FISHERIES OF HOOGHLY MATLAH ESTUARINE SYSTEM – FURTHER APPRAISAL

(1994 –95 TO 1999 – 2000)

Central Inland Capture Fisheries Research Institute
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Fisheries of Hooghly-Matlah Estuarine System
Further Appraisal (1994-95 to 1999-2000)

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Introduction

Fish fauna and fisheries of the Hooghly-Matlah estuarine system have been studied extensively for a number of years. Mitra *et. al.* (1997) reported fisheries of this estuarine system in detail incorporating a decade's data *viz.*, 1984-85 to 1993-94. The ecological and topographical characteristics of Hooghly estuary (Fig.1) and the impact of Farakka barrage on the hydrology, fishery resources and fish production of the estuary has been studied in detail by Sinha *et. al.* (1996). Further investigation carried out in this regard during 1994-95 to 1999-2000 reveals significant changes in catch and effort structure, species spectrum, catch per unit effort, and major shifts of exploitation gear, particularly in the upper estuary. The present communication highlights these changes incorporating six year's data *viz.*, 1994-95 to 1999-2000. Apart from assessment of fishery resources, fish population study was also undertaken. The objectives of the investigation and 'Methodology' (stratification of the estuary, landing pattern of the catch, sampling and estimation procedure) being the same, these are not reproduced here. Growth parameters and von Bertlanffy growth equation of some commercially important species are evaluated. An attempt has also been made to estimate Maximum Sustainable Yield (MSY) from this estuarine system in the light of probable magnitude of potential yield.

1. Fishery Resources

1.1 Total annual catch

The total estimated fish yield from the system fluctuated within 37980.8 to 69607.9 tonnes (t) during the period 1994-95 to 1999-2000 with an avearge of 55915.4 t as compared to an avearge catch of 32874.8 t during 1984-85 to 1993-94 exhibiting an increasing trend over the years (Fig 2). The hike in total catch during the peroid 1996-97 was mainly due to sudden increase in catch of *Tenualosa ilisha* and unusually increased catch of winter migratory bagnet fishery in lower estuarine zone. The hike in catch may be attributed to tremendous increase in effort coupled with astounding improvement in motorisation. The year in question has been assigned the period covered between March to February which enables to account for the seasonal winter migratory catch during the month of mid-October to early February.

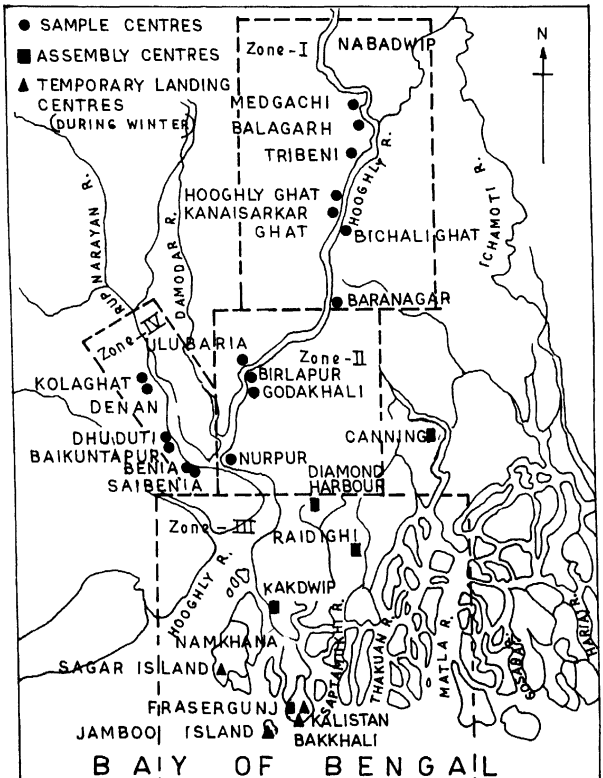
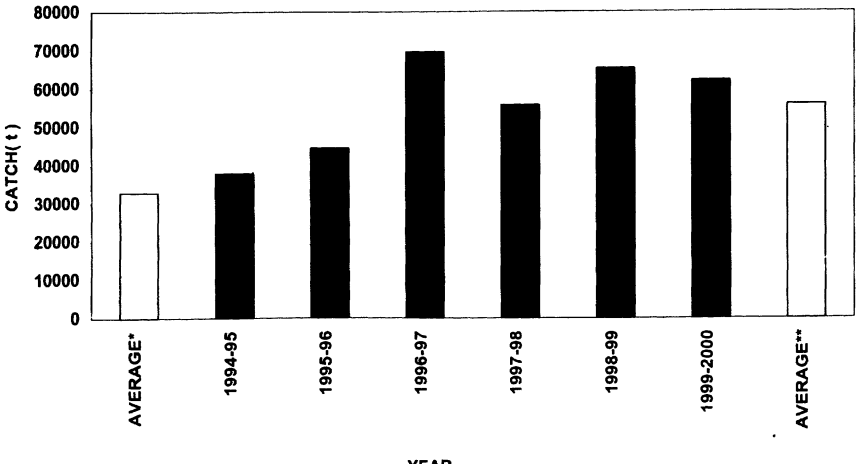


FIG. 1-HOOGHLY ESTUARY AND ITS VARIOUS FISHING ZONES

Fig.2 -TOTAL CATCH (t) from the HOOGHLY-MATLAH ESTUARINE SYSTEM



* 1984-85 to 1993-94

**1994-95 to 1999-2000

1.2 Month-wise catch structure

Like yesteryoars after registering low catch during the summer months of March to June, the catch begins to increase from July with the onset of monsoon and reaches a peak during winter months of November to January(Fig.3). Maximum average catch (82%) was accounted during winter months of November, December and January, while the minimum average catch (3.5%) was during the summer months of March to June, leaving the rest *i.e.*,14.5% average catch for the monsoon months (July to October).

1.3 Zone-wise catch structure

As usual, most of the total annual catch (92 to 95%) comes from the lower estuarine zone (Zone III) while the upper estuary *i.e.*, Zone I, II and IV together contribute 5 to 8% of total annual catch. Zone-wise catch is depicted in Fig 4.

1.4 Species-wise Catch Composition

25 species are mainly represented in the commercial catches of the estuary besides prawn and mackerel, A few species contributing less than 0.01% of the total catch individually were clubbed as " miscellaneous". The species are listed along with their percentage contribution to the total catch during 1994-1995 to 1999-2000 (Table 1). The bulk catch comprises the Bombay duck (*Harpodon nehereus*) -12.7 to 21.2 %, the Indian shad (*Tenualosa ilisha*) -7.0 to 19.0 %, *Pama pama* - 8.4 to 12.9%, anchovies (*Setipinna* spp.) - 6.4 to 12.9%, ribbon fishes (*Trichiurus* spp.) - 5.1 to 12.0 %, prawns - 4.2 to 10.8% , *Tachysurus jella* -3.7 to 5.6 %, pomfret (*Pampus argenteus* = *Stromateus cinereus*) -1.3 to 5.3%, *Coilia* spp. - 2.4 to 4.2%. These species together accounted 70.6 to 81.1% of the total catch.

Table 1 also shows a comparison of the species-wise average catch during the period 1984-85 to 1993-94 (Mitra *et. al.*,1997) and 1994-95 to 1999-2000 (present study). It is seen from Table 1 that average percentage contribution of *T. ilisha* has increased appreciably during the period 1994-95 to 1999-2000 as compared to 1984-85 to 1993-94. The percentage contribution of *T.jella, S. biauritus* have also increased to some extent during the period under report as compared to earlier years,while percentage contribution of some species *viz.*, *Setipinna* spp., prawns and some "miscellaneous" fishes have declined during the period 1994-95 to 1999-2000 as

Fig.3. Average Monthly landings (t) from the Hooghly-Matlah Estuarine System

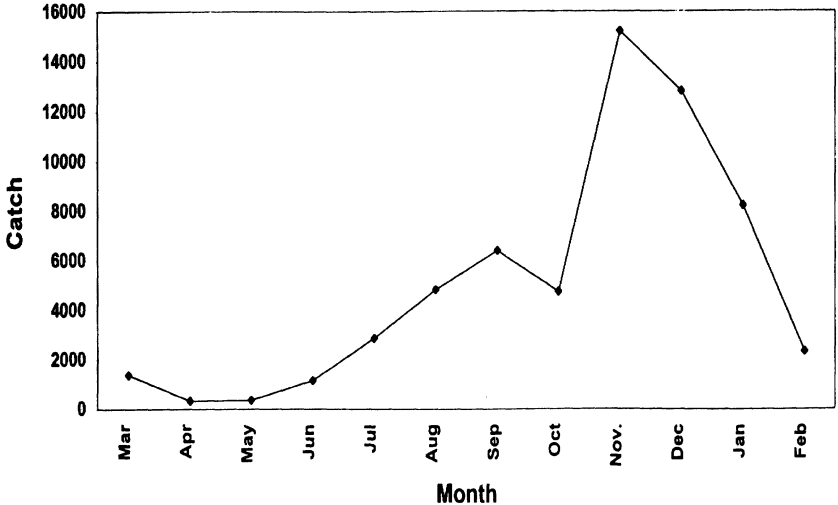
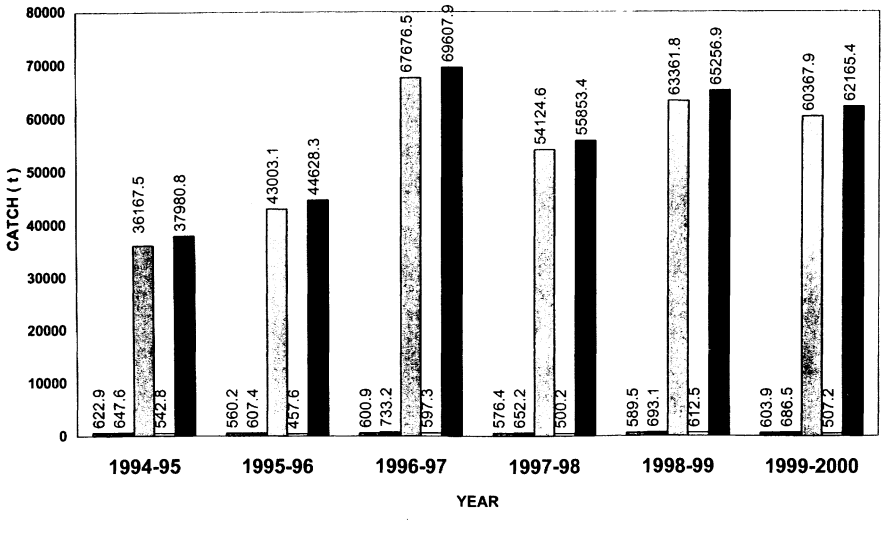


Fig. 4 ZONE-WISE ANNUAL CATCH (t) FROM THE HOOGHLY-MATLAH ESTUARINE SYSTEM



compared to earlier years. It is evident from Table 1 that *Tenualosa toli* is absent in recent years after showing a declining trend from 1989-90 indicating that the species is not available in the off shore areas of the estuary.

Marine and neretic species like *H.nehereus*, *T. ilisha*, *Setipinna* spp., *Trichiurus* spp., *P. pama*, *T. jella*, *Coilia* spp., *P.argenteus*, *Scianea biauritus* , *Ilisha elongata* (at present identified as *Ilisha megaloptera*)and prawns formed the bulk (75 to 85%) of lower zone catches. The hilsa, an active migrant, breeding in upper freshwater region of the Hooghly estuary and species like *P.pama*, *Polynemus paradiseus*, *Sillaginopsis panijus*, *Pangasius pangasius*, *Setipinna* spp. and small sized prawns formed 81 to 91% ; 83 to 93%and 75 to 86% of the total catches of zone I, II and IV respectively. It may be noted that *P. paradiseus*, one of the prized estuarine species after hilsa, alone contributed 25 to 30% of the total catch of Rupnarayan tributory (Zone IV) during the period under report. A few freshwater species (*Rita rita*, *Aorichthys aor*, *Glossogobius giris*, *Wallago attu*, *Ailia coila*, *Catla catla*, *Labeo rohita*, *L. calbasu*, *L. bata*,*Eutropiichthys vacha*, *Rhinomugil corsula*, *Clupisoma garua*) and freshwater prawn (*Machrobrachim rosenbergii*) contributed on average 52 t annually (Table 2) in upper estuary where salinity has almost become nil due to increased freshwater incursion after commissioning of Farakka barrage (Sinha *et. al.*, 1996).

Table 1. Percentage composition of different species in the total catch from the Hooghly-Matlah estuarine System.

Species	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000	Average	
							1994-95 to 1999-2000	1984-85 to 1993-94
Tenualosa ilisha	6.95	10.01	14.69	18.99	17.75	10.52	13.15	8.14
Liza tade	**	**	**	0.01	**	**	**	**
Liza parsia	0.03	0.05	0.05	0.12	0.03	0.03	0.05	0.06
Lates calcarifer	0.20	0.50	0.10	0.47	0.17	0.03	0.24	0.10
Sillaginopsis panijus	0.16	0.06	0.17	0.16	0.04	0.03	0.10	0.11
Polynemus paradiseus	0.40	0.63	0.59	0.61	0.65	0.58	0.58	0.56
Eleutheronema tetradactylum	0.02	**	0.03	0.07	0.03	0.04	0.04	0.06
Polynemus indicus	0.07	0.21	0.14	0.28	0.17	0.16	0.17	0.33
Sciaena biauritus	1.63	3.08	3.27	2.38	3.34	3.40	2.85	1.14
Coilia spp	3.95	2.45	2.82	2.73	4.16	3.38	3.25	2.39
Pama pama	12.92	10.99	12.02	8.36	10.04	12.30	11.11	11.99
Tenualosa toli	*	*	*	*	*	*	*	0.16
Ilisha megaloptera	1.92	1.95	2.09	1.94	1.91	1.95	1.96	1.61
Anodontostoma spp. (=Chaatoessus spp.)	0.02	**	0.07	0.06	0.05	0.02	0.04	0.05
Mystus gulio	0.02	0.01	0.02	0.05	0.04	0.04	0.03	0.02
Setipinna spp	12.87	10.43	8.61	7.42	6.38	11.28	9.50	11.29
Chirocentrus dorab	0.28	0.33	0.75	1.07	1.38	0.60	0.74	0.32
Pangasius pangasius	0.03	0.05	0.03	0.04	0.13	0.02	0.05	0.04
Tachysurus jella	4.19	3.97	3.72	5.52	5.18	5.61	4.70	2.71
Osteogeniosus militaris	0.47	0.42	0.21	0.29	0.32	0.35	0.34	0.28
Plotosus canius	**	**	**	**	**	**	**	**
Lutjanus spp.	0.01	0.03	0.13	0.08	0.05	0.32	0.10	0.03
Trichiurus spp.	5.11	10.44	11.99	6.58	8.00	5.88	8.00	9.06
Harpodon nehereus	13.85	21.19	17.89	16.53	12.75	19.79	17.00	16.06
Pampus argenteus	5.30	2.47	2.94	2.83	2.20	1.30	2.84	2.15
Prawns	10.79	6.54	6.51	7.30	4.18	6.30	6.94	8.66
Mackerel	1.24	0.49	1.05	1.36	2.08	1.13	1.22	0.83
Miscellaneous	17.41	13.57	10.07	14.68	18.88	14.82	14.90	21.67
Freshwater species	0.14	0.11	0.05	0.08	0.08	0.12	0.10	0.18
Total	99.98	99.98	100.01	100.01	99.99	100.0	100.0	100.0

* Nil ** < 0.01

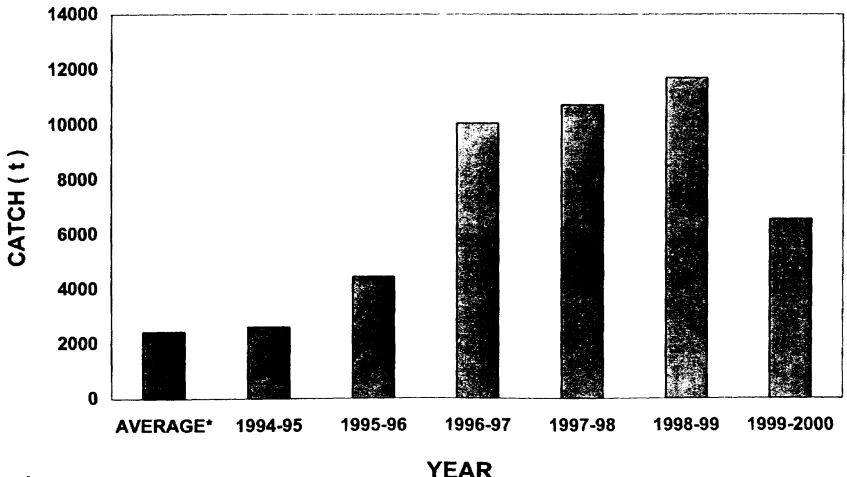
Table 2. Catch (t) of freshwater species in upper estuary

Species	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
M.rosenbergii	14.9	14.6	9.8	7.8	7.2	12.2
A.aor	5.4	3.5	4.5	4.9	8.8	13.9
R.rita	9.8	4.9	7.2	7.8	11.9	21.2
E.vacha	0.8	--	0.8	1.7	2.4	9.1
R.corsula	3.6	--	2.9	5.9	8.2	5.8
G.giris	14.8	16.3	4.4	13.5	7.4	10.7
Others(*W.attu, A.coila, L.rohita L.calbasu etc.*)	4.0	10.3	5.6	4.1	5.5	2.5
Total	53.3	49.6	35.2	45.7	51.4	75.4
% contribution to total upper estuary catch	2.9	3.0	1.8	2.6	2.7	4.2

1.5 Fishery of T.ilisha (hilsa)

The prime fish, hilsa forms commercially the most important fishery of the estuary in veiw of its high market value. The anadromous nature, breeding place and period, seasonal availability, selective gears to capture the fish and other related details have since been reported by many workers (Pillay, 1958; De, 1980;1986; Sinha *et.al*,1996, Mitra *et. al.*, 1997) the same is not reproduced here. Only the volume of hilsa catch and wanton destruction of juvenile hilsa during the period under report are discussed here. As common with Hilsa catch earlier ,the annual yields of the species were highly fluctuating and varied between 2638.0 to 11580.5 t accounting 7 to 18% of the total estuarine catch. Hilsa catch during 1998-99 was recorded highest (11580.5 t) during the period under report. It is evident from the Fig 5. that hilsa catch has increased from 1996-97 onwards which may be ascribed to tremendous increase in effort in recent years coupled with enormous improvement of mechanisation.

Fig. 5. HILSA CATCH (t) from the HOOGHLY-MATLAH ESTUARINE SYSTEM



* 1984-85 to 1993-94

Hilsa, sans winter migratory bagnet catch, forms the mainstay of the estuarine fish catch contributing 15 to 29% to the total annual fish landing. The monsoon (July to October) hilsa catch contributes 68% of the total annual landing of the species from the estuary. Dominance of large sized fishes in the length range of 23 to 53 cm representing third, fourth and fifth year age group, is the striking feature of the monsoon hilsa fishery. The fishery in winter is of a smaller mangnitude which contributes 26.5% of the total catch of the species (Fig. 6). The hilsa catch in different stretches of the estuary is presented in Table 3.

Hilsa juvenile (fry and fingerlings) constitute a substantial part of hilsa catch from the upper freshwater stretches of the estuary. Indiscriminate exploitation of young ones of hilsa through small meshed nets, particularly bagnets, take a huge toll of the hilsa juvelines, when these young ones start their downward migration. Estimated yield varying between 50.9 to 63.3 t, with an average of 57.5 t, during the period under report numerically works out to 13.1 millions of young fish. The weight and size of the juveline fish ranges from 2.2 to 27.0 gram and 6.4 to 15.3 cm respectively.

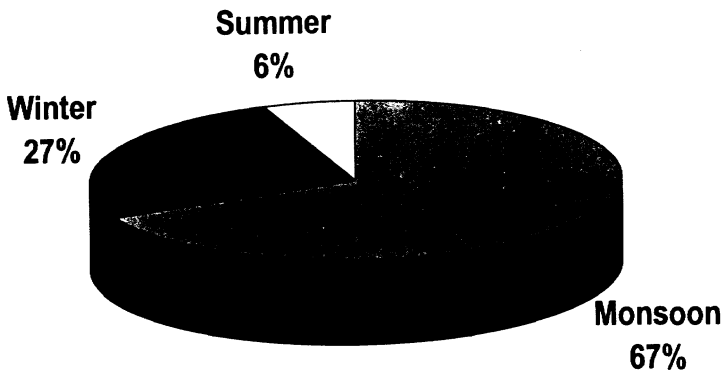
2. Winter Migratory Bagnet Fishery (WMBF)

The number of bagnets deployed at different centres and the number of mechanised and non-mechanised boats pressed into operation as well as migrant fishermen during the year 1994-95 to 1999-2000 in winter migratory bagnet fishery are presented in Tables 4, 5, and 6.

Prior to the commencement of winter bagnet fishing operations an inventory of the number of migrant fishermen, their holdings in terms of crafts and gears was undertaken by visiting individual fishing camps. Adopting a three/four day sampling procedure in a month, information pertaining to total fish catch and effort were recorded based on direct observation. Total catch and effort input for the days of observation were noted for all the camps at a site. A few random samples from the catches were examined to ascertain species composition.

The total estimated winter bagnet fish landing fluctuated within 20820.6 to 35844.6 t per season (Table 7) with an average CPUE of 53.12 to 93.72 kg (Table 8) during the period 1994-95 to 1999-2000. Though the total catch of WMBF shows a rising trend upto the year 1996-9, the downward trend of overall average CPUE from 1995-96 is a warning signal indicative of over exploitation (Fig. 7). The fishing

FIG.6. Season-wise Hilsa Catch from the Hooghly - Matlah Estuarine System



intensity in recent years has been on the increase as revealed by rising number of fishing units from 953 in 1994-95 to 1247 in 1995-96 and further to 1629 and 1660 in 1996-97 and 1997-98. The sudden decline in catch as well as low CPUE during1997-98 as compared to 1996-97 sounds warning signal for future as high levels of extraction over the years and further increase in effort may not be sustainable which is evidenced by the fact that the effort remaining almost the same the catch and CPUE have revived to a little extent during the period 1998-99 and 1999-2000 (Fig. 7).

Table 3. Hilsa catch in different stretches of the Hooghly-Matlah estuarine system.

Year	Upper estuary	Lower estuary	Digha	Total
1994-95	462.0	460.8	1715.2	2638.0
1995-96	466.2	2045.3	1956.4	4467.9
1996-97	411.3	7383.9	2432.0	10227.2
1997-98	397.5	8987.4	1226.0	10610.9
1998-99	528.6	8464.2	2587.7	11580.5
1999-2000	305.0	5037.0	1197.2	6539.2

Table 4. Centre-wise concentration of migrant fishermen in winter migratory bagnet fishery in lower estuary.

Centres	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Fraserganj	308	273	270	338	300	225
Bakkhali	149	176	309	306	258	172
Upper Jamboo	1284	1468	1863	2001	2668	2621
Lower Jamboo	498	1000	1385	1240	1563	1050
Kalisthan	1356	983	1337	1330	936	607
Sagar Island	580	845	1084	1000	895	815
Total	4175	4745	6248	6215	6620	5490

Fig. 7 TOTAL CATCH (t) and CPUE (kg) from WINTER MIGRATORY BAGNET FISHERY

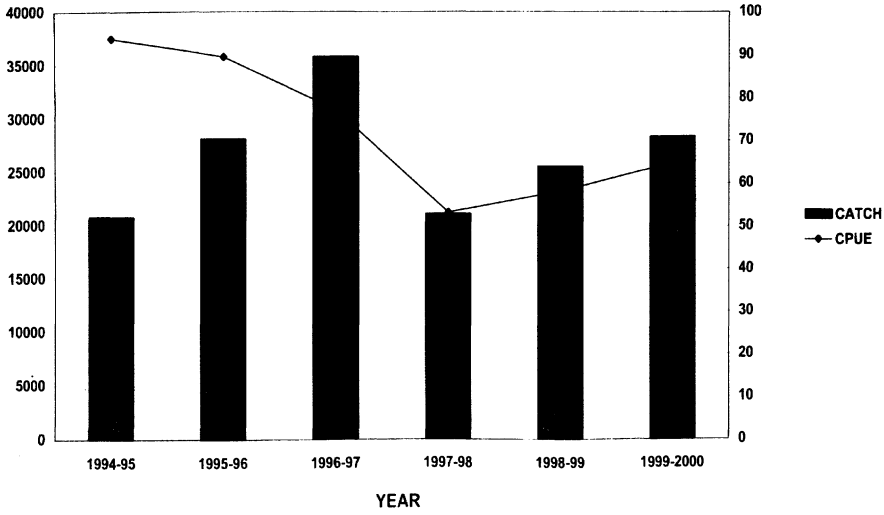


Table 5. Center-wise concentration of bagnets in winter migratory fishery in lower estuary.

Centre	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Frasergunj	120	118	131	138	128	128
Bokkhali	82	95	132	124	115	98
Upper Jamboo	187	257	359	406	464	565
Lower Jamboo	114	221	312	286	328	269
Kalisthan	204	201	231	274	192	134
Sagar Island	246	355	464	432	434	476
Total	953	1247	1629	1660	1661	1670

Table 6. Centre-wise concentration of boats in winter migratory bagnet fishery in lower estuary.

Centre	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Frasergunj	55 (23)	54 (23)	65(30)	62 (38)	55 (41)	56 (43)
Bokkhali	30 (8)	40 (17)	57 (29)	50 (30)	46 (26)	47 (30)
Upper Jamboo	76 (32)	97 (41)	110 (59)	114 (63)	116 (98)	127 (118)
Lower Jamboo	40 (20)	54 (26)	74 (44)	55 (22)	72 (63)	62 (56)
Kalisthan	81 (44)	71 (32)	87 (47)	96 (57)	58 (38)	37 (30)
Sagar Island	104 (39)	139 (42)	172 (59)	163 (54)	151 (50)	170 (68)
Total	386 (166)	455 (181)	565 (268)	540 (264)	498 (316)	499 (345)

Figures in parenthesis indicate the number of mechanised boats out of total no. of boats at respective centres.

Table 7. Centre-wise Catch (t) of winter migratory bagnet fishery in lower estuary.

Centre	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Frasergunj	981.1	902.2	1162.5	711.7	1128.3	1125.4
Bokkhali	385.3	529.1	1006.2	939.9	598.5	508.0
Upper Jamboo	7148.8	9916.2	11725.2	7884.2	10463.9	13783.6
Lower Jamboo	2896.3	9884.8	9584.9	5620.1	6975.2	6487.1
Kalisthan	7206.2	5577.0	7784.2	4307.3	3465.8	4032.4
Sagar Island	2202.9	2276.6	4581.6	1703.6	2943.8	2480.9
Total	20820.6	28185.9	35844.6	21166.8	25575.5	28417.4
% contribution to total catch	54.8	63.2	51.5	37.9	39.2	45.7
% contribution to lower estuary catch	57.6	65.5	53.0	39.1	40.4	47.1

Table 8. Centre-wise CPUE (kg) of winter migratory bagnet fishery in lower estuary.

Centre	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Frasergunj	34.49	29.92	34.28	21.04	34.47	33.70
Bokkhali	26.00	25.85	34.84	29.85	23.80	22.89
Upper Jamboo	122.76	126.10	109.40	69.63	72.59	79.69
Lower Jamboo	93.44	130.51	97.11	69.43	67.60	81.58
Kalisthan	131.86	104.60	140.07	67.27	69.96	101.86
Sagar Island	62.91	35.77	32.77	22.72	34.47	27.40
Total	93.72*	89.46*	77.24*	53.12*	58.11*	64.85*

*** Average CPUE for all centres combined together**

The capture by the WMBF during three and half months accounted for 39 to 66% of the total yield from the lower estuary (Zone III) and 38 to 63% of the total catch of the estuary (Table 7). The bar diagram Fig.8 depicts the total catch and WMBF catch. WMBF catch mainly comprises small sized fishes. The average species-wise landing of WMBF during 1994-95 to 1999-2000 is presented in Table 9.The dominant species contributing to the fishery are : *H. nehereus, Setipinna* spp., *Trichiurus* spp. *P.pama, Coilia* spp.,*I.megaloptera T. jella,P.argenteus* and prawns. These species alone accounted for about 89% of total landings (Table 9). The catches landed during the season are mostly sundried except the highly economic species like *P.paradiseus* (landed in smaller quantity) and *P.argenteus* which are sold out locally to fish merchants in the area. The dried fish stacked in the fishing camps are periodically sent by boats to the marketing centres, mainly to Uluberia, from where further distribution to other markets takes place through dry fish traders.

3. Gear-wise composition of catch

A wide variety of gear is operated round the year in the estuary for commercial fishing.Some are selective for a particular species, but most of them are for multi-species exploitation. Bagnets and drift-gill nets constituded the most dominant gears in the estuary accounting for 62 to 82% (average 73%) and 16 to 31% (average 24%) respectively of the total catch with the rest contributing only 3% on the average (Fig 9). It is seen from the Table 10 that some gears like "Bhola-ber" and "Topsia" which may be classified as drift-gill net are shown separately since they are selective gears. This aspect is dealt with in section 4 (Inventory of crafts and gears of upper estuary) elaborately.

Fig. 8. TOTAL CATCH and WINTER MIGRATORY BAGNET CATCH (WMBC) from the HOOGHLY-MATLAH ESTUARINE SYSTEM

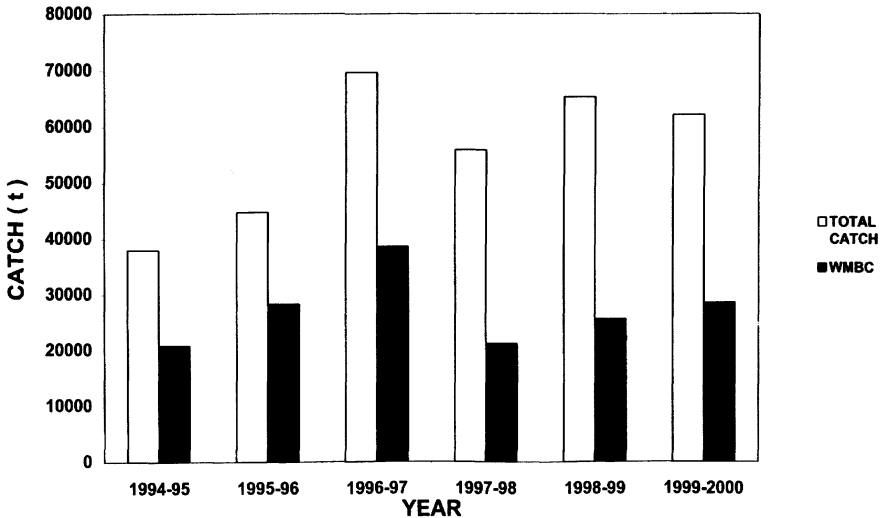
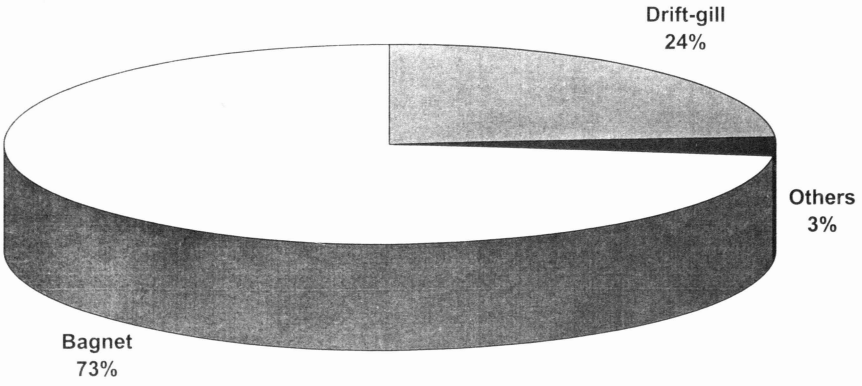


Fig. 9. **GEAR-WISE COMPOSITION of CATCH from the HOOGHLY-MATLAH ESTUARINE SYSTEM**



4 Inventory of crafts and gears of upper estuary

A fresh census of the crafts and gears employed in the upper estuary was conducted in 1997 to raise a new sampling frame to estimate the catch. The Table 11 shows comparative zone-wise census figures of different gears during the peroid 1997 and 1982-83 (Mitra, *et. al.*, 1987). Analysis of inventory data reveals all round decline of gears and boats in the upper stretch of the estuary (Nabadwip to Dakshineswar) compared to census conducted during 1982-83. The principal gears *i.e.*, Bagnet and Drift-gill net declined substantially by 62 and 41% respectively. Purse, Seine, Trawl and Castnet also decreased by 62%, 60%, 25%, and 50% respectively, while Liftnet, Set-barrier and Hooks & Lines remaining almost the same. However, Set-gill and Traps increased by 6 and 2.5 times respectively.

Table 9. Average species-wise composition of catches (t) of winter migratory bagnet fishery in lower estuary.

Species	Catch	Percentage
S.panijus	11.19	0.04
P.paradisus	162.81	0.61
Coilia spp.	1236.88	4.64
P.pama	2830.58	10.61
I.megaloptera	293.05	1.10
Anodontostona spp.	4.64	0.02
Setipinna spp.	4287.59	16.08
C.dorab	17.57	0.07
P.pangasius	16.51	0.06
T.jella	271.85	1.02
O.militaris	132.81	0.50
Trichiurus spp.	3662.50	13.73
H.nehereus	8235.37	30.88
P.argenteus	246.51	0.92
Prawns	1301.64	4.88
Miscellaneous	3956.92	14.84
Total	26668.42	100.00

Table 10. Gear-wise composition of catches (t) of Hooghly-Matlah Estuarine system.

Gear	1994-95	1995-96	1996-97	1997-98	1998-99	1999-2000
Trawl	57.3	66.5	60.3	68.5	69.5	72.5
Small seine	127.5	90.1	11.5	339.9	1058.0	302.5
Purse	28.9	28.2	27.0	24.9	18.7	11.4
Drift	6187.0	8488.0	17344.2	18449.1	20381.0	13283.4
Lift	48.9	35.8	31.1	26.6	15.4	10.4
Cast	21.4	19.6	15.7	9.8	14.5	37.9
Bag	31291.9	35684.2	49686.7	34511.1	43159.0	47711.5
Set-gill	28.8	21.4	10.7	7.3	10.6	16.5
Set-barrier	90.3	68.8	70.1	75.4	161.9	229.4
Traps	7.8	3.8	2.7	2.0	1.6	2.1
Hooks & Lines	91.0	121.9	23.8	535.8	173.0	96.4
Bhola-ber	--	--	--	--	193.7	377.3
Topsia	--	--	--	--	--	14.1
Unknown & Unclassified	--	--	2324.1	1803.0	--	--
Total	37980.8	44628.3	69607.9	55853.4	65256.9	62165.4

Table 11A :Census figures of fishermen and boats in Zone I,II and IV.

Zone	No. of Fishermen				Total		No. of boats				Total	
	Full-time		*Part-time*				*Mechanised*		*Non-mechanised*			
	1997	1982-83	1997	1982-83	1997	1982-83	1997	1982-83	1997	1982-83	1997	1982-83
I	1023	3206	5430	1404	6453	4610	3	--	2198	2284	2201	2284
II	1006	1940	3006	3051	4012	4991	107	--	1153	1401	1260	1401
IV	1316	3309	5366	1911	6682	5220	76	--	1031	1315	1107	1315
Total	3345	8455	13802	6366	17147	14821	186*	--	4382	5000	4568	5000

* More than 100 mechanised boats actually operate in the lo

In the lower stretch (Dakshineswar to Diamond Harbour) the same declining trend is observed although the decrease in case of drift-gill net is marginal (9%). Bagnet, castnet decreased by 45% and 67% respectively, whereas existence of seine net is negligible. However, set-barrier and hooks increased by 5 and 3 times respectively. Some new types of small meshed selective gill-nets locally called " Topsia " and " Bhola-ber " to capture *P.paradiseus* and *P.pama*, and *S. phasa* respectively have been introduced which had no existence during earlier period. About 100 mechanised boats are deployed compared to none during 1982-83 inventory.

In the Rupnarayan tributory (Zone IV) notable decrease of several gears is observed. Bagnet,seine net and purse net decreased by 23%,43% and 68% respectively while drift-gill and set-barrier increased by 7% and 64% respectively. The appearance of new gear "Bhola-ber" in this stretch is quite appreciable which had no existence during earlier period.

A notable feature is the decrease of full time fishermen (60%) in all the stretches with a sharp increase (117%) of part-time fishermen (Table 11A). However, the number of part-time and full-time fishermen put together increased marginally by 15%. Fish yield being remained almost stationary in the upper estuary for over a decade and small sized fish capture (except hilsa gears) fetching low price, fishermen - unable to maintain parity between income and expenditure - appear to have switched over to some gainful alternative occupation generated either through rapid urbanisation or self employment for their economic upliftment and preferred to keep fishing as part-time occupation. The hike of set-barrier net in the upper estuary may be explained by the fact that fishermen may go to some other work for few hours after setting the barrier net in the river. No appreciable change in estimated catch of upper estuary is observed after using new raising factor from July 1997 onwards emanating from new sampling frame. However, the catch by set-barrier net has increased.

5. Growth parameters and von Bertlanffy growth equation of some commercially important species

Growth parameters, *viz.*, asymptotic length (L_∞), growth coefficient (K) and initial condition factor (t_0) based on length-frquency data usuing Gulland and Holt plot through the modal progression of mean lengths of the species have been evaluated and corresponding von Bertlanffy growth equation was determined. These may be summerised as follows :

Species	L_∞ (in cm)	K (per year)	t_0
T. ilisha	68.86	0.220	-0.323
L.parsia	23.68	0.739	-0.537
P.paradiseus	28.40	1.348	-0.520
S.phasa	30.87	1.442	-0.220
P.pama	40.25	2.235	-0.116
S.panijus	52.54	1.619	-0.183

Species	von Bertlanffy growth equation
T.ilisha	$L_t = 68.86 [1 - exp \{ -0.220 (t_0+0.323)\}]$
L.parsia	$L_t = 23.68 [1 - exp \{-0.739 (t_0+0.537)\}]$
P.paradiseus	$L_t = 28.40 [1 - exp \{-1.348 (t_0+0.52)\}]$
S.phasa	$L_t = 30.87 [1 - exp \{-1.442 (t_0+0.220)\}]$
P.pama	$L_t = 40.25 [1 - exp \{-2.235 (t_0+0.116)\}]$
S.panijus	$L_t = 52.54 [1 - exp \{ -1.619 (t_0+0.183)\}]$

Maximum sustainable yield - An Estimate

The total estimated annual catch from this estuarine system exhibits an increasing trend over the years with increasing effort coupled with extraordinary improvement of motorisation. The Table 12 exihibits how the total catch as well as winter migratory bagnet catch increase with percentage increase of motorisation during the period 1984-85 to 1999-2000. The fishing pressure exerted is increasing overs the years.As such, it is necessary to study as to how long the fishery can sustain the increasing trend in the light of probable magnitude of potential yield. Since the catches from remote places of the lower estuary, which on the average constitutes over 90% of the total yield, converge to some assembly centres, no direct contact can be made with the actual fishermenfolk making collection of effort data very difficult or rather impossible.As already mentioned earlier, multispecies are exploited by multigears in this estuarine system. Thus, evaluation of effective effort poses problem due to the selectivity of gear as a result of deployment of wide ranges of mesh size.In the absence of effective effort data, an attempt has been made to predict the maximum sustainable yield (MSY) that the fishery can sustain. Relative Response Model (Alagaraja, 1984) was applied as the three assumptions underlying the success of the model are fulfilled for this estuarine system.The assumptions are : (i) In the progressive fishery where multispecies are exploited by multigears where evaluation of effective effort poses problems particularly in tropical countries, (ii) Stocks existing in a particular area are exploited by various types of gears and (iii) The fishing intensity is increased over a period of time till the optimum level is achieved.

The model is a linear relatoinship between successive catches of each year namely,

$$C_{t+1} = a + b\,C_t$$

where C_t is the catch of t-th year,a and b are the constants.

The maximum catch the fishery can sustain is given

$$C_{max} = a / (1- b) \qquad \ldots\ldots\ldots (1)$$

From the relationship (1), a and b were calculated as

a = 6104.6874 and b = 0.900026

so that maximum catchable potentiality was estimated as 61063 t taking the total catch data for the years 1984-85 to 1997-98 considering the present level of exploitation and present area of coverage for fishing. It is seen from the data that there is a steady increase of catch upto the year 1995-96 and then a hike in total catch from the year 1996-97. This is due to the fact that the area of coverage is increasing day by day as the fishermen started going deep in the sea for 4/5 days with ice due to the reasons mentioned earlier. Thus, with a radical change in the pattern of exploitation the catchable potential may change in future with more area of coverage for fishing.

Table 12 - Year-wise total catch from Hooghly-Matlah estuarine system

Year	Total Catch (t)	Winter bagnet catch (t)	Percentage of motorised boats
1984-85	26044.9	19639.5	20.75
1985-86	23941.7	17581.4	20.69
1986-87	22143.2	8125.3	20.11
1987-88	31591.8	23775.6	20.41
1988-89	41522.0	34258.0	22.84
1989-90	33077.8	25688.7	20.50
1990-91	41568.9	26669.0	22.04
1991-92	37405.2	21460.8	19.87
1992-93	36900.0	26006.3	28.45
1993-94	34551.5	17693.2	31.80
1994-95	37980.8	20820.6	43.01
1995-96	44628.3	28185.9	39.78
1996-97	69607.9	35844.6	47.43
1997-98	55853.4	21166.8	48.89
1998-99	65256.9	25575.5	63.45
1999-2000	62165.4	28417.4	69.14

Conclusion

The total estimated annual yield from the Hoo ghly-Matlah estuarine system exhibits significant sign of increase over the years with in creasing fishing intensity. The fishing pressure exerted is increasing year after year. Thi may ultimately affect in depletion of stock leading to decline in fishery to uneconomi al level.At present,the fishermen are opertaing selective or multispecies gear with a wide range of mesh size to capture different size range of species.Analysis of length frequency data of various species from commercial catches poses a problem due to selectivity of gear as a result of deployment of various mesh size. Furthermore, fishermen are very reluctant to allow measurements of priced fishes like *T. ilisha, P.paradiseus,L.parsia, L.calcarifer, P.argenteus* etc. at the landing site. This problem can be overcome by undertaking experimental fishing in the selected place of the estuary so that mixed fishery assessment can be studied using length / age based cohort analysis to evaluate stock size, MSY, and corresponding optimum level of fishing effort.

Indiscriminate exploitation through small meshed nets particularly bagnet in the upper estuary can have adverse effect on the stocks of those species whose juveniles (fry and fingerlings) are located within the exploited region and are subjected to wanton destruction. As noted by Ricker (1958), a better yield can be obtained in such a case by increasing the fishing effort and at the same time raising the minimum size limits (almost zero as exists at present) to some reasonable values preferably about 20 mm mesh size.The operation of these very small meshed nets may be prohibited in the upper stretch of the estuary where juvenile of many species (*T.ilisha, P.pama, P.paradiseus, S.phasa* etc.). are found to inhabit.Another satisfactory solution is that peak period of abundance of young ones may be declared as closed seasons for operation of small meshed nets in the upper estuary. Mass awareness among fisherfolk may be developed and the fishermen may be motivated to operate their nets during the aforesaid period in the lower estuary.

Indiscriminate killing of seeds of some species of marine habitat available in the shallow coastal waters of the lower estuarine zone in Sunderbans areas is taking place as a result of widespread shooting net operation in order to capture live Bagda (*Penaeus monodon*) seeds which fetch lucrative price for culture in brackishwater areas. Mass awareness should be created among fishermen regarding the adverse effect of such destruction. It is also suggested that Government controlled agencies should come forward to stop such wanton destruction.

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