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Some Observation on the Age, Growth, and Management of *Trachinotus Teraia* Cuvier, 1832 from Ebrié Lagoon System of Ivory Coast (West Africa)

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Abstract: **The aim of this study was to estimate the population parameters and exploitation level of *Trachinotus teraia* from Ebrié Lagoon (Ivory Coast). Monthly data of length composition for *Trachinotus teraia* were recorded between February 2004 and January 2006. ELEFAN in the software package FiSAT was used to analyse the length frequency data. A total of 1806 individuals ranging from 5.0 to 65.3 cm FL (Fork length), were examined.The von Bertalanffy growth constants were, asymptotic fork length (LF_∞) = 58 cm, growth coefficient (K) = 0.43 year $^{-1}$. The theoretical age at length zero (t_0) and the growth performance index (φ') calculated, gave respectively -0.32 year and 3.16. The growth males and females pattern showed positive allometric growth (b > 3), with an asymptotic weight (W_∞) 4020.06 g and 4176.32 g, respectively. *Trachinotus teraia* attained 17.91 cm (LF) at the end of 1 year. Total mortality (Z) = 1.68 year^{-1}, natural mortality (M) = 0.87 year^{-1}, fishing mortality (F) = 0.81 year^{-1} and exploitation rate (E) = 0.48 respectively. The exploitation level (0.48) indicated that *T. teraia* stock was exploited at almost maximum yield in this lagoon.**

Keywords: **Exploitation Rate, Mortality Rates, *Trachinotus Teraia,* Von Bertalanffy Growth Constants**

I. Introduction

Coastal lagoons are known to serve as complementary ecosystems in the life cycle of some fish species because they offer refuge for reproducing adults [1]. This makes these habitats highly productive ecosystems inhabited by many fish species [2]. The Ebrié lagoon, the largest lagoon in West Africa with an area of 566 km ^{2} , has been permanently connected to the sea since the opening of man- made channel (Canal de Vridy) in 1950. Freshwater input comes from a tropical transition regime river, the Comoé, and two small coastal forest rivers, Mé and Agnebi [3].

The sand filling changes the ecological regimes of the lagoon ecosystem both in terns of the physical structure and physico- chemical parameters, which invariably result in changes in the fishery resources. In some countries, the effects of fishing are exacerbated by inadequate resources available to management agencies and increasing human population [4]. Reference [5] has studied the impact on fish assemblages in Ebrié Lagoon. This reference show that there were mayor changes including an increased catch yield (37.5-189 Kg ha $^{-1}$y^{-1}, a lowering of fish diversity in catches and fish biomass (100-20 Kg ha $^{-1}$).

Population dynamics of fishes are studied with the major objective of rational management and conservation of the resource [6]. Knowledge of various population parameters such as asymptotic length (L_∞) and growth coefficient (K), mortalities (natural and fishing) rate and exploitation level (E) are necessary for planning and management fish resources. There are many tools for assessing the exploitation level and stock status. Of these, FiSAT (FAO-ICLARM Stock Assessment Tools) has been most frequently used for estimating population parameters of fish [7], primarily because it requires only length-frequency data. The objective of the present study was to estimate population parameters of *Trachinotus teraia* in order to assess the stock status of this species from Ebrié lagoon and provide data that could be useful for management.

II. Materials and Methods

1. Study Area and Sampling:

From February 2004 to January 2006, *Trachinotus teraia* samples were obtained from commercial gill net catches of mesh size (10, 14, 20, 25, 30, 35, 40, 50, 80 and 100 mm) and examined using keys provided by reference [8]. The monthly length–frequency data analysed in this study were collected from three sites (Layo, Ahua and Gboyo) of Ebrié lagoon (longitude 4°19' to 4°48' W and latitude 5°12'to 5°18' N (Figure 1). All fish samples caught were packaged in ice-chests and transported to the laboratory, where they were counted and the measurements (total length, fork length and weight) were recorded to the nearest 0.1 cm and 0.1g, respectively.

2. Data analysis

2.1. Growth parameters

Data from the sites were pooled monthly and subsequently grouped in length classes at 2 cm intervals. The analysis of data was done using the FiSAT software [9]. Asymptotic length (L_∞) and growth coefficient (K) of the von Bertalanffy Formula (VBGF) were estimated by averages of ELEFAN I routine [10]. Reference [11]'s empirical equation for the theoretical age at length zero (to) was used to obtain this parameter as $\log_{10}(-to) = -0.392-0.275 \log_{10} L_\infty -1.038 \log_{10} K$.

Estimated L_∞ and K were used to calculate the growth performance index (φ') using the equation: $\varphi' = 2 \log_{10} L_\infty + \log_{10} K$ [12].

The inverse von Bertalanffy growth equation of this reference [13] was used to determine *Trachinotus teraia* lengths at various ages. The VBGF was then fitted to estimates of fork length–age curve using non-linear squares estimation procedures [14]. The VBGF is defined by the equation: $L_t = L_\infty\ [1–e^{-K\,(t-to)}]$ where L_t = average fork length at age t; L_∞ = asymptotic fork length; K = growth coefficient; t = age of the *T. teraia* and t_o = the hypothetical age at which the fork length is zero [15].

To establish the fork length–weight relationship, $W = aL^b$ was applied [16], [17]. The parameters a and b in that formula were estimated through logarithmic transformation in the form, $\text{Log } W = \text{Log } a + b \text{ Log } L$, where W is the total body weight of fish (g), L is the fork length of fish (cm), 'Log a' is the intercept on the Y-axis and 'b' is the growth exponent or regression coefficient. The parameters a and b were determined via least- squares linear regression [18]. The value of b gives information on the kind of growth of fish: if $b = 3$ (the growth is isometric) and the growth is allometric if $b \neq 3$ (negative allometric if $b < 3$ and positive allometric if $b > 3$).

2.2. Mortality parameters

A linearized length–converted catch curve was constructed using the following formula to estimate total mortality (Z): $\ln (N_t / \Delta_t) = a + bt$, where N is the number of individuals of relative age (t) and Δ_t is the time needed *for T. teraia* grow through a length class. The slope (b) of the curve with its sign changed gives Z [19].

Natural mortality (M) was estimated using the empirical relationship of [20] average annual habitat temperature used was 29 °C. $\text{Log}_{10} M = -0.0066 - 0.279 \text{ Log}_{10} L_\infty + 0.6543 \text{ Log}_{10} K + 0.4634 \text{ Log}_{10} T$ where M is the natural mortality, L_∞ = asymptotic length; K = growth coefficient of VBGF and T the average annual habitat water temperature (°C).

The exploitation rate (E) was obtained by dividing F by Z [21], [22].

III. Results

3.1. Fork length–weight relationship

Fork length and weight of the individuals for determining the fork length–weight relationship, were ranged from 5.0 to 65. 3 cm and from 5.69 to 6500.0 g respectively. The length–weight relationship is presented in Figure 2. The length–weight equations calculated were:

$W = 1.08 \times 10^{-2}\ LF^{3.20}$ (r = 0.99) for males,

$W = 1.05 \times 10^{-2}\ LF^{3.22}$ (r = 0.99) for Females,

$W = 0.82 \times 10^{-2}\ LF^{3.29}$ (r = 0.99) for males and Females.

The values (b) of regression coefficient in the length–weight relationship equation calculated were 3.20 for males, 3.22 for females and 3.29 for males and females. These values were different from 3. Consequently, it can also be said that the *T. teraia* showed positive allometry.

3.2. Growth parameters

The computed growth curve with the von Bertalanffy (VBGF) parameters is superimposed over the restructured length distribution in Figure 3. The growth coefficient or curvature parameter K obtained by ELEFAN I routine through the Scan of K was 0.43 year $^{-1}$, L_∞ (asymptotic length) of 58 cm fork length with a goodness of fit (Rn) of 0.229 by automatic computer generation (Table 1). The value of t_0 was -0.32 year. The growth performance index (φ') calculated was 3.16 (Table 1).

Recruitment pulses were reconstructed from the time series of length frequency data to determine the number of pulses per year and the relative strength of each pulse. The Figure 4 showed the backward projection, along a trajectory defined by VBGF for *T. teraia* pattern decomposed from Ebrié lagoon exhibit two peaks.

The inverse von Bertalanffy growth equation [13].was used to find the lengths of the fish at various ages presented in Table 2. *T. teraia* attain at least 50 % of the asymptotic length when at the first age class indicating more rapid growth in length at the early age class (Table 2).

3.3. Mortality and level of exploitation for the stock

The total mortality (Z) was estimated at 1.68 year $^{-1}$ (Figure 5). Natural mortality (M) and fishing mortality (F) were calculated as year $^{-1}$ 0.87 and 0.81 year $^{-1}$, respectively. From this figure an exploitation level (E) of 0.48 was obtained for the *Trachinotus teraia* fishery in Ebrié lagoon (Table 1), which seemed to be lower than the expected optimum level of exploitation (E = 0.50).

IV. Discussion

Length frequency data analysis is a reliable way of obtaining fisheries parameters [6]. The results of this study represent the first data on the length-weight relationship of *Trachinotus teraia* in Ebrié lagoon. The growth coefficient b generally varies between 2.5 and 3.5 [23] and the relation is isometric when b is equal to 3 [17]. In the present study, the values are upper to 3. It shows that the *T. teraia* showed positive allometry. Reference [24] has suggested that the parameter b is characteristic of each species and generally does not change significantly throughout the year. The length–weight relationship is a practical index of the condition of fish, and may vary over the year according several exogenous and endogenous factors such as food availability, feeding rate, health, sex, gonad development, spawning period and preservation techniques [25].

The VBGF parameter L_∞ is a mayor parameter for evaluating the status of population. The maximum length (L_∞) obtained was 58 cm. This value was comparable at

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61 cm reported by reference [26] for the same species. In spite of the fishing at smaller sizes or less than 2 years of age, *Trachinotus teraia* had the chance to grow large enough contribute substantially to the stock biomass. Reference [27] reported that the growth performance index (φ') helps to explain the different ecological peculiarities of different stock or population habitat's environment. According to [28], the negative t_0 values shows that juveniles grew more quickly than the predicted growth curve for adults, and the positive t_0 values indicated that juveniles grew more slowly. Our result concerning t_0 value was negative. *Trachinotus teraia* juveniles seem grew more quickly than the predicted growth curve for adults.

They estimated that the growth performance index (φ') value for some important fishes in Africa ranged from 2.65 to 3.32. The growth performance index (φ') for *T. teraia* was 3.16. This perhaps is indicative of the reliability of using ELEFAN analysis samples obtained from a fishery based on a selective, uniform gear [29]. The parameter *K* indicated the body growth coefficient synonym to the rate at which L_∞ is attained [16]. The *K* value of this study was low 0.43 year $^{-1}$. Recruitment has been described as a year round phenomenon for tropical fish species [30]. The *Trachinotus teraia* stock exhibited two recruitment peaks, which are conforms to [31] assertion of double recruitment pulses per year for tropical fish species.

Considering that the maximum level of production was obtained when the exploitation or utilization rate was *E* = 0.5 or in other words, when *F* = *M*, that indicates the inadequate use or overuse of the stock. It is suggested that the existing exploitation rate be increased by 37 % in order to maximize benefit from the stock [32]. Thus, the higher natural mortality (0.87 year $^{-1}$) versus fishing mortality (0.81year $^{-1}$) observed for *Trachinotus teraia* indicates the unequal position of the stock. The exploitation rate (*E* = 0.48) established for *T. teraia* in the present study was below the optimum level of exploitation (*E* = 0.50) reported by reference [32]. This result clearly indicates growth almost fishing for *Trachinotus teraia* and, in combination with the results of the yield-per-recruit analyses, demonstrates that effort reductions are also required in the fishery because target reference points cannot be achieved by modification of the gear-selectivity characteristics alone.

V. Conclusion

Considering exploitation rate values it can be concluded that: catch rate and fishing mortality are near than maximum sustainable yield and must be decreased. Any increase in the existing fishing level/exploitation will most likely result in a reduction in the yield per recruit and there by hamper the optimum level. It is necessary to immediately impose fishing regulation on the stock and this can be done by gradually increasing the mesh size of the gears or by restricting fishing for certain seasons or declaring fish sanctuaries in certain areas, especially in spawning areas.

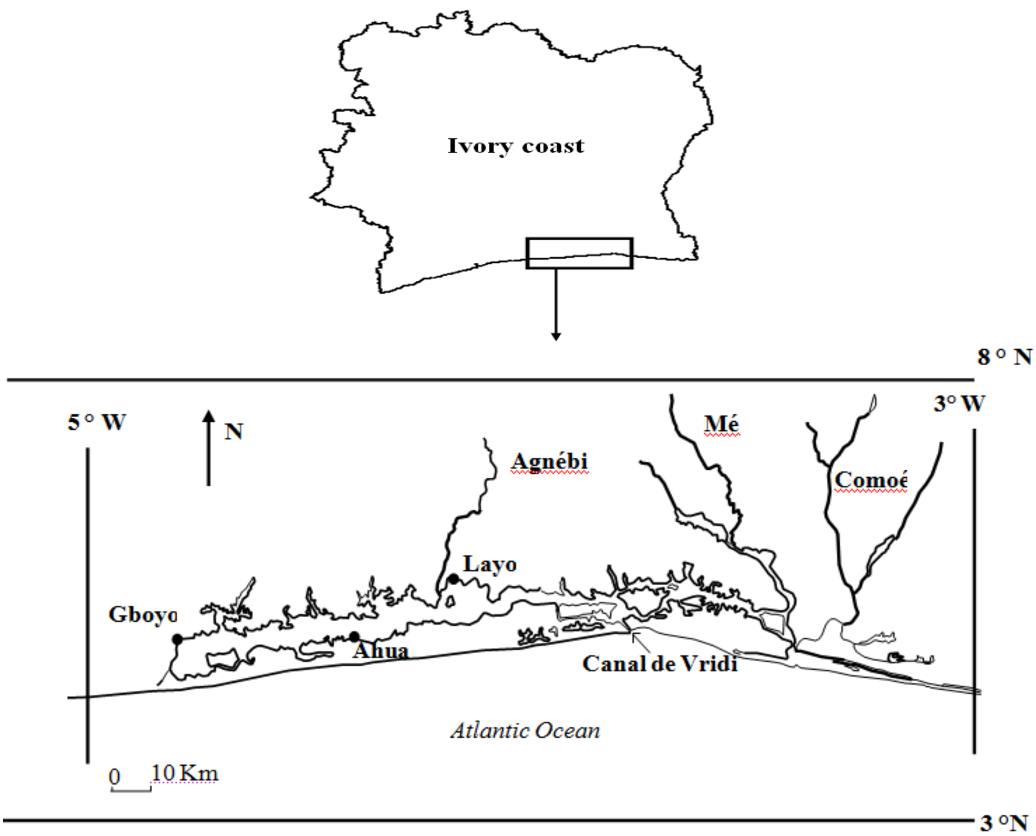

Fig.1. Map of Ebrié lagoon and sampling sites (•). ●

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Males
$W = 1.08 \times 10^{-2} FL^{3.20}$
$r = 0.99$

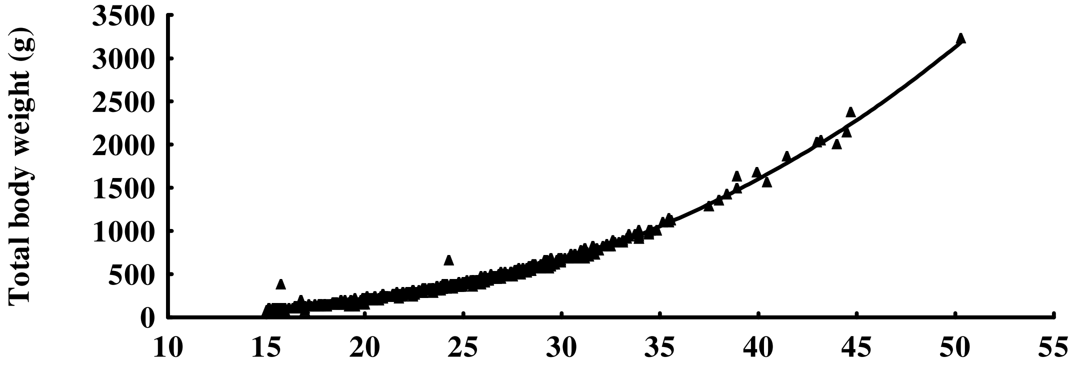

fig 2 (a)

Females
$W = 1.05 \times 10^{-2} FL^{3.22}$
$r = 0.99$

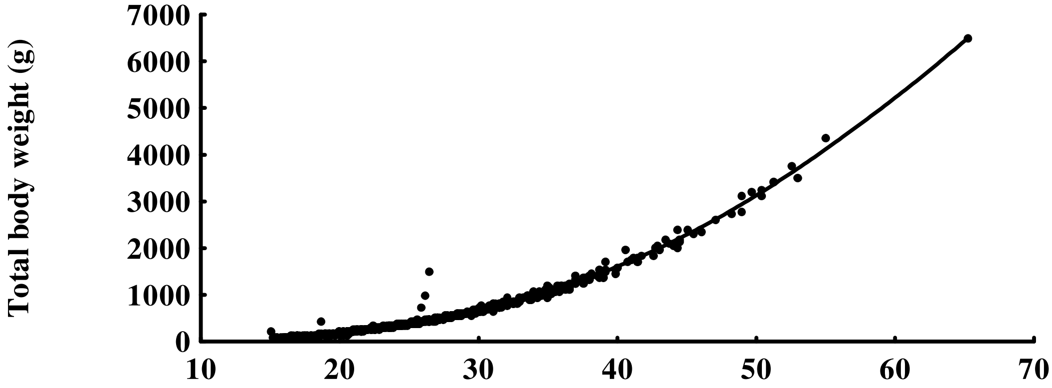

fig 2 (b)

Males + Females
$W = 0.82 \times 10^{-2} FL^{3.29}$
$r = 0.99$

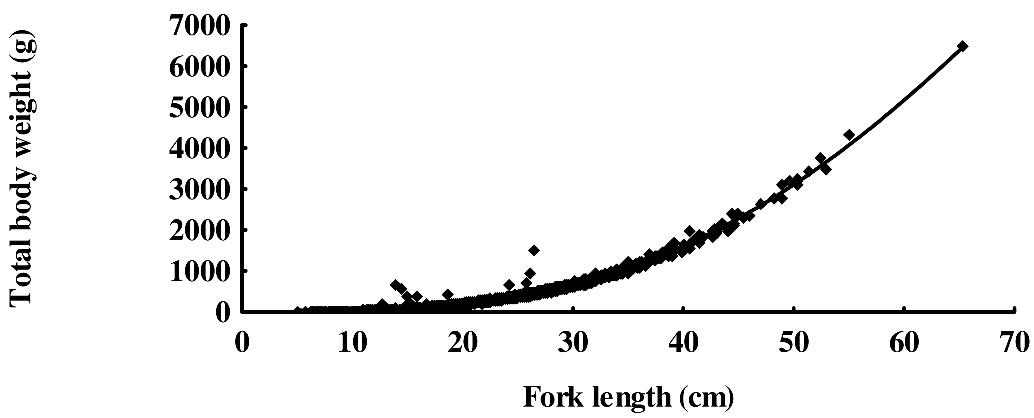

fig 2 (c)

Figure 2: Length–weight relationship for Trachinotus teraia

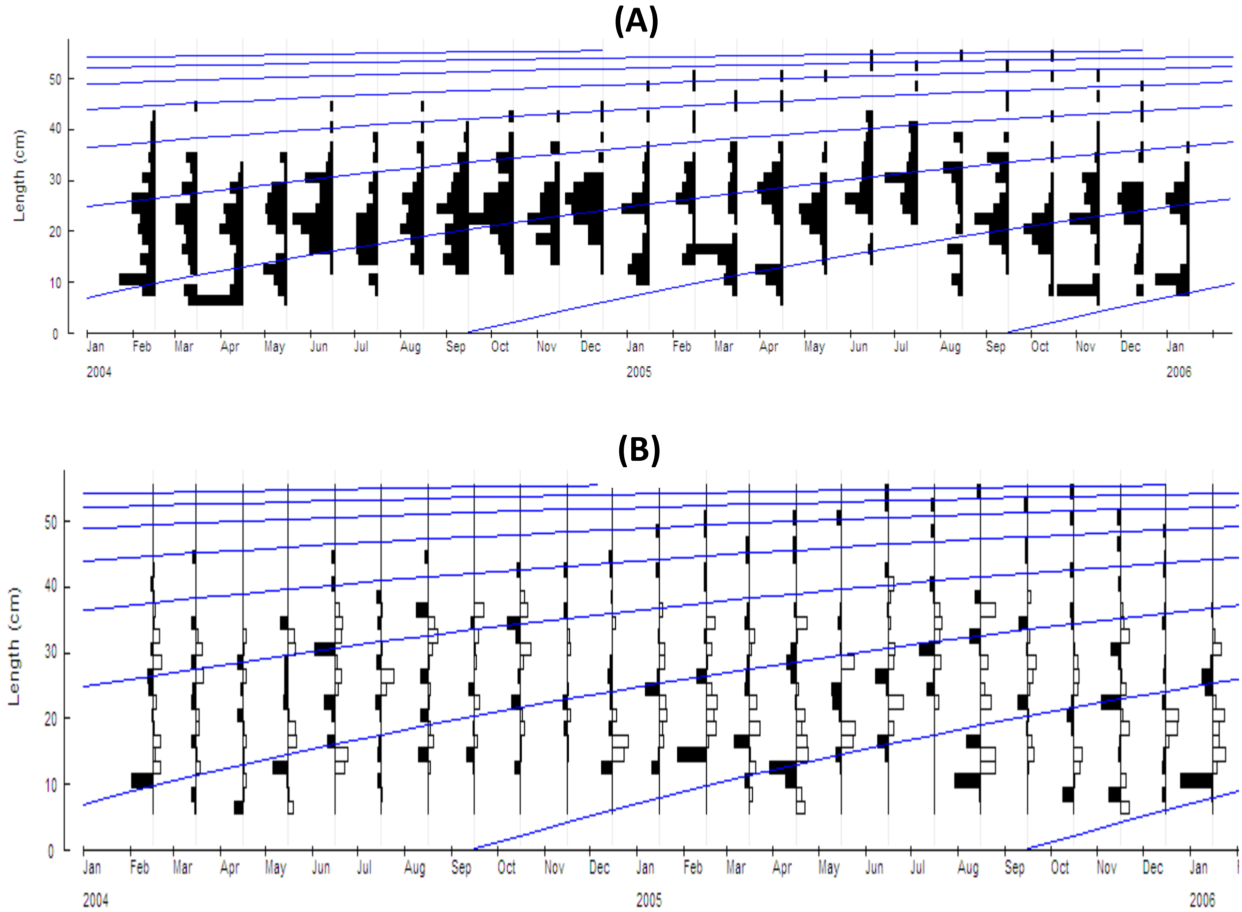

Figure 3: Length frequency distribution output from FiSAT with superimposed growth curves for Trachinotus teraia (A) Original and (B) Restructured. $LF_{\infty} = 58$ cm, $K = 0.43$ year^{-1}, Rn = 0.229

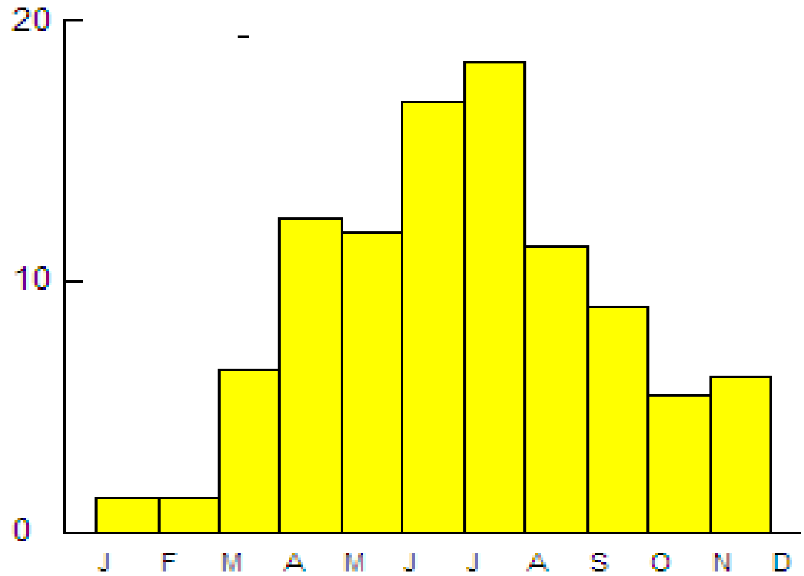

Figure 4: Backward projection, along a trajectory defined by VBGF, of the restructured length frequency data on to an arbitrary one-year timescale for Trachinotus teraia. The months on the X axis cannot be located exactly (hence the abscissa is an arbitrary year) because of the location parameter (t_O) of the VBGF.

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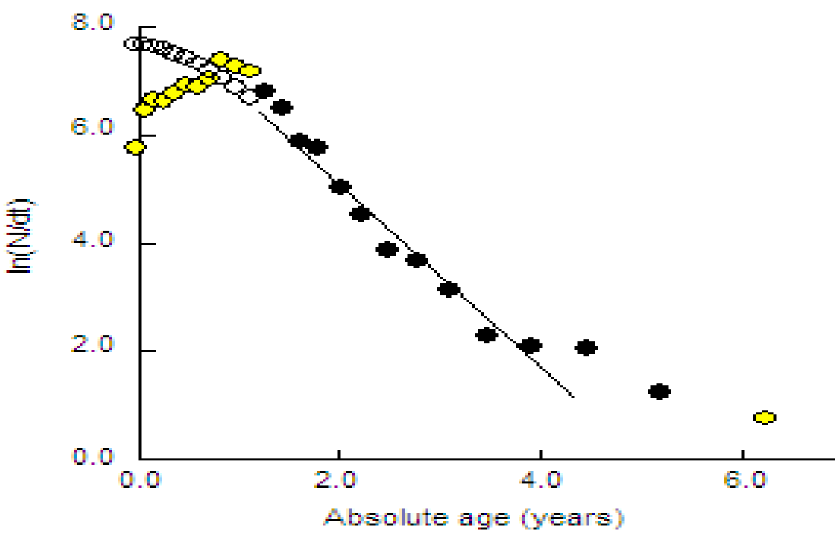

Figure 5: FiSAT output of linearised length-converted catch curve for Trachinotus teraia

Table 1: Population parameters of Trachinotus teraia in Ebrié lagoon

Population parameters	*Trachinotus teraia*
Asymptotic length (LF_∞, cm)	58
Growth coefficient (K)	0.43
Age at length (t_0) year	-0.32
Growth performance index (φ')	3.16
Natural mortality (M) year^{-1}	0.87
Fishing mortality (F) year ^{1}	0.81
Total mortality (Z) year^{-1}	1.68
Exploitation level (E)	0.48
Length range (cm)	5.0-65.3
Sample number (n)	1806

Table 2: Calculated age-length data for the Carangidae Trachinotus teraia on their von Bertalanffy growth equation

Age class (yr)	FL (cm)	% of L_∞
1	17.91	33.17
2	26.17	48.46
3	32.54	60.26
4	37.46	69.37
5	41.24	76.37
6	44.16	81.77
7	46.42	85.96

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