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# Population Dynamics of *Tenualosa ilisha* of Bangladesh Water

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**Abstract:** Population parameters of *Tenualosa ilisha* were estimated using FISAT software with length-frequency data collected from different landing centre of Bangladesh. The von Bcrtalanffy growth parameters $L\infty$ and K for the species were 61.50 cm and 0.83 $yr^{-1}$ respectively. The annual rate of natural (M) and fishing mortality (F) were found to be 1.28 and 2.01 respectively. The estimated values of the exploitation rate (E) using the length converted catch curve and Virtual Population Analysis were 0.61 and 0.346 respectively. $E_{max}$ was found to be 0.697. The recruitment pattern of this species was continuous with one peak per year. The present investigation clearly showed the over fishing (E>0.50) condition for *T. ilisha* in Bangladesh. The estimated length weight relationship for the combined sex was found to be $W = 0.01351*TL^{2.974}$.

**Keywords:** population dynamics, *T. ilisha*

## Introduction

*Tenualosa ilisha* (Hamilton), a diadromous fish, provides the largest single species fishery in Bangladesh especially during the monsoon in almost all the principal river system, contributing about 22-25% of the total fish production of the country (Rahman *et al*., 1998). Historically, the location of major hilsa grounds was restricted to the upper reaches of the main rivers. At present, the major fishing activities are confined to the lower reaches, estuaries and the coastal waters. About 2% of the total population of Bangladesh is directly or indirectly employed in this single fishery. Growth and mortality aspects of hilsa have been studied by Miah *et al*. (1997). The present study was thus undertaken to estimate the key parameters of stock assessment and its population dynamics like asymptotic length ($L\infty$), growth co-efficient (K), total mortality (Z), natural mortality (M), fishing mortality (F), exploitation rate (E), recruitment pattern (R), relative yield per recruit (Y/R), relative biomass per recruit (B/R) and virtual population analysis (VPA), etc. These aspects will help to formulate the management and conservation policies of this species and would be useful for further development of this species in Bangladesh.

## Materials and Methods

Length-frequency data of *T. ilisha* were collected monthly from the commercial catches from different landing station of Bangladesh from January 1997 to December 1997. Samples of *T. ilisha* were mainly caught by gill net. Random samples of 6123 specimens were collected. Total length was measured in cm by a meter scale (1 ± mm) and weight in g by a Salter spring balance. The data were then pooled month-wise from different landing sites and subsequently grouped into classes of two cm intervals. The data were analysed using the FISAT (FAO-ICLARM Stock Assessment Tools) as explained in detail by Gayanilo *et al*. (1995) in the computer software package. Asymptotic length ($L\infty$) and growth co-efficient (K) of the von Bertalanffy equation for growth in length were estimated by means of ELEFANI-I (Pauly and David, 1981; Saeger and Gayanilo, 1986). Additional estimate of $L\infty$ and Z/K value were obtained by plotting $\bar{L}$ minus $L'$ on $\bar{L}$ (Whetherall, 1986 as modified by Pauly, 1986), i.e.,

$\bar{L}-L' = a+b\,\bar{L}$
Where, $L\infty. = -a/b$ 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 $\bar{L}$. The growth performance of *T. ilisha* population in terms of length growth was compared using the index i.e.,

$$\phi' = \text{Log}_{10}\,K + 2\,\text{Log}_{10}\,L\infty$$

Total mortality (Z) was estimated by 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, $L\infty$ is expressed in cm and T, the mean annual environmental water temperature in °C which is here 28°C.
Fishing mortality (F) was obtained by subtracting M from Z and exploitation rate (E) was obtained from F/Z (Gulland, 1971). Recruitment pattern was obtained by backward projection on the length axis of a set of length-frequency data as described in the FiSAT routine. Relative yield per recruit (Y/R) and relative biomass per recruit (B/R) values as a function of E were determined from the estimated growth parameters and probability of capture by length (Pauly and Soriano, 1986). The calculations were carried out using the complete FISAT software package.
An estimated length structured VPA of *T. ilisha* was carried out.

$L\infty. = 61.50$ cm, $K = 0.83\ yr^{-1}$, $M = 1.28\ yr^{-1}$, $F = 2.01\ yr^{-1}$, $a = 0.01351$ and $b = 2.974$ were used as input to a VPA. The $t_0$ value was taken as zero.

## Results

**Growth and mortality parameters:** Growth parameters of von Bertalanffy growth formula for *T. ilisha* were estimated as $L\infty = 6.50$ cm and $K = 0.83\ yr^{-1}$. For these estimates through ELEFANI-I the response surface (Rn) was 0.269 for the curve. The computed growth curve produced with those parameters are shown over it restructured length distribution in Fig. 1.
The corresponding estimates of $L\infty.$ and Z/K by Powell-Wetherall plot method (Fig. 2) for *T. ilisha* were 60.442 cm and 3.095, respectively. This additional estimate $L\infty$ is slightly lower than the $L\infty.$ estimated through ELEFANI-I. The correlation co-efficient for the regression was -0.996 (a = 14.76 and b = -0.244). Calculated growth performance index ($\phi'$) was found to be 3.50. The annual mortality rates M, F and Z computed were 1.28, 2.01 and 3.29, respectively. Figure 3 represents the catch curve utilized in the estimation of Z. The darkened circles were used in calculating the value of Z through least square linear regression. The blank circles represents the points either not fully recruited or very close to $L\infty$. Good fit to the descending right hand limits of

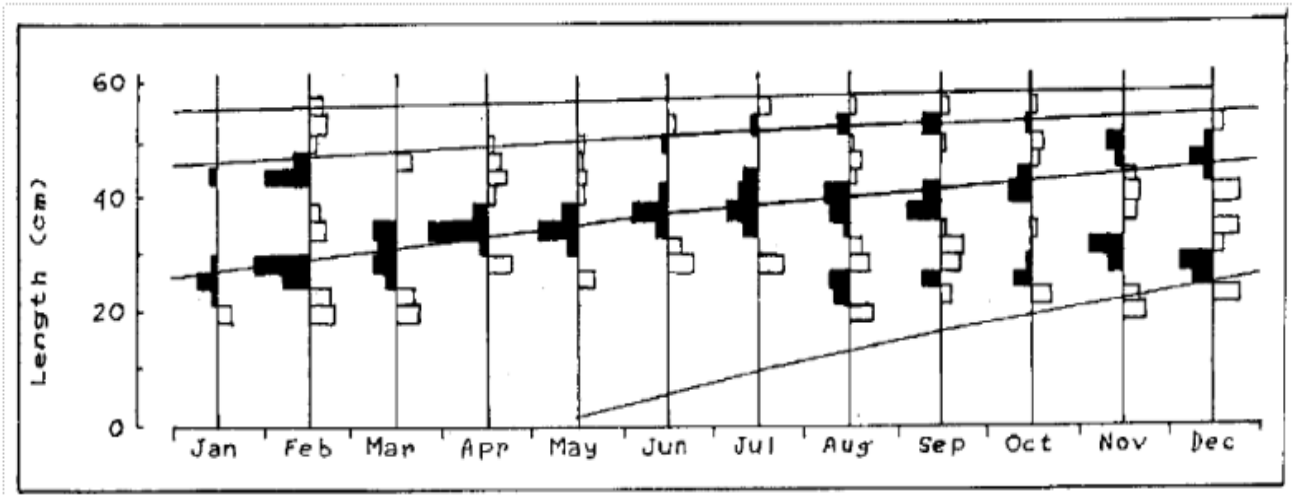


Fig. 1: Growth curve of *Tenualosa ilisha* from Bangladesh by ELEFAN I superimposed on the restructured length-frequency diagram ($L\infty = 61.50$ cm and $K = 0.83/yr^{-1}$)

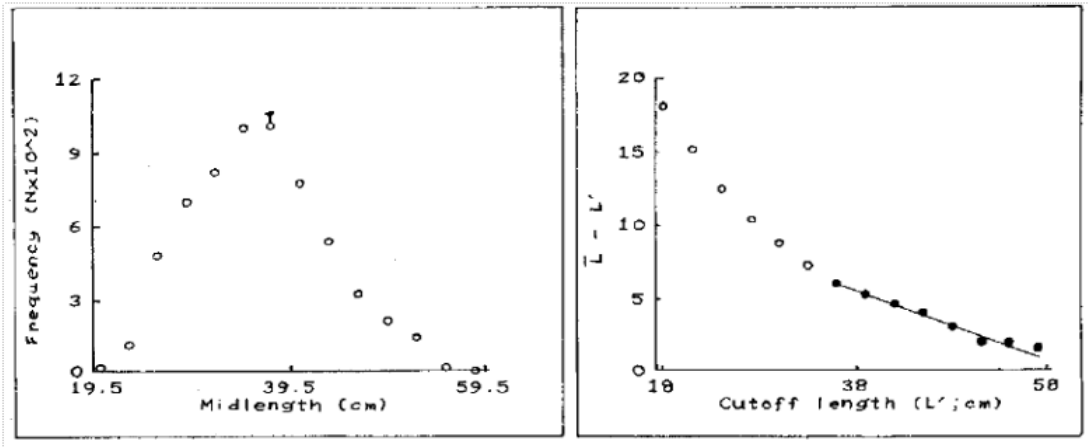


Fig. 2: Estimation of $L\infty$ and Z/K using the methods of powell-wetherall plot for *Tenualosa ilisha* (estimated $L\infty = 60.442$ cm and $Z/K = 3.095$)

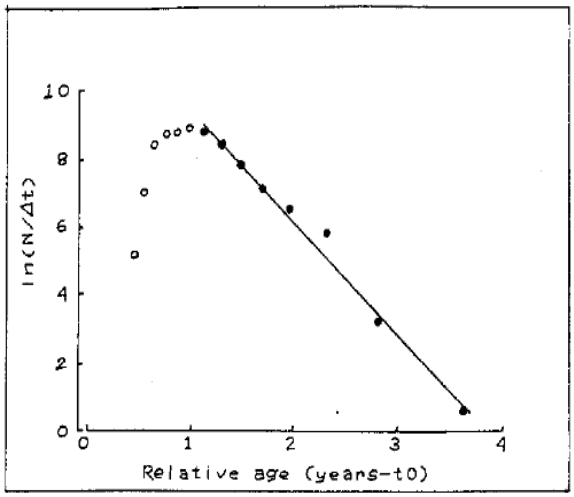


Fig. 3: Lenth converted catch curve of *Tenualosa ilisha*

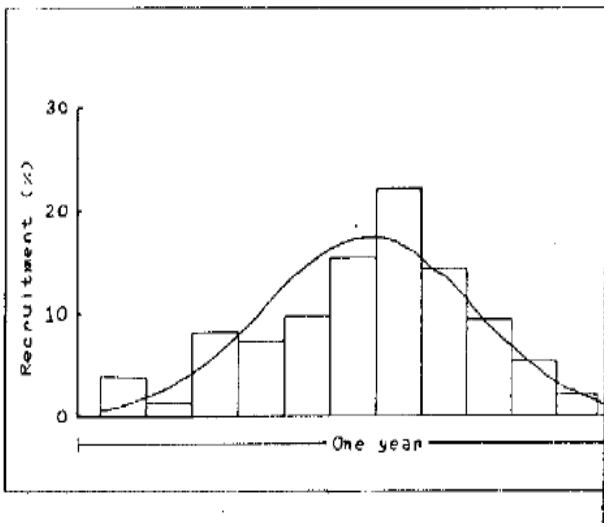


Fig. 4: Recruitment pattern of *Tenualosa ilisha*

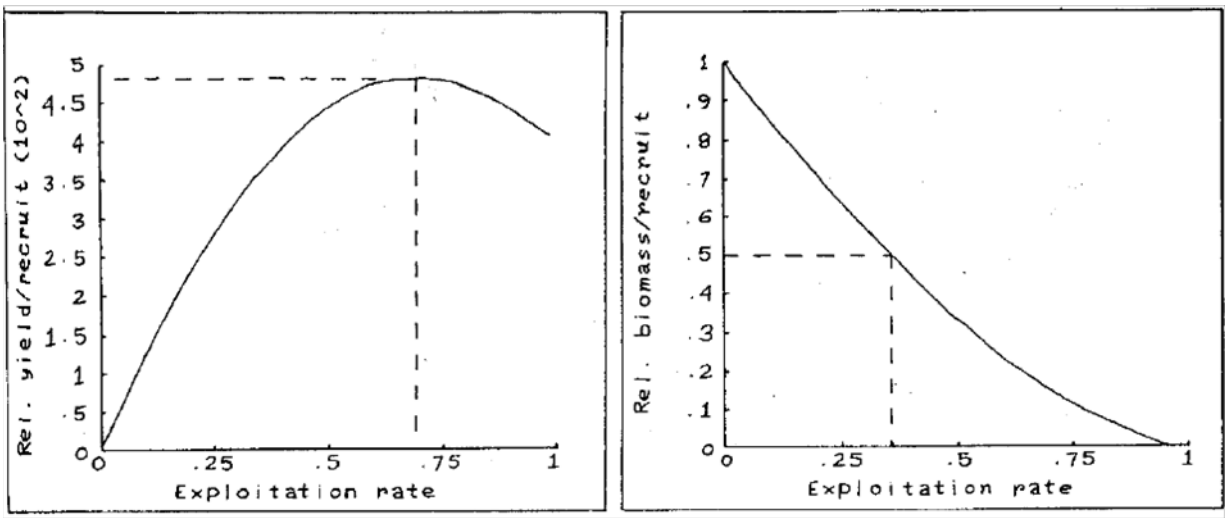


Fig. 5: Relative yield-per-recruit (Fig. a) and biomass-per-recruit (Fig. b) of *Tenualoa ilisha*

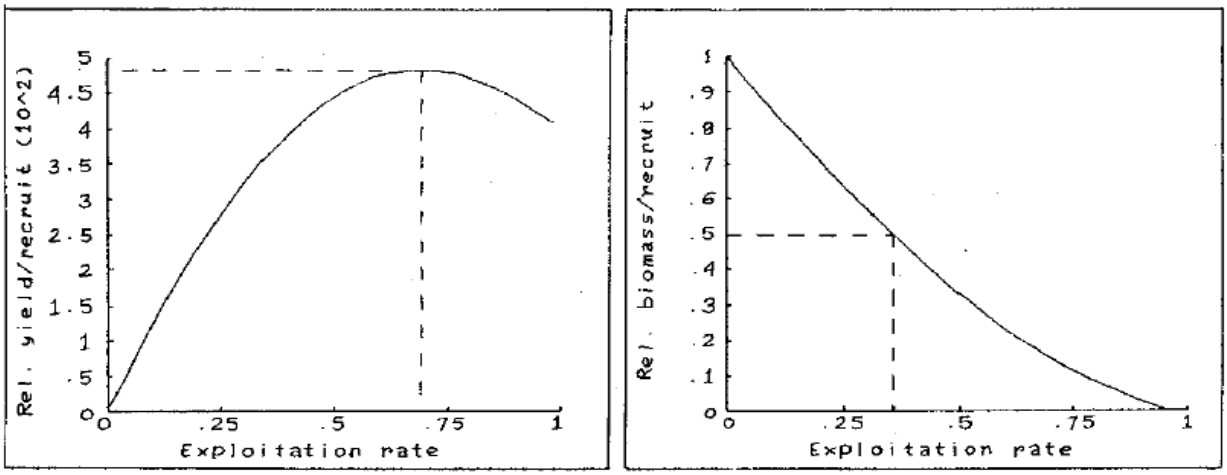


Fig. 6: Length-structured virtual population analysis of *Tenualosa ilisha*

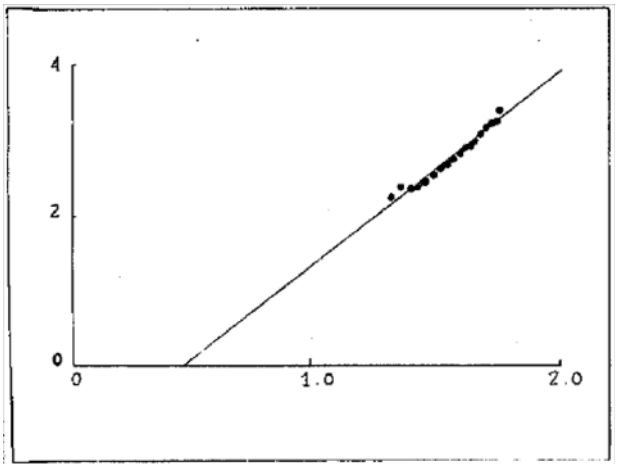

Fig. 7: Linearized form of length-weight relationship of *Tenualosa ilisha*

the catch curve was considered. The correlation co-efficient for the regression was -0.993 (a = 12.79, b = 3.29). The natural mortality rate was estimated from the Pauly's empirical equation (Pauly, 1980). Pauly suggested that this method gives a reasonable value of M. This method of estimating M is widely used throughout the tropic where time series reliable catch and effort data and several years of Z values are not available. So the described method is the common way of estimating M and F. The fishing mortality rate (F) was taken by subtracting M from Z and was found to be 2.01 $yr^{-1}$.

**Exploitation rate:** The rate of exploitation (E) was estimated as 0.61 from the study area. It appears that the stock of *T. ilisha* is under high fishing pressure and very close to the maximum fishing pressure ($E_{max}$ = 0.697) and fishing mortality seems to be of great concern (F - 2.01 $yr^{-1}$). Miah *et al*. (1997) also reported the over exploitation of the species in the Meghna river of Bangladesh.

**Recruitment pattern:** The recruitment pattern (Fig. 4) shows that this species was recruited in the fishery throughout the year with one peak, at the month of June-August. The peak pulse produced 22.30% of the recruits on an average.

**Yield per recruit and biomass per recruit:** The relative yield-per-recruit (Y/R) and biomass-per-recruit (B'/R) were determined as a function of $L\infty/L$ and M/K were 0.48 and 1.54, respectively. Figure 5 shows that the present exploitation rate (E = 0.61) does not exceed the maximum exploitation rate of $E_{max}$ = 0.697.

**Virtual population analysis:** The results of the length-structured VPA of *T. ilisha* were shown in Fig. 6. Values of the mean fishing mortality (F) and the mean exploitation rate (E) estimated by the analysis were found as 0.678 $yr^{-1}$ and 0.35, respectively. The estimated values of the exploitation rate (E) using the length converted catch curve and VPAS were 0.61 and 0.35, respectively. The F-at-length array (Fig. 6) shows a sudden increase from 49.53 to 52.5 cm length group.

**Length-weight relationship:** For the study of the length-weight relationship a total of 3209 specimens of *T. ilisha* for the individuals ranging in sizes from 23 to 57 cm in total length and weighing 202.50 to 2450 g were measured. From these, length-weight relationship were estimated of the form W = aLb, using the logarithmic transformation LogW = Loga +b LogTL, where, a and b are constants estimated by linear regression of the log transformation varieties. The regression takes the form:

Log W = -1.86934 + 2.974 Log TL (r = 0.991) .....(1)

Figure 7 corresponding to, $W = 0.01351 * TL^{2.974}$.....(2)

which may be used to convert length-frequency data to catch at length data.

## Discussion

The estimated values of the growth parameters $L\infty$. and K for *Tenualosa ilisha* were 61.50 cm and 0.83 $yr^{-1}$ respectively. These values have not shown much difference when compared to the $L\infty$. and K values estimated for the same species of Bangladesh waters, which were 58.3 cm and 0.743 $yr^{-1}$ respectively (Rahman *et al*., 1998).

The instantaneous total mortality (Z) estimated using the length converted catch curve during the present study was 3.29 $yr^{-1}$. This value is higher than that of the Z values estimated for the same species, which were 2.61 $yr^{-1}$ (Rahman *et al*., 1998) and 2.03 $yr^{-1}$ (Miah and Shafi, 1995). This could have been probably due to the high fishing mortality of *Tenualosa ilisha* (F = 2.01 $yr^{-1}$) obtained from the present study.

The instantaneous natural mortality (M) estimated using the Pauly's empirical formula during the present study was 1.28 $yr^{-1}$. This did not show much difference when compared to the instantaneous natural mortality (M) estimated for the same species which was 1.18 $yr^{-1}$ (Rahman *et al*., 1998) and 1.16 $yr^{-1}$ (Miah and Shafi, 1995).

From the results of the above parameters it could be concluded that recruitment pattern of the fish revealed that it recruits in the fishery throughout the year. Its fishing pressure is high and needs to be reduced for getting more sustained production.

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