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Present Status of Mud Eel, *Monopterus Cuchia* (Hamilton-Buchanan, 1822) in Bangladesh

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Abstract

Apparent declines in abundance of mud eel, *Monopterus cuchia* in the eight divisions of Bangladesh have prompted concern regarding a long-term determination of this important economic resource. From the survey of eight divisions according to treatment T_1, T_2, T_3 and T_4 the total production of mud eel was recorded to be 14795.55±186.77, 14201.48±190.33, 13385.98±178.66 and 11946.38±168.06 mt in the year 2013, 2014, 2015, 2016 and 2017, respectively. A decreasing trend of total population of mud eel in the country was identified in between 2013 and 2017. The decreasing type was logarithmic (y= -1518In(×) + 15070), where R^2 = 0.810. There is a significant trend in case of mud eel production. In between 2013 and 2017, a decreasing tendency was recorded in case of capturing by line and by hand method, and an increasing trend was found in case of trap method. According to (99.22-99.61)% responded reported that increasing destructive capture pressure, harvesting cuchia brood fish during breeding season and using of high rate agro-chemical were mainly reasons of decline mud eel population. So, a policy should be designed and implemented by jointly discussion with the Ministry of Fisheries and livestock, Agriculture and Environment. Eco-friendly capture of mud eel is to be practiced until established mud eel seed production to minimize the requirement of seed production of *M. cuchia* in aquaculture field.

Keywords: Mud eel; Survey; Biodiversity; Harvesting; Production

Introduction

In Bangladesh, floodplains are important fishing grounds. Once, this wetland was very rich with wild fish species and other aquatic fauna. Due to overexploitation and various ecological changes of the wetland, some important fish species is disappeared. The feeding and breeding grounds of aquatic lives in and around the rivers and wetlands have been reducing drastically from various human and natural created problems. Indiscriminate destructive fishing practices, soil erosion, siltation, construction of flood control and drainage structures and agrochemicals have caused havoc to the aquatic biodiversity in Bangladesh [1]. The floodplain (wetland) receives surface runoff water by rivers and channel (khal), and consequently, floodplains become very extensive water body in the monsoon and dries up mostly in the post-monsoon period [2]. In the past century or so, when human population pressure of Bangladesh was less, most of the rim-lands of the beel remained as cultivable wasteland which was mainly used for extensive grazing in the dry season. As population increased, boro cultivation expanded on these marginal lands leading to a large area being drained. Thus, the existence of these wetlands of the

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beels is now threatened [3]. Owing to massive loss in aquatic biodiversity, a well planned and systematic study is required to assess the economically important species mud eel population of wetland of Bangladesh. The present study focuses on the abundance, catch statistics and related aspects of wetland.

The Gangetic mud eel, *Monopterus cuchia* is a freshwater air breathing, swamp mud eel is locally known as cuchia. This species is available in the freshwater of Bangladesh, Pakistan, Northern and Northeastern India and Nepal [4]. Once, indigenous M. cuchia was abundant throughout the Bangladesh, plenty in mud holes in shallow "beels" and 'boro' paddy fields particularly in Sylhet, Mymensingh and Tangail Districts [5]. But presently this fish is hardly found in the open water bodies. Ecosystem of natural water bodies are being declined due to global warming and climate change. This species is enlisted as threatened species in Bangladesh because of destruction of the natural habitats, horizontal expansion of agriculture, use of chemicals, fertilizer and pesticide and over exploitation and various ecological changes in its natural habitat [2,6-8].

This fish is exported to many countries of South East Asia and Europe. The tribal people belonging to the Garo, Hajong, Shawtali and Koch-Rajbongshi community believes this fish to be therapeutic one and traditionally use for treatment of various ailments, Viz. weakness, anemia, asthma, hemorrhoids and diabetes. Direct consumption of fresh blood of the fish is reported to cure weakness, anemia and asthma [9,10]. Consumption of gall bladder of the fish either fresh or sun dried is believed to have anti-asthmatic and anti-rhinitic properties [11]. Curry prepared by cooking the flesh along with certain herbs or soup prepared from cooking the flesh alone are known to cure anemia, piles and diabetes [12,13]. The average protein content per 100 gm of raw flesh is 18.7 gm, while the concentrations of other nutrients are 0.8 gm fats, 2.4 gm carbohydrate and 185 gm calcium (www.mcgill.ca).

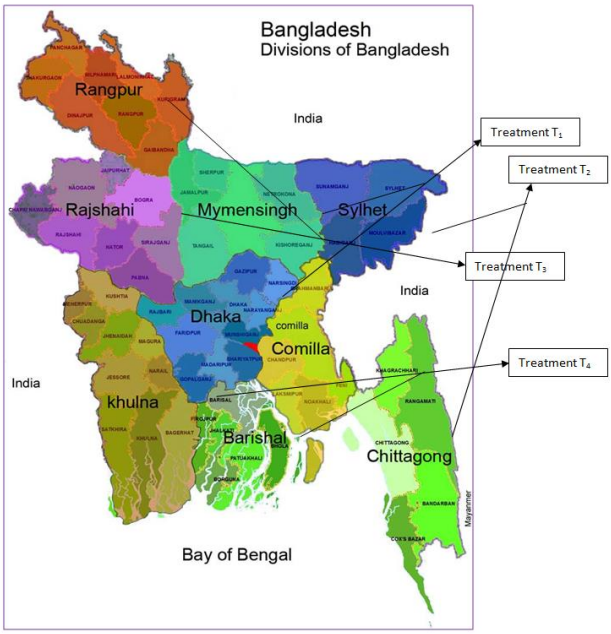

Figure 1: Mud eel (*Monopterus cuchia*) distribution area of Bangladesh.

The caloric value of eel flesh is reported to be as high as 303 Kcal.100 gm^{-1} [14]. 100 gm of fish flesh contains 1400 µgm of Retinol (Vitamin A1), >450 µgm of Dehydroretinol (Vitamin A2) and >3500µgm of Provitamin A11 (www.genderaqua.fish.files). Plasma composition of cuchia fish reported the presence of 3.304-3.745 gm, 67.34-72.46 mg and 224.747-257.027 mg of protein, glucose and triglyceride per 100 ml blood, respectively. Presence of amino acids viz. Alanine, Arginine, Glycine, Histidine, Leucine and Methionine has also been reported from this species [15]. For such nutritional importance, there is a tremendous demand of cuchia in the international market. Considering the importance of this species in nutritional, economic and biodiversity point of

view, its conservation and propagation are considered through fisheries regulation. The present study conducted to determine the abundance, catch statistics and related aspects of floodplain in relation to ecology of open water and the entire catchments area of the water body.

Materials and Methods

Study Area and Experimental Design

The research has been carried out in 514 Upazilas under 64 districts and 08 divisions (Table 1).The survey area was designed as a treatment T_1, T_2, T_3 and T_4. Treatment T_1 was designed with Dhaka and Mymensingh division, Treatment T_2 with Shylet and chittagong division, Treatment T_3 with Rajshahi and Rangpur division and Treatment T_4 with Khulna and Barisal division. The number of cuchia harvesters 514 and collectors 514 was selected under 514 Upazilas for eight divisions.

Treatment	Division	District	No. of mud eel Harvester	No. of mud eel Collectors	No. of Upazilla Office	Data collection Methods	Remarks
T_1	Dhaka	Dhaka	6	6	6	Questionnaire Interviews and Group Discussion	
		Gazipur	5	5	5		
		Narsindhi	6	6	6		
		Narayngonj	5	5	5		
		Munsigonj	6	6	6		
		Manikgonj	7	7	7		
		Faridpur	9	9	9		
		Rajbari	5	5	5		
		Gopalginj	5	5	5		
		Madaripur	4	4	4		
		Shariatpur	7	7	7		
		Kishorgonj	13	13	13		
		Tangail	12	12	12		
	Mymensingh	Mymensingh	13	13	13		
		Netrokona	10	10	10		
		Sherpur	5	5	5		
		Jamalpur	7	7	7		
T_2	Shylet	Shylet	13	13	13		
		Hobigonj	9	9	9		
		Sunamgonj	11	11	11		
		Moulobibazer	7	7	7		
	Chittagong	Chittagong	22	22	22		
		Cox's Bazar	8	8	8		
		Bandhorbon	8	8	8		
		Rangamati	10	10	10		
		Kagrachuri	8	8	8		
		Noakhali	9	9	9		
T_3	Rajshahi	Rajshahi	9	9	9		
		Naogaon	11	11	11		
		Nator	7	7	7		
		Chapai Nawabganj	5	5	5		
		Bogura	12	12	12		
		Shirajgonj	9	9	9		
		Pabna	10	10	10		
		Joypurhat	5	5	5		
	Rangpur	Rangpur	8	8	8		

		Gaibanda	7	7	7		
		Nilphamari	6	6	6		
		Lalmonirhat	5	5	5		
		Kurigram	9	9	9		
		Dinajpur	13	13	13		
		Panchagarh	5	5	5		
		Thakurgaon	5	5	5		
T_4	Khulna	Khulna	15	15	15		
		Satkhira	7	7	7		
		Bagerhat	9	9	9		
		Jessore	8	8	8		
		Narail	4	4	4		
		Chuadanga	4	4	4		
		Kushtia	8	8	8		
		Meherpur	3	3	3		
		Magura	4	4	4		
		Jhenaidah	6	6	6		
		Chuadanga	4	4	4		
	Barisal	Barisal	10	10	10		
		Potuakali	8	8	8		
		Barguna	6	6	6		
		Bhula	7	7	7		
		Pirojpur	7	7	7		
		Jalokati	4	4	4		
			514	514	514		

Table 1: Questionnaire interviews and Group discussion with Cuchia harvesters, collectors and Upazilla offices under 64 districts and eight divisions.

Experimental Procedure

Detail survey on mud eel was conducted during 2013 to 2017 with particular emphasis on water quality, mud eel productivity and status of fishery exploitation. The research was conducted through collection of both primary and secondary data, comprehensive literature review and extracts of local knowledge and information from Adibasi collector. Collection of primary data was made by field observation and different experimentations which comprised of experimental area of different region, survey of different cuchia harvesting methods, cuchia markets, physico-chemical characteristics of open water region and fishers' perception as well. Secondary data were collected from Department of Fisheries (DoF) and from the local fishers.

Study of Physico-Chemical Parameters

Physico-chemical parameters were followed by the standard method of APHA [16]. Water temperature was measured using a Celsius thermometer and transparency was recorded by using a Secchi disc of 20 cm diameter. Dissolved oxygen and pH were calculated directly using a digital electronic oxygen meter (YSI Model 58) and an electronic pH meter.

Capture Method

Detail survey on capture method of the experimental area was conducted with particular emphasis on number of line, by hand and bamboo traps. Fishers' capture cuchia, by line, by hand and bamboo traps according to season and availability of cuchia.

Data Collection

An organized sampling program was run to get a true picture of the catch and catch composition of surveyed area. The experimental area was sampled fortnightly to assess the cuchia abundance and availability. The current study, being a rapid survey, gives only a broad picture of a stock of mud eel was recorded through different cuchia market survey, collection of this species directly fisher's catch and interaction with fishers' in the catching area. To compare the status of the production of cuchia trend among different years Shannon index was followed Shannon Diversity Index by Shannon [17].

Shannon Diversity Index:

$$H = \sum_{i=1}^{s} - (P_i * \ln P_i)$$

Where:

H = the Shannon diversity index

P_i = fraction of the entire population made up of species i

S = numbers of species encountered

$\sum$ = sum from species 1 to species S

Note: The power to which the base e (e = 2.718281828.....) must be raised to obtain a number is called the **natural logarithm** (ln) of the number.

Analysis of Experimental Data

The collected data were reviewed carefully before genuine tabulation. The processed data were reworded to a master sheet from which classified tables were prepared revealing the findings of the study. The data were analyzed through one way ANOVA using MSTAT followed by Duncan's Multiple Range Test to find out whether any significant difference existed among treatment means [18,19]. Standard deviation in each parameter was calculated and expressed as mean ±S.D.

Result

Physico-chemical parameters of experimental area

The results of the physico-chemical parameters of the experimental area is furnished in Table 2 which included temperature, transparency, pH and dissolve oxygen of water were found to be more and less in a normal range. It is evident from the Table 2 that the mean water temperature of the survey.

Parameters	Different year				
	2013	2014	2015	2016	2017
Temperature (°C)	21.11±6.14	21.09±6.55	21.150±7.08	20.25±7.01	21.85±6.44
Transparency (cm)	27.52±7.76^{c}	22.46±6.88^{d}	32.41±6.18^{b}	24.85±6.22^{a}	30.85±6.88^{a}
Dissolved oxygen (mg/L)	5.48±1.22	5.97±1.54	5.58±1.22	6.08±1.52	6.11±1.52
pH	8.55± 3.11	8.65.90±2.44	8.50±1.55	78.80±2.22	7.92±2.22

Table 2: Physico-chemical parameters of 08 divisions of Bangladesh.

Figures with different superscripts in the same row varied significantly (*P*>0.05). Figures in the parenthesis indicate the range. Area was not statistically significant (P > 0.05). Temperature ranged from 13.05 to 31.02oC in between 2013 and 2017. Mean transparency differed significantly (P<0.05), during the year 2013 to 2017 and ranged was 16.15.10 to 40.22 cm. Higher values occurred during February and March due to stable conditions of water. The mean dissolved oxygen (DO) of the experimental area did not differ significantly (P > 0.05). Dissolved oxygen (DO) ranged from 4.38 to 8.54 in between 2013 and 2017. Results obtained from the 24 h series experiment indicated that dissolved oxygen showed a tendency to increase in day. pH of the experimental area differ significantly (P < 0.05). pH ranged from 7.10 to 9.90 between 2013 and 2017. A significant rise in pH during winter; followed by a drop in rainy season was noted in the experimental area.

Capture of mud eel

About three types of capture methods were identified in case of cuchia harvesting in wetland of Bangladesh. The percentage of catch statistics of open water areas showed that the use of line, by hand and bamboo traps were 47.30, 30.60 and 22.10% in 2013, respectively. In between 2014 and 2016, using of harvesting with line, by hand and trap was recorded at 44.30, 28.50 and 27.20%, 41.80, 25.70 and 32.5%, and 39.80, 23.7 and 36.70%. Finally in 2017, a decreasing trend of using line and by hand were recorded at 37.30 and 20.50%, and increasing trend of using traps was noted at 42.20% (Figure 2). In between 2013 and 2017, a decreasing tendency was recorded in case of using line and by hand, and an increasing trend was found in case of trap. There was a significant difference (P<0.05) in percentages of mud eel population among different capture methods in between 2013 and 2017. A significant trend of capture was observed with line, by hand and bamboo trap during the reporting period. In case of line and by hand, the decreasing trend or regression type was Linear and the equations were y = - 2.45x + 49.45, where R^2 = 0.995; y = - 2.50x + 33.30, where R^2 = 0.994.

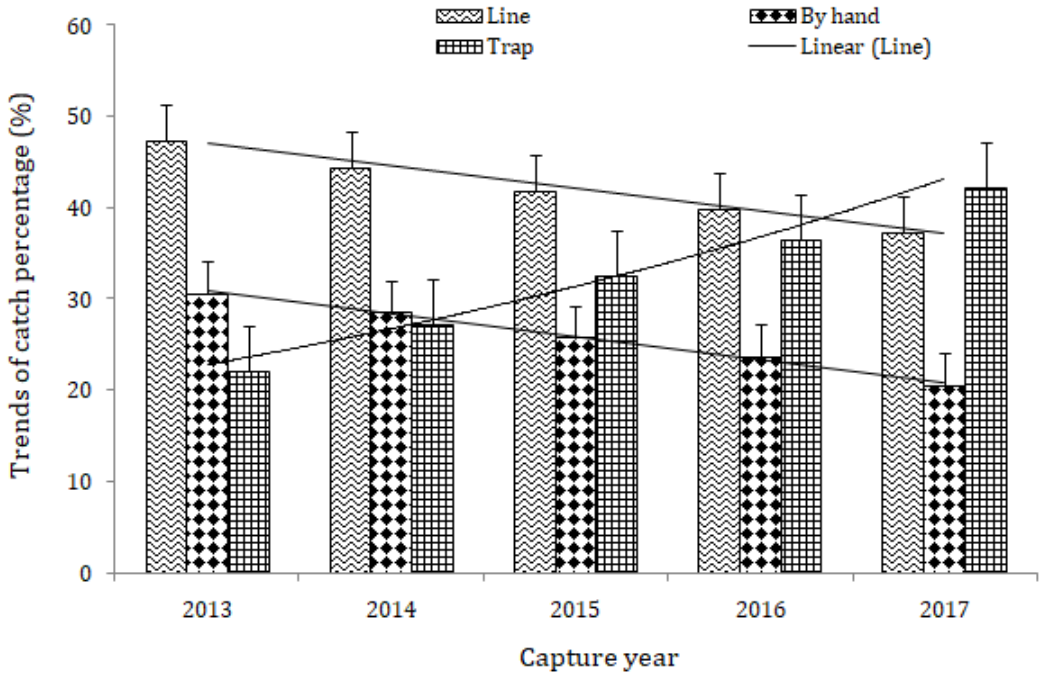

Figure 2: Increasing or decreasing trend of uses of fishing trap, line and by hand within 2013 to 2017 in 64 districts and eight divisions. Number of replicates for each substrate; cuchia harvestor n=514, crab collector n=514 and Upazilla office n=514.

In case of bamboo trap, the increasing trends or regression type was Exponential and the equation was $y = 19.44^{e0.158x}$, where $R^2 = 0.988$. A significant decline in the abundances of mud eel population was accounted due to increasing fishing pressure.

Capture and capture composition

The status of mud eel in the 64 districts under 8 divisions (treatment T_1, T_2 T_3 and T_4) of Bangladesh was identified according to catch statistics (Figure 3). The present study indicated that in 2013, the harvesting of cuchia in treatment T_1, T_2, T_3 and T_4 were 4024.55±86.77, 5881.45±90.33, 2753.75±78.66 and 2135.80±70.66 mt. But in between 2014 and 2016, total capture of 64 districts was decreased gradually at 3990.35±72.07, 5604.68±80.37, 2505.64±68.14, and 2100.81±65.11mt; 3815.25±70.44, 5464.56±82.33, 2380.07±69.65 and 2093.73±62.44 mt; 3710.75±73.52, 5391.87±80.55, 2294.86±78.44 and 1988.50±678.44 mt. Finally, in 2017, the total capture statistics in treatment T_1, T_2, T_3 and T_4 was decreased and recorded at the production of 3312.3±71.22, 4846.63±75.15, 2089.34±67.18 and 1698.11±55.67 mt. There was a significant difference ($P<0.05$) in total production among different treatments in between 2013 and 2017. A significant negative trend of production was observed during reporting period. During 2013-17, in case of treatment T_1, T_2, T_3 and T4, a decreasing trends or regression type was Linear and the equations were $y= -170.4\times + 4281$, where R^2 is 0.884; $y= -228.2\times + 6122$, where R^2 is 0.902; $y= -153.9\times + 2866$, where R^2 is 0.970 and $y=-98.76\times + 2299$, where R^2 is 0.758. A significant decline in the abundances of mud eel population was accounted due to increasing fishing pressure.

A decreasing trend of total catch was recorded in between 2013 and 2017. Annual total catch of the eight divisions was estimated to be 14795.55±186.77, 14201.48±190.33, 13385.98±178.66 and 11946.38±168.06 mt in the year 2013, 2014, 2015, 2016 and 2017, respectively consisting of four treatments. A decreasing trend of total population of mud eel in the country was identified between 2013 and 2017. The decreasing type was Exponential and the equation was $y= 15718^{e-0.4\times}$; where R^2 is 0.906. Increasing capture pressure resulting in gradual reduction in the population of mud eel was clearly demonstrated (Figure 4). Decreasing total production percentage (%) in four treatments between 2013 and 2017 was shown in the figure 5. The percentage of the total production of the experimental area was declined 4.02, 7.02, 9.53 and 19.26% within the year 2013-14, 2014-15, 2015-16 and 2016-17. The decreasing trends or regression type was Exponential and the equation was $y= 2.427^{e0.500\times}$; where R^2 is 0.979.

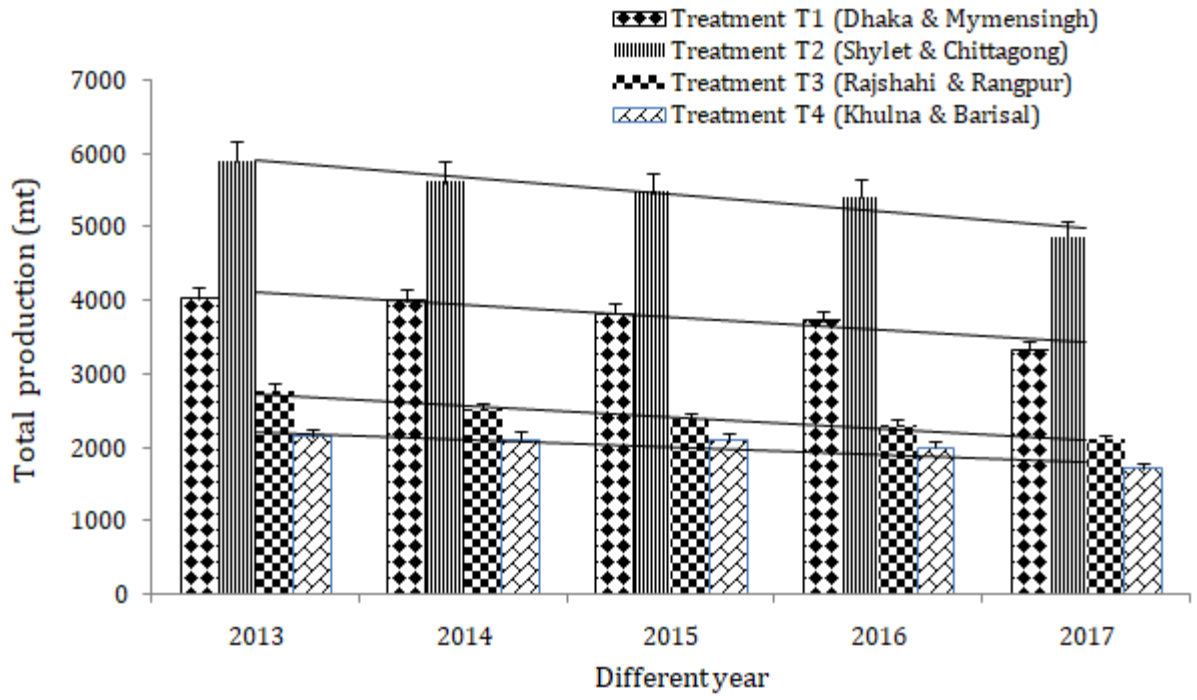

Figure 3: Catch composition of mud eel population in between 2013 and 2017 in 64 districts, nine division under treatment T_1, T_2, T_3 and T_4.

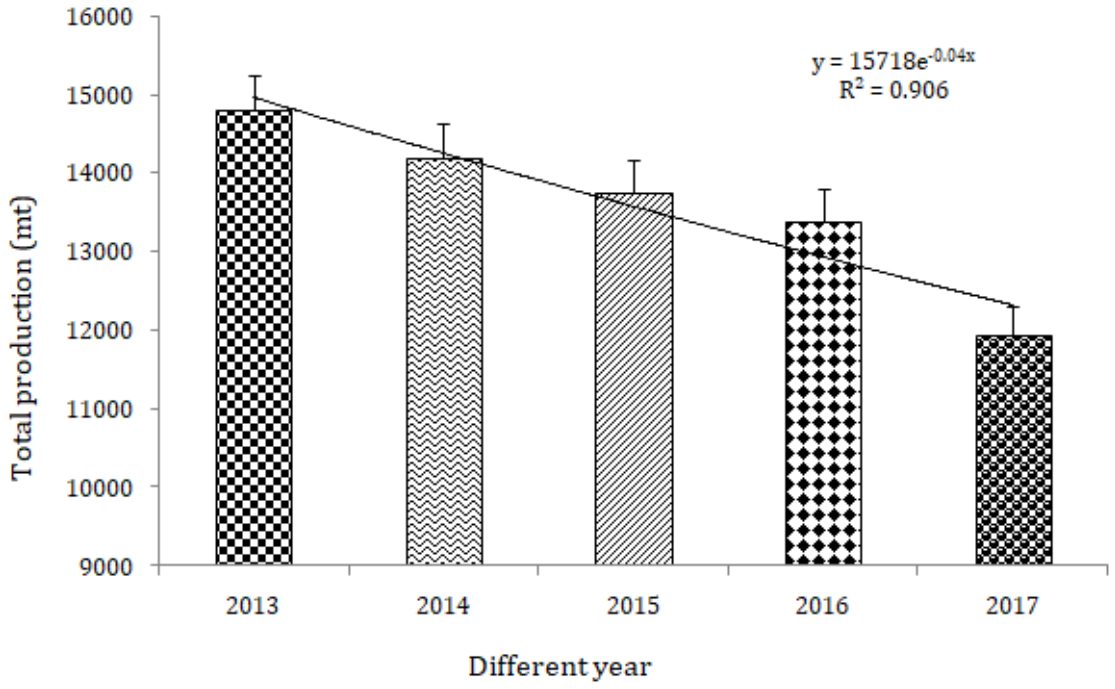

Figure 4: Decreasing total catch of mud eel in 08 divisions in between 2013 and 2017. Number of replicates for each substrate; Cuchia Harvestor n=514, Cuchia collector n=514 and Upazilla office n=514.

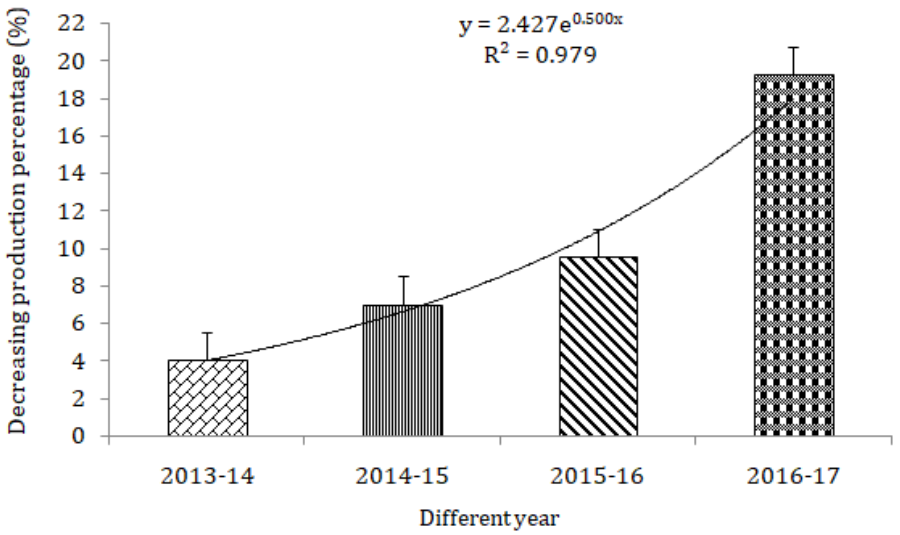

Figure 5: Decreasing catch percentage (%) of mud eel in between 2013 and 2017. Number of replicates for each substrate; Cuchia Harvestor n=514, Cuchia collector n=514 and Upazilla office n=514.

Catch Pressure on under Size Mud eel

Harvesting of under size mud eel was harvested from natural resource of eight divisions of Bangladesh (Figure 6). The catch percentage of under size mud eel between 2013 and 2017 was 5.78±2.01, 9.46±2.12, 12.56±3.07, 15.70±3.37 and 19.34±3.55%. There is a significant increasing trend to catch under size mud eel population from 2013 to 2017 in four treatments. The increasing trends or regression type in different years was Exponential and the equation was $y= 4e^{0.343x}$, where R^2 is 0.928.

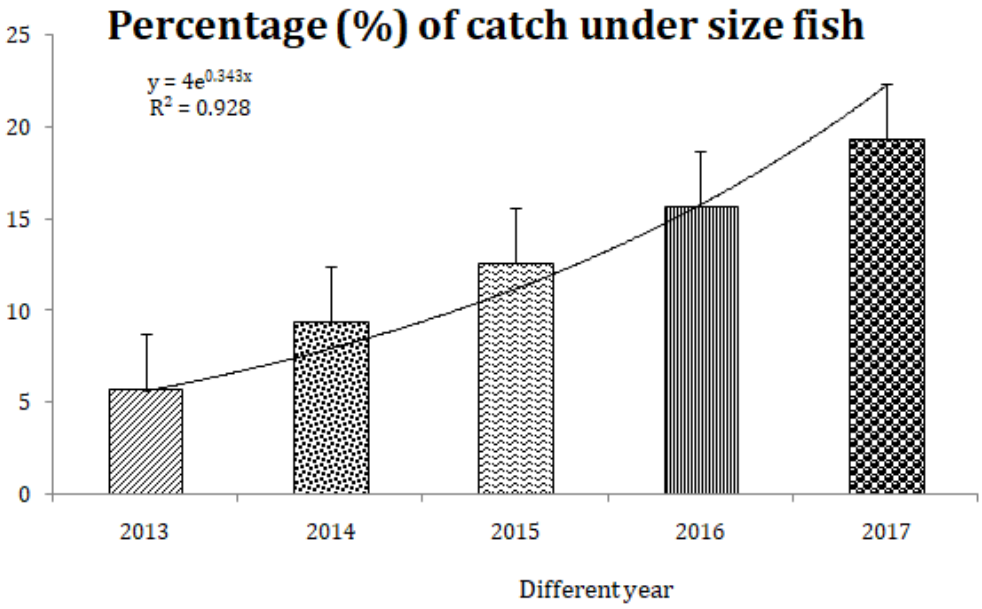

Figure 6: Catch percentage (%) of caught under size mud eel in between 2013 and 2017 in eight divisions. Harvester n=514, collector n=514 and Upazilla office n=514.

Causes of Decline Population

In Bangladesh actual Causes of decline mud crab population was identified interviewing by mud eel harvester, collector and Upazillia Fisheries Officer (Table 3). Increasing destructive fishing pressure on cuchia occurred year to year was responded by 98.83, 97.47 and 99.61% of harvester and collector of mud eel and Upazilla Fisheries Officer. Harvested mud eel brood during breeding season was answered by 99.42, 99.22 and 99.42% of harvester and collector of mud eel and Upazilla Fisheries Officer. About 98.05% harvester and 97.28% collector and 99.22% Upazilla Fisheries Officer said that high rate uses of agro chemical in cropland of floodplain. As a result about (40-55)% cuchia was attracted by different disease and causes mortality of cuchia. About 97.47% harvester, 97.72% collector and 98.25% Upazilla Fisheries Officer responded about losses of cuchia habitat by yearly. About 96.69% harvester and 94.94% collector and 97.28% Upazilla Fisheries Officer said that siltation and construction of flood control in wetland was the reason of declining mud eel population.

Sl. No.	Causes of decline population	No. of mud eel harvester =514	Responded Percentage (%)	No. of mud eel collector =514	Responded Percentage (%)	No. of Upazilla Officer n=514	Responded Percentage (%)
1.	Increasing destructive fishing pressure	508	98.83	501	97.47	512	99.61
2.	Harvested brood during breeding season	511	99.42	510	99.22	511	99.42
3.	High rate uses of agro chemical	504	98.05	500	97.28	510	99.22
4.	Losses of cuchia habitat	501	97.47	492	97.72	505	98.25
5.	Siltation and construction of flood control in water body	497	96.69	488	94.94	500	97.28

Table 3: Identified different causes of decline mud eel population interviewing by mud eel harvester, collector and Upazillia Fisheries Officer.

Culture Practices

There is no culture practice of mud eel in Bangladesh. But the "Culture of Cuchia (mud eel) and Crab in the Selected Area of Bangladesh and research project" was introduced seed production and two culture methods of mud eel Viz. Aquaculture method and natural resource management. The fry was collected from nature and cultured. There is a good success in control natural breeding for seed production in five Fish Seed Multiplication Farm (Sadar and Durgapur, Netrokona; Fulpur, Mymensingh, Nimgachi, Sirajgonj and Parbotipur, Dinajpur) of Bangladesh. But it is in initial stage. Supplementary feed was not practiced as a ration of its life in farmer's level. The source of fry collection is wild environment. Data was collected from the mud eel harvester, collector and Upazilla Fisheries Officer.

Marketing Channel in Mud Crab Trading

The marketing channel of the mud eel business was found to be consisted with the harvester, foria (middlemen), depot owner's suppliers, agents and exporters (Figure 7). The trading pattern involved a series of intermediaries from harvester to consumer. In general it was found that under size and large cuchia were collected exclusively for export in different countries. The demand of the mud eel depended on size. The grading system was almost similar in all places. The under size mud eel was particularly expensive in the china. The mud eel population was collected from the nature whole the year. But the highest pressure is winter due to demand of international market of China.

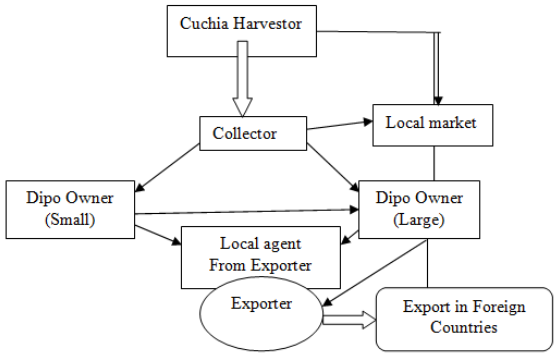

Figure 7: A series of intermediaries involved in the mud eel marketing system in Bangladesh.

Discussion

The physico-chemical factors were found to be more or less in normal range in the surveyed area which is agreed by APHA [16]. Water temperature showed increasing trend in monsoon and post monsoon season and decreasing trend in winter which is supported by Mathew [20]. Transparency was consistently higher in deeper portion of the wetland, possibly due to stagnancy of water. Rahman [21] stated that the transparency of productive water bodies should be 40 cm or less. The uniformly average value of oxygen range (4.05 - 7.65 mg.l^{-1}) as noted in the wetland agrees well with the findings of [22], pH (6.45 - 8.86) values of the wetland was more or less similar with the findings of APHA [16]. An alkalinity level of the wetland was medium to high [23].

The study clearly indicated that mud eel of the wetland identified to over capturing resulting in gradual decline in aquatic population. In addition, aquatic ecosystem health was changed due to global affect, construction of flood control barrage, soil erosion, siltation and drainage structures and agro-chemicals. Domestic organic wastes (sewage) directly or indirectly passing through canals or drains to the wetland were polluted the aquatic ecosystem health. The genetic stock structure of populations was reduced due to pollution and destructive fishing practices [3]. Indiscriminate killing of fish occurred due to the use of pesticides in improper doses, use of forbidden chemicals, and aerial spray of chemicals as used in paddy field which is very much similar to the observation of Mazid and Chakraborty [24,7]. Indiscriminate destructive fishing practices was caused havoc to the aquatic biodiversity of the open water. As a result, the ecosystem health and biological diversity of floodplain was deteriorated at an unprecedented rate [1,3]. Intervention to control floods, adoption of new agricultural technologies and construction of road networks was altered the ecology of wetland significantly which supported the views of Khan and Ali [25,26]. Stock of the wildlife cuchia brood fishes in their breeding ground was also suffered significant damages resulting in a reduction of biodiversity as noted by Nishat, Zaman and Chakraborty [2,3,27,28].

Mud eel, *Monopterus cuchia* has a source of nutritional importance and tremendous demand in the international market [14]. It occurs in the freshwater of Bangladesh, Pakistan, Northern and Northeastern India and Nepal [4]. Eight divisions of Bangladesh are resourceful for mud eel. These mud eel have economic value resulting from export, domestic exchange, and commercial sale to international market. Recent socioeconomic studies show that despite apparent increases in capture effort in the eight divisions, export of cuchia for sale was increased substantially respectively, which is supported by Naylor and Drew [29]. Anticipated economic and human population trends are likely to increase demand for this valuable species. These trends among wetland that mud eel are becoming increasingly scarce have raised concerns regarding the sustainability of current capture levels and determination of mud eel as a viable and valuable resource like mangrove crabs [30].

The catch statistics indicate that capture pressure of open water area was increased rapidly in the year 2013 to 2017. As a result, a decreasing trend in production percentage of the surveyed area was clearly pronounced within five years which was very similar to the report of Moyle and Leidy [31]. The total catch statistics of cuchia fish in the surveyed area indicated that percentage of mud eel was sharply decreased within five years which are very similar to the study of Chakraborty [32-38].

Conclusion

The study clearly indicated that the mud eel of the wetland were subjected to use of agro chemical and over fishing resulting in gradual decline this population. The present study focuses on the abundance, catch statistics and related aspects of open wetland of Bangladesh. Mud eel, *M. cuchia* was facing as higher risk of extinction day-by-day. A planned and systematic study was applied to determine the present status of biodiversity in the open water area with a view to undertake appropriate measures to conserve and manage the mud eel resource. To overcome the basic requirement of mud eel aquaculture, seed production should be ensured and selected supplementary feed should be standardized. But until to ensure seed production and develope aquaculture technology of *M. cuchia*, eco-friendly catch of mud eel should be practiced in the open water area to protect this endangered species from extinction as well as for its rehabilitation.

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