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Impacts of Wetland Conservation and Co-management on Fisheries

Mohammod Ilyas and Paul Thompson

Climate-Resilient Ecosystems and Livelihoods (CREL)
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Cover photo: Diverse fish catch in Hakaluki Haor, February 2015 (Paul Thompson)
Inner photo: Fish landing in Sundarbans (Mohammod Ilyas)

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Climate-Resilient Ecosystems and Livelihoods (CREL) Project was implemented from 2012 to 2018 to strengthen and establish co-management of biodiverse forests and wetlands to restore and protect biodiversity and associated livelihoods. Seven of the biologically significant sites supported by CREL have important capture fisheries and, unlike for example protected forests and their trees, in wetland fisheries conservation and sustainable use can restore fish catches (if fisheries were overexploited) and can secure livelihoods as an incentive for local conservation. Monitoring of fish catches and of fish landings was undertaken to establish baselines and assess changes in fish catches, fish diversity and the value of fish as indicators of co-management impacts. Monitoring was also expected to develop evidence based recommendations for sustainable management of wetlands and their fisheries resources.

Fish catches were monitored in three freshwater sites in the northeast: the large wetland of Hail Haor (where six areas were monitored), the even larger wetland of Hakaluki Haor Ecologically Critical Area (where nine areas were monitored), and in part of a river adjacent to Ratargul Special Biodiversity Conservation Area. In the coastal zone including mangrove-estuarine systems monitoring involved in the southwest: fish catches in four river sections, fish landings at four centers within the extensive Sundarbans Reserved Forest; and one landing center near to Tengragiri Wildlife Sanctuary. In the central coast one landing center serving Nijhum Dwip National Park was monitored, and two landing centers serving Sonadia Island Ecologically Critical Area were monitored on the southeast coast. At each site local enumerators conducted surveys following predefined dates, protocols and formats. Catch monitoring was designed to be consistent with similar surveys prior to CREL (nine years of data for Hail Haor) and involved surveys on four pre-defined days spread evenly through each month. On the survey days all gears operating in the monitoring sites were counted by type. Also the catch by species was weighed and a brief interview conducted for all or a sample of the fishing units using each gear (according to the number of units encountered).

Hail Haor – One of the largest wetlands in Bangladesh, with an average maximum water extent in the early 2000s (during MACH project surveys) of 12,490 ha. Although one significant community managed wetland sanctuary (Baikka Beel) has continued to serve the haor, the other seven community organizations formed by MACH lost rights to waterbodies just before CREL project started and only a few obtained use rights during CREL. Meanwhile, aquaculture has expanded rapidly, and parts of the wetland have been progressively enclosed by high bunds for aquaculture farms – increasing from about 100 ha in 2000 to an estimated 1030 ha in 2016. These areas are no longer part of the seasonally inundated floodplain, fishers and other poor people are excluded from them, and they do not contribute to the open water catch. CREL surveys covered three years, during which 86 species were recorded. Catches were dominated by small fishes, but the catch diversity declined. There was no clear trend in fish catch per unit effort (kg per fishing day), and effort declined somewhat, nevertheless fish catch per hectare was high in all three years at just over 400 kg/ha (comparing with about 380 kg/ha in 2010-12, and a baseline in 2000 before co-management and restoration of 170 kg/ha). The total wild fish catch from the haor has been about 4,600 t/year during CREL compared with a baseline of about 2,000 t/year, and about 3,500-4,700 t/year during restoration and establishment of co-management. Using an average local fish price of BDT 169 per kg in 2016, the additional value of fish caught in Hail Haor during the CREL era was about BDT 14.5 million (USD 0.19 million) per year compared with the IPAC period – maximum sustainable yields had already been approximately restored by the mid-late 2000s. CREL surveys estimates that 3,776 households are involved in open water fishing, if this number has been constant then household incomes from fishing in the CREL project period were about BDT 112,000 higher in 2016 prices than they would have been using the same fish price in 1999-2000. The cumulative additional value of fish catch generated from Hail Haor during 16 years of co-management with USAID support is estimated to be USD 52 million.

Hakaluki Haor – The largest single haor in Bangladesh with an estimated monsoon water extent of about 18,000 ha. Since 2010 12 waterbodies covering 524 ha have been protected as sanctuaries, in addition over 1,200 ha of regenerating seasonally flooded swamp thicket-forest are protected, but most of the haor is fished under the direction of traditional leaseholders. During three years of monitoring there was no significant trend in fishing effort, but catch per day using traps increased, and catch per hectare on average increased by 62% from 171 kg per ha in 2013-14 to 277 kg per ha in 2015-16. The catch of native large fish (such as Boal and Ayre) declined, while the percentage contribution of small shrimps increased (indicators of over fishing). The total fish production of Hakaluki Haor was estimate to have increased from 3,144 tons in 2013-14 to 5,092 tons in 2015-16. Taking a constant 2016 seller's fish price and considering the three years there was an additional Tk 478 million (US$ 6.1 million) of fish caught from the haor in the second and third years compared with the first year. The increased in fish catches may be attributed at least in part to establishment and protection of fish sanctuaries, swamp tree-thicket sanctuaries and measures to reduce fishing during the early monsoon closed season taken by the village conservation groups (VCGs). To restore and sustain a diverse productive fishery fish sanctuaries and swamp forests should continue to be protected by VCGs, the government should enforce rules and limits on fishing by or through leaseholders to allow survival of large fish to reproduce, including observing a closed season in the pre-monsoon and ensuring that the traditional practice of only draining one jalmohal per year in a "group fishery" is restored and followed.

Ratergul - As a baseline fish catch was monitored in 1 km (8.75 ha) of the Gowain River bordering the swamp forest in 2016. Fishing was mostly by push nets and gill nets during the monsoon, catches included several large catfish species such as Boal and Aor, as well as Rita a nationally critically endangered species. The total estimated catch this area was 2,224 kg giving an estimated CPUA of 318 kg/ha in 2016. This is higher than the river/estuary national average fish catch of 172 kg per ha in 2012-13, but comparable to the catch per ha reported in this study in Hail and Hakaluki Haors in the northeast - a similar ecosystem and the same region as Ratargul. The estimated value of all fish caught was about Tk 0.65 million. Assuming only one fisher operated each gear unit would give an average daily income of Tk 271 (US$ 3.52). The CMC in this site which has newly come under co-management should work with fishers to protect fish sanctuaries within the swamp forest and observe a closed season in the river.

Sundarbans - Understanding fish catch trends is a challenge in this large area where an estimated 54,000 fishing households live within 5 km of the Sundarbans Reserve Forest. Gill nets and large seine nets dominate fishing effort, which fluctuates without a strong seasonal pattern. Catch per unit day increased for seven out of 10 main gear types over three years in the catch monitoring, but trends were not consistent with the landing survey, so no trend can be confirmed. Estimated catch per ha was relatively stable in each monitored site, but differed greatly between sites, with exceptionally high catches in the one smaller khal surveyed. Catch diversity in the monitored catches fell from 64 species in 2014-15 to 42 species in 2016-17 which is a concern. Alternative estimates of the overall fish catch from the Sundarbans can be made. Based on catch per ha in sample locations (as very small part of the 187,400 ha of waterways within the Sundarbans catch may have increased from 93,900 t in 2014-15 to 121,000 t in 2016-17. Based on a census of fisher households which found 54,152 households in three effort categories catch could have been 14,700 t in 2014-15 and 24,200 t in 2016-17 (i.e. only 20% of the area based estimate). The actual fish catch probably lies between these figures. There is a concern that fish species diversity is declining, and there is also evidence of declines in carnivorous fish which are indicators of the health of the aquatic system. The evidence suggests that existing fishing rules and limits (including sanctuaries and licensing systems) need to be reviewed to safeguard fish stocks to sustainable levels, and that recent trends may pose threats both to larger carnivorous fish and wild shrimps. Continued monitoring, informed discussion based on evidence, and agreement among fishers, financiers, middlemen, traders/arats, CMCs and Forest Department will be needed if sustainable fishing is to be achieved.

Tengragiri - Two years of fish land records are a limited basis for estimating trends or impacts of the two fish sanctuaries established by the co-management committee here during CREL, which may

benefit 600 local fishing households. There was no trend in overall fish landings, although catch per day for seine net operations increased considerably. A very high diversity of fish were recorded at 138 species (considerably higher than in the Sundarbans) and most of these were estuarine and coastal species, with the dominant species Poma (*Johnius vogleri*), Tular dati (*Sillaginopsis panijus*), several shrimp species, and Hilsha. The value of fish landings here was about US$ 11 million per year. The CMC could coordinate more closely with department of Fisheries and the adjacent Hilsha sanctuary and fishery management area supported by ECOFISH[BD].

Sonadia – All of the 1,865 households living within the ECA are engaged in fishing - some within the ECA and more in adjacent offshore waters. Landings from 1-day duration trips brought to two landing centers were monitored as these were considered to be most likely sources from in and adjacent to the ECA. Landings were higher in the dry season but varied greatly between three years monitored. A high diversity of over 169 species was recorded in fish landings. Fish landings were estimated to have increased greatly in 2016-17 to 2,059 t compared with 728 t in 2014-15, however no conservation measures have been taken so far and the high catches are likely to be unsustainable and involve capture of juvenile fish from this nursery and feeding ground. The VCGs and DoE should promote replacement of non-selective set bag nets with selective gear, and the impacts monitored over a longer period.

Nijhum Dwip – The majority of households living within the National Park fish for a livelihood (992 out of 1,073). Two years of records from the main landing center on the island provide a baseline but are insufficient to estimate trends. Hilsha is the dominant species but was mostly caught in October 2014 and September 2016, and was absent in 2015. Catch diversity for a coastal location was very low (only 23 species), with very few species of larger fish, which either reflects a highly targeted fishing effort tor a very degraded fishery. The overall value of fish landings at this landing center was estimated at Tk 165 million in 2014-15 and Tk 230 million in 2015-16. Because the local Hilsha catch can fail in some years, effort is likely to be excess on small species in those periods. Diversifying livelihoods to reduce fishing pressure and to compensate for fishing bans during the Hilsha spawning season has been a focus of fisheries management in recent years. But other estuarine fish are important for local fishers during the rest of the year. The fish sanctuary established in Muktaria Khal by the CMC is a potentially helpful step for fish conservation, but awareness building is needed, additional sanctuaries for fish and waterbirds should be established, and the impacts need to be assessed over a longer period than has been possible under CREL.

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ABBREVIATIONS

BFDC	Bangladesh Fisheries Development Corporation
CE	Community enumerator
CMC	Co-Management Committee and Council
CPUA	Catch per unit area
CPUE	Catch per unit effort
CR	Critically endangered (global IUCN /BirdLife threat status)
CREL	Climate Resilient Ecosystems and Livelihoods project
CWBMP	Coastal and Wetland Biodiversity Management Project
DoE	Department of Environment
DoF	Department of Fisheries
ECA	Ecologically Critical Area
FAP	Flood Action Plan
FRSS	Fisheries Resource Survey System
GoB	Government of Bangladesh
H’	Shannon-Wiener Index (of diversity)
IFMP	Integrated Forest Management Plan (of Sundarbans)
IPAC	Integrated Protected Areas Co-management project
IUCN	International Union for the Conservation of Nature
MACH	Management of Aquatic ecosystems through Community Husbandry project
NP	National Park
RMO	Resource Management Organization
SBCA	Special Biodiversity Conservation Area
SBCP	Sundarbans Biodiversity Conservation Project
SRF	Sundarbans Reserved Forest
Tk (also BDT)	Bangladesh Taka
VCF	Village conservation forum
VCG	Village conservation group
WS	Wildlife Sanctuary

CHAPTER 1 INTRODUCTION

1.1 Capture Fisheries in Bangladesh

Fish is an essential staple food for the people of Bangladesh and the fisheries sector plays a vital role in the national economy through employment generation, nutrition and poverty alleviation (Alam 2005; Uddin *et al*. 2003). This sector provides employment for 11% of the population, and during 2009-2014, about 0.6 million new jobs were generated in this sector (DoF 2014). In earlier days about 80% of rural households traditionally caught fish for food or for sale mainly in the monsoon (FAP-17 1994; Thompson and Hossain 1998). Total national fish production in 2015-16 was 3.878 million metric tons. Fish remains one of the important foods for Bangladeshis, 60% of the supply of animal protein is met from fish. The total area of inland open waters is reported to be 3.918 million ha of which rivers and estuaries cover 0.85 million ha, Sundarbans 0.18 million ha, beels 0.11 million ha, Kaptai Lake 0.07 million ha and floodplain 2.70 million ha (FRSS, 2016). The total production from inland capture fisheries (defined by the Department of Fisheries to include estuarine and mangrove fisheries) in 2015-16 was 1.05 million tons, which is 27% of the country's total fish production (DoF, 2016).

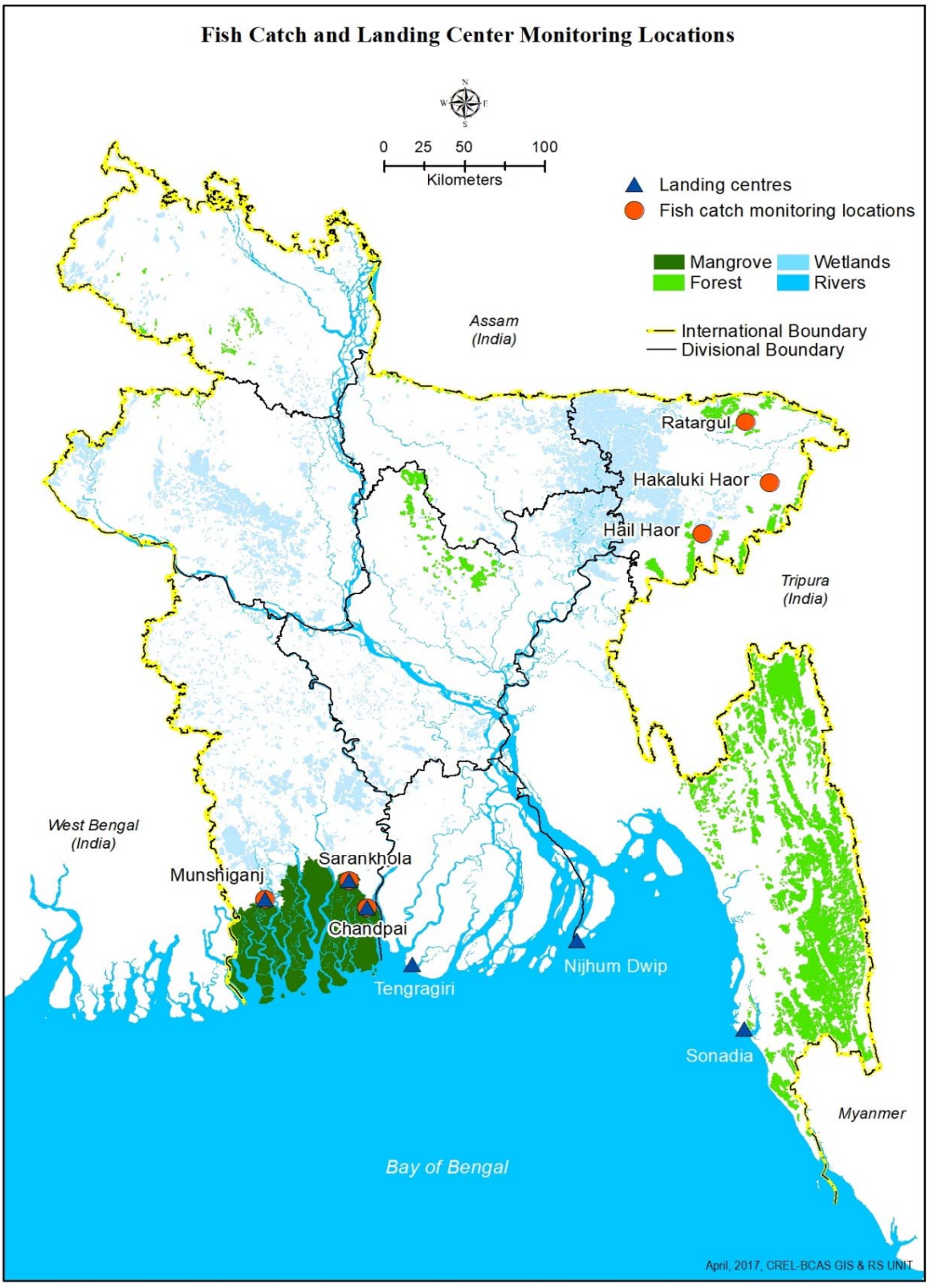
Floodplains are low-lying areas that flood during the monsoon and are home to a diverse fish fauna comprising 260 indigenous species of fish (Rahman, 1989). According to IUCN (2015) out of 253 fish species found in Bangladesh freshwater, a total of 64 freshwater fish are threatened in Bangladesh. Floodplains contribute about 20% of the total fish production, followed by rivers, estuaries, *beels* and the Sundarbans mangrove forests. In inland fisheries, more than half of the fish caught are for household consumption, while a mix of professional and seasonal fishers sells the remainder in local markets. Coastal fisheries are less well documented and intergrade with riverine fisheries and are typically included within inland fisheries statistics, but large numbers of artisanal fishers are involved in fishing – catching fish and shrimps along the shores, using small boats on day trips and also fishing as teams/crew on local wooden "trawlers" making multi-day trips into near shore waters.

1.2 Climate-Resilient Ecosystems and Livelihoods (CREL) Project

The USAID supported CREL project worked from 2012 to 2017 to strengthen and establish co-management of biodiverse forests and wetlands and to restore and protect biodiversity. The project was designed to scale up and adapt successful co-management models to conserve ecosystems and protected areas, improve governance of natural resources and biodiversity, and increase resilience to climate change through improved planning and livelihoods diversification. The co-management approach used includes community level participation in order to provide socio-economic benefits for fishers and other wetland dependent people. The CREL project worked in three regions of Bangladesh: the northeast focused on *haor* wetlands (large deeply flooded basins) and forests, the southwest focused on the Sundarbans mangrove forest, and the southeast focused on forests and coastal wetlands. In total the project-supported areas of biological significance and adjacent landscapes or influenced areas combine to cover 950,663 ha (Fig. 1.1), out of this area about 757,000 ha can be considered wetlands (including mangrove forests).

One of the aims of co-management in the wetland systems is to improve fisheries management, restoring ecosystems and establishing local fishing rules to sustain harvests of fish. The main purpose of the fishery monitoring program (the results of which are analyzed in this report) was to assess changes in fish catches, fish diversity and the value of fish catches as indicators of co-management impacts, and to develop evidence based recommendations for management actions that co-managers could implement to further improve conservation, ecosystem and habitat management, and to ensure sustainable use of the fisheries resources of these wetlands.

Fig. 1.1 CREL wetland sites where fisheries surveys were undertaken



CHAPTER 2 FISH CATCH MONITORING METHODS

2.1 Introduction

One of the important initiatives of CREL and previous related USAID supported projects has been the establishment of effective systems for fish catch assessment to monitor changes in fish catches and landings, and their composition, which could be compared with management actions. In some cases, such as Hail Haor, there is a series of data over several years clearly showing trends and the restoration of catches, in other sites new to co-management CREL has established baseline data such as; in Ratargul swamp forest. In the CREL project fish catches and/or fish landings were monitored in 28 locations representing seven wetlands. The survey data was collected by community enumerators with the supervision of field staff of the project.

2.2 Survey Locations

The sites selected for monitoring of fish catches and landings are comprised of freshwater wetlands in the northeastern region, and the mangrove estuarine systems and coastal islands in the southern region of Bangladesh. The sites and the specific habitats selected are described below:

2.2.1 Freshwater wetlands (northeast)

Three freshwater wetlands, which include two large haors and one swamp forest, were located in the northeast. The two large haors are Hail Haor and Hakaluki Haor. Hakaluki Haor is one of twelve Ecologically Critical Areas (ECAs) declared by Government of Bangladesh. Raturgul is one of the few mature swamp forests in Bangladesh, and has been declared as a Special Biodiversity Conservation Area. Defined areas of wetland (beels with permanent water, seasonal floodplain, and rivers) considered representative of each larger wetland system were selected for monitoring, giving six monitoring sites in Hail Haor, nine sites in Hakaluki Haor and one site in Raturgul (Table 2.1). Co-management with conservation of fish and wetland for sustainable use was originally established in Hail Haor by the Management of Aquatic ecosystems through Community Husbandry (MACH) project, and fish catches were monitored earlier by MACH and by the Integrated Protected Area Co-management (IPAC) project.

Table 2.1 Sites of fish catch monitoring in freshwater wetland habitats (northeast)

Site name	Habitat	Monitoring Area (ha)
Hail Haor*		
1. Alniberi Lalodaho	Beel, floodplain	18.2
2. Gopla River	River within haor	20.0
3. Cheruadubi Beel	Beel	30.4
4. 62-Beel	Beel, floodplain	8.0
5. Lataganj	River within haor	7.5
6. Balla Beel	Beel, floodplain	28.6
Hakaluki Haor ECA		
7. Juri River	River within haor	4.0
8. Boaljur Beel	Haor beel	28.5
9. Dudai Beel	Haor beel	145.9
10. Gorchhikona Beel	Haor beel	6.3
11. Cinaura Beel	Beel connected with river	17.1
12. Fanai khal	Canal within haor	2.0
13. Nagoa-Dalia	Haor beel connected with river	245.12
14. Choula beel	Haor beel	14.02
15. Charua beel	Haor beel	6.38
Raturgul		
16. Goain river	River adjacent to swamp forest	8.75

* these same areas were also monitored during MACH and IPAC projects

2.2.2 Mangrove-estuarine systems (southwest)

Two mangrove-estuarine systems in the southwestern region of Bangladesh are under co-management. One is the vast Sundarbans reserved forest along with part of the ECA that borders the mangroves. Here four river sections and canals typical of these habitats within the Sundarbans, and four typical fish landing centers adjacent to the forest were selected for catch monitoring (Table 2.2). The other protected area under co-management in this region is Tengragiri Wildlife Sanctuary (planted mangroves and estuarine creeks and rivers), where one important landing center was monitored.

Table 2.2 Sites of fish catch monitoring in the mangrove-estuarine system

Forest Range/ Protected area	Site and Habitat		Monitoring Area (ha)
Mangrove Estuarine Systems: Fish Catch Monitoring			
17. Satkhira	Dhumkoli river	River	16
18. Chandpai	Chila khal	Canal	4
19. Sarankhola	Bhola river	River	27
20. Sarankhola	Baleswar river	River	120
Mangrove Estuarine Systems: Fish Landing Centers Monitoring			
21. Satkhira range	Munshiganj	Mangrove	na
22. Chandpai range	Chila	Mangrove	na
23. Sarankhola range	Sarankhola	Mangrove	na
24. Sarankhola range	Gabtola	River	na
Tengragiri Wetland Sanctuary: Fish Landing Center			
25. Tengragiri	Amtoli	Estuary	na

2.2.3 Coastal islands and adjacent waters (southeast)

In this region co-management has been established in two coastal islands and their adjacent waters. In Nijhum Dwip National Park, Noakhali District (planted mangroves, newly accreted islands and extensive intertidal zone) the main fish landing center was monitored (Table 2.3). In Sonadia Island ECA in Cox's Bazar District (sandy coast, mangroves, intertidal zone, inshore sea and creeks) two landing centers were selected. Landings in the monitored markets represent fish caught from within the co-managed sites and from nearby Bay of Bengal.

Table 2.3 Sites of fish catch monitoring in the southeast coastal

Protected area and monitoring sites	Habitat	Monitoring Area (ha)
Nijhum Dwip National Park: Fish Landing Center		
26. Namar Bazar	Coastal	na
Sonadia ECA: Fish landing Center		
27. Nazirertek	Coastal	na
28. Khutakhali	Coastal	na

2.3 Community Enumerators

Community Enumerators (CE) were recruited locally to undertake fish catch and fish landing monitoring. They were selected through discussion with local stakeholders and local staff of the project based on past experience in fish catch monitoring and/or involvement in fishing.

The CEs were oriented by CREL Monitoring Officers and fisheries specialists on the survey methods outlined below. There were also sharing sessions between CEs and staff of CREL from the respective sites about surveys and co-management activities. Spot checking of the monitors was undertaken, monitoring officers checked and coded data forms, and periodic feedback sessions were conducted between CEs and the supervising staff.

2.4 Fish Catch Monitoring

2.4.1 Monitoring methods

At each site, the local CE conducted catch monitoring on four pre-defined days, spread roughly one per week, in each month. A monitoring plan was provided to the CE. On the survey days the gear census covered all the gears (types and numbers) operating in the monitoring sites. The CE recorded by gear type all fishing units seen operating within the defined survey area using the format in Appendix 2.1. If up to ten operating gears were found, then all of those fishing units were interviewed and the catch weighed and estimated by species, and if more than ten operating fishing units were found then 30% of the units of each gear type were interviewed and the catch weighed and estimated by species, using the format in Appendix 2.2. A detail monitoring guideline including format filling instructions in Bangla was provided to the CE. The numbers and weight of all fish species from the catch of these sample units were recorded. But if the catch was large, a sample of the catch was weighed separately by species so that the total weight of catch could be estimated by species. Even in these cases, if some larger fish were found in the catch such as major carps, Boal (scientific names of all fish recorded are given in Appendices 4.3; 6.1; 7.3; 8.1; 9.1 or snakeheads then these species were weighed separately and recorded as directly weighed fish in a separate weight column. A one kg weight cooking balance accurate to 5 g and able to weigh up to 1 kg and a spring balance accurate to 250 g and able to weigh up to 10 kg were provided to each CE. A fish checklist and an identification reference book were also provided for species identification to each CE. Furthermore, the gear-type, mesh size, owner status and the number of gear items (in the cases of traps and hooks for example) used per fisher were recorded accordingly. Later CREL partner staff checked the filled-in formats, verified the codes used on all collected data-sheets, and entered the data into the database using an entry system developed in Microsoft-Access.

Monitoring areas were demarcated during site selection and were constant throughout the study. On the ground they were defined through visible land marks such as *kanda* (patches of higher land), swamp plants, canals. In case of rivers and *khals* (channels) approximately a 1.0 km long section was selected for monitoring with the end points of the survey section marked as spots where two *khals* joined, or by a homestead, or other landmark. Irrespective of the water area within a monitoring area in different months, the area used in calculations was the total monitoring area (which held water in the monsoon.

2.4.2 Calculating catch per unit effort (CPUE)

Catch per unit effort (CPUE) indicates capacity or efficiency of fishing by a gear type in the monitoring habitat. CPUE at its simplest is the average total quantity of fish by weight caught per day per gear unit, where a gear unit is a fishing operation using a particular category of gear. All of the catches for that gear type were divided by the number of gear unit days surveyed. Thus:

CPUE = Sum (Gear type wise catch)/Number of gear unit days surveyed.

Where appropriate CPUE is also adjusted by the number of fishers per unit, for example with cast nets the typical fishing unit is one person so CPUE (gear unit) and CPUE (fisher) are the same, but a typical seine net fishing unit has 6-10 fishers operating the net and boats. So the average of the recorded sample daily catches gives the CPUE (gear unit), and each of those daily records divided by the number of fishers operating that unit that survey day and then averaged is the CPUE (fisher).

2.4.3 Calculating overall catch and catch per unit area

Average number of gear units recorded per day was used to estimate total number of gear units operating in that area for that month, as well as for the whole year. Simultaneously, mean gear-wise catch rate (CPUE gear) was used to estimate total catch for that month, as well as for the whole year. The total monthly catch for each monitoring site was hence calculated as follows:

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

Where:
N: Number of days in a month (assumed to be 30)
$\overline{f}$: Number of gears used per day (for each gear type i)
$\overline{cpue}$: Daily catch per gear type i.

Overall estimated annual catch from the wetland and catch per unit area in each year were calculated as follows: sum of monthly catches over the year estimated for each site (survey area) in basin or wetland system (e.g. haor) divided by total survey area to get annual catch per area (in hectare) or CPUA, multiplied by maximum extent of the wetland of that habitat within the wetland/haor to get total annual catch in the haor.

2.5 Monitoring Fish Landings

2.5.1 Monitoring method

In coastal sites it is not practical to record effort and catch from monitoring specific areas of sea/coastal waters. In these sites, including the Sundarbans, fish catches are largely commercial and fishers "land" their catch for sale at nearby markets. These landing centers may have one or more *aroth* (wholesale operators/assemblers), or *dadondar*/depots (typically they give advance finance to gear units (fishing boat captains) who are then obliged to sell their catch to the same *dadondar* at a fixed price which is less than open market price). These operate as landing centers. One CE was responsible for data collection from one fish landing center. On 4 days per month CEs counted all fishing units bringing catches for sale by type of gear in the landing center. Then catch was recorded in detail for 30% of each gear category landing, except if the gear number was less than ten, then catch from all those gear units was recorded. For each surveyed fishing unit the weight (kg) and price (Bangladesh taka – BDT) of each species were recorded. The number of boats and their gear type were collected from the landing records of the *dadondars* or shop owners on the sampling day. The data collector directly observed the quantity of fish landed for individual fishing boats. In most of the sites the *dadondars* and *aroths* were nominated for sampling. However, the number of a*roths* and *dadondars* was different from one landing center to another depending on fish availability and seasonal fluctuation of fish catch. In landing centers where the numbers of *dadondars* and *aroths* was quite high, 5-8 were selected as sample businesses for data collection. CREL partner staff were assigned to supervise the CEs and provide logistical support.

Different sized shops/operations (*aroth* and/or *dadondar* were sampled. The total number of running/open shops was recorded on the monitoring days. Fishing gear unit (gear and crafts) was also sampled if the number of units landing was higher than 10. Unit wise catch weight, species and price were recorded. Total supplier unit, gear types were also recorded (Appendix-2.3).

2.5.2 Data analysis

Catch per unit effort for fish landing data was calculated as kg/fishing unit/day, based on: total landing weight/fishing boat number/ fishing days.

Total monthly landed (TML) fish was estimated as: total landing weight of each sampled fishing boat that used same type of gear multiplied by total boats using that gear type that landed in that month, and then summing these figures for all types of boat (gear types) landing in that *aroth* in that period to produce an estimate of the total landed fish in each *aroth*. Then the sum of all sample *aroth's* estimated landings was divided by the number of *aroths* sampled to produce an average landing (catch) per *aroth*. This landing amount per *aroth* was multiplied by the total number of *aroth* operating that month to give a total of landings that month. Total landing weight was calculated by the following formula:

$$TML = 30/D * \sum_{i=1}^{n} \bar{f} * CPUE$$

Where:
For gear type (i) 1 to n
D: Number of days per month when fish landing was monitored
A: Running/open *aroth* number
$\bar{f}$: Average number of units landed fish per day per *aroth*
CPUE: average daily landing per gear type in that month (not this is different from the catch per day operated version of CPUE described in the first sentence of this section.

2.6 Fish Diversity

The Shannon-Wiener Index (H') is one of several diversity indices used to measure biodiversity. Biological communities differ in the number of species they contain. The number of species in a community is referred to as species richness, but the relative abundance of species is also important. For example, two communities (sites) may both contain the same number of species but one community may be dominated by one species while the other community may contain high numbers of several or all species. The relative abundance of rare and common species is called evenness. Communities dominated by one or a few species have a low evenness while those that have a more even distribution of species have a high evenness. Species diversity can be considered to be represented by both species richness and evenness. Communities with a large number of species that are evenly distributed are the most diverse and communities with fewer species and/or that are dominated by one species are the least diverse.

The Shannon-Wiener index was developed from information theory and is based on measuring uncertainty. The degree of uncertainty of predicting the species of a random sample is related to the diversity of a community. If a community is dominated by one species (low diversity), the uncertainty of prediction is low; a randomly-sampled species is most likely going to be the dominant species. However, if diversity is high, uncertainty is high (Gregory no date). In this study, species wise catch or landing weights were used to estimate a Shannon-Wiener diversity index (H') for the fishery of each management area. The function is defined as:

$$H = -\sum_{i=1}^{S_{obs}} pi \log_e pi$$

Where:
H: Index of diversity (or degree of uncertainty),
s: Number of fish of all species in sample catch (estimated fish weight converted into species number based on average weight of one individual fish of each species)
p*i:* The proportion of individuals in the i^{th} species.
Note that there is a negative sign in front of the summation sign.
This index of species diversity and richness is calculated using natural logarithm.

CHAPTER 3 HAIL HAOR

3.1 Introduction

Hail Haor is one of the largest of 373 haor wetland ecosystems of northeast Bangladesh (BHWDB, 2012). It is a large, rather isolated, shallow permanent lake with extensive floating and emergent vegetation, surrounded on three sides by low hills, which differs considerably in character from most other haors (Bennett *et al*. 1995). This large heavily exploited wetland is situated in Moulavibazar District, it is reported that approximately 172,000 people live in 61 villages around the haor and depend on it for their livelihood (Majumder *at el*. 2013). When the water level recedes significant areas are used for rice cultivation. During the rainy season (May-October) water extends to about 13,000 ha, but at the peak of the dry season (March) reduces to around 3,000 ha of water (Thompson and Balasinorwala, 2010). Ali *et al*. (2007) from detailed monitoring and modeling found that the maximum annual water extent during 1999-2004 ranged from about 12,200 ha up to 15,800 ha; and the MACH project took a standardized average area of 12,490 ha as the haor area for estimating total fish catch, and this is also used here.

3.2 Management Institutions, Interventions and Physical Changes in Hail Haor

Improved management based on wetland conservation, restoration, sustainable use and community based co-management was introduced in the haor from 2000 onwards under the Management of Aquatic ecosystems through Community Husbandry (MACH) project supported by USAID and Government of Bangladesh (GoB). Eight Resource Management Organizations (RMOs) were formed by MACH in the haor to promote better management of the wetland. They received rights to manage a number of jalmohals (public waterbodies) covering 225 ha on a sustainable basis for 10 years, significant re-excavation works were undertaken, small sanctuaries were established, dewatering ended in these beels, swamp trees were planted, substantial releases of several native fish species that had become scarce in the haor took place, and the RMOs promoted observing a closed season in the pre-early monsoon. In addition a relatively large permanent sanctuary was declared in Hail Haor in 2003, nationally well-known as “Baikka Beel”, this sanctuary now covers about 170 ha and Baragangina RMO was assigned to manage and protect the sanctuary.

After MACH ended in 2008 the RMOs continued their activities, and also received limited follow up support from Integrated Protected Area Co-management (IPAC) Project of USAID and GoB during 2008-2012. However, in 2010-11 the RMOs lost the right to manage jalmohals and smaller sanctuaries were destroyed by local influentials with support of the local administration in the name of “khas collection” and thereafter only the permanent sanctuary of Baikka Beel was protected.

During the CREL project the RMOs continued to receive support, focused on Baikka Beel and on returning rights to other jalmohals to RMOs but reserved leases were only put in place for a few smaller beels in 2016. In parallel with these initiatives for sustainable management of capture fisheries by local communities, there has been a separate trend of capture of the seasonal floodplains of the haor by wealthier investors who have constructed high bunds that remain above monsoon water levels to enclose significant areas around the haor periphery and further within the haor, to convert these into permanent aquaculture.

In parallel with these initiatives for sustainable management of capture fisheries by local communities, there has been a separate trend of capture of the seasonal floodplains of the haor by wealthier investors who have constructed high bunds that remain above monsoon water levels to enclose significant areas around the haor periphery and further within the haor, to convert these into permanent aquaculture. Fig 3.1 shows the change in aquaculture area.

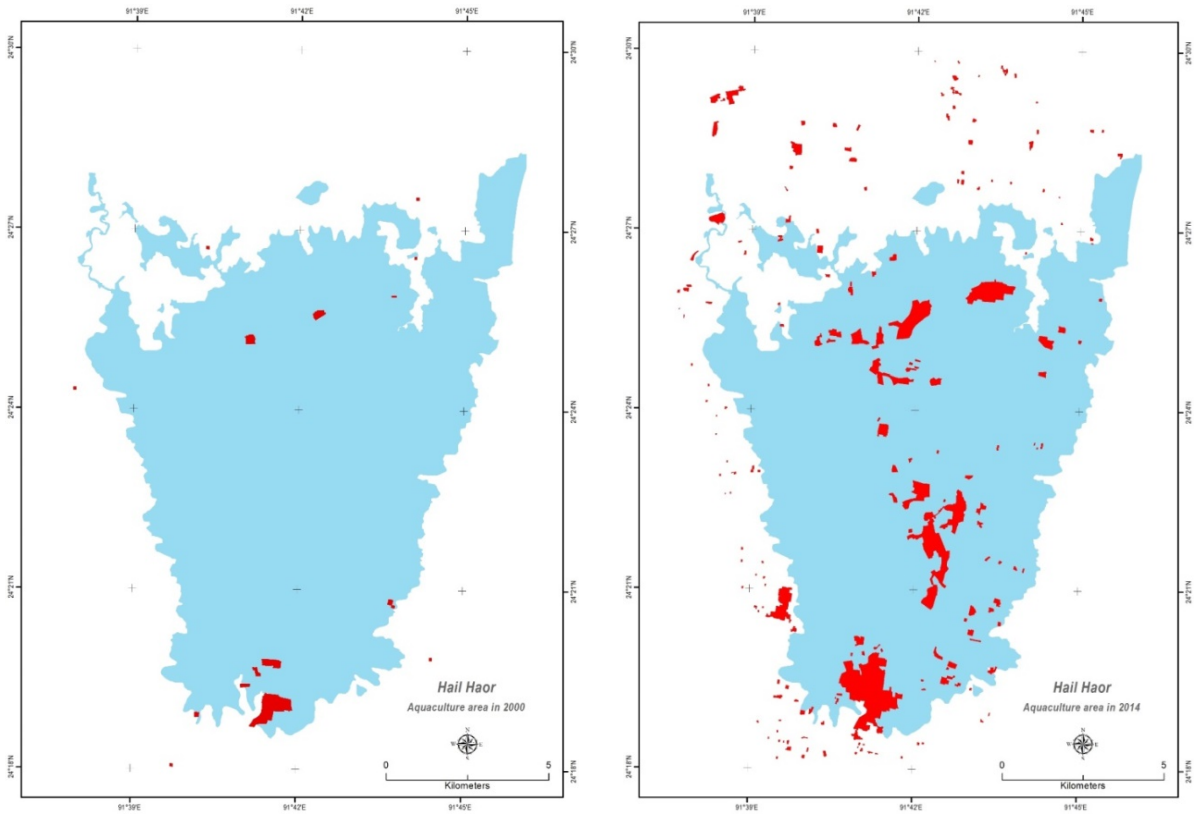
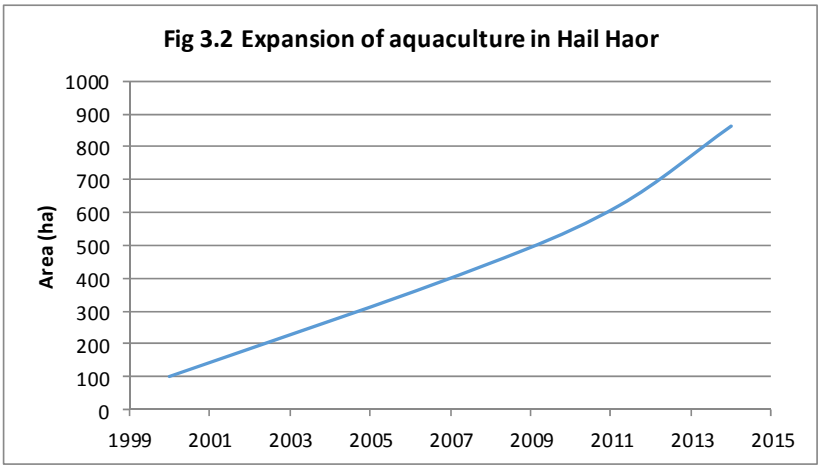


Fig. 3.1 Changes in area lost to aquaculture in Hail Haor wetland 2000 to 2014



The impact of this aquaculture expansion has been to stop those areas connecting with the wider haor and prevent them from holding significant wild fish stocks. Moreover the aquaculture investors and managers prevent poorer local people from their traditional catching of wild fish and collection of other aquatic resources from those areas. Based on analysis of satellite imagery from 2000, 2007, 2011 and 2014 the trend in Fig. 3.2 was determined. This is used to adjust the estimated total catch of wild fish made in Section 3.11 according to the estimated area of floodplain free of aquaculture enclosures in each year.

3.3. Fish Catch Monitoring System Over Time in Hail Haor

The main aim underlying monitoring was to estimate overall fish production and biodiversity in Hail Haor. During the surveys conducted by MACH seven locations were monitored (Table 3.1), this was revised to six locations (areas) monitored during both IPAC and CREL of which four have been monitored since 1999 at the outset of MACH, three extensive floodplain areas within the haor that were monitored under MACH were replaced with a floodplain-beel area managed by one of the RMOs during the 2000s and by a small river area during IPAC and CREL, these are considered to represent floodplain beel and riverine habitats within Hail Haor. The locations of fish catch monitoring sites in Hail Haor are presented in Fig. 3.3. Data were collected by CREL from September 2013 to August 2016 using the methods and formats detailed in Chapter 2.

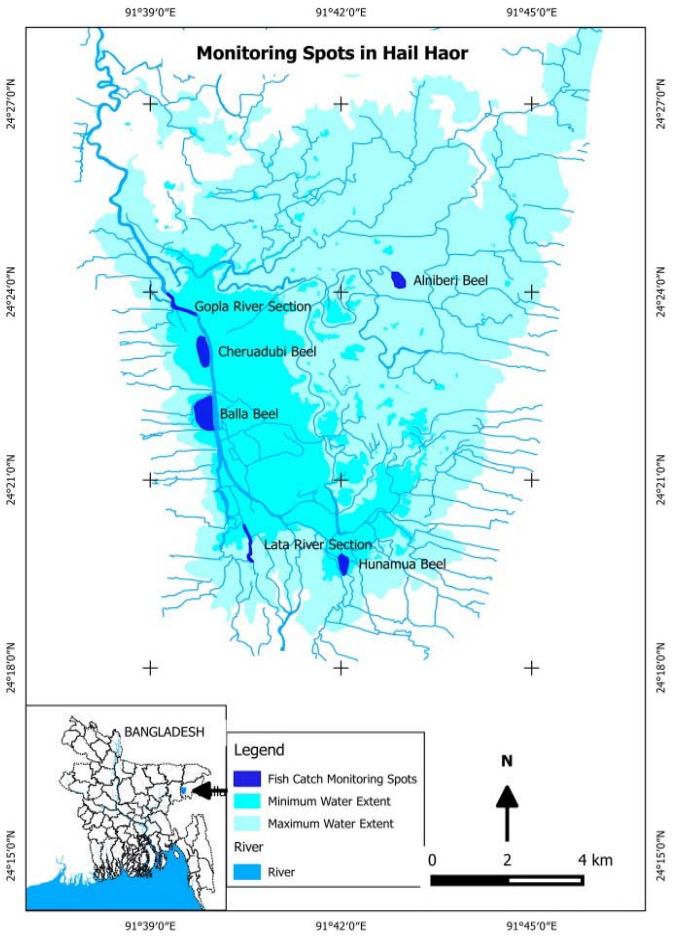


Fig. 3.3. Fish catch monitoring sites in Hail Haor

Table 3.1 Hail Haor fish catch monitoring sites during different monitoring phases (projects)

Monitoring site	Habitat	Monitoring Area (ha)		
		MACH	IPAC	CREL
62-Beel complex	Beel, floodplain	419.5	8.0	8.0
Alniberi Lalodaho	Beel, floodplain	Not surveyed	30.0	18.2
Balla Beel	Beel, floodplain	159.1	159.1	28.6
Boulashir floodplain	Floodplain	234.4	Not surveyed	Not surveyed
Cheruadubi Beel	Beel	30.4	30.4	30.4
Gopla River	River	41.2	41.2	20.0
Jethua Beel	Beel, canal, floodplain	67.9	Not surveyed	Not surveyed
Lataganj	River	Not surveyed	7.5	7.5
Rustompur beel complex	Beel, canal, floodplain	221.7	Not surveyed	Not surveyed

Sources: MACH 2006; IPAC 2012

3.4. Gear Characteristics in Hail Haor

Different types of fishing gears are used in the haor. Their specification differs according to target species, fabrication, and materials

Table 3.2. Common gears used in Hail Haor

Name of gears	Local Bengali name used in the haor (and generally in Bangladesh where different) for each gear type
Gill net	Pata Jal, Fash Jal, Poa Jal, Current Jal, Dacon Jal
Seine net	Ber jal, Jagat ber jal, Moia jal, Katha ber jal, Gamcha jal
Set bag net	Bada jal
Lift net	Bheshal jal, Dharma jal
Cast net	Utar jal, Khepla jal, Toira jal, Jhaki jal
Push net	Thela jal, Hanga jal
Trap	Kholsun, Anta, Polo, Charai, Ghuni, Fala, Bair
Long-line	Chara Barshi, Taja Barshi
Hook and Line	Barshi, Dati Barshi, Shola borshi
Spear	Achra, Aro, Jutya, Koch, Teta
Others	Bana, Katha, Kua, by Hand

available. Cast nets, spears, lift nets and gill nets are operated both day and night. Trap units, long-lines and hooks and lines are operated only at night time; while push nets and seine nets are operated only during the daytime. Use of spears and lift nets is occasional and seasonal. The most common gears used in Hail Haor by type are shown in Table 3.2.

3.5. Seasonal Variations in Fish Catch in Hail Haor

The seasonal variation in fish catch is very high in the haor, and is mainly affected by inundation regime, gear use, fishing patterns, fishing intensity and availability of fishes. In Hail Haor during 2014-16, 33% of the annual catch was caught in the post monsoon season (Oct-Dec), 24% in the dry season (Jan-Mar), 19% in the pre-early monsoon (Apr-Jun) and 24% in the full monsoon (Jul-Sep) (Figure 3.4). The pre-monsoon is a very critical period of the year as this is when many fish species start spawning and make local movements as the floodplain of the haor becomes inundated and connections are re-established between beels and rivers/canals. This is the period when RMOs during their years of holding waterbody rights observed closed seasons for 1-2 months.

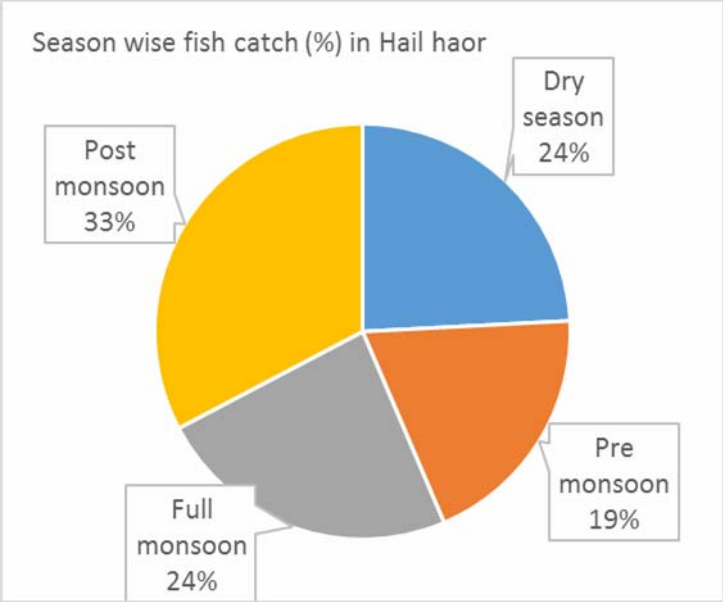


Fig 3.4: Seasonal contributions to fish catch in Hail Haor 2014-16

3.6. Catch Composition, Trends and Diversity in Hail Haor

The top 20 species in the monitored catch are shown in Fig. 3.5, ranked according to their contribution in the monitored catch from all types of gear in three years 2014 to 2016, of these the most notable were Taki, Jatputi,, Mola, Meni, Kholisha, Shol, Boal, and Shing (scientific names are given in Table 3.3).

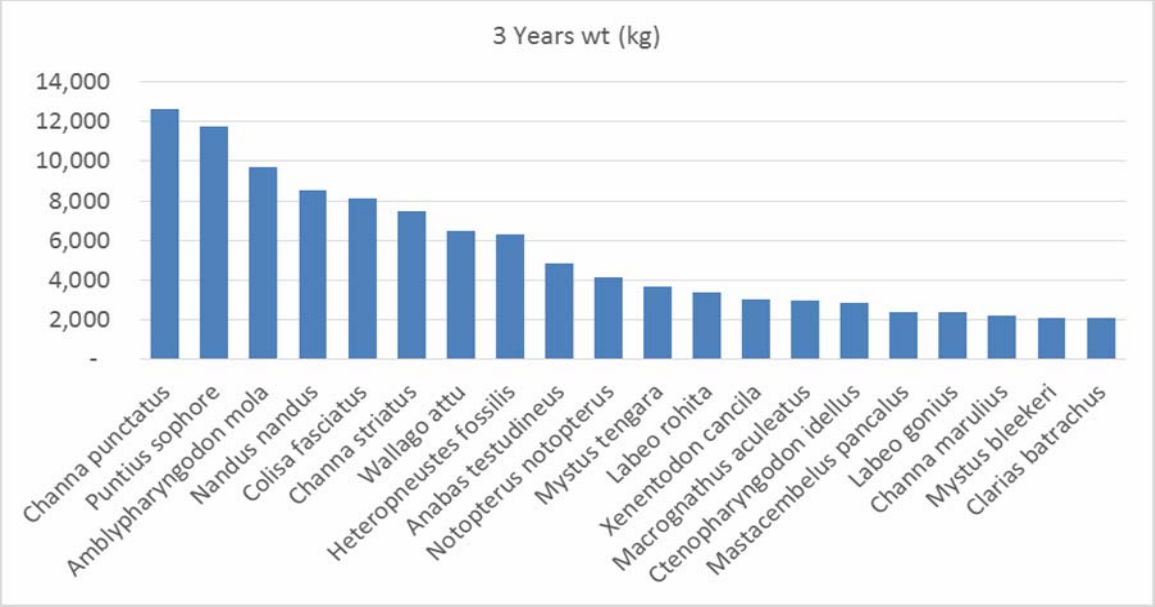


Fig 3.5 Species contribution by weight (20 main species) in Hail Haor 2014-16

Table 3.3 summarize the contributions of the most commonly caught fish species towards total catch, and the trend over three years. Species are listed in order of overall percentage contribution to catch. Those species that have increased as a percentage of catch are highlighted. Combining years, the common species caught by all types of gear in the haor by percentage of overall catches were: Taki (see Table 3.3 for scientific names) 9.2%, Jatputi 8.6%, Mola 7.1%, Meni 6.3%, Kholisha 6.0%, Shol 5.5%, and Boal 4.8%. The 20 main species contributed 88.4% of the catch by weight.

Table 3.3 Fish species contributing 0.75% or more of catch, with % of catch by year and trend – Hail Haor

Sl	Local name	Scientific name	Year			Trends
			2013	2014	2015	
1.	Taki/Ladi/Saitan/Voskol	*Channa punctatus*	7.47	9.87	10.35	Increased
2.	Jatputi/Vadi Puti	*Puntius sophore*	8.58	9.47	7.76	Increased
3.	Mola/Maya/Moa/Mousi	*Amblypharyngodon mola*	4.06	9.14	8.10	Increased
4.	Meni/Veda/Royna	*Nandus nandus*	6.00	6.34	6.47	Increased
5.	Kholisha/Pata Kholisha	*Colisa fasciatus*	6.44	7.03	4.40	Decreased
6.	Shol/Shoil	*Channa striatus*	7.17	5.41	3.83	Decreased
7.	Boal	*Wallago attu*	7.50	3.27	3.54	Decreased
8.	Shing/Jiol Mach/Kanuch	*Heteropneustes fossilis*	2.91	4.80	6.21	Increased
9.	Koi/Gachua Koi	*Anabas testudineus*	4.12	3.32	3.17	Decreased
10	Foli/Kanila/Fotol/Vali	*Notopterus notopterus*	3.85	2.41	2.92	Decreased
11	Bojuri Tengra/Choto Tengra/Guitta Tengra	*Mystus tengara*	2.25	2.45	3.33	Increased
12	Rui/Ruhit/Vuitta	*Labeo rohita*	3.98	1.47	1.99	Decreased
13	Kakila/Kaikla/Kakla	*Xenentodon cancila*	2.48	2.69	1.52	Decreased
14	Tara Baim	*Macrognathus aculeatus*	1.53	2.16	2.88	Increased
15	Grass Carp	*Ctenopharyngodon idellus*	2.79	1.99	1.54	Decreased
16	Guchi Baim/Chikra	*Mastacembelus pancalus*	0.77	1.92	2.55	Increased
17	Goinna	*Labeo gonius*	3.34	1.10	0.81	Decreased
18	Gazar/Gazal	*Channa marulius*	1.98	1.92	1.00	Decreased
19	Golsha/Golsha Tengra	*Mystus bleekeri*	1.17	1.73	1.77	Increased
20	Magur/Mojgur	*Clarias batrachus*	1.07	1.92	1.66	Increased
21	Katla/Katol/Fega	*Catla catla*	1.41	0.56	2.05	Decreased
22	Baila/Bele/Vangla	*Glossogobius giuris*	0.96	1.28	1.28	Increased
23	Darkina/Dakkan/Chukkuni	*Esomus danricus*	0.59	0.67	2.20	Increased
24	Boro Baim/Shal Baim	*Mastacembelus armatus*	0.55	0.70	1.84	Increased
25	Ranga Chanda/Lal Chanda	*Chanda ranga*	0.86	1.09	1.15	Increased
26	Jhili Puti/Gini Puti	*Puntius gelius*	0.91	0.99	0.66	Decreased
27	Golda Icha	*Machrobrachium rosenbergii*	0.99	0.73	0.81	Decreased
28	Gura icha	*Macrobrachium lamarrei*	0.56	0.58	1.29	Increased

Sl	Local name	Scientific name	Year			Trends
			2013	2014	2015	
29	Kanchon Puti/Taka Puti	*Puntius conchonius*	0.94	0.85	0.65	Decreased
30	Tengra/Guinga	*Mystus vittatus*	0.92	0.59	0.84	Decreased

3.7. Gear-based Contribution to Catch

The main fishing gears operated in Hail Haor in 2014-16 and their contributions to the total sample catch documented are shown in Fig. 3.6 - gill nets dominated the catch reported.

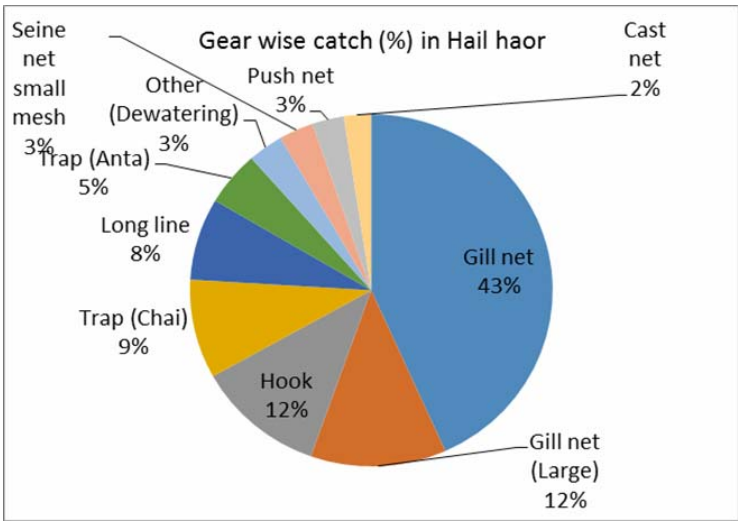


Fig. 3.6. Proportions of sample catch by type of gear used in Hail Haor during 2014-16

3.8. Catch Per Unit Effort (CPUE)

The catch per unit effort (CPUE) is the average daily catch per gear type standardized per fishing unit. CPUE is influenced by several factors, primarily the type of gear used and its efficiency, how many hours it is operated for in a day, weather conditions, and location of fishing. CPUE varies between gears and years in Hail Haor. Seine net (small mesh) and traps (anta) showed significantly higher CPUE than other gears. Whilst, fishing using gill net and long line showed low CPUE. Gear wise CPUE in Hail Haor is presented and gears where CPUE increased are highlighted in Table 3.4.

Table 3.4 Gear wise catch per unit effort (kg/unit/day) in Hail Haor

Sl no	Gear name	Year			Trend
		2014	2015	2016	
1.	Gill net (large mesh)	3.52	3.53	3.03	Decreased
2.	Gill net	2.39	2.59	3.17	Increased
3.	Seine net (small mesh)	30.24	49.86	61.81	Increased
4.	Seine net (large mesh)	7.57	26.09	5.60	Decreased
5.	Lift net (large)	7.72	50.94	6.52	Decreased
6.	Lift net (small)	13.54	14.24	5.90	Decreased
7.	Cast net	3.99	3.54	6.19	Increased
8.	Push net	3.58	4.07	5.81	Increased
9.	Trap (anta)	17.24	14.11	11.28	Decreased
10	Trap (charo)	3.95	3.06	8.37	Increased
11	Trap (chai)	10.58	10.18	7.21	Decreased
12	Long line	2.55	2.49	2.65	Increased
13	Hook	3.59	3.51	7.58	Increased

3.9 Trends and Seasonality in Fishing Days in Hail Haor

During the CREL period fishing effort was recorded as a census on the sample days in the survey areas. This has been multiplied up by the number of days in each month to estimate total fisher days to quantify the fishing intensity in Hail Haor. The number of fishing unit days operated per month was generally higher in the dry (winter) season. During the dry season the water extent reduces, and water is limited to the deeper beels within the haor, here fish are concentrated and easier to catch so effort is highest in this season. Total estimated fisher days per month in Hail Haor in six monitoring sites are shown in Fig. 3.7. The drop in effort in 2015-16 was due to a decline in use of gill net (large mesh) and seine nets, and these gear units are operated by multiple fishers.

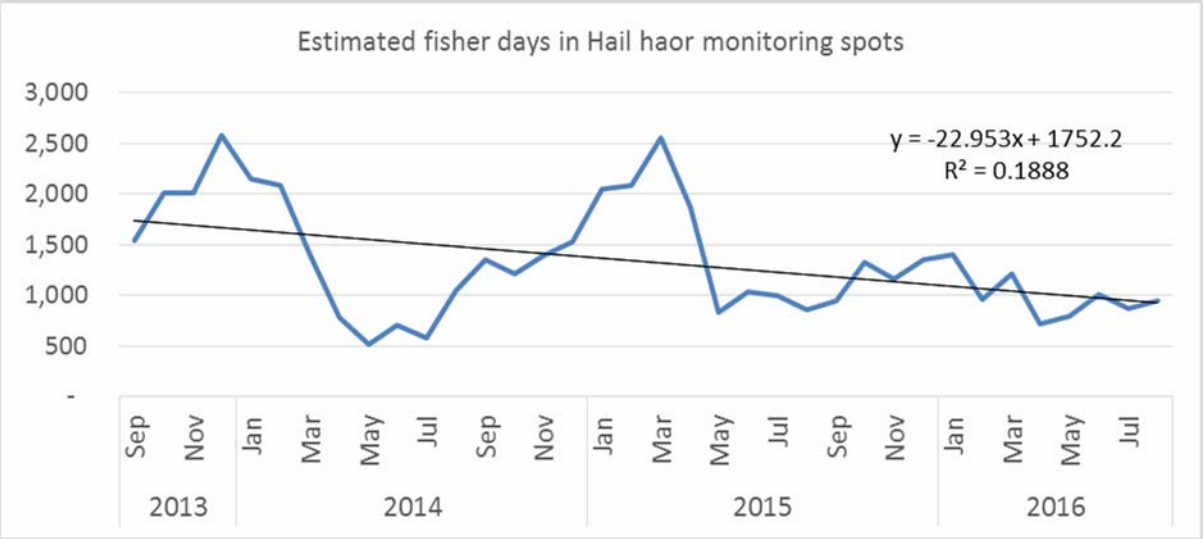
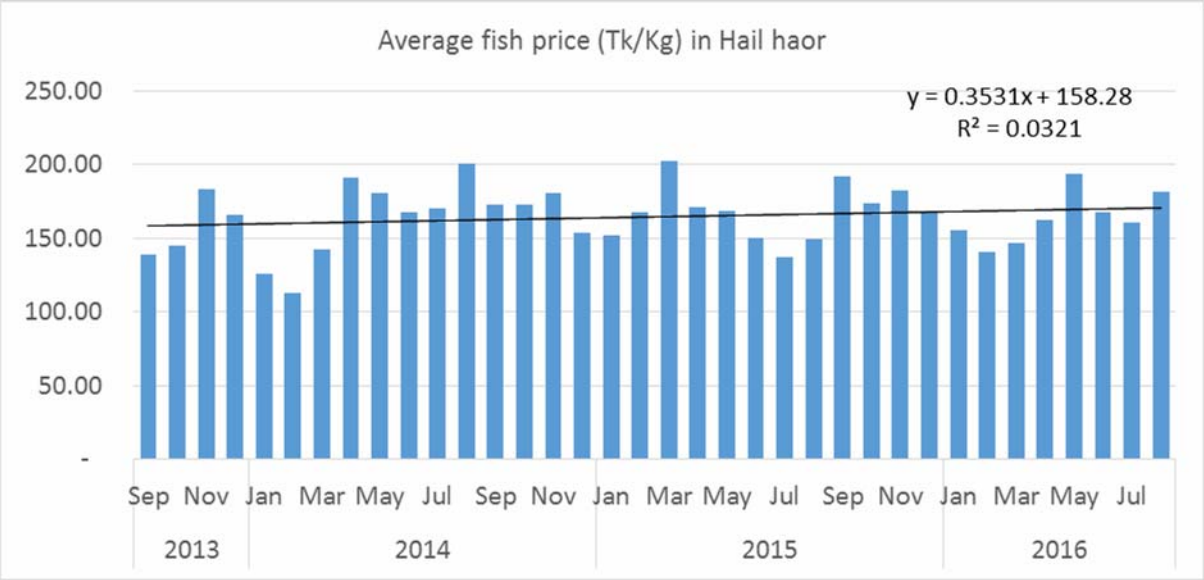


Fig. 3.7 Trend in monthly estimated fishing effort in monitored areas of Hail Haor

3.10 Fish Price in Hail Haor

The average fish price varies according to the fish species and seasonal supply and demand. The average fish price (combining all species) varied from Tk 125 to Tk 200 per kg and after allowing for seasonal variation was almost steady during the three years. Figure 3.8 shows that fish prices here tend to be higher in the pre-monsoon to monsoon and lower in the dry season (when fishing effort and catch are highest).

Figure 3.8 Average fish price (Tk/kg) in Hail Haor



3.11. Fish Catch Per Unit Area in Hail Haor

The wild fish production from Hail Haor was estimated from fish catch monitoring. There was substantial variation in fish catch (CPUA - Kg/ha/year) between sampling sites, during the CREL period CPUA ranged from 199 to 942 kg/ha/year. Moreover when compared with earlier periods, CPUA shows substantial differences for some survey sites, for example Cheruadubi Beel had the lowest CPUA (182-250 kg/ha/year during 2013-16, but had the highest CPUA (900-2174 kg/ha/year) during 2003-06 (Table 3.5).

Table 3.5. Yearly CPUA in sampling sites and in Hail Haor as a whole

Period	Year	Whole Hail Haor	62-Beel Complex	Alniberi	Balla Beel	Boulashir floodplain	Cherua dubi Beel	Gopla River	Jethua Beel	Lata River	Rustom pur Beel
Baseline	1999-00	**171.1**	263.7		35.6	69.8	278.3	393.7	121.6		159.1
Impact-1	2000-01	**205**	315.8		86.8	78	323	465.7	190.6		154.4
Impact-2	2001-02	**190.8**	256.9		123.6	62	619.5	490	160.1		144.9
Impact-3	2002-03	**287.3**	448.3		151.8	57.3	482.9	732.7	154.9		254
Impact-4	2003-04	**161.8**	156		165.8	70	900.8	523.5	102.5		116.7
Impact-5	2004-05	**388.6**	306		331.7	164	2174.8	1203.2	230.7		475.3
Impact-6	2005-06	**256**	229.7		250.6	103.6	1336.5	718.3	197.1		254.8
Impact-11	2010-11	**387**	350.7	1395.6	107.3		871.9	647.3		482.9	
Impact-12	2011-12	**370**	451.5	899.6	99.8		653.8	866.7		586.3	
Impact 14	2013-14	**401.6**	489	780	411		199	314		409	
Impact 15	2014-15	**402.1**	503	779	284		250	353		579	
Impact 16	2015-16	**406.6**	653	942	277		182	298		537	

3.12 Impacts

Estimated fish catch (kg/ha/year) for Hail Haor as a whole during CREL is compared with the MACH and IPAC periods in Fig. 3.9. While the main increases in CPUA occurred soon after co-management and conservation measures were introduced during MACH, these benefits have continued. Compared with the IPAC period, the average CPUA during CREL was about 15 kg/ha/year higher.

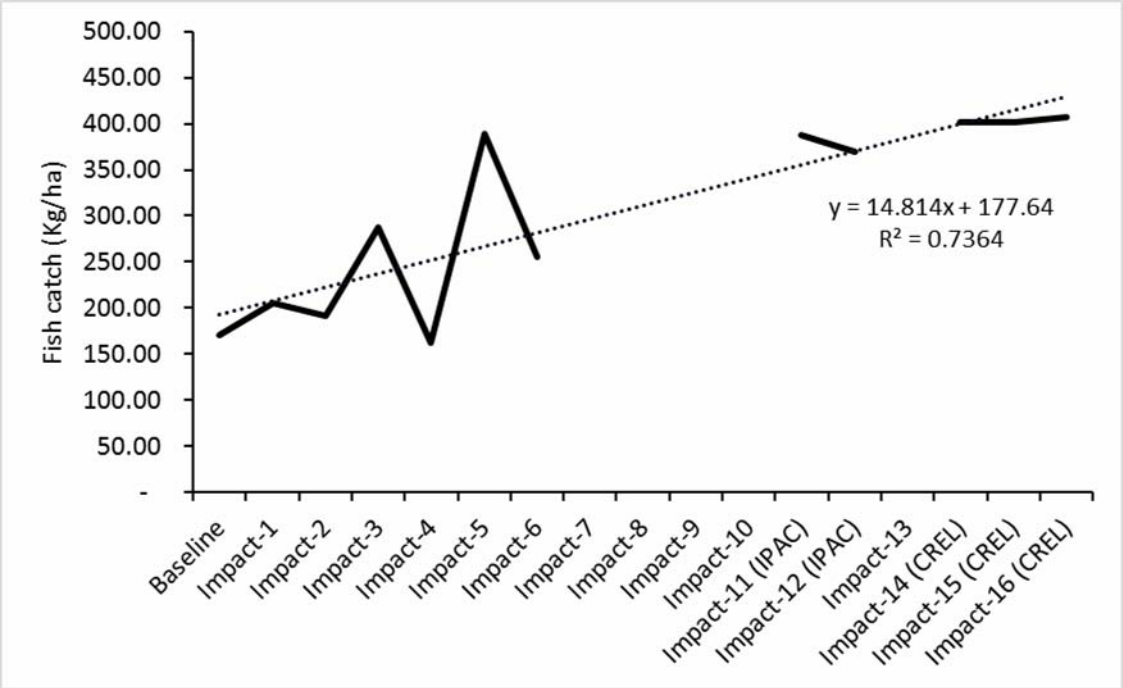


Figure 3.9. Fish catch trend in in Hail Haor
(Baseline: 1999-2000, Impact-1: 2000-01; Impact-2: 2001-02; Impact-3: 2002-03; Impact-4: 2003-04; Impact-5: 2004-05; Impact-6: 2005-06 during MACH; Impact-11: 2010-11; Impact-12: 2011-12 during IPAC; Impact 14: 2013-14; Impact 15: 2014-15; Impact 16: 2015-16 during CREL).

Since 2004 Baikka Beel has functioned as a sanctuary benefiting the entire haor, and this appears to have had an important impact on CPUA, but in 2012 seven other RMOs lost rights to manage sustainably a range of other waterbodies, while several of the monitored areas have not been managed by RMOs. Considering the survey areas as representative of different haor wetland habitats and different local management arrangements, Table 3.5 highlights the impacts of some changes in community rights and the implications for sustainable capture fisheries. Balla Beel was managed by Balla RMO on a sustainable basis, CPUA increased to a sustainable level during MACH, then in about 2012 when the RMO lost rights local elites grabbed the waterbody and maximized their short term catch (by destroying the sanctuary and dewatering), catch reached a short term peak in 2013-14 and has since then been declining. Gopla River was never under RMO management, local elites and mosque committees control access and could not be influenced to adopt conservation and wise use, fish are concentrated here and in line with successful conservation in the rest of the haor catches increased, but have more recently fallen substantially.

3.13. Overall Fish Catch Estimates for the Haor

During MACH the standardized maximum extent of the haor wetland was found to be 12,490 ha, however since then areas have been progressively enclosed by high bunds for aquaculture farms and these areas are no longer part of the seasonally inundated floodplain and do not contribute to the open water catch (Section 3.2). Estimation of the total open water fish catch from the haor is based on the annual CPUA derived from catch monitoring, and the estimated area of remaining open floodplain and wetland. Table 3.6 gives the results of this analysis. During the initial years of co-management and restoration works fish catches fluctuated in response to water extent, but since the time of the IPAC project catches appear to have reached a constant high level, and annual fish production is about 115% of the baseline level. Based on survey data in the haor area the average fish price was found to be Tk. 169 in 2016, and this is used as a constant current price for valuing changes in fish production. On average the additional value of fish caught in Hail Haor during the CREL project was modest compared with the IPAC project (about Tk 14.5 million or US$ 0.19 million per year), because the

maximum sustainable catch of fish from the wetland had already been achieved during the earlier IPAC period, and the open wetland area has been falling due to aquaculture. A survey conducted in all villages in and around Hail Haor during CREL gave a total estimate of households involved in fishing of 3,776, estimates from the earlier eras are not available, from this and assuming on average five persons per household about 18,800 people live in households directly involved in open water fishing in the haor. If the same number of households are assumed to have been fishing in the haor since 1999-2000, annual household incomes from fishing in the CREL era were about Tk 112,000 higher in 2016 prices than they would have been in 1999-2000. Compared with the baseline year, and using the average annual incremental value of fish from the preceding era for years without fish catch data, the cumulated additional value of fish catch from the haor during 16 years of USAID support is estimated to be worth about US$ 52 million.

Table3.6 Estimated total open water fish catch and value in Hail Haor 1999-2000 to 2015-16

Year	Year (ending of survey year)	Estimated aquaculture area (ha)	Open haor area (ha)	CPUA (kg/ha)	Estimated fish catch (t)	% change over base catch	Value of fish Tk mill (constant 2016 price Tk 169/kg)	Incremental fish value over baseline (Tk mill)	Average value of annual catch by era (Tk mill)	Increased value of fish over previous era (Tk mill pa)
Baseline	2000	101	12389	171.1	2120	na	358.20	na	358.20	na
I1	2001	144	12346	205.0	2532	19.4	427.84	69.64	513.08	154.88
I2	2002	186	12304	190.8	2347	10.7	396.63	38.43		
I3	2003	229	12261	287.3	3522	66.2	595.27	237.08		
I4	2004	272	12218	161.8	1977	-6.7	334.14	-24.06		
I5	2005	315	12175	388.6	4732	123.3	799.66	441.47		
I6	2006	357	12133	256.0	3106	46.6	524.93	166.73		
I7	2007	400	12090	*						
I8	2008	452	12038	*						
I9	2009	504	11987	*						
I10	2010	555	11935	*						
I11	2011	607	11883	387	4599	117.0	777.18	418.99	772.40	259.32
I12	2012	692	11798	385	4542	114.3	767.62	409.42		
I13	2013	778	11712	*						
I14	2014	863	11627	401.6	4669	120.30	789.13	430.93	786.89	14.49
I15	2015	948	11542	402.1	4641	118.96	784.31	426.11		
I16	2016	1034	11456	406.6	4658	119.77	787.23	429.03		

* no fish catch monitoring undertaken in these years

3.14. Fish Diversity

A total of 86 species of fish and prawn were recorded during the three year CREL study period in Hail Haor. As Fig. 3.10 shows, the highest diversity was in Gopla River, and the lowest diversity in 62-Beels. The trend in number of species recorded in sample catches in Hail Haor during MACH, IPAC and CREL eras is presented in Figure 3.11. Overall the number of species recorded in catches had been increasing, and MACH (2006) reports the initial impacts of restoration of locally scarce species, but the species diversity trend in the three years of CREL monitoring is downward and may be the result of more intensive fishing and dewatering of waterbodies that are no longer under management by RMOs, or the effect of aquaculture bunds reducing floodplain wetland.

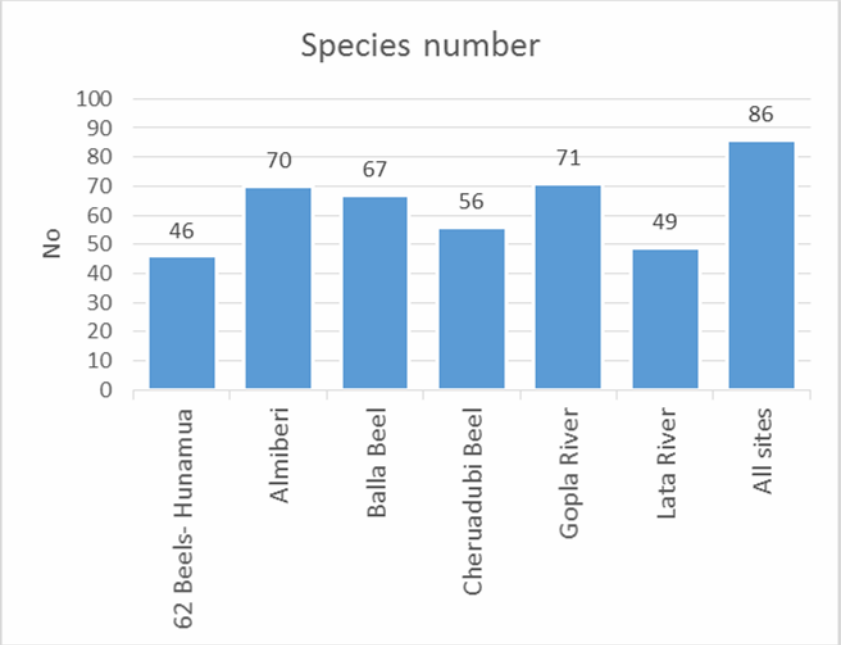


Fig. 3.10. Total number of fish species recorded from Hail Haor catch monitoring sites during three years of monitoring under CREL.

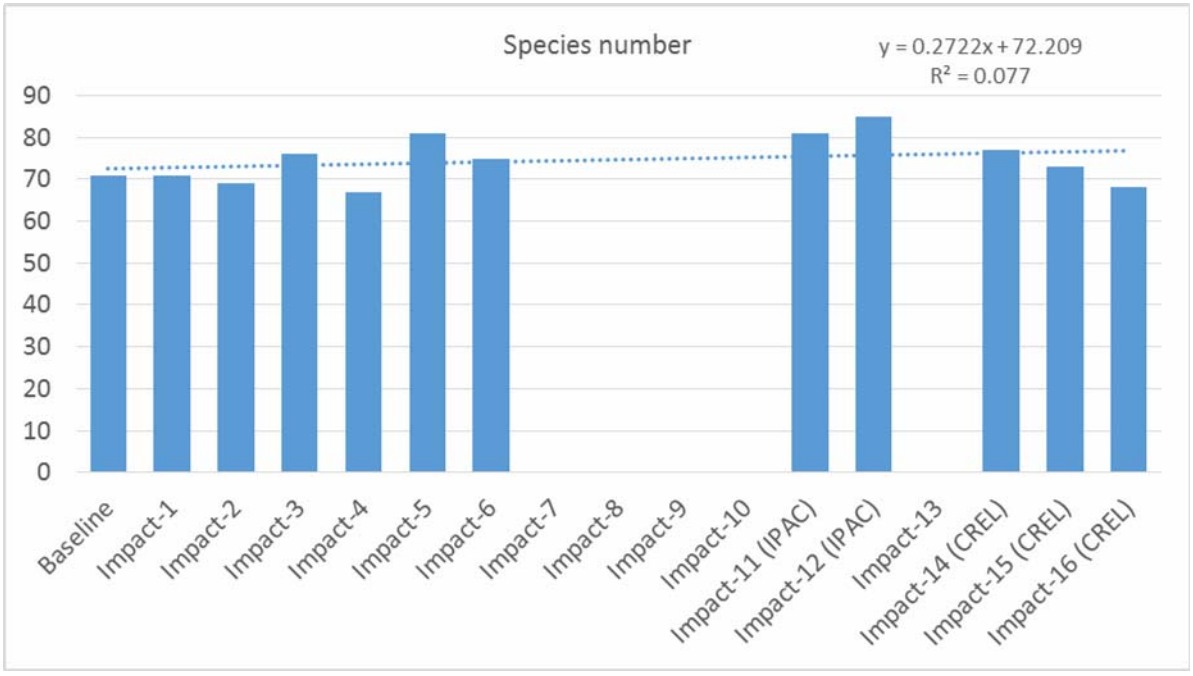
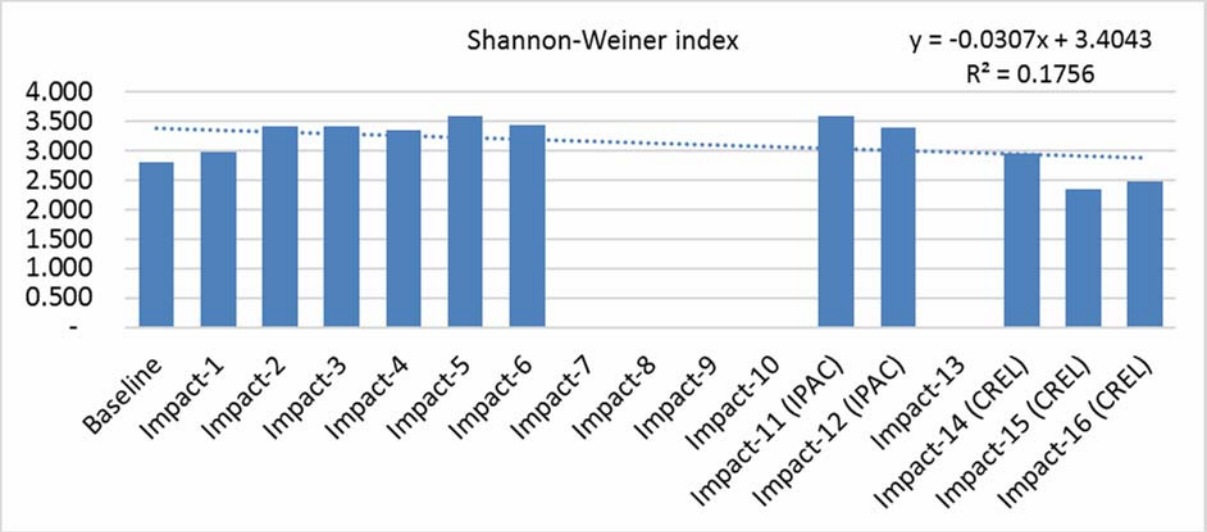


Figure 3.11 Trend in fish species number in Hail Haor
(Baseline: 1999-2000, Impact-1: 2000-01; Impact-2: 2001-02; Impact-3: 2002-03; Impact-4: 2003-04; Impact-5: 2004-05; Impact-6: 2005-06 during MACH. Impact-11: 2010-11; Impact-12: 2011-12 during IPAC. Impact 14: 2013-14; Impact 15: 2014-15; and Impact 16: 2015-16 during CREL).



Biodiversity of all fish species was also measured using the Shannon-Wiener index (H') (see Chapter 2). This reached its lowest levels in the CREL era compared with previous years (Fig. 3.12), this is a worrying trend and indicates that not only have fewer fish species been caught in more recent years, but that the catch is becoming more dominated by a few species (less even). Since the condition of Baikka Beel sanctuary is largely unchanged throughout the period since 2004, we interpret this recent trend to be the result of RMOs losing access rights with associated loss of small sanctuaries and reduced observance of closed seasons, increasing dewatering by elites controlling waterbodies, and loss of areas of floodplain and connections due to aquaculture.

CHAPTER 4 HAKALUKI HAOR

4.1 Introduction

Hakaluki Haor is the largest single *haor* in Bangladesh and an important "mother fishery", and is reported to support more than one hundred fish species (FAP 6, 1994). It is located in north-east Bangladesh in Kulaura, Juri and Borolekha Upazilas of Moulvi Bazar District and Fenchuganj and Golapganj Upazilas of Sylhet District, latitude 24°35' N to 24°45' N and longitude 92°00' E to 92°08' E (Fig. 4.1). It forms a large single sheet of water during the monsoon, but in the dry season comprises over a hundred interconnecting *beel*s (waterbodies) along with rivers/channels, rice fields, marshy areas, and open lands used for grazing. The haor is bordered by low hills - the Patharia and Madhab hills to the east and the Bhatera hills to the west. In recognition of the urgent need to protect Hakaluki Haor from further degradation, the Government of Bangladesh in 1999, under the provisions of the Bangladesh Environment Conservation Act, declared this haor as an "Ecologically Critical Area" (ECA).

The area of this haor and its ECA are uncertain, although Department of Environment gives an official ECA area of 18,383 ha, the ECA is believed to be larger (possibly 39,000 ha) as it includes watershed areas such as surrounding hillocks, forests, tea estates and rubber gardens. The maximum monsoon season water extent of the haor is estimated to be about 18,000 ha and this area remains under water for five or more months. In the peak of the dry season the area of surface water is estimated to be around 6,000 ha. The other two-thirds of the haor comprise of slightly higher "*kanda*" lands many of which are heavily grazed, and marshy fringes to waterbodies – much of which are planted with a single dry season rice crop. The original reed swamps and swamp forests of the *kanda* have been cleared. There are over 200 small and large beels within the haor, some of which are perennial and others seasonal. Five rivers mainly feed the haor: the Juri/Kantinala, Sonai /Bordol, Damai, Fanai and Kuiachara rivers; and it drains out through a single outlet - the Kushiara river. The Sonai /Bordol and Juri/Kantinalla rivers originate in India. Around 190,000 people living in 254 villages directly or indirectly depend on wetland resources of Hakaluki Haor for their livelihoods (CWBMP, 2006). CREL Project conducted a key informant survey (local fishers, waterbody leaseholders, school teachers, Union Parishad members, Village Conservation Group members, farmers, elites) to assess the number of fisher households in 78 villages in 2014, from this 12,811 households were found to be directly involved in fishing (categorized as full time, part-time, and subsistence fishing), the other households living around the haor depend mainly on agriculture and other occupations.

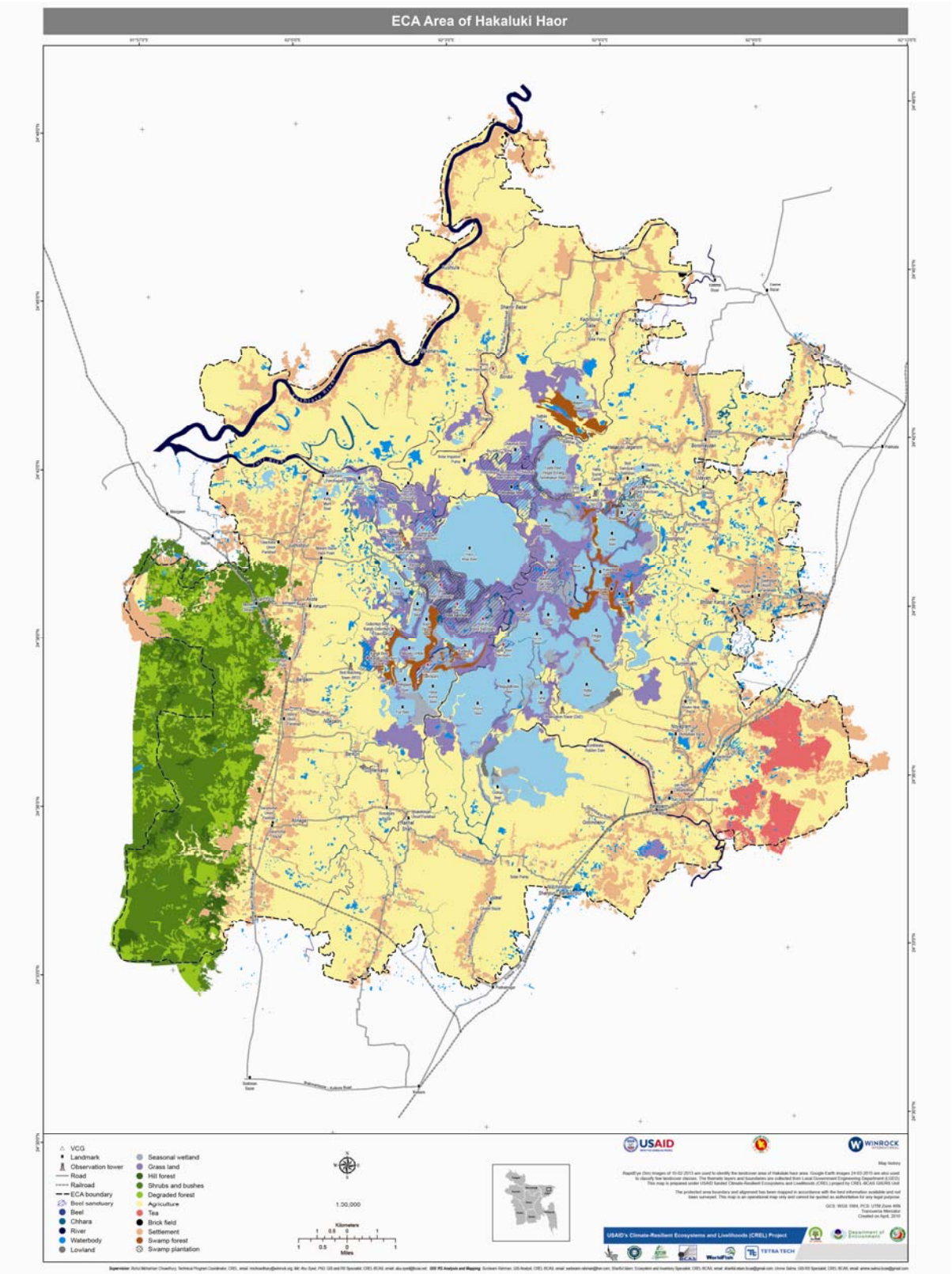


Fig. 4.1 Hakaluki Haor and adjacent landscape

Moving fish traps (left), and fishing (right) in Hakaluki Haor (15 September, 2014).

4.2 Management Institutions, Interventions and Monitoring

The Department of Environment has specified a multi-tier co-management system in ECAs based on administrative units, without clear mechanisms for coordination at the ECA level or strong representation from local communities in higher tiers. Under a National ECA Committee which is intended to coordinate between ministries and departments at a central level (covering sectors such as land, agriculture, forests, social development and tourism), the two districts where Hakaluki Haor is located each have a district level ECA committee intended to resolve issues that could not be solved at upazila level. The five Upazila ECA committees comprise mainly of government officials but also with fisher cooperative and Village Conservation Group representation. Hakaluki Haor has 11 Union ECA Committees and 28 Village Conservation Groups (VCG) at grassroot level (Figure 4.2). VCGs are directly involved in conservation activities based largely on funding from projects and responsibilities allocated to them such as protecting sanctuaries and swamp forest. The VCGs and various ECA committees have not set specific fishing rules other than protecting sanctuaries, but they are supposed to promote compliance with laws and report any illegal activities such as hunting and use of illegal fishing gears to government bodies.

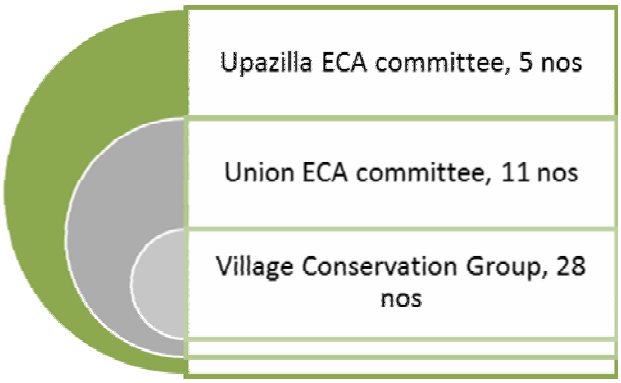


Fig. 4.2 Different levels of management committees for Hakaluki Haor ECA

Out of 125 jalmohals (public waterbodies) within the haor, a total of 524 ha (11% of the public wetland area) has been permanently reserved since 2010 and 2011 (Appendix 4.1) by the Ministry of Land as 12 wetland sanctuaries. These sanctuaries are largely under management by VCGs supervised by the Upazila ECA Committees. CREL has supported VCGs protecting five of these sanctuaries. A further 671 ha of land has been planted with swamp forest trees and another 648 ha protected for regeneration of swamp thicket vegetation by VCGs, and these areas act as seasonal refuges and foraging habitat for fish. However, the status of these lands is in some cases disputed, and the Government of Bangladesh has not formally recognized the local conservation status of these areas. Out of this area 111 ha were planted with swamp trees with CREL support. CREL also invested in submersible bunds to retain more water in three sanctuaries covering about 39 ha (Table 4.1). Hence

in total about 1843 ha or about 10% of the total area of the haor can be considered to be within conservation / sanctuary areas.

Table 4.1 Biophysical improvement supported by the CREL project in Hakaluki Haor

Sl #	VCG and beel name	Area (ha)	Date	Intervention
1	Akota VCG, South kanda of Haor khal beel	12	Nov, 2014	Hijal, Koroch
2	Akota VCG, West kanda of Gajua beel	4	Oct, 2014	Hijal
3	Akota VCG, Gajua beel kanda	35	Oct, 2014	Hijal
4	Hakaluki Jagorani VCG, West, North and South kanda of fuala beel	3.76	Oct, 2014	Hijal
5	Halla VCG, West and south kanda of Koiyerkona beel	4.56	Oct, 2014	Hijal, Koroch
6	Halla VCG Koiyar Kona Beel Sanctuary	30.45	Feb, 2015	Enhanced water retention
7	Judhistipur-Badeduli VCG, East kanda of Baiya Beel	4	Oct, 2014	Hijal
8	Judhistipur-Badeduli VCG, North kanda of Meda Beel and south kanda of Baiya Beel	12.7	Nov, 2014	Hijal
9	Judhistipur-Badeduli VCG, Baiya beel kanda	35	Nov, 2015	Hijal, Koroch
	Total	141.47		

Source: (http://www.crellinkbd.org/admin.php/biophysical-activitys/biophysical_activity_profile/?p=4&rid=30)
Note: Hijal and Koroch are two species of native swamp forest trees

Fish catch monitoring was undertaken in nine waterbodies and floodplain areas see Section 2.1 for details, covering 469.3 ha. The locations of monitored areas and of fish and swamp forest sanctuaries are shown in Fig. 4.1.

4.3 Fisher Population

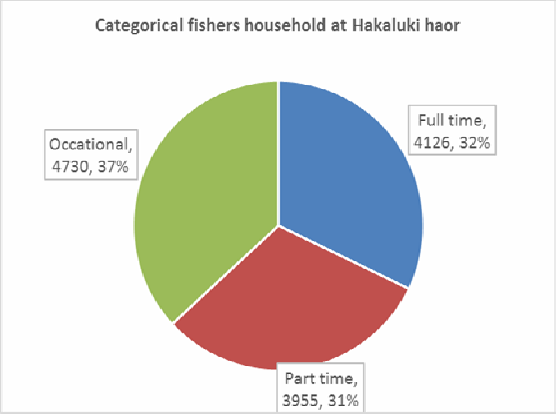


Fig. 4.3 Number of fishing households active in 2014 in Hakaluki Haor

Households engaged in fishing in Hakaluki Haor have been categorized into full time, part-time (seasonally fishing for an income) and occasional fishers (fishing mainly for own consumption, but may sell some fish if they catch more). On average full time fishers spent about 300 days in a year fishing, 90 days a year for part time fishers, and 60 days a year for occasional fishers. The CREL survey (see earlier) found 12,811 households involved in fishing living in 78 villages adjacent to Hakaluki Haor, these were split almost evenly between the three categories with just over 4,000 full time fishing households (Fig. 4.3). This compares with the ECA Management Plan, 2006, which reported that among 34,445 households about 21,907 (63.6%) households involved in fishing from all the villages adjacent to Hakaluki Haor, which would appear to substantially overestimate the number of households now fishing in the haor. The distribution of fishing households is shown in Appendix 4.2.

4.4 Trends in Fishing Effort

Based on the monitoring sites and monitored days, multiplied up by the total haor area, the overall total number of fisher days of fishing was estimated per month for Hakaluki Haor. Fishing intensity varies seasonally and is at its peak in the late monsoon season. The leaseholders of jalmohals within Hakaluki Haor normally do not restrict fishing by local fishers during the monsoon, but restrict fishing when the water level declines and the perimeter of their leased waterbody becomes visible. The most commonly used fishing gears are gill nets, seine nets, traps, and long line (multiple hooks). The fishing peak was prolonged in the 2015 compared with 2014 (Fig. 4.4), which had a short but intense fishing peak, when fish stocks were fished out by a brief intensive period of seine net fishing,

while fishing effort in the 2016 monsoon was low. Overall there was no significant trend in fishing pressure in Hakaluki Haor during the three years.

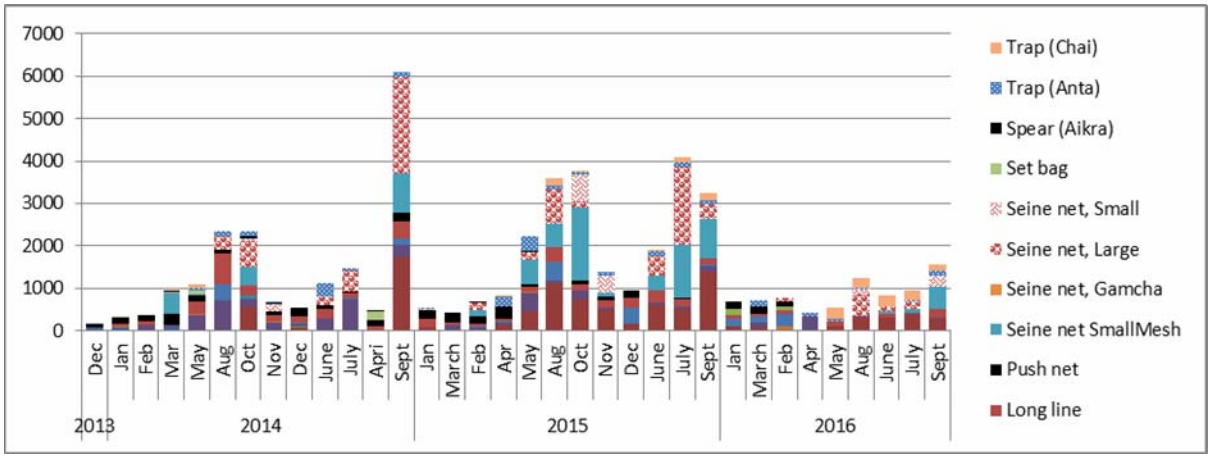


Fig. 4.4 Estimated number of fisher days by gear type observed in monitoring locations in Hakaluki Haor

4.5 Trends in CPUE

The catch per unit effort (CPUE) is here calculated as the average daily catch per gear type (catch of surveyed gear units divided by number of surveyed gear units) – here a seine net operated by multiple fishers is treated as a unit, and likewise one or more fishers operating individually or as a team a network of several (even hundreds) of fish traps is also treated as one unit. Gears differ for example in their size, the wetland conditions they are suited to, and the species they target. Variation in CPUE was observed for different gears in Hakaluki Haor between years, particularly for traps (Table 4.2). On average over three years a catch of 3.73 kg/day was found in gill nets which are operated typically by two fishers, on the other hand the average catch was 15.73 kg/day for seine nets which here are operated usually by 6 to 8 fishers depending on the length of net (hence the catch per person was about 1.8 kg/day from gill nets and 2.2 kg/day from seine nets). Three of the main gears showed no clear trend over the three years, but catch per trap fishing unit increased greatly because the fishers operating traps increased the number of traps per fishing unit, meaning that actual fishing pressure from traps increased, even though the number of unit days did not change much.

Table 4.2. Gear wise catch per unit effort (kg/fishing unit/day) in Hakaluki Haor

Gear	Average	2013-14	2014-15	2015-16	Change
Gill net	3.73	2.68	3.81	3.69	none
Seine net	15.73	13.12	19.61	10.22	none
Trap	11.14	3.92	8.49	12.14	increase
Hooks and line	3.84	3.24	4.34	3.41	none

4.6 Trends in CPUA

Catch per hectare (catch per unit area or CPUA) was calculated for each survey location by multiplying up from the survey fishing units, observed effort and survey dates, to estimate total catch in each location over the 12 month period and then dividing this by the area monitored. This revealed substantial differences

Table 4.3 Yearly CPUA in sampling sites in Hakaluki Haor

Monitoring location	Area (ha)	CPUA (kg/ha/year)			Changes
		2013-14	2014-15	2015-16	
Boaljur Beel	28.52	103	92	427	+
Charua Beel	6.38	420	488	2,754	+
Choula Beel	14.03	933	1,055	351	-
Dudhai Beel	145.86	34	51	21	+
Fanai River	2.00	929	842	181	-
Gorchikona Beel	6.27	1,036	1,323	356	-
Juri River	4.00	832	1,557	4,227	+
All	207	171	213	277	+

between locations and years (Table 4.3). For example, the largest area monitored - Dudhai Beel - is a perennial beel, and had by far the lowest CPUA, because open fishing is more or less restricted here by the lease holder.. Whereas monitoring in two of the smaller monitoring locations – Charua Beel and Juri River – showed a dramatic increase in catch in year 3 (2015-16) to levels that do not reflect the area that was shown in monitoring, one reason in the case of Juri River is that a significant part of the haor drains out through this river and fish are concentrated here. Charua Beel is operated as a traditional "pile fishery" where the leaseholder installs a large brushpark (katha) and harvests that fish aggregating device in the third year by removing the bamboos and tree branches (and often dewatering), and 2015-16 was the year of pile fishing in that beel which explains the high catch that year. The overall fish catch per hectare increased during the three years of monitoring - in year 2 (2014-15) catches were 25% higher than in the previous year, and in year 3 (2015-16) catches were 62% higher than in year 1 (2013-14).

4.7 Trends in Catch Composition

The 20 dominant species by weight in the sample catch over three years combined are shown in Table 4.4. This shows that only one small fish species, small shrimps, and an introduced exotic species of fish that presumably escaped into the haor (Grass Carp) increased as a proportion of catch, with the other main species declining or showing no discernable trend. Notably native large fish species including Boal, Ayre and Kalibaus have declined (Fig. 4.5) which may reflect overfishing, or failure of the fish sanctuaries to protect them. Nationally threatened fishes recorded in Hakaluki Haor include Kalibaus, Boal, Foli, Chital, Pabda and Gazar. The percentage contribution of small prawns increased greatly in year three and this is considered to be an indicator of overfishing, fish habitat degradation and potential fishery collapse (de Graaf et al. 2001). On this basis the increase in catch per ha during the three years may not be sustainable. Moreover the diversity of fish catch is declining – the 20 main species contributed 82% of catch in year 1 and 79% of catch in year 2 but rose to 93% in year 3 (see also Appendix 4.3).

Table 4.4: Fish catch composition in Hakaluki Haor

Rank	Local name	Scientific name	Percentage of sample catch by weight			Trend
			2013-14	2014-15	2015-16	
1	Gura icha	*Macrobrachium lamarrei*	3.90	5.46	26.86	Increased
2	Chapila/Korti	*Gudusias chapra*	12.09	6.36	6.55	Decreased
3	Jatputi/Vadi Puti	*Puntius sophore*	10.55	8.83	4.24	Decreased
4	Kalibaus/Baus	*Labeo calbasu*	7.93	8.97	4.00	Decreased
5	Tit Puti	*Puntius ticto*	2.97	2.84	9.44	Increased
6	Boal	*Wallago attu*	6.05	6.06	5.34	No trend
7	Meni/Veda/Royna	*Nandus nandus*	5.58	7.03	3.62	Decreased
8	Tengra/Guinga	*Mystus vittatus*	4.31	0.96	7.65	Increased
9	Ayre	*Mystus aor*	7.01	3.51	3.19	Decreased
10	Lomba Chanda	*Leiognathus equulus*	2.32	2.16	5.90	Increased
11	Chatka Icha	*Macrobrachium malcolmsonii*	1.43	7.99	0.79	No trend
12	Gazar/Gazal	*Channa marulius*	2.52	5.45	2.08	No trend
13	Shol/Shoil	*Channa striatus*	1.58	2.60	2.42	No trend
14	Grass Carp	*Ctenopharyngodon idellus*	-	0.29	4.60	Increased
15	Air	*Arius platystomus*	-	-	4.13	Increased
16	Boro Baim/Shal Baim	*Mastacembelus armatus*	0.52	3.70	0.61	No trend
17	Foli/Kanila	*Notopterus notopterus*	4.96	1.15	0.29	Decreased
18	Goinna	*Labeo gonius*	3.28	1.70	0.48	Decreased
19	Golsha Tengra	*Mystus bleekeri*	2.92	1.94	0.41	Decreased
20	Raek/Nora/Lachchu	*Cirrhinus reba*	1.79	2.30	0.15	Decreased
Catch percentage of 20 species			81.73	79.31	92.74	

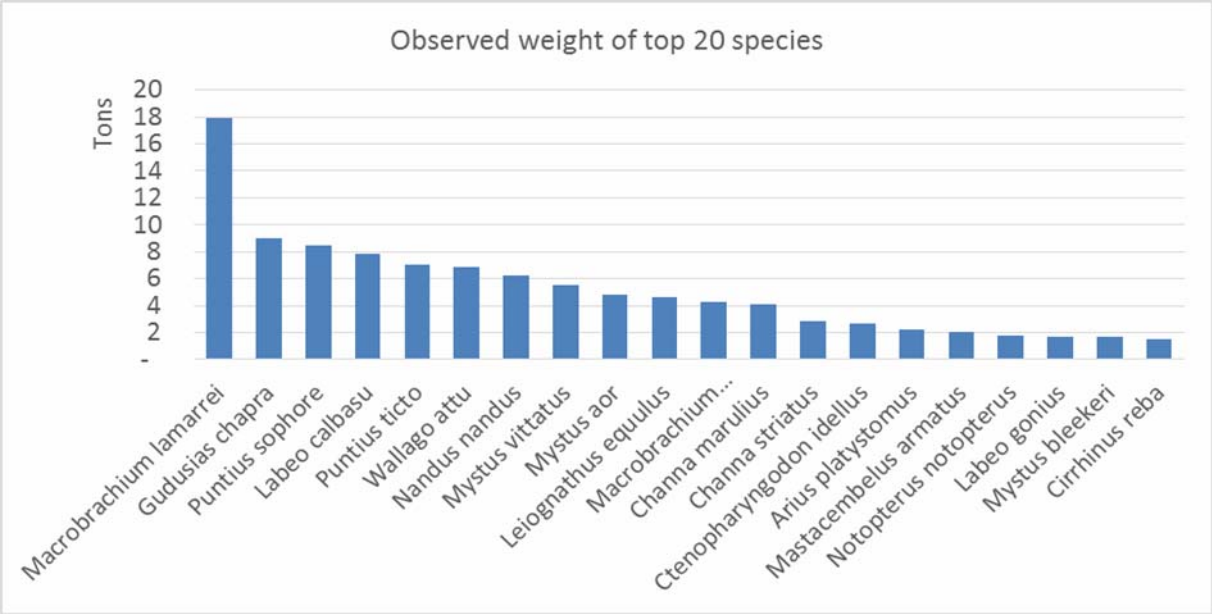


Figure 4.5: Contribution of top 20 fish species to sample catch in Hakaluki Haor, 2013/14 – 2015/16

4.8 Trends in Fish Prices

Variations in average fish price normally depend on the overall supply of fish, the relative supply of different fish species, and demand. Fish prices were consistently lowest in the post-monsoon (peak fishing) season when water is draining out of the haor and the fish that have reproduced and fed in the fully flooded haor become concentrated in rivers and beels and are easier to catch. Fish price was highest in the second half of the dry season (February-March) and in the early monsoon when there is little part-time and subsistence fishing, and the area of water for open fishing is least. However, the monsoon fish price remained relatively high compared with the post-monsoon season. Average fish price varied from below Tk. 100 to above Tk. 200 per kg and slightly increased over the three consecutive years. Fish price variation between months and years is shown in Figure 4.6. Fish prices were higher during 2014-15, despite a higher catch in that year than in 2013-14.

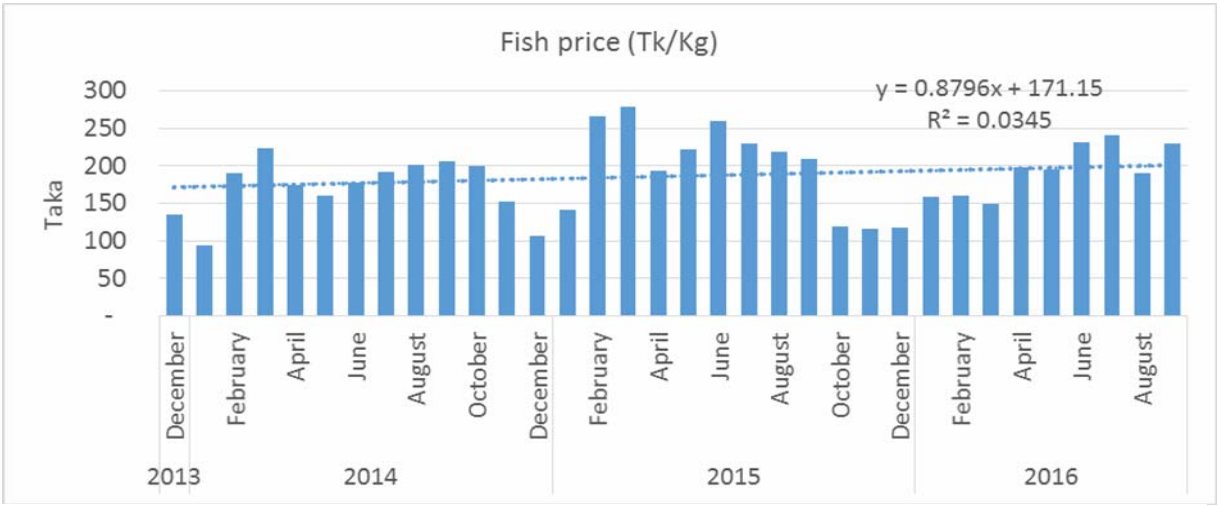
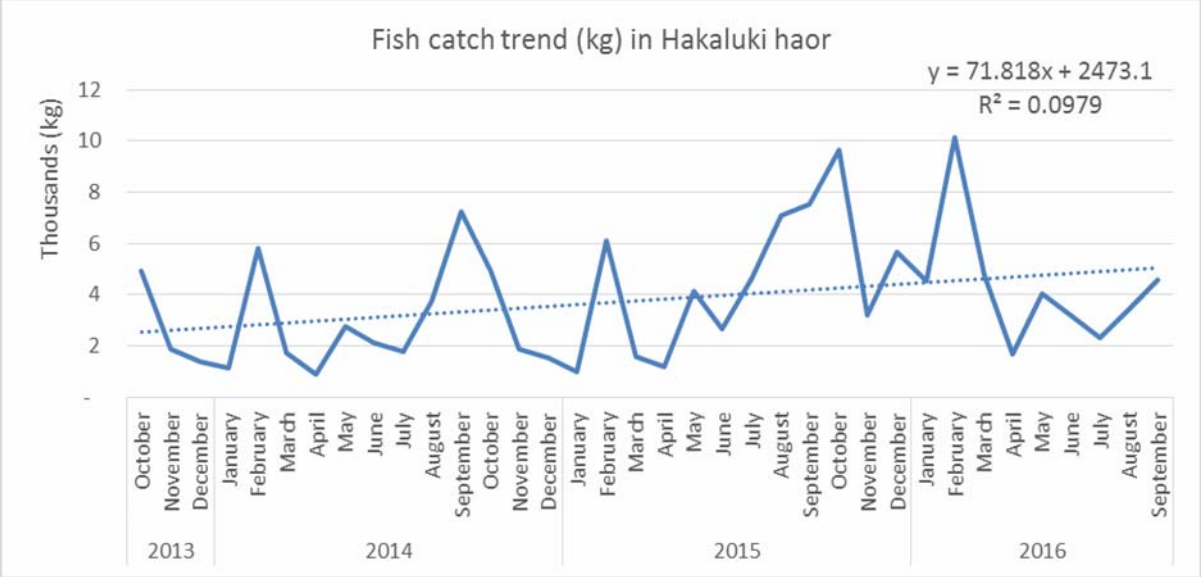


Figure 4.6: Monthly fish price in Hakaluki Haor

4.9 Overall Fish Catch Estimates and Value

Overall the estimated total fish catches in Hakaluki Haor fluctuated greatly between months with clear peaks during the late monsoon (September-October) and again during February (peak dry season when jalmohals are harvested) (Fig. 4.7), and also showed a rising trend.



Total fish catch and value for Hakaluki Haor were estimated based on the maximum water extent of the haor of 18,383 ha, estimates of CPUA made earlier of 171, 213 and 277 kg per ha per year during 2013-14, 2014-15 and 2015-16, and a constant average fish price (2016) of Tk. 176 per kg. This gave an estimate of fish catch in 2013-14 of 3,144 t, valued in 2016 prices at Tk 553 million (about US$ 7.1 million). In the subsequent year (2014-15) fish catch was estimated at 3,915 t, valued in 2016 prices at Tk 689 million (about US$ 8.8 million), and in 2015-16 fish catch was estimated at 5,092 t, valued in 2016 prices at Tk 896 million (about US$ 11.5 million). Therefore considering the three years there was an additional Tk 478 million (US$ 6.1 million) of fish caught from the haor in the second and third years compared with the first. It is tempting to attribute this increase to fishery and habitat management practices such as fish sanctuaries, and these are believed to have played a part, but the increasing catch of freshwater shrimps at the expense of larger fin fish also suggests that the haor continues to be overfished.

Fig. 4.7 Fish catch trend in Hakaluki Haor during monitoring period.

4.10 Management Recommendations

Although a number of fish sanctuaries and protected swamp forests have been established in the haor, the VCGs have no influence over leased out jalmohals. Fishing is traditionally open access in the full monsoon, but most fish are caught in the post monsoon and dry season when leaseholders do control access.

As noted above, it is tempting to attribute the increase in fish catches in 2015-16 to conservation measures, but most of this catch was of small shrimps and small fish. The decline in the catch of larger fish including carnivorous fish combined with the increase in small shrimp catch suggests that within just this three year period leaseholders and fishers are fishing down the food web threatening

the long term survival of a diverse high value fishery in the haor. To restore and sustain a diverse productive fishery the following are recommended:

1. All existing fish sanctuaries and swamp forests should continue to be protected by VCGs
2. The government should enforce rules and limits on fishing by or through leaseholders to allow survival of large fish to reproduce, including:
   a. observing a closed season in the pre-monsoon when many species reproduce, and
   b. ensuring that the traditional practice of only draining one jalmohal per year in a "group fishery" is restored and followed.

CHAPTER 5 SUNDARBANS

5.1 Introduction

The Sundarbans is the largest contiguous area of mangrove forest in the world, about two-thirds of the area is within Bangladesh and in the remainder of this chapter this is what is referred to as the Sundarbans (the rest is within India). The wetland resources of the Sundarbans are of high importance both in terms of national economy and livelihoods of local people. The Sundarbans contributes about 5% of the total national wild fish catch. It is estimated that 400,000 people living around Sundarbans depend for their livelihoods on the resources of Sundarbans. The Sundarbans ecosystem supports a rich fish diversity. IFMP (1998) reported 168 species of bony (Osteichthyan) fish, and 31 species of crustacean from the Sundarbans Reserved Forest (SRF). Hossain (2013) claimed that the Sundarbans region supports 196 species of fish, while an estimated 120 species of fish are commonly caught in the Sunderbans. This system forms a large natural nursing and breeding ground for fish (Huq et al., 2001).

The Sundarbans Reserved Forest covers over 4% of Bangladesh and is located from latitude 21°27'30" to 22°30'00" North, and longitude 89°02'00" to 90°00'00" East. The official area is reported to be 601,700 ha according to the Forest Department. Including marine zone the area is 7,620 km^2 (4,143 km^2 of forest/land; 1,874 km^2 of rivers, streams and canals; and 1,603 km^2 of "marine" (estuarine) zone) (Sundarbans Biodiversity Conservation Project, 2000) (Fig. 5.1). The entire area has been designated as a wetland of international importance (Ramsar site), while the original wildlife sanctuaries in the Sundarbans have been declared a World Heritage Site by UNESCO.

> "Nearly one-third of the Sundarbans is composed of a complex network of tidal and fluvial waterways ranging from a few meters to a few kilometers wide and carries substantial sediment load with a large amount of nutrients" (Forest Department, 2010).

The principal fresh water inflow to the Sunderbans originates from the Ganges/Padma rivers via the Gorai, Bhairab, Rupsha and Pasur Rivers to the central parts of the Sundarbans, and via the Arial khan and Baleshwar Rivers along the eastern boundary of the Sundarbans. There are nine major north-south aligned rivers flowing through the Sundarbans, from west to east these are: Raimangal, Jamuna, Malancha, Arpangasia, Shibsa, Pasur, Sela, Bhola-Supoti and Baleshwar (Sundarbans Biodiversity Conservation Project 2000).

5.2 Survey Locations

Fish catch monitoring was undertaken in the following locations (see Fig. 5.1), these same four river/khal sections were monitored during IPAC from April 2010 to October 2012:

1. **Malancha River** (locally called Dhumkoli River) in Munshigonj Upazila from Horinagor point to the East Side River turning (16 ha), note that Dhumkoli River forms part of the border between Sundarbans and settlements.
2. **Chila Khal** (canal) at Chila from its confluence with the Pasur River for about 1 km upstream along the khal to Chila Bazar (4 ha). Pasur River is the main navigation route to Chalna port in Mongla. Artisanal fishing is found in Chila Khal. This khal is in the middle of the northern part of the Sundarbans.
3. **Bhola River** in Sarankhola Upazila, from Sarankhola bazar upstream to near CSB bazar (27 ha), this river also forms the boundary between the east side of Sundarbans and settlements in Sarankhola (Photo-5.1).
4. **Baleshwar River** in Gabtoli Upazila, from Gabtoli Bazar upstream to the north end of Majher Char (120 ha). Both sides of this river have settlements, the monitoring site was just outside

the Sundarbans and the river flows southwards through the Sundarbans into the Bay of Bengal. Baleshwar River is wider than the other monitoring locations.

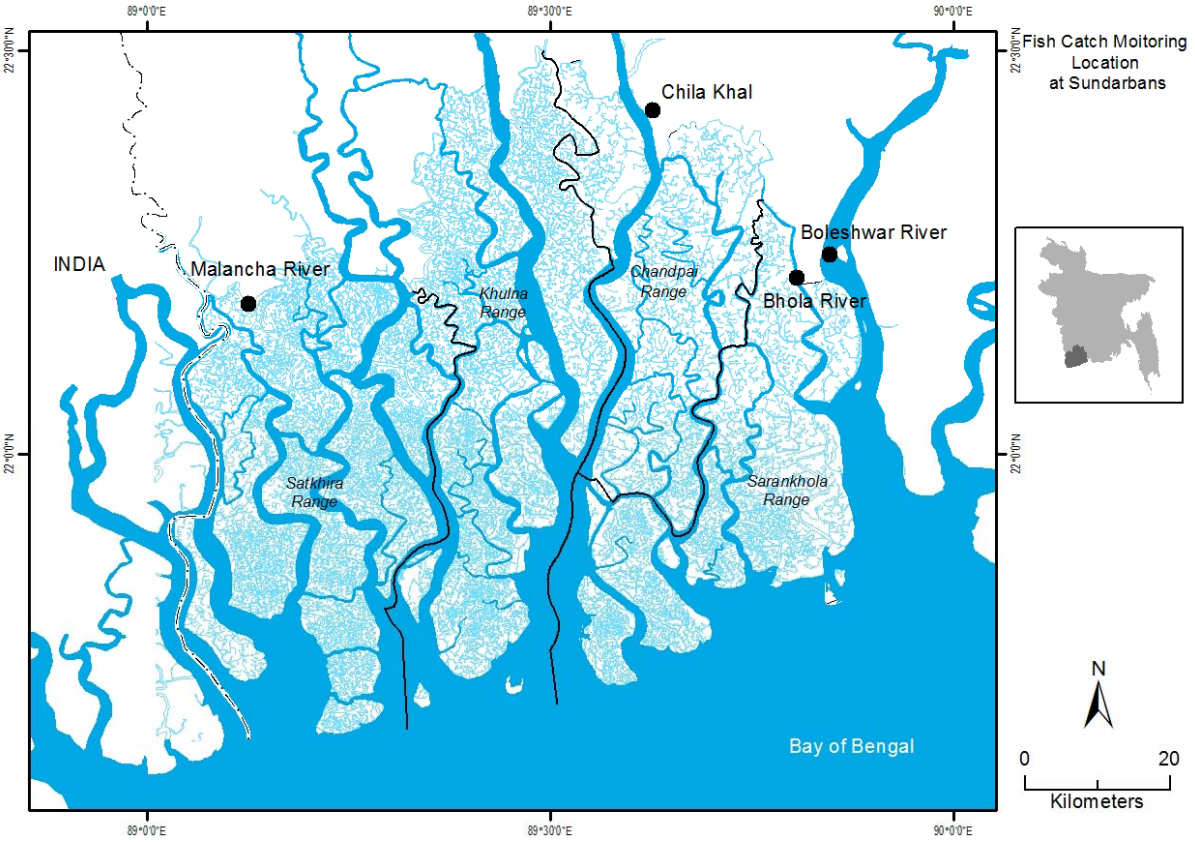


Fig 5.1: Fish catch monitoring locations in Sundarbans under CREL Project

Four fish landing centers were also monitored, these include three of the landing centers monitored by IPAC during April 2010 to October 2012; they comprise:

1. Munshigonj fish landing center – there are up to five *aroth* (whole seller) active in this market depending on size of catch in different seasons.
2. Chila bazar fish landing center.
3. Sarankhola fish landing center at Sarankhola bazar, where 10 to 15 *aroths* are active depending on the season.
4. Gabtoli fish landing center, here up to 5 *aroth* were active according to the season.

5.3 Management Institutions and Interventions

As the Sundarbans cover a large area under Forest Department management, interventions for fishery management are complex and face some limitations. Officially the Forest Department licenses, on a trip basis rather than an annual basis, fishing units that enter the Sundarbans (i.e. fishers pay for each trip into the Sundarbans). However, regulations and enforcement are more limited in the waterways just outside the Sundarbans (which are still in the Sundarbans Ecologically Critical Area). According to Alam and Mowgli (2013) and Thompson et al. (2016) a range of fishing regulations are in place in the Sundarbans, although these restrictions are often ignored by fishers. In summary these comprise:

Sanctuaries

- 18 canals closed permanently to allow fish breeding - Khal Closure Regulation (1989)
- Fishing is permanently prohibited in three wildlife sanctuaries: Sundarbans East, Sundarbans West and Sundarbans South - Wildlife Sanctuary Regulations (1999)

- Fishing is prohibited in three newer Wildlife Sanctuaries along rivers within the Sundarbans that were declared to protect dolphins in 2012.

Closed seasons:

- Fish: *P. pangasius, P. canius, L. calcarifer, M. rosenbergii* and *S. serrata* from 1st May to 30th June to allow breeding.
- Fish: illegal to catch, process, and sell hilsa smaller than 25 cm during the closed season (November-June) - Closed Season Regulation (2000) and Protection and Conservation of Fish Act (1950)
- Crabs: closed season from December to February to allow breeding - Collection and Export of Live Crab Regulation (1995)

Gear bans (illegal fishing methods):

- Fixed engine fishing gears (set bag net, post-larvae set bag net, shore net, canal gill net) are banned in SRF - Hunting and Fishing Rules (1959)
- Use of poison and explosives is banned in SRF - Hunting and Fishing Rules (1959)
- Dewatering of khals including dams or baling out water in a canal is banned in SRF - Hunting and Fishing Rules (1959)
- Blocking a khal with a net or to string a rope transversely across a khal is banned - imposed by FD (Hoq, 2007).

Monitoring sites at Bhola River along Sundarbans (left) and Baleshwar River (right) in Sarankhola.

Thompson et al. (2016; p 418) found that "Besides low awareness, another reason for low compliance was the perceived lack of enforcement. Generally, once respondents are informed about the sanctuary regulation, results suggest that they accept the rationale. Hence, the law is potentially efficient, but would again benefit from outreach and awareness-raising efforts." Although enforcement exists it would appear to be rather arbitrary and inefficiently applied, for example IPAC (2010) found that fishers reported paying at least four fines per year, and that fines are seldom proportionate to the type of violation committed (yet "graduated sanctions" – punishments that increase with scale or frequency of offence are recognized as being more appropriate under co-management arrangements, see for example Ostrom 1990).

Four Co-Management Committees and Councils (collectively CMCs) have been established since 2010 covering four ranges of the Sundarbans, and bringing together representatives of local communities, local government and Forest Department. One of their concerns has been sustainability of fisheries, and they have been active in awareness raising regarding fishing regulations. For example, when local Village Conservation Forum members inform the CMCs that fishers are fishing with poison or are poaching in sanctuary areas, the CMCs have held meetings with fishers in their

villages to explain the harm this causes and obtained commitments that the fishers would not continue the practice. Other direct management interventions have been limited, for example use of mosquito mesh nets for catching shrimp post-larvae (considered very harmful as larvae of many non-target shrimps and fish are killed as by-catch) is still widespread in rivers close to the Sundarbans. Environmental interventions supported by CREL and CMCs have been limited to areas bordering the Sundarbans, but there mangroves have been restored in 376 ha by planting over 400,000 mangrove seedlings.

5.4 Fisher Population

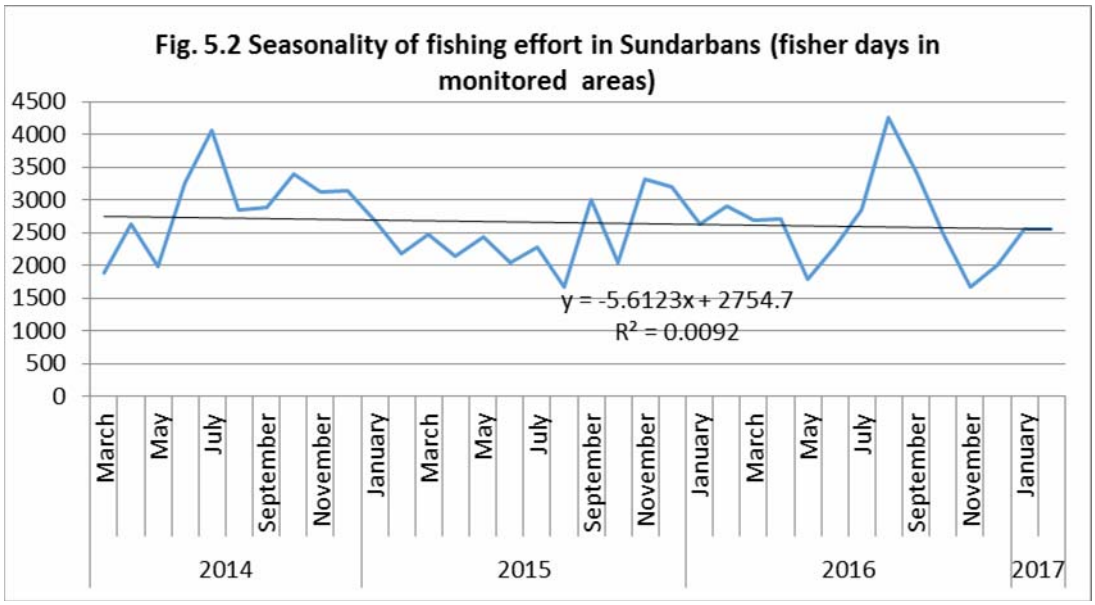
Table 5.1 Distribution of fishers living close to the Sundarbans by location.

Location (CMC area)	Number of Villages	Fisher number			Total
		Full time	Part-time	Subsistence	
Munshigonj	76	14,140	9,856	2,767	26,763
Chandpai	37	3,859	4,933	2,545	11,337
Sarankhola	20	1,955	1,260	1,265	4,480
Dacope-Koyra	78	4,540	3,600	3,422	11,562
Total	211	24,494	19,649	9,999	54,142

Although Sundarbans Biodiversity Conservation Project SBCP (2001) reported that only 4,000 households were engaged in fishing in the Sundarbans impact zone of 17 Upazilas, this was clearly a gross underestimate. Fishers were categorized into: full time fishers (dependent on round the year fishing, averaging about 200 days fishing in a year), part-time fishers averaging about 90 days fishing a year, and subsistence fishers averaging about 60 days fishing a year. A survey identified 54,142 fishers living in the periphery villages within 5 km from Sundarbans forest border, and this does not count fishers who migrate longer distances to fish seasonally in the Sundarbans area. Table 5.1 shows the distribution of fishers.

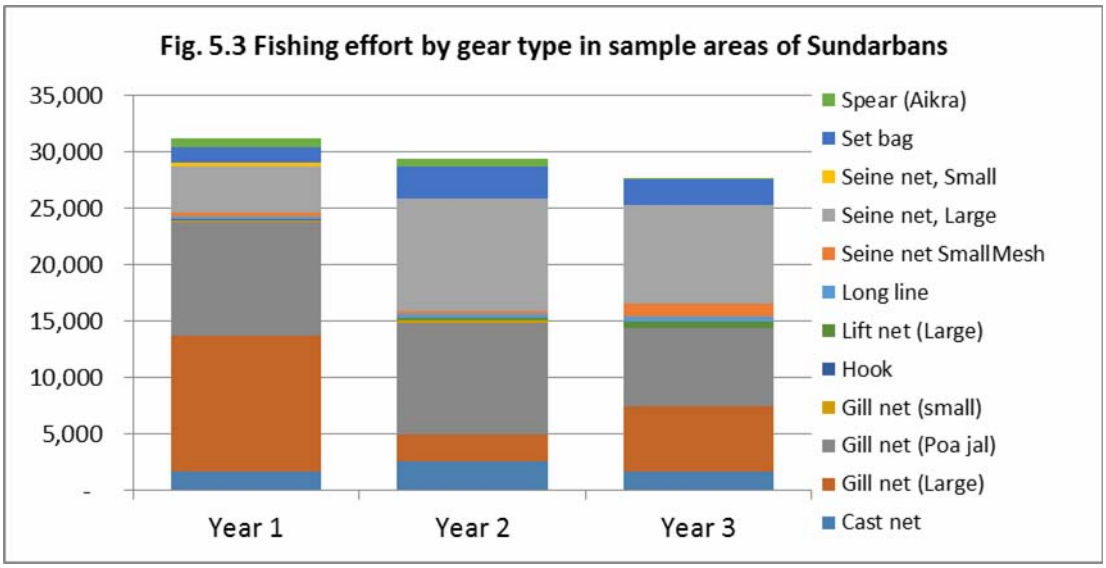
5.5 Fishing Effort

In the four catch monitoring areas, fishing effort was highest in the monsoon (4,065 person days in July 2014; 3,013 person days in September 2015 and 4,257 person days in August 2016). However, effort fluctuated without a consistent seasonal pattern, and the lowest monthly effort occurred in the dry season, monsoon, and post monsoon in these three years respectively (Fig. 5.2). Overall fishing effort showed a small non-significant decrease over three years in the study sites.



A wide range of gear types and sizes were used in these four areas, but three gear types dominated when measured by effort - poa jal (a type of gill net) was used for the most fishing days, followed by

large seine nets, and then large gill nets. Moderate numbers of fisher days were recorded operating set bag nets and cast nets (Fig. 5.3).



5.6 Trends in Catch Per Unit Effort

Catch per unit effort (CPUE) is the average daily catch per gear unit (calculated as the total catch by a gear type sampled over a specified period divided by the number of gear units of that type sampled). Fish catches are influenced by several factors, such as the size and efficiency of gears, populations of fish present, and weather conditions. In these three years monitoring of fish catches showed seine nets (small mesh and large size) with the highest CPUE (Table 5.2). Overall seven gear types increased their catch rate (CPUE) in the three years, while CPUE declined for three types, including a very large drop for small mesh seine nets. While generally increasing CPUE suggests the fishery remains healthy, limiting use of small mesh seine nets would appear to be a desirable management action.

Table 5.2. Fish catch per unit effort (CPUE) in kg/gear unit day in Sundarbans

Fishing gear	April 2010 to October 2012 (IPAC)*	Year-1 (March 2014 to February 2015)	Year-2 (March 2015 to February 2016)	Year-3 (March 2016 to February 2017)
Gill net (small)	1.6	3.92	2.67	7.17
Gill net (large)	0.4	1.44	2.63	2.61
Gill net (poa jal)	0.6	2.10	2.58	3.42
Seine net small mesh	0.8	10.12	4.43	3.17
Seine net, large	1.6	5.32	4.64	5.95
Set bag	1.8	2.57	2.66	2.09
Lift net (large)	0.3	-	2.26	9.58
Cast net	3.0	1.11	1.46	2.39
Long line	1.8	3.50	2.83	2.21
Hook	2.5	1.32	1.94	1.50
Spear (aikra)	-	1.46	1.80	5.71

* IPAC data was expressed as kg/person/day, several gear types have units that involve multiple fishers e.g. seine nets

Catch per unit effort (CPUE) recorded from landings was higher for *Charpata jal* (fixed gill net), *Pata jal* (fixed gill net) and *Behundi jal* (set bag net) compared with other nets used in Sundarbans area. *Charpata jal* CPUE was stable over three years, but *Pata jal* (fixed gill net) and *Behundi jal* (set bag net) CPUE decreased substantially. *Ilish jal* (gill net), *Poa jal* (gill net) and *Khepla jal* (cast net) catch

increased (Fig. 5.4). Hence there were considerable inconsistencies between CPUE levels reported in active fishing and landing center surveys as well as divergent trends reported from the two surveys, for example for set bag nets.

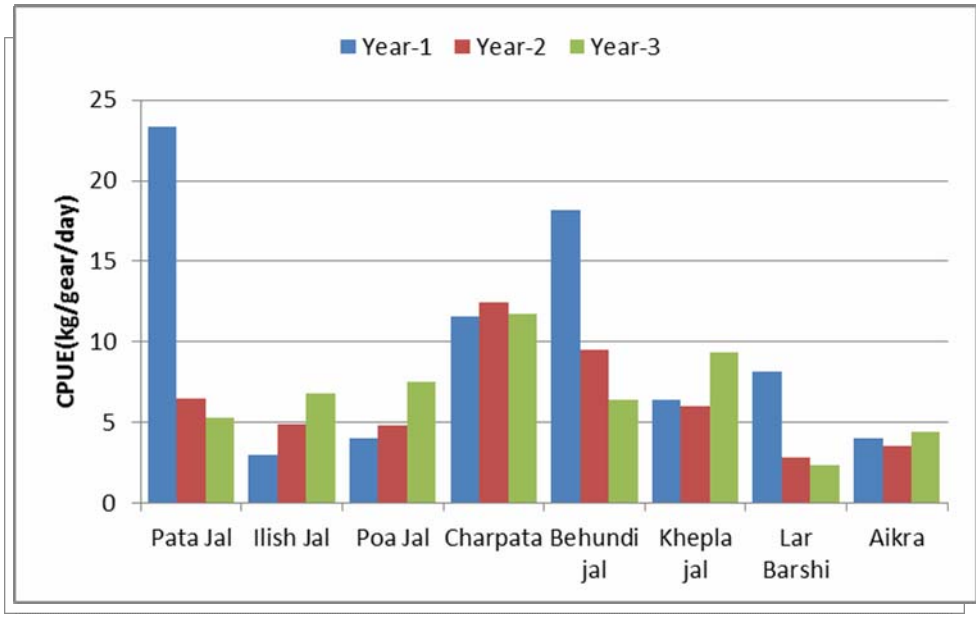
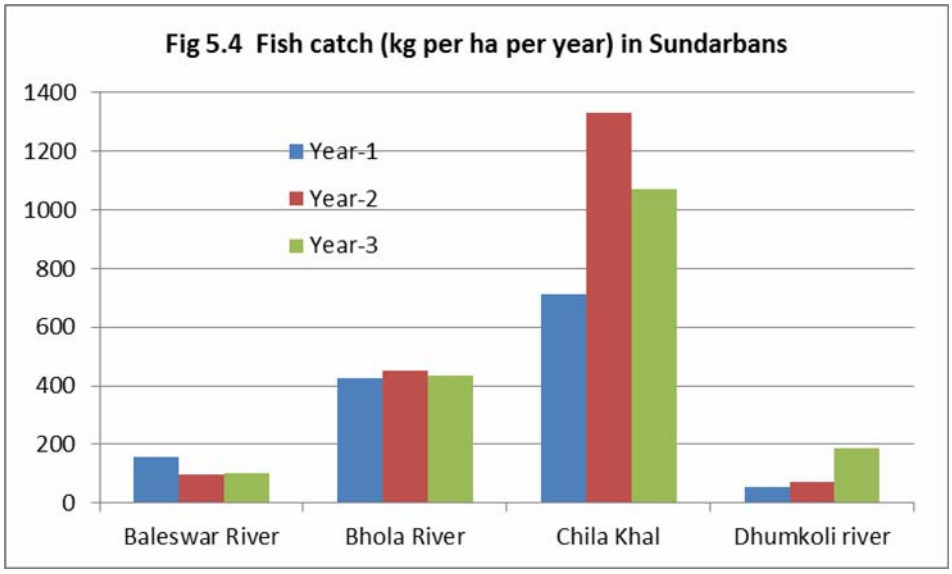


Fig. 5.4. CPUE by gear type recorded from selected Sundarbans fish landing centers

5.7 Trends in Sundarbans Catch and Landings



Catch per unit area (CPUA) calculated as kg/ha varied greatly between the four monitored rivers/khals, being much higher in Chila Khal. Moreover, while catches were quite stable in the other three rivers, variation in catches between years was also greater in Chila, where the Year-2 catch was significantly higher (almost double) the Year-1 catch, although the catch dropped somewhat in Year-3 (Fig. 5.4). This suggests that fish catches in small khals can have a relatively higher level of variation than in larger rivers in the Sundarbans.

Open water fish catch depends on catch efficiency of gear, gear intensity, number of active fishing days, species diversity, and fish abundance. Catches varied not only between the sites monitored but also seasonally and between years. A large proportion of catches were obtained in the post monsoon and winter season (typically October through January) (Fig. 5.5), with a weak increasing trend in overall catches.

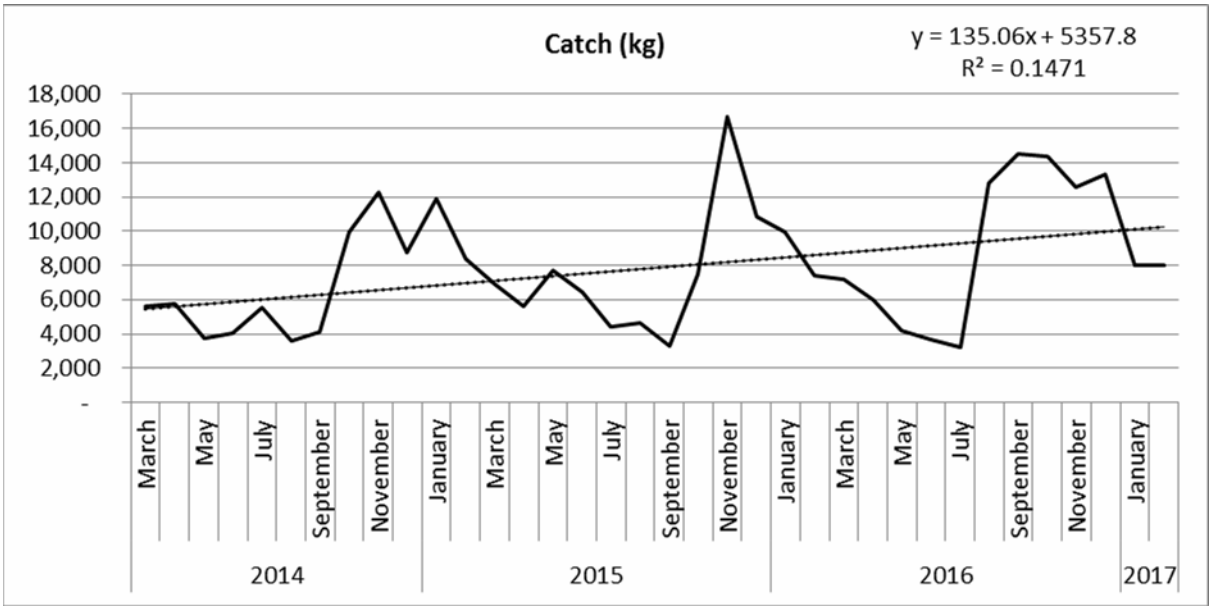
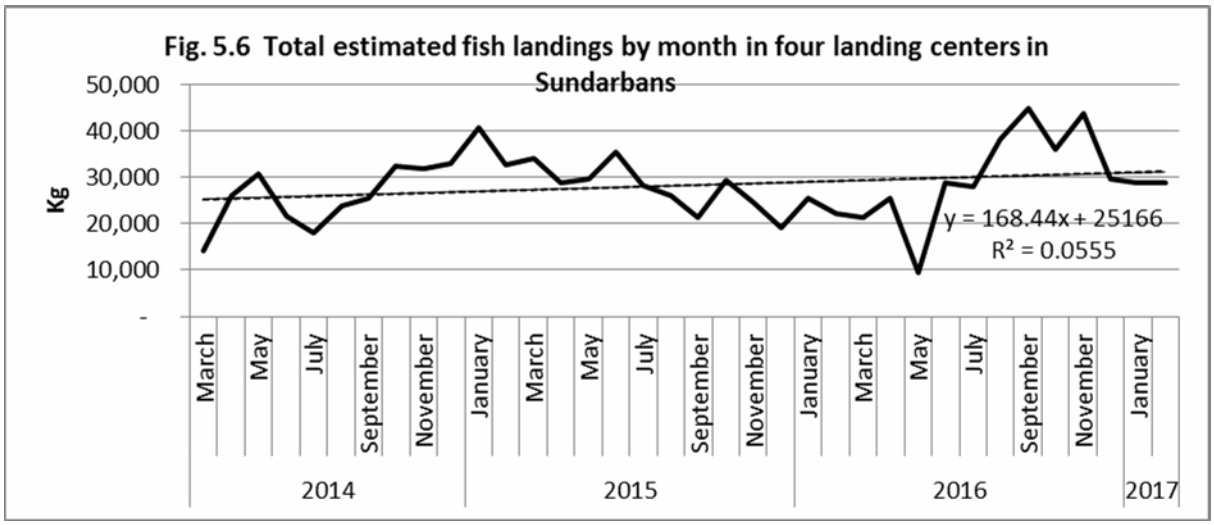


Fig. 5.5 Monthly estimated fish catch (kg) in Sundarbans (in four areas covered by catch monitoring)

Somewhat similar seasonal variation in fish landings was found as in catches in the monitored sites. The landing data reveals that a large portion of fish sales were in the post monsoon and winter season (except in 2015), but peaks did not follow the same pattern each year and included monsoon season months – by year the peak landings in these four centers were in January in 2015 (year-1), in July in 2015 (year-2) and in September in 2016 (year-3) (Fig. 5.6). On the other hand the lowest fish landings were in the dry season in each year: in March in 2014, in December in 2015 and in May in 2016 (Fig. 5.6). Although not strictly comparable due to the change in landing centers monitored, landings showed less variation than found in the earlier IPAC surveys where monthly landings ranged from under 5 t to over 100 t from five landing centers. Chila bazar and Sarankhola bazar are major landing centers with higher volumes of fish recorded, compared with the other two landing centers (Photo 5.2). Gabtoli and Munshiganj bazar are small bazars where mostly catches from nearby waterways were landed. Monthly landing center wise fish weight is presented in Appendix-5.3.



Fish landing at Sarankhola landing center (left) and auction (right).

5.8 Trends in Catch and Landing Composition

5.8.1 Catch composition

Out of 82 identified species (some "species" are species complexes that could not be identified to actual species in the field) in Sundarbans catches during monitoring, a total of 64, 52 and 42 species of fish and prawn were recorded in year-1 (2014-15), year-2 (2015-16) and year-3 (2016-17) respectively. Despite increasing catches overall in the areas monitored, declining species diversity of catch is a worrying trend. Both estuarine and freshwater fish species including prawns and shrimps were found in the catch, as the Sundarbans form a transition zone. Considering the top ten species/ species complexes by weight in the sample catches of all four areas over three years, *Johnius* sp. (poa) had the highest catch ahead of Hilsa which dominated the catch in year 3 (Fig. 5.7). Major carp, snakeheads and some other mainly freshwater species were only recorded in the catch in year 1 (see Appendix 5.2). The catch of native Pangas *Pangasius pangasius* is significant as this is considered a nationally vulnerable species (IUCN 2015). There are also some notable differences from the composition of catches during April 2010 to October 2012 recorded by IPAC from the same sites, in that period only 61 species were recorded and Hilsa was more dominant, the other dominant species was then recorded as Poa *Pama pama* – here treated as part of the *Johnius* sp. complex, but earlier shrimps did not appear among the top species caught.

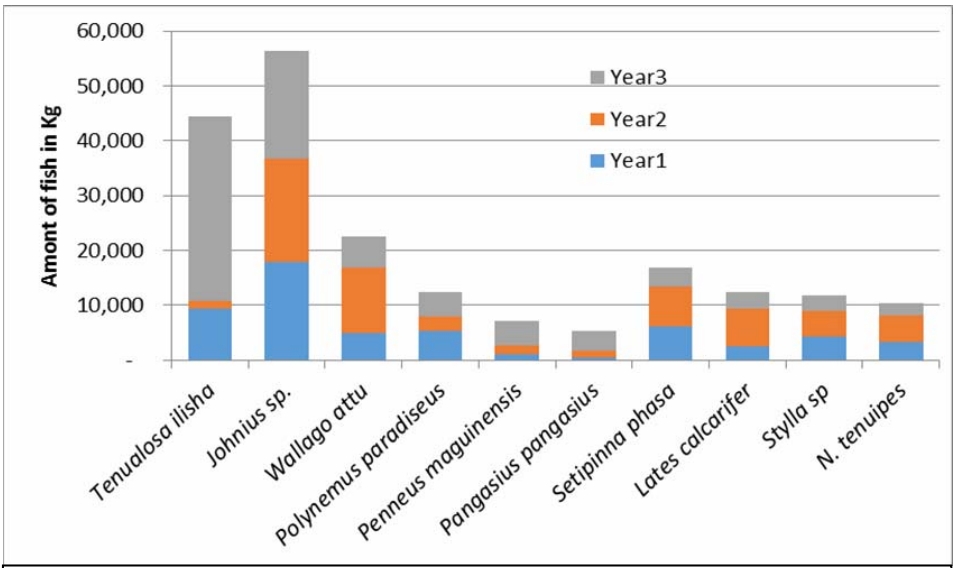


Fig. 5.7 Top ten fish species according to weight (kg) in three years of sample catch monitoring in four sample areas in Sundarbans

The ten main species contributed 73% of total sample catch by weight in year-1, 75% in year-2 and 84% in year-3. However, the species were different. On the basis of niche, size and biological characteristic, all recorded species were grouped as follows:

i) Major carp, including Catla, Rui, Mrigal - larger freshwater species that require river – floodplain - *beel* systems for completing their life cycle and are rare in the estuary and Sundarbans.
ii) Minor carp, barbs, small size fish – they complete their life cycle in small water bodies or closed water bodies.
iii) Large catfish such as *Boal, Aair* - large carnivorous fish dependent for food on other fish or aquatic animals.
iv) Small catfish such as *Tengra, Shing* - small size fish.
v) Medium size fish, except the above mentioned groups - members of a wide range of families including most species that prefer brackish and estuarine waters.
vi) Exotic fish, such as Mirror Carp, Grass Carp, and Silver Carp – these sometimes escape from aquaculture farms into open waters.
vii) Snakeheads and *koi* - smaller predatory fish.
viii) Small Prawns - primary food of other fish and aquatic animals.
ix) Large Prawns - commercially important species, the export earning species.
x) Crabs - increasingly caught for fattening and export sale.
xi) *Hilsha* - the national fish of high commercial and cultural importance. Hilsha need both marine and freshwater to complete their life cycle.

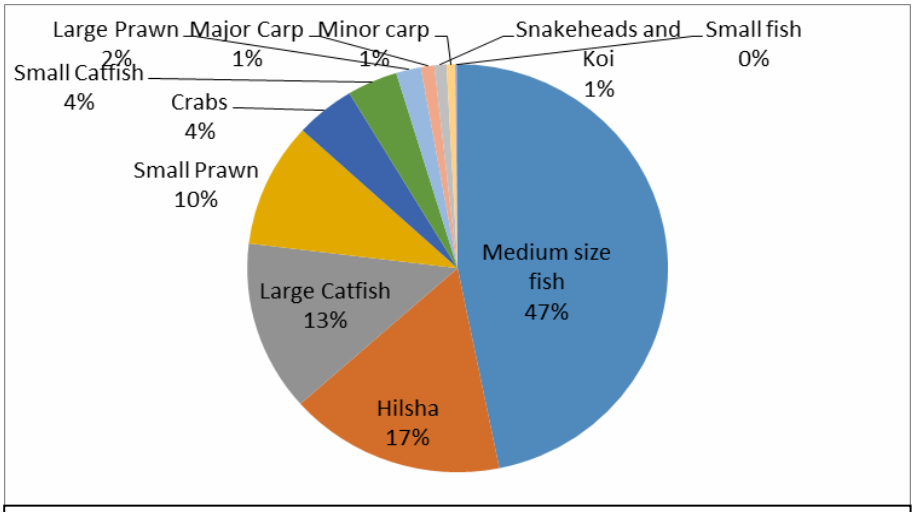


Fig. 5.8 Composition of sample catch (% by weight) in terms of categories of fish in Sundarbans 2014-17

The composition of three years of sample catches in terms of these 11 categories is shown in Fig 5.8. Four categories of fish dominate the catch: miscellaneous medium size fish 47%, *Hilsha* 17%, large catfish 13%, and small prawns 10%.

Species categorized as medium sized fish at adult size (although they are also caught as smaller sub-adults) are mostly low priced fish with a few exceptions such as *Scatophagas sp.* (see photo). It is unknown whether the small prawn catch is sustainable or over exploited, and on the assumption that the Sundarbans are an important nursing ground for shrimps and prawns this deserves further investigation.

Catch of *Scatophagas* sp. from Sundarbans

5.8.2 Fish landing composition

The top ten species were ranked according to the weight recorded in the landing centers. These ten species contributed 57.9% of the total landing weight and are shown in Fig. 5.9. Consistent with fish catch monitoring, *Johnius* species (*poa*) made the highest contribution to landings from Sundarbans. *Johnius* species were caught mainly by gill net (*poa jal*) during the winter. But landings of *Johnius* species and *Lates calcarifer* (bhetki), both of which are carnivorous, decreased over the three years. On the other hand landings of three shrimp species (*Penneus maguinensis*, *Macrobrachium villosimanus* and *Nematopalaemon tenuipes*) increased over three years. These shrimps are one of the feed items of carnivorous fish. It is not clear whether over exploitation of carnivorous fish has impacted shrimp catches, or fishers have switched to shrimp because there are fewer carnivorous fish, or over exploitation of shrimps has reduced carnivorous fish stocks, but whatever the mechanisms this appears to be another case of fishing down the aquatic food web and risks the distortion of aquatic biodiversity.

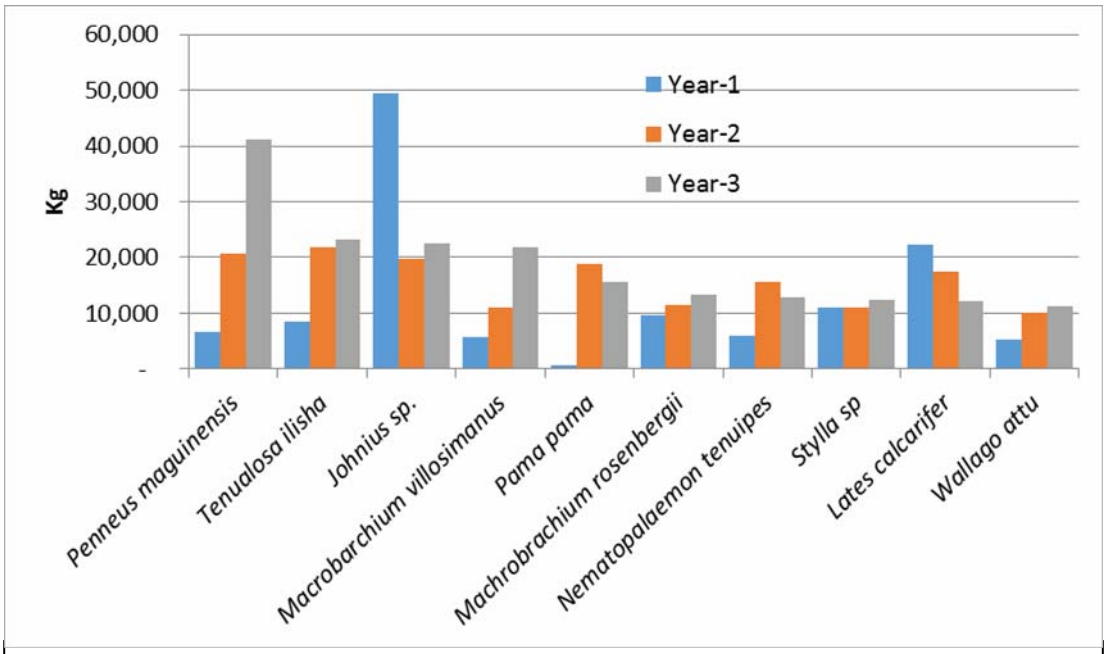


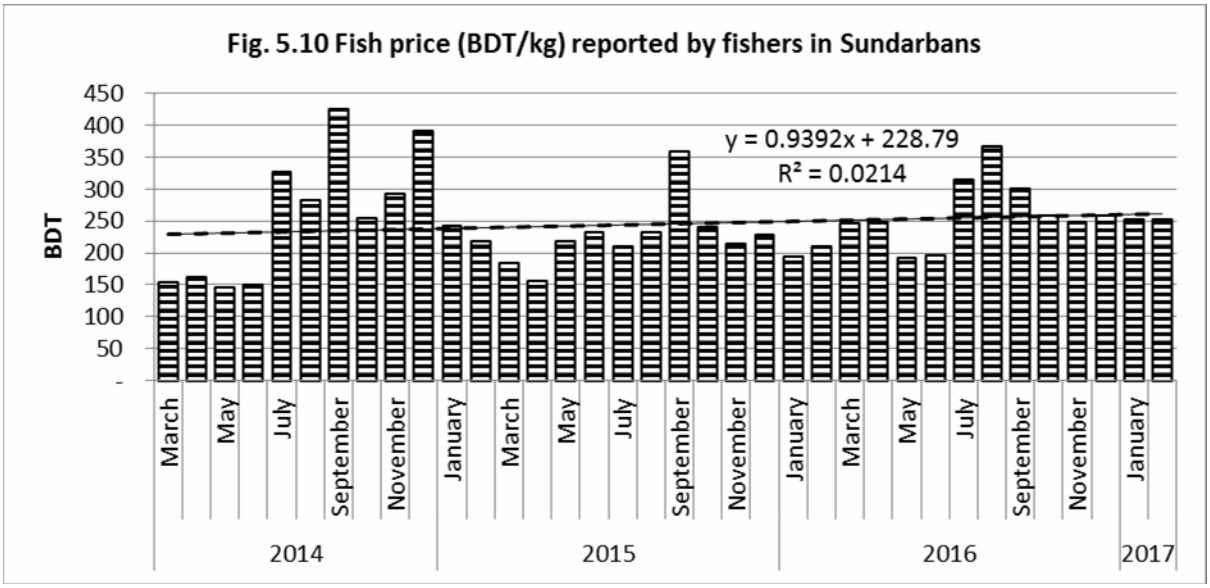
Fig. 5.9. Sample landings of the dominant 10 fish species in four Sundarbans landing centers

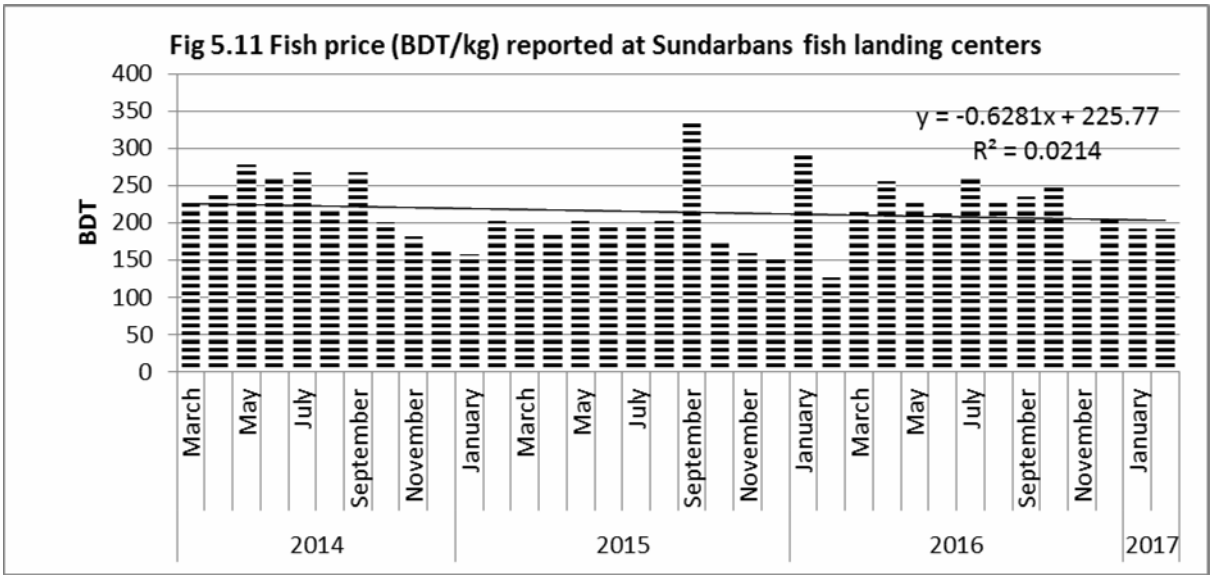
5.9 Trends in Fish Prices

There was no clear trend in fish prices over the three years. While prices reported by fishers during catch monitoring increased slightly (Fig. 5.10), prices recorded at landing centers decreased slightly (Fig. 5.11). Fish are landed at these four centers from a wider area than the four monitored river/khal sections, so it is presumed that data from the landing centers is more representative of price trends for the Sundarbans as a whole.

In general fish prices are higher in the monsoon period and lower during the dry season (Figs. 5.10 and 5.11). The highest monthly average fish price reported by fishers during catch monitoring was BDT 426 per kg in September 2014; while in the landing centers the highest monthly average price was BDT 339 per kg in September 2015; the lowest prices were BDT 145 per kg reported by fishers in May 2014 and BDT 126 per kg in landing centers in February 2016. The main factor explaining variation in average price was changes in the catch composition - the peak catch of Hilsha a high

value fish (reported prices in the range BDT 250 to 800 per kg) was in the monsoon, particularly September, while higher catches of giant freshwater prawn (reported prices in the range BDT 400 to 1,200 per kg) also increased average prices.





5.10 Overall Fish Production

Overall estimated fish catches per hectare of waterways were 501 kg, 546 kg and 646 kg per year during 2014-15, 2015-16 and 2016-17. The four sample rivers and khals are all away from the outer and more saline Sundarbans. With an estimated 1,874 km^2 or 187,400 ha of waterways within the Sundarbans (see Section 5.1) this implies a possible total catch of 93,900 t, 102,300 t and 121,000 t respectively in these three years.

The census of households involved in fishing revealed 24,494 fulltime (professional) households, 19,649 seasonal (part time) households and 9,999 occasional (subsistence) households in CREL working villages around the Sundarbans. Assuming that fulltime and seasonal fisher household CPUE can be represented by the survey result CPUE for poa jal (gill net) and the CPUE for cast nets is representative for subsistence fisher households, and that each category of household fishes for the

typical number of days reported in Section 5.4, then the possible total catch could be about 14,700 t in 2014-15, 18,100 t in 2015-16, and 24,200 t in 2016-17.

The four landing centers monitored receive fish caught outside of the Sundarbans as well as fish caught within the Sundarbans, and the breakdown of gear use by categories of household is an informed estimate. However, an estimate of the number of landing centers by size serving the Sundarbans is not available, and the proportion of catch landed from the Sundarbans is uncertain, so this has not been used to estimate total catch

The average fish price was BDT 222, BDT 202 and BDT 218 per kg during the 1st, 2nd and 3rd year of monitoring respectively. Calculating the value of fish caught in the Sundarbans as a whole using the population of fisher households and approximate CPUE and effort gives a lower estimate, while calculating based on the estimated catch per ha and area of waterways gives an upper estimate. The value of fish caught in the Sundarbans in the three years is likely to lie somewhere within the range shown in Table 5.3 – contributing as direct value of catch BDT 3,200-26,400 million (US$ 40-340 million) to the local economy, and increasing in 2016-17 by 25-60% over the 2014-15 value.

Table 5.3 Estimates of total fish catch from Sundarbans based on fish catch monitoring data

Year	Estimated total catch (t)		Price (Tk/kg)	Value of fish from Sundarbans (Tk mill)		Value of fish from Sundarbans (US$)	
	area based	fisher based		low	high	low	high
2014-15	93,900	14,700	222	3,263	20,843	42	271
2015-16	12,300	18,100	202	3,656	20,669	47	268
2016-17	121,000	24,200	218	5,276	26,391	69	343

5.11 Management Recommendations

Fish catches in the Sundarbans rivers and khals are higher in the dry season when water depth is comparatively low and salinity is higher, and there are fewer dangers of storms to affect fishers. On the basis that fish are more easily caught in the winter and pre-monsoon, selective gears, such as gill nets with larger mesh sizes, should be used for fishing in that period to facilitate escape of juvenile and immature fish especially commercial important species that use Sundarbans as a nursing ground. Tighter monitoring and checking of use of small / fine mesh gears is needed through cooperation of the Co-Management Committees (CMC) and Forest Department.

Fewer fish species were recorded in the river/khal catch and landings in year-3 compared with the two previous years, so there is a concern that fish species diversity is declining, and there is also evidence of declines in carnivorous fish which are indicators of the health of the aquatic system. The evidence suggests that existing fishing rules and limits need review to safeguard fish stocks to sustainable levels, and that recent trends may pose threats both to larger carnivorous fish and wild shrimps. Continued monitoring, informed discussion based on evidence, and agreement among fishers, financiers, middlemen, traders/arats, CMCs and Forest Department will be needed if sustainable fishing is to be achieved. In freshwater systems a high proportion of small shrimps in the catch has been considered a sign of an overfished and collapsing fishery (de Graaf et al. 2001). How far this is true for mangrove based coastal fisheries is uncertain, but continued and larger scale monitoring is needed to more reliably estimate composition and trends in fish catches in the Sundarbans, to determine if and how far the stock is overfished, and guide actions to restore fin-fish stocks by regulating and reducing fishing effort .

While increases in catches of *Hilsha* are encouraging, this species moves over large areas of marine and freshwater habitat during its life cycle, so changes are not completely attributed to the management of fishing practices in the Sundarbans. It also showed that migratory species are important components of the fishery resources of Sundarbans and the health of the wider riverine-estuarine-marine ecosystems of Bangladesh affect fish catches in the Sundarbans. Overall the fisheries

resources of Sundarbans are diverse, it is a complex ecosystem. In order to determine the impacts of management actions, such as sanctuaries and awareness raising against harmful practices, continued monitoring for more sites and years is needed.

CHAPTER 6 SONADIA

6.1 Introduction

Sonadia Island is located in south-east Bangladesh, north-west of Cox's Bazar town. The Sonadia Island ECA includes Sonadia Island in its entirety and most of Ghotivanga Mouza in adjacent Moheshkhali Island. The ECA covers 4,916 ha (DoE, 1999), much of which is government-owned land. Sonadia Island is separated from the mainland by the Moheshkhali channel and from Moheshkhali Island by Bara Canal (Fig 6.1). The ECA is notable for internationally important wintering populations of threatened shorebirds, for nesting marine turtles, and for its diversity of coastal ecosystems.

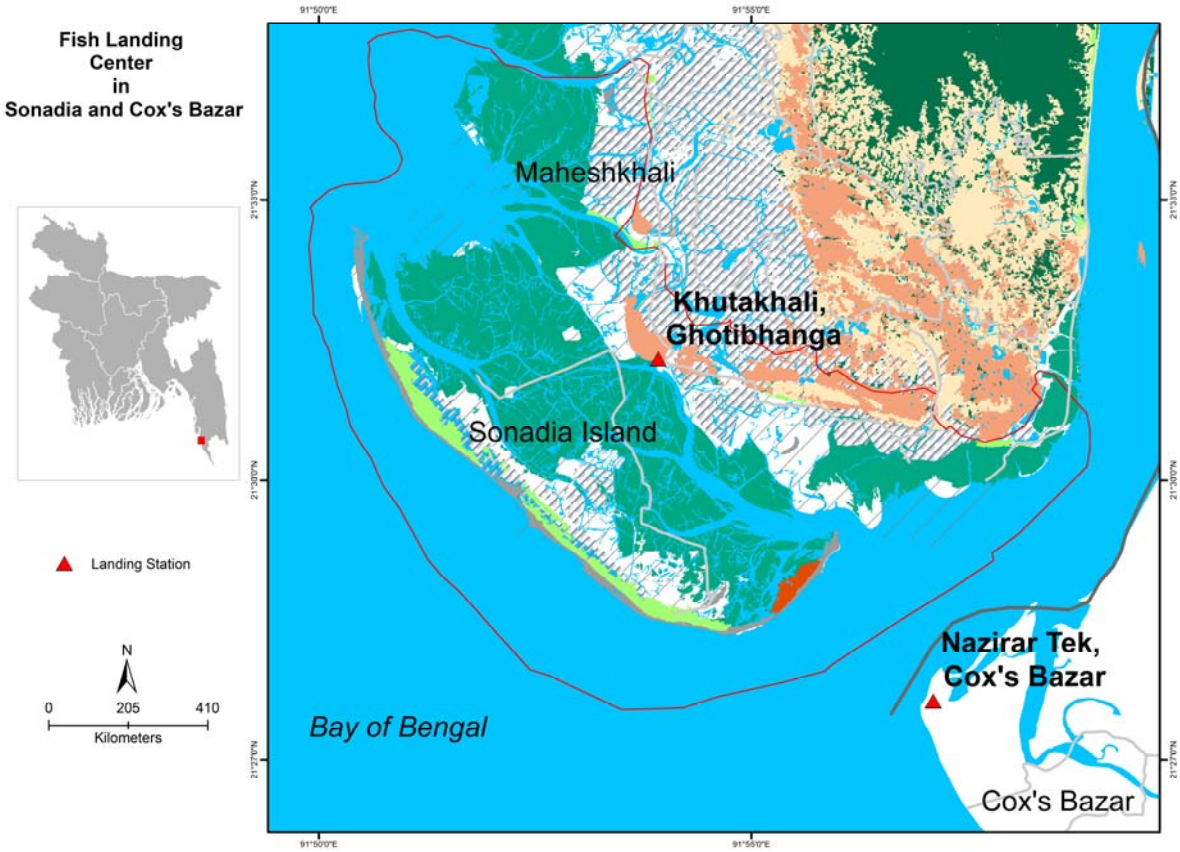


Fig. 6.1 Location of Sonadia ECA and fish landing centers monitored by CREL

Five Village Conservation Groups (VCGs) have been established under Department of Environment initiatives in Sonadia. Linked with these VCGs various initiatives, some supported by CREL, have been taken to protect or change ecosystems, including planting trees, planting grasses to stabilize sand dunes, development of alternative livelihoods, a turtle hatchery, and protecting shorebirds.

6.2 Fisher Population

The local community of around 12,000 people are reported to be highly dependent on the natural resources of the site including shrimp fry collection and fishing (CWBMP,

Table 6.1 Village wise fisher households in Sonadia Island.

Village	Household number	Fisher type
Sonadia Puropara	150	all full-time
Sonadia Poschimpara	140	all full-time
Ghotibhanga	900	all full-time
Baradia	25	all part-time
Tajiakata	650	all part-time
Total	1,865	

2006). The site had 2,000 households in the mid-2000s (POUSH, 2006a). In 2016 CREL found 1,865 households in five villages on Sonadia Island (each of which has a VCG), all of these households are involved in fishing (Table 6.1). Their fishing grounds are mostly along the coast line and closer parts of the offshore Bay of Bengal. Very few fishers were found to be fishing within the ECA which extends less than 1 km from the high tide shoreline into coastal waters. There are also some shrimp culture ponds in Sonadia ECA.

6.3 Trends in Fish Landing and Fishing Effort

Two landing centers were monitored. Khutakhali landing center in Ghotivanga village, on the north side of Sonadia Island has two *aroths* involved with fish trading, but some fishers not tied to the *arothder* also sell their catch directly to other individual fish traders in this market, especially in the case of small catches from nearby areas within the ECA. Nazirertek fish landing center is situated on the mainland of Cox's Bazar, southeast of Sonadia Island, and is on the opposite site of Moheshkhali channel. Here there are many fish drying yards in this center for making dried fish and fish meal. There is no formal *aroth* in this landing center. So, fishers sell their catch directly to fish traders and owners of fish drying yards. Large size edible fish are mainly landed in the Bangladesh Fisheries Development Corporation (BFDC) ghat at Cox's Bazar which was not monitored, it is believed that few such fish are caught within or adjacent to Sonadia ECA and most boats landing here have made trips of more than two days. In the two landing centers monitored, the catches of those who sold fish from one day of fishing, which is presumed to have come from near Sonadia Island were separated and analyzed for this report. A one-day fishing trip from these landing centers covers the area around Sonadia including fishing grounds such as Moheshkhali Channel, local khals, and the shoreline fishing grounds. On the other hand trips of longer than one day take fishing boats away from Sonadia Island into the Bay of Bengal, so these were not considered in the analysis.

The estimated total monthly landing of fish in the two centers varied greatly between months and years (Fig. 6.2). In general landings were greatest in the dry season (December to March), and lowest in the monsoon (e.g. August). However, landings in 2016 were much higher than in the previous years, so that the August 2016 landing was higher than the peak in either of the two previous years (Fig. 6.2). Thela jal (push net) and Jhaki jal (cast net) effort have decreased (Fig: 6.3). Pata jal is used near-shore where it is fixed with a pole at low tide, and has increased in use near Khutakali. On the other hand Behundi jal (set bag net) effort increased and by the third year completely dominated landings at Nazirertek landing center. The catch at this landing center is mainly used for fish meal preparation and drying, since small size fish are caught by Behundi jal. The size of fish in Ber jal catch is also small, but this net's operation requires more than seven fishers (more than Behundi jal) which may explain the change in gear use. If Pata jal and Ber jal (seine net) were used in 2016-17 by fishers who previously landed at Nazirertek, it is also possible that they sold their catch in another landing center.

Gear wise fish catch of Ber jal and Pata jal increased in Khutakhali, where Behundi jal catch decreased (Fig: 6.4). On the other hand at Nazirertek Behundi jal catch increased in line with increased fishing effort.

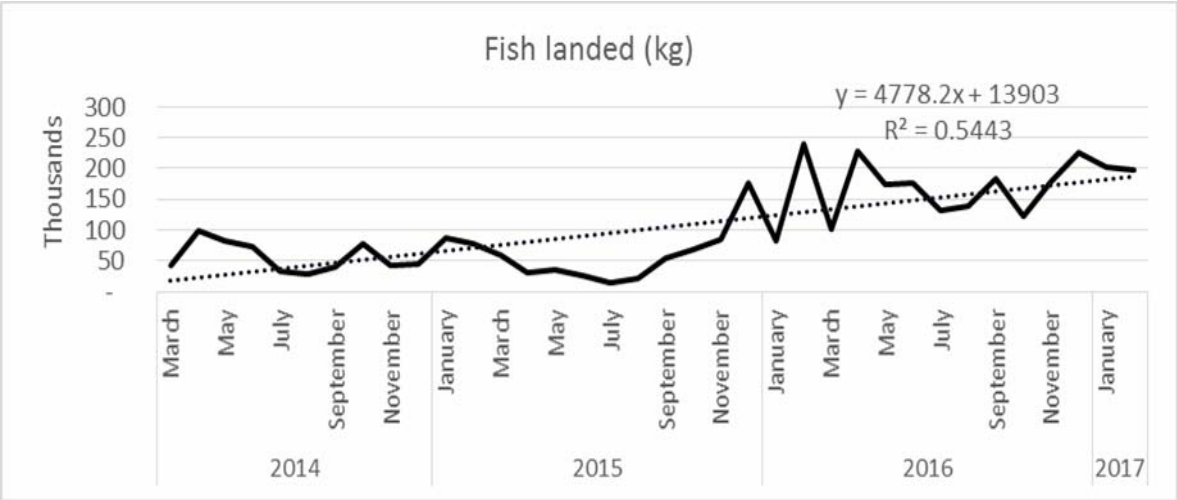


Fig. 6.2 Monthly estimated fish landings at two fish landing centers serving Sonadia.

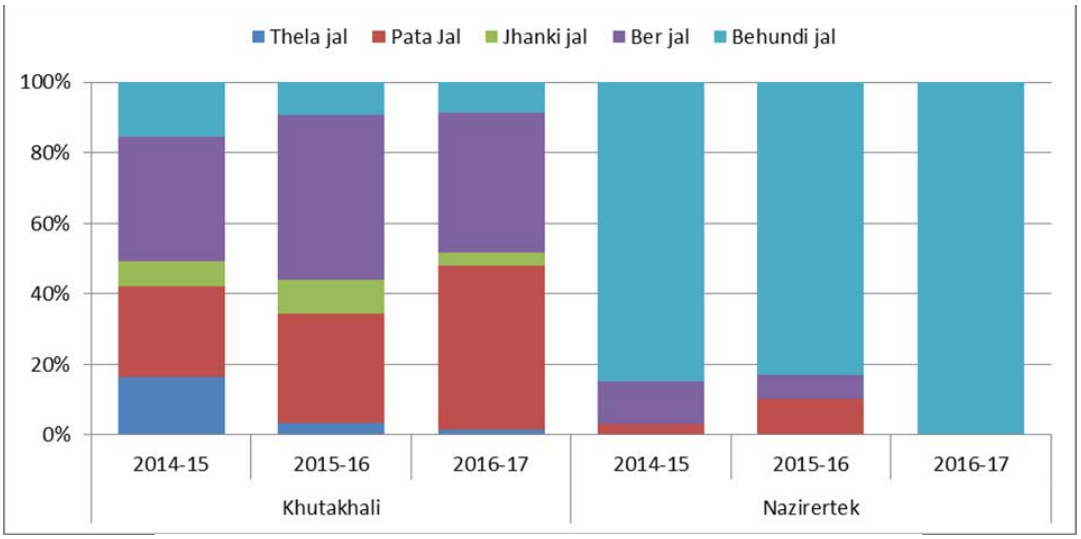


Fig 6.3: Fishing effort by gear in both landing center

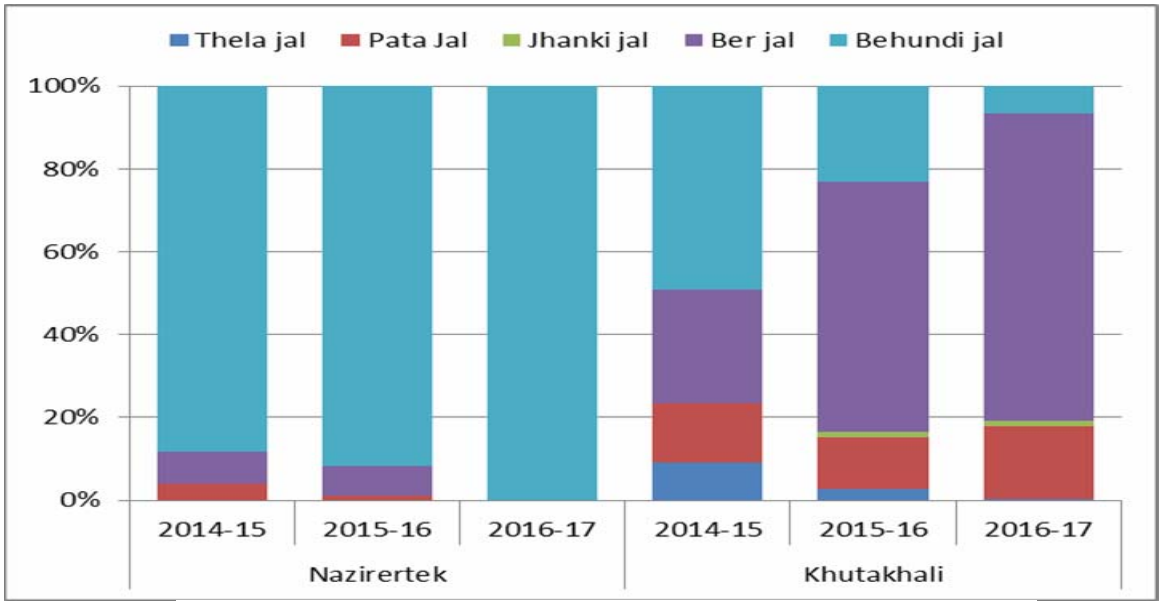


Fig 6.4: Gear wise catch in both landing center (% of total surveyed catch)

6.4 Trends in CPUE

Landings were recorded for sample boats, and in both Khutakhali and Nazirertek each boat was found to have been using only one type of gear at a time on a fishing day, so catch could be attributed reliably to gear type. Catch was calculated per fishing unit (boat) and the net or nets it used. Boats used gears according to where they fished, and some used different gears in different seasons, for example using gill nets at sea to catch Hilsha, or set bag net in shallow water in the channel. In Khutakhali fish landing center fishers used more diverse gears because some landings were by single fishers fishing inside canals of Sonadia Island, where they normally used *jhaki jal* (cast net) and *thela jal* (push net). *Pata jal* (gill net fixed on poles at low tide) and *behundi jal* (set bag net) are fixed nets. Most landings at Nazirertek were from *Ber jal* (seine net) and *Behundi jal*. *Ber jal* catch averaged 77 kg/day and 82 kg/day in years 1 and 2 respectively, but this gear was abandoned in year 3 when *Behundi nets* became exceptionally productive (Fig 6.3). *Pata jal* is a passive and potentially damaging non-selective net which encloses an area of intertidal mud adjacent to the banks, it is set horizontal during low tide, then the fishers raise the net to the vertical after high tide so that they trap any fish that have come into the shallows with the tide, and collect these fish when the tide falls. *Pata jal* CPUE is relatively low considering that on average 8 fishers operate this net.

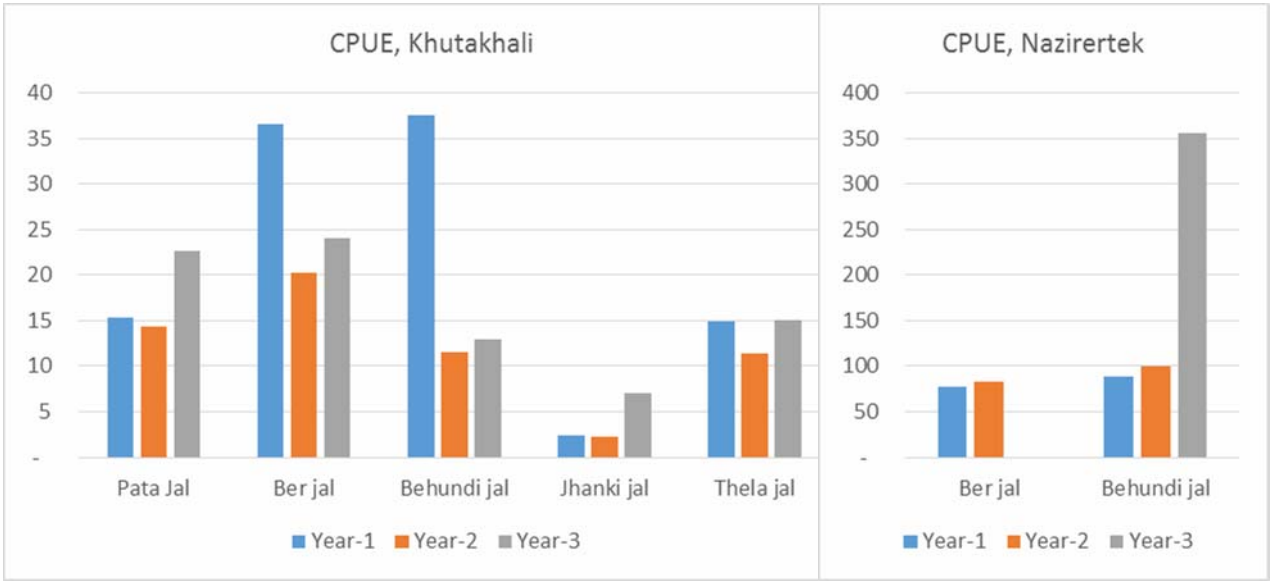


Figure 6.5: Average catch (kg) per fishing unit day for main gear types as recorded over each year at landing centers serving Sonadia Island

6.5 Trends in Catch Composition

Fish composition data shows that bony fish, cartilaginous fish and shrimp were landed in both Nazirertek and Khutakhali. A very high diversity of fish and shrimp species were recorded in the monitored landings compared with other CREL sites. In addition to 169 species recorded in sample landings (Annex 6.1), some bony fish and shrimps were unidentified due to their small size. *Loitta (Harpodon nehereus)* was the top catch during all three years and *Churi mach* (*Lepturacanthus savala*) was the second most important by volume in year 1. The top 20 fish species' contribution to overall catch was 81 % in year 1, 85 % in year 2, and 77 % in year 3 (Fig. 6.6). However, the relative contribution of species in the catch varied year to year. Hilsha *Tenolosa ilisha* was not landed in the monitoring centers though it is also caught by the gill net operator and sold in mainly BFDC fish landing center.

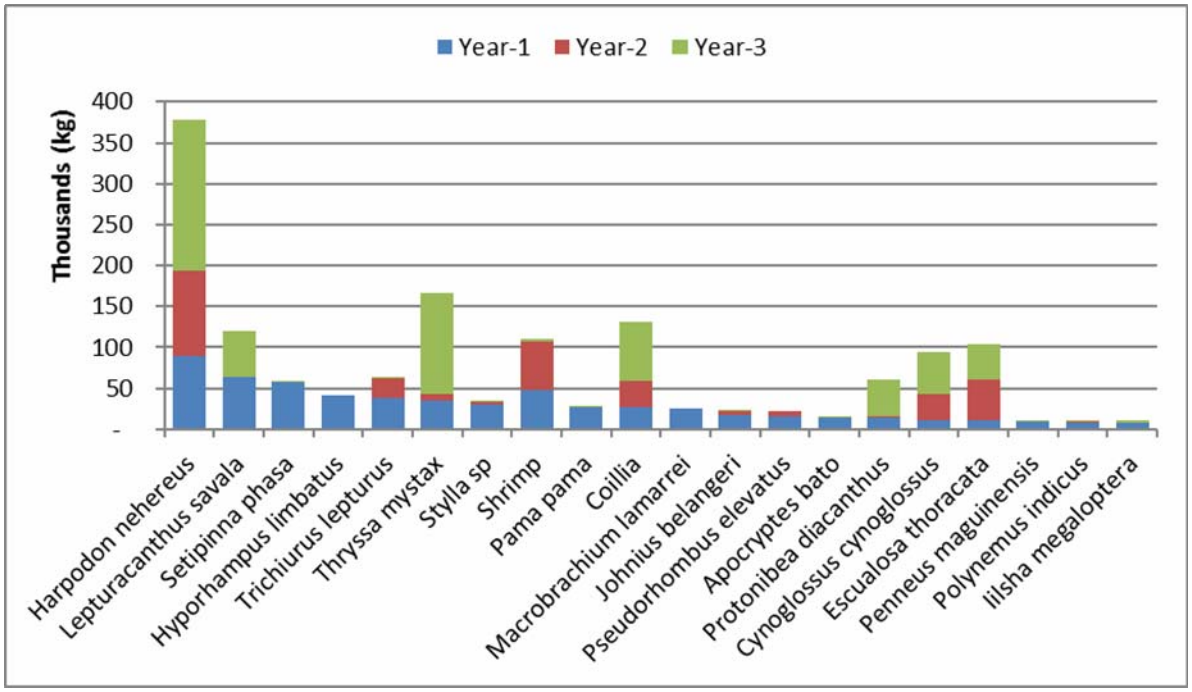


Fig 6.6: Top 20 species based on three years of monitored catches in two landing centers serving Sonadia Island

6.6 Trends in Fish Prices

In years 1 and 2, average fish price per month was inversely related with volume of fish estimated landed, but in year 3 the volume of fish landed increased substantially and average fish price was also about 25% higher. In common with other coastal areas, fish price was higher during June to August, peaking at Tk 120 per kg in July 2016 (Fig. 6.7). Compared with other sites monitored, the average fish price here is low because much of the catch comprises of small size fish that are mainly used for preparation of fish meal, while edible large size fish were not sold in these landing centers.

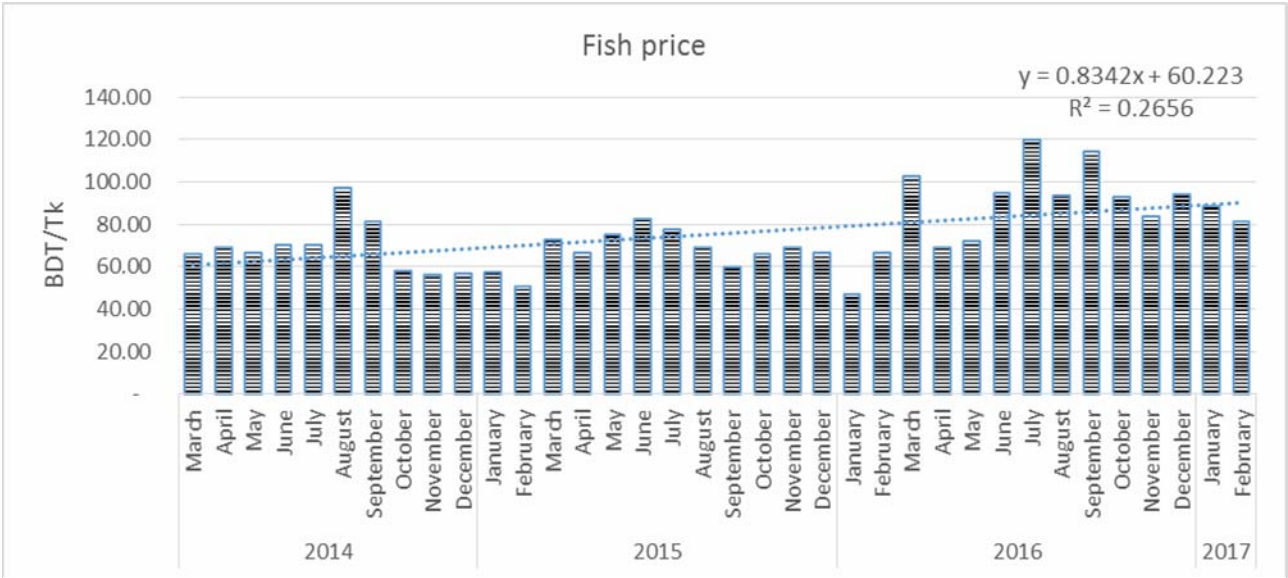


Figure 6.7 Fish price trend at landing centers serving Sonadia Island during three year monitoring period.

6.7 Management Recommendations

Considering only one-day catches that are assumed to comprise the Sonadia landscape catch, we analyzed data excluding multi-day trip catches by sea going trawler boats. Total fish landings were estimated to be 728 ton, 886 ton and 2,059 ton in the three years respectively March 2014 to February 2015, March 2015 to February 2016, and March 2016 to February 2017. The average fish price at landing centers increased from Tk 67 in 2014 and Tk 68 in 2015 to Tk 92 per kg during year 3 (2016), with catch landed also increasing greatly in year 3, this resulted in the estimated value of landings at both centers combined jumping from TK 48.8 million (US$ 0.6 million) in year 1 and Tk 60.3 million (US$ 0.8 million) in year 2, to Tk 189.4 million (US$ 2.5 million) in year 3.

In year 3 the Sonadia landscape catch increased substantially, however no conservation measures were explicitly taken by the local communities or by Department of Environment and the ECA committees, and as the catch largely comprises of small fish this is likely to be unsustainable and involve capture of juvenile fish. The Sonadia landscape area is a nursery and feeding ground of many fish species. It is recommended that the VCGs and DoE should promote use of selective gears such as gill net instead of non-selective gears such as set bag nets, as far as possible and particularly during the spawning and grow out seasons when small juvenile fish come into the landscape area. The effects of fishing practices and any changes in management and fishing norms in the area needs to be monitored over a longer period as it will take time for the VCGs and DoE to change fishing practices, and the three years' data indicates that species assemblage changes year to year in the coastal area.

CHAPTER 7 NIJHUM DWIP

7.1 Introduction

Nijhum Dwip is an isolated coastal island at the south end of Hatiya Upazila, Noakhali District. Nijhum Dwip is in the outer estuarine area of the Meghna River, and its ecosystem mainly depends on inflow of Meghna river discharge. During 1974-94 the Forest Department pursued a mangrove afforestation program on newly accreted lands that formed Nijhum Dwip, and this has by now developed into an extensive area of forest covering about 2,600 ha. On 8 April 2001 the Government declared 16,345 ha as a National Park including extensive areas of intertidal mudflats, shallow coastal waters, and Domar Char, as well as the whole of Nijhum Dwip island proper (Fig. 7.1). The objective of the National park designation is to protect biodiversity. During winter internationally important numbers of waterbirds flock to the National Park, particularly Domar Char, including several globally threatened species. More than 30,000 people reside on Nijhum Dwip and 70% of households are involved with fishing. Nijhum Dwip fishers are active in the channels between chars within the National Park, and in coastal waters outside the National Park extending into the Bay of Bengal. This poor fisher community is highly dependent on local fish stocks that reside or move into channels within Nijhum Dwip National Park. These channels are strongly tidal, and also seasonal salinity fluctuations affect fish populations and fishing patterns over the year.

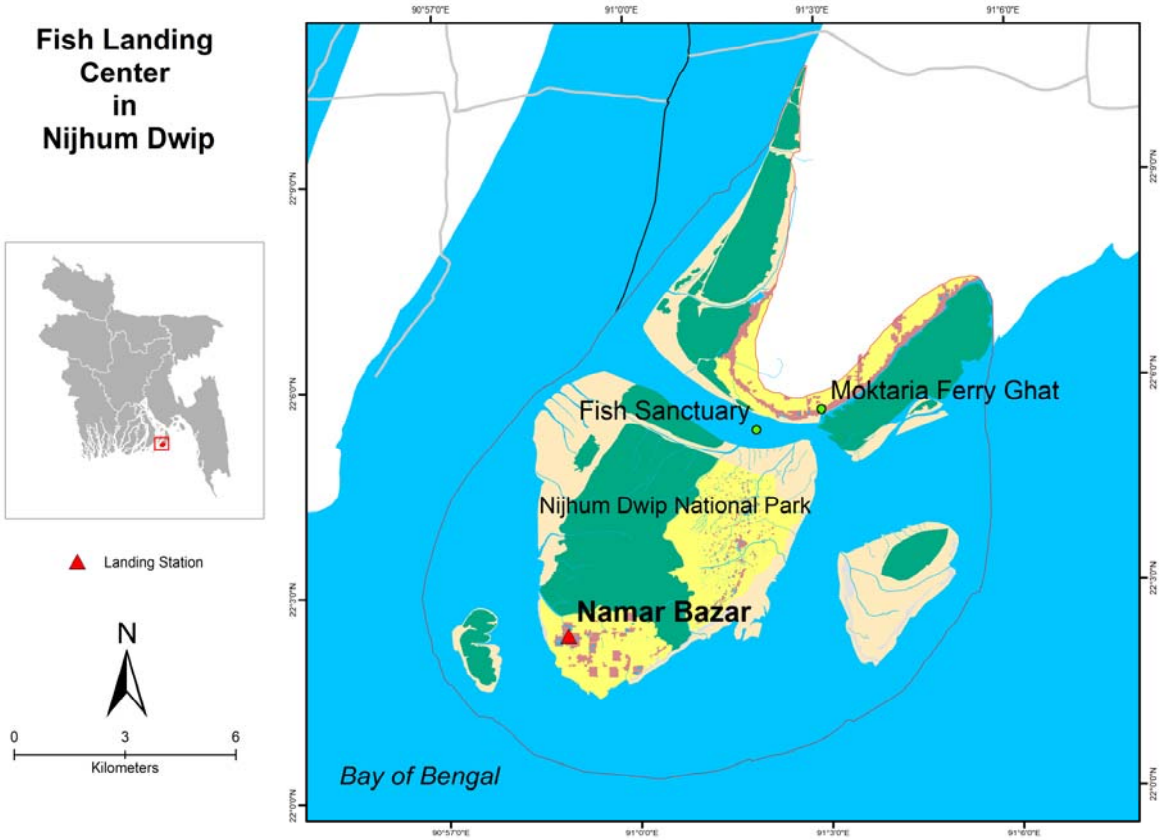


Fig 7.1: Nijhum Dweep National Park and fish landing center of Namar Bazar

Co-management was introduced in Nijhum Dwip National Park in September 2014 with support from CREL project, when a Co-management Council and Committee were formed including representatives of 25 villages within and impacting the National Park. In 2015 the Co-Management

Committee established a fish sanctuary of 5 ha located in Moktara Channel to conserve local fish stocks.

7.2 Fish Landing Centers and Monitoring

CREL undertook fish monitoring in Nijhum Dwip through a fish landing survey for two years from September 2014 to August 2016 to generate baseline data representing catch levels and composition, and to identify recommendations for management actions to ensure sustainability of the fishery.

Data was collected from Namar Bazar, a fish landing center located at the south end of Nijhum Dwip proper, near the Forest Department office (Fig. 7.1). At Namar Bazar there are 10 fish collection shops or fish depots locally called *aroth*, the owner of an *aroth* is called an *arothder*. The *arothders* finance fishing, net purchasing, making/purchasing fishing boats, and advances before fishing trips, on the condition that the fishing boat captain sells his catch to his *aroth*. In this arrangement they are also known as *dadondars* (*dadon* being credit/loan against tied/advance sale of catch at below market rates). The *arothders* also own fishing gear and boats and hire fishers to work for them. One community enumerator (CE) recorded numbers of gear units landing by gear type and their characteristics on sample days. Catch/landing data mainly came from the *arothder/dadonder* own records, but in some cases the CE directly observed and recorded the landing amount of fish from individual fishing units (see Chapter 2 for method).

7.3 Fisher Households at Nijhum Dwip

Nijhum Dwip has full time, part time and subsistence fishers. Some households that own ponds for fish culture were not counted as fishers if they were not involved in open water fishing. On average full time fishers spent about 300 days in a year fishing, while part time fishers averaged about 90 fishing days in a year, and subsistence fishers averaged 60 days fishing in a year. In total 992 households were found to be fishing out of 1,073 households living within Nijhum Dwip (the distribution of fisher households by village is given in Appendix-7.1).

7.4 Fish Landings and Seasonality

The study found high seasonal variation in fish landing. The high volume of fish landed in October-November 2014 and September 2016 was not matched in 2015 due to fluctuation of Hilsha catch in the area. Hilsha availability during 2015 was low in this area. Landings of other fish species were higher than those

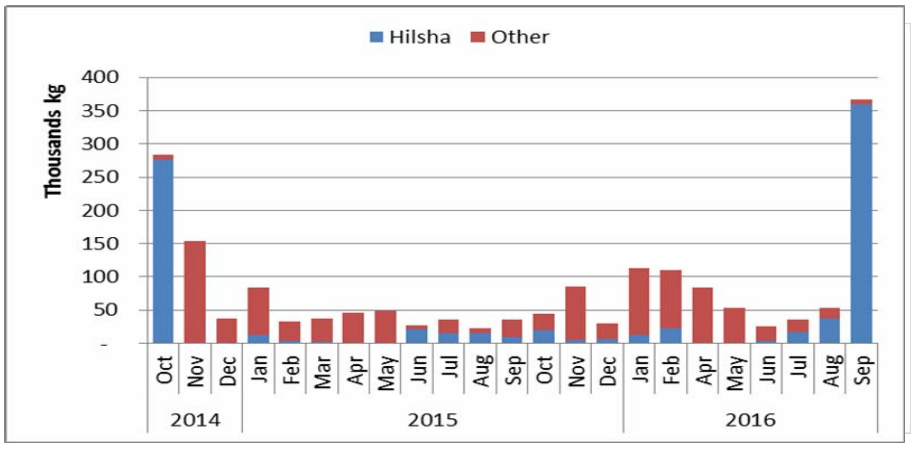


Fig. 7.2 Estimated total fish landings at Namar Bazar

of Hilsha throughout the period November 2014 to June 2016, and catches of other species were highest during both winter seasons (Fig. 7.2). Excluding Hilsha, the catch of other species was higher during the second year (Fig 7.3). Monthly fish landing weight in kg is given in Appendix-7.2.

7.5 Catch (landing) Species Composition

A total of only 23 species of fish, skates and prawn were recorded during the monitoring period. Hilsha was the main species (Fig. 7.3) representing almost half of the total landings, and was mostly caught in September and October. The next species by weight landed was the small shrimp *Exopalaemon styliferus* (20%), followed by the small estuarine fish *Lal Chewa* (*Rubicandus cubicandus)* comprising 13% of landings. The five main species contributed 87% of the total landings by weight (Table 7.1).

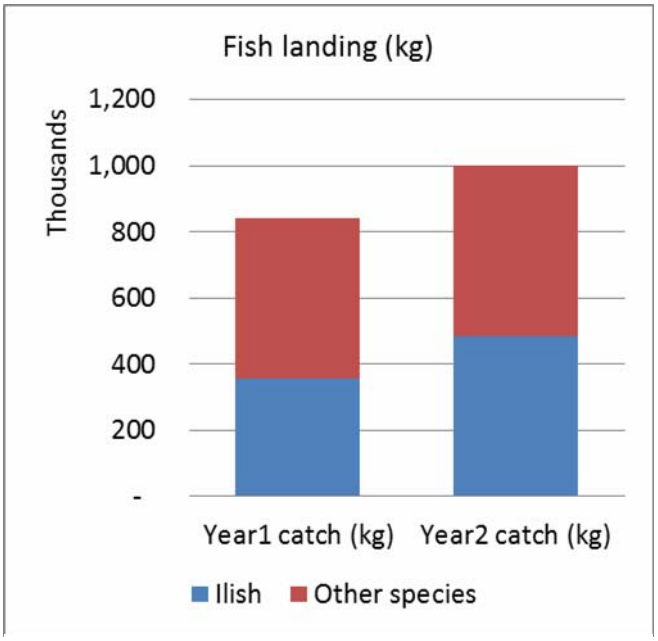


Fig. 7.3 Hilsha (Ilish) compared with other fish landing at Nijhum Dwip

Catch from nonselective gears should be considered for an accurate measure of fish biodiversity in the open waters, but in this case all gears landing were included in the data to represent the diversity of actual catch. For example, gill nets used in the Nijhum Dwip for targeted catch of Hilsa means that the reported landings are biased towards the species targeted by fishers rather than the overall fish population in the estuarine ecosystem. Species number is used for calculating the Shannon-Weiner index of diversity, but from the landing center we recorded only weight and price of catch. So, only the species composition of landings as a percentage of weight can be calculated (Table 7.1). Hilsha fish was caught in the deep and flowing channels or off-shore using gill net (*ber jal*). All other species (Table 7.1) were mainly caught in the comparatively narrow channels within Nijhum Dwip NP by *behundi jal* (set bag net).

Table 7.1 Species composition of sample fish landings in Nijhum Dwip by % of weight, October 2014 to September 2016

Sl no.	Local name	Scientific name	%
1	Ilish	*Hilsa ilisa/ Tenualosa ilisha*	*45.74*
2	Gara chingri	*Exopalaemon styliferus*	*19.98*
3	Lal chewa	*Rubicandus cubicandus*	*13.34*
4	Harina chingri	*Metapenneus monoceruos*	*4.30*
5	Tapshey	*Polynemus indicus*	*3.53*
6	Guley/Chiring	*Apocryptes bato*	*3.41*
7	Poa	*Sciaenoides diacanthus*	*3.26*
8	Bata	*Labeo bata*	*1.49*
9	Chingri	*Penneus maguinensis*	*1.49*
10	Loilla chingri	*Metapenaeus brevicornis*	*1.43*
11	Loitta	*Harpodon nehereus*	*0.54*
12	Koral/Vetki	*Lates calcarifer*	*0.52*
13	Murbayla	*Platicephalus indicus*	*0.27*
14	Taillah	*Eleutheronema tetradactylum*	*0.25*
15	Haush/Sowain/Eagle	*Aetomylaeus nichofii*	*0.11*
16	Bagda chingri	*Penneus monodon*	*0.08*
17	Gura icha	*Macrobrachium lamarrei*	*0.06*
18	Pitambari	*Rhynobatus granulatus*	*0.05*
19	Rita/Ritha	*Rita rita*	*0.05*
20	Raja chewa	*Teanoides buchanani*	*0.05*
21	Tular Dati/Takra	*Sillaginopsis panijus*	*0.03*
22	Sona taillah	*Polynemus sexfiles*	*0.02*
23	Golda Icha	*Machrobrachium rosenbergii*	*0.01*

Note: based on a total sample of 1,841,533 kg of fish

In general only three categories of fish are landed in Nijhum Dwip: Hilsha, small shrimps and other small fish, volumes of other larger species were negligible. In conclusion Hilsha was the dominant

species in the species poor catch recorded in the landing center, and fishers of Nijhum Dwip presumably earn a large part of their fishing income in just a few months of Hilsha fishing.

7.6 Fishing Effort

Three main types of fishing crafts operate in different types of fishing habitat or location in and around Nijhum Dwip: country boats are without engine and usually operate 2-3 gears with two people on day trips; engine boats typically have a crew of 2-3 and operate 2-3 gears on trips of one day and fish in nearby areas; trawlers typically have a crew of 8-10 and operate one gear on trips of 5-10 days and fish in distant areas. Combining the two years engine boats landed 48% of total estimated catch, followed by trawlers (36%) and country boats (15%).

7.7 Catch Per Unit Effort (CPUE)

Catch per unit effort (CPUE) is defined for Nijhum Dwip as the average daily catch per gear type (calculated as catch in kg/gear trip/number of days on fishing trip, hence it represents the catch for several people with the average numbers of fishers per gear unit given in Section 7.6). Catch rates are influenced by several factors, such as gear and its efficiency, and environmental conditions. Seine nets (*ber jal*) showed the highest CPUE (Fig 7.4) compared with *behundi jal* (set bag net) and *chandi jal* fishing units (note that on average more than one *behundi jal* was used in a fishing unit).

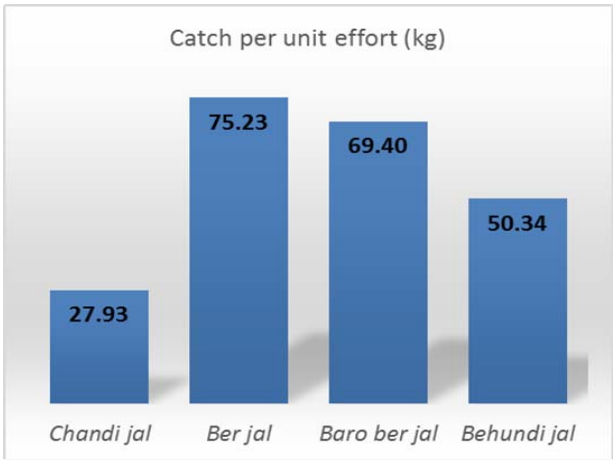


Fig. 7.4: Catch per unit effort (kg/ unit/ day) in Nijhum Dwip combining 2014-15 and 2015-16

Table 7.2. Catch per unit effort (kg/fisher day) in Nijhum Dwip

Month	2014-15	2015-16
October	10.07	4.19
November	12.51	4.84
December	6.04	2.51
January	4.46	7.50
February	2.36	5.84
March	3.29	7.79
April	4.51	9.75
May	3.81	5.92
June	3.00	2.90
July	2.02	2.12
August	1.65	2.30
September	3.35	11.18

At Nijhum Dwip most fishing units are operated by more than two fishers. In Table 7.2.CPUE has been adjusted to catch per person per day, which closely represents fisher daily income. Per head catch varied greatly between months and years, with a peak of 12.5 kg/fisher day in November 2014, and a low of 1.6 kg/fisher day in August 2014 (there was very little Hilsha catch in late monsoon 2015).

7.8 Fish Price and Overall Landings

Monthly average fish price received by fishers varied according to species composition of landings, seasonal demand, and volume of catch. Fish price was higher during the main Hilsha catching season (August to October) – for example over Tk 400 per kg in August in both years. Average fish price was very low during March to May in both years when fishers mainly caught small size fish using *behundi jal* in the adjacent channel of Nijhum Dwip (Table 7.3).

Table 7. 3. Monthly fish price (Tk/kg) in Nijhum Dwip landing center

Month	2014-15	2015-16
October	284.15	256.19
November	96.57	122.11
December	102.44	150.16
January	117.68	96.31
February	111.02	132.34
March	97.92	95.00
April	69.70	57.21
May	78.66	74.56
June	460.43	149.13
July	290.86	382.41
August	489.49	409.75
September	240.10	333.46
Average	198.65	194.92

Based on the sample landing days and sample landings, the total landings by boat type in each year are shown in Table 7.4 along with the overall estimated landings. Based on the monthly fish prices and landing estimates this gives an estimate of the overall value of fish landings at this landing center of Tk 165 million in 2014-15 and Tk 230 million in 2015-16.

7.9 Recommendations

Hilsha is the dominant species by weight and value in fish landing in Nijhum Dwip, and therefore the main income source for fishers, but Hilsha catches are strongly seasonal. This means that a high proportion of fisher income comes from catches in a few months, and if the Hilsha catch fails locally as in 2015, fishers' incomes fall. In these times, and in the off seasons for Hilsha, fishing effort focuses on low value small shrimps and fish and it is likely that these are over fished. Hilsha conservation through maintaining a ban period during the spawning season has been a focus of fisheries management in recent years throughout the coast and supporting this the Department of Fisheries has designated Hilsha sanctuaries and declares the dates for the ban period on Jatka (juvenile Hilsha) fishing.

But as noted above, other estuarine fish are important for local fishers during the rest of the year. The high proportion of small shrimp in catches indicates probable over fishing in the area. Small shrimp are important food for carnivorous fish, and the lack of large fish in the catch also suggests that fishing down the trophic levels (food chain) has already occurred here. The CMC will need to work with the many fishers and the *arotdars* who control the fishery in Nijhum Dwip to limit fishing intensity, by reducing effort, allowing juveniles of other species (shrimps and larger fin fish) to grow – for example with other closed seasons, and with sanctuary areas. This should be guided by local knowledge of the biology of species caught within Nijhum Dwip NP, supplemented where needed with biological study of targeted species. The fish sanctuary established in Muktaria Khal by the CMC is a potentially helpful step for fish conservation, but awareness building is needed, and the impacts of the sanctuary need to be assessed over a longer period than has been possible under CREL. Potentially other areas need to be set aside as no fishing and no-entry areas to provide safe areas for fish as well as for other coastal life including waterbirds and the invertebrates that birds and fish depend on.

CHAPTER 8 TENGRAGIRI

8.1 Introduction

Tengragiri is located in Taltali Upazilla of Barguna District and is bordered to the west and south by the Bay of Bengal and by Andarmanik River to the east. It was declared as a Wildlife Sanctuary in 2010 and covers 4,050 ha (see Fig. 8.1 for location). Most of the WS comprises coastal mangrove plantations and natural mangroves, as well as tidal creeks and some adjacent estuarine waters. The root system of the mangroves provides food and shelter for small fish and is therefore very important to local fish stocks.

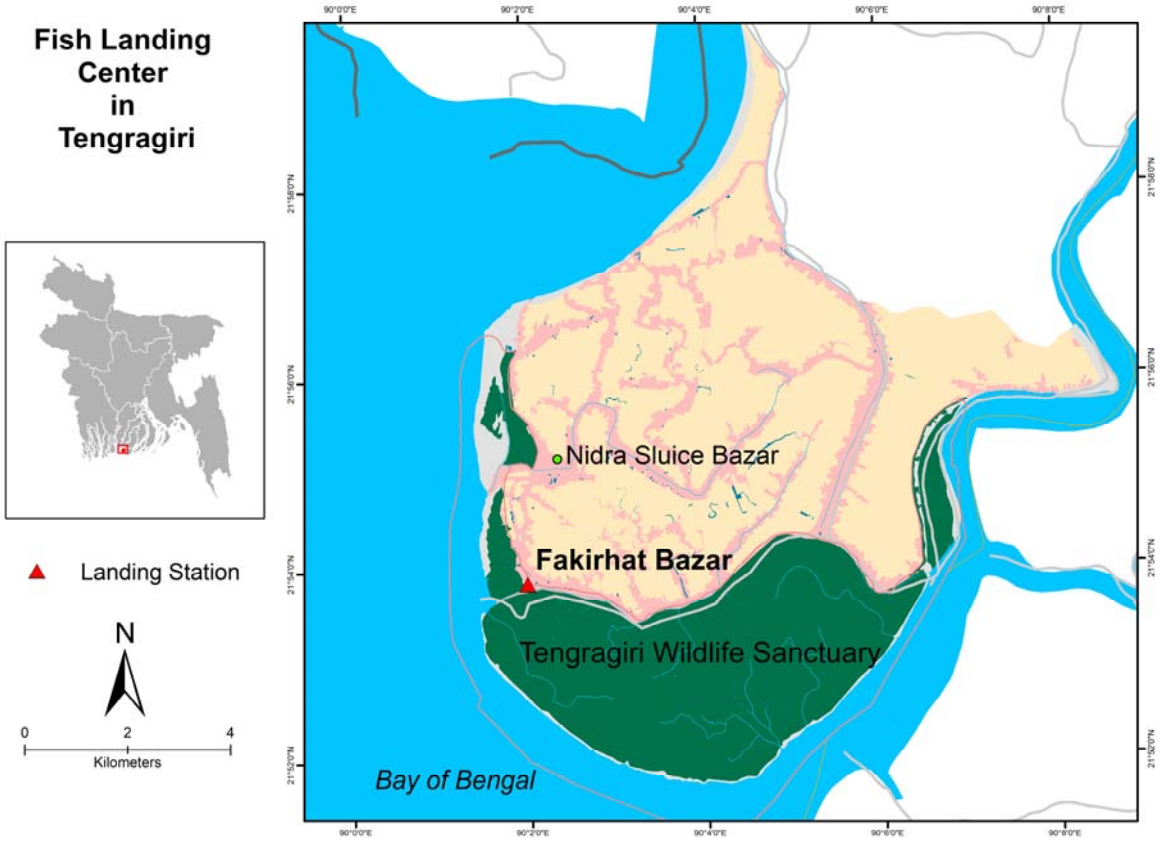


Fig. 8.1 Location of Tengragiri Wildlife Sanctuary.

8.2 Management Institutions and Interventions in Tengragiri

Co-management was introduced to Tengragiri WS in November 2015 by Forest Department, when with CREL project assistance a Co-management Council consisting of 53 members and a Co-management Committee consisting of 22 members and two advisors were formed. There is also an associated People's Forum with 38 members representing 19 Village Conservation Forums (VCF) with a combined membership of 389 men and 387 women. This compares with a population of 5,540 households in 17 nearby villages (Table 8.1) of whom 3,029 households are considered to make significant livelihood use of Tengragiri WS.

In 2015 two fish sanctuaries were established by the CMC - one covering 14 ha in Faicchar khal and the over in Charer khal covering 15 ha. In addition the adjacent Andarmanik River is an important fishing and fish spawning area. It has had attempts to establish community based management during 2001-2006 by Department of Fisheries under Fourth Fisheries Project, which still has community based organizations of fishers here. Andarmanik River has also been declared as a Hilsa conservation

area since 2003-04, where fishing is banned during October to November, and the ECOFISH project is working on fisheries co-management here.

8.3 Fisher Population

Out of over 5,500 households, there are 400 full time and 200 part time fisher households in the 17 villages (Table 8.1). The full time fishers can be categorized in two ways: owners of fishing boat and nets or paid fishers (workers); and sea fishers (fishing in coastal and marine waters south of Tengragiri) or inland fishers (fishing in the river and creeks). Juvenile shrimp are widely collected and this is largely a part time occupation. Fishers mostly live in nine villages (Sokinapara, Idupara, Nidrarchar, Mora Nidra, Nolbunia, Choto Amkhola, Boro Amkhola, Kabirajpara, and Nishanbaria).

Table 8.1: Number of households and population in working villages of Tengragiri WS (source: CREL census, 2015)

Sl#	Union name	Village name	Household #	Population
1	Sonakata	Sokinapara	331	1,347
2	Sonakata	Idupara	211	883
3	Sonakata	Nidrarchar	792	3,095
4	Nishanbaria	Mora Nidra	330	1,363
5	Nishanbaria	Nolbunia	385	1,333
6	Sonakata	Choto Amkhola	339	1,414
7	Sonakata	Boro Amkhola	467	1,606
8	Sonakata	Kabirajpara	410	1,672
9	Boro Bogi	Nishanbaria	347	1,433
10	Nishanbaria	Menipara	201	782
11	Sonakata	Lalupara	277	986
12	Sonakata	Loupara	279	947
13	Boro Bogi	Sowdagorpara	363	1,397
14	Boro Bogi	Charpara	261	901
15	Nishanbaria	Tatipara	274	1,093
16	Nishanbaria	Chamupara	165	624
17	Nishanbaria	Namishipara	108	411
	Total		5,540	21,287

8.4 Trends in Fish Landings

As noted in Chapter 2, CREL monitored landings from sample fishing units at one landing center – Fakir hat for two years to determine baseline conditions. During these two years there were 85 *aroths* (fish wholesale shop) operating in Fakirhat bazar (photo 8.1). On average 60 *aroths* collected fish from fishing boats for marketing. Each *aroth* collected 40 to 400 kg fish every day from their contracted fishing boats and local "inland" fishers. Monthly variations were substantial: an estimated 577 t of fish were landed in November 2015 at all 85 *aroths*, compared with a low of 150 t in April 2015 at all 85 *aroths* (Fig. 8.2).

Fakir hat fish landing center near Tengragiri WS. Date: 13 August, 2014

A monthly average of 342.5 ton fish was landed in Fakir hat bazar. Fish landings increased slightly during the monitoring period, but this is largely due to the first month having very low landings, possibly due to incomplete recording. Total annual landing was very similar in the two years: 3,801 t in 2015-16 and 3,711 t in 2016-17. Landings were highest in the post monsoon (October - December) (Fig. 8.3).

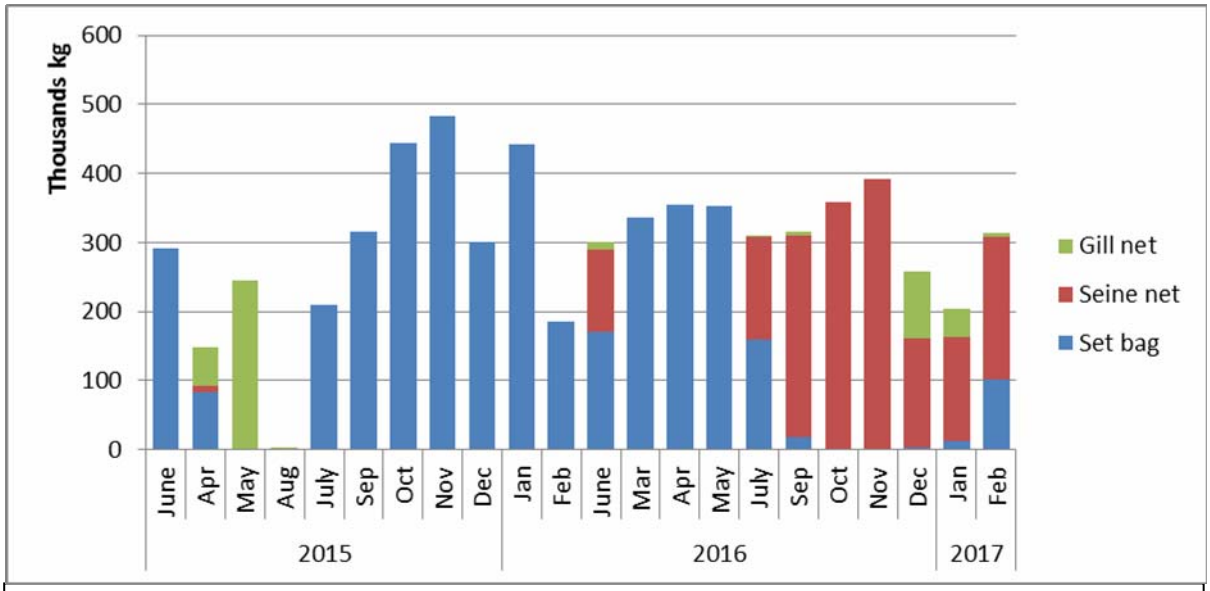


Fig.-8.2: Monthly gear wise catch (kg) landed at Tengragiri

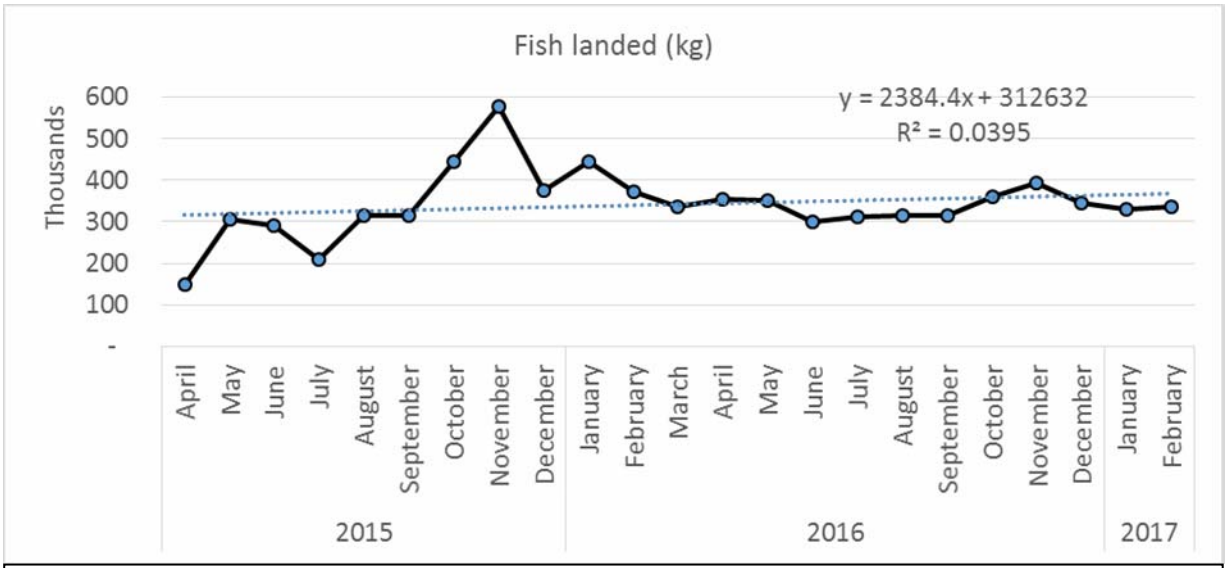


Fig. 8.3 Monthly estimated total fish landing (t) in Fakirhat bazar.

8.5 Trends in CPUE

Gear and craft wise quantities of fish landed were recorded for a sample of fishing units landing their catch. One craft often had used multiple gears on the same fishing trip. So catch was calculated as a fishing unit designated to its prime fishing gear (these were mostly gill, set bag or seine nets). Type of gear used changed seasonally, for example gill nets were used in the rainy season for Hilsha fishing, set bag net in the dry season to catch small fish. The data reveal that catch from static nets (set bag and gill net) was lower in the second year, while active net (seine net)

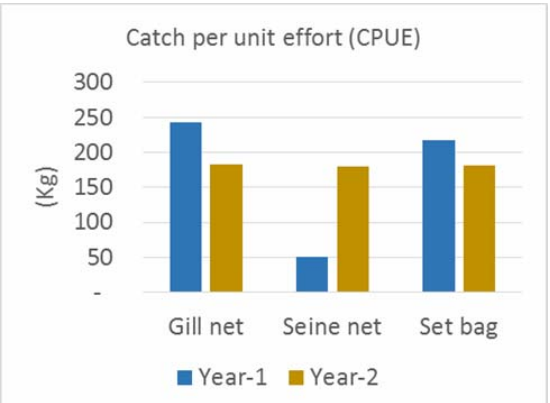


Fig. 8.4 Catch per unit effort (kg/day) from main gears landing fish in Fakir hat bazar

catch increased (Fig. 8.4). Normally four fishers operated a gill net unit, set bags were operated by 2-3 fishers, and 6-8 fishers operated a seine net unit. The catch per seine net unit averaged only 50 kg/day in the first year (April 2015 to February 2016), but 180 kg/day in the second year (April 2016 to February 2017) (Fig 8.4).

8.6 Trends in Catch Composition

For the sampled fishing unit landings that were monitored in detail, catch/landing composition was recorded. This shows that both freshwater and marine fish including cartilaginous fish, bony fish, and shrimps were all landed in Fakir hat. Among 138 species recorded over two years, 19 were shrimps, four were crabs, four cartilaginous fish species were recorded, and the rest were bony fish. Poma (*Johnius vogleri*) was the dominant species by weight and the coastal shrimp *Penneus semisulcatus* was the second top landed species. Hilsha (*Ilish*) was the fourth most abundant species by weight in landings. The top 20 species contributed over 80% of total landings in each year (Appendix 8.1). This shows that fishing pressure by set bag nets was high compare with fishing by gill nets in 2015 and the first half of 2016. The contribution of fish categorized as freshwater species to total landings was low, and none of these species were among the top 20 species landed.

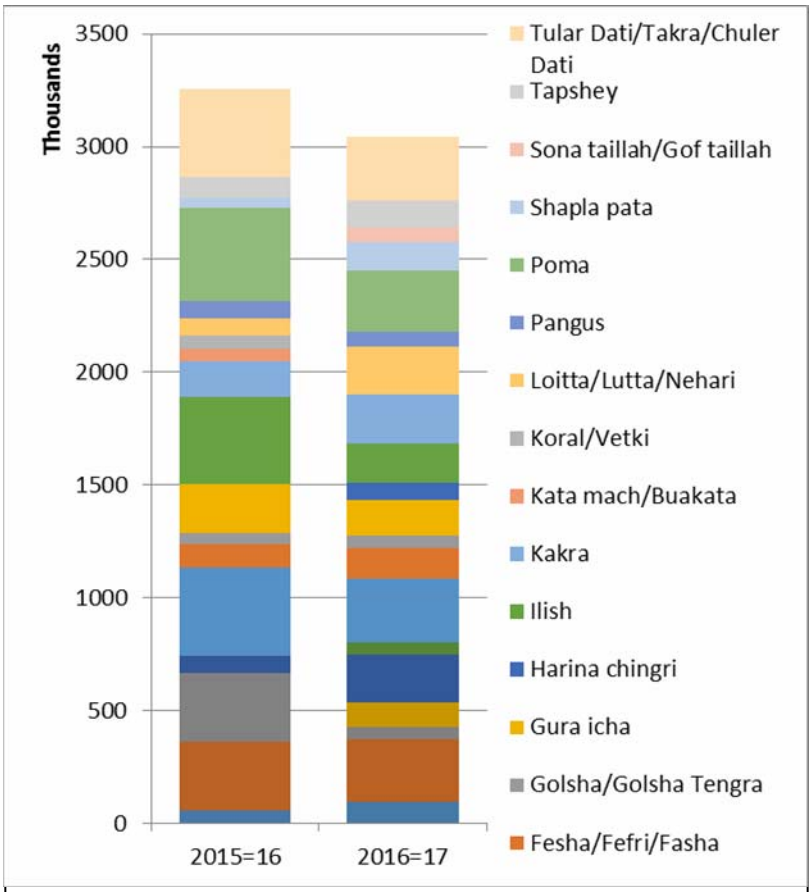


Fig. 8.4 Top 20 species landed by weight (kg) in Tengragiri.

Fig. 8.4 shows the top 20 species landed by weight. The catch of Hilsha fell from second position in year 1 to 8th position in year 2 despite the wider conservation/bans imposed in Andarmanik. The catch of Tular dati (*Sillaginopsis panijus*) increased from 4th position to 1st position in the 2nd year. The combination of all shrimp species landed fell slightly from 917,778 kg in year 1 to 903,406 kg in year 2, but remained high. Shrimps are disproportionally caught in set bag nets, which dominated fishing effort for much of the survey period, and fishing by set bag nets is widely regarded as damaging since they catch many small fish and fry that are not targeted and die as by-catch.

8.7 Trends in Fish Prices

Fish price varied with the availability of different fish species and seasonal demand. Like other coastal areas, average fish price was higher during July to September. Average price of fish sold in the landing center was BDT 226 per kg during the monitoring period, with a peak of BDT 311 per kg in

September 2015. Prices were lowest during the post monsoon and winter season when catches were high and fishers mainly caught small size fish using set bag net (Fig. 8.5).

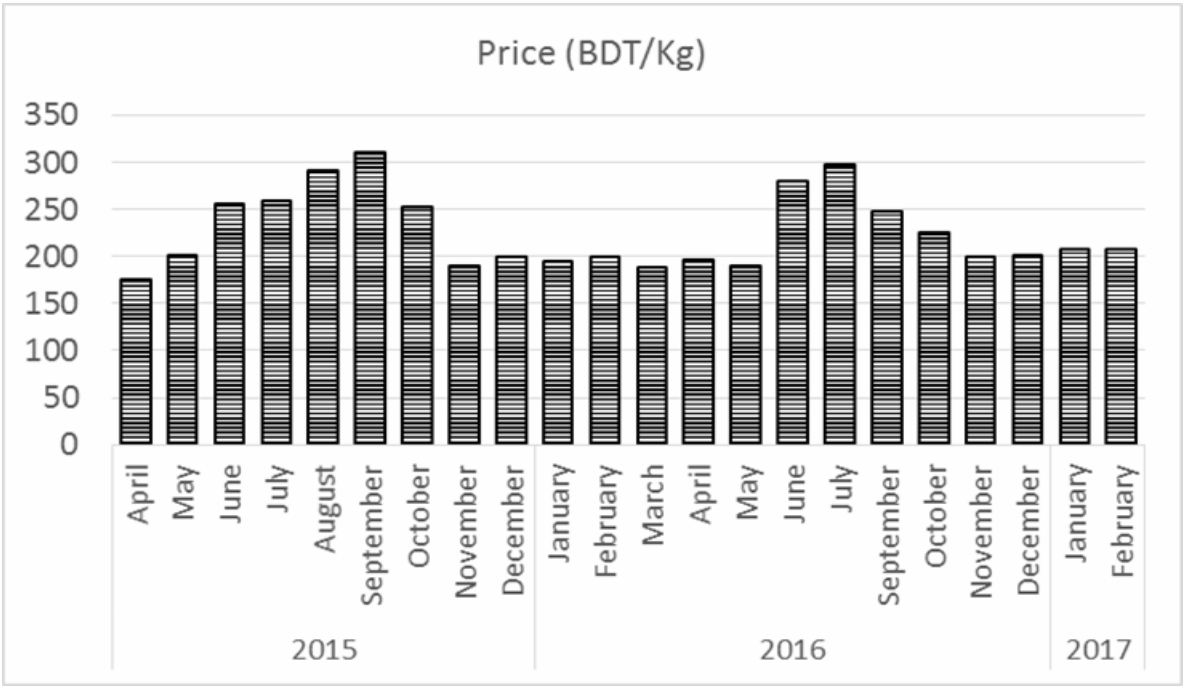


Fig. 8.5 Monthly fish price at Fakir hat bazar in Tengragiri WS during monitoring period

8.8 Future Management

In the two years monitored overall fish landings at Fakirhat were stable, and the value of landings here was estimated to be about Tk 874 million (US$ 11.3 million) in 2015-16, falling somewhat to Tk 823 million (US$10.7 million) in 2016-17. Catches were dominated by Poma (*Johnius vogleri*), Tular dati (*Sillaginopsis panijus*), several shrimp species, and Hilsha.

CREL project helped establish two fish sanctuaries in Tengragiri WS for conservation and to protect spawning/nursing areas in creeks. It is not possible to determine any impact in the two years of data from this initiative, which may be revealed over a longer period, but the CMC should consider developing with its fisher communities a closed season to complement the sanctuaries based on local fishers' knowledge of the life cycle of fin fish important to the area. Hilsha is an economically important and valued fish, but despite the landing center being close to an important Hilsha conservation area the catch was not so high compared with other species, and also declined in the second year. Hilsha conservation through observing closed seasons is essential. There is scope for the Tengragiri CMC and fishers in this area to cooperate with fisher organizations in Andermanik River and with Department of Fisheries initiatives for conservation and sustainable harvesting of Hilsha, including maintaining a larger Hilsha sanctuary outside of Tengragiri. The CMC should be more active in building local awareness of and compliance with measures for fish conservation.

The high shrimp catch indicates over fishing in the area, and fin fish are thought to be declining. Shrimp are an important component in the diet of carnivorous fin fish in their trophic level (food chain). Use of non-selective fishing gear particularly set bag nets which target shrimps but also catch other juvenile fish should be reduced. Limiting set bag net use will require working with their owners and operators. Monitoring the effectiveness of any such limits will require a revised monitoring system as a limitation of the data summarized here is that multiple gears were used by fishing boats and the actual species-wise contribution of set bag nets to catches could not be reliably determined.

Chapter 9 RATARGUL

9.1 Introduction

Ratargul Special Biodiversity Conservation Area (SBCA) was declared in 2015 and covers 204 ha. It mostly comprises of mature freshwater swamp forest and is located in Gowainghat Upazila, Sylhet District. The forest is bordered to the north by the Gowain River, and linked with Chengir Khal. Most of the trees are Koroch *Millettia pinnata*. The forest is flooded with 5-8 m of water during the monsoon, but the forest becomes dry in the winter season. In addition to fishing in the river, during the monsoon when the river current is fast and the surrounding lands are inundated, local fishers shift their effort to the nearby inundated beels. Fish production in the river and beels is influenced by the nutrient supply from the swamp forest, which also acts as a large fish shelter that contributes to fish production in nearby beels.

This is a new protected area, although in practice it has been protected by Forest Department for a number of years. In 2016 co-management was established in Ratargul. However, to date no management actions or interventions have been taken for conserving fish or aquatic resources in the forest or in the river and beel-floodplains.

Fish catch monitoring was carried out in a 1 km long stretch of the Gowain River upstream from Motorghat (Fig. 9.1) bordering the swamp forest, as this is used year round for fishing, and is believed to be directly representative of the contribution of the swamp forest to the fishery, although seasonally fishing also takes place inside the Forest Department lands in excavated ponds/depressions. Data was collected for one year to provide a baseline.

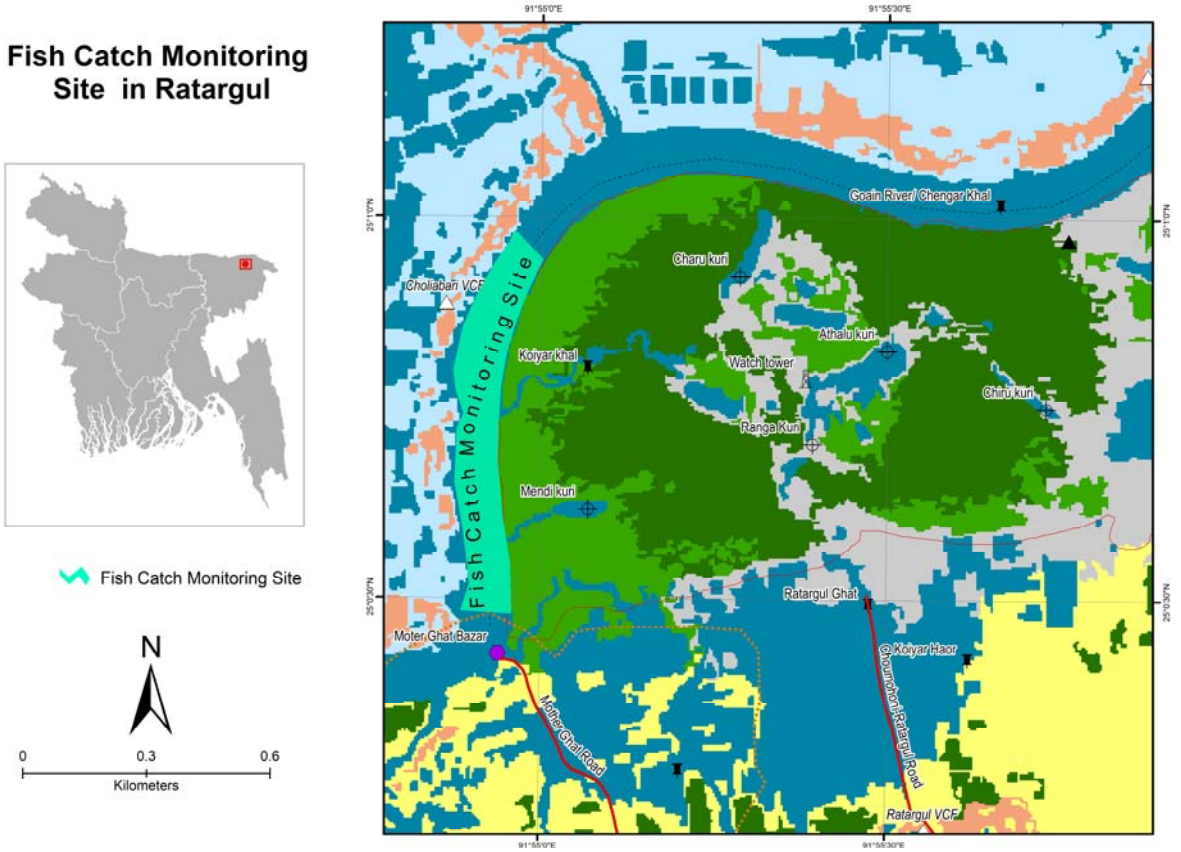


Fig. 9.1: Ratargul SBPA showing fish catch monitoring site.

9.2 Fisher Population

Ten villages that surrounding Ratargul Special Biodiversity Conservation Area are involved in co-management. A census during CREL project inception identified Ratargul stakeholders and their status. This found fishers living in seven villages, comprising 146 full time fisher households and 170 part-time fisher households, out of 1,057 households (Table 9.1). Overall 30% of households earn all or part of their livelihood from fishing.

Table 9.1: Number of fisher households in Ratargul villages

Name of Village/VCF	Full time	Part time
Ratergul	-	17
Bagbari	-	9
Ramnagar	1	2
Jolurmuk	37	65
Jolurmuk (Beterkona)	8	39
Chalitabari	76	26
Chalitabari (Bimarpar)	24	12
Total	**146**	**170**

9.3 Fishing Effort

Fishing effort in the area monitored was found to be highest in August of the year monitored. There are many beels near Gowain River that are inundated during annual flooding, the area monitored extended to the adjacent floodplain in addition to the river itself and much of the effort recorded in August came from this area. The most used gear during the year was push net (44%) which is used mainly for subsistence fishing in the shallow flooded areas (Fig. 9.2). However, gill nets comprised 32% of fishing unit effort recorded, and were mainly operated within the river. About half of the fishing effort monitored was from professional fishers who depend for their livelihood on Gowain River. Overall 2,397 fishing unit days were estimated in the monitored area over 12 months of 2016.

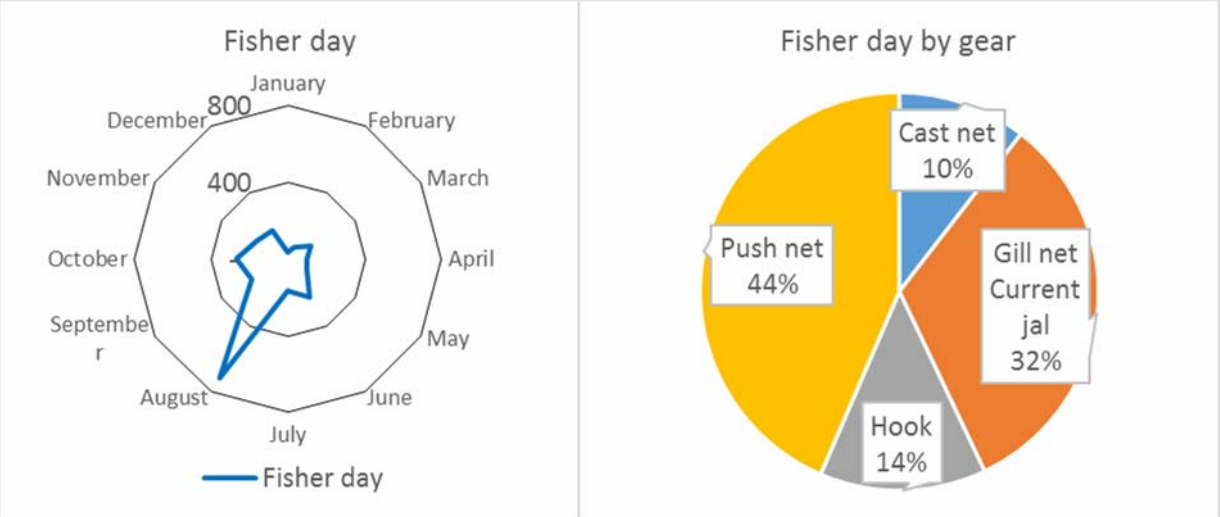


Fig. 9.2 Monthly distribution of fishing effort (left side) and gear composition of fishing effort over a year at Ratargul SBCA

9.4 CPUE

Fish catch per unit per day differed greatly between gear types (Fig. 9.3). High catch rates were found in small gill net, small mesh seine net, and small seine nets, these gears were operated by more than one fisher, normally by professional fishers. An average catch of only 0.9 kg per fishing unit per day was found in the most used gear – current jal (mono-filament nylon gill nets that are officially banned but widely used) which is operated on average by two fishers, on the other hand the highest average catch rate was 3.9 kg per fishing unit per day for small size seine nets (i.e. relatively short length seine nets) which typically are operated by 4-6 fishers.

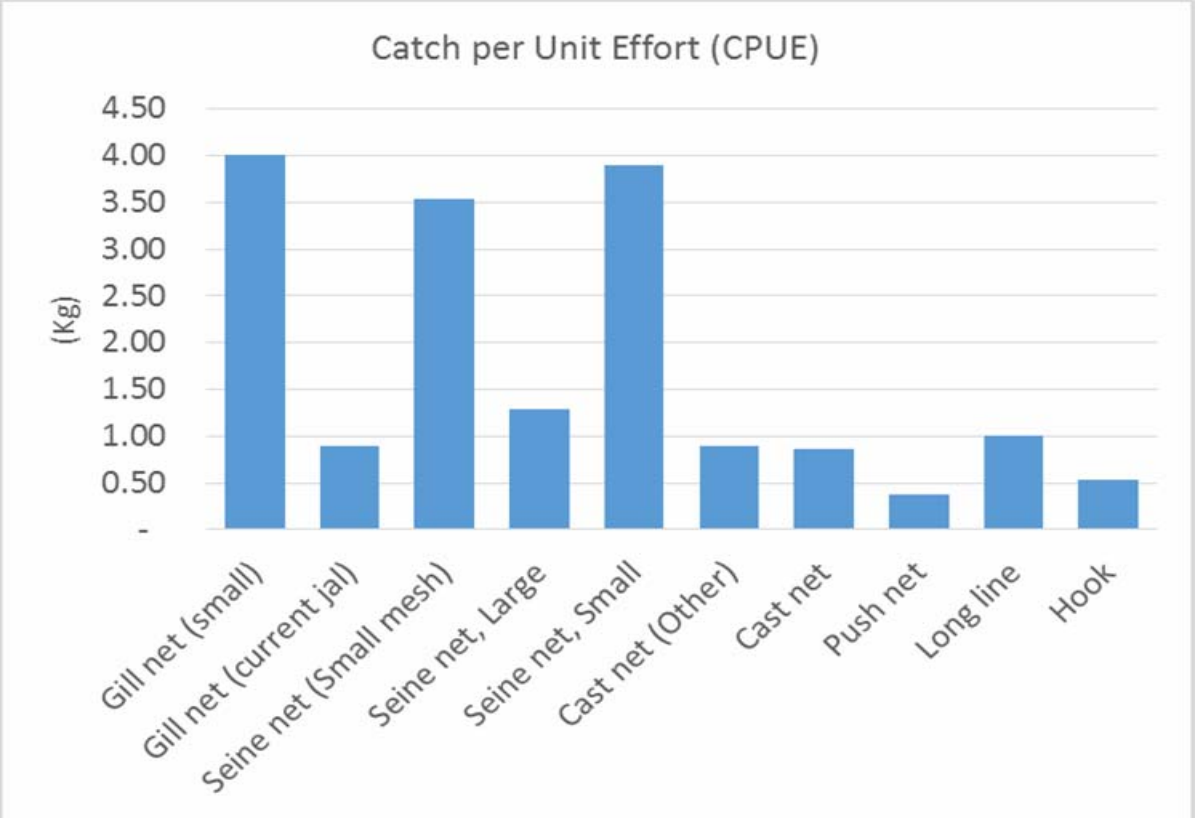


Fig. 9.3 Catch per unit effort (CPUE) in kg/fishing unit in Ratargul SBCA

9.5 Catch Composition

From the sampled catches, the dominant species with over 20% of total catch was Boal (fresh water shark) *Wallago attu*, other large species including Ilish, Aor and Kalibaus also were important components of the catch (Fig. 9.4) indicating a scarcity of small fish in the river. Species are listed in order of overall percentage contribution to catch. The data shows a small contribution from small fish, benthic fish and major carps compared with the catch of large species noted above.

Four nationally endangered species (Kalibaus, Gazar, Kali Koi and Kani Pabda*)* and one nationally critically endangered species (Rita) were caught, indicating that this area may still be important for threatened large riverine fish. Remarkably Hilsha (*Ilish*) was caught in Gowain River despite being hundreds of kilometers from the sea and main rivers – 2016 was a good year for this species. A detail species composition is given in Appendix 9.1.

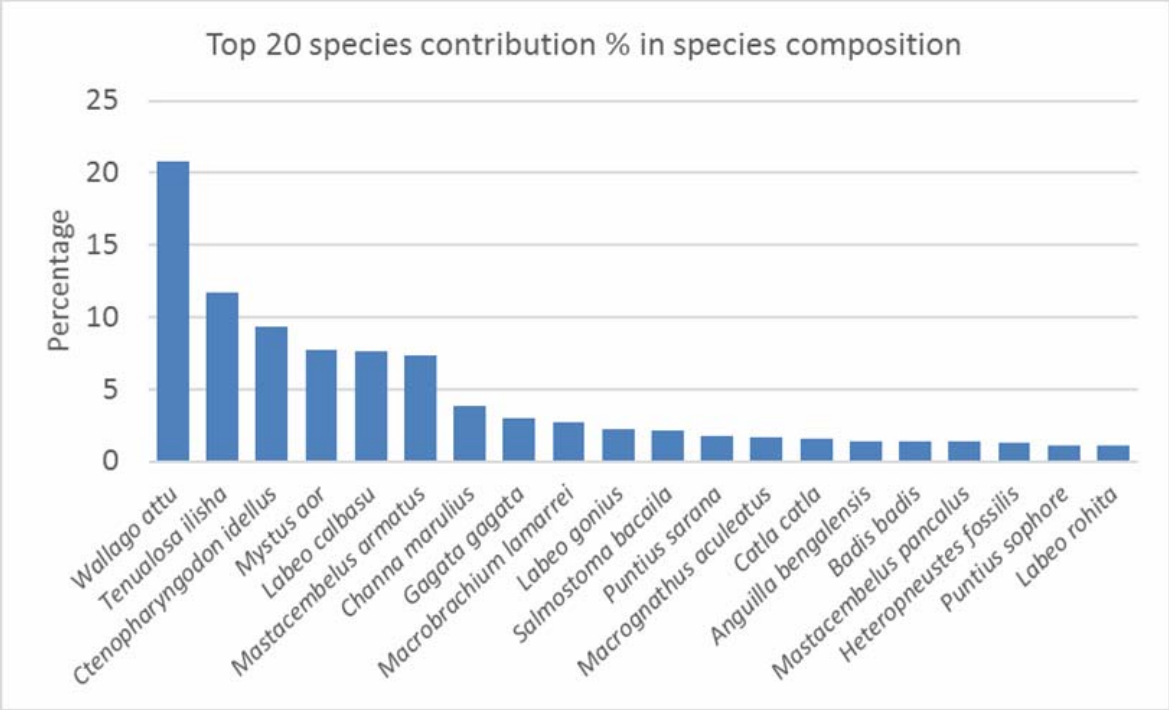


Fig. 9.4 Contribution of top 20 species to sample catch in Ratargul SBCA.

9.6 Fish Prices

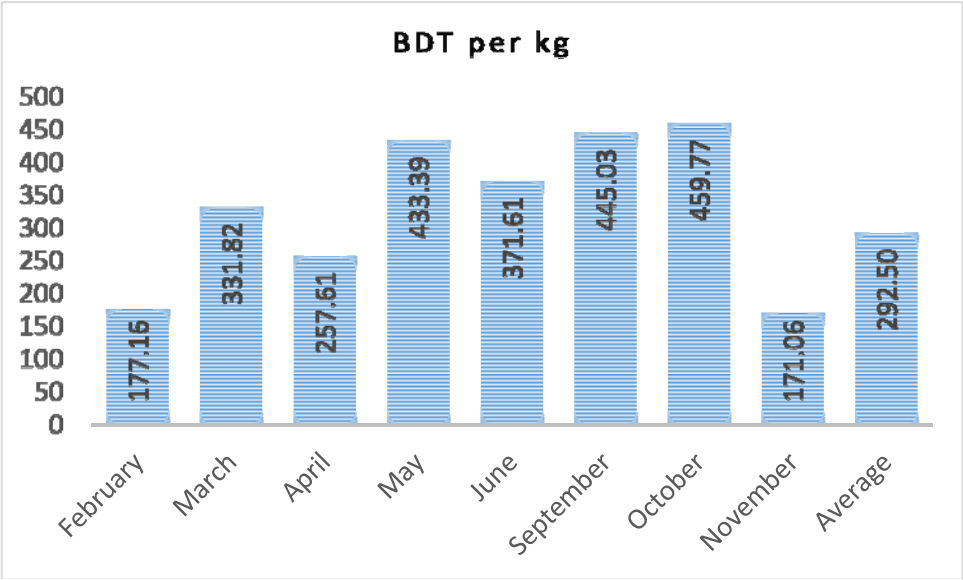


Fig 9.5 Fish price (BDT/kg) in Gowain River, 2016

Fish price varied monthly due to the volume of fish catch in the area. Fish price was high in the early and late monsoon and data is missing for the two peak monsoon months of July and August. Normally the post monsoon fish price is low as this is a peak fishing period, and the November price is consistent with this general pattern at only BDT 171 per kg compared with above BDT 400 per kg in May, September and October (Fig. 9.4), average prices are also influenced by much of the catch comprising large high value species.

6.7 Overall CPUA

Fish catch was monitored in an area of 8.75 ha centered on the Gowain River (maximum extent of monitored area). The total estimated catch in 2016 from this area (including months missing from

monitoring and estimated to be the same as the adjacent monitored months) was 2,224 kg giving an estimated catch per unit area (CPUA) of 318 kg/ha in 2016. This is higher than the river/estuary national average fish catch of 172 kg /ha in 2012-13, but comparable to the catch per ha reported in this study in Hail and Hakaluki Haors in the northeast - a similar ecosystem and the same region as Ratargul. The average fish price over the year was Tk 293 per kg, giving an estimated value of fish caught from this small area of Tk 0.65 million. Assuming only one fisher operated each gear unit would give an average daily income of Tk 271 (USD 3.52).

6.8 Management Recommendations

Ratargul swamp forest is widely believed to act as a fish shelter and nutrient source for fish. It contributes to fish catches in the river and in nearby beels and floodplains. However, Gowain River is the main dry season refuge for fish in this area as the swamp forest dries out in the dry season. Co-management needs to be extended to the river as well as the swamp forest. The very low CPUE suggests overfishing, although the high catch of large fish suggests that the fishery here has not yet collapsed. It is essential that the CMC work with the fishing communities to agree on specific areas within the river as well as inside the swamp forest which will be protected as fish sanctuaries, and to agree on a closed season in the pre-early monsoon when large riverine fish are migrating and spawning. These measures will require a lead from the local fishers and CMC and support from Forest Department, Department of Fisheries, and local administration.

APPENDIX 1 SURVEY FORMATS

Climate-Resilient Ecosystems and Livelihoods (CREL) Project

GEAR SURVEY BEFORE CATCH ASSESSMENT SURVEY

WI-USAID/WorldFish/CNRS

1. Site no. ..... 2. Name of waterbody: .....

3. Date of survey: ..... 4. Name of data collector: .....

5. Section of waterbody: | 1 | 2 | 3 | or location of survey: .....

6. Survey period: Start time: ..... End time: .....

Gear type	Gear code	Active fishing	Landing from fishing	Total
Gill net				
Gill net				
Seine/drag net				
Seine/drag net				
Set bag net				
Lift net (Large)				
Lift net (Smaller)				
Cast net				
Push net				
Trap unit				
Trap unit				
Long line				
Hook and line				
Hook and line				
Spear				
Katha/brush pile				
Kua				
Other gear (name)*				

6. Survey period: Start time: ..... End time: .....

Gear type	Gear code	Active fishing	Landing from fishing	Total
Gill net				
Gill net				
Seine/drag net				
Seine/drag net				
Set bag net				
Lift net (Large)				
Lift net (Smaller)				
Cast net				
Push net				
Trap unit				
Trap unit				
Long line				
Hook and line				
Hook and line				
Spear				
Katha/brush pile				
Kua				
Other gear (name)*				

* In case of new fishing describe the operation mode

Climate-Resilient Ecosystems and Livelihoods (CREL) Project
Fish Catch Monitoring Questionnaire
USAID-WINROCK International /CNRS/ WorldFish

1. Code of Jalmohal: …… 2. Fishing ground operated in: ……

3. Name of Field Assistant: …….....4. Date of sampling: ……..……..

5. Name of fisherman: …….....6. Name of village: …….

7. Distance of fishing spot from house (Km)…... 8. Serial number of form ……

9.i) Full time fisher…. ii) Part time fisher…. iii) Subsistence fishers…. iv) Own land (dec) ....

10. Description of gear used by the fisher in the sampling day:

Sl no.	Local name of gear	Gear code	Description of gear (in Hand)			Mesh size (Inch)	Total no. (Hook/ Net)	Total number of fisher	Water depth (Hand)
			Length	Height	Diameter				
1.									
2.									

11. How many days & night has the gear operated in last 7 days: …..….. Day .....….. Night

12. Number of gear owners: i) How many engaged in fishing ……ii) How many not engaged in fishing

13. Code of fishing right: i) Pay to fish through BUG ii) Pay leaseholder/agent to fishiii) Must sell fish through leaseholder iv) Get share of fish v) Give few fish for permission vi) Can fish freely

14. Duration of fishing since last night:
Fishing began at: …….. When fishing ended: …….
Total time fished so far: ……
Time fishing for present amount of catch (hr, min): …… Expected time fishing will continue today (hr, min):

15. Amount of fish caught (kg) ……How much fish is sold (kg)……
Price of fish sold (kg)……How much fish will be sold (kg)……

16. Amount of fish caught yesterday (kg) …… How much fish is sold (kg)……
Price of fish sold (kg)…….

17. Amount of fish consumed (kg) …….. How much small fish within consumed fish (kg)…

18. Expense for today's fishing:
Cash cost (Net repairing, Fuel, Transportation etc.) ……. (Tk.)
Fees/Share for fishing …… (Tk.)/ %.
Percentage of catch to non-member for gear used……. %

19. Amount of fish caught by fishers during sampling:

Species name	Species code	Total amount (Kg)*	Sample/Measured catch		Length (Inch)		
			Total number	Total amount (g)	Small	Large	Average

*If required the percentage can be calculated from total amount of fish.
Remarks:

Climate-Resilient Ecosystems and Livelihoods (CREL) Project

Fish Landing Center Monitoring Questionnaire

USAID-WINROCK International /CNRS/ WorldFish

1. Date: …… 2. Data collector: ……

3. Name of Fish Landing Centre: ……..…….. 4. Dadandar/Depot name: ....……

5. Number of Dadandar/Depot: ..... 6. Number of fishers: ……..…….

7. Place of fish catch: …… 8. Name of head boatman:

9. Number of fishing days for this catch: ……

10. Information on fishing:

a) Name of Gear		
b) Gear Code		
c) Mesh size (in cm)		

11. Tick (√) on boat type: Country boat/Engine boat/Trawler boat

12. Information on fish catch

Name of fish	Weight (Kg)	Price (Tk)		Name of fish/group	Weight (kg)	Price (Tk)

13. Total fish catch (Kg) : .....

14. Number of boats supplied fish today (24 hours)

Country boat	Engine boat	Trawler boat

APPENDIX 2 DATA TABLES

Hakaluki Haor

Appendix: 4.1: Fish sanctuaries in Hakaluki Haor declared by Ministry of Land in 2010 and 2011

Sl #	**Declaration year- 2010** Name of *beel*	Address			Area
		Mouza	Union	Upazilla	Acre
1*	Tolar beel **	Hakaluki haor	Talimpur	Barlekha	65.62
2	Ronchi beel	Hakaluki haor	Talimpur	Barlekha	224
3	Polobhanga, Mora Sonai O Chikonuti group fishery **	Hakaluki haor	Talimpur	Barlekha	395.75
4	Baiya beel **	Hakaluki haor	Talimpur	Barlekha	155.45
5	Uttor Gazua Dakshin Gazua beel **	Hakaluki haor	Talimpur	Barlekha	112.75
	Declaration year- 2011				
1*	Koiar kona beel (closed) **	Joller haor	Talimpur	Barlekha	75
2	Agder beel (closed)	Chatla haor	Jayfornagor	Juri	22
3	Kangli Gobarkuri Chikon mati group fishery (closed)	Haor	Bhatera	Kulaura	50.7
4	Maiyajuri beel (closed)	Joller haor	Talimpur	Barlekha	28.2
5	Tekuni beel O Koiermura O Keshobdohor group fishery (closed)	Hakaluki haor	Talimpur	Barlekha	80.48
6	Nemu beel (closed)	Islampur	Talimpur	Barlekha	21.65
7	Maishlerdak (closed)	Chatla haor	Jayfornagor	Juri	63.45
	12 declared fish sanctuary in Hakaluki haor		Total area	(Acre)	1,295.05

Tolar beel and Koiar kona beel sanctuaries with swamp conservation
** five sanctuaries managed by CREL project.

Appendix 4.2. Distribution of fisher households by village and category in Hakaluki Haor

SL #	Village	Fishers Households (#)		
		Full Time	Seasonal	Occasional
1	Judistipur	400	250	20
2	Badeduli	150	80	30
3	Nizghila chara	20	30	-
4	Ashighar	7	40	-
5	Bagla	-	60	40
6	Alampur	50	30	10
7	Kautkona	40	30	20
8	Kulia	150	15	-
9	Supatek	40	100	-
10	Jamira	-	-	20
11	Chuar kandhi	20	10	-
12	Anandapur	15	10	-
13	Golap nagar	40	10	-
14	Rangjiul	100	100	50
15	Islampur	100	50	40
16	Kalikrisnapur	200	100	80
17	Meherpur	50	140	-
18	Paniagha	40	120	-
19	Kadirpur	42	50	-
20	Puniar chock	20	40	-
21	Barogaon	-	-	10
22	Brommateka	20	30	-
23	Kharpara	-	-	50
24	Khatgaon	-	-	5
25	Hossainpur	-	-	40
26	Noagaon	100	150	50
27	Maizgaon	200	50	100
28	Berkuri	25	30	20
29	Alinagar	60	140	50
30	Shasher kandhi	10	50	150
31	Bhukshimail	-	-	140
32	Jalalpur	70	20	60
33	Shadipur	500	100	150
34	Mirsongkar	30	60	10

SL #	Village	Fishers Households (#)		
		Full Time	Seasonal	Occasional
35	Gobindapur	20	15	25
36	Shahpur	50	100	70
37	Nischintapur	-	-	80
38	Bahadurpur	-	25	60
39	Hasnabad	-	-	50
40	Taltala	22	15	20
41	Amtail	35	20	90
42	Khakteka	-	-	175
43	Kalnigar	30	40	170
44	Noyagram	30	200	170
45	Belagaon	50	300	500
46	Sonapur	80	30	30
47	Voler kandhi	70	200	20
48	Dasghari	50	50	30
49	Badda	20	30	-
50	Srirampur	150	50	20
51	Pabijuri	100	50	25
52	Halla	50	70	30
53	Kazir banth	20	75	50
54	Salia	10	20	70
55	Jagri	-	20	40
56	Katalpur	-	45	40
57	Murshidabad kura	200	350	50
58	Ahmadpur	45	4	-
59	Bade bhukshimail	-	-	150
60	Gourkaran	100	-	25
61	Madan gouri	-	-	50
62	Mahes gouri	75	-	35
63	Kurbanpur	-	-	80
64	Singhanath	8	10	100
65	Jagatpur	5	15	80
66	Satghari	10	-	25
67	Dighabag	15	20	15
68	Kankair chock	12	3	10
69	Manaharpur	5	3	40
70	Khamaura	15	-	10
71	Shahmir	15	-	20
72	Bashirpur	100	60	450
73	Jangirai	25	50	100
74	Usuf nagar	10	25	60
75	Noyagram (Ratkhal)	-	-	100
76	Chock	-	-	150
	Baromoydan	100	150	100
77	Barhal	-	-	150
78	Khutaura	100	15	20
	Total:	**4,126**	**3,955**	**4,730**

Appendix 4.3. Species composition by weight (kg) of sample fish catches in Hakaluki Haor

Local name	Scientific name	Year1	Year2	Year3	Total	%
Gura icha	*Macrobrachium lamarrei*	846	2,390	14,661	17,897	14.91
Chapila/Korti/Chalpa/Chopra	*Gudusias chapra*	2,620	2,782	3,572	8,974	7.48
Jatputi/Vadi Puti	*Puntius sophore*	2,287	3,861	2,314	8,462	7.05
Kalibaus/Baus/Kalla Mach	*Labeo calbasu*	1,720	3,923	2,186	7,829	6.52
Tit Puti	*Puntius ticto*	644	1,241	5,151	7,036	5.86
Boal	*Wallago attu*	1,312	2,652	2,916	6,880	5.73
Meni/Veda/Royna	*Nandus nandus*	1,209	3,074	1,978	6,261	5.22
Tengra/Guinga	*Mystus vittatus*	934	419	4,173	5,526	4.61
Ayre	*Mystus aor*	1,520	1,537	1,739	4,796	4.00
Lomba Chanda/Nama Chanda	*Leiognathus equulus*	503	946	3,220	4,669	3.89
Chatka Icha	*Macrobrachium malcolmsonii*	310	3,494	434	4,238	3.53
Gazar/Gazal	*Channa marulius*	545	2,386	1,134	4,065	3.39

Local name	Scientific name	Year1	Year2	Year3	Total	%
Shol/Shoil	*Channa striatus*	342	1,139	1,321	2,802	2.34
Grass Carp	*Ctenopharyngodon idellus*	0	128	2,509	2,637	2.20
Aair	*Arius platystomus*	0	0	2,252	2,252	1.88
Boro Baim/Shal Baim	*Mastacembelus armatus*	113	1,618	331	2,062	1.72
Foli/Kanila/Fotol/Vali/Foloi	*Notopterus notopterus*	1,076	503	160	1,739	1.45
Goinna	*Labeo gonius*	712	744	261	1,717	1.43
Golsha/Golsha Tengra	*Mystus bleekeri*	633	848	225	1,706	1.42
Raek/Nora/Lachchu	*Cirrhinus reba*	389	1,006	79	1,474	1.23
Sarputi/Sheron Puti/Puti tor	*Puntius sarana*	725	495	163	1,383	1.15
Rui/Ruhit/Vuitta	*Labeo rohita*	288	877	173	1,338	1.12
Guchi Baim/Chikra	*Mastacembelus pancalus*	196	937	121	1,254	1.05
Mola/Maya/Moa/Mousi	*Amblypharyngodon mola*	103	701	412	1,216	1.01
Kakila/Kaikla/Kakla/Kaikka	*Xenentodon cancila*	181	676	217	1,074	0.90
Taki/Ladi/Saitan/Voskol/Sati	*Channa punctatus*	248	588	129	965	0.80
Unidentified	*Unidentified*	134	232	542	908	0.76
Modhu Pabda/Paiva/Pabda	*Ompak pabda*	320	462	107	889	0.74
Mrigal/Mirka	*Cirrhinus mrigala*	60	385	396	841	0.70
Common Carp/Carfu/Japani Rui	*Cyprinus carpio (specularis)*	0	492	220	712	0.59
Ilish	*Hilsa ilisa/ Tenualosa ilisha*	15	615	0	630	0.53
Batashi/Batai/Aluni/Gilakani	*Pseudeutropius atherinoides*	106	449	47	602	0.50
Gogla	*Apogon septrmstritus*	0	90	490	580	0.48
Gutum/Gutumi/Butkuni/Pia	*Lepidocephalus guntea*	124	155	200	479	0.40
Koi/Gachua Koi	*Anabas testudineus*	51	282	39	372	0.31
Chola Puti	*Puntius chola*	0	344	0	344	0.29
Bojuri Tengra/Choto Tengra/Guitta Tengra	*Mystus tengara*	176	158	10	344	0.29
Telapia/Telapata	*Oreochromis mossambica*	26	0	310	336	0.28
Baila/Bele/Vangla	*Glossogobius giuris*	62	224	2	288	0.24
Balitora	*Psilorhynchus balitora*	124	70	83	277	0.23
Tepa/Potka	*Tetraodon cutcutia*	104	129	9	242	0.20
Rani/Cheka/Bou	*Botia dario*	133	94	0	227	0.19
Bacha	*Eutropiichthys vacha*	122	47	35	204	0.17
Gachua/Cheng/Raga/Laua/Ghaddu	*Channa orientalis*	28	146	11	185	0.15
Kabashi Tengra	*Mystus cavasius*	158	0	0	158	0.13
Kholisha/Pata Kholisha	*Colisa fasciatus*	20	133	3	156	0.13
Shing/Jiol Mach/Kanuch	*Heteropneustes fossilis*	21	97	24	142	0.12
Chitol	*Notopterus chitala*	0	0	99	99	0.08
Kani Pabda/Boali Pabda	*Ompak bimaculatus*	59	34	0	93	0.08
Tara Baim	*Macrognathus aculeatus*	93	0	0	93	0.08
Futani Puti	*Puntius phutunio*	38	23	9	70	0.06
Ranga Chanda/Lal Chanda/Gol Chanda	*Chanda ranga*	61	0	3	64	0.05
Kali Koi/Napit/Koi Bandi	*Badis badis*	2	41	4	47	0.04
Thangua Icha	*Macrobrachium birmanicum*	47	0	0	47	0.04
Kanchon Puti/Taka Puti	*Puntius conchonius*	0	25	20	45	0.04
Katla/Katol/Fega	*Catla catla*	43	0	0	43	0.04
Naftani/Naptani	*Ctenops nobilis*	0	19	16	35	0.03
Gang Tengra/Gongra/Ghagot	*Gagata gagata*	34	0	0	34	0.03
Tek chanda	*Atropus atropus*	0	0	31	31	0.03
Gongonia	*Allenbatrachus grunniens*	20	10	0	30	0.03
Golda Icha	*Machrobrachium rosenbergii*	13	9	2	24	0.02
Magur/Mojgur	*Clarias batrachus*	0	0	21	21	0.02
Kachki/Kechki/Suborna	*Corica soborna*	20	0	0	20	0.02
Chela/Katari/Narkeli Chela	*Salmostoma bacaila*	0	0	9	9	0.01
Teri Puti	*Puntius terio*	0	0	8	8	0.01
Jhili Puti/Gini Puti	*Puntius gelius*	0	7	0	7	0.01
Rita/Ritha	*Rita rita*	0	5	0	5	0.00
Shilong/Shilon	*Silonia silondia*	4	0	0	4	0.00
		21,672	43,743	54,580	119,997	

Sonadia Island

Appendix 6.1: Species diversity in Sonadia Island fish landings

Sl	Scientific name	Local name	Percentage
1	*Harpodon nehereus*	Loitta/Lutta	10.29
2	*Atropus atropus*	Tek chanda	5.12
3	*Thryssa mystax*	Sonali phasa	4.53
4	*Penneus indicus*	Chaga chingri	4.50
5	*Lisa parsia*	Parshey	4.27
6	*Coillia*	Aulua	3.56
7	*Lepturacanthus savala*	Churi mach	3.28
8	*Megalopsis cordyla*	Bula	3.23
9	*Escualosa thoracata*	Hichiri mach	2.81
10	*Cynoglossus cynoglossus*	Pata mach	2.57
11	*Thryssa setirostris*	Damma paisya	2.49
12	(Unidentified shrimp)	Chingri (Nazirertek)	2.41
13	*Gymnothorax punctatus*	Bamos/Kuicha	2.39
14	Mixed Small fish	Gura mach	2.31
15	(Unidentified)	Hala	2.21
16	*Lutjanus malabaricus*	Ranga koi	2.15
17	*Saurida tumbil*	Achila	1.79
18	(Unidentified)	Perki	1.79
19	*Johnius sp.*	Botpoha	1.79
20	*Trichiurus lepturus*	Kala churi	1.76
21	*Galeocardo cuvieri*	Kela bagha hangor/Tiger shark	1.70
22	*Trichiurus lepturus*	Churi mach	1.69
23	*Protonibea diacanthus*	Kala poa/Bol poa	1.67
24	*Setipinna phasa*	Fesha/Fefri	1.56
25	*Metapenneus affinis*	Loilla chingri	1.34
26	(Unidentified)	Goru naillah	1.31
27	*Himantura uarnak*	Shapla pata	1.14
28	*Hyporhampus limbatus*	Akthota	1.13
29	*Johnius argentatus*	Lalpoa	1.12
30	*Trypauchen vagina*	Sada Cheua	1.08
31	*Stylla sp*	Kakra	0.96
32	*Anodontostoma chacunda*	Sarputi (Nazirar tek)	0.85
33	*Pama pama*	Poa	0.76
34	*Platicephalus indicus*	Murbayla	0.74
35	(Unidentified shrimp)	Keyag chingri	0.72
36	*Macrobrachium lamarrei*	Gura icha	0.70
37	Unidentified	Unidentified	0.66
38	(Unidentified)	Puia (Nazirertek)	0.65
39	*Alepes djeddaba*	Lohamori/petbajani	0.64
40	*Pseudorhombus elevatus*	Fali serboti	0.60
41	*Johnius belangeri*	Rupali poa	0.59
42	(Unidentified shrimp)	Meing icha	0.57
43	(Unidentified shrimp)	Holud chingri	0.54
44	*Stylla sp*	Koara/Kakra	0.51
45	*Lobotes surinamensis*	Sagar koi	0.45
46	*Parapenaeopsis sculptilis*	Ruda chingri	0.43
47	*Scoliodon sp.*	Hangor	0.43
48	*Dussumieria acuta*	Nailla, Rainbow Sardine	0.40
49	*Apocryptes bato*	Guley/Chiring	0.40
50	*Pampus chinensis*	Rup Chanda	0.38
51	*Congresox talabonoides*	Kamila	0.37
52	*Metapenneus monoceruos*	Harina chingri	0.35
53	*Eleutheronema tetradactylum*	Lakkha	0.34
54	*Tenualosa ilisha*	Ilish	0.34
55	*Iilsha megaloptera*	Chokha phaisa	0.30
56	*Glossogobius giuris*	Baila/Bele	0.30
57	*Polynemus indicus*	Tapshey	0.27
58	*Scatophagas argus*	Bishtara/Chitra	0.27
59	*Iilsha melastoma*	Dhancha	0.26
60	*Valamugil speigleri*	Patha bata/Fanda bata	0.25

Sl	Scientific name	Local name	Percentage
61	*Penneus maguinensis*	Chingri	0.25
62	*Nemipterus japonicus*	Rupban	0.25
63	*Chelonodon patoca*	Potka	0.24
64	*Scoliodon walbeehmii*	Hangor/Kamut	0.23
65	*Sillaginopsis panijus*	Tular Dati	0.22
66	*Lates calcarifer*	Koral/Vetki	0.22
67	*Lutjanus sanguineus*	Ranga choikka	0.22
68	*Fistularia villosa*	Thota/Bonshi	0.22
69	*Rhabdosargus sarba*	Datina	0.20
70	*Sillago sihama*	Hundra /Undara	0.18
71	Unidentified small fish	Gori	0.17
72	*Valamugil sp*	Bhogahari/barahari	0.14
73	(Unidentified)	Kechki (Nazirertek)	0.12
74	*Rastrelliger kanagutra*	Champa	0.12
75	*Raconda russeliana*	Kona phaisa/Fatra	0.12
76	*Rhynobatus granulatus*	Pitambari	0.11
77	(Unidentified)	Gonjona (Nazirertek)	0.11
78	*Scomberomorus kuhlii*	Maitta	0.11
79	*Setipinna taty*	Telephasa/Archana	0.11
80	*Arius gagora*	Aair	0.10
81	(Unidentified)	Kakshel	0.10
82	*Pangasius pangasius*	Pangus	0.10
83	(Unidentified shrimp)	Pettu icha	0.10
84	*Brachygobius nunus*	Chewa	0.09
85	*Mugil cephalus*	Parshey	0.09
86	*Aetomylaeus nichofii*	Haush/Sowain/Eagle	0.08
87	Unidentified Small fish	Lar Ichkiri	0.08
88	*Mystus gulio*	Tengra/Gooli/Guilla	0.08
89	*Thunnus obesus*	Chapa	0.07
90	*Trichiurus savala*	Chhuri Mach	0.07
91	*Arius dussumieri*	Kata mach/Buakata	0.07
92	*Johnius sp.*	Poa/Poma	0.07
93	*Liza sp*	Khur phaissha	0.06
94	*Labeo bata*	Bata	0.06
95	*Penneus japonicus*	Chingri	0.06
96	*Sillago domina*	Tular dandi	0.06
97	*Hilsa ilisa, G2*	Ilish 2 grade	0.06
98	*Thryssa dussumieri*	Hori faisa	0.06
99	(Unidentified shrimp)	Kaitta icha (Nazirertek)	0.06
100	*Penneus monodon*	Bagda chingri	0.06
101	*Pellona ditchela*	Chaika/Choukka	0.05
102	*Mene maculata*	Tin mach	0.05
103	*Liza sp*	Harul bara	0.04
104	*Odontamblyopus rubicundus*	Lal Cheua	0.04
105	*Mugil corsula*	Bara mach	0.04
106	*Iilsha filigera*	Chokha	0.04
107	(Unidentified)	Potoni	0.04
108	(Unidentified)	Arpula	0.03
109	*Sarda orientalis*	Bom maitta	0.03
110	*Parastromateus niger*	Hail chanda/Kala chanda	0.03
111	*Nematopalaemon tenuipes*	Gura Icha	0.03
112	*Lutjanus johnii*	Ranga koi	0.03
113	*Metapenaeus brevicornis*	Sada chingri	0.03
114	*Penneus indicus*	Lal chingri	0.03
115	*Sphyrna blochii*	Hothari	0.02
116	*Scomberomorus guttatus*	Surma/Maitta	0.02
117	*Johnius vogleri*	Poma	0.02
118	*Gerres filamentosus*	Dom mach	0.02
119	*Scylla serrata*	Shila kakra	0.02
120	*Rhynchopelates oxyrhynchus*	Barguni	0.02
121	*Therapon jarbua*	Barguni	0.02
122	(Unidentified shrimp)	Summu icha	0.02
123	*Alepes djeddaba*	Mouri mach	0.02

Sl	Scientific name	Local name	Percentage
124	*Glossogobius sp*	Baila(Shamudrik)/Kala baila	0.02
125	(Unidentified)	Laal mach	0.02
126	*Scatophagas tetracanthus*	Bishtara/Chitra	0.02
127	*Xenentodon cancila*	Kakila/Kaikla	0.02
128	*Epinephelus fasciatus*	Bol (Blacktip groper)	0.01
129	(Unidentified)	Boira	0.01
130	*Decapterus kurroides*	Nilambori	0.01
131	*Pomadasys hasta*	Sada datina	0.01
132	*Leiognathus faciatus*	Tia chanda	0.01
133	*Coilia neglecta*	Aulua/Moga aulua	0.01
134	*Lelognathus brevirostris*	Tek chanda/Dora chanda	0.01
135	*Macrobrachium malcolmsonii*	Chatka Icha	0.01
136	*Glossogobius sp*	Ful Baila	0.01
137	*(Unidentified shrimp)*	Moriccha icha	0.01
138	*Mugil cascasia*	Kechi khallah/Bata	0.01
139	*Stylla sp*	Keyera/Kakra	0.01
140	*Epinephelus lanceolatus*	Bole	0.01
141	*Mystus vittatus*	Tengra/Guinga	0.01
142	*Liza tade*	Gol bata/Khallah bata	0.01
143	*Hilsa kelee*	Gurta ilish/Bora	0.01
144	*Euthynnus affinis*	Bom maitta	0.01
145	*Rhinomugil corsula*	Khorshola/Kholla	0.01
146	*Mystus seenghala*	Guji Ayre/Guji Kata	0.01
147	(Unidentified shrimp)	Meitta Icha	0.01
148	*Macrobrachium mirabile*	Chingri	0.01
149	*Arius maculatus*	Ram kata/Kata mach	0.01
150	(Unidentified shrimp)	Kala icha	0.01
151	(Unidentified)	Doilla	0.005
152	*Barilius bola*	Vala/Vol	0.004
153	*Carangoides malabaricus*	Malabar cavalla	0.004
154	(Unidentified)	La chhoi	0.003
155	*(Gobidae)*	Chhewa baila	0.003
156	*Chelonodon fluviatilis*	Potka	0.002
157	*Polynemus paradiseus*	Sura/Suraia	0.002
158	*Paraplaguchia bilnata*	Kukur jib/Bashpata	0.002
159	*(Unidentified)*	Ferki	0.002
160	*Iilsha elongata*	Ram chokha	0.002
161	*(Unidentified)*	Lambu	0.001
162	*Monopterus cuchia*	Kuichcha/Kuichcha Baim	0.001
163	*Rubicandus cubicandus*	Lal chewa	0.001
164	*Sciaenoides diacanthus*	Poa	0.001
165	*Arius nenga*	Kata gogat/Goralakata	0.001
166	*Acanthopagrus latus*	Datney	0.001
167	*Arius thatassinus*	Kata gongra	0.001
168	*Penneus semisulcatus*	Baghtara chingri	0.001
169	*Lelognathus faciatus*	Tek chanda/Tikka mach	0.001

Note: Less than 0.001% species excluded

Nijhum Dweep

Appendix 7.1 Distribution of fisher households (number) by village in Nijhumdweep

Sl#	Name of the VCF	Full-time	Part-time	Other occupation
1	Santipur	42	7	5
2	Batayon	24	12	9
3	East Islampur	39	10	1
4	West Islampur	26	13	1
5	Jele Kolony	22	19	3
6	South Molla gram	20	21	7
7	Middle Molla gram	32	17	5
8	North Molla gram	25	20	4
9	Munshi gram	15	29	4
10	Moulovi gram	16	31	2
11	South Adorshow gram	20	26	2
12	North Adorshow gram	8	42	1
13	East Adorshow gram	16	24	8
14	South Modina gram	20	29	4
15	Dubai Khal	28	17	5
16	Anonda	47	3	0
17	Agomoni	42	9	1
18	Sayabithi	26	20	5
19	Basundhara	37	4	4
20	Dhansiri	46	6	2
21	Jugantor	35	3	4
22	Surjodoy	25	19	4
	Total	611	381	81

(Source: CREL-CODEC household census at Nijhumdweep, 2014)

Appendix 7.2: Monthly fish landing (kg) in Namar Bazar, Nijhumdweep

Year	Month	Weight (kg)
2014	October	283,482
	November	154,059
	December	36,787
2015	January	83,174
	February	32,898
	March	36,613
	April	45,480
	May	49,389
	June	26,459
	July	35,672
	August	21,901
	September	35,675
	October	44,150
	November	85,022
	December	30,210
2016	January	113,469
	February	110,622
	March	97,083
	April	83,544
	May	53,112
	June	24,901
	July	35,058
	August	52,612
	September	367,242

Appendix 7.3: Fish species wise catch (kg) in Nijhumdweep fish landing center

Local name	Scientific name	Year1 (kg)	Year2 (kg)	Catch %
Ilish	*Hilsa ilisa/ Tenualosa ilisha*	357,615	484,678	45.74
Rita/Ritha	*Rita rita*		881	0.05
Bata	*Labeo bata*	16,905	10,598	1.49
Tular DatiChuler Dati	*Sillaginopsis panijus*	485		0.03
Tapshey	*Polynemus indicus*	34,895	30,045	3.53
Koral/Vetki	*Lates calcarifer*	6,847	2,735	0.52
Guley/Chiring	*Apocryptes bato*	18,575	44,148	3.41
Raja chewa	*Teanoides buchanani*	874		0.05
Loitta	*Harpodon nehereus*	5,053	4,855	0.54
Lal chewa	*Rubicandus cubicandus*	61,191	184,539	13.34
Murbayla	*Platicephalus indicus*	2,820	2,232	0.27
Poa	*Sciaenoides diacanthus*	34,690	25,277	3.26
Taillah	*Eleutheronema tetradactylum*	2,474	2,070	0.25
Sona taillah/Gof taillah	*Polynemus sexfiles*	412		0.02
Golda Icha	*Machrobrachium rosenbergii*	109		0.01
Bagda chingri	*Penneus monodon*	1,448		0.08
Chingri	*Penneus maguinensis*	27,381		1.49
Harina chingri	*Metapenneus monoceruos*	28,737	50,467	4.30
Gura icha	*Macrobrachium lamarrei*	1,145		0.06
Gara chingri	*Exopalaemon styliferus*	226,360	141,634	19.98
Loilla chingri	*Metapenaeus brevicornis*	10,603	15,786	1.43
Pitambari	*Rhynobatus granulatus*	980		0.05
Haush/Sowain	*Aetomylaeus nichofii*	1,991		0.11

Tengragiri

Appendix 8.1: Species diversity in Tengragiri Wildlife Sanctuary.

Sl#	Local name	Scientific name	Wt (kg)	%
1	Poma	*Johnius vogleri*	722,979	9.40
2	Baghtara chingri	*Penneus semisulcatus*	608,624	7.91
3	Tular Dati/Takra/Chuler Dati	*Sillaginopsis panijus*	599,734	7.79
4	Ilish	*Tenualosa ilisha*	561,990	7.30
5	Chingri	*Penneus maguinensis*	521,443	6.78
6	Kakra	*Stylla sp*	401,855	5.22
7	Gura icha	*Macrobrachium lamarrei*	375,297	4.88
8	Boiragi/Boirali	*Salmostoma argentea*	368,923	4.79
9	Loitta/Lutta/Nehari	*Harpodon nehereus*	292,574	3.80
10	Chela	*Coila ramacaratia*	288,394	3.75
11	Fesha/Fefri/Fasha	*Setipinna phasa*	259,955	3.38
12	Tapshey	*Polynemus indicus*	227,215	2.95
13	Shapla pata	*Himantura uarnak*	186,655	2.43
14	Aair	*Arius gagora*	155,727	2.02
15	Chaga chingri	*Penneus indicus*	153,014	1.99
16	Pangus	*Pangasius pangasius*	145,170	1.89
17	Golsha/Golsha Tengra	*Mystus bleekeri*	120,963	1.57
18	Tular dandi	*Pennahia macrophtalmus*	117,136	1.52
19	Koral/Vetki	*Lates calcarifer*	116,430	1.51
20	Sona taillah/Gof taillah	*Polynemus sexfiles*	99,317	1.29
21	Chingri	*Parapenaeopsis uncta*	98,815	1.28
22	Harina chingri	*Metapenneus monoceruos*	94,254	1.22
23	Boal	*Wallago attu*	85,608	1.11
24	Lal chewa	*Rubicandus ellgoby*	84,405	1.10
25	Chewa	*Brachygobius nunus*	78,228	1.02
26	Chingri	*Macrobrachium mirabile*	72,994	0.95
27	Kuichcha/Kuichcha Baim	*Monopterus cuchia*	55,422	0.72
28	Kata mach/Buakata	*Arius dussumieri*	54,345	0.71
29	Chingri	*Penneus japonicus*	53,419	0.69
30	Gura Icha	*Nematopalaemon tenuipes*	45,402	0.59
31	Chingri	*Macrobrachium idella*	44,638	0.58
32	Gara chingri	*Exopalaemon styliferus*	41,982	0.55
33	Bagda chingri	*Penneus monodon*	40,703	0.53
34	Kukur jib/Bashpata	*Paraplaguchia bilnata*	40,616	0.53
35	Tular dandi	*Sillago domina*	32,171	0.42
36	Churi mach	*Trichiurus lepturus*	31,524	0.41
37	Tengra/Guinga	*Mystus vittatus*	30,856	0.40
38	Sada chewa	*Trypauchen vagina*	23,784	0.31
39	Shila kakra	*Scylla serrata*	22,250	0.29
40	Mola Puti	*Puntius guganio*	20,660	0.27
41	Tara Baim	*Macrognathus aculeatus*	19,709	0.26
42	Dati phasa	*Thryssa setirostris*	18,984	0.25
43	Baila/Bele/Vangla	*Glossogobius giuris*	18,693	0.24
44	Java, (Spindle croaker)	*Johnius elongatus*	17,334	0.23
45	Goda	*Macrobrachium rude*	17,240	0.22
46	Jhaji kakra	*Portunus polagicus*	13,654	0.18
47	Ram kata/Kata mach	*Arius maculatus*	12,133	0.16
48	Boro Baim/Shal Baim	*Mastacembelus armatus*	10,234	0.13
49	Ayre	*Mystus aor*	9,484	0.12
50	Golda Icha	*Machrobrachium rosenbergii*	9,402	0.12
51	Sonali phasa	*Thryssa mystax*	8,601	0.11
52	Mad, (Threadfin sea catfish)	*Arius arius*	8,155	0.11
53	Rup Chanda	*Pampus chinensis*	6,999	0.09
54	Gang Magur/Kaun	*Plotosus canius*	6,443	0.08
55	Parshey	*Mugil cephalus*	6,308	0.08
56	Magur/Mojgur	*Clarias batrachus*	6,176	0.08
57	Chhuri Mach	*Trichiurus savala*	6,076	0.08
58	Poa/Poma	*Johnius sp.*	6,061	0.08
59	Koi/Gachua Koi	*Anabas testudineus*	6,039	0.08
60	Balitora	*Psilorhynchus balitora*	6,017	0.08

Sl#	Local name	Scientific name	Wt (kg)	%
61	Chandana ilish	*Hilsa toli*	5,904	0.08
62	Jatputi/Vadi Puti	*Puntius sophore*	5,567	0.07
63	Chokha phaisa	*Iilsha megaloptera*	5,530	0.07
64	Bishtara/Chitra	*Scatophagas argus*	5,200	0.07
65	Bata	*Labeo bata*	4,991	0.06
66	Kucho	*Metapenneus lysianassa*	3,938	0.05
67	Kukur jib/Bilini sole	*Cynoglossus bilineatus*	3,864	0.05
68	Loilla chingri	*Metapenneus affinis*	3,822	0.05
69	Jhaji kakra	*Portunus sanguinolentus*	3,527	0.05
70	Sura/Suraia/Soria/Toposhi	*Polynemus paradiseus*	3,395	0.04
71	Lal Cheua	*Odontamblyopus rubicundus*	3,279	0.04
72	Bojuri Tengra	*Mystus tengara*	2,972	0.04
73	Loilla chingri	*Metapenaeus brevicornis*	2,835	0.04
74	Chatka Icha	*Macrobrachium malcolmsonii*	2,726	0.04
75	Guley/Chiring	*Apocryptes bato*	2,616	0.03
76	Shing sole	*Aesopea cornuta*	2,112	0.03
77	Ruda chingri	*Parapenaeopsis sculptilis*	1,995	0.03
78	Gazar/Gazal	*Channa marulius*	1,930	0.03
79	Lal chewa	*Rubicandus cubicandus*	1,885	0.02
80	Mrigal/Mirka	*Cirrhinus mrigala*	1,814	0.02
81	Shilong/Shilon	*Silonia silondia*	1,715	0.02
82	Bashpata/Chhebri/Dibari	*Danio devario*	1,620	0.02
83	Tit Puti	*Puntius ticto*	1,426	0.02
84	Tengra/Gooli/Guilla	*Mystus gulio*	1,416	0.02
85	Kukur jib/Ash sole	*Cynoglossus macrolepidotus*	1,403	0.02
86	Guchi Baim	*Mastacembelus pancalus*	1,402	0.02
87	Rita/Ritha	*Rita rita*	1,400	0.02
88	Cheta bele	*Butis sp.*	1,260	0.02
89	Nandil/Nandina	*Labeo nandina*	1,241	0.02
90	Chitol	*Notopterus chitala*	1,158	0.02
91	Pati phasa	*Thryssa dussumieri*	1,150	0.01
92	Pitambari	*Rhynobatus granulatus*	1,077	0.01
93	Shing/Jiol Mach/Kanuch	*Heteropneustes fossilis*	980	0.01
94	Kajoli	*Ailia coila*	933	0.01
95	Poa	*Sciaenoides diacanthus*	900	0.01
96	Shol/Shoil	*Channa striatus*	828	0.01
97	Chuna Kholisha/Chata	*Colisa sota*	788	0.01
98	Maitta	*Scomberomorus kuhlii*	755	0.01
99	Pan (Spotted sickle fish)	*Drepane punctata*	700	0.01
100	Vala/Vol	*Barilius bola*	675	0.01
101	Pata mach	*Cynoglossus cynoglossus*	657	0.01
102	Barguni	*Therapon jarbua*	630	0.01
103	Jhili Puti/Gini Puti	*Puntius gelius*	622	0.01
104	Kaua/Jongla/Telia	*Gagata cenia*	606	0.01
105	Sada belly	*Abalistis stellaris*	597	0.01
106	Thangua Icha	*Macrobrachium birmanicum*	578	0.01
107	Chela/Katari/Narkeli Chela	*Salmostoma bacaila*	560	0.01
108	Tek chanda/Dora chanda	*Lelognathus brevirostris*	560	0.01
109	Kona phaisa/Fatra	*Raconda russeliana*	558	0.01
110	Lal Kholisha/Boicha	*Colisa lalius*	525	0.01
111	Hangor	*Scoliodon sorrakowah*	504	0.01
112	Taillah	*Eleutheronema tetradactylum*	490	0.01
113	Bhrammani	*Macrobrachium dolichodactylus*	476	0.01
114	Taki/Ladi	*Channa punctatus*	475	0.01
115	Barguni	*Terapon sp.*	420	0.01
116	Ghora Mach/Longu	*Labeo pangusia*	382	0.005
117	Kachki/Kechki/Suborna	*Corica soborna*	382	0.005
118	Raja chewa	*Teanoides buchanani*	329	0.004
119	Sada mach	*Lactarius lactarius*	300	0.004
120	Poa	*Pama pama*	267	0.003
121	Haush/Sowain/Eagle	*Aetomylaeus nichofii*	265	0.003
122	Belsanessa loboster	*Thenus orientalis*	252	0.003
123	Chapila/Korti/Chalpa/Chopra	*Gudusias chapra*	231	0.003

Sl#	Local name	Scientific name	Wt (kg)	%
124	Chaika/Choukka	*Pellona ditchela*	210	0.003
125	Bullet maitta	*Auxis rochii*	175	0.002
126	Chakunda	*Anodontostoma chacunda*	162	0.002
127	Surma/Roket mach	*Scomberomorus commerson*	140	0.002
128	Bishtara/Chitra	*Scatophagas tetracanthus*	140	0.002
129	Chekbeka/Cheka	*Chaca chaca*	117	0.002
130	Batashi/Batai/Aluni/Gilakani	*Pseudeutropius atherinoides*	105	0.001
131	Kukur jib	*Cynoglossus lingua*	105	0.001
132	Tatkini	*Crossochelius latius*	93	0.001
133	Baus/Bamus/Bonehara	*Anguilla bengalensis*	93	0.001
134	Tiktiki mach	*Saurida elongata*	90	0.001
135	Bashpata sole	*Brachirus pan*	84	0.001
136	Patha bata/Fanda bata	*Valamugil speigleri*	84	0.001
137	Bashpata/Kajoli	*Aillichthys punctata*	60	0.001
138	Churi mach	*Lepturacanthus savala*	21	0.0003
		Total	7,694,281	

Ratargul

Appendix 9.1: Species composition and their percentage in Gowain river (Ratargul) in 2016.

Sl no	Local name	Scientific name	Weight (kg)	Percentage
1	Boal	*Wallago attu*	462	20.79
2	Ilish	*Hilsa ilisa/ Tenualosa ilisha*	260	11.69
3	Grass Carp	*Ctenopharyngodon idellus*	207	9.30
4	Ayre	*Mystus aor*	173	7.76
5	Kalibaus/Baus/Kalla Mach	*Labeo calbasu*	170	7.64
6	Boro Baim/Shal Baim	*Mastacembelus armatus*	163	7.33
7	Gazar/Gazal	*Channa marulius*	85	3.84
8	Gang Tengra/Gongra/Ghagot	*Gagata gagata*	67	3.01
9	Gura icha	*Macrobrachium lamarrei*	61	2.77
10	Goinna	*Labeo gonius*	49	2.20
11	Chela/Katari/Narkeli Chela	*Salmostoma bacaila*	48	2.16
12	Sarputi/Sheron Puti/Puti tor	*Puntius sarana*	38	1.73
13	Tara Baim	*Macrognathus aculeatus*	37	1.65
14	Katla/Katol/Fega	*Catla catla*	34	1.55
15	Baus/Bamus/Bonehara	*Anguilla bengalensis*	31	1.40
16	Kali Koi/Napit/Koi Bandi	*Badis badis*	30	1.36
17	Guchi Baim/Chikra/Chirpa	*Mastacembelus pancalus*	30	1.35
18	Shing/Jiol Mach/Kanuch	*Heteropneustes fossilis*	29	1.32
19	Jatputi/Vadi Puti	*Puntius sophore*	25	1.13
20	Rui/Ruhit/Vuitta	*Labeo rohita*	24	1.07
21	Shol/Shoil	*Channa striatus*	22	0.98
22	Baila/Bele/Vangla	*Glossogobius giuris*	18	0.79
23	Gutum/Gutumi	*Lepidocephalus guntea*	16	0.73
24	Mrigal/Mirka	*Cirrhinus mrigala*	15	0.69
25	Meni/Veda/Royna	*Nandus nandus*	13	0.60
26	Mola/Maya/Moa/Mousi	*Amblypharyngodon mola*	13	0.59
27	Tengra/Gooli	*Mystus gulio*	12	0.55
28	Taki/Ladi/Saitan	*Channa punctatus*	10	0.44
29	Kabashi Tengra	*Mystus cavasius*	9	0.42
30	Silver Carp	*Hypophthalmichthys molitrix*	8	0.38
31	Chitol	*Notopterus chitala*	8	0.36
32	Rita/Ritha	*Rita rita*	8	0.35
33	Dhela/Lohasur	*Rohtee cotio*	7	0.29
34	Thai Sarputi/Raj Puti	*Puntius gonionotus*	6	0.28
35	Kani Pabda/Boali Pabda	*Ompak bimaculatus*	6	0.27
36	Kholisha/Pata Kholisha	*Colisa fasciatus*	6	0.27
37	Ranga Kholisha	*Colisa lalius*	5	0.24
38	Koi/Gachua Koi	*Anabas testudineus*	4	0.19
39	Golsha/Golsha Tengra	*Mystus bleekeri*	4	0.19
40	Vangra/Vangla/Vangol Bata	*Labeo boga*	4	0.17
41	Bojuri Tengra/Choto Tengra	*Mystus tengara*	2	0.08
42	Tengra/Guinga	*Mystus vittatus*	1	0.03
43	Ranga Chanda/Lal Chanda	*Chanda ranga*	1	0.03
44	Khallah/Choikka bata	*Mugil corsula*	0.15	0.01
45	Rani/Cheka/Bou mach	*Botia dario*	0.1	0.004
		Total weight (kg)	2,224	