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SUNDARBANS FISH CATCH MONITORING STUDY

April 10, 2013
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INTEGRATED PROTECTED AREA CO-MANAGEMENT (IPAC)

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EXECUTIVE SUMMARY

Forest Department (FD) and Department of Fisheries (DoF) requested the Integrated Protected Area Co-Management Project (IPAC) to carry out a comprehensive fisheries study on the Sundarbans Reserved Forest and in line with the terms of reference a study was conducted by the Fisheries and Marine Resource Technology Discipline, Khulna University, Bangladesh (Saifuddin*et al*2010). Present study was designed and implemented as a supplement to the study of Saifuddin*et al*, 2010 on fish catch monitoring and fish population parameters of some key species in the SRF areas.

The current study conducted in the SRF areas indicated that in 2012 annual fish landing increased by 25% compared to the base line landing in 2010. Analysis of catch statistics revealed that Ilisha (*Tenualosailisaha*), Poa (*Pamapmam*), Kakra (*Styllasp*), Tapshey (*P.indicus*), Raek (*Cirrhinusreba*), Pangus (*P. pangasius*), Poma (*Johniussp*) and Air (*Arius gagora*), are the highest resilient species and contributing by 32.47%, 25.62%, 7.5%, 7.23%, 4.91%, 2.38%, 2.35% and 1.77%of the total catch respectively.

The growth parameters derived in the current study were found to be comparable with previous estimates available in the Bangladesh coastal waters and from other localities. The study revealed that the SRF fishery is harvested at a slightly lower level than the optimum fishing pressure and also appears to be bio-physically sustainable. Analysis of effort data indicated that optimum fishing pressure has nearly reached and further increase in the catch effort should be justified carefully. The study also offers a compelling picture of growth parameters, spawning seasons, mortality rates, and exploitation rates. It also reflects how fisheries managers can maintain optimum exploitation levels for sustainable management.

OVERVIEW OF THE SUNDARBANS

The Sundarbans as the world's largest mangrove forest is of great importance for Bangladesh. It is situated to the South-west region of the country. The forest was gazetted as the Sundarbans Reserve Forest (SRF) in 1887, the Sundarbans is a World Heritage Site and a RAMSAR site. It is renowned worldwide for the Royal Bengal Tiger. The Sundarbans in Bangladesh part is 600,000 ha and is rich both in forest and wetland resources. The Sundarbans fisheries constitute important source of livelihoods for millions of people living adjacent to the SRF: There are about 289 terrestrial species and 337 wetland species. The forest plays significant role in the economy, environmental protection, cyclone and other natural hazard protection, biodiversity conservation and natural beauty. It is source of livelihood for many poor households living around and far the SRF.

In the coastal waters of Bangladesh, the fishing pressure is increasing and the indiscriminate operation of detrimental gears in the SRF areas is hampering the pelagic and demersal fish stocks. Relevant information on fishing pressure and sustainable stock position is limited and little information on population parameters and status of exploitation in the SRF areas is available. Natural resources of the Sundarbans have declined mainly due to increased biotic pressure of resource extraction, overexploitation and natural factors. The Sundarbans degradation has been a concern of national and international community.

Main objectives of the study are :i) to provide information needed to assess the current situation of fisheries resources exploitation, and ii) to identify recommendations for management interventions and actions that could be implemented to ensure conservation, improved fisheries ecosystem and habitat management, and sustainable utilization of the Sundarbans fisheries resources.

1.1 WETLAND RESOURCES

Nearly one-third of the Sundarbans is wetland and comprises an extensive network of water systems consisting of main rivers, secondary rivers, canals and beels (locally known as Chatal). There are four major river systems which are connected with freshwater rivers in upstream (the main land to the north) and in the downstream (the south) as they fall in the Bay of Bengal. The wetland resources comprises of about 337 species. It includes 204 species of white fish (includes fin & bony fish), 26 species of prawn and shrimps, 20 species of cartilaginous, 7 species of reptiles, 44 of crab and 36 species of mollusks. In addition, the wetlands have dolphin species.

The wetland resources of the Sundarbans are of high importance both in terms of economy and livelihood of the poor people. Of the total national wetland catches, about 5% is contributed by the Sundarbans. It is estimated that nearly one million people are directly and indirectly dependent for livelihood on the resources of the Sundarbans. But inadequate information on resource status is a crucial issue and should be addressed for improved resource management and conservation required for long-term sustainability. The Forest Department uses a preset method of catch estimation based on the fishing permits issued. It does not give the basic information of the resource status and management planning, due mainly to the data collection being time consuming, expensive and risky.

THE DATA COLLECTION

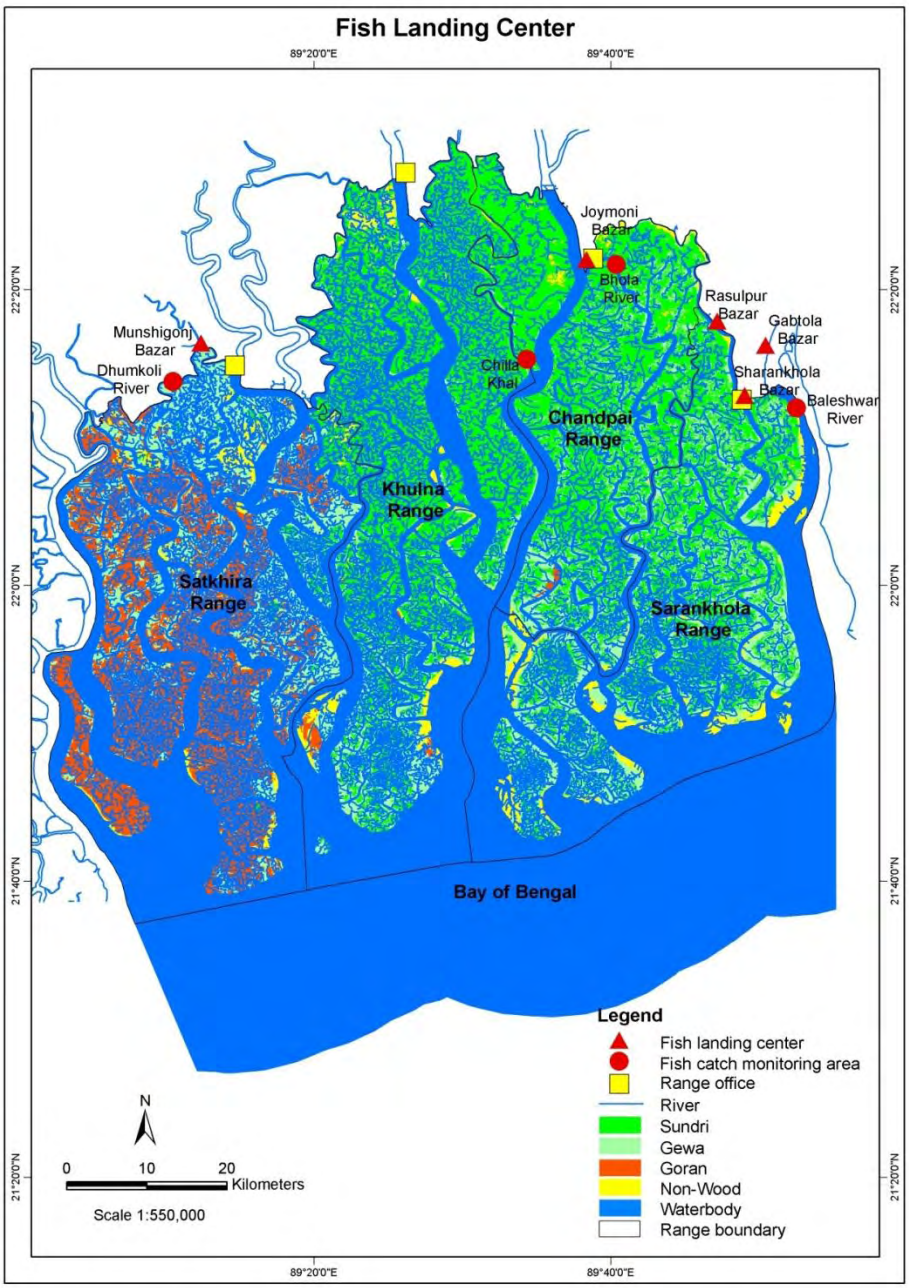

Figure 1. Map of the study area and fish landing centers

The study was conducted from April 2010 to October 2012. Monthly fish catch data were collected from three rivers section (Baleshwar River, Bhola River, Dhumkoli River) and one Canal (Chilakhal) adjacent to the Sundarbans Reserve Forest (SRF), and monthly fish landing data were collected from five local markets (Joymoni Bazar, Gabtala Bazar, Rasulpur Bazar, Sarankhola Bazar and Munshigonj Bazar) nearby SRF (Figure 1).Fish catch/landing data were collected for a duration of two to four days per month per site. Daily catch of every individual fisher was considered as the catch per person per day, and the weights of the dominant species in the catch were recorded. Further the gear-type and its mesh size were recorded. Fish catch monitoring was done at fishing locations at fishing time

and the information was collected at spot by direct catch observation. Fish landing were collected from the boats immediately landed at Bazar. Simultaneously monthly length-frequency data were collected from Joy MoniThota, Kolbari and Sarankhola. All length frequency data for each month were pooled across species and study area.

2.1. DATA ANALYSIS

Survey sampling covered gear census and catch monitoring. Catch monitoring as an observational process on fishing effort was done weekly. It recorded species wise catch statistics of each gear type. Gear survey involved a regular spot survey for a sample of gears in operation and their total catch. In this case, gear census covered all the gears (types and numbers) operating in the study sites. At each sampling site, one Community Enumerator was responsible for catch monitoring and one Community Enumerator was responsible for fish landing data collection.

The total monthly catch for each water body was calculated as below;

$$Monthly\ \ Catch\ \ per\ \ site = N * \sum_{i,j=1}^{n} \overline{f}_{i,j} * \overline{cpue}_{i,j}$$

where;

N: number of days per month when fishing was monitored

f: average number of gears used per day (for each gear type)

cpue: average daily catch per gear type (calculated yield/no of gears).

Average number of gear per day was used to estimate total number of gear-wise fishing effort for that month as well as for the whole year. Simultaneously, mean gear-wise catch rate was used to estimate total catch for that month, as well as for the whole year. Overall species distributions by gear were calculated using annual catch statistics data. Year wise as well as overall species distribution were calculated using catch statistics data. Overall production was estimated by summing all estimated production of different gear types in each year.

2.2. DADONDAR-BASE CATCH MONITORING:

The dadondar/depot/landing centers are the locations where the fish landed for sale or shop owner (dadondar/Mohajan). The data was collected from the landing records of dadondars for a sample day. In some cases, the data collector directly observed the landing amount for individual boat landing. In most of the sites, all the dadondars were selected for sampling. In cases, where the numbers of dadondars were quite high, 5-8 samples were selected for data collection.

2.3. LENGTH-FREQUENCY DATA ANALYSIS:

For the estimation of the growth rates, only samples from non-selective gears were used and aggregated in monthly periods. Population parameters were estimated using the FAO-FiSAT(FAO-ICLARM Stock Assessment Tools) software (Gayanilo*et al.* 1997). The Phi-constant (ϕ') of Pauly and Munro (1984) was used to compare growth performance and is described as follows:

$$\phi' = \text{Log}(K) + 2\text{Log}(L\infty)$$

The decrease in number through time of a cohort/population is described as an exponential decay process (Beverton and Holt 1957).Overall, total mortalities (Z) for the exponential decay model were estimated with a length converted catch curve (Pauly 1984, Spaarre and Venema, 1992). Natural mortality (M) was estimated using the empirical relationship derived by Pauly (1980), i.e. Log10M = 0.0066-0.279Log10L∝+0.6543Log10+0.463Log10T

Where L∝ is expressed in cm and T(°C) is the mean annual environment temperature (here it was taken as 28°C). The exploitation ratio E was then computed from the expression:

$$E = F/Z = F/(F+M).$$

The data collectors were selected from the local area and their education level was between Secondary and Bachelor. It was part time work for them as a person was involved 4-8 days/month. The list of last data collectors is given in Annex-C. There was quite dropping out amongst the data collectors as they were employed part time.

3. RESULTS AND DISCUSSIONS

3.1. FISH LANDING PERFORMANCE

Total estimated fish landing was obtained by combining all five landing sites - Gabtola bazar, Joymoni bazar, Rasulpur bazar, Munshiganj bazar and Shoronkhola bazar. Total fish landing from April to October in each year was found 366, 323 and 458 tons in 2010, 2011 and 2012 respectively. The present study conducted in the SRF areas indicated that the 2012 fish production (April-October in each year) increased by 25.18% compared to the base line survey in 2010 (Figure 2). Fish landing performance in different landing sites has been dependent on market demand and distance from fishing areas. Present evidence shows substantial seasonal variation of fish landing at different landing sites. By combining the fish landing from all five study sites, the monthly distribution of fish landing is presented in figure 3. Monthly distributions of fish landing (Kg) at five study sites are presented in figure 4. Comparison of monthly fish landing in the five landing sites revealed that total landing is higher in Munshiganjand Rasulpurbazar.

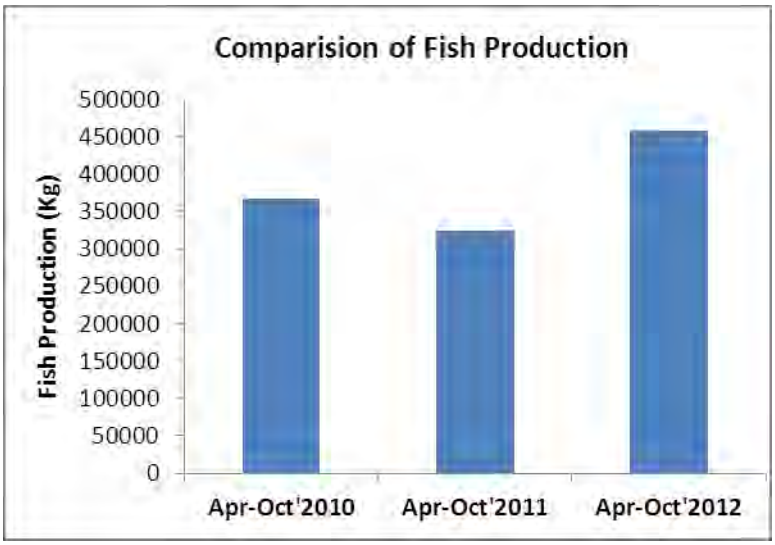

Figure 2.Fish production during April-October in 2010, 2011 and 2012.

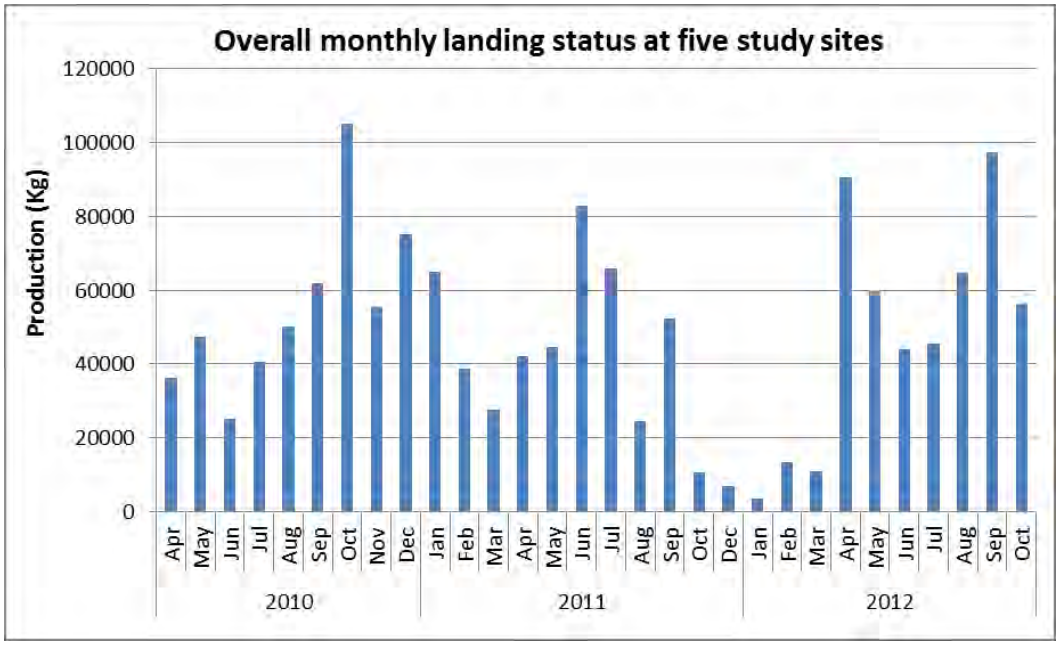

Figure 3. Overall monthly variation of fish production (Kg) in five study sites all together.

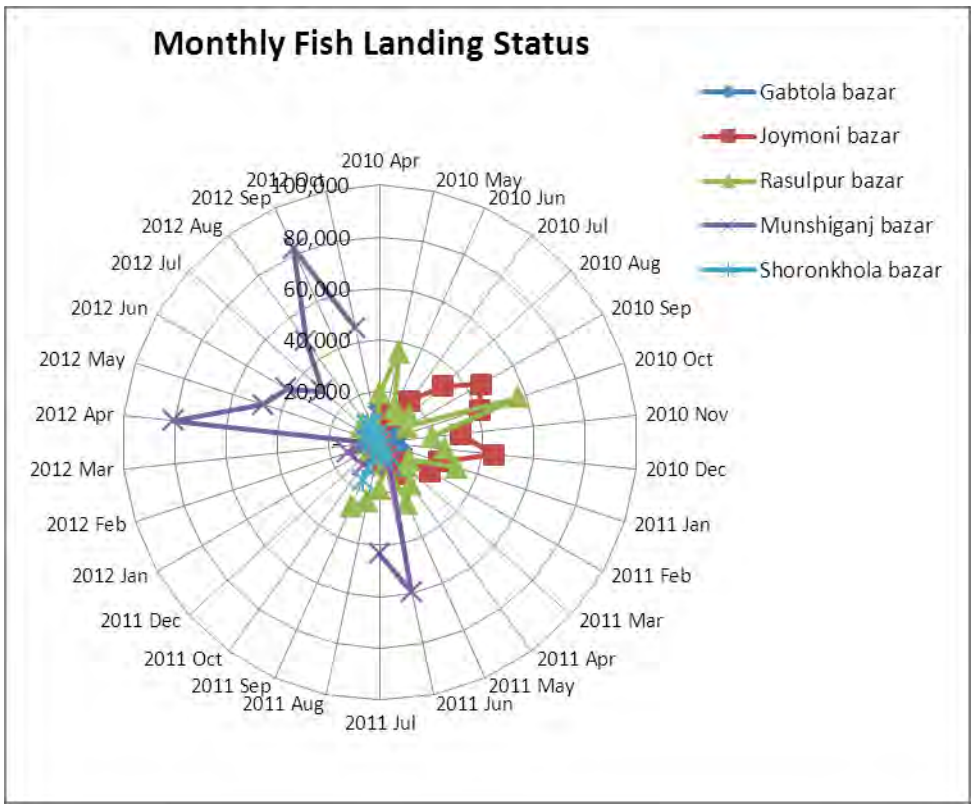

Figure 4. Monthly variations of fish landed at five landing sites in the SRF.

3. 2. FISH CATCH COMPOSITION

3.2.1. FISH CATCH COMPOSITION BASED ON FISH CATCH MONITORING

A total of 61 species of fish and shrimp were recorded during the study period. The number of species caught in the monitored sites revealed that the maximum numbers of species were found in Baleswar River(35), Bhola River (32), Chila Khan River (31) and Dhumkoli River (12). Analysis of catch statistics reveals that 15 main species contributed to the maximum proportion of the catch, all together contributing 91% during study periods. The present study revealed that Ilisha (*Tenualosailisaha*), Poa (*Pamapmam*), Kakra (*Styllasp*), Papshey (*P.indicus*), Raek (*Cirrhinusreba*), Pangus (*P. pangasius*), Poma (*Johniussp*), Air (*Arius gagora*), Rui (*Labeorohita*), Liza parsia (*Liza sp*), Pashey (*Liza parsia*), Baila (*G. giuris*), Ayre (*Mystusaor*), Tengra (*Mustusgulio*) and Shol (*Channastriatus*) are the highest resilient species and contributed as 32.47%, 25.62%, 7.5%, 7.23%, 4.91%, 2.38%, 2.35%, 1.77%, 1.68%, 1.42%, 1.33%, 0.97%, 0.81%, 0.77% and 0.69% respectively in the Sundarbans areas. The percentage composition of catches of 15 main species during study periods are presented in figure 5.

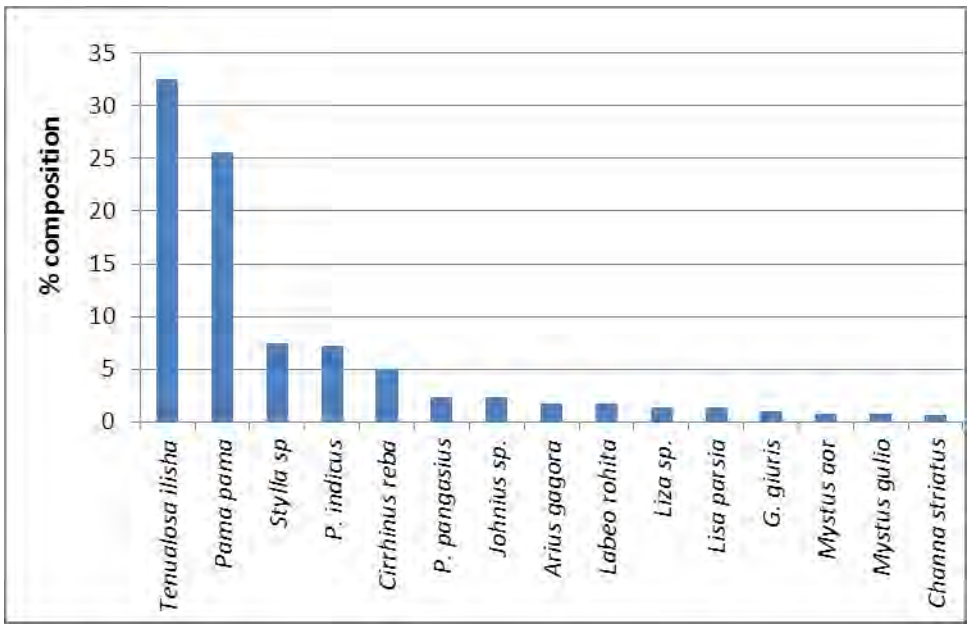

Figure 5. Percentage composition by weight (15 main species) recorded in five study sites.

3.3 GEAR EFFICIENCY AND PRODUCTION

Fisheries in Bangladesh use an extensive range of fishing gears (Alam *et al.*, 1997; Chakrabortyet *al.*, 1995; Hoggarth*et al.*, 1999). Their specifications vary according to target species, types of water body, labor intensity, fabrication, cost, materials available and profit. There are more than 100 types of fishing gears used by professional fishing communities. Gears operated in the Sundarbans can be broadly classified into: gill net (large), gill net (poajal), seine net, cast net, set bag nets, long line and hook.

In Boleswar River the most commonly used gear types were gill nets (large), gill net (poajal), seine nets, cast nets, long lines and hooks, contributedas 86%, 9%, 2%, 2%, 0.1% and 1%respectively. In Dhumkoli River the commonly used gears were long lines, hooks, set bag nets and cast nets which contributed as 79.51%, 1.19%, 18.72% and 0.1% respectively. In ChilaKhal the commonly used gears were cast nets, seine nets and set bag nets which contributed as 82%, 16% and 2% respectively. In Bhola River commonly used gear types were seine nets and cast nets which contributed to 64% and 36% respectively. The most common gears in operation, abundance of fish and prawn species caught by different gears, and their percentage contribution towards catches in Boleswar River, Dhumkoli River, ChilaKhal and Bhola River are given in figure 6.

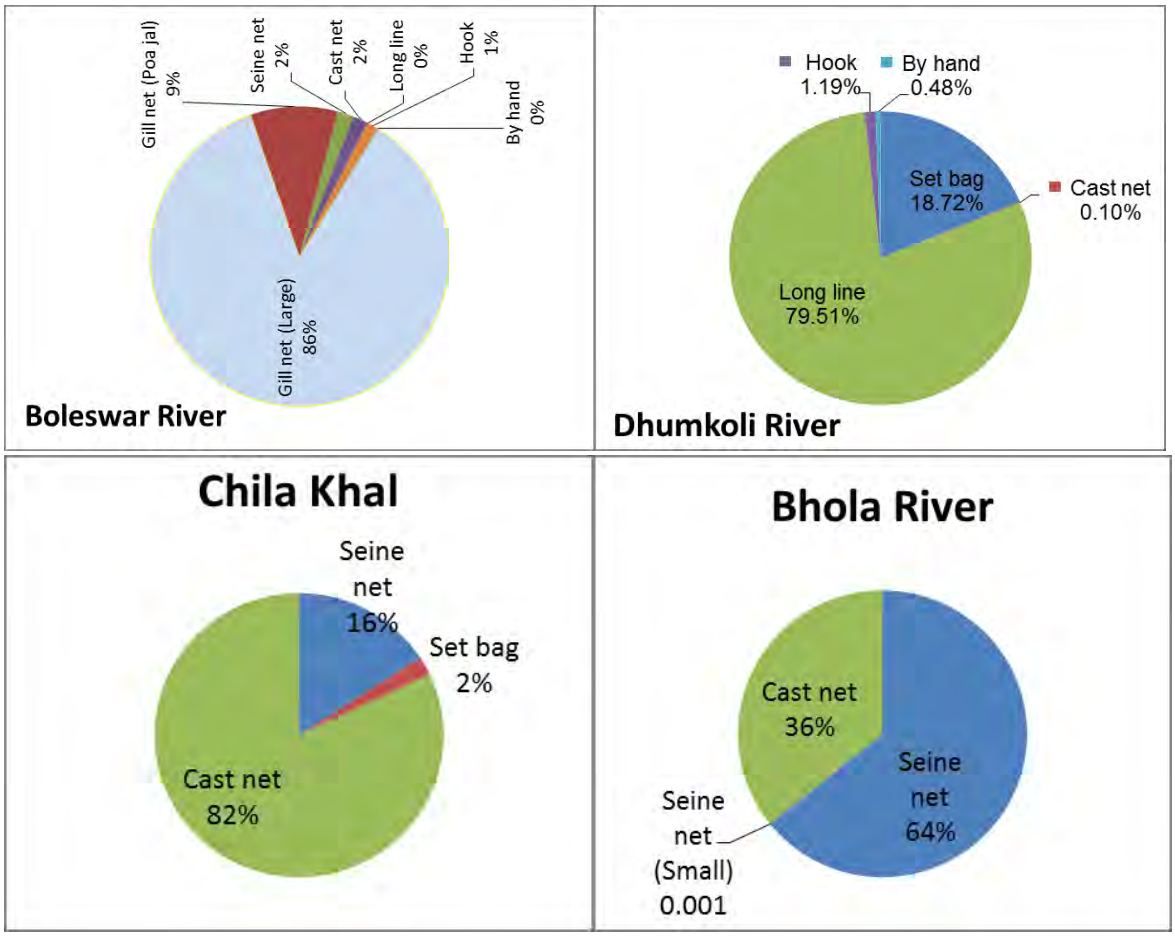

Figure 6. Percentage of catch by different gears in Boleswar River, Dhumkoli River, Chila Khal and Bhola River.

3.3.1. CATCH PER PERSON PER DAY

Fisher's livelihoods are mostly linked with income from fishing activities, such as catch per person per day. The average catch per person per day was found 0.95 kg in all four sites with highest catch of 1.67 kg in Dhumkoli River, followed by 0.94 kg in ChilaKhal, 0.81 kg in Baleswar River and 0.41 kgin Bhola River (Figure 7).In the study sites the most commonly used gear types were cast nets, gill nets, hooks, lift nets, long lines, seine nets, set bag nets and traps with average daily catch rates by fishers by gears as given in figure 8. This data can be an indicator of fish abundance and shows a higher average daily catch with cast nets and traps in the Sundarbans areas.

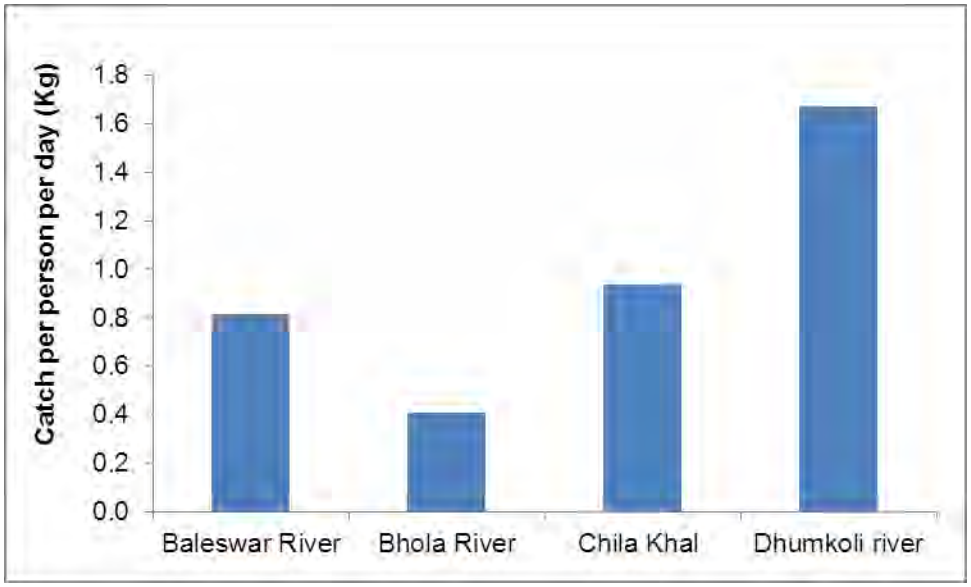

Figure 7. Fish catch per person per day (kg) at different sampling sites during study periods.

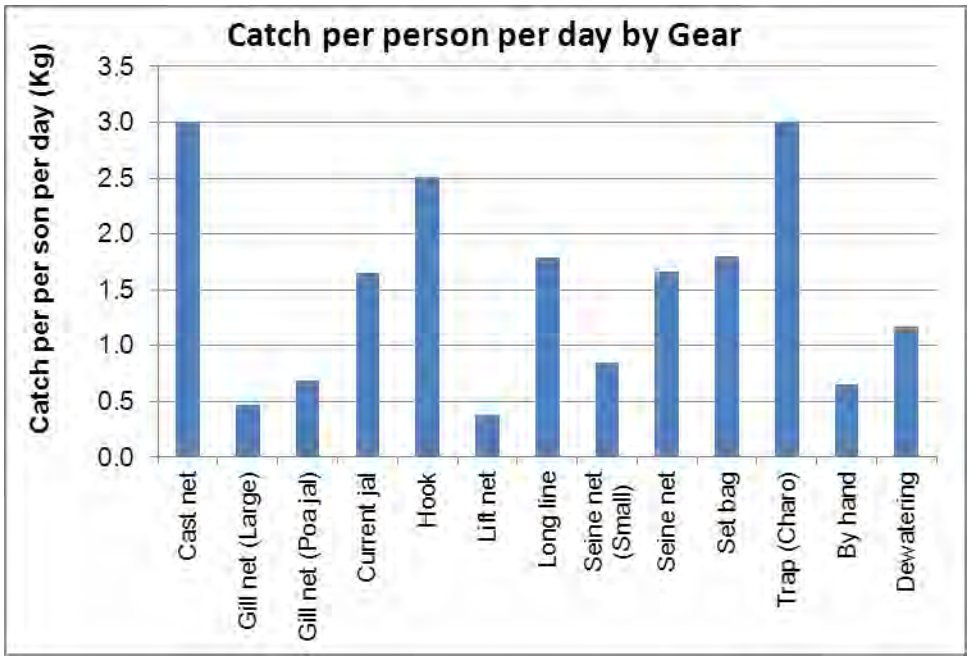

Figure 8.Average catch per person per day by different gears during study periods.

3.3.2. CATCH COMPOSITION BASED ON FISH LANDING

A total of 95 species of fish and shrimp or prawn were recorded from five landing center during the study period. The common species caught by all types of gear wereHannychingri(*Metapenaeuslysianassa),* Rudachingri (*Parapenaeopsissculptilis),* Poa (*Pamapama),* Datney(*Acanthopagruslatus),* Pashey (*Lisa parsia),* Chela (*Coliaramcarati),* Vetki (*Latescalcarifer),* Gang magur (*Plotosuscanius),* Tengra (*Mystusguilio),* Tengra (*Mystusspp),* Guraicha (*Nematopalaemontenupis),* Ilisha (*Tenualosailisha),* Dimuaicha (*Macrobarachiumvillosimanus),* Bishtara (*Scatophagasargus) and* Baila (*Glossogobiusgiuris)*contributing as 13.22%, 9.78%, 9.68%, 6.94%, 6.43%, 5.01%, 4.34%, 4.03%, 3.6%, 3.51%, 3.01%, 2.88%, 2,35%, 2.25% and 1.83% of overall catches, respectively. Catch statistics reveals that 15 main species all together contributed78.85% and all other species (80)

contributed21.15% of the total catch (Figure 9). List of all species and their percentage composition are shown in Appendix 1. *Hanny (M. lysianassa)* was the species making the highest contribution (29.22%) in Munsiganj bazar. However, the highest contribution (55.18%) ofIlisha (*Tenualosailisha)* occurred in Gabtoal bazar and Chela (*Coliaramcarati)* made its highest contribution (17.88%) in Joymoni bazar, Poa (*Pamapama)* made its highest contribution (15.58%) in Rasulpur bazar and Dimuaicha (*Macrobrachiumvillosimanus)* made its highest contribution (24.48%) in Shoronkhola bazar.

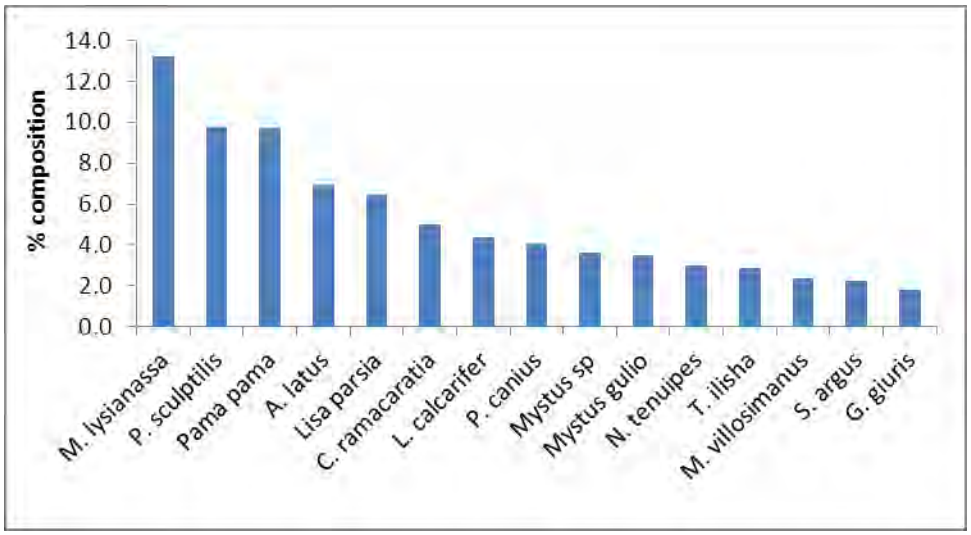

Figure 9. Species composition by weight (15 main species) landed in five study sites.

3.3.2.1 SPECIES COMPOSITION IN GABTOLA BAZAR

A total of 22 species of fish and shrimp were recorded in Gabtola Bazar during the study period. The analysis shows that the majority of the landing (90%) consists of only five species, and these species were Ilisha (*Tenualosailisha*), Pama (*Pamapama*), Tengra (*Mystustengra*), Pashey (*Liza parsia)*and Gang magur (*P.canius*) contributing55.18%,21.36%, 6.62%, 3.88% and 2.98% of overall catches, respectively in Gabtola Bazar (Figure 10).

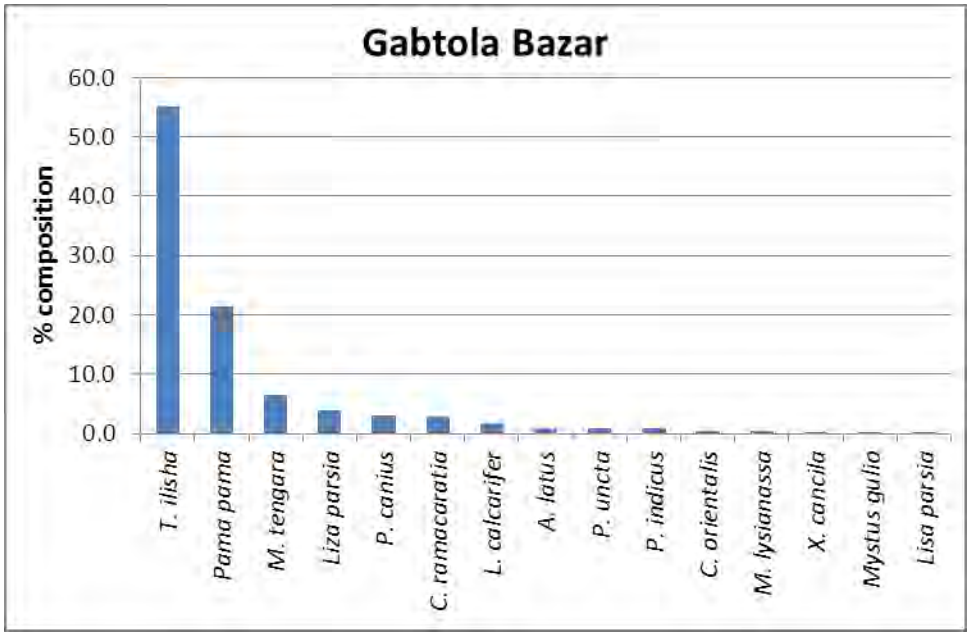

Figure 10. Species composition of 15 main species landed in Gabtola Bazar.

3.3.2.2 SPECIES COMPOSITION IN JOYMONI BAZAR

A total of 17 species of fish and prawn were recorded in Joymoni Bazar during the study period. Analysis of catch statistics reveals that five main species contributed the maximum proportion of the landing catch, all together contributing 54.63% in Joymoni Bazar during study periods. These species were *C. ramcaratia, Pamapama, P. canius, Mystusgulio*and *Liza parsia* and contributing17.88%, 10.76%, 9.01%, 8.64% and 8.34% respectively. The overall contribution of all other species was 45.37%. Figure 11 present species composition of 15 species by weight in Joymoni Bazar.

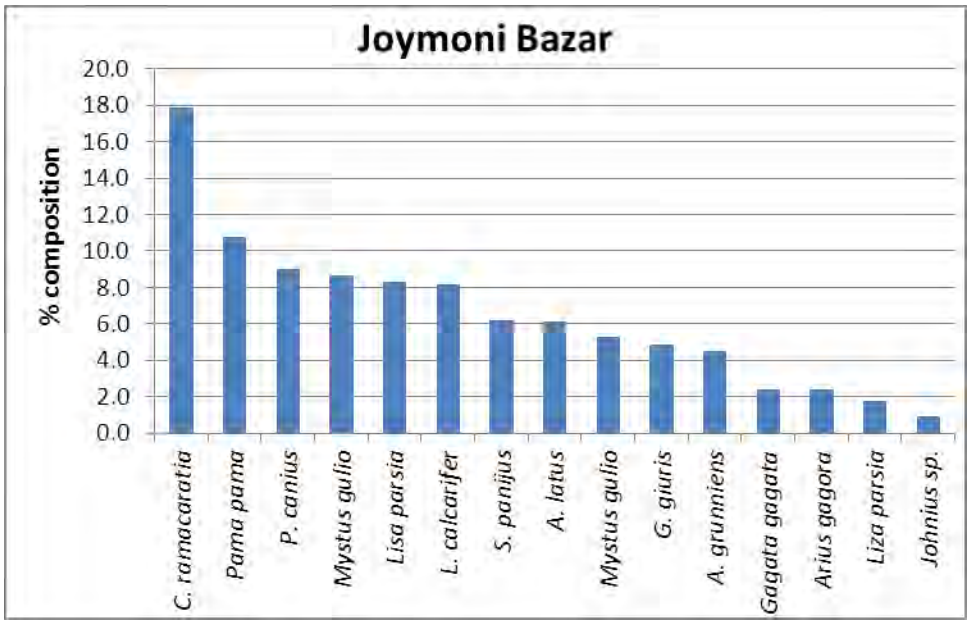

Figure 11. Percentage composition of 15 species landed in Joymoni Bazar.

3.3.2.3 SPECIES COMPOSITION IN MUNSHIGANJ BAZAR

A total of 55 species of fish and shrimp were recorded in Munshiganj Bazar during the study period. The analysis shows that the majority of the catch (75.6%) consists of only five species and these species were Hanny (*M. lysianassa*), Rudachingri (*P. sculptilis)*, Pashey (*Liza parsia), Bagachamachingri* (*P. marguinensis*) and Gang Magur (*Plotosuscanius*) contributing 29.22%,26.85%, 7.61%, 7.59% and 4.32% of overall catches, respectively in MunshiganjBazar. Figure 12 present percentage composition of 15 main species in Munshiganj Bazar.

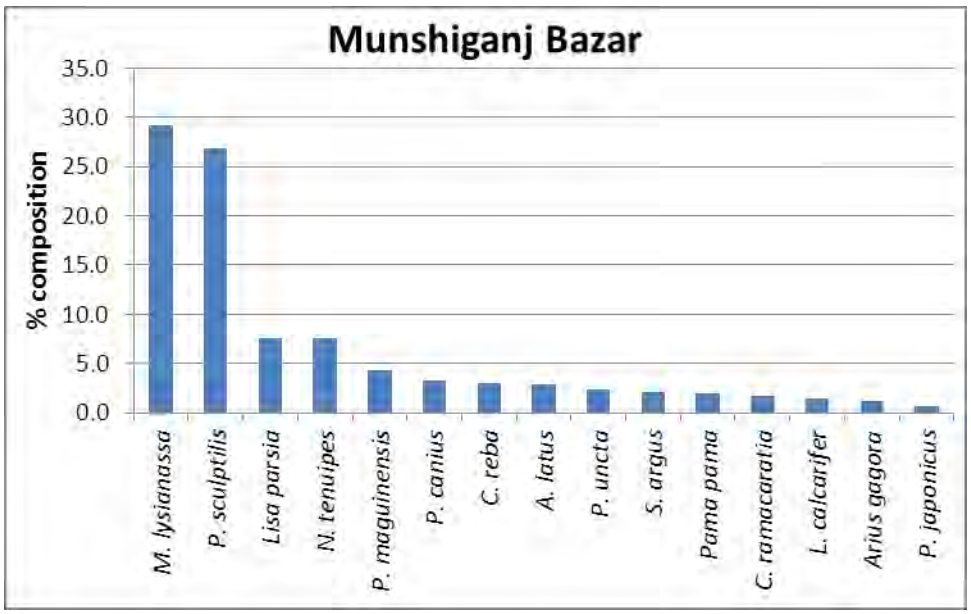

Figure 12. Percentage composition of 15 main species landed in Munshiganj Bazar.

3.3.2.4 SPECIES COMPOSITION IN RASULPUR BAZAR

A total of 64 species of fish and shrimp were recorded in Rasulpur Bazar during the study period. The analysis shows that the majority of the catch (61.96%) consists of only eight species and these species were Poa (*Pamapama*), Datney (*A. latus*), Hannychingri(*M. lysianassa*), Tengra (*Mystusgulio*), Tengra (*Mystus sp.*), Koral (*Latescalcarifer*), Bishtara (*S. argus)* andPashey (*Liza parsia)* contributing 15.85%,12.89%, 7.59%, 6.63%, 5.09%, 4.72%, 4.64% and 4.56% of overall catches respectively in Rasulpur Bazar. Figure 13 present percentage composition of 15 main species in Rasulpur Bazar.

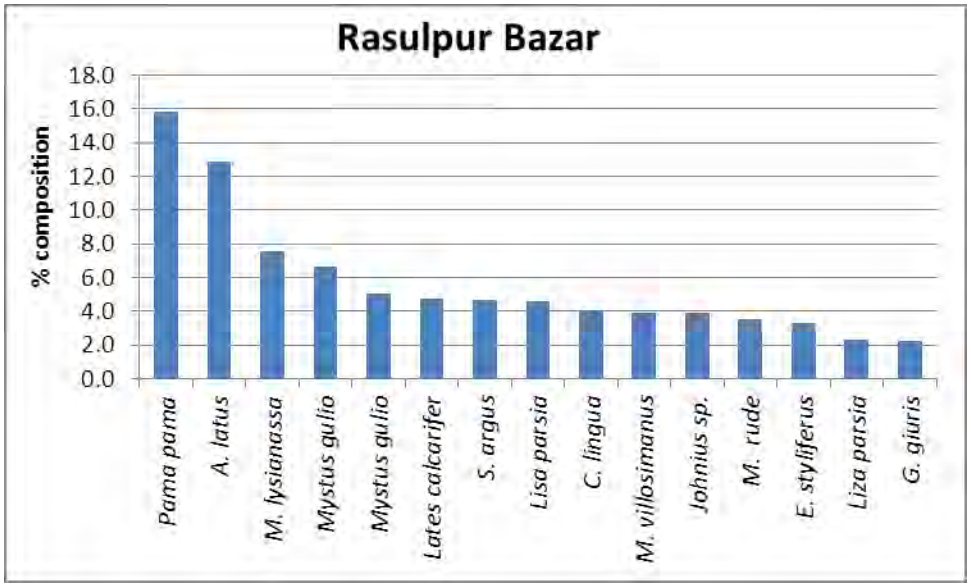

Figure 13. Percentage composition of 15 main species landed in Rasulpur Bazar.

3.3.2.5 SPECIES COMPOSITION IN SHORONKHOLA BAZAR

A total of 46 species of fish and shrimp were recorded in Shoronkhola Bazar during the study period. The analysis shows that the majority of the catch (71.79%) consists of only seven species and these species were Dimuaicha (*M. villosimanus*), Poa (*Pamapama*), Datney (*A. latus*), Koral (*Latescalcarifer*), Pashey (*Liza parsia),* Hannychingri (*M. lysianassa*) and Goda (*M. rude*) and contributing 24.48%,10.07%, 9.28%, 7.6%, 7.05%, 6.77% and 6.55% of overall catches respectively in Shoronkhola Bazar. Figure 14 present percentage composition of 15 main species in Shoronkhola Bazar.

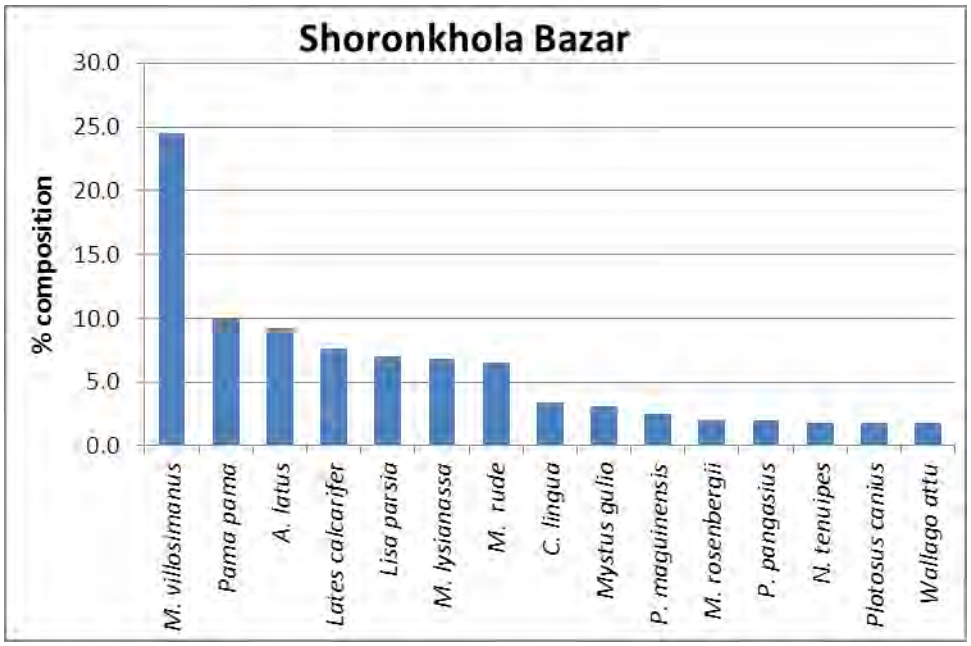

Figure 14. Percentage composition of 15 main species landed in Shoronkhola Bazar.

3.4. COMPARATIVE ANALYSIS OF DIFFERENT FISHING BOATS IN FIVE LANDING SITES

Comparison of different fishing boats landed in the five landing sites revealed that landing performance is higher by country boat in Gabtola(31%) and Munshiganj Bazars (28%). Generally country boat targeted all five landing sites, and the engine boat targeted Gabtola and Shoronkhola bazars, while trawler targeted only Gabtola bazar. The total number of country boat, engine boat and trawler landed in the five landing sites during the study periods are given in figure 15.

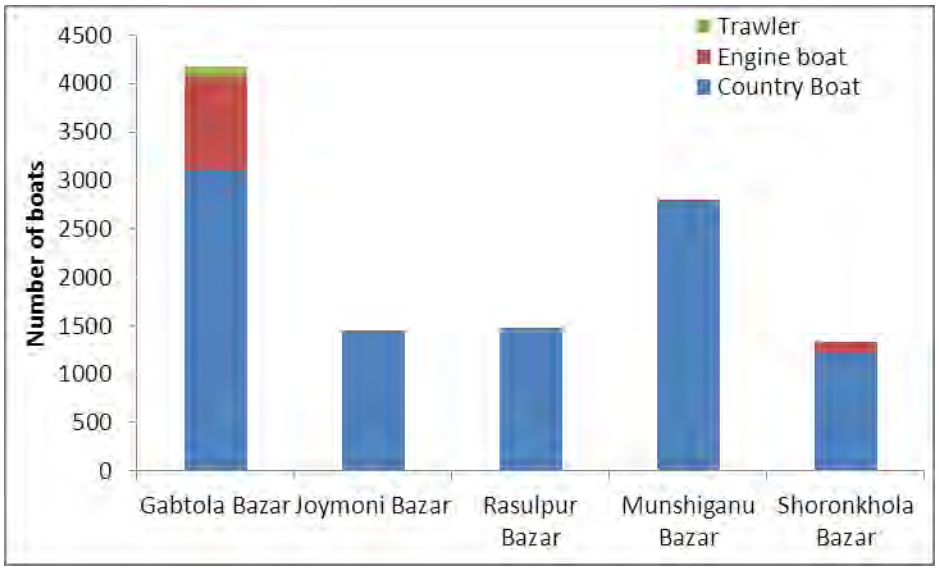

Figure 15.Number of landing boats at five landing centers.

3.5. FISH POPULATION DYNAMICS

Time series of length frequencies are the most common data type collected for population dynamics analysis. The lengths are grouped with a constant interval of 1 cm for small fish and 2 cm for big fish. Length-frequency data was analyzed to estimate growth parameters, mortality rates and exploitation rates for the 5 important species: Tengra (*Mystusgulio*), Datney (*Acanthopaguslatus*),Pashey (*Liza parsia*), Poa (*Pamapama*) *and* Vetki (*Latescalcarifer*).

3.5.1. PARAMETERS FOR *MYSTUSGULIO*

The growth parameters, L∝ (asymptotic length) and K (growth co-efficient) of the *Mystusgulio* were found to be 26.25 cm and 1.0 per year. The growth curves of those parameters are shown over its restructured length-frequency distribution in figure 16. In the present study, the peak spawning takes place in April. The three different mortality rates M (natural mortality), F (fishing mortality) and Z (total mortality) were found to be 1.851, 0.90 and 2.751 respectively. Figure 17 represents the catch curve utilized in the estimation of Z (total mortality). Estimated growth performance index (ϕ') and exploitation ratio (E) values for *Mystusgulio* was found to be 2.838 and 0.33 respectively. It appears that the stock of *Mystusgulio* of the SRF wetlands is not over-exploited. Recruitment pattern (Figure 18) from length-frequency data is correlated with the length of spawning season and a growth co-efficient (K). Recruitment pattern suggested one seasonal pulse from July to October.

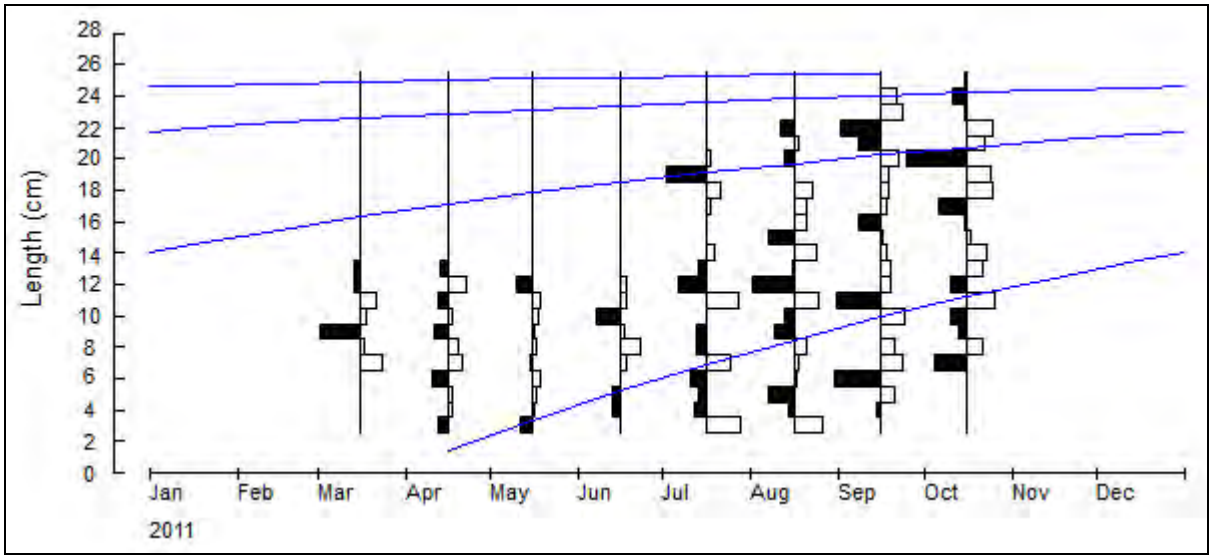

Figure 16.Growth curve superimposed over restructured length-frequency data of *Mystusgulio*

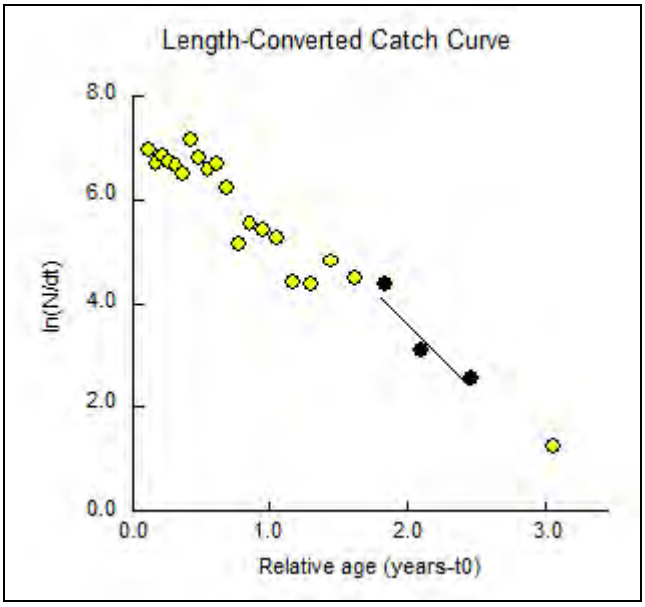

Figure 17.Length-converted catch Curve *Mystusgulio*(darkened circles represents length groups that are fully recruited into the fishery and used in the analysis).

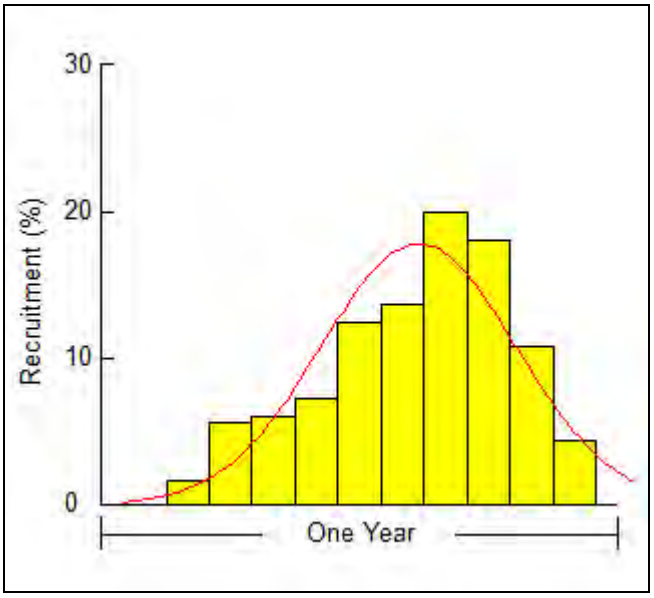

Figure 18.Recruitment of *Mystusgulio*.

3.5.2. PARAMETERS FOR *ACANTHOPAGRUSLATUS* (DATNEY):

The growth parameters, L∝ and K of the *Acanthopagruslatus*were found to be 35 cm and 0.9 per year. The growth curves are shown in figure 19. The peak spawning takes place in May. The three different mortality rates M, F and Z were found to be 1.594, 1.046 and 2.64 respectively. Figure 20 presents the catch curve utilized in the estimation of Z. Estimated growth performance index (ϕ') and exploitation ratio (E) values for *A. latus*were found to be 3.042 and 0.40 respectively. It appears that the stock of *A. latus* of the SRF wetlands is not over-exploited. Recruitment pattern (Figure 21) from length-frequency data is correlated with the length of spawning season and a growth co-efficient (K). Recruitment pattern suggested one seasonal pulse from May to October.

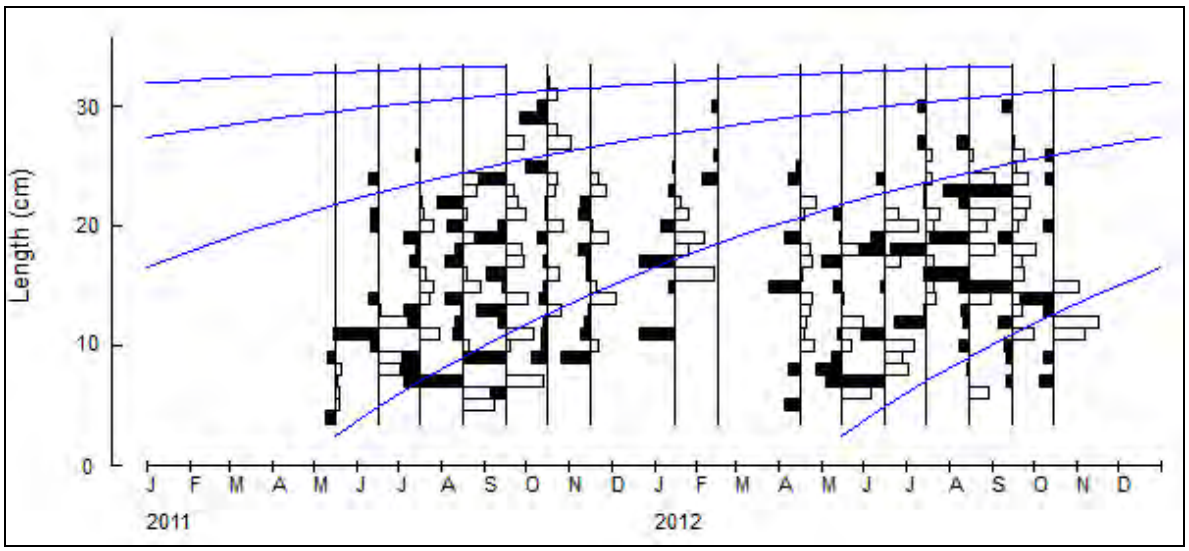

Figure 19. Growth curve superimposed over the restructured length frequency data of *A. latus* (L∝ = 35.0 cm, K=0.9).

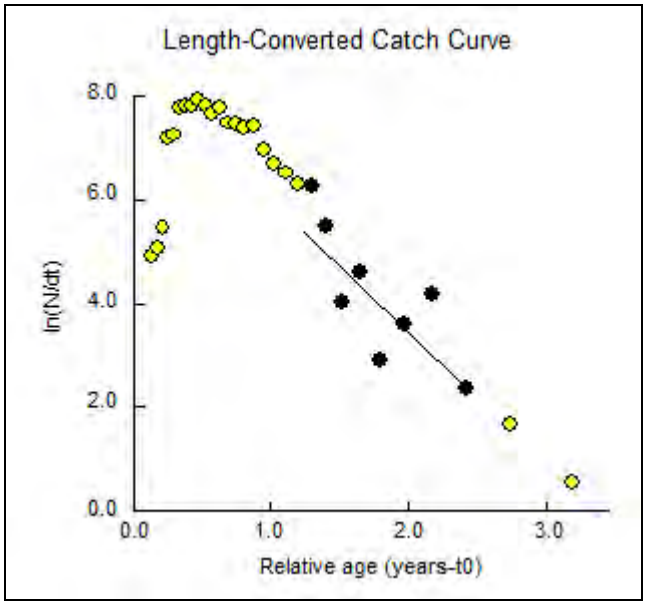

Figure 20.Length-converted catch curve of *A. latus*(darkened circles represents length groups that are fully recruited into the fishery and used in the analysis).

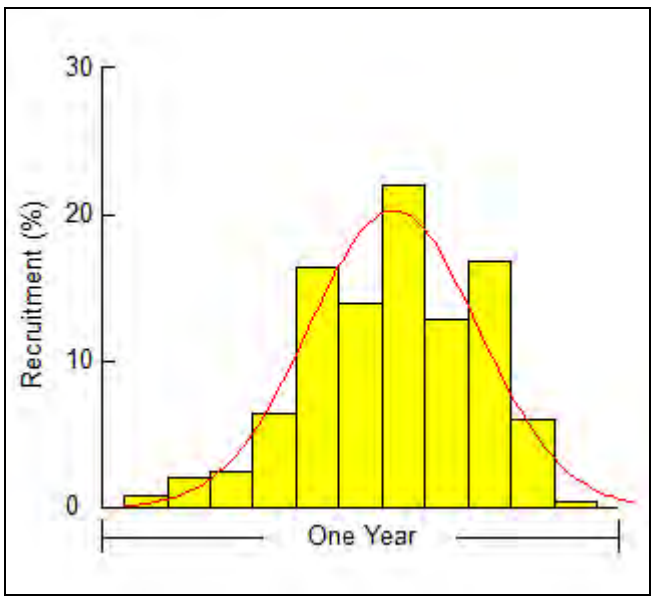

Figure 21.Recruitment pattern of *Acanthopagruslatus*.

3.5.3. PARAMETERS FOR *LIZA PARSIA* (PASHEY)

The growth parameters, L∝ (asymptotic length) and K (growth co-efficient) of the *Liza parsia* were found to be 27 cm and 1.3 per year. The growth curves of these parameters are shown over its restructured length-frequency distribution in figure 22. In the present study, the peak spawning takes place in April. The three different mortality rates M, F and Z were found to be 2.18, 2.27 and 4.45 respectively. Figure 23 represents the catch curve utilized in the estimation of Z. Estimated growth performance index (ϕ') and exploitation ratio (E) values for *Liza parsia* were found to be 2.977 and 0.51 respectively. It appears that the stock of *Liza parsia* of the SRF wetlands is slightlyover-exploited. Recruitment pattern (Figure 24) from length-frequency data is correlated with the length of spawning

season and growth co-efficient (K). Recruitment pattern suggested one seasonal pulse from August to October.

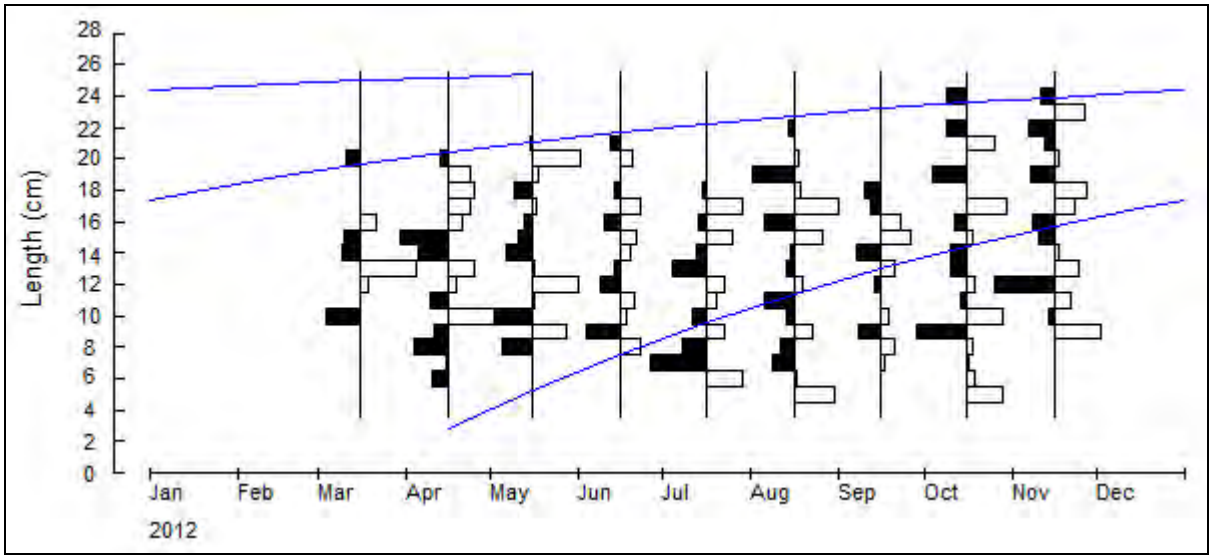

Figure 22. Growth curve superimposed over the restructured length-frequency data of *Liza parsia*(L∞ = 27.0,K=1.30).

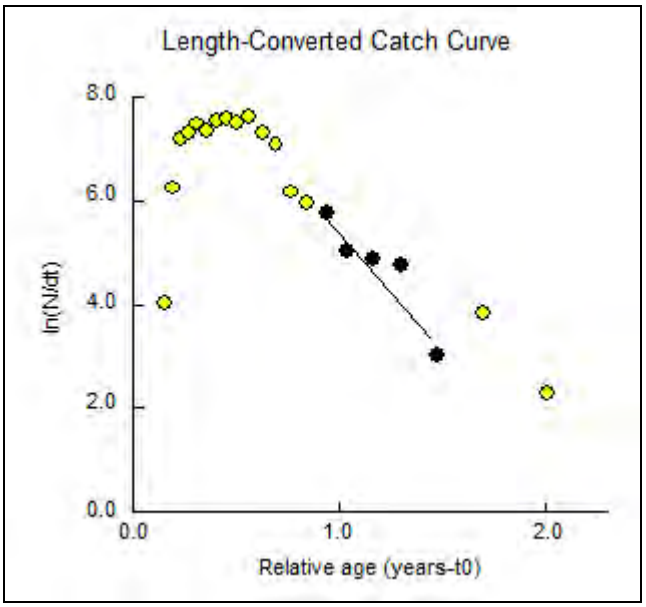

Figure 23.Length-converted catch curve of *Liza parsia (M=2.18, Z=4.45, 0=2.977);*(darkened circles represents length groups that are fully recruited into the fishery and used in the analysis).

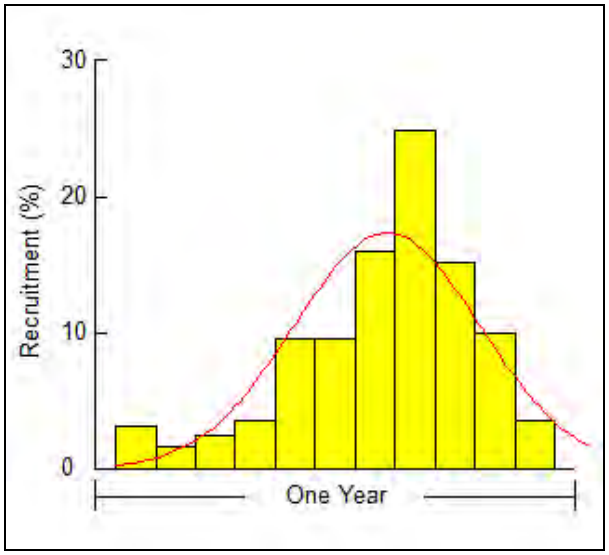

Figure 24.Recruitment pattern of *Liza parsia.*

3.5.4. PARAMETERS FOR *PAMAPAMA*(POA)

The growth parameters, L∞ and K of the *Pamapama* were found to be 52.5 cm and 1.1 per year. The growth curves of these parameters are shown over its restructured length-frequency distribution in figure 25. In this study, the peak spawning takes place in May-June. The three different mortality rates M, F and Z were found to be 1.624, 1.376 and 3.0 respectively. Figure 26 represents the catch curve utilized in the estimation of Z. Estimated growth performance index (ϕ') and exploitation ration (E) values for *Pamapama*were found to be 3.482 and 0.46 respectively. It appears that the stock of *Pamapama* of the SRF wetlands is not over exploited. Recruitment pattern suggested one seasonal pulse from May to September (Figure 27).

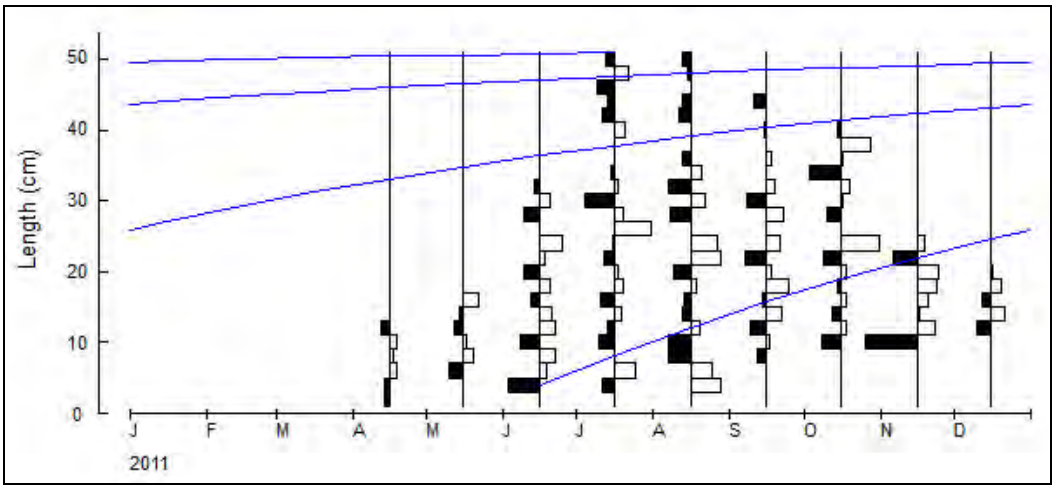

Figure 25. Growth curve superimposed over restructured length-frequency data of *Pamapama.*

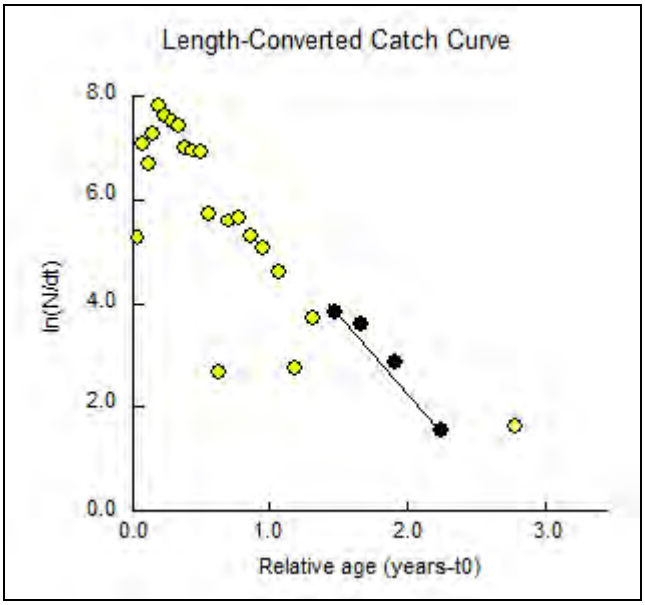

Figure 26. Length converted catch curve of *Pamapama* (darkened circles represents length groups that are fully recruited into the fishery and used in the analysis).

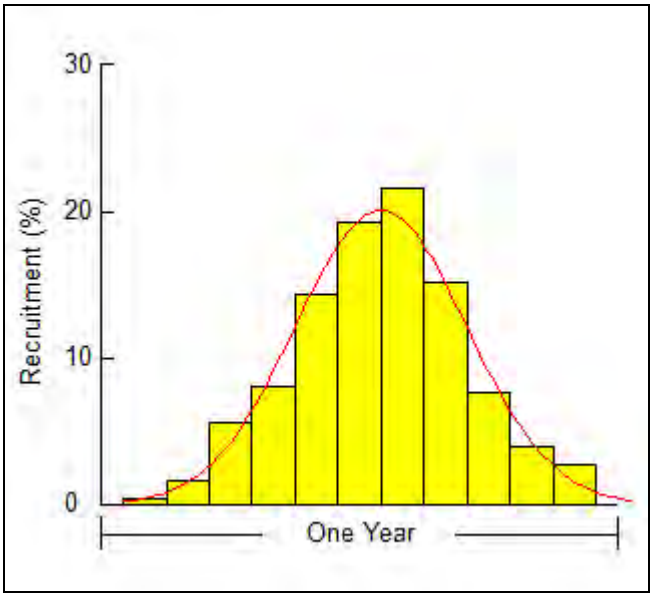

Figure 27.Recruitment pattern of *Pamapama*.

3.5.5. PARAMETERS FOR *LATESCALCARIFER* (VETKI)

The growth parameters, L∞ (asymptotic length) and K (growth co-efficient) of the *Latescalcarifer* were found to be 55 cm and 0.6 per year. The growth curves of these parameters are shown over its restructured length-frequency distribution in figure 28. In the present study, the peak spawning takes place in August. The three different mortality rates M (natural mortality), F (fishing mortality) and Z (total mortality) were found to be 1.078, 1.722 and 2.80 respectively. Figure 29 represents the catch curve utilized in the estimation of Z (total mortality). Estimated growth performance index (ϕ') and exploitation ratio (E) values for *Latescalcarifer* were found to be 3.259 and 0.62 respectively. It appears that the stock of *Latescalcarifer*of the SRF wetlands is over-exploited. Recruitment pattern (Figure 30) from length-frequency data is correlated with the length of spawning season and growth co-efficient

(K). Recruitment pattern suggested two uneven seasonal pulses from February to April and September to November.

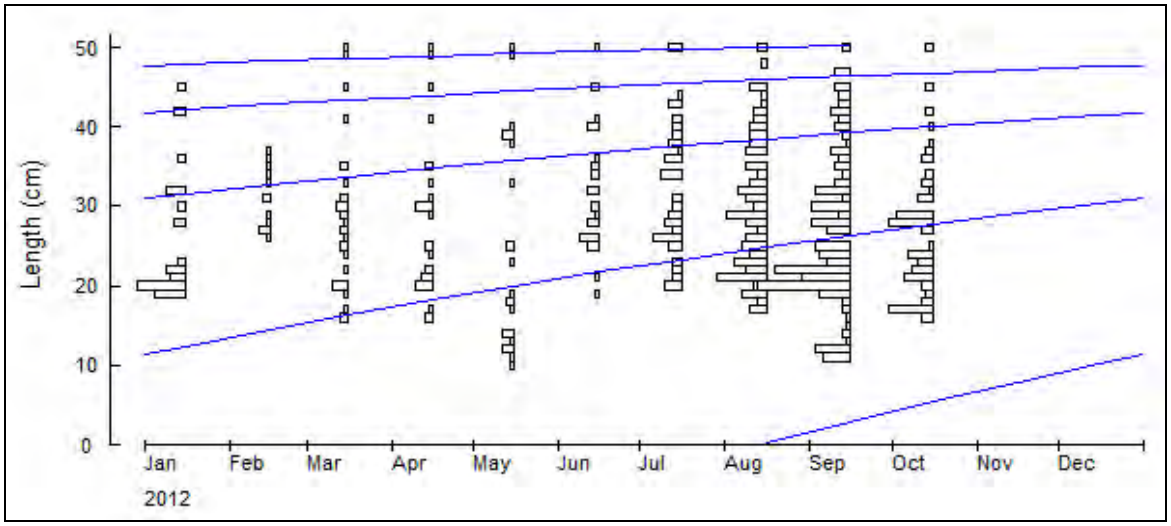

Figure 28. Length frequency distribution of Vatki(*Latescalcarifer*) caught in SRS (L∝ = 55.0 cm, K=0.60).

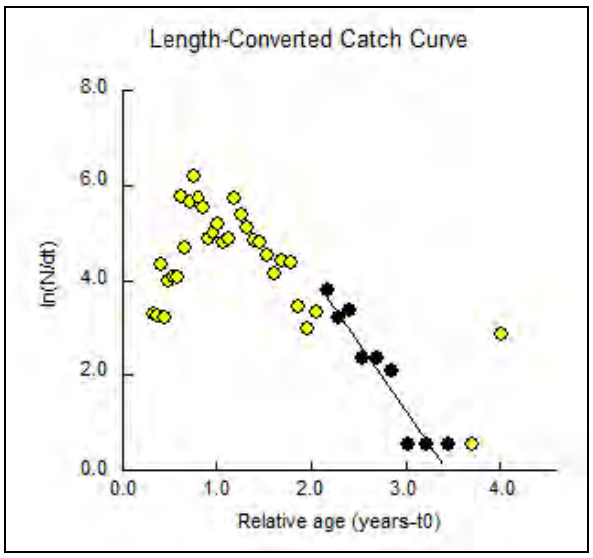

Figure 29. Length converted catch curve of *Latescalcarifer* caught in the SRS(darkened circles represents length groups that are fully recruited into the fishery and used in the analysis).

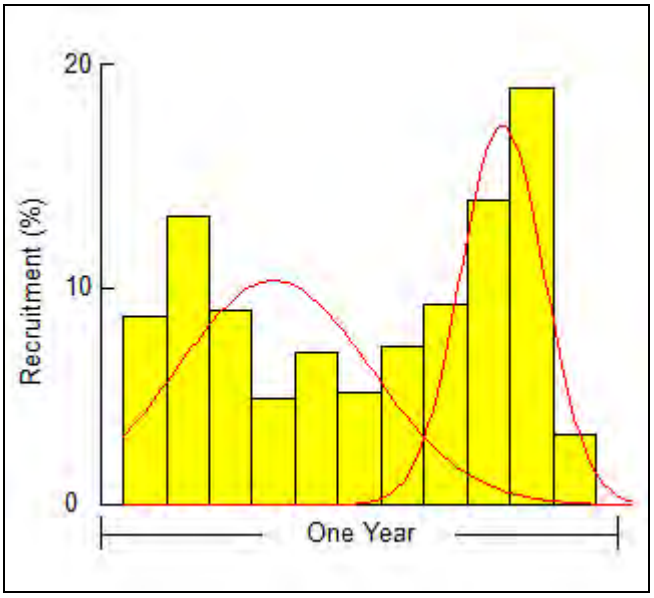

Figure 30.Recruitment pattern of Vetki(*Latescalcarifer*) caught in the SRF.

The estimated growth parameters, mortality rates and exploitation ratio for the five major species in the Sundarbans Reserve Forest wetlands are given in table 1. The estimates of growth performance index (ϕ') varied between 2.83 (*Mystusgulio*) and 3.482 (*Pamapama*). Simultaneously estimates of exploitation rates (E) varied between 0.33 (*Mystusgulio*) and 0.62 (*Latescalcarifer*) with mean E values equal to 0.46. It was found that 60% of major species were optimum exploited (E <0.50) and 40% were over exploited (E > 0.5) in the SRF.This assumption is based on Gulland's theory (1971) which stated that a suitable yield is optimized when F=M, and when E is more than 0.50 the stock is generally supposed to be over-fished.

Table 1. Growth parameters (L∝, K and Phi (ϕ'), natural mortality (M), fishing mortality (F), and exploitation rate (E) estimated for 5 key species in the SRF wetlands sites.

Bengali name	Scientific name	L□□ (cm)	K	Phi (ϕ')	M	F	E
Tengra	*Mystusgulio*	26.25	1.0	2.838	1.851	0.90	0.33
Datney	*Acanthopagruslatus*	35.0	0.90	3.042	1.594	1.046	0.40
Pashey	*Liza parsia*	27.0	1.3	2.977	2.18	2.270	0.51
Poa	*Pamapama*	52.5	1.10	3.482	1.624	1.376	0.46
Vetki	*Latescalcarifer*	55.0	0.60	3.259	1.078	1.722	0.62

CONCLUSION

This is the first comprehensive study on the fish population parameters of *Mystusgulio, Acanthopagruslatus, Liza parsia, Pamapama*and*Latescalcarifer* sampled from the commercial catches in the SRF areas of Bangladesh. The growth and mortality parameters described in this study provide important guidelines for fishery management of these species in the region. The study reveals that the SRF fishery is harvested at slightly lower level than the optimum fishing pressure and also appears bio-physically improved and sustainable. The study also offers a compelling picture of growth parameters, spawning seasons, mortality rates, and exploitation rates. It also reflects how fisheries managers can maintain optimum exploitation levels for sustainable management. However, more detailed studies on maturity, reproduction, yield-per-recruit and biomass-per-recruit are needed for proper management of fishery stock of these commercially important species in the SRF areas.

REFERENCES

Beverton, R.J.H and S.J.Holt. 1957. On the dynamics of exploited fish populations. Fish Invest Minist. Agric. Fish food, G.B2(19):533.

Gayanilo, F.C.Jr. and D. Pauly (eds.). 1997. The FAO-ICLARM Stock Assessment Tools (FiSAT) Reference Manual. FAO Computerized Information Series (Fisheries) No. 8. Rome, FAO. 262 pp.

Pauly, D. 1980.On the interrelationship between natural mortality growth parameters and mean environmental temperature in 175 fish stock. J Cons. Int. Explor Mer. 39(3): 175-192.

Pauly, D. 1984. Fish Population dynamics in tropical waters: A manual for use with programmable calculator. ICLARM Stud: Rev. 8: 325.

Pauly, D. and Munro 1984.Once more on growth comparisons in fish and invertebrates.Fishbyte 2(1):21.

Saifuddin, M. S., Huq, K, A. and Rahman, B, S. M. 2010. Study on the conservation and management of fisheries resources of the Sundarbans. Integrated Protected Area Co-management, 128 p.

Sparre, P. and Venema, S.C. 1992.Introduction to tropical fish stock assessment, Part 1-manual.FAO Fisheries technical paper 306-1 rev. 1.376 p.

ANNEX-1: LIST OF SPECIES AND THEIR OVERALL PERCENTAGE COMPOSITION.

	Scientific name	Bengali name	% composition
1	*Metapenaeuslysianassa*	Kucho	13.22
2	*Parapenaeopsissculptilis*	Rudachingri	9.78
3	*Pamapama*	Poa	9.68
4	*Acanthopagruslatus*	Datney	6.94
5	*Lisa parsia*	Pashiabata	6.43
6	*C. ramacaratia*	Chela	5.01
7	*L. calcarifer*	Koral/Vetki	4.34
8	*P. canius*	Gang Magur	4.03
9	*Mystussp*	Tengra	3.60
10	*Mystusgulio*	Tengra/Gooli	3.51
11	*N. tenuipes*	GuraIcha	3.01
12	*T. ilisha*	Ilish	2.88
13	*M. villosimanus*	DimuaIcha	2.35
14	*S. argus*	Bishtara/Chitra	2.25
15	*G. giuris*	Baila/Bele/Vangla	1.83
16	*Penneusmaguinensis*	White shrimp	1.78
17	*Cynoglossus lingua*	Bashpata	1.54
18	*Johnius sp.*	Poa/Poma	1.50
19	*Sillaginopsispanijus*	TularDati	1.44
20	*Macrobrachium rude*	Goda	1.41
21	*Liza sp.*	Parshey	1.32
22	*Parapenaeopsisuncta*	Icha	1.17
23	*Allenbatrachusgrunniens*	Gongonia	1.13
24	*Cirrhinusreba*	Raek/Nora	1.13
25	*Arius gagora*	Aair	1.12
26	*Exopalaemonstyliferus*	Garachingri	1.04
27	*Gagatagagata*	Gang Tengra	0.66
28	*Styllasp*	Kakra	0.60
29	*Mystustengara*	BojuriTengra	0.54
30	*Cynoglossuscynoglossus*	Kukur jib	0.37
31	*Setipinnataty*	Telephasa	0.34
32	*Channastriatus*	Shol/Shoil	0.26
33	*Penneusjaponicus*	Dorakatachingri	0.25
34	*Penneusmonodon*	Bagdachingri	0.24
35	*Notopterusnotopterus*	Foli/Kanila	0.22
36	*Xenentodoncancila*	Kakila	0.22
37	*Machrobrachiumrosenbergii*	Golda Icha	0.21
38	*Eleutheronematetradactylum*	Lakkha	0.20

39	*Metapenneusmonoceruos*	Harina	0.19
40	*Mystusbleekeri*	Golsha	0.19
41	*Wallagoattu*	Boal	0.16
42	*Polynemusindicus*	Tapshey	0.15
43	*Anabas testudineus*	Koi/Gachua Koi	0.15
44	*Macrobrachiumlamarrei*	Thengraicha	0.13
45	*Clariasbatrachus*	Magur/Mojgur	0.13
46	*Pangasiuspangasius*	Pangus	0.12
47	*Salmostomabacaila*	Chela/Katari	0.11
48	*Unidentified*	Unidentified	0.08
49	*Macrobrachiummalcolmsonii*	ChatkaIcha	0.08
50	*Catlacatla*	Katla/Katol/Fega	0.07
51	*Chela laubuca*	KashKhoira	0.07
52	*Dermogenyspussilus*	Ekthota/Subol	0.07
53	*Labeocalbasu*	Kalibaus/Baus	0.05
54	*Harpodonnehereus*	Loitta	0.05
55	*Monopteruscuchia*	Kuichcha	0.04
56	*Macrobrachiumbirmanicum*	ThanguaIcha	0.04
57	*Labeogonius*	Goinna	0.04
58	*Mugilcephalus*	Parshey	0.03
59	*Puntiusticto*	Tit Puti	0.03
60	*Puntiussophore*	Jatputi	0.03
61	*Arius platystomus*	Aair	0.03
62	*Channapunctatus*	Taki/Ladi	0.03
63	*Channaorientalis*	Gachua/Cheng	0.03
64	*Pellonaditchela*	Chaika/Choukka	0.03
65	*Pampuschinensis*	Rup Chanda	0.02
66	*Penneusindicus*	Chagachingri	0.02
67	*Mystusaor*	Ayre	0.02
68	*Ompakbimaculatus*	KaniPabda	0.02
69	*Clupisomagarua*	Ghaura	0.02
70	*Penneussemisulcatus*	Baghtarachingri	0.02
71	*Badisbadis*	Kali Koi/Napit Koi	0.01
72	*Anodontostomachacunda*	Koi puti	0.01
73	*Rhinomugilcorsula*	Khorshola/Kholla	0.01
74	*Eutropiichthysvacha*	Bacha	0.01
75	*Setipinnaphasa*	Fesha/Fefri/Fasha	0.01
76	*Nemacheilusbotia*	Bali chata	0.01
77	*Paraplaguchiabilnata*	Kukur jib	0.01
78	*Terapon sp.*	Barguni	0.01
79	*Ompakpabda*	ModhuPabda	0.01
80	*Heteropneustesfossilis*	Shing/Jiol Mach	0.01
81	*Mystusvittatus*	Tengra/Guinga	0.01
82	*Trichiurussavala*	Chhuri Mach	0.01

83	*Odontamblyopusrubicundus*	LalCheua	0.01
84	*Teanoidesbuchanani*	Raja chewa	0.01
85	*Macrobrachiumdolichodactylus*	Bhrammani	0.01
86	*Gagatacenia*	Kaua/Jongla/Telia	0.005
87	*Brachygobiusnunus*	Nunabaila	0.004
88	*Chandaranga*	LalChanda	0.003
89	*Unknown species*	Gota	0.003
90	*Trichiurusmuticus*	Chhuri	0.002
91	*Nandusnandus*	Meni/Veda	0.002
92	*Chacachaca*	Chekbeka/Cheka	0.001
93	*Apocryptesbato*	Guley	0.001
94	*Siloniasilondia*	Shilong/Shilon	0.001
95	*Himantura sp.*	Saplapata	0.0005

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