Shrimp Fry (meen) Farmers of Sundarban Mangrove Forest (India): A Tale of Ecological Damage and Economic Hardship

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Abstract. The Sundarban is a stretch of largely impenetrable mangrove forests lying at the southern tip of the Indian state of West Bengal, and stretching into Bangladesh. Nearly 4.5 million people live in Indian Sundarban. In absence of any industry, people entirely live by exploiting the natural resources. Due to the salinity of soil, regular storm, flood agriculture is very difficult. Collection and cultivation of prawn is an alternative means for subsistence in the area. Prawn cultivation not only provided them with ready cash but it appeared to be more paying than agriculture. Instead of high earning from huge collection of tiger shrimps, base level workers collecting the shrimps are facing toughest economic situation. Their socioeconomic condition is very poor. The provision of basic services and infrastructure to the people of the Sundarban is far from satisfactory. Women and children are becoming increasingly vulnerable in the Sundarban. Women are underpaid for jobs that they are employed for. They wish to work to supplement their family in-come but are unable to find employment outside the traditional work. Children are engaged in meendhora (meaning collection of prawn fry), fish drying and domestic work from a young age. But huge ecological damage is being caused over decades by this shrimp collection method. Shrimp fishing produces large amounts of bycatch, which may be as high as more than 65 percent of the total fry caught. These bycatch is completely discarded by the collectors causing huge loss to other aquatic species. Also, due to direct and prolonged contact with the seawater, the collectors develop occupational hazards like waterborne diseases, skin infections, some contiguous diseases. In this work, we present details of this damage- both to ecology and to livelihood of people involved in this occupation. We report national and international studies expressing concern on these issues. Also, we report with examples what safe strategy can be adopted to reduce ecological damage, as well as protect physical damage to shrimp collectors.

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Keywords. shrimps, Panaeus monodon, meen, bheris, Bycatch, Sundarban

1. Introduction

Asia is the principal producer of cultured penaeid shrimp (belonging to the family Penaeidae), accounting for 81 percent of the total world production of about 600,000 t. Thailand is the largest exporter, at 150,000 t in 1992, followed by China, Indonesia, India, Viet Nam, Taiwan, the Philippines, and Bangladesh. The tiger shrimp (Panaeus monodon) dominates Asian shrimp culture production because of its fast growth and adaptability to the pond environment and artificial feed. Culture technology has developed rapidly over the past decade-and-a-half, and in those countries with open economies, shrimp culture production has expanded at a tremendous rate (Angell, 1994).
India is endowed with a long coastline and hence has the scope for large exploitation of marine wealth. Until a few years back, fishermen in India were involved in traditional marine fishing. In the seventies, fishermen started concentrating on catching prawns, more commonly known as “shrimps”, due to high profitable return on the same due to their export value. Brackish water prawn farming started in a big way between 1991 and 1994.

The Sundarban is a stretch of largely impenetrable mangrove forests lying at the southern tip of the Indian state of West Bengal and stretching into Bangladesh. It is a part of the world's largest delta formed by the rivers Ganges, Brahmaputra, and Meghna. It is famous for its Mangrove forest. Actually the name Sundarban derives from “sundari” or beautiful and “ban” or forest. The northern part of the Sundarban region is densely populated. The forested southern part is classified as reserve forest. Within this there are three wildlife sanctuaries and a national park declared as a World Heritage. The soil in the Sundarban delta area is not always suitable for agriculture. Due to the salinity of soil, agriculture is very difficult. Collection and cultivation of prawns is an alternative means for subsistence in the area. Prawn cultivation not only provides them with ready cash, but it appeared to be more paying than agriculture. The agricultural land is inundated with brackish water and is used for raising prawn after the harvest of paddy in winter (Ray et al., 2002). The people of Sundarban, more than 4.5 million in number (in 2001), are mainly engaged in fishing and agriculture. Both are occupations from which the average earnings are meager. The rights and entitlements of the fisher folk who are poor are often not considered. Conversion of the agricultural land of the marginal farmers for shrimp farming by the private sector destabilizes the agricultural economy. There are very few alternative avenues for income generation. The working population of the Sundarban suffers from unemployment and under-employment. This leads to a lack of nourishment for their families, distress migration, exploitative employment practices, and trafficking.

Instead of high earnings from tiger shrimps, base level workers collecting the shrimps are facing the toughest economic situation. Their socio-economic condition is very bad. The provision of basic services and infrastructure to the people of the Sundarban is far from satisfactory. Health services are an area of grave concern. Government health facilities in the villages are poor. Private practitioners are few, and people have no option but to depend on quack doctors. People have no information on how to access health care though there is a desperate need for it. The quality of education is poor. There are primary schools and alternative education centers in almost all the villages, but due to insufficient infrastructure and human resources, the quality of education delivered is poor. Day-to-day living is a challenge for the people of the Sundarban.

Men of the fisher folk community in the Sundarban work as wage labor on deep-sea trawlers and engage in river fishing in mechanized and non-mechanized boats. A small section is engaged in drying fish. Fisher folk face exploitation from trawler owners and middlemen. They risk their lives fishing in the deep seas and in the crocodile infested rivers. Forest department personnel seize their nets and boats whenever the fishermen go for fishing in rivers adjoining the islands under Project Tiger. Women and children are becoming increasingly vulnerable in the Sundarban. Women are underpaid for jobs that they are employed for. They wish to work to supplement their family income but are unable to find employment outside the traditional work. Children are engaged in meendhora (meaning collection of prawn fry in local parlance), fish drying, and domestic work from a young age. Child labor is common in the administrative towns and fish landing centers in the Sundarban. Women and children migrate to other parts of the country to work as domestic help. Trafficking of women and children is also prevalent. Women face domestic violence. Another vital issue is the threat to safety and security. They also make and repair fishing nets. They assist the men in river fishing, sorting fish according to species, in drying fish, and in boat repair. However, women are not allowed to go on trawlers for deep-sea fishing. The fisher folk are victims of pirate attacks in the high seas. Fisher folks in the deep seas face health hazards and hazards arising
from mechanical failure of boats. Those who engage in river fishing do not have information regarding the market price of fish. In addition, being trapped in the vicious cycle of loans, they are forced to sell their catch at the prices dictated by the middlemen in order to repay their loans. Children assist their mothers in meendhora, in collecting crabs, in sorting fish according to species, and in drying fish (Act!onaid, n.d.). Under the given circumstances, this paper tries to address the issue of meendhara and how, on the one hand, the environment is damaged by this occupation and on the other hand how the people are facing health hazards. We will see that no real alternative to meendhara has been possible yet. This is because any alternative shrimp farming cannot prevent the poor people from engaging in their trade, as this occupation is their last resort. In this context we will address the vulnerability and resilience of shrimp farmers. The concept of resilience has evolved from the technical and ecological sciences to engage and incorporate social systems. Social resilience has been described as the capacity of humans – either individual or communities– to withstand external shocks from wider economic, political, or cultural perturbations (Adger, 2000). Berkes and Folke (1998) demonstrate, through an analysis of natural resource management practices, that social and the ecological resilience mutually influence each other through processes of interaction (Bush et al., 2010). In a study led by one of the coauthors (Das and Shaw, 2015), a field survey was conducted in Indian Sundarban during June/July 2013 and a follow-up survey in January/February 2014. Using five (largely ecological) major indicators in the framework, the study found the socio-economic resilience of the study area to be uniformly poor and can be generally categorized between very low and low.

2. What are Meen and What is the Process to Collect Them?

The estimated brackish water area suitable for undertaking shrimp cultivation in India is around 1.2 million ha spread over 10 states, and union territories with West Bengal are in the top most position (MPEDA n.d, 2005).

2.1 Fishery in Sundarban

Fishery (fishing and aquaculture) is treated as the backbone of the Sundarban economy. The Sundarban boasts around 172 species of fish, 20 species of prawn, and 44 species of crabs, including two commercial species. This region is the top producer of fish and prawn, with both districts (South & North 24 Parganas) combined producing roughly 31% of the total inland fish/prawn production of West Bengal. Apart from coastal and brackish water aquaculture, freshwater aquaculture is increasing steadily and contributes to both the economy and livelihood security in the region. Cultivable species in Sundarban include both freshwater and brackish water species (finfish and shellfish). Freshwater aquaculture is practiced mostly in backyard ponds. Villages in the Sundarban have many such ponds. Families excavate a portion of their low-lying paddy field to get earth to raise the land and construct dwelling houses and for drinking water. Therefore, almost every household possesses these excavated areas, which, in the monsoon season, store rain water. These ponds (small water body) are used for fresh water aquaculture. The water of these ponds is also used for household purposes like washing of utensils, bathing, and even for drinking purpose. Fish in these ponds is mostly used for domestic consumption and any leftover amount is sold. Apart from this, freshwater aquaculture is also carried out in big ponds (either owned by individuals or few families), land-shaping ponds (mainly excavated for agricultural irrigation purpose), and low-lying inundated paddy fields. Brackish water aquaculture is practiced in large artificial enclosures developed in coastal swamps by erecting earthen dykes, locally called bheries. Culture is carried out by taking the tidal saline water in and out through sluices from nearby rivers for commercial pisciculture (Chand et al, 2012).

2.1.2 Prawn Species Culture

Slightly fewer than 300 species of shrimp are of economic interest worldwide. Of these, only about 100 comprise the principal share of the an-
nual world catch. Six shrimp species groups account for 83 percent of the global shrimp catch. The most important single species in the world by weight is the akiami paste shrimp (Acetes japonicus). Asia is the most important area for shrimp fishing. China, together with four other Asian countries, accounts for 55 percent of the world catch. Globally, about 60 percent of shrimp production in the world comes from fishing, while 40 percent is from farming (Angell, 1994).

Wide varieties of prawn (chingri - in local language) species (freshwater and brackish water) are cultured by the farmers of Sundarban. The list of these species is given below.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Local Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giant freshwater</td>
<td>Golda chingri</td>
<td><em>Macrobrachium</em> rosenbergii</td>
</tr>
<tr>
<td>prawn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian Freshwater</td>
<td>Sada chingri</td>
<td><em>Macrobrachium</em> malcomsonii</td>
</tr>
<tr>
<td>prawn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ganga River</td>
<td>Chapra chingri</td>
<td><em>Macrobrachium</em> choral</td>
</tr>
<tr>
<td>prawn</td>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Common Name</th>
<th>Local Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giant Tiger</td>
<td>Bagda chingri</td>
<td><em>Penaeus monodon</em></td>
</tr>
<tr>
<td>prawn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ginger prawn</td>
<td>Honnye chingri</td>
<td><em>Metapenaeus</em> monoceros</td>
</tr>
<tr>
<td>Banana prawn</td>
<td>Kola chingri</td>
<td><em>Fenneropenaeus</em> merquisiens</td>
</tr>
<tr>
<td>Yellow prawn</td>
<td>Chamne chingri</td>
<td><em>Metapenaeus</em> brevicorns</td>
</tr>
<tr>
<td>Kiddi shrimp</td>
<td>Rosna chingri</td>
<td><em>Parapenaeopsis</em> stylifera</td>
</tr>
<tr>
<td>Indian white shrimp</td>
<td>Chapra chingri</td>
<td><em>Fenneropenaeus</em> indic</td>
</tr>
</tbody>
</table>

Source: Chand et al., 2012

The dominant species is *Penaeus monodon* or tiger shrimp due to its high unit value realization and expanding export demand.

2.1.3 Shrimp Farming in *bheris*

Shrimp farming is normally practiced in low lying areas and shallow water bodies, influenced by tidal water, especially during lunar phases. Brackish water from the adjacent water body e.g. river, creek, backwater, lake, lagoons etc. is let into by gravity flow to a large and shallow area of 10 to 100 ha, enclosed by constructed earthen bunds on its periphery. The entry of water is normally regulated by a wooden sluice made of planks and bamboo poles. A screen made of bamboo is used for filtration of the water, although seeds of different fish and shrimp species also find entry into these areas along with the tidal water. Farmers usually stock natural or hatchery produced seed of *Penaeus monodon* for better yield in *bheris*. In many cases *P. monodon* seeds are initially released in a specially enclosed nursery area below 1.0 ha located adjacent to the main rearing area and are reared for about a month. Thereafter, seeds are allowed to escape to the main *bheri* by cutting the earthen bund of the nursery pond at 2-3 different places. Stocking and harvesting is periodic according to the lunar phase.

2.1.4 Harvesting Shrimps

Harvesting is normally done for 6 days during the full moon and 2 days before and 3 days after the new moon period, using traps made of bamboo and partially by cast netting. In most of the *bheries* a single sluice is used for both letting in and draining out the water. The water depth of the rearing areas varies between 1-3 feet. Partial water exchange is done during the lunar phases, taking advantage of the tidal amplitude of spring and neap tides - that is tides with and without power respectively. Natural growth of filamentous algae and other aquatic micro/macrophytes in these large and shallow rearing areas provides an excellent natural environment for the growth of shrimp. Usually, in traditional farming systems, no supplementary feed is used, and shrimp grow on the natural productivity. Depending upon salinity variation in the water body, these areas are used exclusively for shrimp farming or together with other fish species. In areas experiencing higher salinity in the range of 10-35 ppt during the year, mostly shrimp monoculture is practiced. In such areas, farming starts during January or February, and harvesting is completed by October / November. However, in a few cases, farmers use supplementary feed and other inputs for higher production (Chand et al., 2012).

2.1.5 Profit Sharing of Fish Catch in Deep Sea and River Fishing

The profit or loss is shared by four stakeholders, namely the fisher folk, *majhis* who drive the
trawler; the *malik* or the owner of the trawler who provides the material requirements of the trawler (diesel, ice blocks and foodstuff); and the *aratdar* or the auction owner from whom the *malik* takes loans for buying the materials. At the outset, 7% of the profit is taken by the *aratdar*. The *malik* then deducts the material cost. From the remaining profit, the *majhis* gets 5%. Then the remaining profit is shared in the ratio 60:40 between the *malik* and the fisher folk if the fisher folk have taken a loan from the *malik* before going on the trawler. The ratio is 55:45 if the fisher folk have not taken any loan.

Fisher folk families are aware that the dried fish market is lucrative. Dried fish is sent to national markets in Assam, Nagaland, Meghalaya and Kerala and international markets in Myanmar and Bangladesh. The fish scraps are used to make poultry feed. Even though there is a market, traditional methods of drying do not fetch a good price. The fisher folk require concrete platforms for drying the fish, but these are not available at present (Act!onaid, n.d.).

3. Shrimp Culture as a Threat to Ecology

3.1 Destruction of Mangrove Forests

Mangrove destruction is a complex subject. There is little doubt that shrimp aquaculture poses the most serious threat to mangroves in regions that are considered suitable for shrimp ponds. There are contrasting views on the amount of mangrove destruction caused by shrimp farming (Gillett, 2008). An environmental group states, “We can reasonably estimate that more than one-third of total mangrove loss has been due to shrimp farming, which appears to be clearly the greatest single threat to mangroves worldwide”. Greenpeace (2004) and Naylor et al. (2001) estimate that in areas of Thailand where shrimp farms have been carved out of mangrove forests, a total of 400 g of wild fish and shrimp are lost from near shore catches for every kg of shrimp farmed (Naylor et al., 2001). Another work studied chronological extinction of the Indo-Malayan mangroves along the South and Southeast Asian coast and categorizes several area-specific anthropogenic and climatic factors that triggered the annihilation of 1.9 million ha of diverse mangroves. On a regional scale, coastal agricultural land development and shrimp farming were identified as major factors accounting for 90% of the reported loss.

3.2 Destruction of Species Due to Bycatch

Shrimp fishing, especially trawling in tropical regions, produces large amounts of bycatch, which is one of the most controversial aspects of the practice. Much of the management attention associated with shrimp fisheries is focused on reducing bycatch. The term “bycatch” is relatively clear in industrial shrimp fisheries of developed countries but becomes increasingly irrelevant in the progression from large-scale fisheries in the developed world to small-scale fisheries in poor tropical countries – where almost all components of the catch have some economic value and may therefore become a target.

Bycatch, particularly when discarded, is a serious concern for a number of interconnected reasons that are not specific to shrimp fishing. First, the lack of identification of the animals killed and rejected (many of which are vulnerable or threatened emblematic species) impedes a proper assessment of their status and trends and any direct management, which raises the risk of depletion or outright extinction. Second, bycatch creates interactions with other fisheries targeting the same species, complicating assessment and management. Third, bycatch, like directed catch, affects the overall structure of trophic webs and living habitats. Finally, the discarding of killed animals raises the ethical issue of wastage of natural production.

3.2.1 Difficulties in Estimating the Amount of Bycatch

There are widely differing estimates for the amount of bycatch in the various shrimp fisheries, partly resulting from the different definitions of bycatch, different systems of measurement and the low level of actual monitoring. Even in relatively regulated fisheries in developed countries, it is not simple to estimate and subsequently compare levels of bycatch in a straightforward manner.
3.2.2 The Species Ratio and Percentage Contribution: TPS Collection

One of the main environmental issues related to the shrimp aquaculture industry is the over collection of prawn seed from the wild. TPS (Tiger Prawn Shrimp) collection is one of the greatest threats to the Sundarban’s mangrove ecology. Thousands of people have turned to collecting tiger prawn seeds for ready cash. They use nylon nets, which are dragged along the riverbanks. In the process of harvesting prawn seeds, around 50 species of finfish juvenile and 28 species of shellfish juveniles are wasted per net per day, making the activity highly unsustainable.

One study estimated that prawn seed collectors destroy 181.4 million seeds of fin and shellfish during the months from January to September. Another study showed that in order to catch 9586 tiger prawn seeds, collectors destroy approximately 1562862 juveniles of other prawn species, 56000 fishes, 1.9 million crabs, 8000 mollusks and a huge bulk of holoplankters (copepods, chaetognaths, mysids, lucifers etc.) and meroplankters (mega-lopa, alima and anomuran larvae). Indiscriminate seed collection causes a severe depletion of balance between the quantities of seeds produced in nature and the quantity harvested, leading to loss of estuarine biodiversity. Constant dragging of nets along the coast and tidal creeks leads to soil erosion, uprooting the mangrove seedlings and salt marsh vegetation (like Ipomea pescarpae, Sueda maritima sp.) (Chowdhury et al., 2008).

In West Bengal, the basic input of tiger shrimp fry is met from the wild with a large number of the rural poor engaged in shrimp fry-catching and trading in the 24 Parganas (N and S) and Medinipur Districts. However, the destruction of by-catch captured during fry-collection has been causing concern. By-catch is 64-99.4 percent of the total fry caught.

A study (Banerjee and Singh, 1993) based on work done from October 1990 to September 1991 was undertaken by collecting data from three centers in three different districts of West Bengal selected for observations: Harwood Point, Najat and Ramnagar. The estimated total catch of *P. monodon* and other species in the observation areas of different centers was obtained by using a raising factor of 80 (nets operated for eight hours a day, four hours during high and four hours during low tide, on five days during each lunar phase). The ratio between the total estimated catch of *P. monodon* and others at Harwood Point, Najat and Ramnagar were 1:1.78, 1:65.6 and 1:156.6, respectively. The percentage contribution of *P. monodon* and others at the three centers is as follows:

<table>
<thead>
<tr>
<th>Centre name</th>
<th>Percentage contribution recorded</th>
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<tbody>
<tr>
<td></td>
<td><em>P. monodon</em></td>
</tr>
<tr>
<td>Harwood Point</td>
<td>36.0</td>
</tr>
<tr>
<td>Najat</td>
<td>1.5</td>
</tr>
<tr>
<td>Ramnagar</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Seed collection activities are much more pronounced in North 24 Parganas, as about 90 percent of the bheries are located in that area. The total number of shrimp fry-collectors in both districts may be more than 50,000. Das (1987) reported large-scale destruction of prawn and fish fry in the Hugli-Matla estuarine system. Verghese et al., (1988) reported 25,000-100,000 post-larvae of *M. monoceros* occurring in the shoot net collections in the Muriganga estuary per net per hour (Verghese et al., 1988). Afore-said data (Banerjee and Singh, 1993) suggests that for every *P. monodon* fry caught, the total number of other species caught is as high as 190.87 at Ramnagar.

The impact of wanton killing of various shrimp fry can be observed from the fact that out of 10754.9 t of fish landings from the Hugli-Matla estuary during as far back as 1970-1971 (that pre-Farakka period when the big dam was built), shrimp contributed 1975 t, forming 14.4 percent (Datta, et al., 1973; Mahapatra et al., 1999) of the landings. Although the total fish landings from the Hugli-Matla estuary has increased considerably during the recent past (Anon, 1988-89, 1989-90), the percentage contribution of shrimp has declined to 8.1 percent in 1989-90. This increase in total fish landings has been attributed to the significant increase in fishing effort, especially *Hilsa* gear. Along with the increased craft, the introduction of modern synthetic gear employed for catching *Hilsa* (Broadhurst, 2000).
3.2.3 The FAO Study on Discards

Bycatch that is discarded is especially troublesome. A recent FAO study (Kelleher, 2005) indicated that shrimp trawl fisheries are the single greatest source of discards, accounting for 27.3 percent (1.86 million t) of estimated total discards. The aggregate or weighted discard rate for all shrimp trawl fisheries is 62.3 percent and is extremely high compared with other fisheries.

3.2.4 Shrimp: Catch or Culture of WL (Wild Fry) or PL (Post Larvae)

Garcia (1989) indicates that the collection of PL from natural sources is a major source of conflict between shrimp culture and capture (Garcia, 1989). Clay (1996; 2004) reviews the collection of PL for shrimp culture. Traditionally, shrimp farmers relied on wild shrimp for the production of seed stock. Currently, they either capture wild juveniles, which are stocked directly in a nursery or grow out pond, or they spawn egg-laden or gravid females at a hatchery. Unfortunately, there is good evidence that the bycatch from capturing wild PL is even higher than from the shrimp trawling industry. Two studies are cited in support of the statement that “for every single shrimp grown in a pond, almost a hundred other fish or shrimp are killed” (Clay, 1996, 2004).

The situation is changing. Most of the shrimp seed used in the world today no longer relies on wild-caught larvae but comes from hatcheries. Clay (2004) indicates that globally, some 98 percent or more of PL used by farming operations are produced in hatcheries. Wild-caught PL is most common in Bangladesh, India and Ecuador, where hatcheries are not required by law. Because of hatcheries, the capture of wild PL has become much less of an issue in many countries but continues to be problematic in some places. Shrimp farmers in Bangladesh are currently partly dependent on wild fry, and its collection contributes to the livelihood of several hundred thousand poor people. In Indonesia, there is considerable hatchery production of fry for shrimp farming, but a significant amount of fry in the wild is still collected (Gillett, 2008).

3.2.5 Shrimp Fry Collection and Wastage in Bangladesh

Fry collection from the sea, called baishdhora in Cox’s Bazaar and bacchadhora in Satkhira, Khulna, is skilled work that requires hard physical labor. A large number of the poor — men, women and children — do such work in these areas.

A number of other species, besides the fry of other varieties of shrimp and fish, are caught in a khep or trip. The catchers, however, seek only the fry of Bagda chingri (P. monodon). So, after sorting the fry, the first task is to “return” the other species to the sea. However, the other species caught in the net sometimes die while being sorted, and it makes little difference whether they are thrown back into the sea or not. From the ecological point of view, it is necessary to consider this waste, which occurs during Bagda chingri fry collection. This rate of “wastage” is very high compared to the Bagda chingri fry collected. Though some estimates are as high as 50,000 other fry wasted for every 500 Bagda fry, the general consensus is that about 5,000 other fry are wasted for every 100 Bagda fry. These other fry include Goldachingri fry, Macrobrachium rosenbergii (or white chingri) fry and Chaga or red chingri fry. There are also a number of fish fry. In Satkhira, these fish fry include paisha, chauma, tengra, bekti and more. Some of these fish, if fairly big in size, are eaten, not wasted (UBINIG, 1990).

3.3 Other Bycatch Effects

Specialized studies examining the bycatch of shrimp fisheries point to important issues other than species loss. These include the following:

- **Effects on individual species.** If shrimp bycatch removes a large portion of the abundance of a particular species, the effect is the same as if the species were a target. Beyond a certain level of removal, that species can be threatened.

- **Effects on endangered species.** The effect described above is a particular source of concern when the species is already endangered by direct fishing or other threats such as pollution and the destruction of nesting beaches.
Effects on ecosystems. If the abundance of key species is reduced through bycatch, major and unpredictable changes may occur in food chains. This impact is similar whether the removal results from targeted catch or bycatch. “Cleaned” upper slope grounds form predators (e.g. sharks) (Gillett, 2008).

4. Occupational Health Hazards of Shrimp Collectors

4.1 Prolonged Contact with Sea Water

Due to direct and prolonged contact with the seawater, the collectors develop occupational hazards like waterborne diseases, skin infections, reproductive tract disease (in females) and some contiguous diseases. A work (Chand et al., 2012) to study the physical damage of collectors reveals the following:

Sagar Block: Among the respondent of Sagar Island, 86% of farms were affected by diseases in their mid-crop phase, 8% of farms were affected by diseases in their mid- and end-crop phase, 4% of farms were affected by diseases just after stocking and 2% of farms were affected by diseases after stocking and in their mid-crop phase. No occurrences of diseases were reported during end- crop and all-crop phases.

Basanti Block: Among the respondents of Basanti Block, the farms of 73% of the farmers were affected by diseases in their mid-crop phases, and 15% of farmers encountered diseases in their farms during mid- and end-crop phases. The farms of 10% of farmers were affected by diseases in their end-crop phases, and the farms of 2% of the farmers were affected by diseases just after the stocking phases. The farms of 4% of farmers were affected by diseases after stocking.

Overall: All together, the data of the two blocks reveal that occurrence of disease is highest during the mid-crop phase (78%) followed by the mid- and end-crop phases (12%). Few farmers (6%) encountered diseases in end-crop or just after stocking (3%).

4.2 Assessing Types of Physical Damage of Shrimp Collectors

A study (Das et al., 2012) assessed the nature of physical damage to shrimp collectors. Sixty female prawn seed collectors and 60 female control subjects from the Sajenakhali and Sandeshkali Sundarban, West Bengal, India, were randomly selected to evaluate and compare musculoskeletal disorders and physiological stress. The control group was engaged in domestic work involving minimum hand-intensive activities. Most subjects suffered from discomfort in different body parts, especially in the lower back (98%), knees (88%), shoulders (75%), ankles (70%) and feet (67%). This study reveals that female prawn seed collectors suffer from significant physiological load and extreme physiological stress due to prolonged working hours in a standing posture and excessive work pressure. Consequently, all these factors affect female prawn seed collectors’ health and work performance.

Female prawn seed collectors are forced to do hard, manual and physically demanding work in prawn seed collection for a prolonged time. Women collect prawn seed to earn money for their families. They perform different activities in prawn seed collection, e.g., dragging a net (forwards and backwards), spreading a net and collecting seed.

This study also revealed that subjects mostly complained of intense discomfort (pain) that led to sleep disturbance, suggesting that sleep disturbance was a regular occurrence. Discomfort persisted during and after work. The intensity of discomfort was higher among the experimental group than among the control group. This finding suggests that a rigorous work schedule exerts a negative effect on subjects’ physical health. This study showed that during prawn seed collection activities, the heart rate becomes high among collectors.

Thus, it can be concluded that female prawn seed collectors suffer from physiological stress due to the hazardous working conditions and behavior, which also affects their health and work performance (Das et al., 2012).

4.3 Human Animal Conflict

Injuries due to shark (locally named Cammot) or crocodile (Crocodylus porosus) bites (disfigurement) are also common. TPS collection near the
SRF (Sundarban Reserve Forest) exposed them to tiger attacks also.

The occupation has severe hazards. The meendharas are often victims of attacks from crocodiles and sharks. Constant contact with saline water creates health hazards. Several cases of skin problems are noted due to continuous immersion in brackish water. Above all, inadequate income neither compensates for the hazard nor allows workers to take care of their ill health. In spite of the above problems, the poor meen collectors are engaged in this occupation because this is the only way by which they earn some cash for their subsistence (Ray et al., 2002).

### 4.4 Social Problems

Money and trade network: Although the meendharas continuously collect prawn seeds throughout the year, the price of tiger prawn seed varies according to the commercial crop production of adult prawns. The prawn seeds are bought from the collectors and sown in the brackish water aquaculture areas or *bheris*. These are shallow inundated fields with a depth of about 6–8 feet. In fact, these are paddy fields. After harvest, the fields are inundated with brackish water, and aquaculture is carried on. After about six months, the fully grown prawns are taken out. The fields are again cultivated in the rainy season with paddy.

A prawn has a life span of about six months (Ganguly et al., 1996). The juvenile Tiger Prawn becomes its full size within 4 to 6 months. The best season for sowing tiger prawn seeds is winter specifically the middle of December to January. It may continue up to the middle of February. Demand for seed prawn is at its peak during winter time and its lowest during September–October.

The price of *meen* at Kamdebnagar village (1 US$ was nearly Rs 45 at data collection time):

- Summer season: Rs. 200 per thousand
- Rainy season: Rs. 250 per thousand
- Autumn season: Rs. 16–40 per thousand
- Winter season: Rs. 400 per thousand

The breeders of prawn and aquaculturists buy the prawn seeds from the meendharas of Kamdebnagar at the above-mentioned rates during the different seasons through the middlemen. The price is the highest during winter. The price of seed prawn goes down in summer and is lowest in the autumn months.

It takes about four days for a family to catch one thousand prawn seeds. On the fifth day, they sell the seeds. The next day they rest, and the following day they start again with the catch. The average annual income of a family from the collection of prawn seeds is not sufficient to take care of the needs of every member of the family. Economically, the living standard of the meendharas is very poor. It is hardly at the subsistence level (Ray et al., 2002).

Social problems related to this activity include children leaving the education system to make money, and many adults spend this ready cash on alcohol consumption. They are also subjected to various forms of economic exploitation by the TPS trade network. Many environmental activists think that TPS collection is one of the causes of the recent ecological disaster in Sundarban (Chowdhury et al., 2008).

### 5. Alternative Strategy

#### 5.1 Bycatch Management

A variety of measures has been used to reduce bycatch in the various shrimp fisheries. These include a complete ban on trawling, bans on fishing in areas and/or periods when bycatch is known to be high, reduction of overall fishing effort and, most commonly, modifications to fishing gear, mainly through the use of bycatch reduction devices (BRDs) and other modifications to the trawl net. Other measures used to reduce bycatch are catch quotas, discard bans and limits in the shrimp-to-bycatch ratio. Measures to make better use of bycatch are also considered to be part of shrimp bycatch management. Several large shrimp bycatch initiatives are at least partially based on the concept of bycatch enhancement. Included in bycatch enhancement are improvements in bycatch handling and marketing as well as product development.
There have been some remarkable reductions in shrimp bycatch from large- and medium-scale shrimp fisheries. The situation appears manageable, and it is likely that further reductions in bycatch levels could be made, albeit with some sacrifices by fishers. One of the main challenges is to determine the acceptable levels of bycatch, taking into consideration the costs and benefits of reaching these levels. Small-scale shrimp fishing is very important in many regions and is responsible for a large portion of the total shrimp catch, especially in Asia. The number of small-scale shrimp fishers in the world is not known but is likely to exceed, by far, those working on industrial shrimp vessels. The objective of reducing bycatch in many small-scale shrimp fisheries of developing countries is challenging and perhaps even impossible (Gillett, 2008).

The authorities (MPEDA) have created a survey regarding the dangers to the meendharas. As an alternative, artificial breeding grounds are prepared. Permanent hatcheries are made. Mother prawns are raised there and artificial spawns and seeds are bred. Such breeding grounds are presently found at Gopalpur. The breeders may raise two yields of adult tiger prawns in this way. This has not yet given any viable result. However, so far, no alternative income generating employment has been devised for them, so the poor meendharas are still facing the hazards and carrying on with their traditional occupation of catching juvenile tiger prawns in the creeks and estuaries (Verghese et al., 1988).

Providing infrastructural development is another method of tackling the problem. This includes providing drinking water and developing irrigation facilities, brick pathways and jetties in addition to training and awareness building. Alternate livelihood options provided through the FPCs include poultry farming, social forestry, digging ponds and making roads (Patel and Rajagopalan, 2008).

5.2 Bycatch Reduction Devices (BRDs) in Trawlers

The large amount of bycatch generated by shrimp trawl fisheries has resulted in worldwide attention. Various programs and mechanisms have been introduced for the unwanted and wasted portion of the catch. Although bycatch issues can be quite different with regard to warm- and cold-water shrimp trawl fisheries, many devices to reduce bycatch are shared between the two. Developments in one group have had impacts on the other, especially those of coldwater on warm-water shrimp trawl fisheries. In general, BRDs in the latter are required to deal with a more heterogeneous group of animals than those of cold-water fisheries, and, consequently, there is a greater variety of devices.

Broadhurst (2000) reviews the evolution of bycatch reduction through technological changes to trawl gear (Gillett, 2008).

5.3 Experience of Cage Nursery Rearing in Bangladesh

The shrimp culture industry of Bangladesh depends on the catch of the wild fry of tiger shrimp. Employment as fry-catchers has been generated for thousands of rural poor, but the marketing system is not well developed and high fry mortality occurs due to poor handling. However, the growing freshwater prawn farming sector continues to demand increasing quantities of large juveniles.

A report based on field trials from 1990 to 1993 describes the results of cage nursery culture trials with both tiger shrimp (P. monodon) and giant freshwater prawn (M. rosenbergii) fry. It was thought that fry-catchers would be able to increase their earnings through sales of nursed post-larvae and juveniles. The survival of nursed
post-larvae in the distribution system would also be increased. However, it is unlikely that tiger shrimp fry nursing can be made profitable. On the other hand, cage culture of a combination of hatchery-reared post-larvae and wild-caught fry of the freshwater prawn could be profitable (Angell, 1994).

5.3.1 Technological Alternatives - Pond Nursery and Floating Cage

Coastal aquaculture in Bangladesh has become synonymous with shrimp culture. Unlike in some of the Southeast Asian countries, the commercial development of species other than tiger shrimp is nonexistent.

Technical and market factors led to the selection of shrimp fry nursing as a suitable economic activity for fry-collectors. Such nurseries are widespread in the Philippines and Indonesia. Considerable experience has been amassed in their operation. Nurseries offer several benefits when incorporated into farming systems:

Sufficient quantities of fry can be accumulated at one site to reduce marketing costs.

Survival in the grow-out system is increased, because nursed PL are larger and stronger. Mortality of weak PL is also absorbed in the nursery.

Where hatcheries exist, early PL can be held in nurseries, resulting in faster turnover for both the hatchery and nursery operators.

Nurseries may be land-based, in ponds, or floating cages may be used. The latter is more applicable to BOBP's target group. The basic cage design has been described by Nielsen and Hall (1993) as follows: it consists of a frame of four narrow bamboo platforms. The sides are 0.45 x 6.00 m and the end pieces are 0.45 x 3.00 m. These are tied together by rope to form a rectangular frame with inside dimensions of 2 x 5 m.

Four to six 100-litre plastic barrels are attached under the raft as floats (see picture alongside).

Feed consists of a paste made of low-value shrimp and fish caught by the fry-catchers. The paste is spread on a feeding tray made of plastic mosquito screen sewn to a wire frame. The paste is allowed to sundry for a few hours, after which it is suspended in the cage. A small tin, holding 200 g, is used to measure and control the amount of feed.

Stocking rates, being dependent on the availability of post-larvae, varied widely during the BOBP1 field trials. The target was 10,000 PL/cage but ranged from less than 200 to somewhat more than the target.

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1 BOBP, The Bay of Bengal Programme (BOBP) is a multiagency regional fisheries programme which covers seven countries around the Bay of Bengal — Bangladesh, India, Indonesia, Malaysia, Maldives, Sri Lanka and Thailand. The programme plays a catalytic and consultative role: it develops, demonstrates and promotes new technologies, methodologies and ideas to help improve the conditions of small-scale fisher folk communities in member countries. The BOBP is sponsored by the governments of Denmark, Sweden and the United Kingdom, and also by UNDP (United Nations Development Programme). The main executing agency is the FAO (Food and Agriculture Organization of the UN).
5.3.2 Experience of This Strategy

The cage nursery culture trials were undertaken over a period of three years. The outcomes of these were considered from both technical and community participation aspects. Culture trials for both tiger shrimp fry and freshwater prawn fry were undertaken during the 1990-1991 and 1991-1992 seasons, while only tiger shrimp fry nursing was attempted during the 1992-1993 season. Tiger shrimp fry nursing was implemented at Mognamapara, Cox's Bazar, and the freshwater prawn fry nursery trials were located in Potiya by the Chandkhali River near Chittagong.

Tiger shrimp fry nursing trials were conducted very early in the 1990-1991 season. A total of 35,600 fry were stocked of which only 948 survived. The results for 1991 were equally discouraging. Nielsen and Hall (1993) summarized their conclusions for cage nursery culture in West Bengal, most of which remains true for Bangladesh. The strong tidal and river currents in Bangladeshi channels and rivers require the use of sturdy bamboo frames. Materials are locally available to fabricate the cages (Angell, 1994).

6. Social Aspects

Practicing the shrimp catch/culture also perpetuates the age old division of labor and social hierarchy. As mentioned in the Introduction, poverty, illiteracy, child labor, exploitation and more are perpetuated by this dangerous occupation. The men involved risk their lives but do not earn enough to substantiate their own families. Poverty compels women and children to work, and they are tremendously underpaid. Women are not involved in any formal way in decision-making processes and do not directly participate in meetings of fry-catchers. UBINIG (1990) field staff made a sustained effort to include women in cage nursery activities but found it difficult to overcome the social pressures to which the women are subjected.

6.1 Gender Division of Labor

The following gender division of labor was found:

1. Equipment procurement  
   Men
2. Catching with net  
   Men, women and children
3. Sorting  
   Women and children, sometimes men.
4. Disposal of wastes (“return to the sea”)  
   Women and children (those who have done the sorting)
5. Nursing  
   Women, men
6. Selling  
   Men, women (those who were involved in catching)

6.2 Women in Fry Catching

Women take part in fry collection and fry trading either as family labor or as independent catchers. In the patriarchal society of these areas, this involvement is not by choice. Social, cultural, religious and economic factors as well as strong patriarchal notions determine the extent of women’s involvement, and, more importantly, recognition of this work. It was found that only women from the poorest families worked as catchers. Where male members earned enough to maintain their families, the women were “not allowed to work outside”.

Two patterns of employment emerged. In one, the men and the male children caught fry and brought them back to the shore or to the house where women and female children sorted the catch. In the other, both husband and wife went out to sea together to catch fry with separate nets while the children did the sorting. Women with no adult male support turned to fry catching to earn their livelihood, despite cultural, social and religious taboos. Necessity forced them to go out and “work like men”.

6.3 Children in Fry Catching

Children in almost all fry-catcher families took an active part in catching and sorting fry. Though it is said in these parts that “the child born today begins catching fry tomorrow”, the children usually become involved only after they are five years old. They are happy children who consider fry catching fun, but they are in the business because of need.

6.4 Other Stakeholders in Sundarban

Fishers in most of the remote islands do not have access to ice or other means to preserve their catch and are often forced to travel to Canning or
Gosaba to sell their catch on the same day itself or transfer the catch to fish merchants who come to the villages. The fish depot owners, *Aratdars* as the fish merchants are called, also play the role of moneylenders, serving fishers who often do not have the money to buy boats and nets and to cover the running costs of fishing. The *Aratdars*, besides lending money, also arrange for the marketing of the catch from the villages. Fishers are often indebted to the *Aratdar* for years on end.

Socioeconomic data about the numbers of people in the area dependent on resources within the STR, the manner in which they have been affected and the options they have explored to cope, remains unavailable. Though most of those fishing in the STR are men, women and children are known to have been involved in activities such as catching prawn (*meendharas*). The women have also lost their sources of livelihood, as they are now prohibited from fishing in the creeks near the Critical Tiger Habitat and Reserve Forests and also from collecting prawn seeds near the shores of the inhabited islands (Patel and Rajagopalan, 2008).

7. Conclusion

In this work, we have reviewed literature to show that though shrimp culture is a highly profitable business, the shrimp catchers in Sundarban are horribly underpaid. In the absence of any modern infrastructure or alternate livelihood, poor people of Sundarban are compelled to take on the occupation of *meendhara* as a last resort. We have also shown how these people endanger their own life and health on one hand and destroy the ecology in terms of killing bycatch and depleting mangroves. We have also discussed how a lack of basic governmental facilities, like roads, heath care and education, keep the people bound in medieval social darkness. Exploitation and social problems are making the lives of common people even darker and uglier in the Sundarban, the “beautiful forest”. We confine our discussion only to reducing bycatch and addressing the issue of poverty. Better methods of BRD will be explored to reduce bycatch. We call upon researchers to explore better methods of shrimp catching to save this people.

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