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Population Dynamics of Jatka (Juvenile Hilsa) in the Meghna River, Bangladesh

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Abstract

Population parameters of the jatka (juvenile hilsa, *Tenualosa ilisha*) were estimated using FISAT software with length-frequency data collected from the Meghna River (Shatnol to Hajimara), Bangladesh. The predicted extreme length was 19.34 cm (95% probability of occurrence). Based on the von Bertalanffy growth equation, the ultimate (asymptotic) length of the jatka was estimated as 18.60 cm while the predicted best growth coefficient (K) was 8.80·year. The annual rate of natural mortality (M) and fishing mortality (F) were found to be 8.39 and 14.13, respectively. The estimated value for the exploitation rate (E) was 0.63. The length-weight relationship of jatka was found to be $W = 0.00736\ TL.^{3.092}$ The present investigation indicated overfishing (E > 0.50) of jatka in the Meghna River.

Introduction

The adult hilsa as well as the jatka are widely distributed in the coastal waters, estuaries and riverine waters of Meghna, Padma, Jamuna and other deltaic rivers of Bangladesh. The size of juvenile hilsa is up to 15.00 cm (Hora and Nair 1940). Hilsa is normally exploited during migration both in adult and juvenile stages. It contributes about 22 to 25% of the total fish production of the country (Rahman et al. 1998). Jjatka is usually caught using jagat ber jal (large beach seine net), current jal (monofilament net) and poa jal (medium beach seine net). The rate of jatka catch gradually increased each day. A continuous indiscriminate catching of jatka may adversely affect the annual total catch of hilsa fishery. Hence the present study was undertaken to estimate the natural mortality (M), fishing mortality (F) and exploitation rate (E) of jatka. These aspects will help

authorites in formulating management and conservation policies regarding this species in the Meghna River of Chandpur.

Materials and Methods

Every month (January to April 1999) the length-frequency data of the jatka were collected from different places in the Meghna River (Satnol to Hajimara). Total length (TL) of 2,296 jatka in the size range 2 to 18 cm were measured using a meter scale (± 1 mm) while the weight of 375 jatka were taken using an electronic balance of 0.0001 g accuracy.

The data were then analyzed using the FISAT (FAO-ICLARM Stock Assessment Tools) as explained in detail by Gayanilo Jr. et al. (1996) in the computer software package. Ultimate length (L_∞) and growth coefficient (K) of the von Bertalanffy equation for growth in length were estimated by means of ELEFAN I (Pauly and David 1981, Saeger and Gayanilo 1986). Additional estimates of L_∞ and Z/K values were obtained by plotting $\bar{L}$ minus L′ on $\bar{L}$ (Wetherall 1986 as modified by Pauly 1986), i.e.

$$\bar{L} - L' = a + b\bar{L}$$

where, L_∞ = - a/b and Z/K = - (1 + b)/b

where $\bar{L}$ is defined as the mean length computed from L′ upward in a given length-frequency sample, while L′ is the limit of the first length class used in computing a value of $\bar{L}$.

Total mortality (Z) was estimated using the length converted catch curve method. Natural mortality rate (M) was estimated using Pauly's empirical relationship (Pauly 1980) i.e.

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

where L_∞ is expressed in cm and T, the mean annual water temperature in °C which here is 27°C. Fishing mortality (F) was obtained by subtracting M from Z and exploitation rate (E) was obtained from F/Z [E = F/Z = F/ (F+M)] (Gulland 1971). An estimated length structured VPA of jatka was carried out by employing the growth and mortality parameters. The t_0 value was taken as zero.

Results and Discussion

Maximum length (L_∞) and growth co-efficient (K)

The length-frequency data were entered into the FISAT and the extreme value theory was applied to find out the maximum length (L_∞) from extreme

values. The observed extreme length was 18 cm and the computer predicted extreme length was 19.34 cm (Fig.1). The confidence interval was 15.78 to 22.91 cm (95% probability of occurrence).

The Powell-Wetherall plot is shown in figure 2. The corresponding estimates of L_∞ and Z/K for the jatka were 15.55 cm and 0.729, respectively and the correlation coefficient for the regression was 0.994 (a = 8.99 and b = -0.578). The growth parameters of jatka were estimated by using the von Bertalanffy growth formula: L_∞ = 18.60 cm and K = 8.80·yr. Hora and Nair (1940) reported that the juvenile hilsa attains a length of 15.0 cm in the eastern Bengal. For these estimates through ELEFAN I, the response surface (Rn) was 0.275. The computed growth curve are shown over the restructured length distribution in figure 3.

Age and growth

It is assumed in the ELEFAN I analysis that the value of the third parameter of the von Bertalanffy growth function, t_0 is zero (Pauly and David 1981). Therefore the sizes attained by the jatka were estimated as 3.51 cm, 10.92 cm, 14.26 cm and 16.48 cm in I, II, III and IV months of age. The average growth rate of jatka was shown as 4.44 cm·mo. Rahman et al. (1998) recorded the growth rate of the jatka at 3.64 cm·mo from the first to the third months of rearing in pond condition.

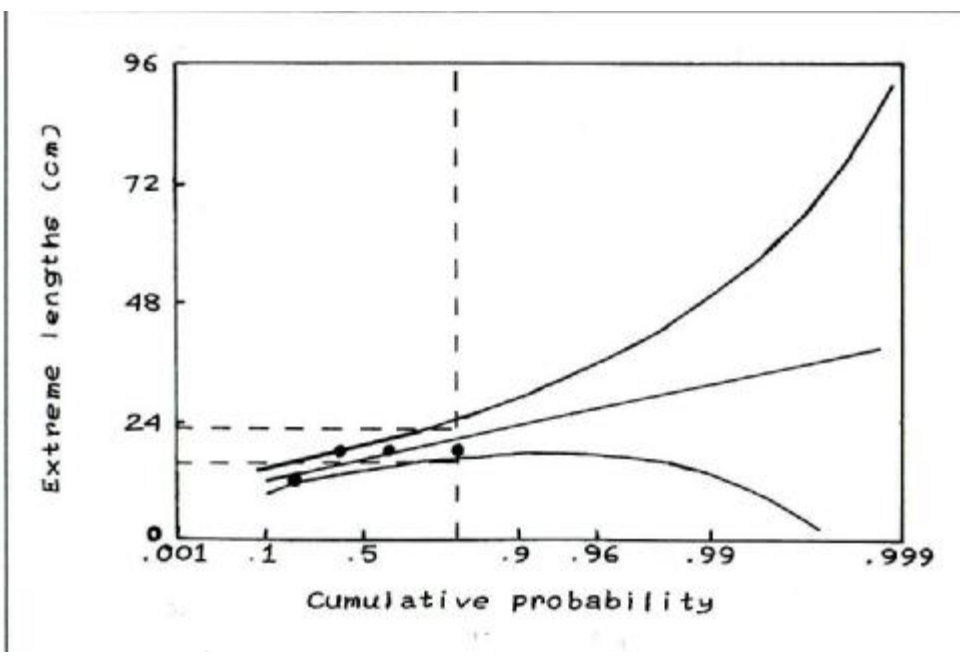

Fig. 1. Predicted extreme length of jatka (juvenile hilsa).

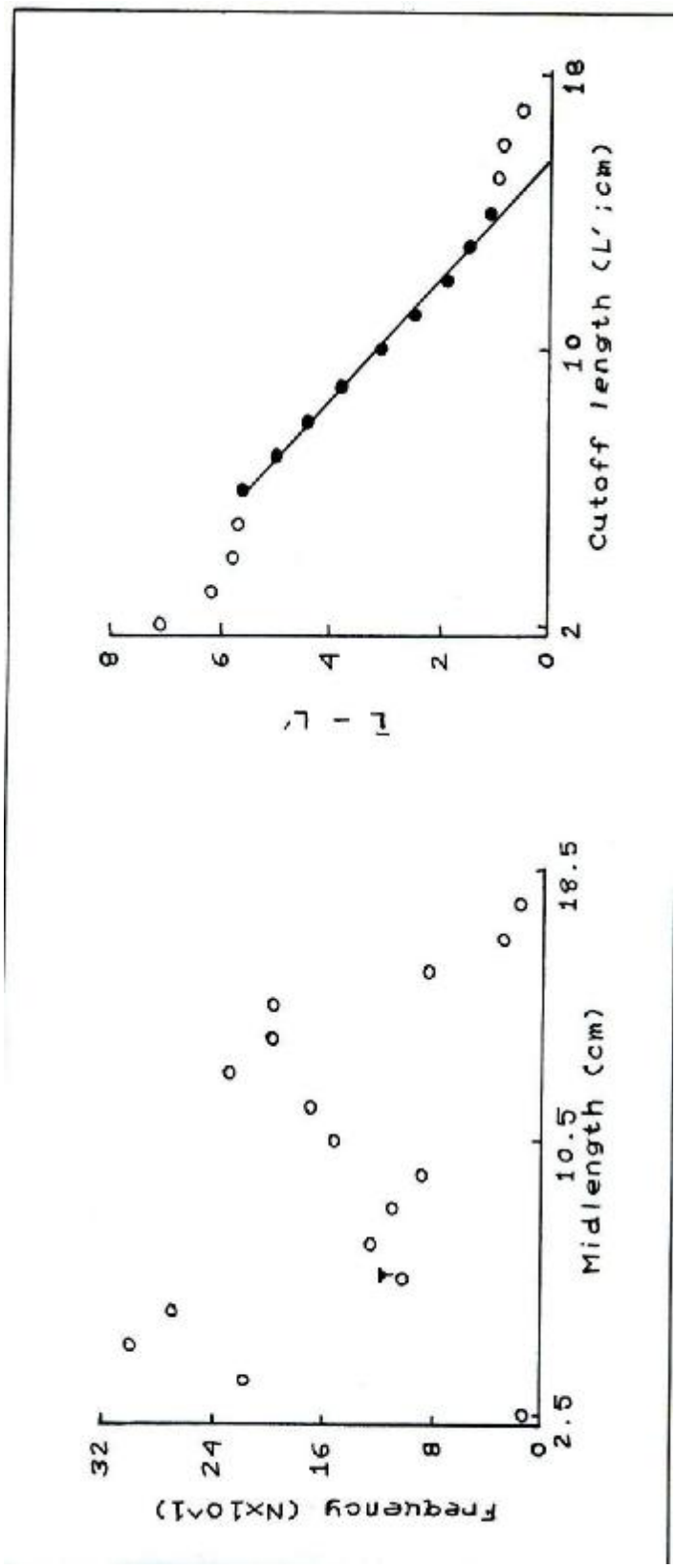

Fig. 2. Estimation of L_∞ and Z/K using the methods of Wetherall (1986) for jatka, (estimated L_∞ = 15.55 cm and Z/K = 0.729).

Mortality

The annual rates of M, F and Z were computed as 8.39, 14.13 and 22.52, respectively. The catch curve utilized in the estimation of Z is represented in figure 4. The darkened circles represent the points used in calculating Z through least square lines regression. Goodness of fit to the descending right hand limits of the catch curve was considered. The correlation coefficient for the regression was -0.981 (a = 12.22 and b = - 22.52).

Exploitation rate

The rate of exploitation (E) in the investigated area was estimated as 0.63. From this value, it seems that the stock of the jatka in the Meghna River is under high fishing pressure. Gulland's (1971) stated that the yield is optimum when F = M and when E is more than 0.50; the stock is generally supposed to be overfished. The jatka appear to be vulnerable to large seine net when they migrate to the shallow nursery grounds for feeding.

Length-weight relationship

To estimate the length-weight relationship, 375 jatka were measured. Total length varied from 3.50 to 15.50 cm while body weight was from 0.44 to 38.0 g. The calculated value of log a and regression coefficient b were -2.13332 and 3.092, respectively. Thus the logarithmic equation for the total length-body weight relationship was: log W = -2.13332 + 3.092 log TL as shown in figure 5. In the exponential form of this equation, $W = 0.00736TL^{3.092}$ (r = 0.997, t_{cal} = 40.948)

The coefficient of correlation (r) between log of total length and that of body weight was positive and highly significant at 0.1% (t_{cal} = 40.948) level.

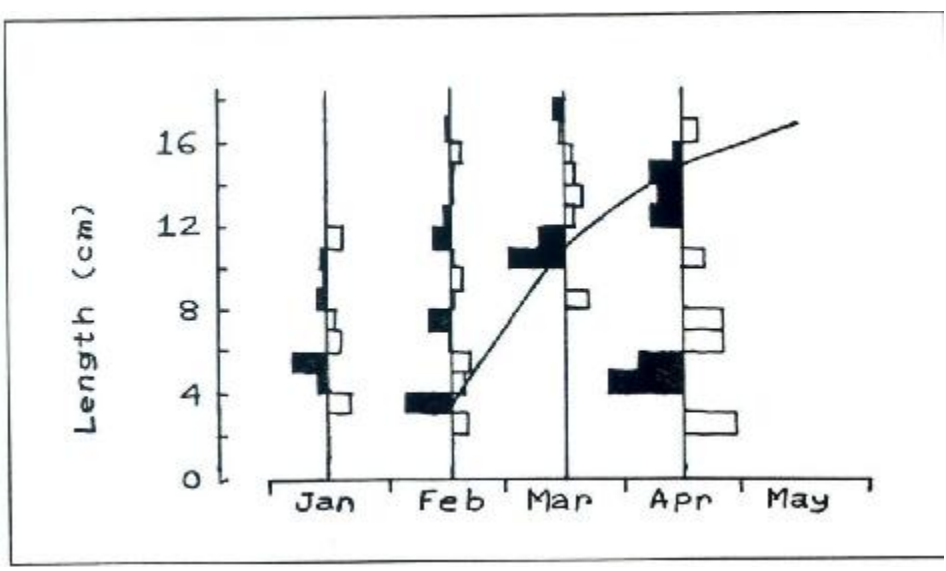

Fig. 3. Growth curve of jatka, by ELEFAN I superimposed on the restructured length-frequency diagram (L_∞ = 18.60 cm and K = 8.80·yr).

Virtual population analysis

The results of length-structured virtual population analysis (VPA) indicated two peaks of fishing mortality (F). The highest peak of F occurred in the length range between 3.5 to 5.5 cm with the value of F exceeding 8 (Fig. 6) which may be associated to excessive use of large seine net locally known as jagat ber jal (mesh size 0.5 to 1.5 cm). Another peak occurs in the length range between 10.5 to 15.5 cm which could be attributed to the current jal (mesh size 1 to 2.5 cm).

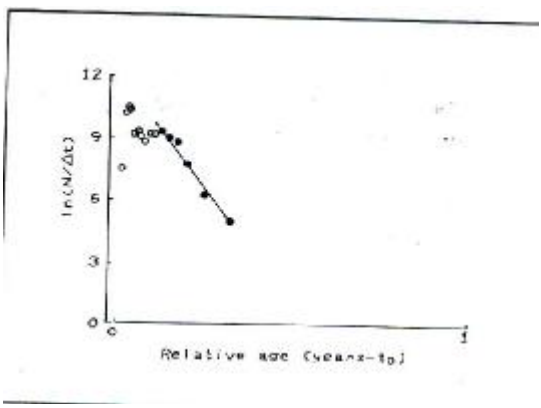

Fig. 4. Length converted catch curve of jatka.

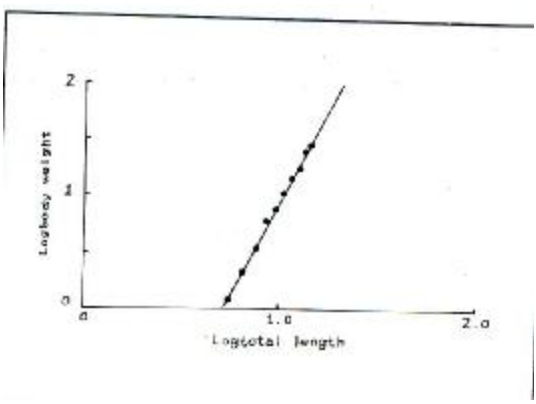

Fig. 5. Linearized form of length-weight relationship of jatka.

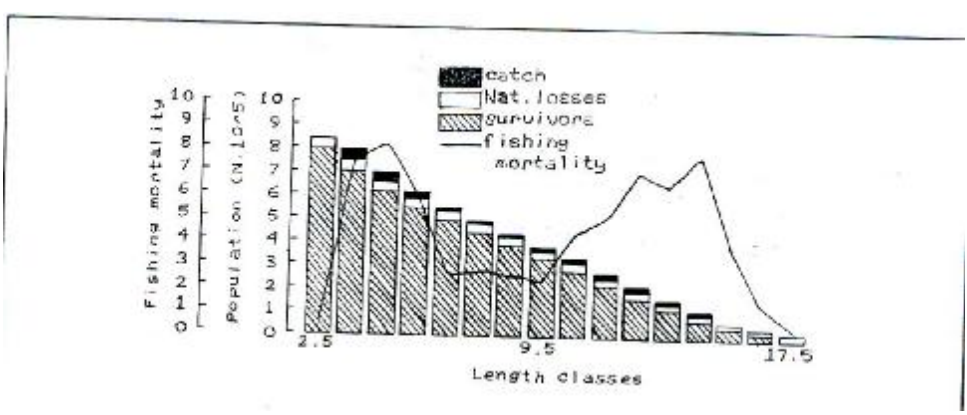

Fig. 6. Length-structured virtual population analysis of jatka.

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