



## Review

# Indiscriminate exploitation of wild prawn postlarvae in the coastal region of Bangladesh: A threat to the fisheries resources, community livelihoods and biodiversity

Ferdous Ahamed<sup>a,\*</sup>, Md. Yeamin Hossain<sup>b,c</sup>, Bernerd Fulanda<sup>a,d</sup>, Zoarder Faruque Ahmed<sup>e</sup>, Jun Ohtomi<sup>b</sup>

<sup>a</sup>The United Graduate School of Agricultural Sciences, Kagoshima University, 1-21-24 Korimoto, Kagoshima 890-0065, Japan

<sup>b</sup>Faculty of Fisheries, Kagoshima University, 4-50-20 Shimoarata, Kagoshima 890-0056, Japan

<sup>c</sup>Department of Fisheries, Faculty of Agriculture, University of Rajshahi, Rajshahi 6205, Bangladesh

<sup>d</sup>Kenya Marine and Fisheries Research Institute, Marine and Coastal, P.O. Box 81651, Mombasa 80100, Kenya

<sup>e</sup>Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

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## ABSTRACT

In Bangladesh, prawn farming is dependent on wild postlarvae (PL) because of inadequate supply of hatchery produced PL compare to the demand. Moreover, farmers prefer wild PL because the survival of wild PL is reported to be much higher than hatchery produced PL. Wild prawn PL fishing have given an employment opportunity for thousands of coastal landless and unemployed poor people in Bangladesh. On the other hand, indiscriminate wild PL fishing has notorious impact on biodiversity in coastal ecosystems due to high levels of by-catch. This has provoked imposition of ban on PL collection to conserve fisheries resources. In 2000, the Government of Bangladesh imposed ban, however, it was not implemented firmly because of the lack of alternative livelihoods for coastal poor. This paper describes the impact of wild prawn PL fishing in coastal Bangladesh and drawn a conceptual framework in relation to management of coastal fisheries resources.

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## 1. Introduction

Bangladesh is very rich in fish, crustacean, mollusks and other aquatic animal biodiversity. Inland water bodies are known to be the habitat of 266 species of indigenous fish, 13 exotic fish, 56 prawns, about 26 freshwater mollusks and 150 birds. The marine water bodies (200 nautical miles along the coast) are also remarkable for being habitat of 442 species of fish, 36 marine prawns and about 336 mollusks, covering 151 genera have been identified from the Bay of Bengal (Sarker and Sarker, 1988; Ali, 1997).

The coastal zone of Bangladesh is filled with a rich and unique biodiversity. It has a great natural ecosystem value in terms of scientific interest and because of its outstanding aesthetic value. It also provides multiple renewable resources of direct economic benefits to the nation. Coasts are dynamic interface zones involving the meeting of atmosphere, land and sea. The coastal zone also provides an important buffer zone and filtering system for the coastal ecosystem. All these components are in a fragile balance

controlled by physical and biological processes which can be easily upset by natural or human-induced perturbations (Viles and Spencer, 1995). The interaction between human societies and the environment in this zone is very pronounced in the coastal regions of Bangladesh. Hence coastal resource management has become important and imperative for nutritional, economic and environmental reasons (Bergin and Michaelis, 1996).

In Bangladesh, prawn farming is currently one of the most important sectors of the national economy. During the last two decades its development has attracted considerable attention because of its export potential. Consequently a vast area in the coastal zones of Khulna, Satkhira, Bagherhat and Cox's Bazar has been converted into prawn farm. The most widely cultured fast growing species in Bangladesh are giant freshwater prawn *Macrobrachium rosenbergii* and black tiger prawn *Penaeus monodon*. Prawn farming of Bangladesh still depends on wild postlarvae (PL) (Angell, 1990, 1994; Ahmed, 2000; DOF, 2002). Traditionally, prawn farmers have preferred to stock their gher (prawn farms are locally known as gher) with wild PL rather than hatchery-produced fry because the production of hatchery PL has been limited and farmers consider them to be of lower quality (Angell, 1992; Ahmed et al., 2005). In addition, the survival of wild PL is reported to be much higher than that of hatchery-produced fry (Muir, 2003). It has

\* Corresponding author.

E-mail address: [ferdous\\_bau04@yahoo.com](mailto:ferdous_bau04@yahoo.com) (F. Ahamed).

been estimated that approximately 2 billion prawn fry are collected annually from wild sources in Bangladesh (Banks, 2003). With respect to freshwater prawn (*M. rosenbergii*) more than 90% of the total PL is derived from natural sources and in the case of black tiger prawn (*P. monodon*), more than 50% is derived from wild sources (Banks, 2003).

Wild PL collection has given employment opportunity for thousands of coastal landless and unemployed people (Angell, 1990; FAO/NACA, 1995; Islam and Wahab, 2005). In Bangladesh more than 0.42 million people are involved in prawn seed collection (USAID, 2006). On the other hand, wild PL fishing has assumed a notorious impact on coastal biodiversity (Primavera, 1998; Islam et al., 1999; Hoq et al., 2001; Bhattacharya and Sarkar, 2003). It has been reported that about 99 fin fish and other prawn species fry are discarded for collecting a single prawn PL (Rashid, 2000), which is a great threat to the biodiversity. This paper describes the indiscriminate wild prawn PL collections in the coastal zone of Bangladesh and their impact on the fisheries resources, livelihoods and biodiversity, in relation to management of coastal fisheries resources.

## 2. Coastal biodiversity of Bangladesh

Biodiversity encompasses the variety of life in all its forms, levels and combinations including ecosystem diversity, species diversity and genetic diversity (CBD, 1992). The coastal regions of Bangladesh are endowed with numerous resources and distinctive development opportunities that help reduce the vulnerability and poverty levels of coastal the communities thus contributing significantly to the development of the country as a whole. The diversity of the natural resource base ranges from coastal fisheries, mangrove and other coastal forests, marine salt works and other minerals. Furthermore, the coastal regions of Bangladesh have received wide international attention over the last decade due to the high potential for exploitation of both onshore and offshore natural gas (MoWR, 2005). The coastal zone also encompasses crucial ecosystems that are important for the conservation of both natural and cultural heritage including the world's largest uninterrupted stretch of mangrove ecosystem, the Sunderban, which is designated as a World heritage since 1997. Moreover, other ecosystems such as coral reefs, sea grass meadows, and extensive tidal flats abound in the offshore islands including St. Martin Island which lies to northeastern part of the Bay of Bengal, at the southern of the tip of the Cox's Bazar-Teknaf peninsula. These ecosystems are present both biodiversity hotspots as well as ecological foundations for important common property coastal and marine resources. A few of the most important flora and fauna of the coastal zones of Bangladesh are shown in Table 1.

## 3. Fishing of postlarvae (PL) in the coastal zone of Bangladesh

The coastal ecosystems of Bangladesh serves as a nursery ground for many prawn, fish and other aquatic species since they provide physiologically suitable environment with respect to temperature, salinity and other physiochemical parameters. Millions of tiny larvae, postlarvae and juveniles are swept into the intertidal areas and associated ecosystems where they complete crucial stages of their lifecycles.

In Bangladesh, there is limited availability of hatchery produced PL and the current production supplies only about 20% of total demand, hence the harvesting of wild PL remains the only alternative to the demand and supply gap in the rapidly expanding prawn farming ventures in the country (Muir, 2003; Khondaker, 2007). Moreover, majority of farmers prefer wild PL because of their hardiness, with the survival of wild PL reportedly higher than

**Table 1**

The available flora and fauna in the coastal zone of Bangladesh (source: Khan, 1991; Ahmed and Ali, 1996; IUCN, 2000).

Category	Number of species
<i>Flora:</i>	
Algae/Seaweed	168
<i>Fauna:</i>	
Sponges	3
Corals	66
Mollusks	336
Shrimp/Prawn	56
Crabs	16
Lobsters	3
Echinoderms	4
Fish	442
Amphibians	22
Birds	442
Mammals	628
	3

hatchery produced PL (Muir, 2003). The harvesting of wild prawn PL first started in the southwest region in the early 1970s (Mazid, 1994) and by the early 1980's. The harvesting of wild PL had emerged as an important economic activity for the coastal communities (Hoq et al., 1995). Furthermore, the high demand for PL, low investment for harvesting of wild PL and the high returns associated with these fishing ventures encouraged thousand of coastal folks especially girls, poor families and other vulnerable and low income groups of the society to embrace the harvesting of wild PL as major source of livelihood. Consequently, there is a need for socioeconomic and environmental research to understand the state of current production and harvesting of wild PL and ensure responsible resource use practices for minimal environmental impact (NEW, 2005). The harvesting of wild PL in the coastal areas of Bangladesh runs all year around with a peak season during April to June during spring tides (when the high tides are very high and the low tides are very low) when the numbers of planktonic PL are reportedly are high (Ahmed et al., 2010). The fishing gears employed in the harvesting of PL include push/pull nets, drag nets used behind boats and passive set bag nets. The push/pull nets are the primarily used by women and children and are used along the estuarine riverbanks and intertidal areas and the push/pull net fishers present the poorest groups since the gear requires very little capital to invest and are the cheapest options for the coastal poor. Set bag nets are used in the middle of the river as well as also along the coast and are considered to be the most efficient gears accounting for a greater bulk of the catch of wild PL as well as by-catch. These types of gears also require boats, a strong anchor line as well as buoys such as drum or barrels and therefore calls for a considerable amount of capital. Consequently, set bag net fishers are considered to belong to the better-off households that have access higher capital. Furthermore, this type of fishing involves the transfer of each haul to earthen, plastic or aluminium containers after which the PL collectors and/or family members select only the targeted prawn PL while the rest, comprising other prawn species, zooplankton as well as fish larvae and juveniles are discarded along the shores.

## 4. Impacts of indiscriminate prawn PL harvesting

### 4.1. Impact on coastal livelihood

Wild prawn PL harvesting remains an important source of income and livelihoods for the coastal poor and estimates show that over 40% of the mostly landless households living along the coast are involved in PL collection (Frankenberger, 2002). Together

with trade in prawn PL, both ventures account for over 60% of the total income of landless poor. The collection of wild PL also makes a significant contribution to the incomes of poor marginal farmers who are engaged in prawn related activities such as trade in fishing gear, transport of the harvest PL and other activities. It is difficult to determine how many people are actually involved in fry collection since some are engaged in the activity on a full time basis and some as a part time occupation. However, statistics estimate that the livelihoods of about 400,000 people including women and children are associated with prawn PL fishing in coastal Bangladesh (USAID, 2006) and more than 2000 million PL valued at around US\$ 30 million are collected from these coastal zones every year (EJF, 2004). Notwithstanding, despite the low incomes from these ventures, the harvesting of wild PL lasting only few months of the year can contribute a relatively substantial part of the annual incomes of the poor and vulnerable groups among the coastal communities as well as to the economy of coastal zones of Bangladesh (Rosenberry, 1992; Ahmed et al., 2005; Hoq, 2007).

#### 4.2. Impact on biodiversity

Although the harvesting of wild prawn PL forms a relatively good source of income and only lifeline for some of the coastal poor, this practice has substantial negative impacts on estuarine and marine fishery and prawn stocks. This is because during the PL collection, many other non-target fin and shellfish species larvae and juveniles are caught and discarded during the selection of the target species. This is in contrast to brackish water prawn culture which involves high value species that are often exported along with much of their production chain (FAO, 2007). Consequently, the indiscriminate harvesting of PL present a threat to the fisheries resources on which the coastal fisher folks are dependent on as well as to the wider ecological biodiversity on which the fisheries are based. This paper aims to highlight a few but critical impacts the indiscriminate harvesting of wild PL on the fisheries resources, coastal livelihoods and biodiversity within the marine and coastal zones of Bangladesh.

##### 4.2.1. Destruction of other pelagic resources

The crude and indiscriminate harvesting of wild PL involves removing a large proportion of several species of shellfish, finfish and other pelagic biota as by-catch. Due to high market demand for the wild PL and low or zero value of much of the by-catch, the fishers only retain the targeted PL which obtains the maximum price in the trade. Therefore, after sorting out the target PL species, the entire by-catch is discarded on the river banks and shores of the harvested water bodies. These practices, like in other fisheries subsectors such as trawling, are not a threat to the target species, but comprise deleterious resource use practices which threaten the livelihoods of the very fisherfolks depending on these ecosystems and resources. Moreover, the loss of a wide range of larvae and juveniles of finfish, shellfish and macrozooplankters of immense ecological, commercial and biomedical values present a big threat to biodiversity and an impediment to ecological conservation and sustainable resource-use practices. The continued destruction of valuable pelagic biota could, in the long run, lead to severe stock depletion in these ecosystems present very fragile environment (Brown, 1997). Some studies have reported in the harvesting a single prawn PL, over 1000 non-target fin and shellfish larvae are destroyed in the process (Ahmed et al., 2010). Further, several studies have shown that the amount of by-catch from the harvesting of wild prawn PL is the highest of any fishery in the world and it is estimated that over 98 billion of larvae and zooplankton are discarded by every year, globally (EJF, 2004; FAO, 2001; Latif et al., 2002), calculating to about 35,000–50,000 t of discarded

**Table 2**

The most common commercially important by-catch species caught during PL collection in the coastal zone of Bangladesh (source: Ahmed et al., 2010).

English name	Scientific name	Local name
Monsoon river prawn	<i>Macrobrachium malcolmsonii</i>	Chotkaicha
Freshwater prawn	<i>Macrobrachium villosimanus</i>	Dimua icha
Freshwater prawn	<i>Macrobrachium mirabilis</i>	Lutia icha
Freshwater prawn	<i>Macrobrachium birmanicus</i>	Thengua icha
Freshwater prawn	<i>Macrobrachium rude</i>	Goda icha
Freshwater prawn	<i>Macrobrachium dayanus</i>	Kaira icha
Black tiger prawn	<i>Penaeus monodon</i>	Bagda chingri
White shrimp	<i>Penaeus indicus</i>	Sada icha
Shrimp	<i>Penaeus merguensis</i>	Bagha chingri
Shrimp	<i>Metapenaeus monoceros</i>	Horina chingri
Hilsa shad	<i>Tenualosa ilisha</i>	Hilsa
Indian river shad	<i>Gadusia chapra</i>	Chapila
Sea bass	<i>Lates calcarifer</i>	Vetki

by-catch every year (DOF, 2002; Islam, 2003). Table 2 shows the most common, commercially important by-catch species discarded from the harvesting of wild prawn PL in the coastal zones of Bangladesh. Furthermore, this indiscriminate harvesting of wild prawn PL presents a critical threat to endangered and/or threatened species (Table 3) of the coastal zones of Bangladesh therefore hampering the global efforts on conservation and maintenance of biodiversity.

##### 4.2.2. Impacts on the species recruitment and capture fishery production

The extensive and massive harvesting of wild prawn PL threatens the coastal ecosystem due to the damage of critical habitats such as feeding and nursery grounds of many species utilizing these areas during part of their life cycles thus impacting on recruitment (Saikat, 1992). In the coastal region of Bangladesh postlarvae, juveniles and pre-adults of finfish and shellfish species are indiscriminately harvested with some species already at critical levels of over-exploitation due to the deleterious PL collection practices. Table 4 shows data on the estimated loss of other non-target shellfish, finfish and macro-zooplankton over the past 10 years during the harvesting of wild PL in the coastal zones of Bangladesh. Furthermore, the recruitment of shell and finfishes and macro-zooplanktons which act as a foundation for the food webs for numerous aquatic animals, is also severely damaged as a consequence of extensive PL collection in these coastal ecosystems. Due to the extensive harvesting of the wild PL, the actual recruitment of the prawn population as well as that of other

**Table 3**

Endangered/threatened fish species of the coastal zone of Bangladesh (source: Hoq, 2007).

Family	Species	Status	Global status
Ambassidae	<i>Pseudambassis baculis</i>	VU	–
	<i>P. ranga</i>	VU	–
Anguillidae	<i>Anguilla bengalensis</i>	VU	–
	<i>Carcharhinus limbatus</i>	–	VU
Carcharhinidae	<i>Glyphis gangeticus</i>	–	CR
	<i>Butis butis</i>	NO	LR
Eleotridae	<i>Plotosus canius</i>	VU	–
Plotosidae	<i>Pristis microdon</i>	–	EN
Pristidae	<i>Scatophagus argus</i>	EN	–
Scatophagidae	<i>Pangasius pangasius</i>	CR	–
	<i>Silonia silonia</i>	EN	–
Schilbeidae	<i>Hippocampus kuda</i>	–	VU
	<i>Microphis deocata</i>	EN	–

CR, critically endangered; EN, endangered; LR, lower risk; NO, not threatened; VU, vulnerable.

**Table 4**

Losses (%) of shellfish, finfish and macro-zooplankton during PL collection in coastal water of Bangladesh.

Year	Other shrimp/prawn	Finfishes	Macro-zooplankton	References
1990	21.5	30.8	46.5	Deb, 1998
1992	16.0	10.0	73.4	Rahman et al., 1985
1995	13.2	3.2	83.2	Ahmed et al., 1998
1996	7.6	2.1	90.1	Islam et al., 1999
1999	17.2	7.2	75.4	Hoq et al., 2001

shellfish, finfish, and numerous other species discarded as by-catch is severely affected by these deleterious fishing practices which destroy the juveniles and larvae at the intertidal and estuarine nursery and feeding grounds. Thus, the harvest can only compare to industrial and commercial non-selective fishing methods such as bottom prawn trawling. Furthermore, the destruction of the nursery and the associated habitats remains the greatest ecological drawback to the conservation of biodiversity due to its direct impact on species recruitments well as to fisheries production. Moreover, there is a rapid growth of the coastal populations in Bangladesh, augmented by the scarcity for agricultural land, increasing competition for the limited natural resources and declining livelihood opportunities. Consequently, the indiscriminate harvesting of wild prawn PL and the intensification of the prawn culture practices will have a significant impact on the existing fisheries stocks with detrimental impacts on the ecosystems and existing conservation efforts. This scenario will evidently impact heavily on the coastal fisher folks whose livelihood depends on the very resources currently to non-sustainable exploitation approaches. Paez-Osuna et al. (2003) attributed the declining catches of wild prawns and fishes in many coastal ecosystems to overexploitation both in terms of harvesting of food fish and shellfish as well as the impacts of the fishing practices on the aquatic ecosystems. It is also noted that the expansion and intensification of the prawn culture systems has also reduced the agricultural land available for the farming of the rice which forms the staple food for majority of the coastal Bangladesh population. In Bangladesh, statistics show that the rate of depletion of the aquatic and fisheries resources from rivers and estuaries has been, on average 10% during the past 10 years (DOF, 2009).

#### 4.2.3. Impacts of wild PL collection on the coastal ecosystems

The indiscriminate and extensive harvesting of wild prawn PL has been directly linked to the destruction of important coastal ecosystems including mangrove forests. However, the mangrove forests and associated ecosystems have remained a source of livelihood for coastal fisher folks, providing the population with a direct source of food items including fish, crustaceans, molluscs in addition to numerous other economic activities linked to the mangrove ecosystems (Primavera, 1997). Moreover, the ecosystem functions of these mangrove forests in nutrient and waste sorption as well as in carbon sequestration thus mitigating the impacts of anthropogenic activities and climate change on these coastal poor populations cannot be overstated. Dewalt et al. (1996) observed that due to the decline in the catch per unit effort (CPUE) from the capture fisheries attributed to declining stocks augmented to deleterious fishing practices, many a fisher livelihoods have become increasing vulnerable in the face of increased competition for other sources of livelihoods and the more recent phenomenon of climate change and global warming. Therefore, the livelihoods of many artisanal fisher folks in the marine, coastal and estuarine fisheries of Bangladesh are under serious threat due to the continued destruction of coastal ecosystems and declining fishery yields (Paez-Osuna et al., 2003). The impacts of these threats are

evident in many parts of coastal Bangladesh where the fishers switch to other livelihood avenues for survival, and the harvesting of mangroves for sale, cheap source of energy and construction materials has drastically increased over the last decades (Dewalt et al., 1996). Therefore, these shifts in the sources of livelihoods and changes in employment patterns remain the main factors contributing to the destruction of crucial ecosystems such as the mangrove forests. The impacts of the ecosystem degradation, destruction of the mangroves forests and the resultant loss of wildlife, the increases in flood risks and other natural disasters such as typhoons and tsunamis which threaten the lives and properties of the wider coastal populations cannot be over emphasized (Primavera, 1997; Iftekhar and Takama, 2008).

### 5. Mitigating the impacts of wild PL harvesting

The localized and wider impacts of the harvesting wild PL on the already vulnerable and poor coastal population of Bangladesh calls for institutional intervention to assess the socioeconomic and environmental impacts of these livelihood activities and ensure responsible resource use practices for development. The detrimental impacts of this indiscriminate harvesting wild PL can be mitigated only if adequate knowledge transfer through institutional changes and sufficient monitoring of compliance with environmental and social requirements is conducted (Primavera, 1997; Hein, 2002; Alam et al., 2005). Consequently, improved governance remains an essential precondition to reduce wider livelihood conflicts for limited and declining resources, social discrimination and safeguard the natural ecosystems (Samarakoon, 2004; Costa-Pierce, 2008). There is a need to heavily restructure the functions of the multitude of institutions in the fisheries sector of Bangladesh which encompass several ministries divisions and departments as well as government and non-governmental agencies (Maniruzzaman, 2006). In addition, there are several institutions and organizations that are crucial to this sector including the donor community, fisheries and prawn farming cooperatives and the local union councils (locally known as parishad) (Pokrant and Bhuiyan, 2001). Moreover, numerous policies, laws, government acts, rules and ordinances have been enacted in Bangladesh for the regulation of the prawn farming activities including the wild harvesting of PL in order to safeguard the integrity of the coastal ecosystem as outlined in Table 5. The department of fisheries (DOF) is designated as the main implementing agency for the policies governing the fisheries and aquaculture sector under the administrative control of the Ministry of Fisheries and Livestock. However, the implementation of the policies, laws and regulations governing the fisheries sector remain the main hurdle to the sustainability of this sector and the long term conservation of the marine, coastal and estuarine ecosystems on which the livelihoods of the wider coastal populations of Bangladesh depends. Although a ban on wild PL harvesting was imposed in September, 2000, implementation of the ban by Department of Fisheries (DOF) was not keenly followed up due to numerous institutional weaknesses including lack of enough manpower assertiveness (Hein, 2002; Alam et al., 2005). Moreover, numerous other policies relevant to this sector are in existent including the FAO Code of Conduct for Responsible Fisheries, the National Water Policy, National Agricultural Policy, National Rural Development Policy, National Land Use Policy, National Environmental Policy and Coastal Zone Policy among others (DOF, 2006). However, the lack of alternative sources of prawn seed for the expansive prawn farming activities in coastal Bangladesh remains the biggest bottleneck towards the implementation and enforcement of these policies, laws and regulations governing the wise-use of the fisheries and aquatic resources in Bangladesh.



**Table 5**  
Different fishery policies, laws, rules, acts and ordinances in Bangladesh. (Source: Maniruzzaman, 2006; DOF, 2006, 2010).

Title of policy/law/rule/act/ordinance	Aspects covered
Forest Act, 1927	Allocation of fisheries management responsibilities to the Forest Department in mangrove areas
The Protection and Conservation of Fish Act, 1950	Conservation of fisheries resources as a whole
Embankment and Drainage Act, 1952	Protecting crops, not allowing cuts in embankments (to produce shrimp)
The Government Fisheries Protection Ordinance, 1959	Protection of government owned water bodies against unauthorized fishing
Bangladesh Water and Power Development Board Ordinance, 1972	Develop water management infrastructure for shrimp farming
Territorial Water and Maritime Zone Act, 1974	Conservation of marine fisheries
The Marine Fisheries Ordinance, 1983	Conservation of marine fisheries
Fish and Fish Product (Inspection and quality control) Ordinance, 1983	Quality control of fish and shrimp, mainly targeting export
The Protection and Conservation of Fish Rules, 1985	Farming rules for enforcement of various provisions of Fish Act 1950
Shrimp Estate (mohal) Management Ordinance, 1992	Allocate suitable state (khas) land for shrimp culture
Shrimp Farm Taxation Law, 1992	Imposing higher tax on shrimp land to cover cost of polder infrastructure
Bangladesh Environment Conservation Act, 1995	Conservation of natural resources and ensure eco-friendly development
Bangladesh Environment Conservation Rules, 1997	Conservation of natural resources and ensure eco-friendly development
Fish and Fish Product (quality control) Rules, 1997	Quality control of fish and shrimp, mainly targeting export
National Fisheries Policy, 1998	Conservation, management, exploitation, marketing, quality control and institutional development
Fish and Animal Food Act, 2010	Safe fish and animal feed production, processing, quality control, import, export, marketing and transportation
Hatchery Act, 2010	Hatchery development to ensure quality fish and shrimp seed

## 6. Conclusion

The harvesting of wild PL for seed in the aquaculture and prawn farming sector is an important feature of aquaculture ventures and remains a critical point in the prawn farming activities in many countries worldwide (Paez-Osuna, 2001). Although hatchery produced PL seed is now available in several countries in Asia and Latin America, wild PL still remains the significant and often preferred source of seed for the extensive systems especially among the rural poor population worldwide (World Bank et al., 2002; FAO, 2007). In Bangladesh, the wild PL remains the main source of seed for the giant freshwater prawn (*M. rosenbergii*) and black tiger prawn (*P. monodon*). Moreover, the collection of wild PL is a major employer for thousands of coastal landless and vulnerable groups of the coastal population especially women and children. However, the indiscriminate harvesting of wild PL leads to the destruction of the very fisheries resources the wider community depends upon. Furthermore, the resulting loss of aquatic biodiversity as well as the destruction of the coastal ecosystems and the wider impacts of these ventures on the entire coastal populations cannot be overstated.

Therefore, it is important for the government to seek alternate livelihood opportunities for the expansive population which is dependent on these resources while designing modalities for the regulation and management of the fisheries and aquaculture industry. Evidently, seasonal or total ban on the harvesting of the wild PL in certain ecologically sensitive areas such as Sundarbans and finfish and shellfish migration routes for postlarvae appears

inevitable. These are but a few of the measures that may ease the exploitation pressure on the aquatic and fisheries resources thus helping sustain the marine, coastal and estuarine fisheries. Furthermore, the imposition of policies, rules and/or regulations such as the September 2000 on wild OL collection by the Department of Fisheries (DOF) calls for strict monitoring to safeguard the livelihoods of the coastal populations and support the conservation of biodiversity efforts spearheaded by the government and other world bodies such as the World Wide Fund for Nature Conservation (WWF) and the International Union for Conservation of Nature (IUCN) which has already registered several species in Bangladesh waters as extinct, endangered or threatened. Community awareness must be created to ensure a community based drive for sustainable resource use and ecosystem conservation. Secondly, the government must take the drive to ensure that the high demand of prawn PL seed to the aquaculture industry is provided for through development of hatchery based PL to the ever growing industry. Furthermore, the wild PL collection is dominated by the vulnerable and rural poor and therefore without the provision of alternative livelihood opportunities, any rules and regulation on this industry are bound to face unprecedented resistance. Therefore, a sustainable concept should be developed that could conserve the biodiversity at the same time protect the livelihoods of wider coastal communities whose livelihoods depend on the aquatic and fisheries resources. As a trial, spatial and seasonal bans should be implemented for the sustainability of wild prawn stocks with the harvesting of PL being banned in areas where hatcheries are already in place in order to increase the productivity of these hatcheries. Further, a seasonal ban should be applied during the breeding season. In areas where PL collection is allowed, a licensing system may be introduced in order to reduce fishing pressure. PL fishing gears of very fine mesh size are destructive especially the set bag net which have been classified as the most damaging gears used in PL fishing. Therefore, there is a need to regulate the fishing gears used in this industry with the set bag net and similar gear being banned to reduce the impacts of the PL harvesting. Further, it is important to note that significant reduction of PL mortality can reduce the fishing pressure on the existing resources. Therefore, PL survival rates can be improved by promoting better practices in gear operation, fry sorting, holding, transporting, and stocking. Training and awareness programs should be conducted for fishers through the national media, DOF and NGOs to minimize the adverse effects of PL fishing. Mangrove forest acts as a natural nursery grounds for prawn fry and other fish and should be protected. The development of hatcheries will reduce the pressure of wild PL exploitation, reduce the negative environmental impacts of PL fishing and increase job opportunities and provide seed for enhancement of wild stocks if well planned and developed. The current hatchery production in Bangladesh can only supply about 20% of the total demand of prawn PL seed. Consequently, there is an urgent need to develop a comprehensive hatchery system and/or increase the PL productivity of the existing hatcheries. Furthermore, the quality of hatchery produced PL should be improved in order to increase the preference and demand for hatchery produced PL and thus decreases the demand the seemingly more hardy wild prawn PL.

The lack of alternative livelihoods for PL collectors is one of the principle constraints on implementing any policies, laws and/or regulations geared towards the development of a sustainable resource use strategy as well as conservation effort for the wise use of the marine, coastal and estuarine resources of Bangladesh. Therefore, program for the provision of alternative sources of livelihood and conduct public awareness campaigns to encourage the wild prawn PL fishers to venture into more eco-friendly occupations. Moreover, the introduction of a comprehensive free

primary education with provision incentives such as food for education may be an alternative and effective way of keeping girls and school going children away from cheap wild prawn PL labour traps. Moreover, the Bangladesh government has extensive food for work and food for education programs in other areas of the economy (DOF, 2002) and the therefore similar programs must be introduced in the expansive wild prawn PL fishery and prawn farming sectors if the problem of indiscriminate harvesting of wild prawn PL and its associated impacts are to be mitigated, and drive the conservation of the marine, coastal and estuarine resources of rural Bangladesh. Other livelihood opportunities available for the expansive manpower in the wild prawn PL fishery includes small crops cultivation, reforestation, livestock rearing, seaweed farming, small scale fish processing and fish marketing but the government must intervene to develop and expand these subsectors to attract the entry of the wild prawn PL collectors. Moreover, free lying Khas land should be developed and utilized in settling the poor and landless groups of the society who comprise vulnerable groups in the wild prawn PL collection sector, farmers and fishers. The provision of micro-credit schemes to these vulnerable groups is also important in the drive towards creation and development of alternative sources of livelihoods. In face of the growing concerns for the rural and coastal poor populations due to the impacts of global warming and climate change, the development of policy programs to start tackling this indiscriminate harvesting of wild prawn PL, the ever growing extensive prawn culture systems and the perceived impacts, both local and regional, on the very live hoods of the coastal poor populations depending on these resources.

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