East African Scholars Journal of Agriculture and Life Sciences
Abbreviated Key Title: East African Scholars J Agri Life Sci
ISSN 2617-4472 (Print) | ISSN 2617-7277 (Online) |
Published By East African Scholars Publisher, Kenya

Volume-2 | Issue-3 | March-2019 |

Original Research Article

Growth, Mortalities and Recruitment Pattern of Palaemon maculatus In River Nun Estuary, Bayelsa State, Niger Delta

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Abstract: Growth, mortalities, recruitment pattern and exploitation rate of *Palaemon maculatus* in the River Nun Estuary, Bayelsa State, Niger Delta was investigated on a monthly basis from May 2008 to April 2009 using Length - frequency data. This was done to ascertain the population dynamics of the shrimp stock. Result from analysed data reveal that Von Bertalanffy growth parameters were estimated as L_∞ = 12.11mm, carapace length K=1.20 per year, growth performance index ǿ as 2.25. Total mortality (Z) was estimated as 1.83 per year and natural mortality (M) as 0.40 per year, while fishing mortality was estimated as 1.43 per year. Exploitation rate (E) was estimated at 0.78 indicating heavy fishing pressure on the stock. The recruitment pattern of *Palaemon maculatus* indicates an all- year-round recruitment with two peaks. Although there are uncertainties associated with the analysis of length-frequency data, it is vital to encourage, indeed introduce management strategies to safe-guard the stock from extinction.
Keywords: Exploitation, Growth, Mortality, *Palaemon maculatus*, *Recruitment*, River nun.

INTRODUCTION

The pelagic shrimps Palaemon *maculatus* are widely distributed in estuarine and coastal waters of the Niger Delta. Together with their close relatives *Nematopalaemon hastatus* are ranked amongst the important shrimps because they are harvested for commercial purposes in most areas (Powell C.D, 1982). Crayfish as they are commonly known in the Niger Delta are used by most households in Nigeria because they are cheap and easy to find.

Due to the high demand of these shrimps, their exploitation has continued unabated and unrestrained. Unfortunately, Palaemon shrimps are not found everywhere and their distribution is greatly influenced by the presences or absence of fine sediments, high organic content, salinity and temperature variation (Marioghae I.E, 1981).

In the Niger Delta, *Palaemon shrimps* are found only in salinity of 15psu and above and do not penetrate the river mouth beyond 6km inland even if the salinity is adequate (Marioghae I.E, 1981; Powell C.D, 1982).

There is therefore a growing concern in the scientific community to monitor the population dynamics of these shrimps. The use of Length – frequency data is a classical method to monitor fish and shrimp populations. The finding in this report examines growth, mortalities and recruitment patterns of this shrimp as well as exploitation rate of the shrimp stock. This information can provide useful bases for management strategies to safe-guard the stock from extinction.

MATERIALS AND METHODS

Description Study Area

The study area extends from Akassa at the river mouth to about 12.5km north and lies between longitude $5^{o}55^{'}$ N and latitude 4^{0} $20^{'}$ E (Fig 1.). It is one of the many rivers that discharge into the Atlantic Ocean through the Niger Delta on the Bight of Benin and Bonny.

Quick Response Code

Journal homepage:
http://www.easpublisher.com/easjals/

Article History
Received: 01.03.2019
Accepted: 08.03.2019
Published: 25.03.2019

DOI: 10.36349/easjals.2019.v02i03.001

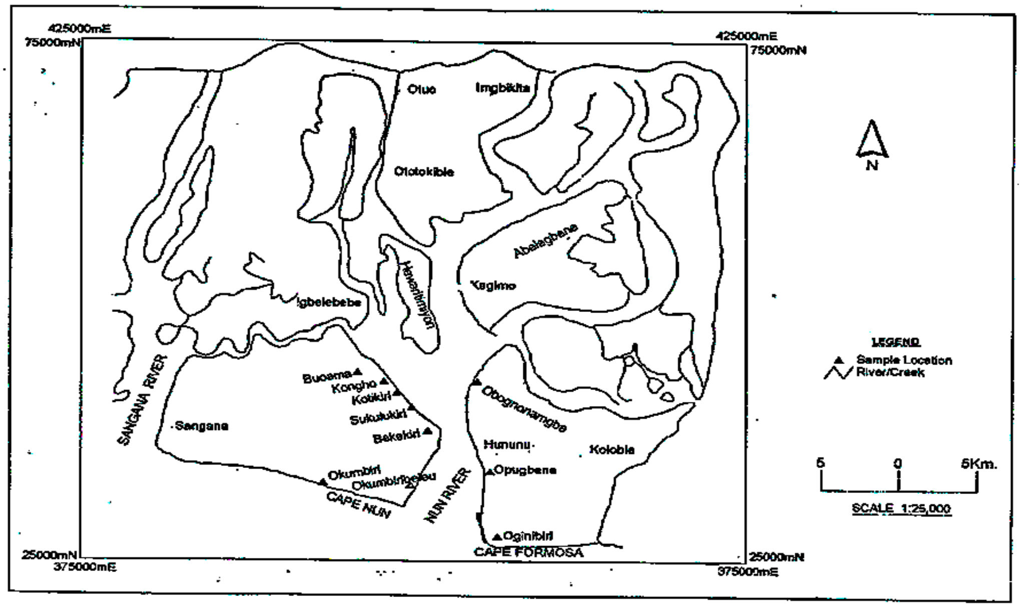

Fig 1: Map of Study area

Collection of Samples

Samples used in this study were collected from artisanal shrimpers operating along the River Nun Estuary. Collected samples were sorted into species and identified according to Powell C.D, (1982). Carapace length of specimens was determined to the nearest 1.0mm.The length-frequency data was analyzed using ELEFAN 1 Package (Gayanilo F.C, *et al.*,., 1988) .The procedure taken to extract growth parameters using ELEFAN 1 from length-frequency data are described by (Pauly D, 1987).The growth model used in the analyses was the seasonally oscillating version of the von Bertalanffy growth function as proposed by Pauly D and Gaschutz. G, (1979). The model has the form:

$$=L_\infty(1-e^{-[K(t-to)+CK/2\prod Sin\int 2\prod(t-ts)]})$$

L_t is predicted length at age t, L_∞ is asymptotic length, K is growth coefficient, C is the amplitude of seasonal growth oscillation, $_{to}$ is the hypothetical age at zero length, t_s is the age at the beginning of growth oscillation. Winter point ($WP=t_s+0.5$) is the time of year when growth is slowest (Pauly D, 1987). Modified Wetherall Plot (Pauly D, 1987) was used to obtain an initial estimate of asymptotic length(L_∞).This method is based on the right- descending part of the length frequency curve and calculates the regression equation:

$$L - L' = a + bL'$$

L' is the cut-off length for each size class; L is the mean length from L′ upward. Growth parameters were estimated as $L_\infty = al-b$, $_Z$/K= (1+*b*) *l-b*. The estimate of L_∞ was then seeded in ELEFAN 1 to optimize the estimates of the growth parameters, L_∞ and K. Since the maximum recorded carapace length L max of *N.hastatus* in Nigeria is 15mm (Sagua V.O, 1981) and 16.7mm in the southeast coast of Nigeria (Enin U.I *et al.*,, 1996), seeded L_∞ values used ranged between 10mm to 15mm and seeded K values ranged 0.3 to 2.0 per year.

ELEFAN 1 identifies the peak in the length - frequency samples and searches for the best combination of growth parameters (L_∞,K,C,WP) using a goodness-of-fit index (R_n) (Pauly D, 1987).The final estimates of L_∞ and K were used to calculate an index of growth performance: ($\acute{\phi}$)=$\log_{10}K + 2\log_{10}L_\infty$ (Pauly D and Munro J.L, 1984; Moreau J *et al.*,, 1986) Total mortality was estimated by the length-frequency catch curve procedure of ELEFAN 2,where percentage of samples in length groups were pooled to stimulate a Steady-state population. The right descending arm of the curve which pertains to length groups fully recruited to the fishery was then fitted with a regression line. The regression equation has the form $\ln(N/(1-\exp(-Z\Delta t))) = a + bt'$,where N is the number of animals of relative age(t') and Δt is the time needed for the shrimp to grow through a length class. The slope (b) of the curve with its sign changed gives Z. Natural mortality (M) was estimated by Pauly′ D, (1980) empirical formula:

$$\log_{10}M = 0.0066 - 0.279\log_{10}L_\infty + 0.6543\log_{10}K + 0.4634\log_{10}T$$

Using a mean annual temperature of 28°C for the inner continental shelf of Nigeria (Williams F, 1968). Fishing mortality (F) was estimated from the relationship F=Z−M (Pauly,1980).The fraction of total mortality (Z)due to fishing mortality (F) or exploitation rate was estimated from E=F/Z.

The recruitment pattern was estimated by projecting the length-frequency data backward onto the time axis down to zero length, using the von Bertalanffy growth equation and the estimated growth parameters (Pauly D, 1982).

Results

From the length-frequency data used in the analyses of growth parameters of *Palaemon maculatus* (Table 1), the Wetherall plot gave estimates of L_∞ = 12.11mm carapace length and Z/K=1.03 (Fig 2). The best estimates of growth parameter estimates obtained are K=1.20, C=0.5, WP=0.5. Growth performance index of 2.25 was estimated (Fig 3) from reconstructed length- frequency data superimposed on the estimated growth curve. Length-converted catch curve (Fig. 4) estimated total mortality (z) at 1.83 per year and natural mortality 0.10per year giving a fishing mortality of 1.43 per year. Exploitation rate (E) was estimated at 0.78. The recruitment pattern of *Palaemon maculatus* as shown in Fig 5 indicates a year-round recruitment with two peaks.

Table 1: Length-frequency data of *Palaemon maculatus* of the River Nun Estuary,Bayelsa State, Niger Delta. May 2008−April 2009.

Length (mm)	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
3.0	2					3	17				8	7
4.0	1	3					18				9	12
5.0	8	2	6	2		9	23	18			6	12
6.0	2	3	5	4	3	5	13	29	10	8	38	24
7.0	32	21	14	7	6	25	12	42	23	42	38	25
8.0	40	5	23	12	20	25	14	7	25	36	26	35
9.0	31	53	31	20	40	30	13	27	28	38	12	30
10.0	14	57	52	48	54	20	-	27	30	20	9	-
11.0	19	15	18	55	30	18	-	14	25	25	-	2
12.0	1	8	11	10	6	14	-	-	38	8	10	9
Total	**15 2**	**168**	**160**	**158**	**159**	**149**	**110**	**164**	**179**	**177**	**156**	**156**

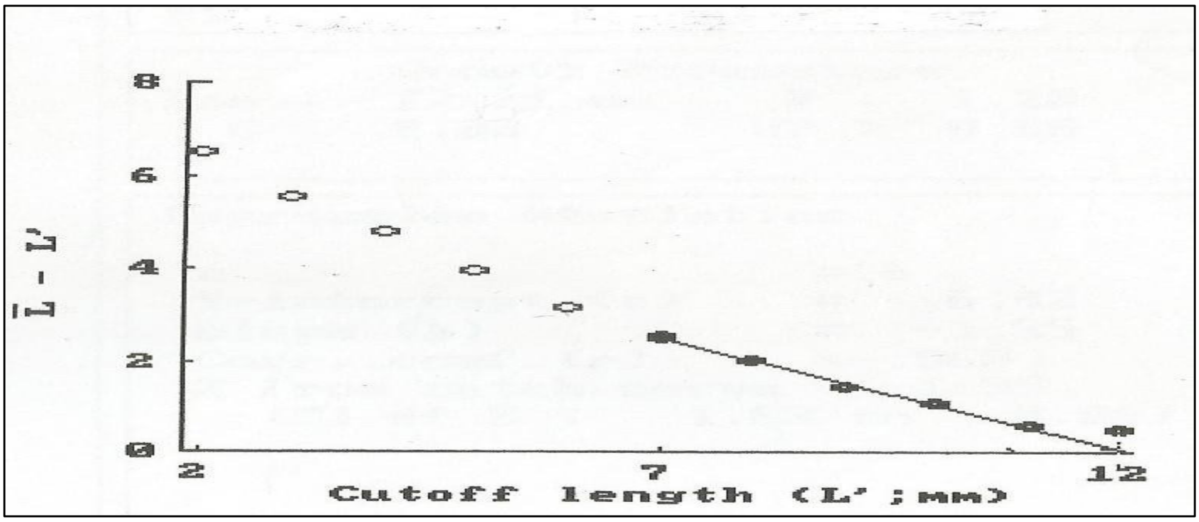

Fig 2: Wetherall plot of *Palaemon maculates* in River Nun Estuary, Bayelsa State.

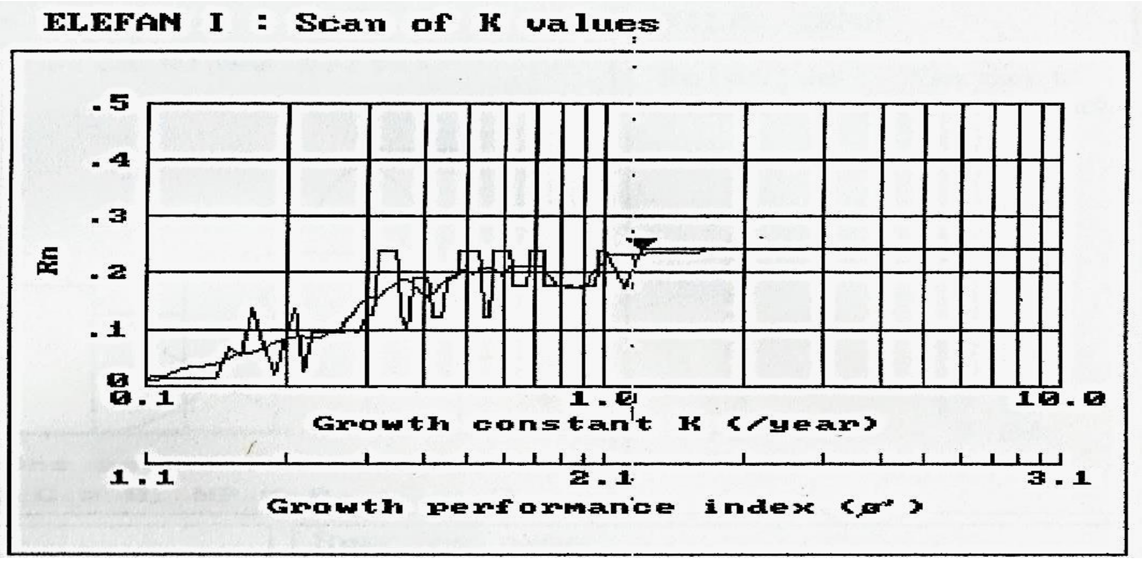

Fig 3: Growth performance index of *Palaemon maculates* in River Nun

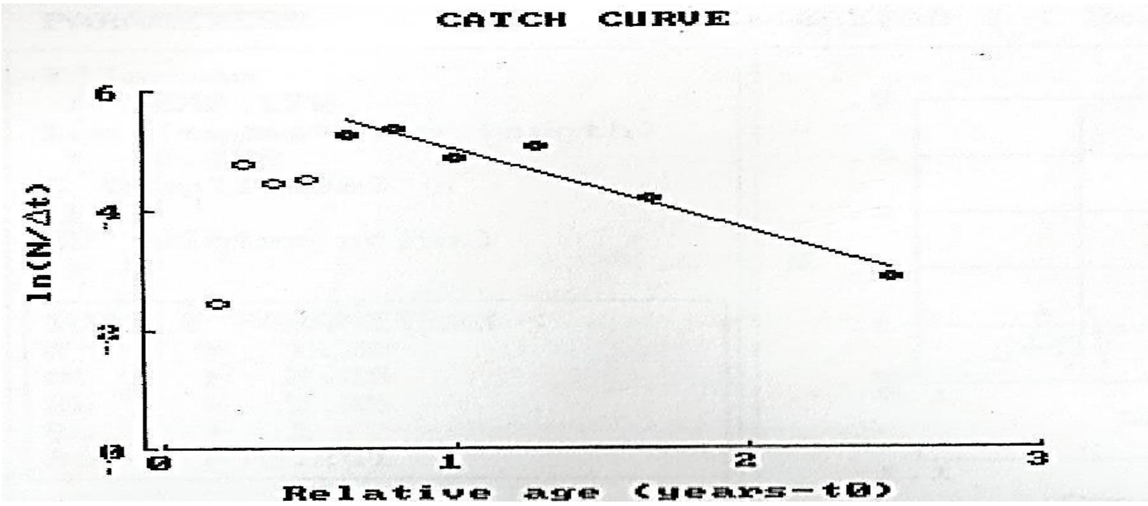

Fig 4: Carapace length-converted catch curve of Palaemon *maculates* in River Nun Estuary

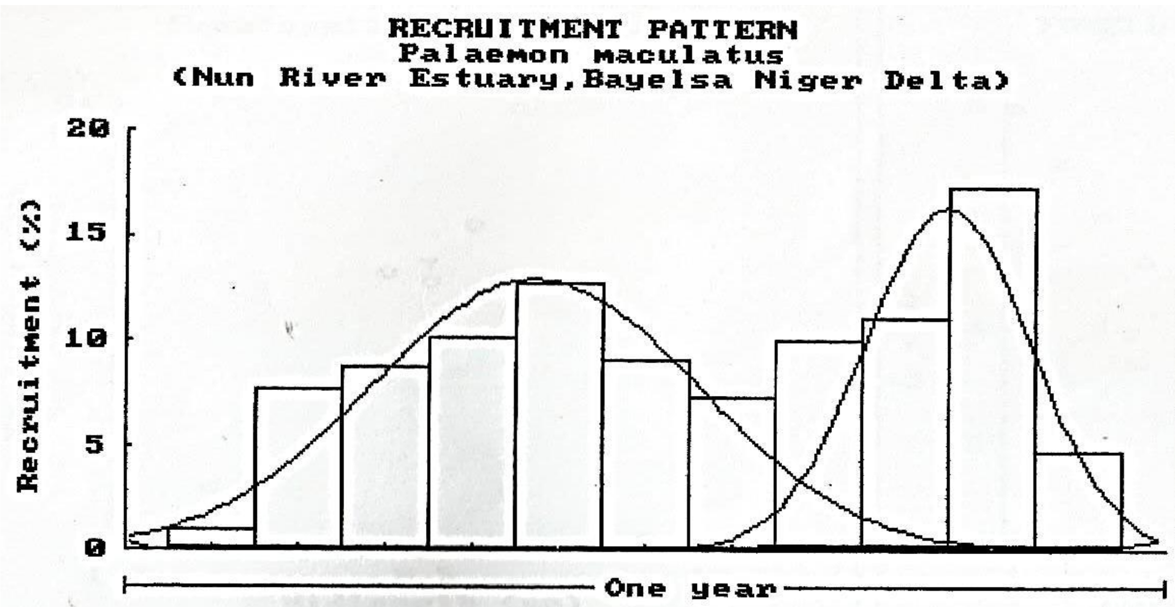

Fig. 5: Recruitment pattern of *Palaemon maculatus* in River Nun Estuary, Bayelsa State.

Discussion

The best estimate of L_∞ =12.11mm carapace length for *Palaemon maculatus* was lower than that given by Sagua V.O (1981) and Enin U.I *et al.,* (1996). This could be accepted since L_∞ is supposed to be the mean value (Ricker W.E, 1975, Pauly D, 1981,). K value of 1.2 per year for *P.maculatus* estimated falls within the range of values (0.39 and 1.6 per year) given by Pauly D *et al.,* (1984) for various stocks of penaeid shrimps. The Winter Point (WP, the period of the year with the slowest growth) of 0.5 indicates that growth was slowest between June and July of the year. This may be due to reproductive activity of the shrimp, whereby energy is converted into reproductive material and could have affected the growth process thereby accounting for the estimated amplitude of seasonal growth oscillation of 0.5.Growth performance index (ǿ) of 2.25 estimated favorably with (2.24) similarly estimated by Enin U.I *et al.,* (1996) for *Nematopalamon hastatus* (Waribugo S.A, 2005).

A number of criteria exist for considering the suitability of length-frequency data used for the estimation of growth parameters of shrimp species. Wolff M (1989) insists that the presence of modal groups should be discernible from the raw data, with apparent shift in the modal length over time. The need to obtain a sufficient number of measurements, well distributed over time was developed by Pauly D (1984). A total sample size of 1500 and above accumulated over a period of six months and above is regarded as excellent for such analysis. The sample used in this study is above this criterion.

Growth parameters estimated from ELEFAN 1are usually biased due to individual variability in growth parameters, seasonal oscillation in growth, size-dependent selection, variable recruitment period and large length-class intervals used in grouping length data (Isaac V.J, 1990).The first of these factors was not taken into account is the deterministic VBGF. It was found to be the principal source error in K. Double recruitment peaks per year observed in this study disagrees with the concept of continuous recruitment believed to be the rule among tropical species (Qasim S.Z, 1973; Weber W, 1976) but rather conforms to the assertion of Pauly D (1982) and Enin U.I *et al.,* (1996) that the double recruitment pulse per year is nearly a general feature of tropical fish species.

Since t_o the third parameter of the von Bertalanffy growth model cannot be estimated from the length-frequency data alone (Pauly D, 1987), the position of month of the year corresponding to the peak of recruitment cannot be calculated. However, the peaks of the juvenile shrimp could be used. The highest was observed in November and a second peak was between March and April.

Total mortality(Z) estimated (1.83 per year) compares well with values (2.46-7.07) given by Pauly D *et al.,* (1984) for species of penaeid shrimps and several stocks; while Enin U.I *et al.,*, (1996) values up to 5.61 per year have been obtained for *N.hastatus* in the southeast coast of Nigeria. Natural mortality (M) estimated here (0.40per year) compares well with values 0.77-3.12 estimated by Pauly *et al.,* (1984) for species of penaeid shrimps. The estimated fishing mortality(1.43 per year) in this study falls within the range of values (0.55-4.68) and (2.68 per year) by Pauly D *et al.,* (1984) and Enin U.I *et al.,* (1996) respectively .Scarcity of the shrimp during the rainy season due the migratory behaviour of the shrimp could affect the data collected and this can lead to bias estimates of mortality parameters estimate (Pauly D,1987); by introducing emigration term into the right-descending arm of the catch curve (Caddy J, 1987).

Exploitation rate (E) of 0.74 estimated in this study indicates that the fishery might be experiencing excessive fishing pressure. This is based on the assumption that in an optimal exploited stock, natural and fishing mortalities should be equal or E=F/Z=0.5(Gulland J.A, 1971). Analysis of exploitation rate (E) based on mortalities estimates indicate that the fishery is subjected to high fishing intensity. This is based on the assumption that a stock is optimally exploited when fishing mortality (F) equal natural mortality or E=F/Z=0.5 (Gulland J.A, 1971). The results presented in this study should be applied with care because of the 'unreliability' and uncertainties associated with length-frequency data. Caution should therefore be exercised when introducing management strategies.

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