

# Noncompliance a major threat in fisheries management-Experiences from the artisanal coastal fisheries of Bangladesh

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August 2010

# Noncompliance a Major Threat in Fisheries Management – Experience from the Artisanal Coastal Fisheries of Bangladesh

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*Abstract*

*Non-compliance with regulation is a major problem that undermines the effectiveness of the coastal fisheries management in Bangladesh. The result of non-compliance with regulation is over fishing, resource depletion, habitat degradation and resource use conflicts. From a management perspective, it is important to examine the level and causes of non-compliance and explore policies for encouraging or securing compliance. An attempt has been made in this study to investigate these issues in the case of the marine fisheries of Bangladesh. The specific area of interest is the mesh size regulation. Result showed an absolute violation of the mesh size regulation. The study found that the opportunity of getting higher catches and economic returns, weak enforcement, influence of the social environment, ignorance about the law and limited livelihood opportunities are the main causes behind the non-compliance of the fishers with respect to mesh size regulation.*

**Keywords:** Noncompliance, Estuarine Set Bag Net, Marine Set Bag Net, Small Mesh Drift Net Coastal fisheries, Policies for compliance management, Co-management, Bangladesh.

## Introduction

Traditionally Bangladesh's coastal fisheries have been one of the main source for food and livelihoods of the people in the coastal areas. Increasing population, ineffective management, conflicts and competition between commercial and artisanal fishers over resource access, and proliferation of destructive fishing practices are not only imposing severe stress on aquatic resources, it is also threatening the livelihoods of hundreds of villagers in the coastal areas of Bangladesh. Although regulations have been imposed to manage coastal fisheries, in practice, non-compliance and incidence of encroachment by the large-scale and even by the small scale gears are common. The outcome of non-compliance with the regulations is over fishing, resource depletion, habitat degradation

and social and economic conflicts amongst the various segments of the population over the share of the resource. Non-compliance with regulations is a serious problem that undermines the effectiveness of fisheries management in the coastal fisheries of Bangladesh. The success of the Food and Agriculture Organization's Code of Conduct for Responsible Fisheries (CCRF) management depend heavily on compliance with management regulations. Improvement in the compliance is a major determinant for the application of the code at the local level. Responsible fisheries management cannot be achieved without strategies for improving the compliance with regulations in the fishery. Examining ways to promote compliance with management regulations in the fishery is thus a crucial need for sustainable management of the coastal resources.

Marine fisheries of Bangladesh are managed through the centrally planned management system. However, in few cases has this worked well because of institutional problems and difficulties in ensuring compliance, especially over such diverse fisheries. In Bangladesh, the government regulates the fishery sector through licensing, area and gear restriction scheme and seasonal closures. However, in most of the cases, a significant level of non-compliance with regulations is observed in the fisheries of Bangladesh (Rouf and Jensen 2001). As a result, many species are now vulnerable, threatened, endangered and becoming extinct. From a management perspective, it is important to investigate the causes of non-compliance and explore policies for encouraging or securing compliance. One of the prerequisites for a sound management system is to measure the extent and patterns of non-compliance and to explore ways to secure compliance. This will help to identify the gaps in the knowledge on fisheries regulations and fisher's response to regulation (Kuperan, 1993). The present study is an attempt to contribute in this aspect.

In general, an individual's compliance is influenced by deterrence and, intrinsic and extrinsic factors (Kuperan 1992). Deterrence factors include those factors that affect individual vessel owner or boat operator's motivation for maximizing profit. The intrinsic factors refer to the individual's moral obligation to obey a law or regulation, which consists of the two components such as the individual moral understanding and the level of legitimacy the individual accords to the regulation, and the regulatory institution. The extrinsic factors cover the individual's social standing in the community. From a management perspective, factors responsible for non-compliance need to be isolated and understood for designing policies for securing compliance. Also, how compliance is secured in the context of high poverty levels is important for designing resource management programs. Unfortunately, very little research work has been conducted in this field. The present study is an attempt to explain the nature and magnitude of non-compliance of the mesh size regulations and to examine the factors responsible for the non-compliance behavior of fishers. It will be an important step for formulating improved fishery regulatory programs. Compliance studies are also useful for the evaluation of the success of a fisheries management program and for the design of effective management institutions.

This paper is organized in six sections. Section two gives an overview of the marine fisheries of Bangladesh, its regulation and enforcement program. Section three discusses

the data and methodology. Section four presents the results of the study. The issues such as fishers' views about the rules and regulations and the recommendations from the fishers' perspective to improve the compliance level is discussed in the fifth section. The conclusion is presented in the final section.

## Marine fisheries of Bangladesh

Bangladesh is a subtropical country situated at the apex of the Bay of Bengal with a vast coastal plain with 710 km of coastline. Marine waters extend over 166,000 $km^2$ of the sea area, following the 1974 declaration of a 200 nautical mile Exclusive Economic Zone (EEZ) over which Bangladesh has the right to exploit and manage living and non-living aquatic resources. The coastal water of Bangladesh is very shallow with depth less than 10 meter covering 24,000 $km^2$. The self area down to about to 150 meter has been found suitable for trawling with few obstacles. Depth contour of artisanal fisheries has been extended up to 20-meter depth before and now have been further extended up to 40 meters. Marine fisheries of Bangladesh enjoy a very rich biodiversity. About 511 marine species including shrimps are available in the Bangladesh waters (Mazid 2002).

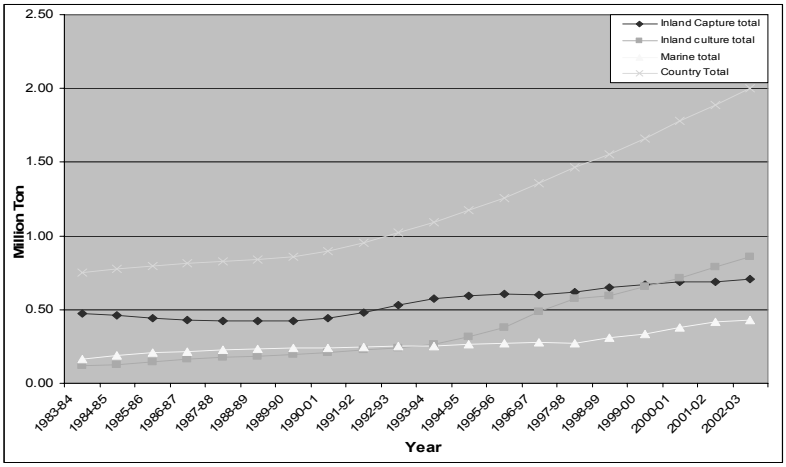


**Figure 1: Fish Production and Sector wise Contribution over the Years**

Fisheries sector assumes unique status in Bangladesh as it holds enormous potential for providing livelihoods to millions of rural poor and contributes significantly to national food and nutritional security. Currently about 1.28 million rural poor are fully dependant on fishing out of which over 0.51 million people fish in near shore waters and coastal creeks (DOF, 2003). The country produced about 1.99 million tons of fish including 0.43 million tons (about 22%) from marine sources (Figure 1) (FSYB, 2003). The marine fisheries sector also registered an overall growth of 6.14%. Unlike other food producing sectors, artisanal fishers who belong to one of the poorest section of the rural society, are considered as the major player. Apart from drawing their own livelihoods, they also produce the bulk of fish from capture fisheries sources which are consumed locally,

thereby contributing to national food and nutritional security. However, in spite of all these, the sector is confronted with a number of emerging issues and challenges. During the last two decades, there has been increasing pressure on the resources. These in turn have affected the lives of the resource users as well. Catch per unit fishing effort is going down and several species of marine shrimp and fish stocks are showing a declining trend. The continuation of the non-compliance with fishing rules and regulations and application of primitive fishing methods and the abnormally long delay in attending to the development needs of the marine fisheries and the coastal communities engaged in the fisheries, resulted in the present state with poor modernization program and poor income level of the communities and the great difficulties in pulling the small-scale fisheries and the coastal communities, out of the doldrums.

Currently, the catch from artisanal fisheries indicates that this is largely composed of post larvae and juveniles. This has a damaging effect on the stock. Consequently, there is desperate attempt on the part of the coastal fishers to earn their livelihoods through any possible short term means resulting in ever increasing fishing pressure, extensive use of destructive fishing methods and gears, and growing tendency to fish whatever available in the water - from larvae to juveniles. All such activities are causing further damage to the fragile coastal fishery resources. Due to rapid and unregulated expansion of shrimp aquaculture, a number of traders saw opportunity to earn quick money by employing large number of coastal poor for fishing shrimp seed from coastal waters. In the short term this activity was considered to be an employment provider but in the long term it has proved to have a devastating consequence on the resource. Currently there are about 0.45 million costal poor who operate a number of locally designed / modified gears (fine meshed push net and fixed bag nets) round the clock for catching shrimp larvae, thereby casing massive destruction of larvae and juveniles of non-target species. Industrial fishery operation on the other hand is also causing damage as it catches the parent stock during peak spawning season and also the post juveniles. Further, it is also observed that considerable amount of fish catch of industrial fishing fleet is discarded in the sea.

The development potential of marine fisheries sector has not yet been fully explored. The highest priority has always been accorded to the fresh water sector, which is reflected by the number of development projects implemented in Bangladesh after independence in 1971. Because of unplanned development of this sector, many of the marine fish species have already declined. As a result, coastal fishing communities are getting poorer and putting more and more damaging pressure on the resource through harmful fishing practices and through the use of prohibited gears. It is said that if proper management and development attention is given to the marine fisheries sector, it would be possible to achieve substantially increased production from marine fisheries sector.

**Major fishing gears and landings in the marine fisheries**

Costal fisheries of Bangladesh offer complex multi species and multi-gear fisheries. Any single fishing operation catches a number of species at different sizes and ages on the one

hand. On the other hand, members of the population of one species belonging to a single gear become available to different interactive fishing gear, in a sequential order (BOBP 1997). Therefore, for the success of any management program, all these fishing gears need to be brought under the rules and regulations which may create complexity in the implementation of the regulatory program.

**Table 2: Gear wise marine production in 2001 -2002**

| Fishing Gears | Number of Craft (Trawler/Boat) | No of Gears (Gear/Net) | Fish catch (MT) | Gear wise contribution (%) |
|---|---|---|---|---|
| Finfish Trawl net | 42 | - | 8,504 | 2.0 |
| Shrimp Trawl net | 45 | - | 19,450 | 4.5 |
| Gill Net / Drift Net | 25369 | 106316 | 230,853 | 53.4 |
| Set bag Net (ESBN & MSBN) | 12765 | 50083 | 133,305 | 30.9 |
| Long line fishing | 2641 | 24614 | 26,062 | 6.0 |
| Trammel net fishing | 1103 | 6925 | 8,483 | 2.0 |
| Other traditional gears | 2082 | 30643 | 5,251 | 1.2 |

Source: FSYB (2002-03)

Marine fisheries in Bangladesh are open access in nature and allow any craft-gear combination to exploit the resources from any part of the sea in the EEZ depending on the capabilities of certain gears and subject to rules and regulations. In Bangladesh, around 94 % of the marine total catch comes from the traditional gears such as gill net/driftnet, estuarine and marine set bag net, trammel nets, bottom long lines and beach seines, and the rest 6% comes from the commercial gears such as trawlers.

The gears which are of interest in this study are the Small Mesh Drift Net (SMD) and set bag nets (ESBN & MSBN). Table 2 shows that drift net and set bag net represents about 72 % of traditional gears that contributes around 84% of country's total marine fish catch. A brief description of these gears is given below.

**Gill Net/Drift Net**

Gill net is a rectangular piece of netting fixed to a headline, which is fitted with floats on top and with a foot rope weighted with stones or shells at the bottom. The gill net is either operated as set net, where the foot rope is heavily weighted and anchored at each end so that the net fishes at a fixed position, or as a drift net where the foot rope is lightly weighted or not weighted so that the nets drift with current. Among the drift nets, Small Mesh Drift (SMD) net, mainly targets the adult Hilsha fishes. Its mesh size is supposed to be 100 mm according to the law.

**Set Bag Net**

The behundi net or set bag net is a fixed type of gear. The net is shaped like an elongated tapering funnel. The mouth opening is rectangular and held open by two vertical bamboo poles. The net is oriented into the tidal stream and held in place by attachment to stakes driven into the sea bottom. It catches fish, which drift with the tidal current and passively swept into the net (and then unable to swim out against the velocity and/or force of the tidal current. Among the set bag net, Marine Set Bag Net (MSBN) is placed at the deep sea, while the Estuarine Set Bag Net (ESBN) is placed closer to the shore. MSBN mainly catch the species such as ribbon fish, phaissa, Bombay duck, black pomfret, silver pomfret, tiger shrimp, black tiger shrimp etc. On the other hand, ESBN mainly targets mixed juveniles and fingerlings of fin-fishes, shrimps, crabs, ribbonfish etc.

**Fisheries Regulations and Enforcement Program**

There are some important fishery related acts and ordinance in Bangladesh. These legislations cover all aspects of the fisheries sector from capture fisheries to fish marketing. These laws deal with overall fisheries i.e. inland and marine. The main aim of these laws is to protect and conserve the fisheries along with conducting research in the field of fish production, processing and marketing, quality control of fish and fish product etc. The regulation is of direct relevance in the present study, i.e. the mesh size regulation is contained in Marine Fisheries Ordinance, 1983 and the Marine Fisheries rules, 1983. According to the mesh size regulation of Marine Fisheries Ordinance 1983, the gears operating in the marine water shall use mesh sizes of the following dimension:

i) For shrimp trawl net (Boom) with low opening, the minimum mesh size shall be 45mm at the cod end.
ii) For fish trawl net, mesh size at the cod end shall be 60 mm.
iii) For large mesh drift net (LMD), the minimum mesh size shall be 200mm.
iv) For small mesh drift net (SMD), the minimum mesh size shall be 100 mm.
v) For set bag net (Behundi net), the minimum mesh size at the cod end shall be 30 mm.

The reason behind the mesh size regulations, which is of interest in the present study, is to reduce the conflict between different gear operators. It also bears conservation value because it is assumed that it will protect the juveniles and small fishes for future growth and sustenance of the stock. Sustainable growth and management of the fishery heavily depends on the enforcement of regulations by the management authorities and compliance by fishers. A maximum fine of Taka 100,000 or an imprisonment of three years or both can be imposed as a penalty for illegal activities as stipulated in the ordinance. In addition to that, courts may order for the forfeiture of the fishing vessels and gears in addition to any other penalty imposed. The penalties are mainly imposed to discourage the fishers from committing any offence.

The management of fishery is largely regulated by the *ad hoc* practices adopted by the government from time to time through executive orders and is subject to frequent change. The Marine Fisheries Ordinance 1983 authorized the government to appoint a director

and other Fisheries Officers for the purpose of implementing the provisions of the ordinance and the rules made there under. In accordance to that government appointed the Director- Marine Fisheries who and his office are mainly responsible for management, conservation, supervision and development of marine fisheries and responsible for issuing licenses in respect of all marine fishing in the Bangladesh territorial waters. He works directly under the supervision of Director General of the Directorate of Fisheries (DOF). Foreign marine fishing operations are restricted in Bangladesh EEZ waters except when a license is granted to them by the government. The Director may refuse, suspend or cancel any license in respect of a foreign fishing vessel on the ground of improper management, conservation, development etc. Although this enforcement structure is planned to implement the regulatory measures, however, due to the huge financial requirement, this structure is not fully functional in Bangladesh.

At present, the enforcement system for marine fisheries management in Bangladesh is carried out jointly by the relevant agencies or institutions such as marine fisheries office, district and thana (sub-district) fisheries office, coast guard, navy, police and other local administrative offices. The Navy, however, is in charge of enforcement of maritime defense of Bangladesh waters. Therefore the enforcement of fisheries regulations is not intensively carried out in Bangladesh.

## Methodology and Data Collection

The main objective of the study is to examine the non-compliance behavior of fishers with mesh size regulation. The study focuses on the compliance behavior of fishers of three major gears (SMD, ESBN and MSBN) with respect to mesh size regulations. This study is jointly implemented by WorldFish Center (Bangladesh Office) and 'Empowerment of Coastal Fishing Communities for Livelihood Security' (ECFC project) (GoB/UNDP/FAO project: BGD/97/017) based at Cox's Bazar. One of the targets of this study is to provide support to the ECFC project for its future action plan for marine fisheries management. ECFC project works in all the upazillas of Cox's Bazar with the small-scale poor fishers to get them organized and make an enabling environment so that they can participate in coastal resource management. Thus, it was felt necessary to select Cox's Bazar district for the present study to give necessary guideline and proper feed back to the project. A total of one hundred eighty samples considering sixty from each gears were collected for the study. As there is no list of license holder fishers in the study area, the intercept methods were used to collect the samples for the traditional gears.

A standardized questionnaire was used to collect the primary data from the respondent. Information was elicited on the socio-economic characteristics of fishers, boats and gears, fish landings, fishers' views and experience about the rules and regulations and the enforcement activities. Gears are used as the units of analysis. The sampling unit of this study is the captain of the boat who has a decision-making role while at sea. Six trained field staff conducted the face-to-face interview. Training was given to all field staff before they undertook the survey. The fishers were interviewed at the landing centers.

Enumerators were told to interview the fishers who have completed all the important activities such as landing and sorting the fish and the marketing arrangement with fish traders. Vernier scale and standard measurement scale were used to measure the mesh sizes of the gears. In addition to the questionnaire survey, six group discussions and two workshops with fishers, boat owners and other stakeholders were organized to validate the results of the survey and receive feed back and recommendation for improving the compliance level in fisheries.

Descriptive statistics such as frequency distribution, means, mode, percentages, and standard deviations are used to analyze the data. One way Analysis of Variance (ANOVA) procedure is used to measure the variability of catch and return for different mesh sizes.

**Sample Characteristics**

**Profiles of the respondent**

The average age of the fishers was around 40 years. There was not much difference between gear operators in terms of age. On an average, fishers of ESBN and MSBN (40 years old) were older than the fishers of SMD (39 years old). The ESBN fishers are found to be more experienced in fishing (21 years) followed by SMD (18 years) and MSBN (17 years). Illiteracy rate (around 83%) was found to be very high among the traditional gear operators. The illiteracy rate is high in ESBN (97%) followed by SMD (84%), MSBN (81%). Only 17% SMD, 3% ESBN and 19% MSBN operators are found to have primary and secondary education. The average household size of the gear operators is 8.3. The gear operator's primary occupation is fishing. Only 30% SMD, 32% ESBN and 27% MSBN operators had secondary occupations. Fishing contributes around 93% of their total family income.

**Profile of fleet, gear and catch**

On average the boat gross tonnage is higher for SMD (14 tons) than the MSBN (13 ton) and ESBN (1 ton). The average horsepower of engine used by SMD (49 HP) is more powerful than MSBN (40 HP) and ESBN (11 HP). The ESBN is mainly operated by non-mechanized boats. The study observed that only 15% (9 out of 60) of the ESBN operators have small engines with the average horsepower of 11. The number of crewmen in MSBN (17 persons) is higher than SMD (15 persons) and ESBN (3 persons). The length and width of SMD and LMD is 2470 meters and 35 meters respectively. Among the set bag nets, the MSBN is larger (41 m in length) than the ESBN (37 m in length). The length and width of the mouth of MSBN and ESBN is 14 m and 7 m, and 12 m and 6 m respectively.

On average, the peak season of the fishing operations is around 4 months. The peak season for SMD, ESBN and MSBN is 3 months (mid August to mid November), 4

months (mid June to mid October) and 6 months (mid August – mid February) respectively. Rest of the periods of the year is considered as lean period for these gears. The average number of trips in the peak and lean period for SMD, ESBN and MSBN was 12 and 10, 17 and 14, and 13 and 9 respectively. There is no significant difference between the gears on fishing days in the peak and lean seasons. The fishing days of the gears in peak and lean season were 9 days and 10 days respectively. Total catch and return per trip is higher in MSBN in the peak and lean seasons than the SMD and ESBN, except the return of SMD in peak season. The total catch and return of SMD in peak season is higher than the MSBN and ESBN. The total catch and return of MSBN in peak and lean season per trip was 3,463 kg and Tk. 87,675 and 2,400 kg and Tk 52,780 respectively. On the other hand for SMD, the total catch and return in peak and lean season per trip was 1,866 Kg and Tk 98,366 and 1,305 kg and Tk 48,212 respectively, while for ESBN, it was 357 kg and Tk. 7,335 and 194 kg and Tk. 3,745 respectively.

## Results and Discussions

### Level of compliance with the mesh size regulation

This section presents and discusses the results of the analysis undertaken to examine and explain the level of compliance of three major gears with mesh size regulation in Bangladesh. The analysis of the compliance level of the gears with mesh size regulation is presented first. An examination of the factors that are mainly influencing the uses of the lower mesh size on fishing is presented in the following section.

According to the Marine Fisheries Act (1983), the minimum mesh size requirement for SMD is 100 mm. Results showed that 100% of SMD users are violating the mesh size regulations (Table 3a). One full unit of SMD net is the combination of 32 pieces. It was observed that the SMD users usually use different meshed pieces in one complete unit of SMD. The mesh sizes are equal within pieces but vary across the pieces. It is found that in SMD, the mesh sizes of about 55.85 percent of the pieces are below 100 mm and the remaining 44.15 percent pieces mesh sizes are 100 mm or more than that.

**Table 3a: Level of compliance of Small Mesh Drift (SMD)**

| Gear Type | Minimum mesh Size requirement | No. of pieces in one unit | Mesh size distribution | | | Non-compliance (%) |
|---|---|---|---|---|---|---|
| | | | Mesh size (mm) | No. of pieces | % of pieces | |
| SMD | 100 mm | 32 | 75 | 7 | 20.70 | 100 |
| | | | 88 | 11 | 33.15 | |
| | | | 100 | 9 | 28.96 | |
| | | | 112 | 2 | 7.36 | |
| | | | 125 | 3 | 9.83 | |

Source: Survey data (2003)

**Table 3b: Level of compliance of ESBN and MSBN**

| Gear Type | Minimum mesh Size requirement | Mesh size distribution at the cod end | | | Noncompliance (%) |
|---|---|---|---|---|---|
| | | Mesh Size (mm) | No. of gears | % of gears | |
| ESBN | 30 mm | 2.54 | 14 | 23.00 | 100 |
| | | 5.00 | 38 | 63.00 | |
| | | 6.35 | 3 | 5.00 | |
| | | 10.00 | 3 | 5.00 | |
| | | 12.70 | 2 | 3.00 | |
| MSBN | 30 mm | 6.35 | 2 | 3.33 | 100 |
| | | 12.70 | 24 | 40.00 | |
| | | 15.00 | 9 | 15.00 | |
| | | 20.00 | 21 | 35.00 | |
| | | 25.00 | 4 | 6.67 | |

Source: Survey data (2003)

According to the Marine Fisheries Act (1983), the minimum mesh size requirement at the cod-end for ESBN and MSBN is 30 mm. The sample gears examined in this study, showed 100% non-compliance with the mesh size regulation of ESBN and MSBN (Table 3b). The maximum number of ESBN operators (63.00%) is using the mesh sizes of 5 mm. The minimum and maximum mesh sizes observed in the study for ESBN are 2.54 mm and 12.70 mm respectively. On the other hand, about 40 percent of the MSBN operators are using the mesh sizes of 12.70 mm. The minimum and maximum mesh sizes used by the MSBN operators are 6.35 mm and 25.00 mm respectively.

**Factors affecting non-compliance**

The results presented in the study showed the incidence of 100 percent non-compliance with mesh size regulation of the gears. One of the main objectives of this study was to find out the factors responsible for non-complying behavior of the fishers. However, in a situation where there is virtually no enforcement and most of the fishers are not aware of the rules and regulations, it is very difficult to establish any relationship between non-compliance behavior of the fishers and the factors responsible for non-compliance. Instead of doing that, this study explored the causes of using the lower mesh sizes based on the fishers' response. The investigation revealed that probability of getting higher catch and economic return, weak enforcement, the influence of others, limited livelihood opportunities as well as ignorance about the law are found to be mainly responsible for the non-compliance behavior of the fishers.

**Ignorance about the law**

Ignorance about the law has been identified as the major factor for non-compliance with regulations in Bangladesh. It was found that about 74 percent of the gear operators (SMD: 80 percent; ESBN: 70 percent; MSBN: 70 percent) have no knowledge about the mesh size regulation. They said that they had never heard of this type of regulation before this interview.

One of the possible reasons revealed from the study of the ignorance of the law is the weak institutional linkage of the fishers with the Department of Fisheries (DOF) and other related government and non-government organizations responsible for managing the fisheries. Around 90 of the gear operators (SMD: 92 percent; ESBN: 93 percent; MSBN: 85 percent) said that the government officers had never discussed with them about the fishery rules and regulations. All the operators confirmed the existence of the NGOs in the village where they stay. However, these NGO's are mainly working with them on micro-credit and they also did not mention to them about existence of fishing regulations. Among the gear operators around 63% of SMD, 70% of the ESBN and 20% of MSBN are the member of the fishers' organizations. However, they also noticed that only a few of these fishers' organizations have discussed about the mesh size regulation. These organizations mainly deal the financial and credit issues. In most of the cases, these groups were formed by the NGOs to operatioanlize the credit program. The study also observed that there is no role of the fishers in the decision making process of developing rules and regulations on fisheries. All the gear operators mentioned that their opinions were never considered in the preparation of the rules and regulations on fisheries.

**Probability of getting higher catches**

As a regulatory approach, mesh size regulation was introduced in the marine fisheries to protect the juveniles. However, the results presented in this study showed an absolute violation of this regulation. Fishers argue that they are using the lower mesh size gears because they think that lower mesh size would result in substantial gain in terms of enhanced fish catch and return. They said that the present alarming situation of the resources such as stock depletion, non-abundance of big sized fishes as a result declining fisheries forced them to use the lower meshed gears.

Lower meshed gears would get more catch. Is their any strong argument for this type of reasoning? An examination based on the observation of this study is presented in this section to validate this argument. The Single Factor Analysis of Variance (ANOVA) procedure is used to determine whether significant difference exists between two groups of fishers using same gears but different mesh sizes. The groups are differentiated based on the average mesh sizes. In case of SMD, the fishers using the lower meshed pieces are placed in one group while fishers using the higher mesh size pieces are placed in another group. For ESBN and MSBN, the fishers using equal to or below the modal mesh

size is in first group and the fishers using the mesh size above the modal class is in another group.

This analysis was done based on the catch data that the interviewer observed during data collection. The results showed that there is a difference on fish catch and return between two groups (Table 4a and 4b). Those using lower mesh sizes are catching higher amount of fish and getting more return, although, statistically significant difference exists only for ESBN on fish catch. The results reveal that a higher probability of getting good catch and more economic return may attract fisher to use the lower meshed fishing gears. However, based on these results, it is very difficult to draw any conclusion as the different mesh sizes used for comparison within the gears was very minimal.

**Table 4a: Catch and return of SMD using different mesh sizes**

| Gear type | No. of gears | Distribution of mesh sizes among the pieces | | | Fish Catch (Kg) | Gross revenue (Tk) |
|---|---|---|---|---|---|---|
| | | Mesh Size (mm) | No. of pieces | % | | |
| SMD | 36 | 75 | 10 | 30.70 | 866 | 50616 |
| | | 88 | 11 | 33.55 | | |
| | | 100 | 8 | 25.39 | | |
| | | 112 | 1 | 4.02 | | |
| | | 125 | 2 | 6.34 | | |
| | 24 | 75 | 2 | 5.71 | 751 | 39773 |
| | | 88 | 10 | 32.56 | | |
| | | 100 | 11 | 34.30 | | |
| | | 112 | 4 | 12.37 | | |
| | | 125 | 5 | 15.06 | | |
| F-value ($F_{1, 58}$) | | | | | 1.33 | 1.97 |

Source: Survey data (2003)

**Table 4b: Catch and return of ESBN & MSBN using different mesh sizes**

| Gear type | Mesh Size at the cod end (mm) | No of gear | Fish Catch (Kg) | Gross revenue (Tk) |
|---|---|---|---|---|
| ESBN | ≤ 5 | 52 | 228 | 4374 |
| | > 5 | 8 | 143 | 3708 |
| F-value ($F_{1, 58}$) | | | 2.77* | 0.50 |
| MSBN | ≤ 12.7 | 26 | 331.684 | 7600 |
| | > 12.7 | 34 | 316.01 | 6446 |
| F-value ($F_{1, 58}$) | | | 0.12 | 2.06 |

Source: Survey data (2003); * significant at 10 percent level

**Weak enforcement**

A higher probability of detection and conviction arising out of enforcement activities will discourage people from committing illegal activities (Sutinen and Anderson, 1985). Fishers are assumed to calculate rationally the opportunity costs of non-compliance with regulation. If a fisher observes that the costs are greater than the benefit he receives from the illegal activities he will refrain from doing the illegal activities. This can be easily done from outside through the monitoring and enforcement activity (Kuperan 1998). Sutinen and Anderson (1985) argued that when there is no enforcement or enforcement on fisheries law is imperfectly applied to certain fishery sector, it would affect the behavior of the fishing farms and management policy. This is the reason behind the large-scale violation of the fishing regulation in the marine fisheries of Bangladesh. Although laws exist lack of enforcement, leads to non-compliance with this regulation in the Bangladesh marine fisheries.

During the survey, most of the fishers said that weak enforcement is the main cause behind the non-compliance with the regulation. From their observations, they mentioned that they had seen the enforcement officials quite a few times (SMD operators: 4 times; ESBN operators: 2 times; MSBN operators: 5 times) at sea during the survey year. However, they had never inspected their boat and penalized for violating the regulation. The weak enforcement has led to the perception among most of the gear operators that if they violate law, the chances are that they will not be caught. They agree that the mesh size regulation is just a regulation but it is not being enforced.

**The influence of other factors**

Many authors are of the opinion that if other people violate the law, this will induce the individual fishers to violate as well (Susilowati 1998; Kuperan 1998). The influence of others is one of the main reasons pointed out by the fishers for using the lower mesh size. Fishers, from their observation said that most of the fishers where they catch fish are violating the mesh size regulation and they have never seen anybody faced any problem. This is one of the major problems of ensuring compliance in an open access fishery where most of the fishers are violating the law. The SMD, ESBN and MSBN operators' believe that 100% of the gear operators in their areas are violating the mesh size regulations. As other fishers are violating the rules and regulations, this encourages more and more of the fishers to violate as well. Kuperan (1992) argued that if many of the fishers are able to get away from detection and conviction, the overall compliance rate for a given population will decline and will threaten the success of the regulatory program.

**Limited livelihood opportunities/limited scope for alternative profession**

Limited livelihood opportunities are considered as one of the main reasons for violating the regulation. Results show that 100 percent of the gear operators' major occupation is

fishing. Among them, only around 30 percent of the operators have secondary occupations. The secondary occupations are mainly crop farming, poultry and duck farming, livestock rearing, fish selling and processing, net/gear making, daily labor etc. In case of fishers having the secondary occupation, fishing contributes over 90 percent of their total income, while the others livelihood are totally dependent on fishing. The fishers have responded that the greater dependence on fishery motivates them to catch as much as they can without any concern for complying with conservation and management regulations. Many of the fishers argued that without creating scope for alternative livelihood, it is very unfair to impose any regulation.

**The way forward**

In practice, non-compliance with fishery rules and regulations is very high in Bangladesh. In theory, this situation can be improved by improving the current enforcement system. However, developing a strong enforcement institution is a costly activity and is very difficult to operationalize in a country like Bangladesh. The outcome of non-compliance with regulation is overfishing and stock depletion. Despite several negative issues, the present study attempted to find out some possible solutions through group discussion, workshop and interview to address the problems in fisheries and improve the compliance level for better management of the resources. During the discussion and interview, these issues were raised and discussed with the fishers. It was observed during the survey that fishers' view about the mesh size regulations is quite positive. Almost all the respondents agreed that the government has done the right thing by making this type of regulation. They believe that the mesh size regulation is important to conserve and protect the fishery resources and it would bring long-term benefit for the fishers. The positive attitude of the fishers about the regulatory program implies that there is scope for better management of the resources.

In a multi gear and multi species fishery, violation of the regulation by any particular gear will not only affect the catch of that gear but also affect the other gears. During the group discussion and interview, all these three gear operators noticed some drawbacks of the mesh size regulation. They said that present regulation only focused on some gears but there are other gears which are destructive and used by the fishers frequently, which need to be brought under the mesh size regulation. Moreover, they suggested that government should take steps to increase the awareness level of the fishers. Specific attention must be given for developing awareness, education and training about rules and regulation.

The ESBN operator mainly targets the fish species available in the shallow water. The minimum mesh size requirement of the set bag net is 30 mm according to the marine fisheries ordinance. The study observed that the ESBN operators are using the mesh sizes ranges between 5 –12.5 mm and this is disastrous for artisanal fishery. Some ESBN fishers have talked against this minimum mesh size requirement. They argued that the minimum mesh size requirement of 30 mm is not appropriate to catch some of the target species of ESBN, e.g. estuarine small shrimp. They have suggested that the existing

regulation needs some reevaluation considering this biological condition of the fish species. Hansen and Mustafa (1992) also supported this type of argument. They showed that the increased mesh size of ESBN would result in no catch as this gear mainly targeted the small fishes. In this view research should seek to investigate or re-evaluate the minimum mesh size requirement considering the biological nature of the species.

The fishers from all the gears suggest that some indirect mechanisms can be effective to force the violators to comply with mesh size regulations. They said that strong enforcement is needed not only in the sea where they catch fish but also in the market place where they sell and buy small sizes fishes and in the factories where these types of small mesh sizes nets are produced. If there is no market for small sized fishes, they will not catch those. Before creating scope for alternative livelihood opportunities, regulatory measures are considered unfair by most of the traditional gear operators. They have suggested that training for new livelihood opportunities, credit support mechanism may direct them into some positive ways to find some alternative income and improve their socio economic condition.

Fishers would tend to choose activities that bring them more benefit than losses. The present study showed that fishers are violating the mesh size regulation to get more catch and income. Kuperan (1998) argued that this profit motive behaviour of the fishers can be successfully manipulated from outside by increasing the cost through enforcement and monitoring program. However, to develop a strong enforcement institution is a costly activity. Fishery managers and policy makers should explore the alternative approach to manage the fisheries. One of such approach is co-management. From a policy perceptive, the advantage of the co-management approach is that fishers feel obligated and attached to this type of organization as they participate in the management program to prepare the rules and regulations. A close cooperation between the fishers and the government is likely to increase the legitimacy of the regulation and also the management authority. The fishers suggested during the discussion and workshop that if the government, boat owner and the fishers work closely, the present situation of the resource depletion would be improved. This type of co-operation would decrease the enforcement costs of the government, as the community will take some responsibility.

## Conclusion

The results presented in this study shows that all the fishers are violating the mesh size regulation and weak enforcement, probability of getting higher catch and return, ignorance about the law, the influence of the environment and limited scope for alternative livelihood opportunities are found to be the main reasons for the violation of the regulation. Such a situation is accelerating overfishing in the marine fisheries. The economic impact of the non compliance with mesh size regulation is very detrimental. The resource as well as the national economy will benefit greatly from better enforcement programs. However, it would be very difficult to make benefits available to the poor artisanal fishers who are solely dependent on fishing for their livelihoods and

particularly those who would be displaced by such regulatory measures. This problem is more severe because most of the artisanal fishers do not have any other skill other than fishing (Khan 1999). Lack of access to capital, institutional inadequacies, and a lack of skill and capacity keeps the fishers away from any alternative livelihoods. From the policy perspective, the resource can be better managed and the compliance level can be improved if the fisherfolk have other means of generating income to manage their losses for the regulatory measures. Government and other non-governmental agencies can play the role to create scope for alternative income generating activities through credit support mechanism and training.

The study observed that probability of detection and conviction for violating the regulation is absolutely zero in Bangladesh fisheries. The high incidence of non-compliance with regulation and zero conviction supports this observation. From a policy perspective, a higher probability of detection and conviction will discourage people from undertaking illegal activities. Thus the government should pay attention to enhance enforcement resources and monitoring programs. Penalties or fines can be imposed to make people comply with the rules and regulation. Awareness creating activities about the rules and regulations should be increased in the coastal areas to inform the fishers about the tangible benefits of the regulatory program. Fisheries authorities should also explore alternative management approach to improve the compliance level and mange the fisheries. One such approach is the co-management where the fishers will work closely with the government and other stakeholders to manage the fisheries. Due to the transparency of this approach, it is expected that in co-management systems, overall compliance level would improve and the enforcement costs would decline (Kuperan et. al 2006, Kuperan et. al 2003, Nerissa et. al 2008)

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