

Gill Net Selectivity of Hilsa (*Tenualosa ilisha*) in the Meghna River Estuary of Bangladesh

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Abstract

In this study gill-net selectivity for *Tenualosa ilisha* in the River Meghna was estimated. Traditional fishing was conducted by using gill-net with 55 mm, 65 mm and 75 mm mesh-size during August 2016 to October 2016. From the Meghna River estuary, a total of 660 specimens of *T. ilisha* were caught by gill-net during the study period. Mean total lengths were calculated as 24.7 ± 2.7 cm, 31.2 ± 2.78 cm and 34.33 ± 4.69 cm for 55 mm, 65 mm and 75 mm mesh sizes gill-net respectively. Selectivity analysis indicated an optimum catch length of 260.50 mm for the 55 mm mesh size, 328.36 mm for the 65 mm mesh size and 370.99 mm for the 75 mm mesh size gill-nets. The catch percentage of Hilsa by 55 mm, 65 mm and 75 mm mesh size gill-net were 38.78%, 39.10% and 22.12% respectively. The majority of fishes caught by these three-mesh size gill-net were found to be matured. Therefore, 65 mm mesh size were suitable for the sustainable fisheries of *T. ilisha* in the River Meghna in Bangladesh.

Keywords: Gillnet; *Tenualosa ilisha*; Hilsa; Meghna River; Bangladesh

Introduction

Tenualosa ilisha is a commercially important and the national fish of Bangladesh. It's an anadromous clupeid fish species which is a popular food fish in South Asia. According to Department of Fisheries, Bangladesh [1], the total (inland and marine) hilsa production of Bangladesh was estimated 3,87,211 metric ton whereas total (inland and marine) fish production was 36,84,245 metric ton in 2014-2015 fiscal year. Hilsa contributes 10.51% to the total fish production of Bangladesh. The contribution of Hilsa is 1% to the national GDP of Bangladesh [2].

T. ilisha is the largest single species fishery in Bangladesh. Hilsa has a wide geographical distribution in Asia from the Persian Gulf to the South China Sea. In Upper Bay of Bengal (BoB), particularly large stocks are found to be sustained by the large river systems.

At present 75% of the global Hilsa catch is caught from Bangladesh waters, 15% from Myanmar, 5% from India, and 5% from other countries such as Thailand, Iran, Iraq, Kuwait, Malaysia, and Pakistan, Kuwait etc. [3].

At present, the *Jatka* and matured Hilsa fishes are being caught indiscriminately during downstream migration from Meghna River to seawater in the year round cycle. Increasing population, protein demand, temptation of huge income makes an overfishing of *Jatka* and adults in the gill net fishery [4-6].

Due to the unplanned and unrestricted fishing method Hilsa production and Hilsa size have shown an unknown questionable effect day by day. So recommended optimum mesh size of gill-net for catching Hilsa can be appropriate steps to stop the indiscriminate exploitation of *Jatka* and matured Hilsa. The aim of this study was to help the stake holders in taking decisions about the determination of optimum mesh size of gill-net for sustainable Hilsa fishing in Bangladesh inland water bodies.

Materials and Methods

Study area and study period

The present study was carried out during August 2016 to October

2016 in the Meghna River estuary of Bangladesh. Different Hilsa fishing grounds were selected for this study such as Ramgoti, Hatia and Monpura [7] (Figures 2).

Sampling

Approximately 660 adult Hilsa were randomly selected from commercial gillnet catches by Riverine Station (RS) Hilsa Research Team of Bangladesh Fisheries Research Institute (BFRI) with speed boat and research vessel '*MV Rupali Ilish*' (Figure 1). The gill net with 55 mm, 65 mm and 75 mm mesh sizes were used for the fishing. These three mesh sizes were selected for analysis because these are mostly used in commercial fishing in Bangladesh.



Figure 1: Bangladesh Fisheries Research Institute (BFRI), Riverine Station (RS)'s Research Vessel: '*MV Rupali Ilish*'.

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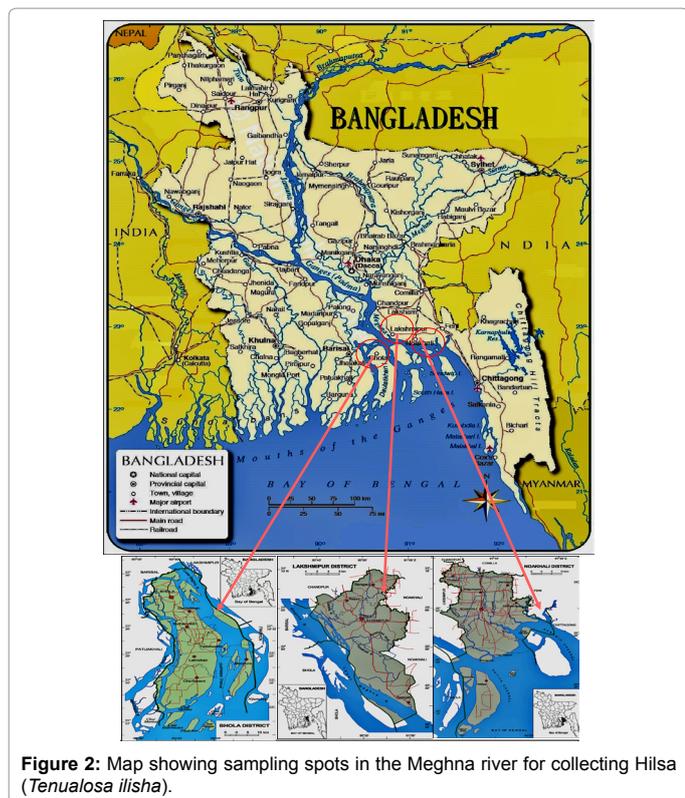


Figure 2: Map showing sampling spots in the Meghna river for collecting Hilsa (*Tenualosa ilisha*).

Data analysis

The optimum length (L_m) was measured from the data analysis. At first the base line of data analysis, length frequency of *T. ilisha* were analyzed. In order to compare and estimate the result, linear regression method was applied. The selectivity parameters were estimated using Holt's model [8,9] by the following formula:

$$S_L = \exp\left[-(L - L_m)^2 / 2 * s^2\right]$$

Where, L_m is optimum length for being caught, S_L fraction (ranged 0 to 10), and S , the common standard deviation. Input data for this model were the numbers of caught fish by length group for each gear, i.e., C_a , C_b and the two used mesh sizes, including ma and mb . The calculation of selectivity parameters was performed as follows:

Step 1: Calculation of log ratios for each length group using $y = \ln(C_b/C_a)$. Only the lengths where the frequencies overlap were used. In this formula, C_a is length group caught using the smaller meshed net (55 mm) and C_b is length group caught using the larger meshed net (65 mm and 75 mm).

Step 2: Performing a regression analysis of the calculated log ratios [$y = \ln(C_b/C_a)$] versus the interval midpoint for fish length ($x = L$), to determine a and b coefficients as following:

$$y = \ln(C_b/C_a) = a + b * L$$

Step 3: The obtained values of a and b along with ma and mb were used to estimate the selection factor (SF) in following formula:

$$SF = \left[-2 * a / b * (ma + mb)\right]$$

The optimum fish lengths for the small and large mesh size were calculated as following:

$$L_{ma} = SF * ma \text{ and } L_{mb} = SF * mb$$

Where, L_{ma} is optimum length for the smaller meshed net and L_{mb} is optimum length for the larger meshed net. The common standard deviation (s) is determined as following:

$$s^2 = \left[-2 * a * (mb - ma) / b^2 * (ma + mb)\right] = SF * (mb - ma / b)$$

Step 4: Points on the selection curves are found by inserting values of L :

$$S_a(L) = \exp\left[-(TL - L_{ma})^2 / (2 * S^2)\right]$$

$$S_b(L) = \exp\left[-(TL - L_{mb})^2 / (2 * S^2)\right]$$

Where, S_a is selection curve for gill-net with 55 mm mesh size and S_b , selection curve for gill-net with 65 mm mesh size.

Step 5: From the obtained data of step 4 and the catches $C_a(L)$ and $C_b(L)$, an index of the number in the population is estimated for each mesh size as following:

$$N_a(L) = C_a(L) / S_a(L)$$

$$N_b(L) = C_b(L) / S_b(L)$$

Results

Firstly, primary analysis was done. The catch percentage of Hilsa by 55 mm, 65 mm and 75 mm mesh size gill-net were 38.78% (256 fish), 39.10% (258 fish), and 22.12% (146 fish) respectively. The majority of fishes caught by the gill-net with three mesh sizes were found to be matured. Total length of the fish ranged from 200 mm to 360 mm for 55 mm mesh size, 240 mm to 380 mm for 65 mm mesh size and 280 mm to 440 mm for 75 mm mesh size gill-net. Mean total lengths were calculated as 24.7 ± 2.7 cm, 31.2 ± 2.78 cm and 34.33 ± 4.69 cm for 55 mm, 65 mm and 75 mm mesh sizes gill-net respectively (Table 1).

Secondly, length frequency data were calculated. The distribution at the points designated by $\ln C_b(L) / C_a(L)$ for three mesh size of gill-nets is presented in Figure 3. The regression constants a and b were estimated. For the calculation of selectivity parameters using Holt's method, the data and value of the selectivity parameters are presented

Sl. No.	Mesh Size (mm)	Fish No.	Catch Percentage (%)	Total Length Range (mm)	Mean Total Length (cm)
1	55	256	(38.78%)	200-360	24.7 ± 2.70
2	65	258	39.10%	240-380	31.2 ± 2.78
3	75	146	(22.12%)	280-440	34.33 ± 4.69

Table 1: Catch percentage and mean total lengths of Hilsa by the gill-net with different mesh sizes in the River Meghna of Bangladesh during 2016.

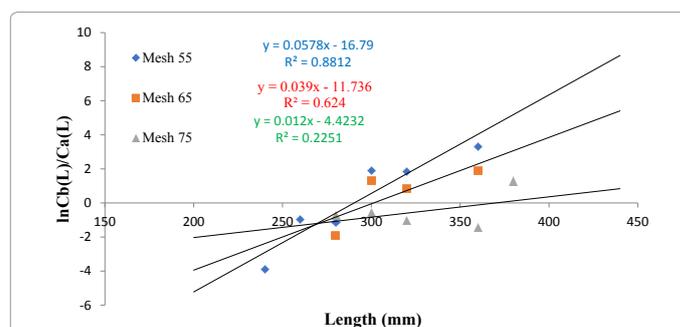


Figure 3: The regression of $\ln(C_b/C_a)$ on fish length for *T. ilisha* for gill-nets of 55, 65 mm and 75 mm mesh size from River Meghna in Bangladesh.

Length interval midpoint L (x)	Number caught of Hilsa		
	Ma=55	Mb=65	Mc=75
	Ca(L)	Cb(L)	Cc(L)
200	5		
220	38		
240	99	2	
260	43	16	
280	47	15	7
300	8	54	30
320	13	83	30
360	3	83	20
380		5	18
400			20
420			16
440			5
460			
Total	256	258	146

Table 2: Length-frequency data used for estimating the gill-net selectivity of hilsa (*Tenualosa ilisha*) in the River Meghna of Bangladesh during 2016.

Mesh Size	a	b	SF	s	Selection Range	Optimum Length (L _m)
5.5 cm	-16.79	0.0578	4.84	38.84	254.71-266.28	260.50 mm ^m
6.5 cm	-11.73	0.039	4.63	47.58	314.69-342.02	328.36 mm
7.5 cm	-4.42	0.012	5.26	57.48	347.34-394.64	370.99 mm

Table 3: Regression constants (a and b), Standard deviation (s), Selectivity factor (SF) and Optimum length (L_m) estimated from the gill-net selectivity studies of *Tenualosa ilisha* in the River Meghna of Bangladesh during 2016.

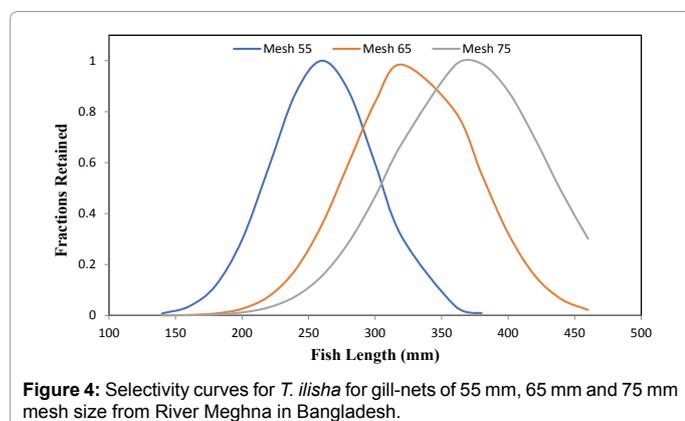


Figure 4: Selectivity curves for *T. ilisha* for gill-nets of 55 mm, 65 mm and 75 mm mesh size from River Meghna in Bangladesh.

in Table 2. The values of the Selectivity Factor (SF) and Standard Deviation (S) were calculated (Table 3).

The probability of capture against lengths for all mesh sizes showed three different selection ranges and formed a Selectivity curves (Figure 4). The optimum catch lengths of the gill-nets with 55 mm, 65 mm and 75 mm mesh sizes were calculated as 260.50 mm (L_m), 328.36 mm (L_m), and 370.99 mm (L_m), respectively (Table 3).

Discussion

Due to the regulation of the mesh size of gill net for recognizing the approximate minimum catch sizes of the target species fishing gear selectivity studies are very important for fisheries management [8,9]. *Jatka* below 250 mm size are not allowed to catch in Bangladesh water for sustainable Hilsa production [10]. Therefore, the results indicate that 55 mm mesh size gill-net for fishing operation should be discouraged for *T. ilisha* in the River Meghna and its estuary.

Besides, Size at first capture in 1995 to 2003 was 35 cm, 30 cm, 30.34 cm, 30.25 cm, 27.06 cm, 22.80 cm, 13.12 cm, 19.87 cm and 21.21 cm respectively presented by BOBLEME [11]. Amin et al. [12] calculated the length at first capture were 29.81 cm, 22.80 cm and 27.06 cm in the year of 1997, 1998 and 1999 respectively. Rahman and Cowx [13] reported that optimum mean length (L_m) at first capture were 329 mm (32.9 cm) which was lower than the value 350 mm (35.0 cm) of BFRI/RS Annual Report [14]. Rahman et al. [13] also suggested that less than 325 mm TL Hilsa must not be captured. In the year of 2013, length at first capture was 26.9 cm for freshwater and 27.6 cm for marine water reported by BOBLEME [15]. In the other research work (gill-net selectivity) on *T. ilisha*, the mesh size wise optimum length were calculated such as 29.05 cm for mesh size 7.6 mm, 39.92 cm for mesh size 10.2 mm, 42.16 cm for mesh size 11.4 mm and 53.62 cm for mesh size 12.7 mm [16].

Aforementioned all first capture data range of Hilsa are found between 13.2 cm to 35 cm. As *jatka* below 25 cm length size are not allowed for catching, 26 cm to 35 cm length size should be taken into consideration regardless of 13 cm to 25 cm length size. The length rage found from the present study was 314.69 mm to 342.02 mm is within the range of above mentioned length range. Moreover fish at 30 cm to 35 cm length range are being caught enormously by the fisherman in Bangladesh [6,17-21]. On the other hand Hilsa above 35 cm length size are found in lesser amount day by day in the commercial catches. However the use of gill-net with 65 mm mesh size is appropriate and should be suggested to ensure the sustainability of the Hilsa fisheries resources and will enhance the Hilsa production in Bangladesh.

Conclusion

Selectivity parameter of *T. ilisha* was estimated and allowable gill-net mesh size was determined as 65 mm for sustainable Hilsa fisheries management in the rivers of Bangladesh. Therefore, this conclusion might be an indicator to the optimum fishing range in the rivers and estuary of Bangladesh. Mainly the gill-net selectivity should be used for the Hilsa conservation approach, sustainable Hilsa fishing and implementation of Hilsa Fisheries Management Action Plan (HFMAP) and at least it will help to optimize the fishing standard.

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