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Conservation of Marine and Coastal Shrimp Resources and Sustainable Aquaculture

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Abstract: Maximum Sustainable Yield (MSY) estimates from surplus production model of Schaefer showed that the optimum yield for shrimps in industrial fishery in Bangladesh is estimated at 3,441.73 t and the optimum effort for producing the amount is 9,383 standard days. During 1992-93, the catch per unit effort (CPUE) of trawl shrimp was 592.78 kg/day and fishing effort was 7,065 fishing days in Bangladesh. In 2000-01, the CPUE of trawl shrimp has decreased and it was 284.23 kg/day (52% less) although fishing effort has been increased (11,160 fishing days) which was higher than maximum sustainable fishing effort (9,383 fishing days). At present (data to 2001), the maximum sustainable yield (MSY) of trawl shrimp was 3,441 t, which is about 54% less than previous report during 1989 (MSY = 7000-8000 t). The exploitation level (E) of trawl and ESBN fishery of Bangladesh have been briefly reviewed in this paper to reveal the stock status of the marine fisheries of Bangladesh and to take necessary step for management option of the overexploited stocks. Attempts are needed to culture some other species specially those, which have market price and growth fast. The candidate species may be *Penaeus indicus*, *P. merguiensis* and *Metapenaeus monoceros.*

Key words: Conservation, marine shimp resources, Bangladesh

INTRODUCTION

The open water fishery resource provides important source for food and has been traditionally exploited for centuries in Bangladesh. With the rapid increase in the human population over the years, the demand for fish has increased considerably. During the last few years there has been a growing awareness among the users about the need to conserve and manage open water fisheries resources based on data collected in a scientific manner so as to ensure proper utilization and maximum sustainable yield (MSY). Increasing pressure on the coastal resources has caused decline of many of the marine fish and shrimp stocks. The general brief that the continental shelf of Bangladesh is a treasure of fish, for unlimited exploitation, has led to a production oriented strategy and thus resulted in some cases over exploitation of resources[7]. Stock assessment of fishery is important for its effective management. Fisheries are a renewable resource with a built in system of replenishing the harvested stock. Hence, if an effective management strategy can be developed on a sound scientific basis and implemented properly, it would help to obtain sustainable yield every year.

For management purpose, it is necessary to understand the important parameters of fish population (i.e., growth, mortalities - fishing, natural and total, recruitment, exploitation rate and its stock position). Without the knowledge of these parameters of a fish population, it is not possible to undertake sound and effective management program on a fish stock. All these information help us to provide advice to fishing industry, fishermen, fisheries managers and the planners and policy makers on the optimum level of exploitation of fisheries resources and to provide possible options achieving the same.

Several surveys have been conducted in Bangladesh marine water to stock assess, particularly the demersal shrimp resources[20,16,14,6,21,22,10] and on the basis of biological information, the penaeid shrimp MSY was estimated at 7000-8000 mt annually[9]. Over exploitation of the fisheries resource are greatly affecting the livelihood of fishermen. Common property and open access nature of the fisheries allows more and more people to enter the fishing sector leading to overexploitation of the resources. So, if we do not attempt to conserve the marine and coastal fishery resources, once abundant and plentiful fish resource could be lost and livelihood of fishermen will be adversely affected.

MATERIALS AND METHODS

A 10-year's time series (1991-2001) of basic catch statistics comprising annual industrial landings and their

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corresponding effort has been analyzed in this paper. The analytical tools employed are based on the model introduced by Schaefer[17,18] and later reviewed by several authors including Fox[3], Ricker[15], Gulland[4], Pauly[13] and Sparre and Venema[19]. The results of MSY and their corresponding optimum values for effort were obtained using the following equation:

$MSY = -a^2/4b$
$f_{MSY} = -a/2b$

Where a and b are intercept and slope in the linear regression analysis of catch per unit effort on effort (fishing days). Available literature was also consulted for past data.

RESULTS AND DISCUSSIONS

Trend of shrimp production: Year wise actual production (1991 – 2001) of shrimp in Bangladesh was shown in Fig.1. The total production was varied between 2,416 t and 4,188 t. The lowest catch was observed 2,416 t in the year 1994-95. The highest catch was observed 4,188 t in the year 1992-93. The fishing effort was 6,122 days and corresponding CPUE was 474.03 kg/day during 1991-92. After that the effort has been increased every year and it was 11,160 fishing days and CPUE was 284.23 kg/day in the year 2000-01. Unfortunately the catch per unit effort (CPUE) has been decreased every year (Fig.1).

Maximum Sustainable Yield (MSY): The statistical results of the linear regression analysis and the estimates for MSY are shown in Table 1. The MSY of penaeid shrimp was 3,441.73 t and the optimum effort for producing the amount was 9,383 standard days. During 1992-93, the catch per unit effort (CPUE) of trawl shrimp was 592.78 kg/day and fishing effort was 7,065 fishing days in Bangladesh. In 2000-01, the CPUE of trawl shrimp has decreased and it was 284.23 kg/day (52% less) although fishing effort has been increased (11,160 fishing days) which was higher than maximum sustainable

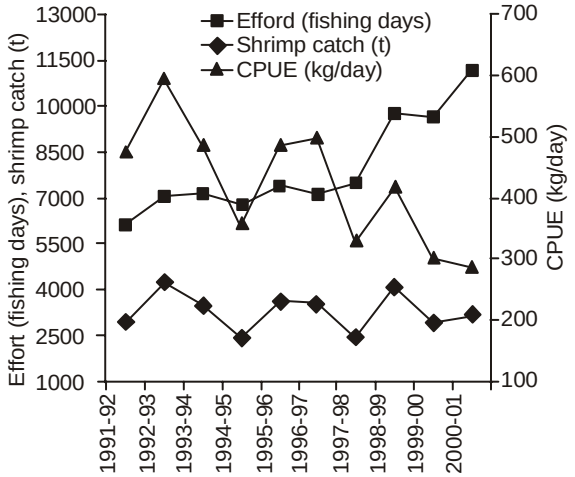

Fig. 1: Fishing effort (days), corresponding catch and catch per unit effort (CPUE) of shrimp in Bangladesh

Table 1: Estimates for the surplus production model and their corresponding statistical.

Derived statistics	Derived values
MSY (t)	3441.73
f_{MSY} (f days)	9383
a	733.58
b	-0.03909
r	-0.62
No. of observations	10

Table 2: Population parameters of some commercially important species exploited by trawl net from the Bay of Bengal, Bangladesh.

Sl	Species	Lμ (cm)	K/yr	M/yr	F/yr	Z/yr	E_{max}	E	Lc (cm)	Sources
1	*Nemipterus japonicus*	27.20	0.92	1.74	0.51	2.25	0.58	0.23	15.70	Amin *et al*. (1999)
2	*Ilisha filigera*	32.5	0.90	1.63	1.25	2.88	0.60	0.43	21.44	Zafar *et al.* (1998a)
3	*Johnius argentatus*	46.10	0.86	1.44	0.58	2.02	0.57	0.29	22.13	Zafar *et al*. (2000)
4	*Megalaspis cordyla*	*37.90*	*0.58*	*1.17*	*0.58*	*1.75*	*0.61*	*0.33*	*21.80*	*Azad (1998)*
5	*Lepturacanthus savala*	*106.50*	*0.80*	*1.08*	*0.81*	*1.89*	*0.79*	*0.43*	*60.39*	*Mustafa, et al (2000)*
6	*Penaeus monodon (M)*	*30.5*	*1.14*	*1.94*	*4.89*	*6.83*	-	*0.71*	*17.5*	*Khan and Latif (1997)*
7	*Penaeus monodon (F)*	*31.5*	*1.35*	*2.14*	*3.58*	*5.72*	-	*0.62*	*15.7*	*Khan and Latif (1997)*
8	*Metapenaeus monoceros(M)*	*15.7*	*1.6*	*2.91*	*2.98*	*5.89*	-	*0.50*	*8.9*	*Khan and Latif (1997)*
9	*Metapenaeus monoceros(F)*	*18.5*	*1.65*	*2.84*	*1.68*	*4.52*	-	*0.37*	*9.5*	*Khan and Latif (1997)*
10	*Pampus argenteus*	*30.67*	*1.66*	*2.35*	*2.90*	*5.25*	-	*0.55*	-	*Khan and Latif (1997)*

Table 2: Continue

11	*Upenaeus sulphureus*	*22.0*	*1.1*	*2.96*	*7.63*	*10.59*	*-*	*0.72*	*-*	*Khan and Latif (1997)*
12	*Nemipterus japonicus*	*24.96*	*1.06*	*1.94*	*1.81*	*3.75*	*-*	*0.48*	*-*	*Khan and Latif (1997)*
13	*Saurida tumbil*	*39.0*	*0.97*	*1.66*	*0.88*	*2.54*	*-*	*0.35*	*-*	*Khan and Latif (1997)*
14	*Pomadasys hasta*	*56.9*	*0.38*	*0.81*	*0.79*	*1.61*	*-*	*0.51*	*-*	*Khan and Latif (1997)*
15	*Lepturacanthus savala*	*105*	*0.85*	*1.33*	*0.73*	*2.06*	*-*	*0.65*	*-*	*Khan and Latif (1997)*
16	*Harpodon nehereus*	*38.3*	*0.42*	*0.94*	*0.60*	*1.54*	*-*	*0.38*	*-*	*Khan and Latif (1997)*
17	*Lutjanus johni*	*64.72*	*0.28*	*0.59*	*2.11*	*2.70*	*-*	*0.78*	*-*	*Khan and Latif (1997)*
18	*Arioma indicus*	*22.0*	*1.12*	*2.10*	*3.43*	*5.53*	*-*	*0.62*	*-*	*Khan and Latif (1997)*

Table 3: Population parameters of some commercially important species exploited by ESBN in the coastal waters of Bangladesh

Sl	*Species*	*$L\infty$ (cm)*	*K/yr*	*M/yr*	*F/yr*	*E*	*Lc (cm)*	*Sources*
1	*Harpodon nehereus*	*24.48*	*1.50*	*2.46*	*3.27*	*0.57*	*6.74*	*Mustafa et al. (1998a)*
2	*Coilia dussumieri*	*16.80*	*1.30*	*2.49*	*2.30*	*0.48*	*10.49*	*Zafar et al. (1999)*
3	*Parapenaeopsis sculptilis*	*16.80*	*1.25*	*2.43*	*2.93*	*0.55*	*6.30*	*Zafar et al. (1997b)*
4	*Exopalemon styliferus*	*11.21*	*2.20*	*3.94*	*4.57*	*0.54*	*6.28*	*Zafar et al. (2000)*
5	*Acetes indicus*	*3.10 mm*	*1.70*	*4.76*	*1.31*	*0.22*	*1.58mm*	*Zafar et al. (1997a)*
6	*Acetes erythraeus*	*3.70 mm*	*1.20*	*3.61*	*1.11*	*0.24*	*1.82 mm*	*Zafar et al. (2002)*
7	*Acetes chinensis*	*4.00 mm*	*1.60*	*4.26*	*1.13*	*0.21*	*2.35 mm*	*Zafar et al. (1998)*
8	*Penaeus monodon*	*31.36*	*0.72*	*1.42*	*8.37*	*0.85*	*13.79*	*Khan and Latif (1997)*
9	*Penaeus indicus*	*22.83*	*0.55*	*1.303*	*3.70*	*0.74*	*5.91*	*Khan and Latif (1997)*
10	*Metapenaeus monoceros*	*19.77*	*0.43*	*1.16*	*3.65*	*0.75*	*5.86*	*Khan and Latif (1997)*
11	*Metapenaeus brevicornis*	*15.57*	*0.31*	*0.99*	*4.23*	*0.80*	*4.80*	*Khan and Latif (1997)*
12	*Metapenaeus spinulatus*	*20.06*	*0.39*	*1.07*	*5.90*	*0.84*	*5.29*	*Khan and Latif (1997)*
13	*Parapenaeopsis sculptilis*	*16.90*	*0.76*	*1.75*	*4.15*	*0.70*	*15.30*	*Khan and Latif (1997)*
14	*Palaemon stylifera*	*14.37*	*1.66*	*3.06*	*3.00*	*0.49*	*2.80*	*Khan and Latif (1997)*
15	*Acetes indicus*	*4.97 mm*	*0.73*	*2.40*	*1.10*	*0.31*	*2.03 mm*	*Khan and Latif (1997)*
16	*Macrobrachium. roserbergii*	*35.54*	*0.34*	*0.84*	*1.96*	*0.70*	*7.34*	*Khan and Latif (1997)*
17	*Parapenaeopsis styliferus*	*15.37*	*0.63*	*1.59*	*3.20*	*0.67*	*3.73*	*Khan and Latif (1997)*
18	*R. russelina*	*23.62*	*0.43*	*1.09*	*2.10*	*0.65*	*2.93*	*Khan and Latif (1997)*
19	*Setipinna taty*	*21.27*	*0.53*	*1.28*	*0.80*	*0.28*	*15.79*	*Khan and Latif (1997)*
20	*Stolephorus tri*	*16.83*	*0.65*	*1.58*	*9*	*0.85*	*3.35*	*Khan and Latif (1997)*
21	*Harpodon nehereus*	*34.90*	*0.38*	*0.90*	*3.75*	*0.80*	*6.27*	*Khan and Latif (1997)*
22	*Lepteracanthus savala*	*93.00*	*0.29*	*0.57*	*2.62*	*0.81*	*22.60*	*Khan and Latif (1997)*
23	*E. tetradactylum*	*38.08*	*0.18*	*0.85*	*3.50*	*0.86*	*5.30*	*Khan and Latif (1997)*
24	*Polynemus paradiseus*	*21.63*	*0.52*	*1.27*	*4.72*	*0.78*	*2.69*	*Khan and Latif (1997)*
25	*Sillago domina*	*43.26*	*0.38*	*0.85*	*2.70*	*0.75*	*10.05*	*Khan and Latif (1997)*
26	*S. sihama*	*27.36*	*0.39*	*0.99*	*3.00*	*0.75*	*5.10*	*Khan and Latif (1997)*

fishing effort (9,383 fishing days). At present (data to 2001), the maximum sustainable yield (MSY) of trawl shrimp was 3,441 t which is about 54% less than previous report (MSY = 7000-8000 t) during 1989[9]. In 1992-93 and 1998-99, shrimp production was higher than MSY (3,441.73 t) level. In some years, it was more or less around the level of MSY. At present (2000-01) total production (3,172 t) was below the MSY level (Fig.1). It is revealed that the shrimp stock of the Bay of Bengal has been destroyed by excessive fishing effort in the last decade.

Exploitation by Trawl fishery: The exploitation level (E) of species caught by trawl net from the Bay of Bengal varied from 0.23 in *Nemipterus japonicus* to 0.78 in *Lutjanus johni* (Table 2). The table showed that nine species (50%) were under-exploited (E < 0.5) and other nine of them (50%) were overexploited beyond the optimum E value of 0.50. The mean exploited rate (Emean) for the species was estimated at 0.50 that indicates that the fishing pressure by trawl net is in optimum level of the Bay of Bengal. Since the gear is non-selective and tiger shrimp *P. momodon* was the targeted species, its population has been over exploited[7].

Exploitation by Estuarine Set Bag Net (ESBN): The exploitation level (E) for species caught by ESBN varied from 0.21 in *Acetes erythraeus* to 0.85 in *Stolephorus tri* (Table 3). The table showed that six species were under-exploited (E<0.50) but 19 species of them (73%) were overexploited (E>0.50). The mean exploitation level (Emean) for the species of ESBN fishery was estimated at 0.62. About 73% of the species for ESBN fishery were being exploited beyond the optimum value (E = 0.50) and subjected to heavy fishing pressure on coastal waters of the Bangladesh.

Sustainable Shrimp Aquaculture: Coastal aquaculture in Bangladesh mainly concentrates on *Penaeus monodon.* Total shrimp farming area in Bangladesh occupies about 110,000-120,000 ha[5]. Shrimp farming has generated environmental, ecological, economic and social problems. Sustainable of this type of coastal aquaculture is now under serious question following outbreak of an unknown disease (tentatively identified to be China virus disease) and mass mortality of shrimp in 1994[5].

Over dependence on a single species leads to disaster for any husbandry through the seeds are to be collected from nature and hatchery. Natural stock of post larvae and prospective broods are declining due to fry and brood collection of *P. monodon*. Repeated farming of same species in the same farming area is easily affected by disease[5]. Rapid expansion of *P. monodon* culture is under traditional, improved traditional and semi-intensive methods leads to over exploitation of natural fry resources. Destruction of mangrove area affects adversely the nursing ground; commercial trawling and set bag net fishery decrease natural brood stock and recruitment, respectively. Ban of ESBN during breeding season might help better recruitment to natural stock. Trawling in breeding ground during breeding season should be strictly regulated.

Indiscriminate fishing of wild tiger shrimp fry should be discouraged to prevent mass scale destruction of other shrimp and finfish post larvae and other marine life. Establishment of new hatcheries for other commercial shrimps like *Penaeus indicus*, *P. merguiensis* and supply of brood stock may lower the pressure on natural stock. Attempts are needed to culture some other species specially those, which have market price and growth fast. The candidate species may be *Penaeus indicus*, *P. merguiensis*, *Metapenaeus monoceros* and *M. brevicornis.*

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