Investigation on species abundance by catch per unit effort (CPUE) in Chalan Beel, Bangladesh

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Abstract
An assessment was carried out to investigate the species abundance by catch per unit effort (CPUE) in Ruhul Beel 1, 2 and Bamonji Beel 1, 2 under Chalan Beel in Pabna district of Bangladesh. Data were collected from selected sanctuary sites, focus group discussion, personal and group contract as well as Government and Non-Government organizations with prepared and pretested questionnaire. Total 38 species were observed in sample catch from RB-1 and RB-2 during the whole study period. Each of 38 species was not available during all the months in the sample catch. Some species were found during whole study period and some were not available in every month. The mean highest CPUE was observed in case of Badai jal and Khora jal in both Beels in both years whereas, the lowest CPUE was recorded in case of Dhundi and Borshi in both sites in both years. The CPUE was increased in RB for every gear and decreased in BB for every gear other than Dharmo Jal. There was a highly significant difference in total catch and CPUE among the sites (P<0.001), gears (P<0.0001), months (P<0.001) and years (P<0.01).

Keywords: Species abundance, catch per unit effort (CPUE), Chalan Beel

1. Introduction
Catch assessment is an observational process through catch monitoring by a regular visit on the study spot survey for a sample of gear in an operation (Azher, 2009) [1]. There is a great contribution of selection of water body, geographical location and gear type on fish production, species richness, diversity, catch composition, species composition and distribution of the species (Kulbicki and Wantiez, 1990) [18]. The numbers or mean numbers of fish species may be statistically different due to the differences in bottom environment, depth of water, quality of bottom soil and shelters (Dugas and Debenay, 1980) [6]. The number of species as well as species richness may be varied due to deep or shallow waters or the variation in season (Rainer, 1984) [24]. The catch and species composition was observed in Chalan beel area which is comprised by a series of small depression of which each depression were a separate small beel (Sayeed, 2010) [26]. There are about 93 small Beels under Chalan beel area. Especially the small ditches inside the whole Chalan beel have been omitted for the study. There are so little works on this respect and has not been widely focused on understanding these patterns, with emphasis, among others, on the seasonal variation of fish abundance, species composition, biomass and ecological indices (Fischer and Eckmann, 1997; Grant et al., 2004; Gray et al., 2009) [7, 12, 13]. There are many differences in distribution of fish species among the rivers and the small ditches/beels/ depressions (Hossain, 2009) [15]. The distribution of fish communities, biomass and species composition fluctuates over space and time in the water-body (Matthews, 1998) [19]. The species composition of fishes and the abundance or biomass of several species or functional groups depends on human pressures (Mehner et al., 2005; Zambrano et al., 2006) [20, 21] and planning of developing systems (Gassner, 2003; Moss et al., 2003; Freund and Petty, 2007) [25, 26]. The aim of the study was report on species and catch composition of fish species by CPUE.

Materials and Methods
Data Collection
The primary data was collected from selected sanctuary site and control site using various methods like baseline survey by transaction, focus group discussion, social mapping, wealth
The secondary data was collected from Department of Fisheries (DoF), Bangladesh Fisheries Research Institute (BFRI), Rajshahi University (RU), Dhaka University (DU) and Bangladesh Agricultural University (BAU) library, using internet and the selective fish landing centers in the study area.

Sample Gear Selection

Samples were taken from the catch by the local fishers from the selected Beel using different type of fishing gears such as nets (Badai jal, Current jal, Khora jal, Thela Jal, Dharmo jal), traps (Dhundi and Polo) and hooks (Borsi). Other than these gears fishers also fish by hand fishing and dewatering. In case of Badai jal, Dhundi, Khora jal, Thela jal, Dharmo jal and polo, every single gear was considered as one unit of gear. But in case of Borsi 100 pieces of dati borsi (hooks) were considered as one unit of gear. In case of Current jal every 75 feet of net was considered as one unit of gear because all the current jal was 75 feet long. On the other hand, in case of hand fishing and dewatering every individual fisherman was considered as one unit of fishing gear. Firstly, total gears or any other tools was observed and then sample fishing unit was selected by random sampling methods from the experimental site and name, total numbers of active gears, type of gear, date, duration of sampling, manpower involved in fishing and related other information about fishing practices and fishing tools were recorded during every sampling day. If the gears were more than 10 units then 5 units of gears were taken as sample gear and 3 gears from 5-9, 2 from 2-4 and 1 gear from 1 was selected as sample gear (JIMBA, 1996). [16]

Catch Data and Species Count

The experiment was conducted for 24 months from May to April in Ruhul Beel and Bamonji Beel. The catch data collected by the local DoF office was used as the baseline data for estimating the yield of fish that is before the establishment of sanctuary. Data was collected weekly in each site starting from 6:00 am to 6:00 pm from the fishers catch. Two portable balances (weighing up to 0.01 gm) were used to weight the sampled catch. Total catch was taken including personal consumption. Time spent in fishing (time of collecting the observed fish, days per week, hours per day) was recorded too. Pretested survey forms were used to collect the data.

The catch record was taken gear-wise on weekly basis using structured format which contained the local name, common name, scientific name and catch weight of the respective species (Rahman MF et al., 2010). [23] The number of fish species was counted to estimate the catch composition, species composition as well as fish diversity of fish population, while the catch weight of fish offered a quantitative indicator of species biomass also related to the species composition, catch composition and fish diversity. The collected samples were sorted to species level (Kulbicki and Wantiez, 1990) [18]. The fishes were identified upto species level followed by Roberts (1995), Kapoor et al. (2002) and Haque (2014) [25, 17, 21, 4]. Each species was then weighted and counted one by one. If a species was represented by more than 200 individuals, the sample was then divided into sub-samples and from the divided sub-samples fish numbers were estimated by extrapolation (Kulbicki and Wantiez, 1990). [18] The previously collected data by the local Upazilla Fisheries Office, Project office and prepared and pretested questionnaire etc. Statistics office was used as baseline for the comparison with data collected in 1st year. On the other hand, data of first year was used as baseline to estimate changing trends of species composition, fish diversity and any other parameters of second year. Fish species composition and catch composition are usually expressed as the catch-per-unit-effort (gm/unit gear/hour). This term can be used to assessing the degree of exploitation of fishery resources (Degerman et. al., 1988; Ahmed and Hambrey, 2005) [4, 2].

Calculation

Total catch of fish and prawn was estimated from the data collected by catch assessment survey. To estimate the total catch, gear wise fish catch was recorded by calculating CPUE. The abundance and biomass of fishes are usually expressed as the catch-per-unit-of-fishing effort (CPUE). This is also used to assess the degree of exploitation of fishery resources (Degerman et. al., 1988; Ahmed and Hambrey, 2005) [4, 2]. Total monthly catches for every gear type were estimated from their CPUE and average number of gears recorded monthly following a model equation (modified) developed by de Gaston and Spicer (2004) [11].

\[
CPUE = \frac{S_s}{S_c/S_h \times T_d}
\]

Where

- \( CPUE \) = Catch Per Unit Effort for gear
- \( S_s \) = Total sample catch (g)
- \( S_c \) = Number of sample gear
- \( T_s \) = Fishing time to catch the observed sampled fish (hour)
- \( T_d \) = Total fishing time in a day (hour)

Total fish production was estimated according to Suwarso and Wasilum (1999) [28] and Solarin (1998) [27] with the formula:

\[
\text{Total catch} = h \times n \times \text{CPUE}
\]

Where,

- \( h \) = average catch per unit Effort for gear (in a month)
- \( n \) = estimated average number of active or functional gear units

Catch-per-unit-of-fishing effort (CPUE) is usually used to express the abundance and biomass of fishes which is also used to assess the degree of exploitation of fishery resources (Degerman et. al., 1988; Ahmed and Hambrey, 2005) [4, 2]. Catch per unit effort is the catch of fish by number or weight for a unit of fishing effort during a certain time. Here weight was considered to calculate the CPUE (gm/unit gear/day) for every unit of fishing gear (Sayeed, 2010). [26]

Statistical Analysis

Catches were analyzed separately for each season and the total number and weight of specimens up to species level were sorted and recorded. For each unit gear CPUE was calculated by body weight of the individual fish species. The numbers and weight of species caught per season and the one way Analyses of Variance (ANOVA) at 0.05 probability level in order to assess potential differences between the sample sites, years and fishing months were calculated by SPSS-20 and Office Excel program 2010. Correlation within different value and parameters were calculated using Pearson Correlation method. Inter annual catch changes of the species were tested by the catch Co-efficient of Variation (CV) within each year and months using the following formula;
CVm = Sm/Xm ×100 (among the months)
where Xm = mean of monthly abundance
Sm = standard deviation of monthly abundance
and CVa = Sa/Xa ×100 (among the years)
where Xm = mean of annual abundance
Sm = standard deviation of annual abundance

Results

Frequency of Species in Sample Catch in different Months

Total 38 species were observed in sample catch from RB-1 and RB-2 during the whole study period. Each of 38 species was not available during all the months in the sample catch. Some species were found during whole study period and some were not available in every month. Such as *Danio rerio* was available in August to December in RB-1 and RB-2. In others month it was not available. It was also absent in BB-1 and BB-2. The distribution of species has been showed in the Table 1, Table 2, Table 3 and Table 4.

Table 1: Monthly distribution of fish species observed in sample catch from Ruhul beel (RB-1) during the study period from May- April

| Name of Species      | May | June | July | August | September | October | November | December | January | February | March |
|----------------------|-----|------|------|--------|-----------|---------|----------|----------|---------|----------|-------|
| *Denio rerio*        |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Puntius ticto*      |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Macrobrachium armatus* | +  | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Glossogobius giuris*|     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Wallago attu*       |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Catla catla*        |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Chanda baculis*     |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Chanda nama*        |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Chanda ranga*       |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Chela baccula*      |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *M. lamarei*         |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Puntius chola*      |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Esomus dunira*      |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Channa orientalis*  |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Mastacembelus aculiatus* | +  | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Mastacembelus pancalus* | +  | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Lapidocephalus guntea* | +  | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Puntius sophore*    |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Esomus dunira*      |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Colisa sota*        |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Colisa fasciatus*   |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Colisalalia*        |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Anabas testudineus* |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Cyprinus carpio*    |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Amplipharyngodon mola* | +  | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Puntius guganio*    |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Badis badis*        |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Panchax panchax*    |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Puntius Phutuni*    |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Labeo rohita*       |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Heteropneustes fossilis* | +  | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Channa triatus*     |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Channa punctatus*   |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Mystus tengara*     |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Mystus cavasius*    |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Leidion cattia*     |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Nandus nandus*      |     | +    | +    | +      | +         | +       |          |          |         |          |       |
| *Species Count*      | 21  | 21  | 19  | 20     | 25        | 36      | 37       | 37       | 13      | 30       |       |
| Total species = 38   |     |     |     |        |           |         |          |          |         |          |       |
Table 2: Monthly distribution of fish species observed in sample catch from Ruhul beel (RB-2) during the study period from May- April

| Name of Species | May | June | July | August | September | October | November | December | January | February | March |
|-----------------|-----|------|------|--------|-----------|---------|----------|----------|---------|----------|-------|
| D. retio        |     |      | +    |        | +         | +       | +        | +        | +       | +        |       |
| P. ticto        |     |      |      |        |           |         |          |          |         |          |       |
| M. armatus      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| G. giuris       | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| W. attu         |     |      | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. casta       |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| C. baculus      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. nana         | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. ranga        | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. bacaila      |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| M. lamareei     | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| P. chola        | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| E. danrica      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. orientalis   | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| M. aculatius    | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| M. pancaulus    |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| L. guoteca      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| P. sophore      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| X. cancila      |     |      | +    | +      | +         | +       | +        | +        | +       | +        |       |
| P. conchonius   | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. sota         | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. fasciatus    | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. lalia        |     |      | +    | +      | +         | +       | +        | +        | +       | +        |       |
| A. testudinaria | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. carpio       |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| A. mola         |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| P. guganio      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| B. badis        | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| P. pancahax     | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| P. Phutani      |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| L. rohita       |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| H. fossilis     |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| C. triatus      |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| C. punctatus    | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| M. tengara      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| M. cavasius     |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| T. cutcutia     |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| N. nandus       | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| Species Count   | 21  | 22   | 19   | 21     | 28        | 37      | 37       | 36       | 15      | 29       | 25    |
| Total Species   | 38  |      |      |        |           |         |          |          |         |          |       |

Table 3: Monthly distribution of fish observed in sample catch from Bamonji beel-1 (BB-1) during the study period May- April

| Name of Species | May | June | July | August | September | October | November | December | January | February | March |
|-----------------|-----|------|------|--------|-----------|---------|----------|----------|---------|----------|-------|
| P. Ticto        |     |      | +    |        | +         | +       | +        | +        | +       | +        |       |
| M. armatus      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| G. giuris       | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| W. attu         |     |      | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. casta       |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| C. baculus      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. nana         | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. ranga        | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. bacaila      |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
| M. lamareei     | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| P. chola        | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| E. danrica      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. orientalis   | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| M. aculatius    | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| M. pancaulus    | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| L. guoteca      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| P. sophore      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| X. cancila      | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| P. conchonius   | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| C. sota         | +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| Colisa fasciatus| +   | +    | +    | +      | +         | +       | +        | +        | +       | +        |       |
| Colosalalia     |     |      |      | +      | +         | +       | +        | +        | +       | +        |       |
3.2 catch per unit effort (CPUE)

Average CPUE (gm/gear/hour) for all fishing gears varied widely by gears, months and also by years (Table 1 for RB and Table 2 for BB). The mean highest CPUE was observed in case of Badai Jal followed by Khora Jal in every site in both years whereas the lowest CPUE was recorded in case of Dhundi followed by Borshi in both the sites in both the years. It was also observed that the CPUE for every gear were remarkably higher in RB-1 except hand fishing in RB-2 (Table 1). But the rate of CPUE was decreased in BB-2 for every gear other than Dharo Jal (Table 2). Badai Jal showed the highest CPUE in RB and BB which varied from 334.76 gm to 3841.93 gm and 332.53 gm to 1744.78 gm, respectively. The lowest CPUE was found in Dhundi which was varied from 9.06 gm to 48.76 gm in RB and 3.79 gm to 32.88 gm for in BB. There was a highly significant difference (Table 7) in total catch and CPUE among the sites (P<0.001), gears (P<0.0001), months (P<0.001) and years (P<0.01).
The co-efficient of variation (CV) of CPUE of several gears (Badai jal, Borshi, Current jal, Dharno jal, Khora jal and Thela jal) illustrated decreasing in RB (Table 5). On the other hand, the variability (CV) of CPUE in different gears (Badai jal, Borshi, Dewatering, Dhundi and Hand fishing) was increased in BB (Table 6).

### Table 5: Statistical presentation of catch per unit effort (CPUE) characteristics of different gears in RB under Chalan beel

| Gear          | Mean | Standard Dev. | CV | Mean | Standard Dev. | CV |
|---------------|------|---------------|----|------|---------------|----|
| Badai Jal     | 1453.60 | 689.85        | 47.46 | 334.76 | 2285.86        | 39.43 |
| Borshi        | 20.90   | 6.49          | 31.05 | 6.88  | 39.43          | 37.48 |
| Current Jal   | 25.43   | 13.28         | 52.18 | 5.95  | 60.21          | 157.37 |
| Dewatering    | 1231.88 | 704.77        | 57.21 | 524.74 | 2197.77        | 1275.42 |
| Dharno Jal    | 375.79  | 291.17        | 77.48 | 102.42 | 751.40          | 476.63 |
| Dhundi        | 18.32   | 5.03          | 31.80 | 9.06  | 31.88          | 31.37 |
| Hand Fishing  | 1192.43 | 266.20        | 22.32 | 814.68 | 1396.02        | 631.03 |
| Khora Jal     | 1300.09 | 402.89        | 30.99 | 919.24 | 2249.95        | 1850.37 |
| Polo          | 238.96  | 17.10         | 7.16  | 226.86 | 251.05          | 326.38 |
| Thela Jal     | 194.69  | 122.75        | 63.05 | 89.71 | 402.06          | 366.02 |
| Total         | 254.08  | 515.88        | 203.04 | 5.95  | 2285.86        | 345.91 |

### Table 6: Statistical presentation of catch per unit effort (CPUE) characteristics of different gears in BB under Chalan beel

| Gear          | Mean | Standard Dev. | CV | Mean | Standard Dev. | CV |
|---------------|------|---------------|----|------|---------------|----|
| Badai Jal     | 83.86  | 566.98        | 68.01 | 332.5  | 1225.94        | 83.34 |
| Borshi        | 15.1   | 7.7           | 50.99 | 3.99  | 34.11          | 13.64 |
| Current Jal   | 16.99  | 12.54         | 73.81 | 3.45  | 62.93          | 14.02 |
| Dewatering    | 408.58 | 25.79         | 63.31 | 370.6 | 427.32          | 131.43 |
| Dharno Jal    | 90.61  | 38.76         | 42.78 | 44.78 | 144.95          | 121.41 |
| Dhundi        | 15.93  | 6.15          | 38.61 | 3.79  | 25.9           | 14.93 |
| Hand Fishing  | 453.74 | 48.25         | 106.30 | 405.5 | 520.48          | 140.61 |
| Khora Jal     | 344.28 | 73.73         | 21.42 | 281.7 | 474.81          | 293.23 |
| Polo          | 0      | 0             | 0    | 0.00  | 0              | 0.00 |
| Thela Jal     | 66.14  | 35.09         | 53.05 | 30.45 | 127.05          | 57.94 |
| Total         | 104.74 | 241.24        | 230.32 | 3.45  | 1825.9         | 81.13 |

### Table 7: Analysis of Variance (ANOVA) of the effects of Sites, year, months, gears and species on total fish catch and CPUE

| Variable      | By Total catch (F value) | By CPUE (F value) |
|---------------|-------------------------|-------------------|
| CPUE *Site    | 19.545                  | 30.727            |
| CPUE *Gear    | 25.116                  | 67.889            |
| CPUE *Month   | 5.296                   | 7.028             |
| CPUE *Year    | 8.456                   | 1.719             |

### Discussion

In the present study, average CPUE for all fishing gears were fluctuated widely by gears, months and years which might be due to mesh size, species availability in the beels, variation of water level in different months, water quality, productivity, fishing pressure, fishers’ preferences and seasonal changes of weather which is supported by the findings of Sayeed (2010) [26]. The mean highest CPUE was observed in case of Badai jal and Khora jal in both beels in both years whereas the lowest CPUE was recorded in case of Dhundi and Borshi in both sites in both years. The CPUE was increased in RB for every gear and decreased in BB for every gear other than Dharno jal. There was a highly significant difference (Table 7) in total catch and CPUE among the sites ($P<0.001$), gears ($P<0.0001$), months ($P<0.001$) and years ($P<0.01$). The highest number of fish species was caught by Dhundi (29) and lowest numbers were caught by Polo (5). The findings of the present study were more or less similar to the findings of Ahmed (2008) [3].

In case of BB the highest mean CPUE was observed in Badai jal (1992.75 gm) followed by Khora jal (1850.37 gm) and the lowest CPUE was observed in Borshi (20.90 gm). On the other hand, in case of BB the highest CPUE was observed in Badai jal (833.66 gm) followed by Khora jal (344.28 gm) and the lowest CPUE was observed in Borshi (13.64 gm). The present findings were within the range to the findings of Munir (2008) [22], World Fish Centre (2005) [29] and Francis and Beriche (2013) [8]. In case of Dhundi, Badai, Khora all though the numbers of species were more but weight was less because of the smaller size of fishes. From the overall study, it was found that the CPUE value was gradually increased in RB but decreased in BB. So the abundance and biomass of fishes in RB was increased and in BB was decreased. It might be due to the establishment of sanctuary in RB.

Overall yield was increased 1.94 times in RB by 1st year and 2.07 times by baseline yield whereas at the same time the yield was decreased 0.97 times in BB by 1st year and 0.89 times by baseline yield which was supported by the findings of Ahmed and Hambrey (2005) [2]. The yield was gradually increased in RB and vice versa in BB.

The yield rate of RB-1, BB-1 and BB-2 were lower than the average national beel yield (786 kg/ha) whereas the average yield rate of RB-2 (1178.83 kg/ha) was higher than the average national beel yield (DoF 2013). It might be due to the establishment of fish sanctuary in RB which was strongly supported by the findings of FFP (2005). The fish yield was gradually increased in RB which might be due to the establishment of fish sanctuary. This result was similar to the findings of Azher (2009) [11] and Rahman et al. (2010) [23].

### Conclusion

There are a series of small beel under the Chalan beel which is quite different from biodiversity, water depth, hydrography,
physico-chemical characteristics and biological conditions. A total of 38 species were observed in sample catch from RB-1 and RB-2 during the whole study period. Each of 38 species was not available during all the months in the sample catch. Some species were found during whole study period and some were not available in every month. The mean highest CPUE was observed in case of Badai jal and Khora jal in both beels in both years whereas the lowest CPUE was recorded in case of Dhundi and Borshi in both sites in both years. The CPUE was increased in RB for every gear and decreased in BB for every gear other than Dhamro jal.

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Conflict of interests
The authors declare that there is no conflict of interests regarding the publication of this paper.

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