

CLP '0217810: Assessing the considerable human elements in the proposed sanctuaries for conserving threatened freshwater dolphins in the Sundarbans, Bangladesh

Project location: Sundarbans mangrove forest, Bangladesh

Field work: August – December 2010

Conserving threatened freshwater dolphins through ensuring a sustainable management plan of aquatic resources in the Sundarbans, Bangladesh



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Executive Summary

An intensive socio-economic study was conducted among the fishermen living in close proximity to the proposed sanctuaries using dolphin entangling gears. The study also documented catches from dolphin entangling gears and analyzed by-catch rate of two commonly seen shrimp larvae collecting gears. After the one year of study the team managed to find out that majority of the interviewed fishermen earn very low and the income level generally increased among the fishermen who has completed their primary level of education (5 years). It was seen from the study that the villagers generally have a positive attitude towards dolphin and appreciate them for their beauty. The also managed to find out that the multiple middlemen in the fish market chain earns majority of the benefits and the actual fishermen earns very little from their work. The interviewed fishermen depend fully on fisheries during the wet season and only a minor percentage of the interviewed fishermen have a secondary occupation during the rest of seasons.

The team has managed to assist the existing dolphin project to develop a recommendation plan for the proposed sanctuaries and some of the team members are continuing their involvement in dolphin conservation and expecting to increase their capacity.

Table of Content

| | |
|--|----|
| 1. Introduction..... | 1 |
| 1.1 Team members | 4 |
| 2. Aim and objectives | 6 |
| 3. Methodology | 7 |
| 3.1 Planning | 7 |
| 3.2 Training..... | 7 |
| 3.3 Field work | 8 |
| 3.3.1 <i>Estimating the contribution of fisheries in local livelihood and socio-economic status of the fishing communities</i> | 8 |
| 3.3.2 <i>Assessing the CPUE of fishing gears known for dolphin entanglement</i> | 8 |
| 3.3.3 <i>Investigating sustainable method for collecting shrimp larvae inside the Sundarbans</i> | 9 |
| 3.3.4 <i>Strengthening the capacity of the team members and local communities</i> | 9 |
| 3.4 Analyses | 9 |
| 4. Outputs and results..... | 9 |
| 4.1 Number of gears and people involved in fisheries..... | 9 |
| 4.2 Socio-economic status of the fishermen and contribution of fisheries in their livelihood | 12 |
| 4.3 Prevailing fish market chain..... | 14 |
| 4.4 Perceptions of local people regarding dolphins and reported dolphin entanglements | 15 |
| 4.5 Catch per unit effort (CPUE) of the focused fishing gears | 18 |
| 4.6 Shrimp larvae collection and the by-catch rate..... | 19 |
| 4.7 Strengthening the capacity of the team members and the local communities | 20 |
| 5. Achievements and impacts | 21 |
| 6. Conclusion..... | 22 |
| 7. Problems encountered and lessons learned..... | 23 |
| 8. Future activities | 24 |
| 9. References | 25 |
| 10. Distribution list..... | 28 |
| Appendix 1: Datasheets and questionnaires | 29 |

| | |
|---|----|
| 1.1 Questionnaire for fishermen in the proposed wildlife sanctuaries | 29 |
| 1.2 Questionnaire for fish traders in the proposed wildlife sanctuaries | 36 |
| 1.3 Data sheet for fishing gear census | 40 |
| 1.4 Fishing effort and catch composition data sheet..... | 41 |
| 1.5 Data sheet for investigating shrimp fry collection..... | 42 |
| Appendix 2: Financial report..... | 43 |

List of Figures

| | |
|---|----|
| Figure 1: Eastern Sundarbans mangrove forest in Bangladesh with dolphin hotspots circled in red. | 3 |
| Figure 2: Sundarbans mangrove forest with the three existing wildlife sanctuaries and the three proposed wildlife sanctuaries in Bangladesh indicated. | 4 |
| Figure 3: Number of active fishing gears in the hotspot segments during the wet season | 10 |
| Figure 4: Number of active fishermen in the hotspot segments during the wet season..... | 10 |
| Figure 5: Number of active gears in the hotspot segments during the dry season | 11 |
| Figure 6: Number of active fishermen in the segments during the dry season | 11 |
| Figure 7: Literacy level of fishermen | 12 |
| Figure 8: Average monthly income of the fishermen in compare to their education level | 12 |
| Figure 9: Literacy level of fish traders | 13 |
| Figure 10: Average monthly income of the fish traders in compare to their education level | 13 |
| Figure 11: Fish market chain | 15 |
| Figure 12: Perceived importance of dolphins in the rivers | 16 |
| Figure 13: Reported dolphin entanglements according to gears and seasons | 16 |
| Figure 14: Reported dolphin entanglements | 17 |
| Figure 15: Reported fate of the entangled dolphins | 17 |
| Figure 16: Reported fate of the dolphin carcasses..... | 18 |

List of Tables

| | |
|---|----|
| Table 1: Percentage of income from fisheries..... | 14 |
| Table 2: Weight, economic value and catch per unit effort (CPUE) for gill nets in proposed wildlife sanctuaries..... | 19 |
| Table 3: Weight, economic value and catch per unit effort (CPUE) for long lines in proposed wildlife sanctuaries..... | 19 |
| Table 4: Comparison of by-catch from post larvae set bag nets and box nets | 20 |
| Table 5: Comparison of dead by-catch percentage in the post-larvae nets | 20 |
| Table 6: Women and children involved in collection of post-larvae..... | 20 |

1. Introduction

Bangladesh, a country known for its high population density, also contains one of the world's largest river networks. The alluvial channels and adjacent floodplains of the Ganges-Brahmaputra-Meghna (GBM) river system occupy approximately 80% of the country's geographical area and support three quarters of its human population (Dalal-Clayton, 1990).

The Sundarbans is the world's largest contiguous mangrove forest, encompassing almost 600,000 ha. About one third of the area is composed of a complex network of tidal and fluvial waterways ranging from a few meters to a few kilometers wide. The network is fed almost entirely by the GBM river system (Hussain and Karim, 1994). A significant population of Asia's only remaining two freshwater dependant dolphin species still remains in the waterways of Sundarbans which can be saved from extinction through early conservation initiatives (Smith, *et al.*, 1998).

Ganges River dolphins or Shushuks (*Platanista gangetica*) range from the major Himalayan tributaries of the Ganges-Brahmaputra-Meghna river system in the north to the Bay of Bengal in the south as well as in the much smaller Karnaphuli–Sangu River system in south-eastern Bangladesh (Kasuya and Haque, 1972; Haque, 1976; Reeves and Brownell, 1989; Reeves, *et al.*, 1993). The distribution of these true river dolphins tends to be clumped in deep counter-current pools created by channel confluences, mid-channel islands, and sharp meanders. The species range was mapped by Anderson (1879), but since then the range has declined especially in the upstream reaches (Sinha, *et al.*, 2000; Smith, *et al.*, 2001) and the species is currently considered as 'Endangered' according to IUCN Red List criteria (Smith, *et al.*, 2004a). A comprehensive study in the Sundarbans mangrove forest of Bangladesh has estimated 225 Shushuks living in the waters of the Sundarbans mangrove forest (Smith, *et al.*, 2006).

The Irrawaddy dolphin (*Orcaella brevirostris*) in Bangladesh ranges from freshwater channels of the Sundarbans mangrove forest to the shallow coastal waters under influence of freshwater inflow. Similar to Ganges River dolphins, Irrawaddy dolphins also prefer counter-current habitat,

but they are generally found in higher salinity areas of the Sundarbans with a seasonally varying zone of overlap in the distribution of both species. The waterways of the Sundarbans are home to 451 Irrawaddy dolphins (Smith, *et al.*, 2006), with an additional 5,383 animals estimated to occur in adjacent coast waters (Smith, *et al.*, 2008). This constitutes the world's largest population of Irrawaddy dolphins.

Declining freshwater flows profoundly threaten the world's riverine and estuarine biodiversity (Covich, 1993; Postel and Richter, 2003). Cetaceans living in these environments are especially at risk due to their particular environmental needs, including sufficient flow to allow movement between deep pools and the availability of hydraulic refuge from high velocity currents (Smith and Reeves, 2000). As for most small cetaceans, fishing gear entanglements pose a serious threat especially from gill nets (Kreb, *et al.*, 2010); gill nets and long lines are known to cause their death in the Sundarbans of Bangladesh. (Fahrni Mansur, *et al.*, 2008). The Wildlife Conservation Society's Bangladesh Cetacean Diversity Project (BCDP) has proposed the establishment of three new wildlife sanctuaries which were identified as 'dolphin hotspots' based on the occurrence of both Ganges river and Irrawaddy dolphins and the encounter rates of the two species recorded during opportunistic surveys conducted by the captains of nature tourism vessels (Smith, *et al.*, 2010). These three 'dolphin hotspots' are in close proximity to fishing villages with a majority of fisherfolk using dolphin entangling gears. Establishing protected areas in these crucial river segments aims to protect these threatened dolphin populations through promoting sustainable fisheries and non-entangling gear.

A group of seven young conservationists was selected by the Conservation Leadership Programme to carry out a study aimed at identifying the human elements which need to be considered when developing an effective management plan for these proposed sanctuaries. The study includes socio-economic analyses of the fishing communities living in close proximity to the protected areas, identification of fish market mechanism relevant to the aquatic resources collected from these river segments and an assessment of the impacts freshwater dolphins and their prey from dolphin entangling fishing gears. The team also attempted to identify less destructive practices for collecting crustacean larvae and to gain a better understanding of local perceptions of dolphins.

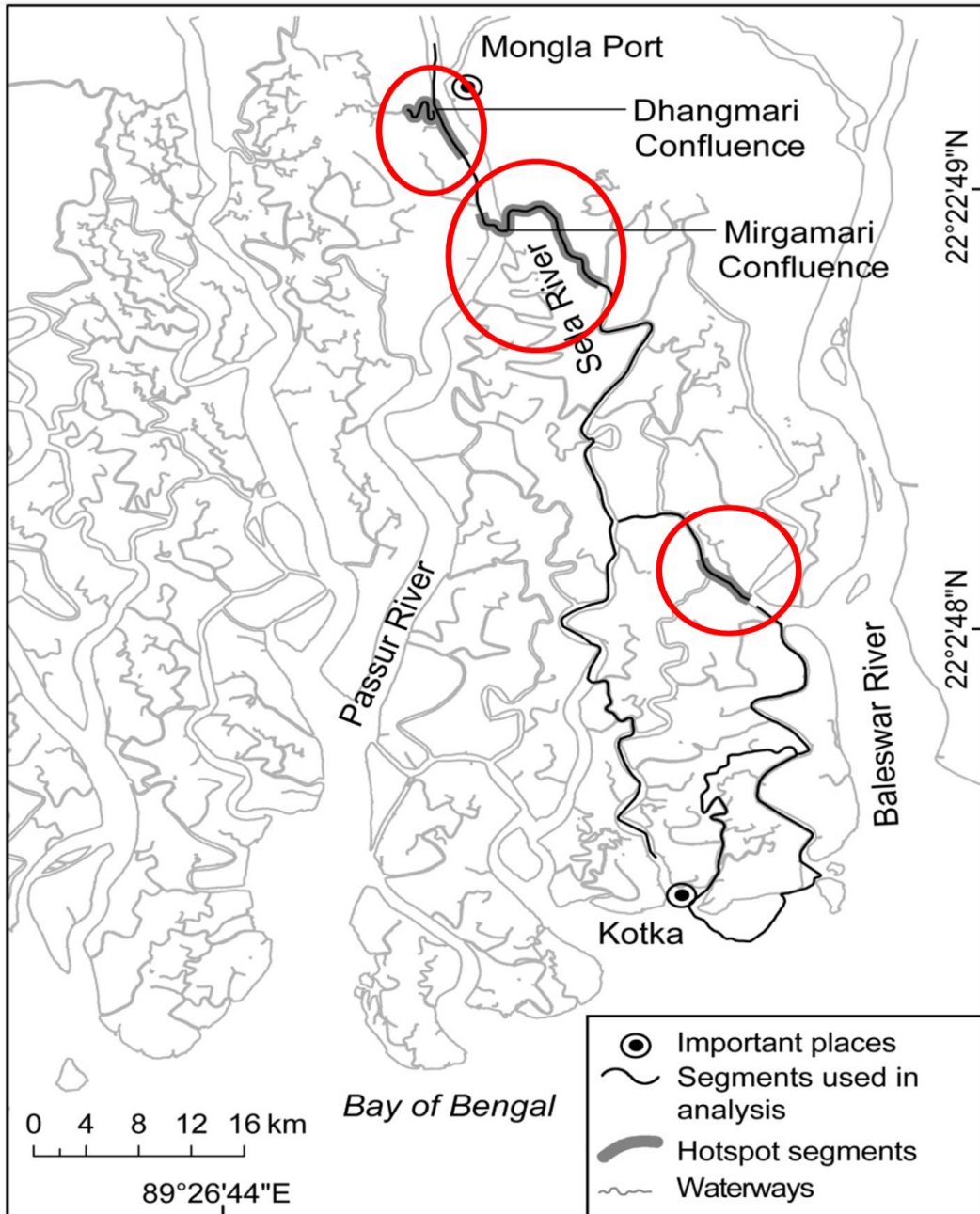


Figure 1: Eastern Sundarbans mangrove forest in Bangladesh with dolphin hotspots circled in red.



Figure 2: Sundarbans mangrove forest with the three existing wildlife sanctuaries and the three proposed wildlife sanctuaries in Bangladesh indicated.

1.1 Team members

| Name | Qualification | Experience | Roles in the project | Current occupation |
|---------------|-----------------------------------|--|----------------------|---|
| Emile Mahabub | B.Sc. in Environmental Management | Sundarbans Nature Guide since 2006 Local GIS consultant for Swiss | Team Leader | CLP Intern with WCS Marine Bangladesh Program |

| | | | | |
|-----------------------|--|--|---|---|
| | | Development Corporation and Swiss Red Cross Water-Sanitation project | | |
| Shaikh Tareq Arafat | B.Sc. in Fisheries and Marine Technology | Volunteer Interpreter for BCDP Dolphin Exhibition | Data analyst and research coordinator | M.Sc. student, Khulna University, Bangladesh. |
| Muhammad Abiar Rahman | B.Sc. in Fisheries and Marine Technology | Volunteer for BCDP ecological investigations in the proposed sanctuaries | Fisheries Investigation Leader | M.Sc. student, Khulna University, Bangladesh |
| Shaikh Shahidul Islam | Masters of Developmental Studies | Volunteer for BCDP ecological investigations in the proposed sanctuaries | Data Analyst and Socio-Economic Investigation Coordinator | Monitoring and documentation officer at Jatrata Juba Sangstha (JJS) |
| Md. Rafiqul Islam | B.Sc. in Environmental Science Post graduate diploma in Disaster Management | Research assistant for NGO Prodiplan Volunteer for BCDP | Local Communication Coordinator | M.Sc. student, Environmental Science, Khulna University, Bangladesh |
| Razib Chandra | M.Sc. in Zoology | Volunteer for | Taxonomic | M.Phil. thesis |

| Bhowmick | (Parasitology) | BCDP | Expert | work |
|-----------------|---|---|--------------------------------------|---|
| Delip Kumar Das | M.Sc. in Zoology (Wildlife ecology, management and conservation biology) | Research Officer for Spoon-billed Sandpiper hunting mitigation project, Bangladesh Volunteer Interpreter for BCDP Dolphin Exhibition Volunteer for BCDP ecological investigations in the proposed sanctuaries | Field Work and Logistics Coordinator | M.Sc. student, Bio-informatics, University of Mumbai, India |

2. Aim and objectives

The main aim of this project was to identify the human elements which need to be considered to ensure the sustainable use of aquatic resources in the proposed wildlife sanctuaries of the Sundarbans, Bangladesh. The objectives of the study are:

- Estimating the contribution of fisheries to the local livelihood and economy.
 - Documenting the number of people involved in fishing with dolphin entangling gears.
 - Assessing the percentage of monthly income from fisheries among the fishermen and fish traders.

- Evaluating the fish market chain prevalent in the study areas.
- Understanding the management structure governing the aquatic resources.
 - Understanding the present management policies.
 - Documenting the perceptions of aquatic resource managers regarding the conservation of dolphins.
- Understanding the socio-economic status of the people engaged in fishing with dolphin entangling gears.
 - Documenting their income and literacy levels.
 - Identifying their alternate income generating options.
 - Understanding their perception regarding the needs of river dolphins.
- Assessing the catch-per-unit effort (CPUE) of dolphin entangling gears.
 - Identifying the fish and crustacean species caught.
 - Assessing the market value of the fish caught in those gears and income from each effort of the fishermen.
- Identifying the less destructive method of collecting shrimp larvae.
 - Comparing the by-catch rates of two commonly used shrimp larvae collecting gears and identify the less destructive option of harvesting crustacean larvae from the wild.
- Strengthening the capacity of the team members and the local communities.

3. Methodology

3.1 Planning

All team members met with the staff of the BCDP to identify the objectives of this study. They then jointly developed plans for the field work required. Datasheets and standardized questionnaires were developed in consultation with the BCDP researchers.

3.2 Training

A reconnaissance trip accompanied by the BCDP's principal researcher and project coordinator was conducted in August 2010 when the team visited the study areas. During this trip the team members received the necessary training to carry out the research. In the field the methodology was assessed and adapted as necessary.

3.3 Field work

Field work was conducted in four sessions between August and December 2010 to collect data during the wet/monsoon (4th to 15th August and 15th to 23rd September) and dry (2nd to 13th December and 15th to 27th December) season in the proposed wildlife sanctuaries.

3.3.1 Estimating the contribution of fisheries in local livelihood and socio-economic status of the fishing communities

Identification of the socio-economic status and contribution of fisheries to monthly income of 78 fishermen actively engaged in fishing with gill nets, long lines and set bag nets (nets known to have accidental dolphin entanglements) in the proposed wildlife sanctuaries were done through standardized interviews (50 gill nets, 13 long lines and 15 set bag net users). General attitudes of fishermen towards dolphins were also recorded through these interview surveys. Documentation of entanglement of dolphin in their gear was also recorded from the interview surveys. Similar surveys were conducted among 39 fish traders engaged in fish trading in and around the proposed sanctuaries to identify their socio-economic status, dependency on aquatic resources from these river segments and the prevalent fish supply and market chain.

Conducting gear census in the segments allowed the team to record the total number of deployed fishing gear and the number of fishermen involved in it. This census was conducted 4 times (day time incoming tide, day time outgoing tide, night time incoming tide, night time outgoing tide) in each of the proposed sanctuaries in each season (monsoon and dry). This survey also allowed the team to document the involvement of women in the fishing activities.

3.3.2 Assessing the CPUE of fishing gears known for dolphin entanglement

Fish and crustaceans caught with gill nets and long lines were identified and the total weight and median length of each species were documented. The team recorded the catch from 56 drifting gill nets and 6 long lines and calculated the CPUE based on these catches. The economic value of each catch was estimated with the help of the current market value of each species caught, as identified by the fishermen and the fish traders. Generally the fishermen sell their fish to the fish trader, so the identified market value of the fish species by the fishermen was considered as the buying rate of the fish collectors.

3.3.3 Investigating sustainable method for collecting shrimp larvae inside the Sundarbans

The catches from 56 post-larvae set bag nets (PLSBN) and 26 post larvae box nets (PLBN) were analyzed. Each catch were taken in to a bowl and 20 liters of water was added to that. 2.5-5% was taken from that 20 liters by using smaller mugs (the mugs had marks of 500 ml and 250 ml) and the number of target and non-target species in that portion was calculated. Large number of by-catch (several thousand often) restricted the team from analyzing the total catch from those nets. Assistance from local skilled fishermen enabled the team to identify the target and non-target species more accurately. Separation of dead and alive non-target species was done through visual confirmation by the same fishermen. The total by-catch and by-catch mortality was estimated from that sample.

3.3.4 Strengthening the capacity of the team members and local communities

The capacity of the team members and the local communities were increased through the field works and disseminating the educational outreach materials among them. Also a workshop was conducted initially to introduce the team members to the techniques which were taught to one of the team members during the CLP training.

3.4 Analyses

Collected data were digitized and analyzed using available Microsoft Office Excel and was used for preparation of this report. Literatures from BCDP of WCS helped the team to identify different baseline information from the study area as well as the local WCS personnel were consulted during the preparation of the final report.

4. Outputs and results

4.1 Number of gears and people involved in fisheries

Deployment of dolphin entangling gears is significantly higher during the wet season (Figure 3) than during the dry season (Figure 5). It was found that drifting gill nets were more used during the wet season which requires more man power resulting in increasing the number of people involved in fishing with entangling gear during that season (Figure 4) than the dry (Figure 6).

Figure 3: Number of active fishing gears in the hotspot segments during the wet season

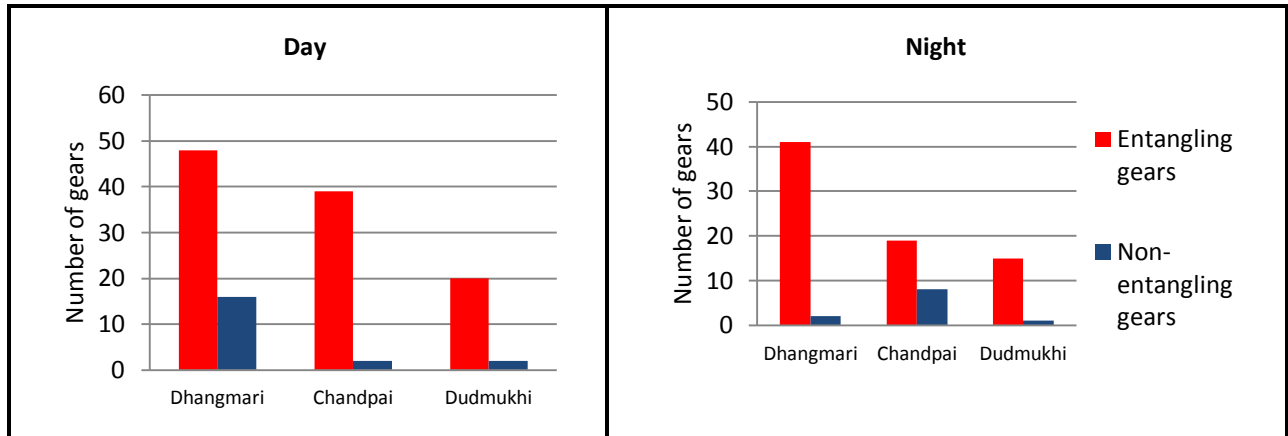


Figure 4: Number of active fishermen in the hotspot segments during the wet season

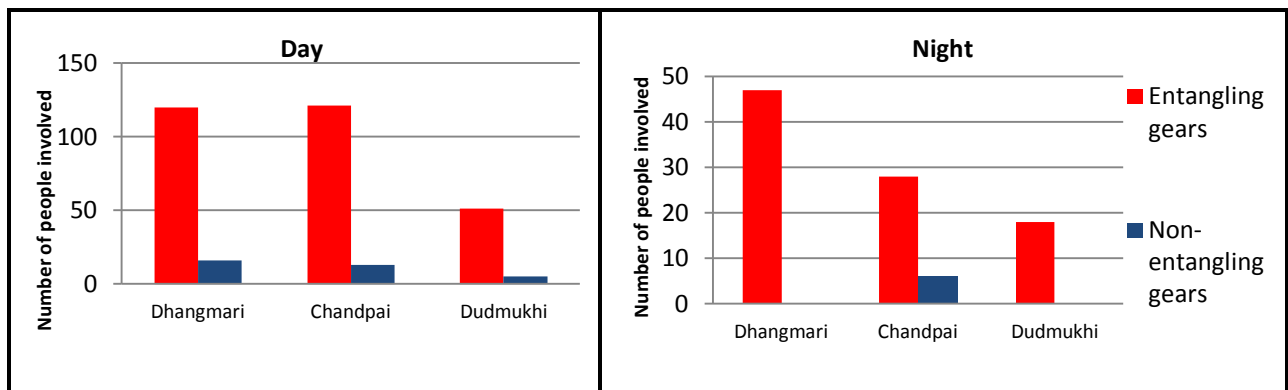


Figure 5: Number of active gears in the hotspot segments during the dry season

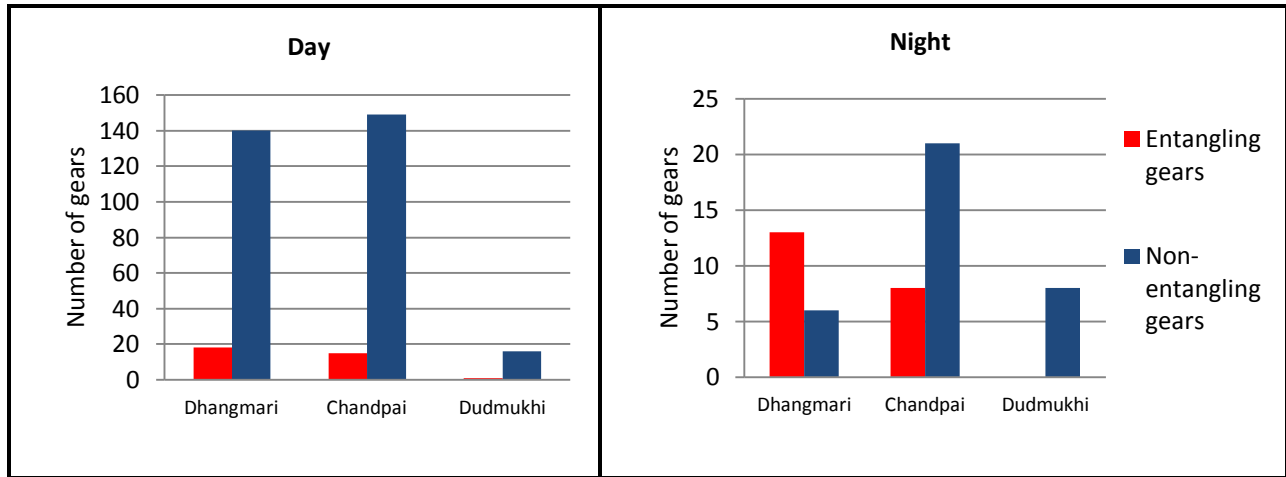
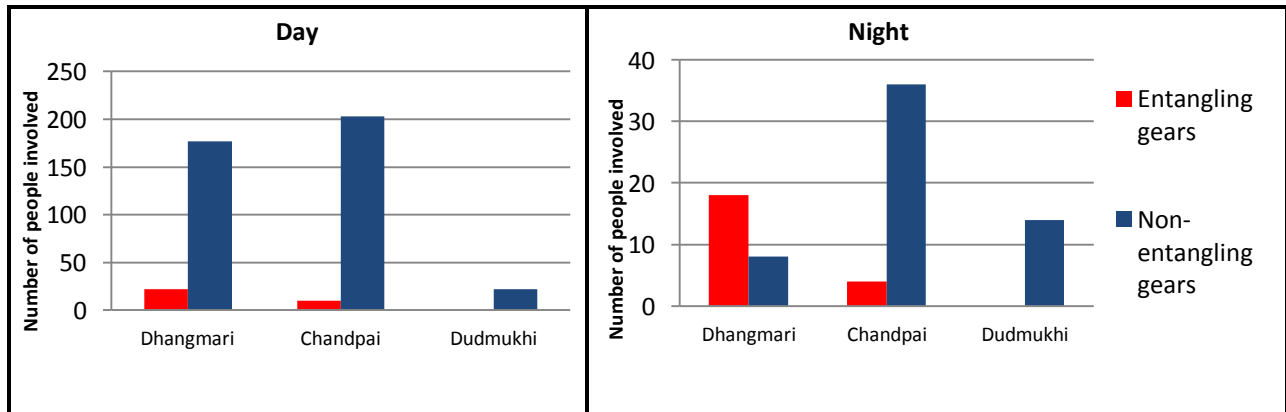


Figure 6: Number of active fishermen in the segments during the dry season



4.2 Socio-economic status of the fishermen and contribution of fisheries in their livelihood

82% of the interviewed fishermen had not completed their 5 years of primary education (Figure 7) and it was seen that education level of the interviewed fishermen had a strong relationship with their average monthly income (Figure 8).

Figure 7: Literacy level of fishermen

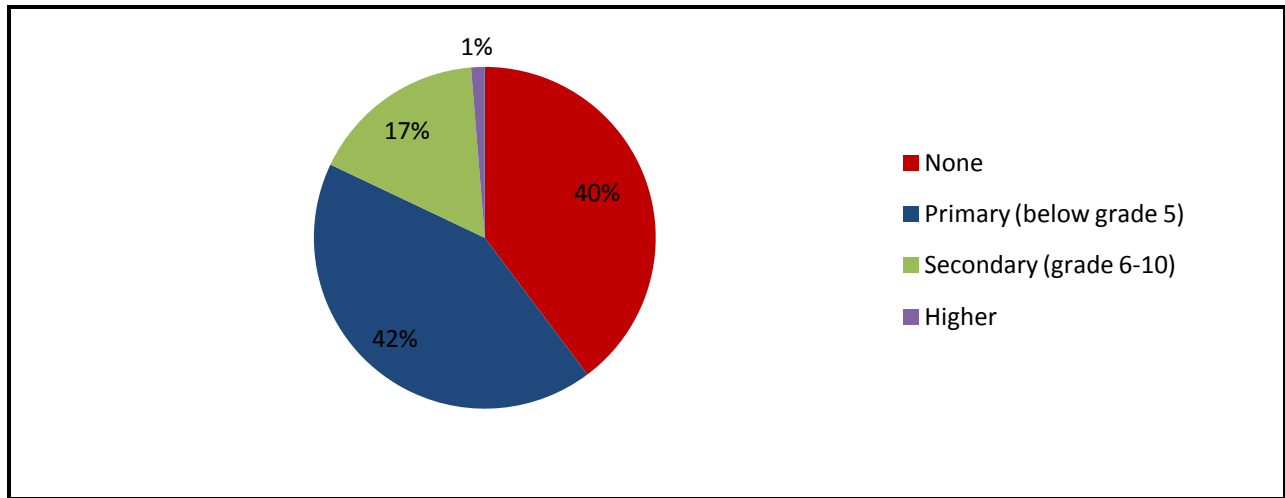
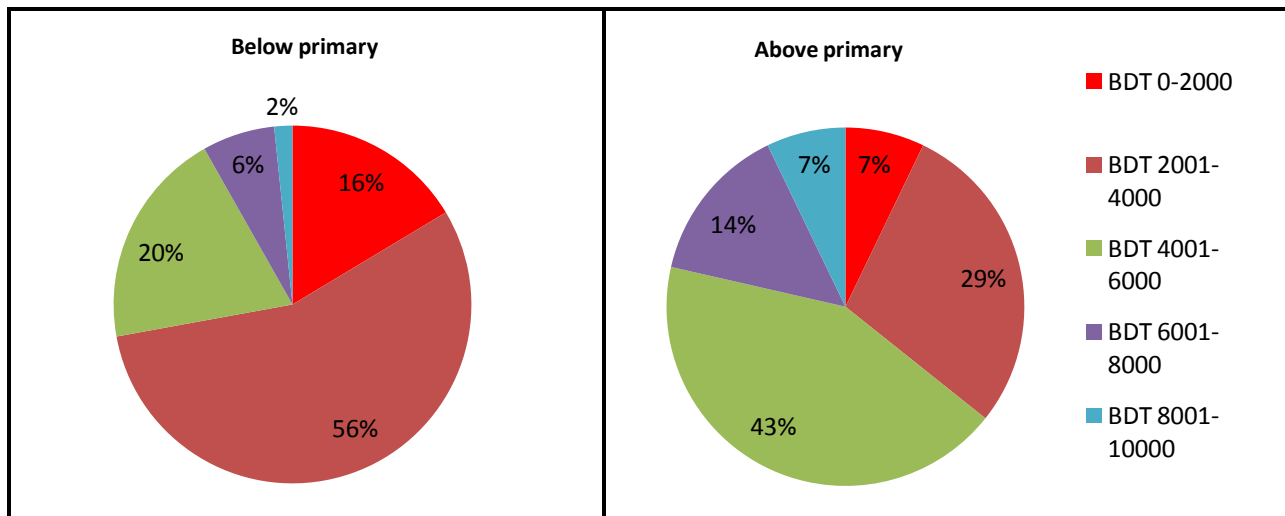


Figure 8: Average monthly income of the fishermen in compare to their education level



Similar surveys among the fish traders also revealed that 61% of the interviewed fish traders had not completed their 5 years of primary education (Figure 9) and similar to the fishermen, their average monthly income also varied according to their educational background (Figure 10).

Figure 9: Literacy level of fish traders

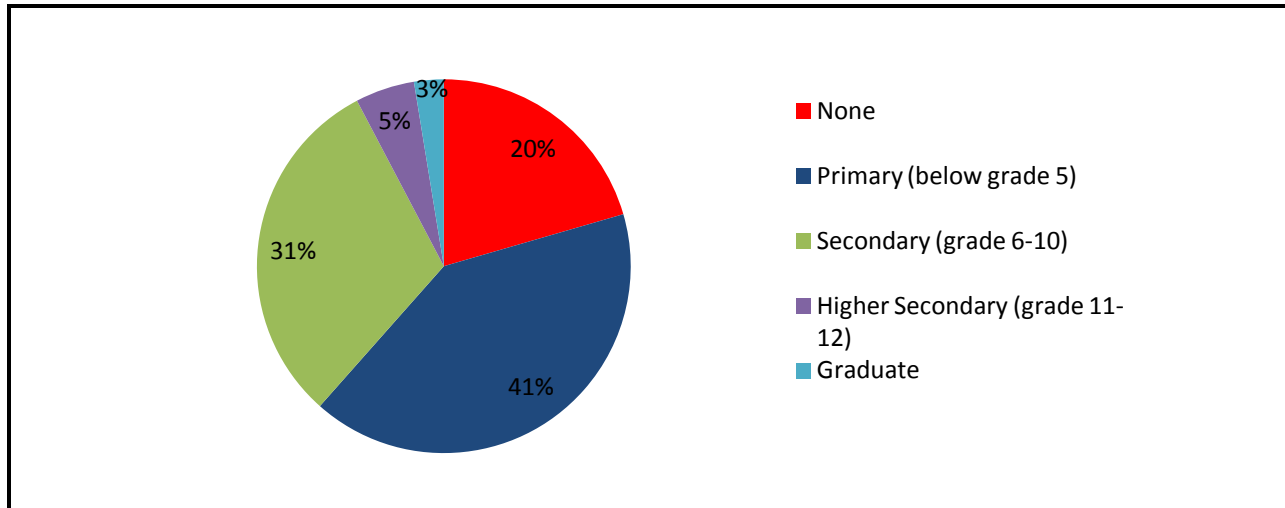
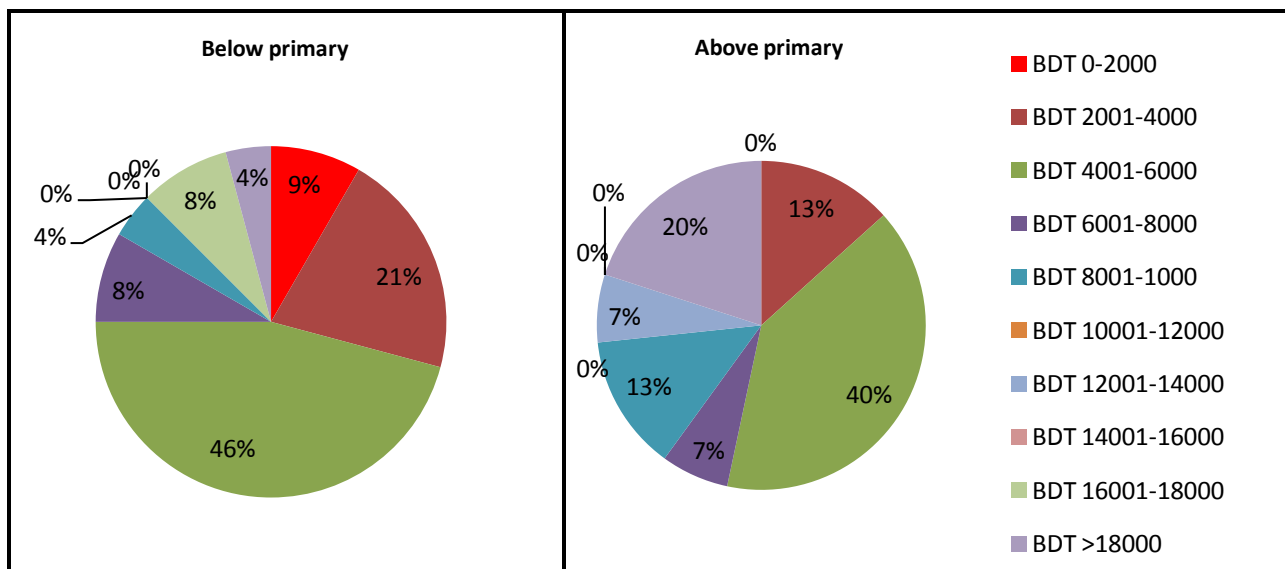


Figure 10: Average monthly income of the fish traders in compare to their education level



Fisheries, both direct and trading has the largest contribution among the interviewed fishermen or fish trader’s monthly income. They almost fully depend on fisheries especially during the wet season (Table 1).

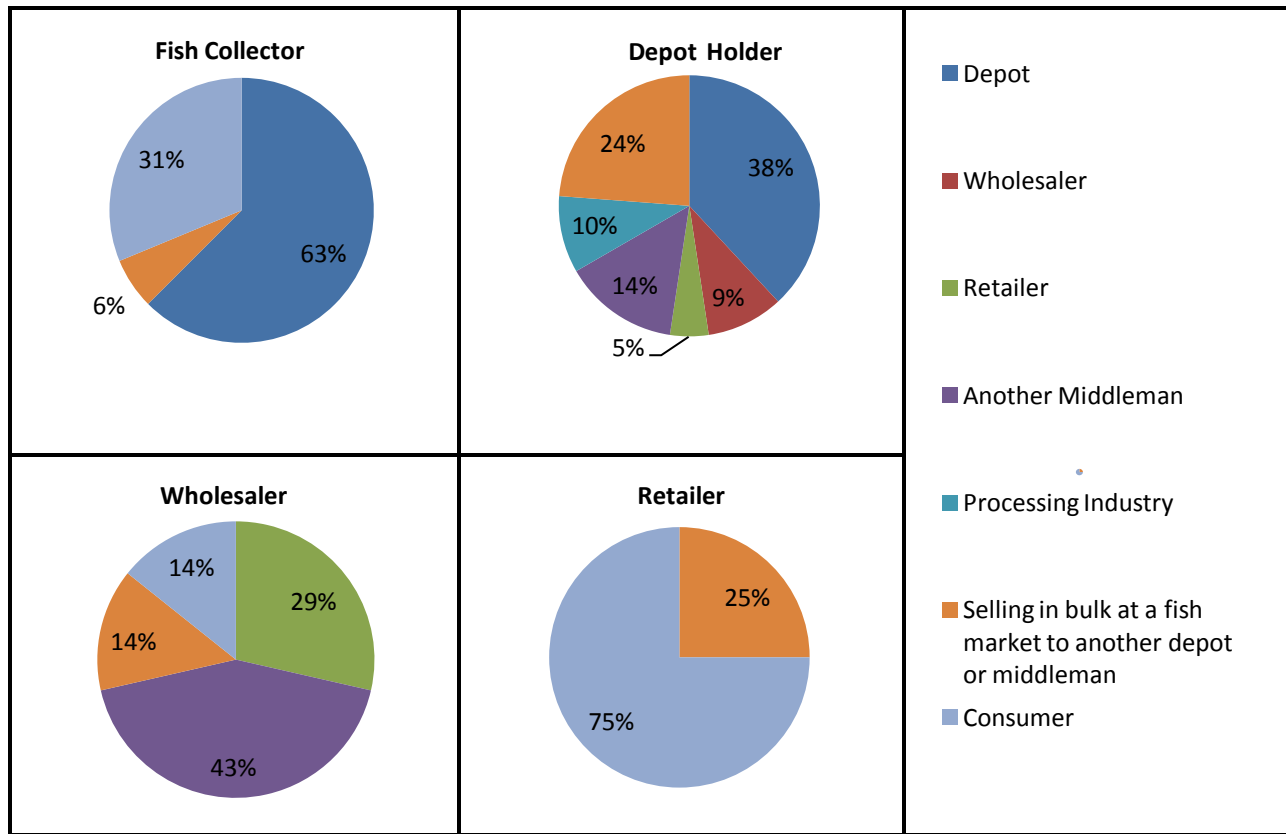
Table 1: Percentage of income from fisheries

| | Dry season (December - March) | Pre-monsoon season (April – May) | Monsoon season (June - September) | Post monsoon season (October – November) |
|--|--|---|--|---|
| Percentage of fishermen's income from fisheries | 73.8 | 76.5 | 99.9 | 74.1 |
| Percentage of fish trader's income from fisheries | 96.4 | 92.6 | 99.0 | 86.2 |

4.3 Prevailing fish market chain

Four types of fish traders (fish collector, depot holder, wholesaler and retailer) were identified in the 5 markets (Mongla, Digraj, Baniashanta, Chandpai, Pathorghata) examined close to the proposed wildlife sanctuaries. Fish collectors gather and buy the catch directly from the fishermen in the location or in the local markets and 63% sell it to a depot, take the fish to the weekly market in the close-by villages (6%) or sell to consumers directly (31%). 38% of depot holders sell the produce to another depot. The wholesalers mostly sell the fish they have purchased from fishermen or depot to other middlemen (43%), while 75% of the retailers sell the fish directly to the consumers. Figure 11 shows the different fish selling channels of these fish traders.

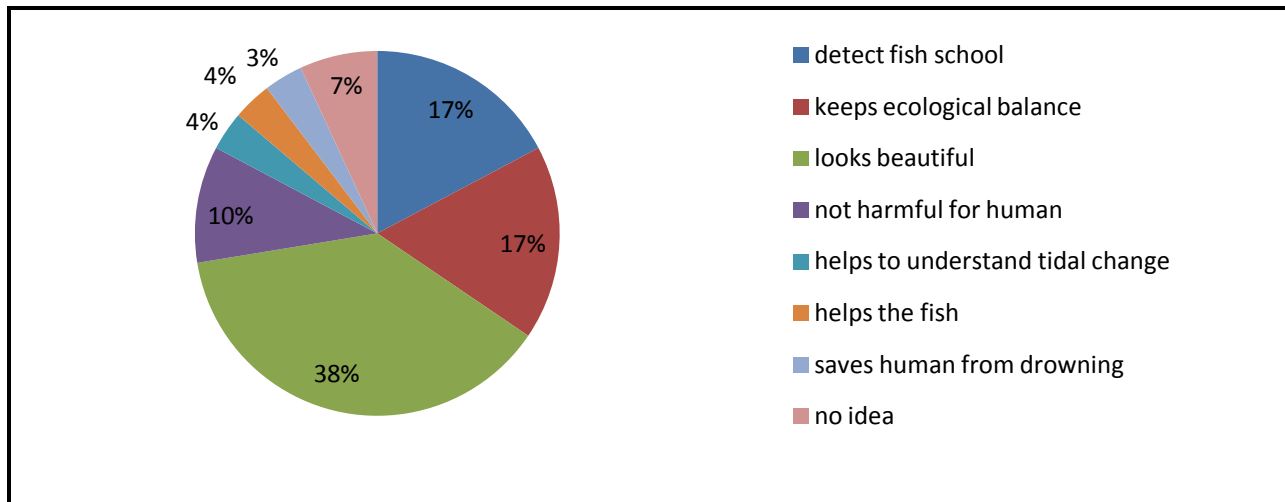
Figure 11: Fish market chain



4.4 Perceptions of local people regarding dolphins and reported dolphin entanglements

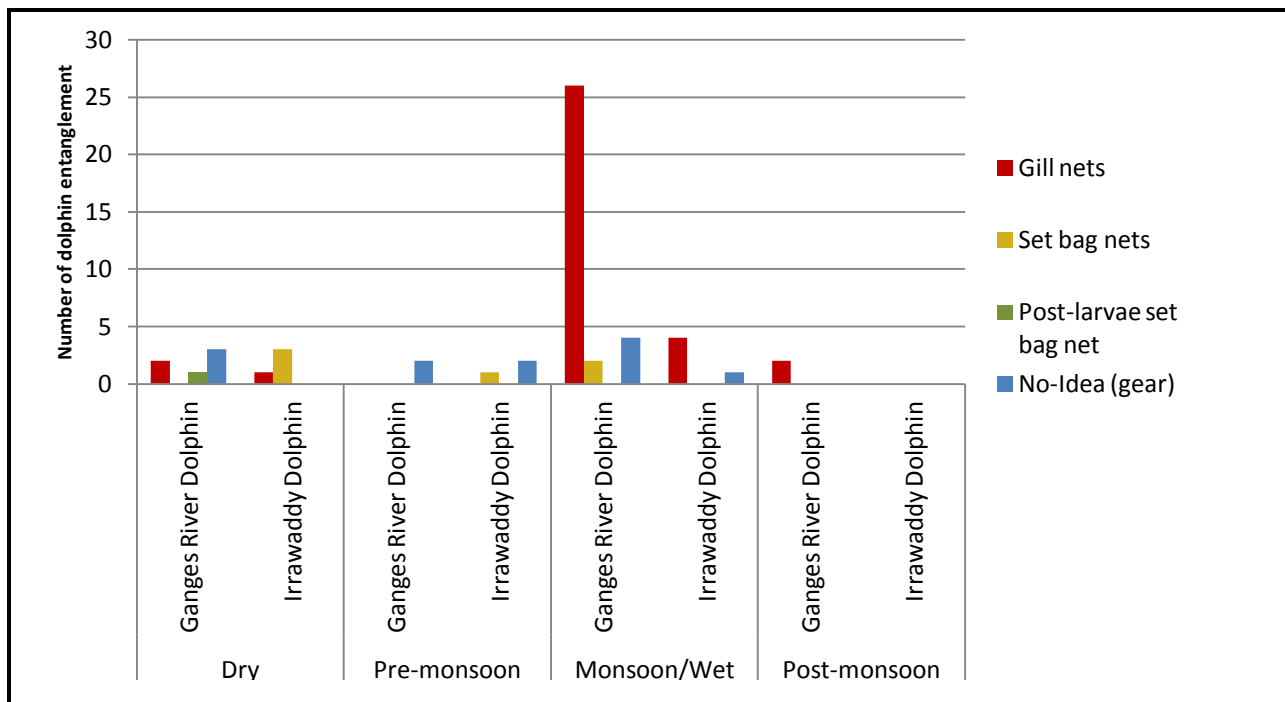
In general the interviewed fishermen had positive attitude towards the presence of dolphins in the rivers and almost three-fourth of them believed that dolphins are important for the rivers; thereof 34% mentioned that presence of dolphins help to keep ecological balance or to detect fish schools (Figure 12).

Figure 12: Perceived importance of dolphins in the rivers



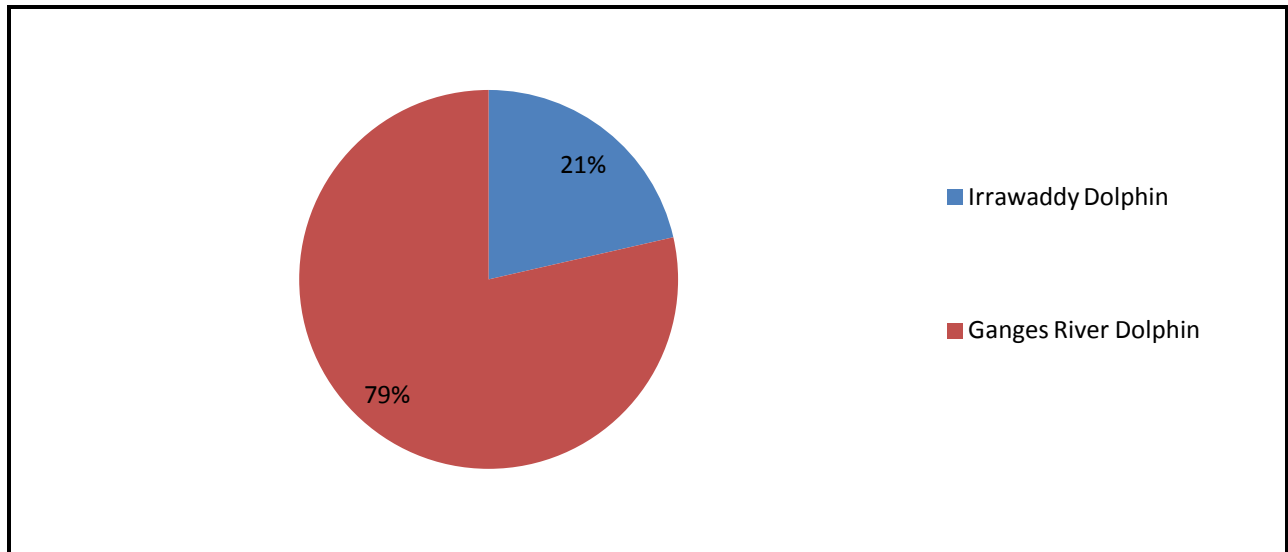
It was seen earlier that the deployment of dolphin entangling gears is significantly higher during the wet season (Figure 3 and Figure 4) than during the dry season (Figure 5 and Figure 6). That is also reflected on the reported dolphin entanglements as 54% of the entanglements reported by the interviewed fishermen took place during the wet season and from gill nets (Figure 13).

Figure 13: Reported dolphin entanglements according to gears and seasons



Reports of Ganges river dolphin getting entangled in the fishing gears were more common during the interview surveys than Irrawaddy dolphin (Figure 14). This shows the presence larger Ganges river dolphin population in the study area than Irrawaddy dolphin. But change of different environmental parameters due to climatic change may change that scenario in future.

Figure 14: Reported dolphin entanglements



It was also found during the interview surveys that during most of those dolphin entanglement cases, the animal died (Figure 15) and the carcass was thrown in to the river (Figure 16).

Figure 15: Reported fate of the entangled dolphins

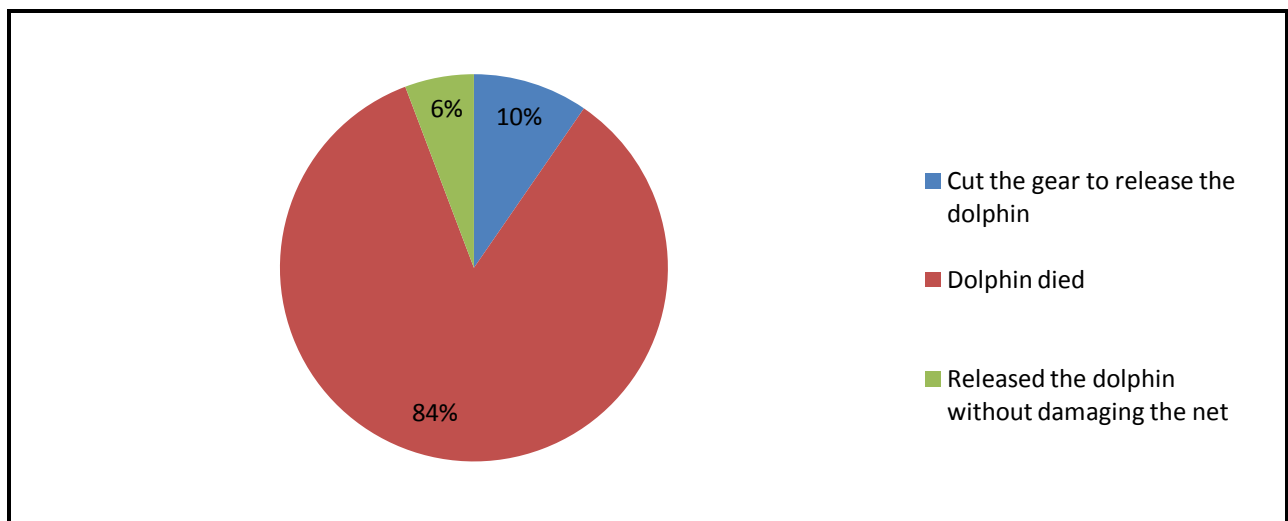
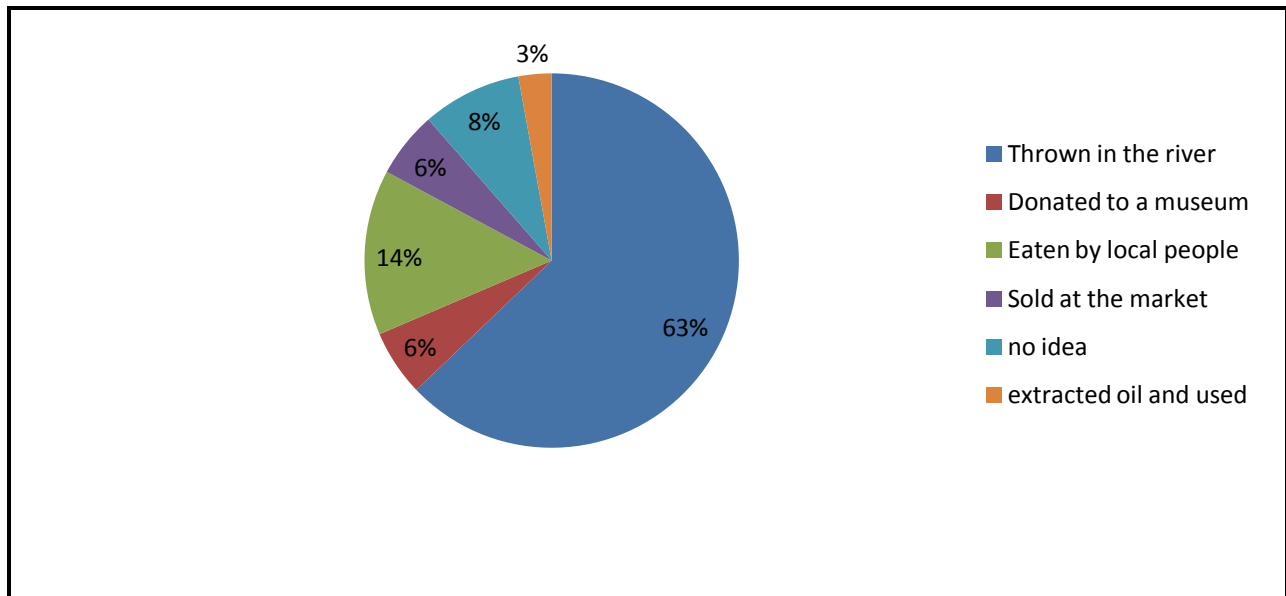


Figure 16: Reported fate of the dolphin carcasses

4.5 Catch per unit effort (CPUE) of the focused fishing gears

The catch from 56 gill nets and 6 long lines deployed within the proposed wildlife sanctuaries were analyzed. The number of deployed long lines was very low in these river segments (27 times observed during the gear census but many of those occasions were during night and the team failed to analyze their catch). Evaluation of these catch confirms that the economic value of the yield from gill nets is relatively higher than long lines (Table 2 and Table 3).

Table 2: Weight, economic value and catch per unit effort (CPUE) for gill nets in proposed wildlife sanctuaries

| Location | Soak duration or effort (hours) | Total catch (number of fish and crustacean) | Total catch weight (gm) | Total economic value (BDT) | CPUE (gm/hour) | Economic value to the fishermen (BDT/hour) |
|-----------|---------------------------------|---|-------------------------|----------------------------|----------------|--|
| Dhangmari | 36.25 | 424 | 12613 | 946 | 348 | 29 |
| Chandpai | 67.33 | 30 | 17916 | 4741 | 266 | 70 |
| Dudmukhi | 32.25 | 41 | 28703 | 7731 | 890 | 240 |

Table 3: Weight, economic value and catch per unit effort (CPUE) for long lines in proposed wildlife sanctuaries

| Location | Soak duration or effort (hours) | Total catch (number of fish and crustacean) | Total catch weight (gm) | Total economic value (BDT) | CPUE(gm/hour) | Economic value to the fishermen (BDT/hour) |
|-----------|---------------------------------|---|-------------------------|----------------------------|---------------|--|
| Dhangmari | 3.50 | 45 | 1531 | 88 | 437 | 25 |
| Chandpai | 33.00 | 21 | 3274 | 204 | 99 | 6 |
| Dudmukhi | - | - | - | - | - | - |

*No long line fishermen were found in the proposed Dudmukhi wildlife sanctuary

4.6 Shrimp larvae collection and the by-catch rate

Shrimp larvae are mainly collected during the dry season and the team investigated catches from both post-larvae set bag net (PLSBN) and post-larvae box net (PLBN). It was found that both gear types have over 99% by-catch (Table 4), with PLSBN having a lower percentage of dead by-catch (Table 5) in compare to PLBN.

Table 4: Comparison of by-catch from post larvae set bag nets and box nets

| Gear Type | By-catch (%) | | |
|-----------|--------------|---------|---------|
| | Minimum | Maximum | Average |
| PLSBN | 98.73 | 100 | 99.69 |
| PLBN | 99.00 | 100 | 99.86 |

Table 5: Comparison of dead by-catch percentage in the post-larvae nets

| Gear Type | Dead by-catch (%) | | |
|-----------|-------------------|---------|---------|
| | Minimum | Maximum | Average |
| PLSBN | 4 | 88 | 53 |
| PLBN | 45 | 97 | 73 |

A significantly high percentage of women and children were seen collecting shrimp larvae using post-larvae hand drag nets (PLHDN), whereas most of the PLSBN and PLBN were attended by male fishermen (Table 6).

Table 6: Women and children involved in collection of post-larvae

| Gear Type | Total Fishermen | No. of Women | No. of Children | % of Women and Children |
|-----------|-----------------|--------------|-----------------|-------------------------|
| PLHDN | 47 | 30 | 4 | 72.3 |
| PLSBN | 143 | 2 | 0 | 1.4 |
| PLBN | 8 | 0 | 0 | 0 |

4.7 Strengthening the capacity of the team members and the local communities

The initial workshop among the team members to introduce them with the techniques learned during the CLP training had increased their capacity significantly and they were involved greatly

afterwards to finish the assignments given by the CLP facilitators. The survey conducted during the study period also increased their capacity in the field of conservation as they were directly involved during the research and also took significant roles during the analyses and report writing. The educational outreach materials were disseminated among the local communities which had increased their knowledge on the cetacean diversity of Bangladesh as well as the threats and the conservation efforts.

5. Achievements and impacts

Major insights gained through this project include:

- The income of fishermen using dolphin entangling gear appears directly related to their level of education. Fishermen without primary level education earn below 4000 Taka per month, with generally increasing income for those having completed primary and secondary school.
- Most fishermen believe that dolphins are important for the health of riverine ecosystems. Many believe that the dolphins indicate the presence of fish schools and more than one-third of the interviewed fishermen appreciate the dolphins for their beauty.
- In the existing fish market chain multiple middlemen earn most financial benefits. Fishermen receive a very low price for all fish species caught.
- More than half of the interviewed fishermen do not have any other source of income. Among the fishermen with a secondary occupation, the majority was engaged in day labor and work in the agricultural sector .
- Both PLSBN and PLBN had significantly high by-catch. The different gear deployment locations resulted in variations of the average by-catch mortality rate (near shore for PLSBN vs. mid-river for PLBN).
- This study had increased the capacity of the team members in the field of conservation and motivated them to stay engaged in wildlife conservation. The team leader has successfully applied for an internship with the Wildlife Conservation Society's Bangladesh Cetacean Diversity Project to further strengthen his capacity in this field.

6. Conclusion

The fishing communities surrounding the proposed wildlife sanctuaries engage in unsustainable fishing practices which potentially could lead to the extinction of the only two remaining freshwater dolphin species of South Asia. Challenges for conserving these species from extinction are increased due to the predominant low income of the fishermen as selling an entangled dolphin sometimes is more economically beneficial than damaging their nets and releasing the animal which may cause them not earning anything that day.

Gill nets generate higher income compared to sustainable gear types, which explains their extensive use in the study areas. Efforts must be undertaken to promote sustainable fishing techniques which generate same or higher economical benefits for fishermen.

The high by-catch rate from the shrimp fry collecting nets leads to lowering dolphin prey density and have severe impact on the dolphin population. The CLP team along with the BCDP has proposed the government of Bangladesh to strictly prohibit the use of such gears inside the proposed sanctuaries as well as other areas.

In general the interviewed fishermen have positive attitude towards the presence of dolphins in the rivers and believe that the dolphins are necessary for the river. This provides a firm platform for the team to promote sustainable use of the aquatic resources and conserve the remaining two freshwater cetaceans of South Asia.

Recommendations based on this study to be included in an effective, science-based and community informed management plan for the proposed wildlife sanctuaries include:

- As it is seen from the study, gill nets act as a serious threat to the freshwater cetaceans present in the study area, it is recommended to ban the use of gill nets and other dolphin entangling gears inside the proposed wildlife sanctuaries. The interview surveys showed that the fishermen believe that developing alternative income sources like agricultural activities, working in different industrial plants and working as day labour can provide them similar monthly income as they currently have.

- Further studies should be conducted to assess the by-catch of post-larvae hand drag net (PLHDN) and check if that can be used inside the proposed sanctuaries and strictly enforce the ban on PLSBN to conserve the fish diversity in the areas.
- Encourage the local communities to ensure minimum primary level of education to the children to have higher income levels.
- Conduct educational outreach activities to ensure the understanding of local communities of legal protection of dolphins and highlight the gravity of offence from trading dolphins or any parts of it as it was observed in some occasions that the fishermen were selling the dolphin carcass at the local market or extracting the oil and using it.
- Support developments for alternative income generating activities for the local people to reduce the pressure from aquatic resources especially during the monsoon season when the use of dolphin entangling gears is significantly higher. Dolphin friendly tourism can be encouraged among the local people as an alternative livelihood generating option.
- Conduct further studies to see the impact of seasonal or gear closures in the areas to reduce the pressure on aquatic resources.

The implementation of the above mentioned recommendations within the proposed wildlife sanctuaries will effect over 100 fishermen, who catch fish daily in this area during the monsoon currently using gill nets and long lines as well as many families who are involved in catching shrimp fry using PLSBN or PLBN mostly during dry season. To ensure compliance with the proposed regulations, alternative income generating opportunities need to be found for these fishermen.

A management plan for protecting the threatened freshwater dolphins in the Bangladesh Sundarbans must also to take into account the urgent needs for improved livelihoods for the fishing communities living in close proximity to the proposed sanctuaries. Ensuring their well-being will strengthen their willingness to save dolphins as well as other threatened wildlife and habitat.

7. Problems encountered and lessons learned

Some of the major problems encountered and important lessons learnt during this study are:

- Calculating the actual earnings of fishermen in the different seasons was difficult because fishermen sometimes could not provide specific amounts.
- To obtain more accurate information on the CPUE of different gears and on the by-catch rates of different shrimp larvae collecting nets field work needs to cover a complete lunar cycle. Limited funding did not allow for this.
- Coordination among the seven team members was challenging due to varying university exam schedules and related obligations. Most of the team members are currently holding full time positions, which limit time for further collaboration and hinders the team from applying for the CLP follow-up award.

8. Future activities

Some team members hope to continue their engagement with the BCDP and propose the following activities be carried out:

- Develop an effective mortality monitoring system for freshwater dolphins within the Sundarbans Reserved Forest.
- Incorporate the information gathered on the fishing communities and the fish market chain in the BCDP educational outreach activities.
- Provide this report to organizations and government agencies involved in conservation of the Sundarbans in support of science-based, community informed management plans. A copy of the report will also be sent to the Forest department who will be responsible for developing and implementing the management plan with the assistance from BCDP.
- Attempt to publish this study in an international peer-reviewed journal, thereby sharing the gained insight and provide assistance for further studies in this field.

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10. Distribution list

- Forest Department, Bangladesh.
- Fisheries Department, Bangladesh.
- Wildlife Conservation Society, Bangladesh.
- Wildlife Trust of Bangladesh.
- Other national NGO's working in the field of conservation in Bangladesh.
- Universities with whom WCS, Bangladesh is planning to collaborate.

Appendix 1: Datasheets and questionnaires

1.1 Questionnaire for fishermen in the proposed wildlife sanctuaries

| | | | | | | |
|----------------------|---------------------|----------------------|-----|------------------|-----------------------|-------|
| Date | Boat Code (fishing) | Date | WP | Time | Location of Interview | Seg # |
| | | | GPS | | | |
| Name of interviewer1 | | Name of interviewer2 | | No. of fisherman | Gear Types | |

Socio-economic questions for all fishermen and fish traders

| | Owner | Employee 1 | Employee 2 | Employee 3 |
|---------------------------------|-------|------------|------------|------------|
| Name | | | | |
| Village | | | | |
| Union | | | | |
| Thana | | | | |
| District | | | | |
| Sex (Male/Female) | | | | |
| Job | | | | |
| Age | | | | |
| Marital status (Single/Married) | | | | |
| Religion | | | | |

| | | | | | | |
|---|----|-----|----|-----|----|-----|
| Literacy (None/Primary/Secondary/Other) | | | | | | |
| Number of children | M= | F = | M= | F = | M= | F = |
| Number of children enrolled in school | M= | F = | M= | F = | M= | F = |
| Number of children left school | M= | F = | M= | F = | M= | F = |
| Cause of leaving school | | | | | | |

| | Owner | | | | Employee 1 | | | | Employee 2 | | | | Employee 3 | | | |
|-------------------------------|-------|-----|---|-----|------------|-----|---|-----|------------|-----|---|-----|------------|-----|---|-----|
| | D | PRM | M | PSM | D | PRM | M | PSM | D | PRM | M | PSM | D | PRM | M | PSM |
| Monthly income from fisheries | | | | | | | | | | | | | | | | |
| % income from fisheries | | | | | | | | | | | | | | | | |

| | | | | |
|---|--|--|--|--|
| Do you have another occupation other than fishing/fish trading? | | | | |
| If yes, What is your second occupation? | | | | |
| How much land do you own? | | | | |
| What is your land used for? | | | | |
| How does your wife contribute to your families earnings? | | | | |
| Other earning member | | | | |
| Occupation and income(other earning member) | | | | |

Questions about cetacean entanglement (Crew 1)

| Cetaceans caught in net/seen | # of incidence | # of individuals | Gear type(s) | Season(s) | Year | Location(s) | Response | Animal Saved? | Carcass? |
|------------------------------|----------------|------------------|--------------|-----------|------|-------------|----------|---------------|----------|
| Shushuk | | | | | | | | | |
| Irrawaddy, | | | | | | | | | |
| Finless porpoise | | | | | | | | | |
| Other..... | | | | | | | | | |

Questions about cetacean entanglement (Crew 2)

| Cetaceans caught in net/seen | # of incidence | # of individuals | Gear type(s) | Season(s) | Year | Location(s) | Response | Animal Saved? | Carcass? |
|------------------------------|----------------|------------------|--------------|-----------|------|-------------|----------|---------------|----------|
| Shushuk | | | | | | | | | |
| Irrawaddy, | | | | | | | | | |
| Finless porpoise | | | | | | | | | |
| Other..... | | | | | | | | | |

Questions about cetacean entanglement (Crew 3)

| Cetaceans caught in net/seen | # of incidence | # of individuals | Gear type(s) | Season(s) | Year | Location(s) | Response | Animal Saved? | Carcass? |
|------------------------------|----------------|------------------|--------------|-----------|------|-------------|----------|---------------|----------|
| Shushuk | | | | | | | | | |
| Irrawaddy, | | | | | | | | | |
| Finless porpoise | | | | | | | | | |
| Other..... | | | | | | | | | |

Questions about cetacean entanglement (Crew 4)

| Cetaceans caught in net/seen | # of incidence | # of individuals | Gear type(s) | Season(s) | Year | Location(s) | Response | Animal Saved? | Carcass? |
|------------------------------|----------------|------------------|--------------|-----------|------|-------------|----------|---------------|----------|
| Shushuk | | | | | | | | | |
| Irrawaddy, | | | | | | | | | |
| Finless porpoise | | | | | | | | | |
| Other..... | | | | | | | | | |

Questions about socio-economics of fishery (captain/headman of fishing vessel)

| | | | | | | | | | |
|---|---------------------------------|---|---|---|--|---|--|--|--|
| How much fish (percentage of fish catch) do you consume per day in sundarbans? Ans: | | Do you think the price of fish is fair? <input type="checkbox"/> Y <input type="checkbox"/> N | | Do you <input type="checkbox"/> Receive a fixed price ? <input type="checkbox"/> Negotiate with buyer? <input type="checkbox"/> Others?..... | | Where do you sell your fish? Whom do you sell your fish? | | <input type="checkbox"/> Do you pay your crew a salary? <input type="checkbox"/> Share of fish? <input type="checkbox"/> Others..... | |
| Do you pay a permission fee to fish in the sundarbans? <input type="checkbox"/> Y <input type="checkbox"/> N | How long does your permit last? | How much do you pay to fd when submit the permission? | How much do you pay to other fd/station when fishing in sundarbans? | What area does your permit not allow you to fish? | What types of gear does your permit allow? | Are there any other restrictions on your permit? | | | |
| How much do you pay for permission? | | | | | | | | | |

| | |
|---|--|
| Are you associated with any club/NGO/organization/society/cooperative? <input type="checkbox"/> Y <input type="checkbox"/> N | |
| If you are associated with any club/NGO/organization/society/cooperative, give the name, goal, purpose, benefits, extent of involvement and state whether or not this association has resulted in an improvement of your livelihood? Name: _____ related info: _____ | |

If fishing is banned, are there any alternative income generating activity(s) that can improve your livelihood? Y N

If yes, specify.....

Questions about conservation perceptions (captain/ headman of the fishing vessel)

| | | | |
|--|---|--|---|
| Do you think we need dolphins in our waters? Why? | | | |
| Do you think the number of dolphin is changing in the rivers? | | | |
| Would Seasonal Fishing Closure (SFC) improve fish catch by protecting breeding stock? <input type="checkbox"/> Y <input type="checkbox"/> N Others..... | Would a Seasonal Fishing Closure (SFC) improve dolphin survival? <input type="checkbox"/> Y <input type="checkbox"/> N Others..... | Would Area Fishing Closure (AFC) improve fish catch by protecting breeding stock? <input type="checkbox"/> Y <input type="checkbox"/> N Others..... | Would Area Fishing Closure (AFC) improve the survival of dolphins? <input type="checkbox"/> Y <input type="checkbox"/> N Others..... |
| What season? | What season? | What area? | What area? |
| Would fishing gear modifications reduce dolphin entanglement? <input type="checkbox"/> Y <input type="checkbox"/> N Others..... | What gears? | What modifications? | How would these modifications affect fish catch? |

Questions about target fish and crustacean species (captain/ headman of fishing vessel)

| | | | | |
|-------------------------------|-------|-----|---|-----|
| Seasons caught | Dry/W | PRM | M | PSM |
| Gear Type | | | | |
| Local name of target species | | | | |
| Locations were fish is caught | | | | |
| Average daily catch in season | | | | |
| Market location | | | | |
| To whom you sale your fishes | | | | |

CODES

Seasons: **PRM** = pre monsoon (Apr-May), **M** = monsoon (Jun-Sep); **PSM** = post monsoon (Oct-Nov); **W** = winter (Dec-Mar); **Environment:** **MCL** = mid-channel large (>200m wide); **SCL** = side-channel large; **MCS** = mid-channel small (≤200m wide); **SLS** = side-channel small

1.2 Questionnaire for fish traders in the proposed wildlife sanctuaries

| | | | | | | |
|----------------------|---------------------|----------------------|-----|------------------|-------------------------------|-------|
| Date | Boat Code (fishing) | Date | WP | Time | Location of Interview | Seg # |
| | | | GPS | | | |
| Name of interviewer1 | | Name of interviewer2 | | No. of fisherman | Gear Types (fish bought from) | |

Socio-economic questions for all fishermen and fish traders

| | Owner | | Employee 1 | | Employee 2 | | Employee 3 | |
|---|-------|-----|------------|-----|------------|-----|------------|-----|
| Name | | | | | | | | |
| Village | | | | | | | | |
| Union | | | | | | | | |
| Thana | | | | | | | | |
| District | | | | | | | | |
| Sex (Male/Female) | | | | | | | | |
| Job | | | | | | | | |
| Age | | | | | | | | |
| Marital status (Single/Married) | | | | | | | | |
| Religion | | | | | | | | |
| Literacy (None/Primary/Secondary/Other) | | | | | | | | |
| Number of children | M= | F = | M= | F = | M= | F = | M= | F = |

| | | | | | | | | |
|---------------------------------------|----|-----|----|-----|----|-----|----|-----|
| Number of children enrolled in school | M= | F = | M= | F = | M= | F = | M= | F = |
| Number of children left school | M= | F = | M= | F = | M= | F = | M= | F = |
| Cause of leaving school | | | | | | | | |

| Monthly income from fisheries | Owner | | | | Employee 1 | | | | Employee 2 | | | | Employee 3 | | | |
|-------------------------------|-------|-----|---|-----|------------|-----|---|-----|------------|-----|---|-----|------------|-----|---|-----|
| | D | PRM | M | PSM | D | PRM | M | PSM | D | PRM | M | PSM | D | PRM | M | PSM |
| | | | | | | | | | | | | | | | | |
| % income from fisheries | | | | | | | | | | | | | | | | |

| | Owner | Employee 1 | Employee 2 | Employee 3 |
|---|-------|------------|------------|------------|
| Do you have another occupation other than fishing/fish trading? | | | | |
| If yes, What is your second occupation? | | | | |
| How much land do you own? | | | | |
| What is your land used for? | | | | |
| How does your wife contribute to your families earnings? | | | | |
| Other earning member | | | | |
| Occupation and income(other earning member) | | | | |

Questions about market chain and regulation (fish traders)

| |
|---|
| You are buying the fishes from... (Fishermen/Middleman/Depot/Hatchery) |
| You are selling the fishes to... (Depot/Merchant (another middleman)/Market/Consumer) |
| You are selling the fishes at (Location)... |
| Do you... (get a fixed price/negotiate with buyer) |
| Are there any regulations in the market chain (tax/fee/rules)? Yes/No |
| If yes, please specify |

Questions about perception regarding dolphins and conservation of dolphins

| |
|--|
| Have you seen dolphins in the rivers? |
| Have you heard of dolphin entanglements in any fishing gear? |
| If yes, then where and when? |
| In which gear type? |
| Do you think they are important for our rivers? |
| How do you think we can save the dolphins? |

| |
|---|
| If fishing banned, are there any alternative income generating activities that can improve your livelihood? |
| If yes , specify- |

Specific rate (selling price) of fishes (fishermen and fish traders)

| Sl No | Species name (Bengali) | Buying price | Selling price |
|-------|------------------------|--------------|---------------|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |
| 13 | | | |
| 14 | | | |
| 15 | | | |

1.4 Fishing effort and catch composition data sheet

| Sam # | Date | Seg # | Gear Type | GPS # | WP | Soak Start Time | Soak End Time | Soak Duration | # Casts | Depth | Time | Env | Page # | Total Pages |
|-------|------|-------|-----------|-------|----|-----------------|---------------|---------------|---------|-------|------|-----|--------|-------------|
| | | | | | | | | | | | | | | |

| Sample # | Species Name | Type | Total Individual | Total Weight (gm) | Length | | | Market Value of Species | Specimen No. | Photoframe # | Recorder | Notes |
|----------|--------------|------|------------------|-------------------|--------|-----|-----|-------------------------|--------------|--------------|----------|-------|
| | | | | | Min | Max | Med | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Tide codes: H = high tide, L = low, 1/2F = middle of incoming tide, 1/2E = middle of outgoing tide

Fishing gear codes: BFGN = bamboo fixed gillnet; DGN = drifting gill net; FFGN = fixed floating gill net; MGN = monofilament gill net; CN = cast net; LSN = long shore net; SBN = set bag net. PLSBN = post-larvae set bag net; PLBN = post-larvae Box net; PLPN = post-larvae pole-net; PLHDN = post-larvae hand-drag net; PLHPN = post-larvae hand-push net, CL = crab line; HL = hook and line, CT=Crab tarp, HR=Hook and Rod;

Environment codes: MCL = mid-channel large (>200m wide); SCL = side-channel large; MCS = mid-channel small (≤200m wide); SLS = side-channel small

1.5 Data sheet for investigating shrimp fry collection

| | | | |
|------|---------|-----|----------|
| Date | Segment | GPS | WP |
| Gear | Tide | ENV | Recorder |

| Sample percentage | Number of catch (100%) | | Bycatch (recorded) (sample) | | Total Bycatch for 100 shrimp fry (estimated) | | |
|-------------------|------------------------|--------------------------|-----------------------------|-------|--|-------|-------|
| | Shrimp fry | Edible fish & crustacean | Dead | Alive | Dead | Alive | Total |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

ENV: MCL (Mid channel large), SCL (Side channel large), MCS (Mid channel small), SCS (Side channel small)

Gear: PLSBN (Post-larvae set bag net), PLBN (Post-larvae box net)

Appendix 2: Financial report

| Itemized expenses | Total CLP requested (USD) | Total CLP used (USD) |
|--|---------------------------|----------------------|
| Phase 1- Project Preparation | | |
| Administration | 1,200.00 | 1,061.11 |
| Communication (internet/phone bill) | 200.00 | 187.73 |
| Visa/Permits | 200.00 | 169.37 |
| Team training | 800.00 | 704.01 |
| Reconnaissance | 300.00 | 291.76 |
| Reconnaissance trip to test the methodology of the study | 300.00 | 291.76 |
| Equipment | 3,430.00 | 3,609.80 |
| Scientific/field equipment | 0.00 | 51.86 |
| Photographic equipment (batteries) | 50.00 | 27.67 |
| Camping equipment | 200.00 | 0.00 |
| Boat rent (for field works with fuel cost) | 3,380.00 | 3,530.27 |
| Phase 2-Implementation Expenses | | |
| Administration | 0.00 | 625.00 |
| Tax (paid to the organization who handled the funding) | 0.00 | 625.00 |
| Transportation | 4,440.00 | 4,056.23 |
| Accommodation/food for team members during post field work meeting | 400.00 | 323.70 |

| | | |
|---|------------------|------------------|
| Food for team members and local guides during field work | 3,400.00 | 3,483.94 |
| Transportation | 640.00 | 248.59 |
| Workshop | 2,330.00 | 2,069.08 |
| Outreach activity materials (printing of outreach materials) | 1,830.00 | 1,500.00 |
| Others (Remuneration for fishermen and stipend for team members during data analyses) | 500.00 | 569.08 |
| Phase 3- Post Project Expenses | | |
| Administration | 800.00 | 430.34 |
| Report Production and result dissemination | 800.00 | 430.34 |
| TOTAL | 12,500.00 | 12,179.43 |