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Article

Bio-economic analysis of ESBN fishery of Kumira, the coastal area of Chittagong, Bangladesh

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Abstract: The present investigation was conducted from May to December 2005 at Kumira, the representative area of Chittagong coast for bio-socioeconomic analysis of ESBN fishery. In catch composition of Kumira, it was observed that finfish occupied 77.03 %, shrimp 19.82 % and crab 3.15 % and the average catch per boat per day were found 16.6 kg in Kumira. The highest total catch per boat per day (50 kg) was found in October at Kumira. The lowest catch was found (2 kg) in August at Kumira. The average total catch per landing center per month was found 14805 kg at Kumira. The average catch per fishermen per day was found 3.39 kg at Kumira and the average cost per boat per month was about 7,813 Tk in the study area. Average sale per month was found over 18,713 Tk in Kumira. During the month July and August most of the fishermen were engaged in Hilsa fishing with the Hilsa gill net resulting the total catch was with ESBN lowest in those months.

Keywords: bio-economic; ESBN fishery; coastal area; Chittagong; Bangladesh

1. Introduction

Bangladesh is endowed with vast inland and marine water resources where large numbers of fishermen are engaged in fishing. Fisheries sector provides full time employment to an estimated 20 million people comprising of full time fishermen, small fish traders, fish transporters, processors, packers etc, (World Bank, 1998). Beside this, about 10 million people are directly or indirectly involved in fishing and /or related occupation (Nuruzzaman, 1990). The amount of fishermen in dissimilar sub-sector of fisheries amplified promptly for the former few years (Islam, 1994). One single operation of any type of fishing gear in any fishing area brings in a number of species of varies sizes and ages. It also has the complexity of multi-gear fisheries system making the situation further complex for management and conservation of the resources for sustainable use. Bangladesh has a coastline of 480 km along the North and North-East part of the Bay of Bengal. It has an internal estuarine water area of 7,325 sq. nautical miles up to 10 fathom depth baseline, territorial waters of 2,640 sq. nautical miles from the baseline, EEZ of 41,040 sq. nautical miles and the continental shelf of 2,480 sq. nautical miles. The total of marine water areas is about 48,365 sq. na, miles which is almost as big as the country itself. The marine catch increased from 95,000 MT in 1975-76 to 250480 MT in 1992-93 an increase of about 265%. This

has been possible due to Government's encouragement for the introduction of deep sea fleet of 70 trawlers (out of which 56 are in operation now) and over 6,000 mechanized boats in the Bay of Bengal yet, there remain much unexplored areas for development of off-shore fishing (Hussain, 1994; Barua *et al*., 2014). Increasing pressure on the costal resources has caused decline of many of the marine fish and shrimp stocks. The general belief that the continental shelf of Bangladesh is a treasure of fish for unlimited exploitation that has led to a production oriented strategy and thus resulted in some cases overexploitation of resources. The management of the EEZ is also very multifaceted. Fishery resources play a very important role in economy of Bangladesh and about 80% of the animal proteins contributed by the fisheries item. About 10.7% million people are directly or indirectly related with different fishery activity (Khan, 1982). The development and expansions of the shrimp fisheries of Bangladesh during the past ten years have been rapid. The discovery of productive fishing ground in the offshore and inshore belt of the coast, introduction of mechanized fishing boats and modern technique of bottom trawling, establishment of processing and export trade industry, and ever increasing demand for marine fishes in the international markets contributed to progressive development (Pauly and Zeller, 2016; Barua *et al*., 2014). However, this process of development intricate conversation and management of the exploited fish stocks for the continued sustenance of the fishery. It is also being pointed out that a systematic and planned survey on the shrimp resource of the country may be undertaken immediately to understand the extent of the resource available at present and for sustained fishing operation in the inshore region and unexploited grounds in the offshore or deep-sea region (Hussain and Hoq, 2010; Lodge *et al*., 2017; Ullah *et al*., 2014). The Bay offers a potential source of fisheries for Bangladesh. A total of 490 species of belonging to 133 families were recorded and out of these 65 species are of commercial importance (Jit *et al*., 2014; Amin *et al*., 2006; Ghosh *et al*., 2016; Islam, 2003; Miah *et al*., 2015; Johnson and Welch, 2009). Of these, *Scylla serrata*, *Portunus pelagicus and P. sanguinolentus* are commercially important.7 species of squid and 2 species of cattle fish or sepia have been recorded from the Bay of Bengal (Shafi and Quddus, 1982). 165 species of algae have been recorded from the Saint Martin Island, Sundarban area and the coast area of Chittagong (Islam, 1976). 17 taxa families of soft-bottom invertebrates are identified in Feni River which is adjacent to Bay of Bengal (Matin *et al*., 2018).

About 185 species of fish are exploited by fishermen operating estuarine set bagnets. There include 15 species of penaeid shrimp, three nonpenaeids, nine freshwater prawns, three crabs, three mollusks, 90 pelagic finfish and 62 demersal finfish (Islam *et al*., 1992). Many of the finfish and shellfish species are also caught by other major interactive gear, such as marine set bagnet, beach seine, push net, trammel net, bottom long line and trawl (Pauly and Zeller, 2016). A few finfish species are caught either as targeted species or by catch, by the Hilsa gillnet operated in the marine sector. The estuarine set bag net fishery has traditionally been organized as a family enterprise in many parts of Bangladesh. Three is a high degree of involvement of family members in its operation and repair. Marketing and traditional processing are also taken up by family members (Alam, 2001). The socioeconomic conditions of estuarine fisher folk was made primarily by conducting a detailed bio-economic enquiry into the operations of ESBN fisheries and other fisheries and by examining how certain social features relations (family size participation of family members in fisheries, fishery-related and no fishery jobs distribution and ownership of fishing assets sharing of catch value etc. (Thomson *et al*., 1993; Habib, 2010; Mondal *et al.*, 2018).

Since the ESBN fishery involve 55000 fishermen and 150000 dependences, it would not be easy to withdraw the nets at once stroke, leading such a big community to starvation. It appears that area and season closer would help substantially for time being. Length modal progression and the peak season for catch rates in ESBN (such as July to September and to a slightly lesser extent during February to April) show that regulating the operation of ESBN during this period even in the single stratum may be vulnerable as well as possible. The income of ESBN fishermen in this stratum is at least 3 times more than in other strata and they live much above the poverty level. They also have alternate sources of income and they live close to trammel and bottom long line fishing areas. Many of them are familiar with those methods of fishing. So transferring some of these fisher folk to trammel netting and long line would be much easier and feasible than those of the other stratum (Khan, 1994; Islam *et al*., 2017; Viswanathan and Jahan, 2010). The present study was conducted to evaluate the catch composition of ESBN fishery; to observe monthly fluctuation of fishes and to suggest some proper management practices of ESBN fishery resources.

2. Materials and Methods

2.1. Study area and periods

The study was conducted in an ESBN fishing village Kumira; coordinates 22°30'58.9"N and 91°41'37.1"E during January to December, 2005.

2.2. Data collection

Biological data collection started from January to December, 2005; it included catch and species composition and prices of the various commercial fishes collected by ESBN. Data were collected by sampling fishing vessels operating the ESBN. Fishing effort of ESBN fishery was estimated. These data were then used to estimate production and revenue from the ESBN. Subsequently, this information was utilized to assess the ESBN stock in the area.

2.3. Bio-economic analysis

2.3.1. Species composition of the catches

Catch and species composition data were treated separately for each fishing gear due to the differences in fishing efficiency of catch gear and the different criteria used for sorting the shrimp into various commercial categories. Around 5 to 10 kg of mixed fishes was directly collected from the fish baskets when the fishing boats came to the landing center. Samples were collected for two days in every month. The days were the full moon in each month and the next day. The samples were than transport in to laboratory and finally sorted into different group or species. The weight of each group of species was taken and their percentage composition was determined.

2.3.2. Effort estimation

Fishing effort with the various gears was obtained from interviews with the fishing gear-operators and shrimp-collectors as well as from direct observations of the vessels engaged in fishing. Direct observations of fishing effort using bag nets were not possible as this gear is operated off a small. Fishing effort, therefore, had to be estimated based on interviews with the operators of this gear. Correct estimation of fishing effort is very important, as monthly production figures for each species are dependent on it.

2.3.3. Sampling of catch and effort

Catch and effort data, with details of number of craft, number of ESBN net, number of huals/day, trip/day, catch per boat, catch/trip etc. were collected at the fishing. Information on total landing for a number of boat and the number of hauls/ day, estimated number of fishing days per month, species composition of catch (by weight), and value (Taka) for each species for caught was collected at the landing sites.

2.3.4. Estimation of total catch

The boats were selected and fish baskets in each selected boats were counted and their weight was confirmed thought particularly discussion with the fishermen of the study area.

2.3.5. Estimation total effort

Monthly total effort in involved in the landing centre for ESBN fishing was calculated by the following formula:
Total effort (boat) = (Number of boat/trip) X (Number of trip/day) X (number of fishing/month)

2.3.6. Estimation of Catch per Unit Effort (CPUE)

Total CPUE was calculated with the following formula:

$$CPUE=(Catch/month) / (boat/month)$$

2.4. Cost and earning

Monthly data of cost and earning were collected for every month regularly. The monthly gross revenue for each species or group of shrimp or fin fish caught by a unit was obtained by multiplying the monthly mean catch rate of the species, or group, by the average price of the species/group, the number of fishing days and the average number of hauls per day.

2.5. Data analysis

Entire collected data were précised and inspected cautiously and documented. Afterward assortment of data, these were revised and notched. In conclusion, significant tables were prepared in accordance with the objectives of the study. Data presented mostly in the tabular form and bar chart as well as pie chart because it is simple in calculation, widely used and easy to understand. Data were analyzed using the Microsoft excel 2007.

3. Results

3.1. Species composition of the catches

In the village of Kumira, finfish comprised the highest 81.23%, shrimp 15.58% and crab 3.19% in the proportion of catches annually. *Harpodon nehereus* (Bombay duck) showed the highest 28.41% in Kumira in the annual catch of the ESBN. In composition of *P. japonicus* possessed 8.60% , other Penaiedaee shrimp 11.22%, *Johnius* sp. (Crooker) 21.88% & *Coila* sp. 6.37%, *Polynemus paradesius* 10.28% and crab 3.19%, Gobiidae (O. rubicandus) 4.50% for the village Kumira. In kumira, ribbon fish (*L. savala*) 0.12% comprised the lowest (Table 1 and 2).

Table 1. Seasonal variation of species composition (weight in gram) of the ESBN fishery in the Kumira.

		Catch composition (weight in gram)							
Common Name	**Species/group**	**May**	**June**	**July**	**Aug**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
Cat fish	*Aereus* sp.						54	60	120
Chiring machh	*Apocryptus bato (*sp.*)*	35		10	5	‘55			
Puiya	*Bregmerossis* sp.	80	65	55	25	200	18	30	80
Flat fish	*Cynoglossus* sp.	40	35	40	10	78	18	80	20
	Coila sp.	1440	1250	740	750	95	72	60	35
Moilla	*Escualusa thorakata*	100	80	120	85				
Bombay duck	*Harpodon* sp.	1360	960	570	588	335	1000	2000	1250
	Johuinius sp.	160	80	60	65	70	410		440
Ribbon fish	*Lepturacanthus* sp.	0	20	0	0		9	30	20
Mullet	*Mugil* sp	40		15	0	40			
	Polynemus paradesius	40	50		45		840	360	800
	Platycephalus sp.	60		200	24	25			
	Silago sp.	0	20	50	0	70			
	Satiphina sp.	80	75	50	42	230	150	70	
Chewa	*O. rubicandus*	340	250		254	15	18	280	50
Crab	*Crab*	20	30	50	55	240	16	100	50
Shrimp	*P. japonicus*	340	220	250	220	250	310	340	350
	P. merguensis	80	60	50	62	80	100	340	160
	P. teneupes	40			0				
	P. stylifera	80	50	75	0	230	5	60	
	Other	220		230	185	270		220	

Table 2. Proportion (%) of different species/groups.

Group	**Species**	**% by species**	**% by group**
Fin Fishes	*Bregmerossis* sp.	1.28	**77.03**
	Aureus sp.	0.4	
	Cynoglossus sp.	0.51	
	Coila sp.	6.37	
	Escualusa thorakata	0.69	
	Harpodon sp.	28.41	
	Johuinius sp.	21.88	
	Lepturacanthus sp.	0.12	
	Mugil sp.	0.24	
	Polynemus paradesius	10.28	
	Platycephalus	0.27	
	Silago sp.	0.30	
	Satiphina sp.	1.78	
	O. rubicandus	4.50	
Shrimp	*Penaeus japonicus*	8.60	**19.82**
	P. merguensis	3.71	
	P. stylifera	0.08	
	Other	7.43	
Crab		3.19	**3.15**

3.2. Estimation of total catch

Average catch per boat per trip was found 8.8 kg with highest 25 kg in the month of October and lowest (2 kg) in the month of August at Kumira. Average catch per boat per day were found 16.6kg in Kumira. The highest total catch per boat per day (50 kg) was found in the month of October in Kumira. The lowest catch was found (2 kg) in August for Kumira. The average total catch per boat per month was 498 kg with the highest (1500 kg) in the month of October and the lowest (60 kg) in the month of August at Kumira. The average total catch per landing center per month was found 14805 kg with the highest (49500 kg) in the month of October and lowest (600 kg) in the month of August at Kumira (Table 3). During the month July and August most of the fishermen were engaged in Hilsa fishing with the Hilsa gill net. Their target catch was Hilsa sp. and usually they do not operate ESBN at that time. As a result, the total catch was found lowest in those months.

Table 3. Catch and effort estimation of the ESBN fishery in the Kumira.

Months	Catch (kg)/boat /trip	Trip /day	Catch (kg) /boat /day	Total catch (kg) /boat /month	No. of boat operated/ day	Total catch (kg)/ landing center/ month	Net/ boat	Catch (kg)/ net/day	Fisher men / boat	Catch (kg)/ fisherman /day	Catch (kg)/ fisherman /month
May	15	2	30	900	28	25200	4	7.5	6	5	150
June	5	1	5	150	21	3150	4	1.25	4	1.25	37.5
July	3	1	3	90	22	1980	5	0.6	4	0.75	22.5
Aug	2	1	2	60	10	600	4	0.5	4	0.5	15
Sept	4	2	8	240	15	3600	6	1.33	5	1.6	48
Oct.	25	2	50	1500	33	49500	6	8.33	5	10	300
Nov.	21	2	42	1260	31	39060	5	8.4	4	10.5	315
Dec	13	2	26	780	32	24960	6	4.33	6	4.33	129.9
Average	8.8	1.3	16.6	498	19.2	14805	4	3.224	3.8	3.393	101.79

3.3. Effort estimation

Four fishermen operated 4 nets per trip on an average at Kumira. The average catch per net per day was found 3.22 kg with the highest 8.33 kg in the month of October and the lowest 0.5 kg in the month of August at Kumira. The average catch per fishermen per day was found 3.39 kg at Kumira. The average catch per fishermen per month was found 101.79 kg at Kumira. The highest average catch per fishermen per month was found 315 kg at Kumira in November. The lowest catch per fishermen per month was found 15 kg at Kumira in August (Table 3).

3.4. Cost and earning

The price of the mixed species of fish and shrimp ranged from Tk. 25 to 45 per kg in Kumira. The highest value of Tk. 45 of mixed species was found in the month of July and the lowest Tk. 25 in October. Average cost per boat per month was about 7,813 Tk in Kumira. Maximum cost was 11,500 Tk during high fishing season for greater involvement of crew and fuel. Average sale per month was found over 18,713 Tk in Kumira with the highest sale of 37,800 Tk in November at Kumira. The fish price per kg of mixed species was 35.5 Tk and 28 Tk in that month. The lowest income was showed during the month of August (Table 4).

Table 4. Comparison cost and earning per boat for ESBN catches in Kumira.

Months	Cost/boat/month (Tk)	Total catch (kg)/boat/month	Market price of mixed species (Tk/kg)	Total sale (Tk.)	Income/month
	Kumira	Kumira	Kumira	Kumira	Kumira
May	10000	900	28	25200	15200
June	6500	160	42	6720	220
July	5000	120	45	5400	400
August	2000	60	42	2520	520
September	8500	240	40	9600	1100
October	11500	1500	25	37500	26000
November	10000	1260	30	37800	27800
December	9000	780	32	24960	15960
Average	7813	627.5	35.5	18713	10900

4. Discussion

The average catch composition of Bombay duck (*Harpodon neherius*) was found highest in the present investigation followed by Shrimp. Ahmed (1981) and Munga *et al.* (2014) found highest result (9.64 %) of the catch composition of Shrimp; Jit *et al*. (2014) investigated contribution (76%) to total catch in shark species; Chowdhury *et al*. (2011) mentioned 21.5-31.5% of marine catch in Naaf river; Hossain *et al*. (2012) mentioned *Oxyurichthys microlepis, Hemiarius sona, Arius thalassinus, Batrachocephalus mino* and *Arius caelatus* are the major contributory species. Oh *et al*. (2010) found similar result in Malaysian coast. The highest catch rate and composition was found in the month of October which is known as the most suitable season for fishing in Bangladesh. The catch rate and composition was found lower in the winter season which is very identical with the Khan (1982) report and with report Islam *et al.* (1992); FAO (1982); Jit *et al*. (2014) Ghosh *et al*. (2016); Kar and Chakraborty, (2011) also reported that *Acetees* sp, Gobiodies and Bombay duck are the most dominant species in ESBN. A very recent study done by Begum (2004) on the Salimpur coast showed that finfish comprises highest followed by shrimp, crab and other invertebrates which is almost coincide with present study. In the present investigation daily average production per boat was found 16.6 kg for Kumira which disagrees with the daily average production of 56.55 kg in Kumira as reported by Islam *et al.* (1992). Begum (2004) and Chakma (2004) found average catch per boat was 32 kg and 23.08 kg respectively and these reports also differ from the results of the present study. Khan *et al.* (1997); Habib *et al*. (2014); Ahmed (1991) and Rabbani *et al.* (2017); Nielsen *et al*. (2018); Nabi and Ullah, (2012) studied on the population parameters of these investigated area and found over exploitation of the most commercial species and this also agrees with the present study. Islam (1987) found the highest average daily production (231.68 kg) in the month of October; this agrees with the present investigation the highest average daily production was found in the month of October in Kumira. Though the amount of production greatly varied with the result of Hossain *et al*. (2012) and Mondal *et al.* (2018); but the peak season was found the same. A details investigation regarding catch rate of Behundi Net was conducted by Islam *et al.* (1993). In that investigation the highest catch rate (15.10 kg) was observed in Moheshkhali, and the lowest in Kaligange (2.35 kg), similar result was also observed by Barua *et al*. (2014); while Kumira had (3.10 kg). The highest catch rate of 25 Kg at Kumira which are higher than the result of Islam *et al.* (1993). In the present investigation the average numbers of net per boat were 4 for Kumira while according to Akerman (1986), average number of net per boat was 1.17 Kg. This report seems to be erroneous as from the verbal discussion it was confirmed that some boats used to 6 to 8 nets in single trip which is similar with the study of (Islam and Haque, 2004). The average catch per fishermen per day was found 3.39 kg for Kumira and these results coincide with 4.22 Kg as reported by Begum (1994) and 8 Kg as reported by Chakma (1994).

5. Conclusions

Estuarine Setbagnet (ESBN) fishing is organized as a family enterprise, with active participation of the family in fishing, marketing and processing. Although it is practiced almost round the year, fishermen seasonally shift to other fisheries also i.e. Hilsha fishing by gill net. They also undertake a variety of non-fishing activities as part time source of additional income.

Conflict of interest

None to declare.

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