) [11]:

$$t_{max} = \frac{3}{K}$$

K: growth coefficient

2.2.3 Recruitment

Recruitment is characterized by the entry of a smaller size group into the stock of the potentially exploitable size group. This size is determined from the size frequency distribution (Ahouansou, 2011) [12].

2.2.4 Mortality parameters and exploitation rate

Total mortality (Z) is estimated from the capture curve. This curve is based on length in a sample of population that is assumed to be stable (size frequency data with a constant size class). It uses for its realization, the parameters L_∞ , K et T . Natural mortality (M) is determined by Pauly's method (Pauly, 1980b) [13]. The mortality from picking (F) is determined by the difference between Z and M . The Parameters required for determining Z , M and F are L_∞ , K and T (annual habitat temperature average in °C). The exploitation rates (E) and survival rates (S) of populations are

determined from the empirical formula of Pauly (1980a) [13] and Gayanilo *et al.* (1996) [14] according the following formula:

$$E = F/Z \text{ et } S = \text{Exp}(-Z) \text{ à l'âge } t_0$$

Age t_0 is calculated from Pauly's equation (Pauly, 1979) [15]:

$$\text{Log}_{10}(-t_0) = -0,392 - 0,275 \text{log}_{10}(L_{\infty}) - 1,038 \text{log}_{10}(K)$$

t_0 : theoretical conventional age for which the oyster has a null length; L_{∞} : asymptotic size and K : growth rate.

2.2.5 Virtual Population Analysis

Virtual Population Analysis (VPA) describes the state of exploitation and provides reliable assessments of stock management. It is used to estimate stock size and picking mortality. It is based on the defined size classes, F_t (0,5), M , L_{∞} , K , recruitment and allometry coefficients, a and b of the length-weight relationship.

2.2.6 Relative efficiency per recruit (Y'/R)

The relative efficiency per recruit is expressed by the model of Beverton and Holt (1966) [16]. It is used to determine the ratio of efficiency to picking effort based from first catch sizes. The expression Y'/R is:

$$\frac{Y'}{R} = 1 - LcL_{\infty}$$

Lc : first capture size L_{∞} : asymptotic length

The efficiency of biomass per recruit was determined by the following formula:

$$(B'/R) = (Y'/R) \times F$$

FiSAT II 1.1.0 allowed the application of the model of Beverton and Holt (1966) [16].

3 Results

3.1 Growth curve

The growth curve was represented from the values of the parameters determined through the distribution of the restructured lengths in figure 2. The asymptotic length (L_{∞}) reaches by Grand-Lahou lagoon oysters is 14.2 cm.

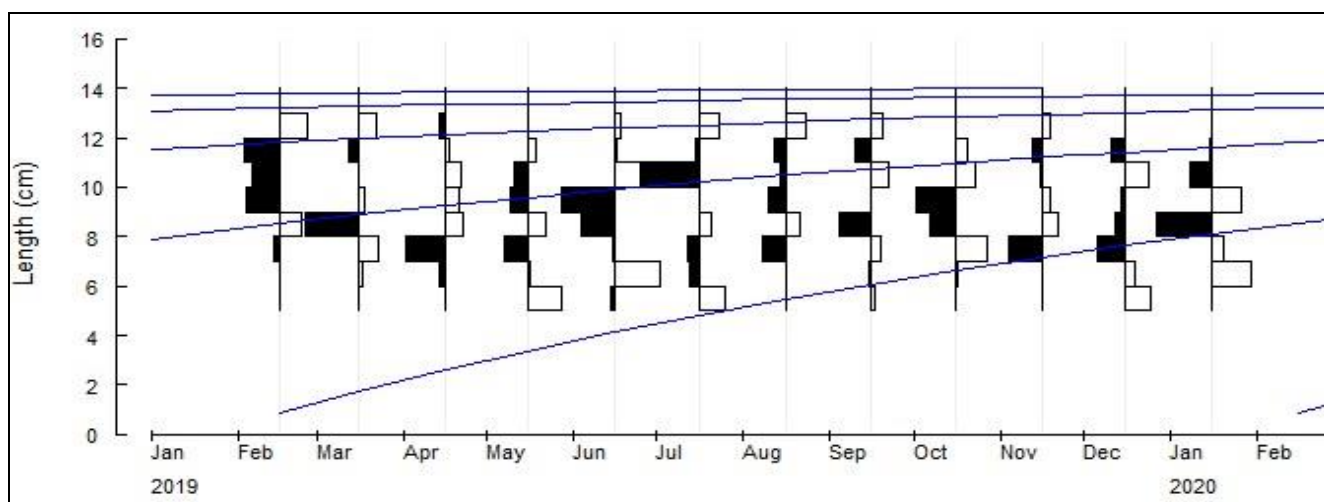


Fig 2: Growth curves obtained from size frequency histograms of *Crassostrea gasar*

3.2 Growth coefficient K and Growth Performance Index (Φ')

The figure 3 presents the estimated value of the annual growth coefficient K and the growth performance index (Φ') for

oysters in the Grand-Lahou lagoon. It appears that the oysters in this lagoon have a growth constant $K = 0,85 \text{ year}^{-1}$ and a growth performance index $\Phi' = 2,234$.

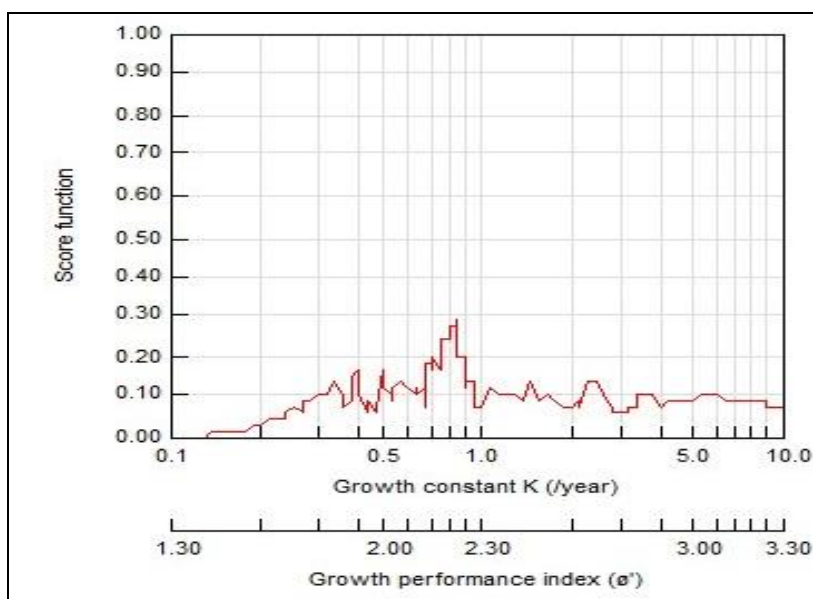


Fig 3: Growth coefficient and growth performance index of Grand-Lahou oyster *Crassostrea gasar*

3.3 Recruitment and longevity of Grand-Lahou lagoon oysters

Two recruitment peaks were recorded in the oyster stocks sampled in the Grand-Lahou lagoon. The first recruitment runs from February to June. The recruitment percentage for this period is 42.46% with a maximum recruitment level of 12.85% in April. The second, longer recruitment takes place

from July to December with a global recruitment percentage of 57.55%. The recruitment peak for this period is 19.08% and takes place in October. The month of January does not record any recruitment (0%). The figure 4 shows the evolution of oyster recruitment in the Grand-Lahou lagoon during the study period. Age t_0 and longevity $t_{(max)}$ were -0.53 and 3.53 years respectively.

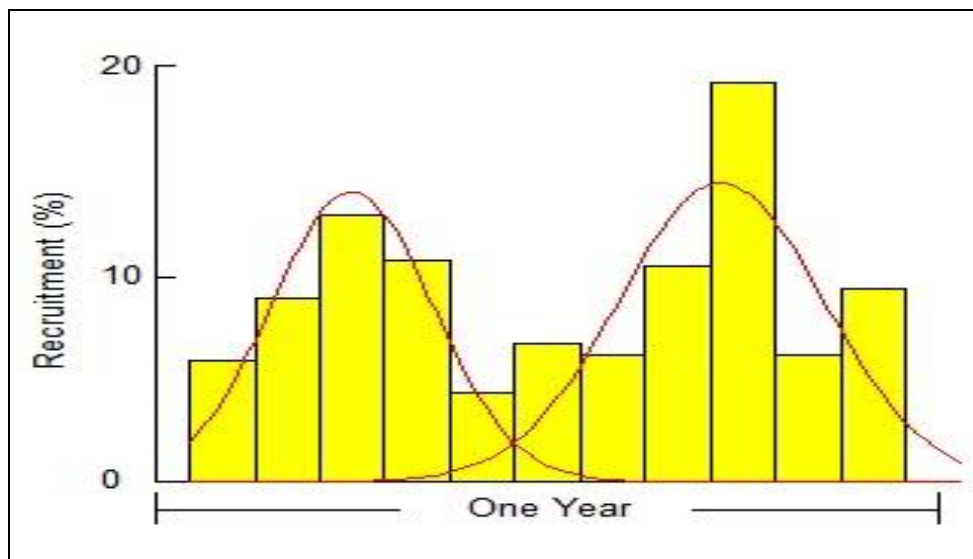


Fig 4: Recruitment of oysters in the exploitable population in the locality of Grand-Lahou for the period from February 2019 to January 2020

3.4 Mortality and exploitation parameters

The figure 5 shows the capture curve for oysters from the Grand-Lahou lagoon at an average annual temperature of 29°C. For this period, the total mortality (Z) determined is

2.26 year⁻¹, the natural mortality (M) is 2.01 year⁻¹, and the fishing mortality (F) is 0.25 year⁻¹. The exploitation (E) and survival (S) rates are 0.11 and 0.104 year⁻¹, respectively.

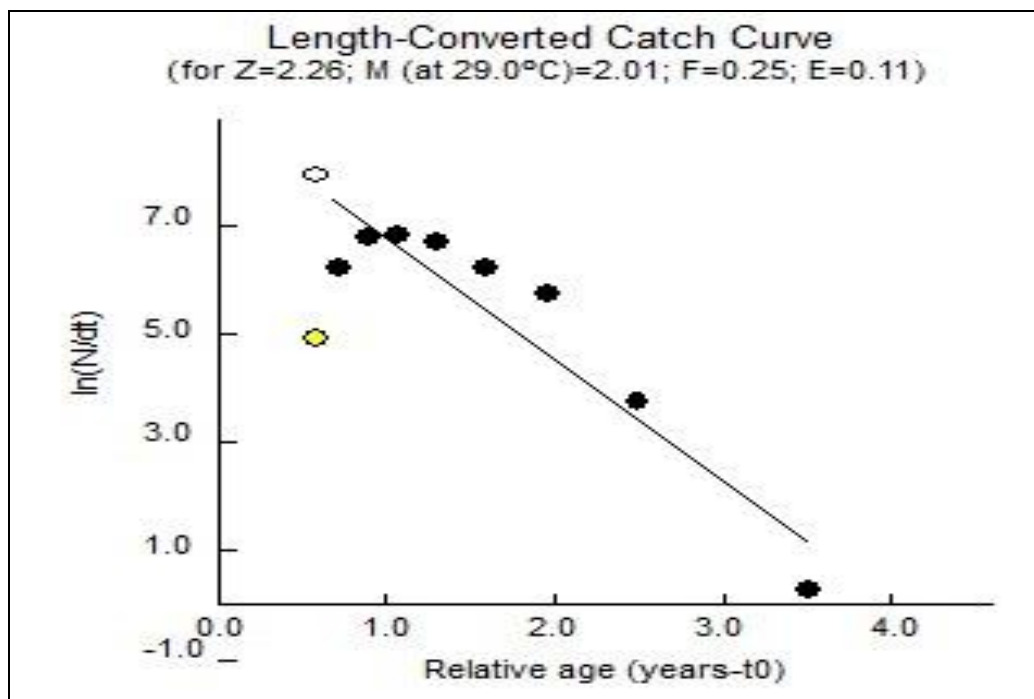


Fig 5: Catch curve based on oyster size in Grand-Lahou localities for the period February 2019 to January 2020.

3.5 Virtual Population Analysis (VPA)

3.5.1 Capture probability and first capture size

The figure 6 shows the catch probabilities of oysters from the Grand-Lahou lagoon. The first LC or L50 catch size of the oysters of the Grand-Lahou lagoon is estimated at 59.50 mm.

The size for which the probability of capture is 25% (L25) is 52 mm. The size for which the probability of capture is 75% is 67.10 mm.

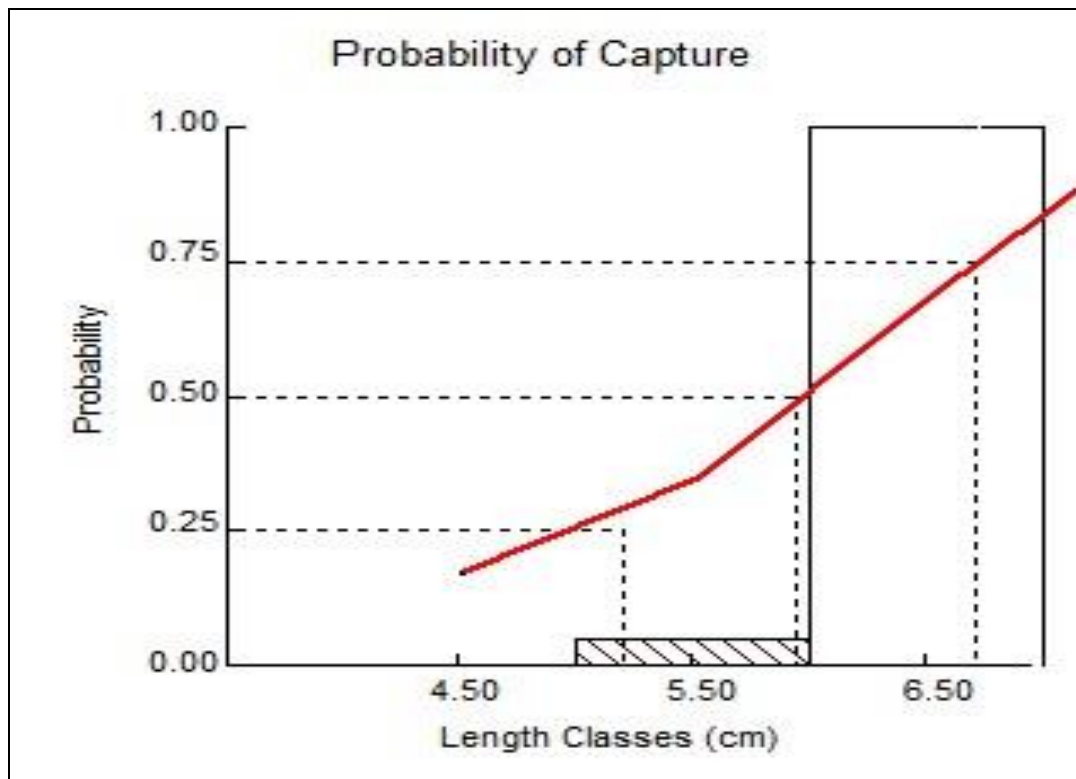


Fig 6: Probability of catching oysters from Grand-Lahou localities: (— Capture probability curve)

3.5.2 Reconstructed population and stock vulnerability size

The figure 7 shows the reconstructed population based on size data collected depending on exploitation parameters. The proportion of survivors decreases inversely with increasing size. The same is true of natural mortality. As regards catches, they affect individuals of all sizes. However, the most

captured individuals are those larger than 70 mm. Contrary to survivors, fishing mortality increased with size to its highest point (most vulnerable size) in individuals 115 mm in size. The size decreases progressively in individuals from more than 115 mm up to 120 mm. Finally, the size remains stable in individuals over 120 mm.

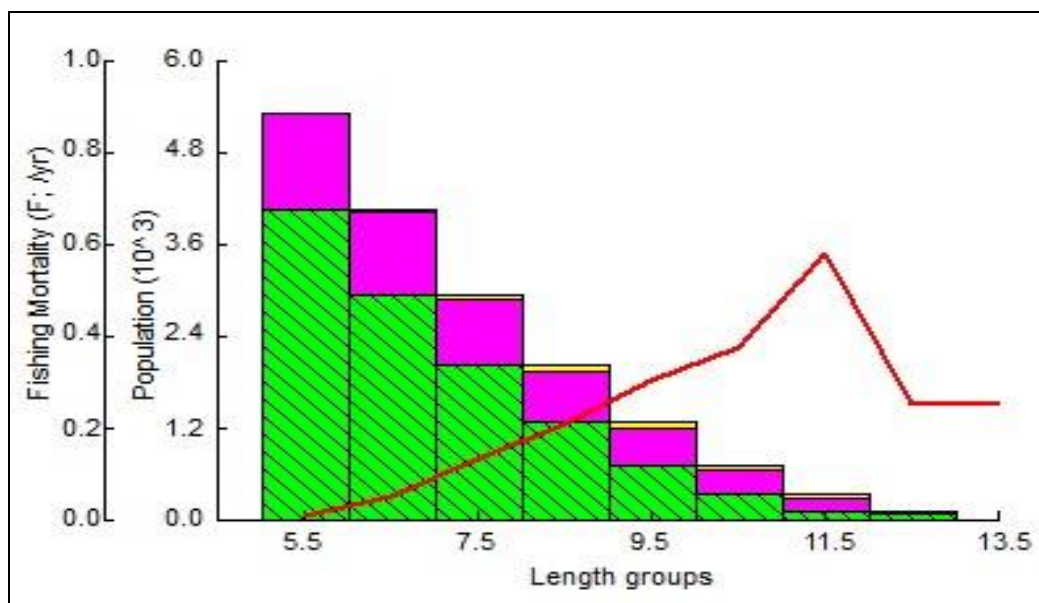


Fig 7: Virtual representation of oyster biomass based on size of individuals studied

3.5.3 Relative analysis Y/R and B/R by using the warhead of selection (Model of Beverton and Holt)

The plots of Y'/R and B'/R as a function of $E (F/Z)$ made it possible to estimate the exploitation rates E_{max} , $E_{0.1}$ and $E_{0.5}$. Figure 8 shows the exploitation level of oysters in the Grand-Lahou lagoon from February 2019 to January 2020.

The value of the exploitation rate with maximum production yield (E_{max}) is 0,704 while the value of the exploitation rate (E_{50}) for which the stock is reduced by 50% is 2.6 times less than that of E_{max} . Finally, the exploitation rate for a Y'/R increase of 1/10th (E_{10}) is 0.602.

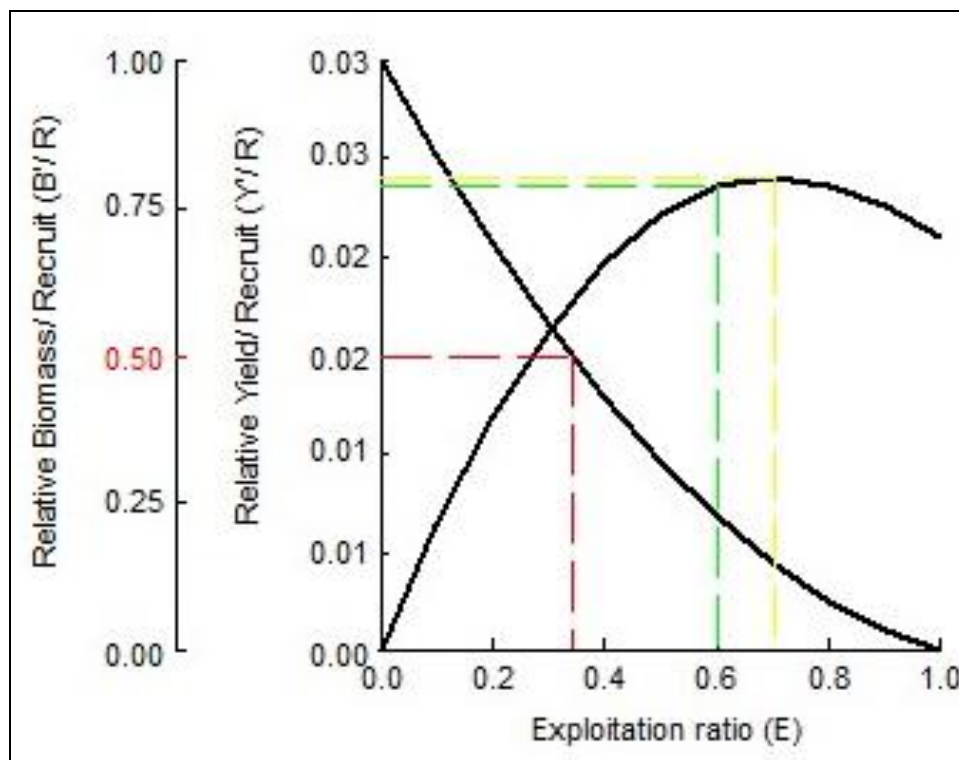


Fig 8: Probability of capture of Grand-Lahou oysters

4. Discussion

The growth coefficient (K) obtained in the Grand-Lahou oyster populations is 0.85 year^{-1} . Similar work has been carried out by Yapi *et al.* (2017)^[17] in the Ebrié and Aby lagoons, specifically in the towns of Assinie, Grand-Bassam and Azito. The growth coefficient of this study, although lower, is similar to that obtained at Grand-Bassam (0.88 year^{-1}). However, it is lower than that of Azito (1.80 year^{-1}) and higher than that of Assinie (0.58 year^{-1}). The Growth Performance Index Φ' (2.234) obtained is lower than Φ' of oysters from the abovementioned localities. However, Grand-Lahou oysters recorded a greater asymptotic length than that obtained in the study of Yapi *et al.* (2017)^[17] with a value of 142 mm. Variations in the population dynamics of oysters from these different lagoons would be related to their environment, particularly physicochemical conditions. This affirmation was supported by Yapi *et al.* (2017)^[17]. Differences in oyster performance between study sites were attributed to the physicochemical parameters of the water, in particular, to stress. The same observation was made by Nadira (2009)^[18] during work on mussels. Several studies have shown that bivalve growth is influenced by the nutritional quality of the environment (Utting, 1986)^[19] and environmental stresses (Yapi *et al.* (2017)^[17]; Bayne *et al.*, 1999^[20]; Etchian *et al.*, 2004^[21]). Most organism use their energy resources to activate their defence mechanisms during fluctuations of environmental factors. Yapi *et al.* (2017)^[17] have shown that *C. gasa* oysters from Azito Ebrié lagoon direct most of their energy to restoring and maintaining their physical condition. Grand-Lahou oysters have a means lifespan ($t_0 = -0.53 \text{ year}^{-1}$ at $t_{\text{max}}: 3.53 \text{ year}^{-1}$). The specimen's longevity value is similar to that obtained at Grand-Bassam (3.47 years by Yapi *et al.* (2017)^[17]). This result would lead to the conclusion that Grand-Lahou lagoon would be in physicochemical conditions similar to those of the Ebrié Lagoon, but particularly at Grand-Bassam level. Kambiré *et al.* (2014)^[22] indicated that anthropogenic activities such as

domestic waste, agricultural soil leaching and illegal gold panning sites upstream of the Bandama river would pose a risk of pollution of the Grand-Lahou lagoon with which the Bandama river communicates. The recruitment of young oysters into the exploitable stock usually takes place during the rainy season. During this period, the level of the lagoon increases considerably and is provided with nutrients. This observation is consistent with the recruitment of *C. gasar* in the Assinie lagoon and contradictory in the Azito and Grand Bassam lagoons (Yapi *et al.*, 2017)^[17]. The unsynchronized recruitment time would be related to the difference in growth rate values.

In this study, the total mortality values and the exploitation rate (E) are low. Oysters are under exploited in the Grand-Lahou lagoon. The low mortality rate of oysters reflects a lower level of pollution in the lagoon. Oysters are used by local fishermen as bait rather than human consumption. Our results are controversial in Azito, Grand Bassam and Assinie. In these communities, total mortality and exploitation rates are very high and could be attributed to pollution and fishing (Yapi *et al.*, 2017)^[17].

The estimated first capture size (LC or L_{50}) is 57 mm and is less than the more vulnerable size (115 mm). This situation is interesting because individuals will have time to procreate before being captured. Reproduction will therefore favour the maintenance and renewal of the stock. Our results are contradictory to those obtained by Yapi *et al.* (2017)^[17] in Azito oysters. In this locality, the LC (98.36) is substantially equal to the average size exploited (99 mm) and could result in the extinction of this fishery resource.

5. Conclusion

This study revealed that the mangrove oyster *Crassostrea gasar* is under exploitation in the Grand-Lahou lagoon with an exploitation rate below the threshold of 0.5. The growth and mortality parameters are enough good with an asymptotic length of 142 mm. Recruitment is continuous throughout the

year with two peaks in April and October. Oysters in the Grand-Lahou lagoon have a longevity of 3.53 years. This study would make it interesting to use the data obtained for sustainable stock management.

6. References

1. Costanza R, Darge R, Degroot R, Farber S, Grasso M, Hannon B *et al.* The value of the world's ecosystem services and natural capital. *Nature*. 1997;387:253-260.
2. Jouzier E. L'huître : Aliment ou Médicament ? Bulletin de la Société de Pharmacie de Bordeaux 1998;137:71-89.
3. Tamburri MN, Luckenbach MW, Breitburg D, Bonniwell S. Settlement of *Crassostrea ariakensis* larvae: effects of substrate, biofilms, sediment and adult chemical cues. *Journal of Shellfish Research* 2008;27(3):601-608.
4. Baron J. Reproductive cycles of the Bivalve Molluscs *Acteodea striata* (Gmelin), *Gafrarium tumidum* and *Anadra scapha* (L.) in New Caledonia. *Australian Journal of Marine Freshwater Research* 1992;43:393-402.
5. Yapi JN, Blé MC, Etchian AO, Kadjo V, Soro D, Yao K. Actors and effort of the artisanal harvesting of mangrove oyster *Crassostrea gasar* along the littoral lagoons Ebrié and Aby (Côte d'Ivoire). *International Journal of biosciences*. 2016;9(6):45-54.
6. Scheren PAGM, Kroeze C, Janssen FIJG, Hordijk L, Ptasinski KJ. Integrated water pollution assessment of the Ebrie Lagoon, Ivory Coast, West Africa. *Journal of Marine Systems*. 2004;44:1-17.
7. Gayanilo FCJr, Sparre P, Pauly D. *FAO-ICLARM stock assessment tools (FiSAT). User's guide*. FAO Computerized Information Series (Fisheries), 8, Rome, FAO 1996, 126.
8. Von Bertalanffy L. A quantitative theory of organic growth (inquiries in growth laws II). *Human Biology*. 1938;10:181-213.
9. Pauly D, Munro JL. Once more on the comparison of growth in fish and invertebrates. *Fishbyte*. 1984;2(1):1-21.
10. Bhattacharya CG. A simple method of resolution of a distribution into Gaussian components. *Biometrics*. 1967;23:115-135.
11. Pauly D. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. *Journal du Conseil International pour l'Exploration de la Mer*. 1980a;39(3):175-192.
12. Ahouansou MS. Etude de la biodiversité et de l'exploitation des poissons de la rivière Pendjari au Bénin. Thèse de Doctorat de l'Université d'Abomey-Calavi 2011, 219.
13. Pauly D. A Selection of Simple Methods for the Assessment of Tropical Fish Stocks. *FAO Fishery Circular*, 1980b;729:54.
14. Gayanilo FCJr, Sparre P, Pauly D. *FAO-ICLARM stock assessment tools (FiSAT). User's guide*. FAO Computerized Information Series (Fisheries), 8, Rome, FAO 1996, 126.
15. Pauly D. Theory and management of tropical multispecies stocks. A Review with Emphasis on Southeast Asian Demersal Fisheries 1979, 35.
16. Beverton RJH, Holt SJ. Manual of methods for fish stock assessment: Part II. Tables of yield function. *FAO Fisheries Biology Technical Paper* 1966;38 :67.
17. Yapi JN, Blé MC, Etchian AO, Kadjo V, Yao K. Population Dynamics of Mangrove Oyster, *Crassostrea gasar* of the Lagoons Ebrié and Aby (Côte d'Ivoire). *International Journal of Sciences: Basic and Applied Research*. 2017;36(8):122-137.
18. Nadira B. Etude de la croissance et du cycle de reproduction de la moule *Perna perna* dans le golfe d'Annaba et le littoral d'El Kala. Mémoire de Magistère, Université Badji-mokhtar, Annaba 2009, 112
19. Utting SD. A Preliminary study on growth on *Crassostrea gigas* larvae and spat in relation to dietary protein. *Aquaculture* 1986;56:123-138.
20. Bayne BI, Svensson S, Nell JA. The physiological basis a for faster growth in the Sydney Roch oyster, *Saccostrea commercialis*. *Biological Bulletin* 1999;197(3):377-387.
21. Etchian AO, Pellerin J, Audet C, Mathieu M. Sexual maturation and related changes in aspartate transcarbamylase activity of gonad tissues in the soft shell clam (*Mya arenaria*). *Comparative Biochemistry and Physiology*. 2004;139:287-297.
22. Kambiré O, Adingra AA, Eblin SG, Aka N, Kakou AC, Koffi-Nevry R. Characterization of an estuarine lagoon waters of ivory coast: the aby lagoon. *Larhyss Journal* 2014;20:95110.