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Article

Bio-socio-economic analysis of ESBN fishery of Kattoli coastal area of Chattogram, Bangladesh

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Abstract: In consideration of the characteristics inherent to the estuarine ecosystem, the employment of the estuarine set bag net (ESBN) emerges as an effective instrument for the capture of a diverse spectrum of finfish and shellfish species. The present investigation, conducted between May and December 2015 in Kattoli, a representative locality along the Chattogram coast, was undertaken to perform a comprehensive bio-socio-economic analysis of the ESBN fishery. The analysis of the catch composition in Kattoli revealed that finfish constituted 67.67%, shrimp accounted for 24.34%, and crab made up 7.99% of the total catch. The average daily catch per boat in Kattoli was determined to be 25.8 kg. The zenith of the total daily catch per boat, reaching 70 kg, was observed in December, while the nadir occurred in August, when no fishing activities were recorded in Kattoli. The cumulative catch over the study period in Kattoli amounted to 26,664 kg, with a complete absence of fishing in August. Moreover, the average daily catch per fisherman stood at 6.19 kg in Kattoli. In terms of economic considerations, the mean monthly cost per boat in the Kattoli region was approximately 8,750 BDT, while the average monthly sales revenue exceeded 28,695 BDT in Kattoli. Notably, during July and August, a substantial proportion of fishermen were engaged in Hilsa (*Tenualosa ilisha*) fishing utilizing gill nets, which resulted in a diminished catch with ESBN during these months. Furthermore, the preliminary socio-economic conditions of the study area were also explored. This research offers valuable insights into the bio-socio-economic dimensions of the ESBN fishery in the Kattoli coastal area, with potential practical implications for fisheries management and the livelihoods of the local fishing community.

Keywords: estuarine fisheries; catch composition; catch per unit effort; total catch; total effort

1. Introduction

Bangladesh possesses substantial inland and marine water resources that support a significant population of fishermen engaged in fishing activities (Shamsuzzaman *et al*., 2020). The fisheries sector serves as a primary source of employment, encompassing around 20 million individuals engaged in various roles such as full-time fishermen, small-scale fish traders, fish transporters, processors, and packers and additionally, there are roughly 10 million individuals directly or indirectly associated with fishing or related occupations (Hossain, 2014;

Shamsuzzaman *et al*., 2017). Notably, the number of fishermen across diverse sub-sectors of the fisheries industry has notably expanded in recent years (Azim *et al*., 2009; Baul, 2022).

The act of employing various fishing gear in distinct fishing areas results in the capture of a diverse array of species, varying in size and age (Tikadar *et al*., 2021; Sultana *et al*., 2023). This complexity is compounded by the presence of a multi-gear fisheries system, further complicating resource management and conservation efforts for sustainable utilization (Al Arif, 2017). Bangladesh boasts a coastline spanning 720 km along the northern and northeastern reaches of the Bay of Bengal (Mitra *et al*., 2023). This geographical setting encompasses an internal estuarine water expanse measuring 7,325 square nautical miles up to a baseline depth of 10 fathoms, territorial waters spanning 2,640 square nautical miles from the baseline, an exclusive economic zone (EEZ) covering 41,040 square nautical miles, and a continental shelf extending 2,480 square nautical miles (Mondal *et al*., 2018a; Mondal *et al*., 2018b). The cumulative marine water area covers approximately 48,365 square nautical miles, a size comparable to the nation's land area (Islam, 2003). Over time, marine catch quantities have escalated significantly, rising from 95,000 metric tons in 1975-76 to 650000 metric tons in 2020-2021, reflecting a substantial increase of approximately 584.21%. This growth has been facilitated by government support for the establishment of a deep-sea fleet comprising numerous trawlers and over 6,000 mechanized boats in the Bay of Bengal. Nevertheless, ample unexplored prospects for offshore fishing development persist (Barua *et al*., 2014; Azad and Azad, 2022).

The escalating demand on coastal resources has led to the decline of numerous marine fish and shrimp stocks (Fabinyi *et al*., 2022). The prevailing perception that Bangladesh's continental shelf offers boundless fish resources for exploitation has engendered a production-oriented approach, resulting in instances of resource overexploitation (Islam and Haque, 2004; Hoq, 2007). Managing the EEZ proves highly intricate. Fishery resources hold a pivotal role in the nation's economy, contributing roughly 80% of animal protein consumption (Ghose, 2014).

Over the past decade, Bangladesh has experienced rapid growth and expansion in shrimp fisheries (Shabuj *et al*., 2016; Al-Asif *et al*., 2021). Factors contributing to this progress include the identification of productive fishing grounds in offshore and inshore regions, the introduction of mechanized fishing vessels employing modern bottom trawling techniques, the establishment of processing and export industries, and rising international demand for marine fish products (Mondal *et al*., 2018b). However, this developmental trajectory necessitates meticulous management and conservation of exploited fish stocks to ensure the continued sustenance of fisheries (Hossain, 2014; Mozumder *et al*., 2018). Urgent calls have been made for systematic and planned surveys of the nation's shrimp resources to gauge the current availability and enable sustained fishing operations in both inshore and unexploited offshore areas (Habib *et al*., 2014; Abdullah *et al*., 2019).

The Bay of Bengal stands as a promising fisheries source for Bangladesh, boasting a recorded total of 490 species belonging to 133 families, among which 65 species hold commercial significance (Islam, 2003; Amin *et al*., 2006; Jit *et al*., 2014; Miah *et al*., 2015; Ghosh *et al*., 2016). Furthermore, the Bay has revealed 7 species of squid and 2 species of cuttlefish or sepia (Siddique *et al*., 2016; Fatema *et al*., 2022; Kamal *et al*., 2022). A study of the Saint Martin Island, Sundarban area, and Chittagong coast has documented 185 species of algae (Billah *et al*., 2018). Adjacent to the Bay of Bengal, the Feni River has been identified as hosting 17 taxa families of soft-bottom invertebrates (Matin *et al*., 2018).

The estuarine set bag net fishery, which involves approximately 55,000 fishermen and supports 150,000 dependents, presents a challenge in terms of immediate cessation due to the risk of causing widespread deprivation (Nabi *et al*., 2007; Mondal *et al*., 2018a). Implementing area and seasonal closures could provide a viable interim solution (Islam *et al*., 2020). The progression of length modality and the peak catch rate season for the estuarine set bag net fishery (notably July to September and to a lesser extent, February to April) underscores the potential vulnerability of regulating this activity during such periods (Hasan *et al*., 2014; Blaber *et al*., 2000). The fishermen in this segment generate income at a rate at least three times higher than their counterparts in other segments, elevating their living conditions above the poverty threshold. They also possess alternative income sources and reside near trammel and bottom long line fishing areas, many of whom are well-versed in these alternative fishing methods (Rahman *et al*., 2002; Deb, 2012). Transitioning some of these fishermen to trammel netting and long-lining appears more feasible compared to other segments (Baeta *et al*., 2010; Islam *et al*., 2017). The depletion of marine fish and shrimp stocks in Bangladesh's fisheries sector, along with the challenge of regulating the estuarine set bag net (ESBN) fishery, necessitates effective strategies to balance conservation needs with the socio-economic well-being of fishing communities in the Kattoli coastal area of Chattogram. Considering the above importance of ESBN fishery this present study was conducted to evaluate the catch composition of ESBN fishery of Kattoli coastal area of Chattogram, observing monthly

fluctuation of fishes, socio-economic context of Kattoli and suggesting some proper management practices of ESBN fishery resources.

2. Materials and Methods

2.1. Ethical approval

No ethical approval was required for conducting this research in the study area.

2.2. Study area and periods

The investigation took place within the ESBN fishing village of Kattoli, located at coordinates 22°30'58.9"N latitude and 91°41'37.1"E longitude, spanning the period from January to December in the year 2005 (Figure 1).

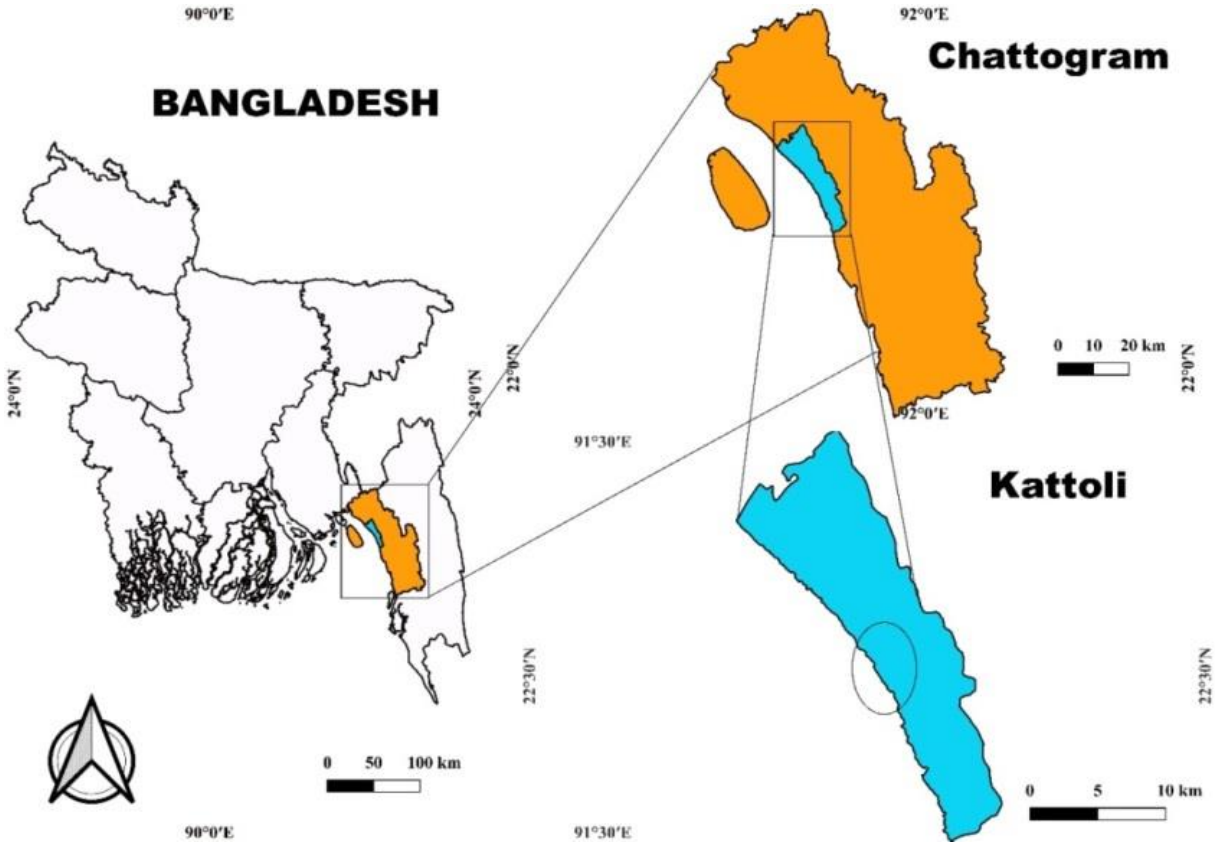

Figure 1. The circular area in the map denotes the study area of present study.

2.3. Data collection

Data collection related to biology commenced in the span of January through December 2005. This encompassed the recording of catch, species composition, socio economic contexts of the fishermen, and the prices associated with diverse commercial fish harvested by ESBN. The information regarding total population and number of the family in the study area were acquired from the secondary sources, for instance, newspaper, local government authority, books, journals and social welfare offices. The process involved sampling fishing vessels engaged in ESBN operations. The fishing intensity of the ESBN fishery was estimated, and these collected data points were subsequently utilized to calculate the production and revenue generated by ESBN activities. The resulting data was then employed to assess the stocking levels of the ESBN within the region.

2.4. Bio-economic analysis

2.4.1. Species composition of the catches

Data pertaining to catch and species composition were managed separately for each type of fishing gear, primarily due to variations in the fishing efficiency of these gears and the diverse criteria utilized to classify shrimp into distinct commercial categories. Approximately 5 to 10 kg of assorted fishes were directly acquired from the fish baskets immediately upon the arrival of fishing boats at the landing center. Sampling was conducted bi-monthly, specifically during the full moon and the following day, spanning a two-day period.

These collected samples were then transported to the laboratory, where they were subsequently categorized into various groups or species. The weight of each species group was measured, and their respective percentage compositions were determined.

2.4.2. Effort estimation

Data on fishing effort employing various types of gears were collected through a combination of interviews with fishing gear operators and shrimp collectors, along with direct observations of vessels engaged in fishing activities. However, in the case of estuarine set bag nets, direct observations of fishing effort were unfeasible due to the utilization of smaller vessels. As a result, the estimation of fishing effort for this particular gear relied on interviews with its operators.

2.4.3. Sampling of catch and effort

Data pertaining to both catch and fishing effort were meticulously gathered, encompassing various specifics such as the count of vessels, the quantity of ESBN nets employed, the number of hauls conducted daily, trips made per day, catch volume per boat, and catch per trip. This comprehensive data collection took place during the fishing operations. Concurrently, comprehensive information was amassed at the landing sites. This encompassed the total volume of fish landed by a specific number of boats, the daily count of hauls conducted, the estimated number of fishing days per month, the species composition in the catch (measured by weight), and the corresponding value (in Taka) for each species that was captured.

2.4.4. Estimation of total catch

The boats were chosen for inclusion in the study, and within each selected boat, the number of fish baskets was tallied. The accuracy of these counts and the weight of the baskets were verified through in-depth conversations held specifically with the local fishermen from the study area.

2.4.5. Estimation total effort

The monthly total effort at the landing center for ESBN fishing was determined using the following formula:
Total effort (boat) = (Number of boat/trip) × (Number of trip/day) × (number of fishing/month)

2.4.6. Estimation of catch per unit effort (CPUE)

Total CPUE was calculated with the following formula:
CPUE = (Catch/month) / (boat/month)

2.5. Cost and earning

Monthly data on costs and earnings were consistently collected. The gross monthly revenue for each species or group of shrimp or finfish captured by a unit was computed by multiplying the mean monthly catch rate of the specific species or group by the average price of that species or group. This calculation also factored in the number of fishing days and the average number of hauls executed per day.

2.6. Data analysis

The complete dataset was meticulously summarized and subjected to thorough scrutiny before being officially documented. Subsequent to the data compilation process, a meticulous revision and notation process was undertaken. As a final step, pertinent tables were meticulously formulated in alignment with the study's objectives. The data were predominantly presented in tabular format, alongside graphical representations like bar charts and pie charts. These visualization methods were chosen due to their simplicity in computation, widespread utilization, and ease of comprehension. The data analysis itself was performed utilizing Microsoft Excel 2013.

3. Results

3.1. Species composition of the catches

In the village of Kattoli, the annual catch composition was as follows: finfish accounted for 67.67%, shrimp constituted 24.34%, and crab represented 7.99% of the total catch. Notably, Harpodon nehereus, commonly known as Bombay duck, comprised 32.71% of the annual ESBN catch in Kattoli. The composition of *P. japonicus* possessed 14.21%, other Penaiedaee shrimp comprised of 10.13%, *Johnius* sp. (Crooker) comprised of 13.17%, *Coila* sp. comprised of 5.40%, *Polynemus paradesius* comprised of 5.28%, crab comprised of

7.99%, Gobiidae (*O. rubicandus*) comprised of 5.55% in the village Kattoli. In Kattoli, *Silago* sp. 0.15% comprised the lowest (Tables 1 and 2; Figure 2).

Table 1. The ESBN fishery in Kattoli exhibited seasonal variation in species composition, with changes in the weight (measured in grams) of captured species.

Common name	Species/group	May	June	July	Aug	Sept	Oct	Nov	Dec
Chiring machh	*Apocryptus bato* (sp.)		10	8	0	20			
Cat fish	*Aereus* sp.	5	5	0	0	75		340	40
Puiya	*Bregmerossis* sp.	22	15	10	0	200	45	40	140
Flat fish	*Cynoglossus* sp.	50	45	25	0	20	18	70	70
	Coila sp.	310	280	175	0	220	160	80	100
Moilla	*Escualusa thorakata*	25	0	0	0	0			
Bombay duck	*Harpodon* sp.	1520	1230	750	0	500	630	800	1420
	Johuinius sp.	600	500	250	0	220		500	150
Ribbon fish	*Lepturacanthus savala.*		20	25	0	65	20	100	70
Mullet	*Mugil* sp.				0	28			
	Polynemus paradesius	5	10	5	0	30	200	460	60
	Platycephalus sp.	50			0	25			
	Satiphina sp.	95	80	65	0	75	20	40	
Chewa	*O. rubicandus*	220	150	120	0	250	180	150	80
Crab		35	30	18	0	90	160	700	25
Shrimp	*P. japonicus*	520	450	370	0	550	80		190
	P. merguensis		250	160	0	225	80	190	
	P. teneupes				0				80
	P. stylifera			200	0	250			40
	Other		200	50	0	250		180	30

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

Group	Species	% by species
Fin fishes	*Apocryptus bato* (sp.)	0.55
	Bregmerossis sp.	1.76
	Cynoglossus sp.	0.92
	Coila sp.	5.40
	Escualusa thorakata	0.33
	Harpodon sp.	32.71
	Johuinius sp.	13.17
	Lepturacanthus sp.	0.48
	Mugil sp.	0.13
	Polynemus paradesius	5.28
	Silago sp.	0.15
	Satiphina sp.	1.22
	O. rubicandus	5.55
Shrimp	*Penaeus japonicus*	14.21
	P. merguensis	4.31
	P. stylifera	5.52
	Other	0.30
Crab		7.99

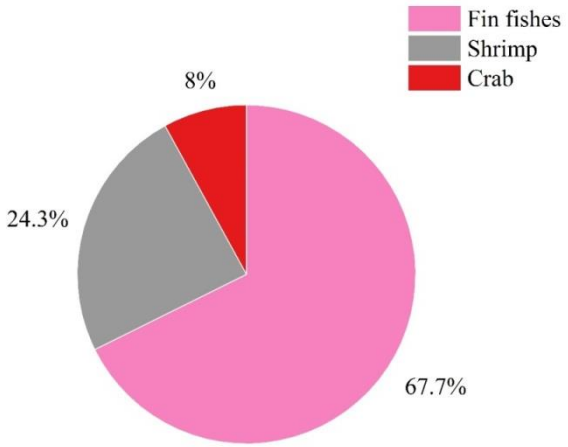

Figure 2. Contribution of different fishery catch from ESBN fishing of Kattoli area.

3.2. Estimation of total catch

The average catch per boat per trip in Kattoli was determined to be 12.9 kg, with the highest recorded capture being 35 kg in December. Notably, no ESBN fishing activity occurred during the month of August. When assessed on a per-day basis, the average catch per boat in Kattoli was 25.8 kg. The peak daily catch per boat, reaching 70 kg, was observed in December, while the lowest catch, at 0 kg, was recorded in August when no fishing took place in Kattoli. Further analysis reveals that the average total catch per boat per month in Kattoli amounted to 774 kg, with December yielding the highest catch of 2100 kg, and August registering no fishing activity. At the Kattoli landing center, the average total catch per month was approximately 26,664 kg on average. The highest monthly catch, reaching 96,600 kg, was recorded in December, whereas no fishing was conducted during the month of August. It's noteworthy that during the months of July and August, a significant number of fishermen were engaged in Hilsa (*T. ilisha*) fishing using Hilsa gill nets, targeting Hilsa. During this period, they typically did not operate the ESBN, which resulted in the lowest total catch during those months.

3.3. Fishing effort estimation

In the Kattoli region, a team of three fishermen operated an average of four nets per trip. The average catch per net per day in Kattali was determined to be 4.63 kg, with the highest catch, reaching 8.7 kg, recorded in the month of October. No ESBN fishing activities occurred in the month of August. On a per-fisherman, per-day basis, the average catch was found to be 6.19 kg in Kattoli. When examining monthly figures, the average catch per fisherman was 185.7 kg in Kattoli. The peak average catch per fisherman per month, at 450 kg, was observed in November, while the lowest catch per fisherman per month, at 0 kg, coincided with the absence of fishing activities in August at Kattoli (Table 3).

Table 3. Month wise Catch and effort estimation of the ESBN fishery in the Kattoli.

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
May	13	2	26	780	18	14040	5	5.2
Jun	9	2	18	540	12	6480	5	3.6
Jul	4	2	8	240	13	3120	4	2
Aug	0	0	0	0	0	0	0	0
Sept	12	2	24	720	15	10800	5	4.8
Oct	26	2	52	1560	35	54600	6	8.7
Nov	30	2	60	1800	45	81000	5	12
Dec	35	2	70	2100	46	96600	7	10
Average	12.9	1.4	25.8	774	18.4	26664	3.7	4.63

3.4. Cost and earning

The cost associated with the assortment of mixed fish and shrimp species in the Kattoli area exhibited fluctuations within a range of BDT 25 to 45 per kilogram. Fishermen typically sell their entire basket catch on a per-kilogram basis. Notably, there was a seasonal variation in the composition of different species captured by ESBN, leading to price fluctuations. The highest price observed for the mixed species was Tk. 45 per kilogram during July, while the lowest value of BDT 25 per kilogram was recorded in October. On average, the cost per boat per month amounted to approximately BDT 8,750 in Kattoli. However, during the high fishing season when there was greater involvement of crew and fuel, the maximum cost reached BDT 11,500 in Kattoli. Conversely, the average monthly sales revenue exceeded BDT 28,695 in Kattoli, with the highest monthly sales revenue of BDT 63,000 occurring in December. During this month, the fish price per kilogram for the mixed species was BDT 35.5 and BDT 28, reflecting variations in pricing. The lowest income was observed during the month of August (Table 4).

Table 4. Comparison Cost and earning per boat for ESBN catches in Kattoli.

Months	Cost/boat/month (BDT)	Total catch (kg)/boat/month	Market price of mixed species (BDT/kg)	Total sale (Tk.)	Income/month
May	10500	780	28	21840	11340
June	9000	540	38	20520	11520
July	8500	240	40	9600	1100
August	0	0	0	0	0
September	11500	720	35	25200	13700
October	10500	1560	25	39000	28500
November	10000	1800	28	50400	40400
December	10000	2100	30	63000	53000
Average	8750	967.5	28.0	28695	19945

3.5. Socio-economic context of Kattoli

In the Kattoli region, there exist four distinct fishing communities or PARAs, namely Uttar para, Lonka para, Moddom para, and Modongong. Kattoli primarily comprised a Hindu population, accounting for approximately 99% of its residents. Among these, 65% of the people were employed in the fishing profession, while others pursued various occupations such as business, service jobs, rickshaw pulling, and day labor. The total number of families in the study area of Kattoli was 580, and the overall population of this village amounts to around 3,300 individuals (Figure 3).

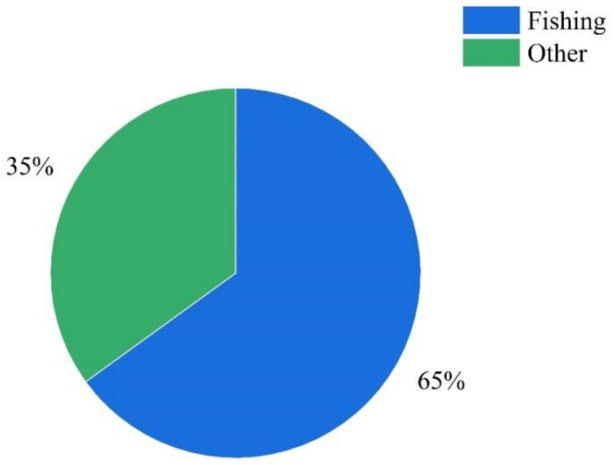

Figure 3. Profession distribution among inhabitants of Kattoli area.

4. Discussion

Within the confines of Kattoli village, the predominant share of annual catches was constituted by finfish, with shrimp and crab following suit in terms of proportion. Notably, the Bombay duck (*Harpodon nehereus*)

emerged as the most prevalent catch species throughout the year within the ESBN fishery at Kattoli. Munga *et al*. (2014) reported the highest catch composition result for shrimp at 9.64%. Jit *et al*. (2014) investigated shark species and found their contribution to the total catch to be 76%. Chowdhury *et al*. (2011) indicated that the marine catch in the Naaf River ranged from 21.5% to 31.5%. Hossain *et al*. (2012) identified major contributory species including *Oxyurichthys microlepis*, *Hemiarius sona*, *Arius thalassinus*, *Batrachocephalus mino*, and *Arius caelatus*. Oh *et al*. (2010) observed similar findings along the Malaysian coast.

The peak capture rate in Kattoli occurred during the month of December, whereas no ESBN fishing activity took place in August. This specific period, August, is designated as a fishing ban interval for Hilsa (*T. ilisha*) and other fish species due to their breeding season, as mandated by the Bangladesh government. Consequently, it is entirely logical that there was a complete absence of fishing activities by the fishermen during this month. The investigations conducted by Rahman *et al*. (2017), Bhowmik *et al*. (2021), and Mozumder *et al*. (2023) have indicated that the implementation of fishing bans during particular months of the year, specifically aligned with the breeding seasons of different fish species, could potentially contribute to a substantial augmentation of their natural populations. The quantity of fish caught in December surpassed that of any other month throughout the study duration. This elevation in catch can be attributed to the successful breeding of fishes and the abundance of available feed during this specific month (Agumassie, 2019; Kuzuhara *et al*., 2019; Rahman *et al*., 2022; Biswas *et al*., 2023). Kar and Chakraborty (2011) documented that *Acetees* sp, Gobiodies, and Bombay duck are the prevailing species within the ESBN fishery. A recent study conducted by Mondal *et al*. (2018b) along the Kumira coast highlighted a pattern where finfish constituted the majority, followed by shrimp, crab, and other invertebrates - a trend that closely aligns with the findings of the present study.

Average catch per boat per day were found and 25.8 kg in Kattoli which disagreed with the result of 16.6 kg in Kumira (Mondal *et al*., 2018b). Nabi and Ullah (2012), Habib *et al*. (2014), Rabbani *et al*. (2018), and Nielsen *et al*. (2018) investigated population parameters within the same region and identified instances of overexploitation among the most commercially relevant species, aligning with the findings of the present study. The peak total catch per boat per day, reaching 70 kg, was recorded in December within the Kattoli area which is far higher than the Mondal *et al*. (2018b) study from Kumira region.

In the current investigation, it was determined that the average number of nets per boat in Kattoli was four, which aligns with the findings of Mondal *et al*. (2018b), who also reported an average of four nets per boat. However, it should be noted that this report may contain errors, as discussions with local sources confirmed that some boats actually used 6 to 8 nets in a single trip, a pattern similar to the study conducted by Islam and Haque (2004). Furthermore, the average catch per fisherman per day was measured at 4.63 kg in Kattoli, a result that coincides with the figure of 3.39 kg reported by (Mondal *et al*., 2018b).

The average cost per boat per month in Kattoli was approximately BDT 8,750, whereas in Kumira, it was reported to be about BDT 7,813 (Mondal *et al*., 2018b). Due to its close proximity to well-developed residential areas and locations offering improved livelihood opportunities, the operational expenses for running a boat were notably elevated.

Kattoli is primarily comprised a Hindu population which was confirmed by a previous research by Mondal *et al*. (2018a). As a fishing area near to the coast of Bay of Bengal, majority of the people are engaged in fishing or fishery activity over the year. While some other occupations were also observed including business, service jobs, rickshaw pulling, and day labor (Mondal *et al*., 2018a). Similar socio-economic contexts of fishermen or fish farmer were described by various author in different part of Bangladesh (Islam *et al*., 2014; Islam *et al*., 2015; Al-Asif *et al*., 2015; Sharif *et al*., 2015; Hossain *et al*., 2015; Al-Asif and Habib, 2017; Islam *et al*., 2017; Razeim *et al*., 2017; Vaumik *et al*., 2017; Zaman *et al*., 2017; Adhikary *et al*., 2018a; Adhikary *et al*., 2018b).

5. Conclusions

The study revealed the bio-economic status of the estuarine set bag net (ESBN) fishery in the Kattoli coastal area of Chattogram, Bangladesh. The catch composition in Kattoli consisted of finfish, shrimp, and crab, with finfish being the dominant species. The study highlighted the seasonal variability in the composition of different species captured by ESBN, with the highest catch observed in December. The findings provide insights into the economic aspects of ESBN fishery in Kattoli, including costs and earnings. The study highlights the seasonal variability in the composition of different species captured by ESBN, which can help fishermen plan their fishing activities and optimize their earnings. The findings of the study can contribute to the sustainable management of the estuarine ecosystem and the conservation of fish and shrimp stocks in the Bay of Bengal. Future research could focus on assessing the ecological impact of the ESBN fishery on the estuarine ecosystem in Kattoli and its surrounding areas. This could include studying the species composition, abundance, and biodiversity of the captured fish and shellfish species.

Data availability
All relevant data are within the manuscript.

Conflict of interest
None to declare.

Authors' contribution
Conceptualization: Md Atiqul Islam Mondal, Anwar Hossain Choudhury and Md. Rashed-Un-Nabi; methodology: Md Atiqul Islam Mondal and Abdullah Al Mamun Siddiqui; formal analysis: Md Atiqul Islam Mondal and M.A. Kader; writing-original draft preparation: Md Atiqul Islam Mondal and Abdullah Al Mamun Siddiqui; writing-review and editing: Md Atiqul Islam Mondal, Anwar Hossain Choudhury, Abdullah Al Mamun Siddiqui, Md. Rashed-Un-Nabi and M.A. Kader. All authors have read and approved the final manuscript.

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