Status of hilasa (Tenualosa ilisha) management in the Bay of Bengal
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An assessment of population risk and data gaps for more effective regional management

David A. Milton
Email: david.milton@csiro.au

Report to FAO Bay of Bengal Large Marine Ecosystem Project
15 February 2010
Executive summary

This report summarises my assessment of the country status papers on hilsa fisheries that were presented at the BOBP – IGO 2nd Regional Consultation held at the Peninsula Hotel in Chittagong, Bangladesh from 7 – 8th February 2010. The three country reports are included as Annexures 2 - 4. A brief assessment of the status of hilsa management in each country is then made. The assessment includes brief recommendations of potential follow-up activities that could enhance management. The status of knowledge on hilsa and the sophistication of fisheries management for hilsa varied greatly between countries. Bangladesh has benefitted greatly from a number of externally-funded projects that have helped the government implement a number of management measures. These appear to be having a positive effect on the catch rates in the artisanal fisheries for hilsa. However, the several stock assessments of hilsa all indicate that hilsa are over-exploited in Bangladesh. This excessive fishing effort has not been addressed. In India, hilsa fisheries management is a state rather than a national responsibility. The Indian status report indicates that there are currently no controls on hilsa fishing effort in West Bengal. A few legislated seasonal fishing closures may protect part of the hilsa population from fishing, but the report does not indicate on their level of enforcement. Limited assessment of the optimal production in India indicates that the hilsa populations are probably overfished. Much less information is available from Myanmar. The country status report indicates that reliable data are available on fishing gears, vessels and overall export catch. No data were included on domestic catch and no scientific studies on hilsa or its habitats were reported.

Following the assessment of the country status reports, I undertake a risk assessment of hilsa in each country with Productivity Susceptibility Analysis (PSA). This analysis examined the trend in hilsa productivity and susceptibility attributes in each country with a view to providing insight into the threats hilsa face. The results indicate that there is limited data on the productivity of hilsa in either India or Myanmar. The trends in productivity attributes of hilsa in Bangladesh are better known and the results highlight worrying declines in several attributes. Susceptibility attributes are better known in India and Bangladesh. The analysis indicated that hilsa populations in India are more susceptible to threats than in Bangladesh. Almost no data are available on susceptibility attributes of hilsa in Myanmar. The increasing susceptibility trend in India, the declining productivity in Bangladesh and an absence of any data in Myanmar suggest that ecosystem services are under threat in the region. I include a summary of a new approach recently developed within CSIRO in Australia to assess ecological risk within a structured framework (Annexure 5). This approach is similar to other approaches available to assess risks to ecosystems but has the advantage of using a highly visual approach to conceptualising the focal ecosystem. Conceptual models are developed in workshops of stakeholders and appear to have high levels of engagement. I recommend that BOBLME consider incorporating this or a similar, structured approach to identify the major ecological risks in the Bay of Bengal. This will highlight those ecosystems services and habitats at risk within an objective comprehensive framework. Outputs from this approach are easily mapped or displayed with simple conceptual diagrams. This makes the outputs easily visualised and better understood by most stakeholders. A better understanding by most stakeholders should lead to better-focused project activities that engage national governments and other stakeholders.

I make a number of recommendations for activities to collect additional data in each country that are currently lacking. These data will better inform the development of both national and regional hilsa management strategies.
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Acronyms used

ACIAR      Australian Centre for International Agricultural Research
BFRI      Bangladesh Fisheries Research Institute
BOBLME   Bay of Bengal Large Marine Ecosystem Project
BOBP-IGO Bay of Bengal Programme – Inter Governmental Organisation
CPUE      Catch per Unit Effort
CSIRO    Commonwealth Scientific and Industrial Research Organisation
DFID      Department for International Development
FAO       Food and Agriculture Organisation
FFP       Fourth Fisheries Project
FRI       Fisheries Research Institute
GIS       Geographic Information System
MSY       Maximum Sustainable Yield
PSA       Productivity Susceptibility Analysis
TCP       Total Catchable Potential
1. Background

This report follows from my attendance of the Bay of Bengal Program (BOBP-IGO) 2nd Regional consultation on preparation of management plan for hilsa fisheries held in Chittagong, Bangladesh from 7-8 February 2010. The meeting was attended by representatives of three countries with hilsa fisheries in the Bay of Bengal - India, Bangladesh and Myanmar. The aims of the meeting were (1) for each country to develop a roadmap of their plans to each make a national hilsa fishery management plan and (2) develop a framework for more coordinated regional management of hilsa fisheries.

This report provides a summary of recent hilsa fisheries research in Bangladesh, summarises the status reports presented at the consultation by each country (Annexures 2-4), undertakes a Productivity Susceptibility Analysis (PSA) for hilsa in each country and identifies knowledge gaps and institutional weaknesses that will impact on successful implementation of an effective regional hilsa management plan. Options for actions that BOBLME may consider to reduce the risks to implementation of a regional plan are discussed. Brief details of an alternative ecosystem asset assessment method developed by CSIRO in Australia are provided in Annexure 5.

2. Summary of recent hilsa fisheries research in Bangladesh undertaken since 1996 with particular reference to the ACIAR-funded hilsa fisheries research project

Staff from Commonwealth Scientific and Industrial Research Organisation (CSIRO) Marine and atmospheric research and the Bangladesh Fisheries Research Institute (BFRI) undertook a collaborative research project on hilsa from 1996 to 2001. The main aims of the project were (1) to undertake studies of hilsa biology relevant to managing the fishery and (2) develop a draft hilsa fishery management plan. The biological studies focussed on three aspects of hilsa life history - population structure within Bangladesh and throughout the range, age and growth and reproductive biology. In my presentation to the BOBP IGO 2nd consultation I summarised the results of the project and more recent studies on hilsa in Bangladesh (Appendix I).

2.1. Hilsa population structure

The project examined the population structure of hilsa in Bangladesh by three methods that each provided complementary data on population structure. Previous studies had used either genetics or morphology of fish from a few sites to identify multiple hilsa populations in Bangladesh. The Australian Centre for International Agricultural Research (ACIAR) project examined a much larger number of samples from a broad range of sites throughout the country with both methods. Several sites were also sampled on multiple occasions to assess the temporal stability of the population structuring identified. In addition, samples of hilsa from the Irrawaddy River in Myanmar, Kuwait and Northern Sumatra were analysed. When samples from this broad range of sites were analysed, any weak population structure identified within Bangladesh was shown to be similar to that among samples from throughout the Bay of Bengal. Samples from the Persian Gulf were the only region found to be genetically distinct (Salini et al., 2004).

Previously studies had shown that the morphology of hilsa varied within Bangladesh and adjacent India. Our project (Salini et al., 2004) showed that this regional morphological variation was similar to that found within a single site and was probably not related to population structuring. Our third method examined the chemical composition of the otolith cores (spawning grounds) of the same fish that were examined for genetic and morphological variation. These studies (Milton and Chenery 2001) showed similar within and between site variation to that found by the
genetics and morphology. The studies of otolith chemical composition were consistent with the results from the genetic and morphological studies. All three methods indicated that the hilsa populations in the Bay of Bengal should be treated and managed as a single population.

2.2. Age and growth

Previous studies of hilsa age and growth had examined length cohorts or annual rings identified in scales and otoliths. The range of ages and growth rates varied widely among studies, with some suggesting hilsa lived at least nine years. The scientists in the ACIAR project counted daily growth increments in hilsa otoliths. The data showed that hilsa lived for a maximum of three years and that the majority of the population was less than two years old. This fast growth rate helped explain ability of hilsa to sustain the known high exploitation rate for so long. However, it suggested that the fishery was reducing the numbers of two and three year old fish to low levels, such that over 90% of the commercial catch was less than 1+ year olds in 1999.

2.3. Reproduction

The spawning grounds of hilsa in Bangladesh were not well defined before the ACIAR project. Spawning fish had been found in the lower Meghna estuary and around Aricha Ghat North of Dhaka. Project scientists examined the reproductive biology of hilsa from throughout Bangladesh, including several coastal sites. The project showed that hilsa matured at one year of age. Fish spawned throughout the country year round in low or zero salinity waters. There were two periods of more intense spawning that coincided with the main monsoon (July-November) and the spring warming (February-May). Spawning occurred in coastal areas and in the northern Bay of Bengal during the monsoon season when river flow was greatest. Fish fecundity was high (800 000-10 000 000 eggs) but declining in many areas. This reduction in fecundity was shown to be impacting on hilsa productivity. Other unique aspects of hilsa reproductive biology included the sex ratio. This was found to be biased towards females in larger and older fish. Almost all two and three year old fish were females and their fecundity was related to size. Thus, the reductions in the numbers of older age classes were compounding the effect of the fishery on the breeding potential. Regulations were needed to allow more, older fish to spawn.

Other species of Tenualosa were shown to be sequential hermaphrodites. The ACIAR project found that although the smaller sized hilsa were almost all males, a few small functionally female fish were present. No hilsa with transitional gonads were found among the >2 000 fish examined histologically. Thus, the sex ratio bias appears to be related to differential survival of males and females. Almost all males live less than two years.

2.4. Project management recommendations

The main management recommendations that arose from the project were summarised below:

- Reduce catch of immature fish by banning mesh sizes < 10 cm ✔
- Establish seasonally closed protected areas for spawners and jatka ✔
- Improve registration of inland and marine fishing vessels and gear ✔
- Improve system of catch recording ?

All the recommendations appear to have been taken up and incorporated in the current Bangladesh hilsa management plan. The possible exception may be the recommendation to improve catch recording within the country. I do not have the capacity to assess this without additional field visits.

2.5. Recent biological studies of hilsa in Bangladesh

Since the completion of the ACIAR-funded project in 2001, several new studies on hilsa have been undertaken in Bangladesh. Two of these (Amin et al., 2002; 2008) were written by project staff. These assessed the status of the hilsa fishery based on an analysis of the large volume of length
frequency data collected during the project. Both studies demonstrated that hilsa were over-exploited in Bangladesh. Amin et al., 2002 made recommendations that fishing mortality needed to be reduced by 25% to be sustainable.

Other recent studies of hilsa in Bangladesh have focussed on the genetic population structure. Both analysed tissue samples from a small number of sites with newer more sensitive methods than those used by Salini et al., 2004. Both found some genetic subdivision within Bangladesh, but failed to assess this variation in the broader context of the Bay of Bengal (Appendix I).

2.6. Economic assessment of the hilsa fishery in Bangladesh

An economist from the Bangladesh Department of Fisheries undertook an economic assessment of the fishery in 2006. This assessment (Mome, 2007) found some dramatic and worrying data on the economics of the fishery. She found that the overall fishery was barely economically viable and most fishers were not or barely making a profit. In order to maximise the overall profit from the fishery, fishing effort needed to be reduces by 33%. Unlike the biological assessments by Amin et al., 2002; 2008 and Mome, 2007 found that maximum sustainable biological yield occurred at 60% of current fishing effort. In order to achieve this reduction, she recommended reducing the more efficient motorised vessels from current estimates of 25 000 vessels to as few as 8 000. This would be expected to have the effect of increasing individual vessel catch rates from the current average 9 tonnes per year to at least 24 tonnes per year. Profits would then be expected to rise from 7% about 68% of revenue.

This approach took a whole of fishery perspective of the economic efficiency. In other countries where improvements in economic efficiency are desirable, fishers pay a resource rent for their access to the fishery. Thus, fishers who want to remain in the fishery usually compensate those that leave. In Bangladesh, the hilsa fishery is currently an open-access fishery and so if maximising the overall profit is a desirable management objective, it’s unclear how vessel numbers could be reduced in an equitable way that compensates those fishers who have to leave the fishery.

3. Brief assessment of the status of hilsa management in Bay of Bengal

The status reports submitted by the three countries, India, Bangladesh and Myanmar enclosed above for the BOBP 2nd Regional consultation workshop vary widely in their scope, details, scientific insight and potential for active management of the fishery in each country. I will provide a brief summary of the most relevant sections of each document and identify the measures each country uses or identifies as management measures for their hilsa fishery. I will then provide a brief assessment of the major knowledge and institutional constraints in providing effective management of hilsa in each country.

3.1. Bangladesh

In reading the status report from Bangladesh by Rahman, Emran and Islam, it is clear that Bangladesh have a much greater understanding of the life cycle of hilsa in Bangladesh than either India or Myanmar. The Bangladesh Department of Fisheries (DoF) have made several practical management interventions that seem to have had a positive effect on the total production of hilsa reported in Bangladesh. The Fisheries Research Institute (FRI) scientists involved in hilsa research have made major contributions to this understanding and the DoF have implemented these measures. The Department for international Development (DFID) Fourth Fisheries Project (FFP) appears to have made a demonstrable contribution to improved management and sustainability of hilsa in Bangladesh. It built on the improved biological understanding gained during the Australian Centre for International Agricultural Research (ACIAR) funded study from 1996 to 2001. The DoF have legislated a ban on catching, transporting and sale of juvenile hilsa (jatka) from November to
May each year. The FFP have helped implement this jatka ban and the spawning closures by relevant Bangladesh government institutions. The ban and closures were enforced well during the FFP project period and are still being enforced at present (B. Collis pers. comm. 15 Feb 2010). Thus, Bangladesh has a much clearer management path than either India or Myanmar and the measures appear to be having improved the catch rates of fishers.

Bangladesh scientists have also undertaken several stock assessments of hilsa in Bangladesh based on analysis of large samples of fish length frequencies. Although only one of these analyses adjusted the data for gill net selectivity, the results were remarkably consistent (Table 1). This approach is not rigorous and thus the estimated exploitation rates are highly uncertain and would not form the basis of management changes in most situations. However, alternative more rigorous stock assessment approaches require an index of hilsa abundance. These data are not available and are unlikely to be reliably collected in any of the countries. Thus, the stock assessments of Bangladesh scientists probably provide the only realistic indicators of hilsa population status in Bangladesh.

### Table 1. Stock assessments undertaken on hilsa in Bangladesh in the last 13 years

<table>
<thead>
<tr>
<th>Study period</th>
<th>Adjustment for selectivity</th>
<th>Fishing mortality</th>
<th>Exploitation rate</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>Yes</td>
<td>1.32-1.38</td>
<td>0.57-0.58</td>
<td>Rahman and Cowx 2008</td>
</tr>
<tr>
<td>1997-1999</td>
<td>Yes</td>
<td>2.01-2.49</td>
<td>0.59-0.64</td>
<td>Amin et al., 2004</td>
</tr>
<tr>
<td>1999</td>
<td>Yes</td>
<td>2.49</td>
<td>0.59</td>
<td>Amin et al., 2002</td>
</tr>
<tr>
<td>2002</td>
<td>Yes</td>
<td>2.16</td>
<td>0.61</td>
<td>Haldar and Amin 2005</td>
</tr>
<tr>
<td>2003</td>
<td>Yes</td>
<td>1.92</td>
<td>0.61</td>
<td>Amin et al., 2008</td>
</tr>
</tbody>
</table>

They all point to the hilsa population in Bangladesh being overexploited and that fishing mortality needs to be reduced by at least 10% if maximizing biological yield is the overall objective. An alternate analysis that optimised the economic yield of the fishery suggests that the hilsa fishing fleet needs to be reduced to as little as 33% of the existing levels (Mome, 2007). None of these stock assessments have led to a change in DoF policy or management of fishing effort in Bangladesh. Controlling fishing effort would require a major change in DoF practices and thus seems to be unlikely to be effective at increasing sustainability. Further assessment and expansion of the current approach of restricting catch during critical spawning periods and spatial closures for jatka would be more likely to succeed.

#### 3.1.1. Recommendations for further studies

If it is agreed that a direct reduction in the number of vessels fishing for hilsa is impractical, then the best option would be to try and understand the proportion of hilsa that need to escape that will allow sufficient spawners to breed for a sustainable fishery in Bangladesh.

In order to estimate this proportion, collecting the following data is suggested:

1. Undertake a GIS-based analysis of the catch distribution in the marine, estuarine and freshwater reaches of the main rivers in order to optimise temporal and spatial closures to reduce total catch by the desired amount
   The studies in Table 1 suggest Maximum Sustainable Yield (MSY) is about 160 000 tonnes, which is about half of the most recently reported landings (2008) in Appendix II. This would be most easily done with interviews of fishers stratified by region, fishing sector and habitat type. This could also obtain estimates of daily catch rates, mesh sizes used and some better economic statistics on the returns from each sector.

2. Obtain fishery-independent estimates of hilsa biomass, possibly with help from Indian survey vessels in marine waters
3. Undertake better and more effective publicity and stakeholder consultation on the objectives of the closures

Rahman et al., 2008 also highlight pollution as a source of concern in the Meghna River. Some quantitative water quality data on the extent of the problem in relation to the spawning and nursery grounds of hilsa would help assess its relative importance and identify options to reduce it. This could be linked with the GIS developed above to generate a comprehensive spatial management tool that would help inform DoF.

Another way to increase the escapement of hilsa is to change the mesh size and the length of gillnet able to be used in the fishery. At present a range of mesh sizes from 7-12.5 cm are used by different sectors and in different seasons. Fishers may use more than one mesh size indifferent seasons as they target the most common size class of fish present. The best way to optimise mesh size and/or net length would be through a bio-economic analysis. This can account for minimum daily economic catch per fisher, maximise the overall profitability of the fishery while accounting for sustainability by estimating the total length of net the hilsa population can sustain.

3.2. India

Unlike Bangladesh, the report on the status of hilsa in India (Appendix III) contains a summary of much fewer studies of Indian hilsa populations in West Bengal. In India, the hilsa fishery is managed by the state, rather than by the central government. This is likely to mean that there is less capacity and resources to actively implement management measures. This situation will constrain what management options are likely to be implemented in India.

The report (Appendix III) states that there is currently no control on fishing effort, that small size mesh nets are widely used to catch jatka and similar-sized juveniles of many species. Mitra et al., 1998 (not in reference list) undertook an assessment of the trend in hilsa catch in the Hoogly River. They suggested that the MSY for hilsa would be exceeded by 2000. Nath et al., 2004 (not in reference list) undertook an assessment of the “Total Catchable Potential” (TCP) of the Hoogly River system and some of the main species, including hilsa. They estimated that the TCP for hilsa was 3 507.6 tonnes and this has already been exceeded. Thus, the limited studies on Indian hilsa suggest that hilsa are almost certainly over exploited in India. The report also states that there are annual closures in the Indian marine waters from 15 April to 15 June. However, it is unclear how this closure relates to the areas of the main hilsa catch or to the main spawning period of Indian hilsa.

The estimated catch of jatka in West Bengal appears to be much lower than that estimated for Bangladesh (60-80 tonnes/year (Appendix III) vs 19 000 tonnes in early 2000s in Bangladesh (Amin et al., 2008). There are few details on how the jatka figures were estimated in West Bengal, nor are the main nursery areas identified. There also does not appear to be any data on the main hilsa spawning grounds in India. Thus, if India was to use similar management measures to improve sustainability as Bangladesh, then major spawning and nursery areas need to be identified and mapped. This could allow similar spatial and temporal closures to be defined and gazetted.

Appendix III also identifies pollution and poor environmental flows as being serious problems that may be affecting hilsa and other riverine and estuarine fishes in West Bengal. The extent of this problem and its severity could be easily assessed. This could then be either taken into account in any assessment of the sustainable catch in India, or actions taken to improve water quality.

The proposed management plan (Appendix III) identifies many valuable management actions. However, as Dr Yadava pointed out in the meeting, the proposed timeframes for the majority of actions were extremely optimistic. Many of these proposed actions could have been implemented before, so the plan must be viewed with some scepticism. One management measure proposed that would be very effective if implemented is the proposal to buy back some vessels. If this action does
remove vessels from the fishery, that could be one of the most effective measures to reduce fishing effort.

3.2.1. Recommendations for further studies
Given the poorer understanding of the ecology, fishery and population status of hilsa in India, I think there would be benefit in undertaking some biological studies and possibly attempting a stock assessment, if sufficient reliable data were available. My suggested studies would include:

1. Identify and map the spatial and temporal extent of major spawning and fishing grounds
2. Identify and map the spatial and temporal extent of major juvenile nursery areas
3. Quantify the spatial extent and severity of pollution and its impacts on hilsa habitats
4. Verify age structure of hilsa populations in India and measure the size structure of the commercial catch
5. Assess the reliability of commercial catch statistics and undertake a stock assessment if feasible.

I also think a better understanding of the social and economic structure of the hilsa fishery in India would help inform the state authorities in West Bengal. It would help in understanding the scale of impacts from any future restrictions on the fishery. Stakeholder consultations and publicity on the objectives of any management plan could also be included.

3.3. Myanmar
The report on the status of hilsa in Myanmar (Appendix IV) demonstrates that there is limited information on the hilsa fishery in Myanmar. There also appears to have been no scientific studies of hilsa in Myanmar. Thus the knowledge base and technical resources available to undertake management of the fishery in Myanmar appear limited. This means that there is probably much less capacity within the Myanmar Fisheries Department to implement studies to inform any management plan or to formulate viable management options. This limits the scope of any management plan and what can be realistically feasible in Myanmar.

3.3.1. Recommendations for further studies
I would advise that a visit by technical staff needs to be undertaken to provide an independent assessment of the fisheries department capacity and the state of hilsa catch statistics in Myanmar. This could be linked to the preparation of the proposed status document that each country needs to prepare for the BOBP-IGO 3rd Regional hilsa consultative meeting planned in February 2011. Additional catch data and any biological data collected during that visit could be included in the status paper. An assessment of institutional capacity and possible training needs could also be undertaken during the visit.

The report (Appendix IV) identifies a spatial closure in coastal marine waters from June to August each year. This would reduce fishing effort on hilsa in Myanmar if compliance is enforced. In addition, Myanmar appears to have set up a registration scheme for all small craft. If this has occurred, this process could also be transferred to both Bangladesh and India, where no registration scheme exists. The export statistics reported in Appendix IV appear to be the best source of data on total catch available in Myanmar. Additional data on the proportion of hilsa sold locally would allow these data to be scaled to provide a more accurate estimate of total catch. If the small vessel registration scheme includes information on gears, then some idea of total effort may be able to be estimated. Until these data are investigated, it is difficult to comment on the status of the hilsa fishery in Myanmar.
4. Productivity Susceptibility Analysis (PSA) of hilsa population and habitat risk

The reports outlining the status of the hilsa fisheries in the three countries show that accurate data on the status of hilsa populations are lacking (Annexures 2-4). The fishery is undertaken by a large number of artisanal and subsistence fishers in each country. Obtaining accurate catch rate data to provide an index of abundance is not feasible. Thus, less data intensive approaches need to be applied to inform about the sources of risk that the fishery faces. One approach available to objectively inform the BOBLME Project is to identify and assess the relative importance of different threats to the hilsa population in the Bay of Bengal by undertaking a risk assessment. In its broadest sense, a risk assessment will identify and consider all threats to the species of interest-hilsa. These threats come from all possible sources, including habitat loss and degradation, pollution, fishing, environmental variability and climate change.

There are many risk assessment methods available for fisheries, but methods vary in the rigour of the assessment, the quantity of data required to undertake the assessment and the types or risk being assessed. Fisheries stock assessment is one form of risk analysis that only considers the risk to the population from fishing. In most industrial marine fisheries, this risk is usually much greater than other threats. A stock assessment usually requires a time series of an index of abundance such as fishery catch rates (Catch per Unit Effort (CPUE)). Less data-intensive approaches such as those of Zhou and Griffiths 2008 and Zhou et al., 2009 allow quantification of absolute risk of fishing to a population without the need for several years of population abundance data. This method requires a broad understanding of the fishing grounds, species distribution, biomass (or density) and species life history. There may be the potential for this approach to be applied to hilsa in Bangladesh with available catch rate data. However, density or biomass data are almost completely lacking in India and Myanmar (Annexures 3 and 4).

A more realistic alternative approach is to undertake a Productivity Susceptibility Analysis (PSA). This risk assessment method measures the relative risk to a species or population (Stobutzki et al., 2001; 2002 and Milton, 2001). The method can include risks of habitat loss and degradation as well as fisheries, but may not be sensitive to changes in fishing impacts (Griffiths et al., 2006). Data required to undertake the PSA are more limited, thus making the approach more attractive for data-poor fisheries, such as hilsa in the Bay of Bengal.

4.1. PSA methods

The method involves an expert assessment of the productivity of the species and its susceptibility to the main threats identified within the range of hilsa (fishing, habitat loss and degradation and pollution). Details of the methods used to develop the PSA can be found in previous applications of the approach (Stobutzki et al., 2001a, b and Hobday et al., 2006; Griffiths et al., 2006). Here, I will undertake a PSA of the threats in each country in order to provide insight into the relative risk to hilsa populations in that country.

In previous applications, attributes of the productivity and susceptibility of each population were weighted as all attributes were not equally important to the susceptibility or recovery of a species (Stobutzki et al., 2001b and Milton, 2001). For this analysis, the susceptibility and productivity attributes of hilsa and their weighting will be the same for all countries and types of threat. Instead of a static analysis, I have attempted to assess the trend in the attributes. I hope that this will be more informative than a static assessment. Trends in attributes alluded to in the reports (Annexures 2-4) have been incorporated. Further enhancement of the PSA analysis undertaken here could include estimate of relevant life history parameters for hilsa populations in both India and Myanmar.

The susceptibility criteria chosen in this analysis are broader than those used in earlier applications. Hilsa is a migratory species and in Bangladesh, nursery areas are in different regions to the main
fishing grounds. In the absence of other data, I have assumed a similar situation exists in each country. Threats to the habitats and fishing on jatka need to be included in the types of threats examined.

4.2. PSA results

The results of the PSA analysis show that there is great uncertainty in the status of trends in the attributes from India and Myanmar (Table 2). River flow was the only attribute where I felt I had some confidence in predicting the trend. Even the trend in this attribute was uncertain. The results suggest that where we have some data, hilsa appear to be more susceptible in India. In Bangladesh, the population appears to be less capable of recovering from the effects of fishing than in other countries. However, there are no data on trends in the recovery attributes for either India or Myanmar. Thus, these results remain uncertain and require further data to be of greater use in identifying attributes on which to focus project activities.

Table 2. The weighting of attributes and their ranking (1=declining trend; 2=no trend; 3=increasing trend) in each country.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Weighting</th>
<th>India</th>
<th>Bangladesh</th>
<th>Myanmar</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Susceptibility</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adult habitat quality</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2*</td>
</tr>
<tr>
<td>Juvenile habitat quality</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2*</td>
</tr>
<tr>
<td>Life stages fished</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2*</td>
</tr>
<tr>
<td>River flows</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<td>Protected areas</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>2*</td>
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<td>Range</td>
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<td>2*</td>
<td>2</td>
<td>2*</td>
</tr>
<tr>
<td>Overall susceptibility</td>
<td></td>
<td>1.47</td>
<td>1.80</td>
<td>2</td>
</tr>
<tr>
<td><strong>Productivity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability of breeding</td>
<td>3</td>
<td>2*</td>
<td>2</td>
<td>2*</td>
</tr>
<tr>
<td>Mortality index</td>
<td>1</td>
<td>2*</td>
<td>1</td>
<td>2*</td>
</tr>
<tr>
<td>Age composition</td>
<td>2</td>
<td>2*</td>
<td>1</td>
<td>2*</td>
</tr>
<tr>
<td>Fecundity</td>
<td>3</td>
<td>2*</td>
<td>1</td>
<td>2*</td>
</tr>
<tr>
<td>Commercial catch rates</td>
<td>3</td>
<td>2*</td>
<td>1</td>
<td>2*</td>
</tr>
<tr>
<td>Growth rates</td>
<td>2</td>
<td>2*</td>
<td>2</td>
<td>2*</td>
</tr>
<tr>
<td>Overall recovery</td>
<td>2</td>
<td>1.36</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

An * next to a value indicates no data. No trend was assumed for attributes without data.

Many of the susceptibility attributes are new in the analysis above. The attributes on habitat quality attempt to capture concerns expressed in the Indian and Bangladeshi reports (Annexures 2. and 3). Life stages fished refers to the catching on jatka and the trends in its occurrence. We have data to suggest it is declining in Bangladesh. Hilsa is a migratory species that breeds in freshwater. There is concern about reduced river flows in both India and Bangladesh. For this reason, an attribute that captures this concern was included. Similarly, the increasing use of protected areas in Bangladesh as a method to reduce susceptibility was included as an attribute.
Figure 1. The overall susceptibility and recovery of hilsa in Bangladesh, India and Myanmar.

(The line represents equal values for both attributes. Larger values indicate more sustainable fisheries.)

The overall conclusion from the analysis is that the productivity of the Bangladesh population appears to be declining. In contrast, the Indian hilsa population appears to be more susceptible than in Bangladesh (Figure 1). A lack of data on the productivity attributes from India and Myanmar mean that the interpretation of the results for this axis remains uncertain. In order to improve the accuracy and reliability of the results, data on the life history attributes of the Indian and Myanmar populations need to be collected. These data could be collected by local scientists following short training (India) or may be better collected by independent scientists in collaboration with local scientists (Myanmar).

The absolute values of the PSA scores made in this analysis reflect the relative proportion of attributes that are showing a trend. Score values below two indicate that some attributes are declining. Values of two indicate that attribute and the overall productivity and susceptibility are stable and possibly sustainable. There has been no demonstration of the linkage between population sustainability and overall PSA scores. However, if the exploitation rate is well above sustainable levels, then this will be reflected in at least one attribute. Based on the scoring system used, the lowest score is one. Table 2 and Figure 1 show that many productivity attributes of the hilsa population in Bangladesh are declining. This indicates that further management intervention will be needed in order to reduce catch to a sustainable level. The causes of the declines in the productivity of hilsa populations in Bangladesh are unclear. A more detailed ecosystem-wide analysis would help identify the key ecosystem components or services that may be affecting hilsa productivity.

4.3. Recommendations

The value of the PSA outlined above is severely limited by a lack of data on hilsa population productivity from India and Myanmar. This is where Bangladesh has benefitted from the ACIAR-funded project and subsequent studies (Appendix I). The main recommendation from this analysis would be to undertake studies of the productivity of hilsa populations in each country. Hilsa has a
very plastic life history and has adapted to a dynamic environment. It would be unlikely that population attributes from Bangladesh could be applied to populations in India and Myanmar.

In order to update the PSA assessments, I recommend short-term biological studies be undertaken in India and Myanmar to measure the trends in hilsa productivity attributes in these countries. The Indian scientists in West Bengal have the capacity to undertake these studies, but this does not appear to be the case in Myanmar. Thus I recommend an expert joins Myanmar scientists to undertake these studies. When these data are available, I recommend the PSA assessment be updated incorporating these new data.

The PSA for Bangladesh identified declining trends in many of the productivity attributes. I recommend that the reliability of these trends be further investigated through broader consultation with relevant Bangladesh government agencies. If the trends prove accurate, the analysis suggests greater effort into maintaining important ecosystem functions is needed.

5. Coastal and marine ecosystem assets assessment

A broader, more comprehensive approach to assessing risk to particular resources of interest, such as hilsa, would be to make this assessment within an overall Bay of Bengal ecosystem asset assessment. There are several ways in which these assessments could be undertaken. Two use a broad framework applicable to fisheries (Fletcher et al., 2005; Hobday et al., 2006). A third approach that has proved useful in coastal ecosystem planning is outlined in Annexure 5. The proponents of this approach could be contacted for more details (tim.skewes@csiro.au or james.butler@csiro.au). This approach is flexible and can be adapted to focus on particular assets (species or populations or ecosystems) or processes. Thus, it appears to be a potentially useful approach to assess species (hilsa or Indian mackerel) or trophic group (sharks and rays) risk in a structured way.

All three approaches use a common way to identifying key ecosystem assets and processes and how they interact with fisheries. They require workshops by groups of experts with an understanding of the local fisheries and ecosystems. The approaches differ mostly in the methods applied to assess the potential interactions and subsequent risks to these assets and ecosystem services. I was been involved in the study by Hobday et al., 2006 and feel that the approach by Skewes and Butler offers benefits over the other methods. These include better local stakeholder engagement through the greater use of visual aids and direct involvement in the assessments. The approach adopted in the other two studies required one or more experts to remotely undertake the assessment and then report this to stakeholder meetings and adjust the responses accordingly. The methods were difficult for most Australian non-technical stakeholders to understand. Valuable workshop time was wasted in explaining concepts and coming to consensus about asset and service scores. The approach by Skewes and Butler is similar, but starts with a workshop to develop a visual concept model of the ecosystem services or assets that affect the fishery of primary interest. Once the workshop agrees on this model, the project team then researches the scientific literature to obtain data relevant to all components of the model. This includes assessing the current status and trends in these assets and services in the region of interest. Visual models of their status are developed and these are then discussed in follow-up workshops with stakeholders. The final output from the approach is a visual-based management support framework that fishery managers can apply to their decision making in response to particular issues of concern.
6. Summary of recommendations

The following summary of recommendations is the outcome from the assessment of the status reports from the three countries (Chapter 3) found in Annexures 2-4 and the PSA risk assessment (Chapter 4). These recommendations are intended to provide guidance on data gaps that are limiting management in each country.

Bangladesh country report (Appendix II)

1. Undertake a GIS-based analysis of the catch distribution in the marine, estuarine and freshwater reaches of the main rivers in order to optimise temporal and spatial closures to reduce total catch by the desired amount. The studies in Table 1 suggest MSY is about 160,000 t, which is about half of the most recently reported landings (2008) in Appendix II. This would be most easily done with interviews of fishers stratified by region, fishing sector and habitat type. This could also obtain estimates of daily catch rates, mesh sizes used and some better economic statistics on the returns from each sector.

2. Obtain fishery-independent estimates of hilsa biomass, possibly with help from Indian survey vessels in marine waters.

3. Undertake better and more effective publicity and stakeholder consultation on the objectives of the closures.

India country report (Appendix III)

1. Identify and map the spatial and temporal extent of major spawning and fishing grounds.

2. Identify and map the spatial and temporal extent of major juvenile nursery areas.

3. Quantify the spatial extent and severity of pollution and its impacts on hilsa habitats.

4. Verify age structure of hilsa populations in India and the measure the size structure of the commercial catch.

5. Assess the reliability of commercial catch statistics and undertake a stock assessment if feasible.

6. Undertake a socio-economic survey of the hilsa fishery to enable the state authorities to make better informed management decisions.

Myanmar country report (Appendix IV)

1. Undertake an assessment of the Myanmar Fisheries Department fishery statistics, institutional capacity and ability to implement management.

2. Collect relevant biological data to update the PSA risk assessment for Myanmar.

3. Assess the accuracy and precision of hilsa catch data and the vessel registrations in order to ascertain if an index of total catch or catch rates can be calculated.

4. Provide technical advice to Myanmar fisheries department staff to enable a status report on hilsa to be prepared for the proposed BOBP IGO 3rd consultation on hilsa in February 2011.

PSA risk assessment (Chapter 4)

1. Undertake studies to obtain relevant productivity parameters from hilsa populations in India and Myanmar.

2. Update PSA risk assessment with new data.

3. Engage with relevant national experts in Bangladesh to verify declining trends in hilsa habitat quality identified in Bangladesh country report for BOBP IGO meeting (Appendix II). Update PSA risk assessment as necessary.
7. References


Appendix I  Presentation summarising recent hilsa fisheries research in Bangladesh

**Background**
- Collaborating agencies: BFRI and CSIRO
- Focussed on biology relevant to fishery
- Provided input towards a draft hilsa management plan in Bangladesh

**Biology of Hilsa**
- Population structure
  - in Bangladesh
  - throughout range
- used multiple methods (genetics, morphometrics and otolith chemistry)
- Age and growth
- Reproduction

**Genetic stock structure throughout range**

**Single genetic stock in Bay of Bengal**

**Overall population structure**

**Movements within Bangladesh**

**Growth and age structure**

**Reproduction**
- Both sexes mature at 20 cm and 1 yr old
- Sex ratio bias to males in smaller fish
- Almost all fish > 40 cm are female
- Species spawns throughout year with two peaks
- Individuals only spawn a few times each year
- Fecundity increases with size
- Fecundity averages 800,000 to 1 M eggs

**Spawning seasonality**
Status of hilsa (*Tenualosa ilisha*) management in the Bay of Bengal

**Egg production and gillnet selectivity**

**Contribution of each age class to fishery**

**Management recommendations**
- Reduce catch of immature fish by banning mesh sizes < 10 cm
- Establish seasonally closed protected areas for spawners and juveniles
- Improve registration of inland and marine fishing vessels and gear
- Improve system of catch recording

**More recent biological studies**
- Amin et al. (2002) recommend 25% reduction in fishing mortality to reach MSY
- Amin et al. (2008) found catch rates declined by 28% from 1998 to 2000
- Ghosh et al. (2003) found Pseudun and Nemichirus hilsa separate genetic stocks
- Banerjee et al. (2005) found Ganges/Yamuna separate genetic stock from Hooghly and Narmada (W India)

**Recent economic analysis**
- Momes (2007) analyzed economic yield from fishery
  - Fishery currently barely profitable
  - Fishing effort needs to be reduced to 33% current effort to maximize overall profit
  - Biogios production maximized at 30% current effort
  - Recommended number of motorized boats be reduced from current 25,000 to 10,000
  - Catch rates would increase from current 9 trawl/week to 15 trawl/week
  - Profit increase from 7 to 9% of revenue
Appendix II  BOBP-IGO/RC-HF2/5: Status of hilsa fisheries in Bangladesh

BOBP-IGO/RC-HF2/5 February 2010

Regional consultation on preparation of management plan for hilsa fisheries
Chittagong, Bangladesh, 7-8 February 2010

| Hilsa fisheries management in Bangladesh |

A2.1 Introduction

Hilsa is the most important single species fishery and national fish of Bangladesh. The fish has already gained international fame for its nutritional value, taste and delicacy. It accounts for nearly half of the total marine catches, and about 12% of total fish production and about 1.0% of GDP. The average annual production of hilsa is 0.25 million tons, worth Tk. 50 000 million (Tk. 200/kg). It also contributes to foreign exchange earnings of Tk. 500-1 000 million/year. The peak fishing season extends from June to March, with a major peak in September to October and a minor one is February to March. This fishery is artisanal and uses mainly drift and set gill nets from traditional non-mechanized and mechanized wooden boats. About 460 000 fishers of 148 Upazilas are directly employed in hilsa fishing with an indirect employment about 2.5 million in the wider hilsa sector (trading, processing etc.). Thus the fishery is playing an important role in employment, foreign exchange earnings and poverty reduction of the country. At present 50-60% of global hilsa catch is reported from Bangladesh waters, 20-25% from Myanmar, 15-20% from India other 5-10% from other countries (e.g. Iraq, Kuwait, Malaysia, Thailand and Pakistan). Hilsa fat is unsaturated and helps for reducing blood cholesterol.

A2.2 Species diversity and geographical distribution of hilsa

Three species of shad occur in Bangladesh waters under genus Tenualosa and Hilsa, one of them is exclusively marine and the other two occur in marine, estuarine and freshwaters. Out of them two species exist of the genus Tenualosa, T. ilisha (ilish) and T. toli (Toli shad or Chandana ilish) and another one is Hilsa kelee/kanagurta (Five spot herring) under Hilsa genus. T. toli is confined to seawater whereas H. kelee occurs both in inland waters and the sea. Geographical distribution and present status of the genus, Tenualosa and Hilsa in Bangladesh are shown in Table 1. Except these species there are other four species found occasionally in the coastal waters of Bangladesh, those are almost identical to hilsa. These species are Ilisha elongata (Ramgacha/Ramchowkka), I. melastoma (Peti chowkka), I. megalooptera (Chowkka/Chowkka faisha) and I. filigera (Coromondel ilish). Pellona ditchela, a species of Pellona genus also found in coastal waters, which has strong resemblance with hilsa.

At present, the main species of hilsa fishery of Bangladesh is T. ilisha and contributes more than 99% of total the hilsa catches. Previously, a considerable amount of T. toli was caught in Bangladesh especially in Cox’s Bazar region. Hossain et al, 1987 reported 0.08% and 6.01% contribution of T. toli in the gillnet fishery at Chittagong and Cox’s Bazar landings and T. ilisha were around 85%. But recently, T. toli, are almost absent in commercial and subsistence catches at these two centres. As a result, it is thought that the species may be endangered in Bangladesh. Decline of T. toli catch is loss of production and their complete absence is loss of hilsa species diversity.
A2.3 Abundance and distribution of hilsa in Bangladesh

Hilsa occur in inland, marine and coastal waters of Bangladesh almost throughout the year. Until, the introduction of mechanized boats and nylon twine in early 1980s, the catch of hilsa were mainly concentrated in the inland waters and in the estuaries and very little in the coastal zones. Now, the main catches are concentrated in the estuaries, coastal zones and in the seas. The distribution of hilsa in Bangladesh is discussed below:-

I) Distribution of hilsa in the Bay of Bengal

The details of marine distribution of hilsa in Bangladesh are not available. Although in earlier days, the marine hilsa catch was restricted in the coastline, it has now dispersed in the wider areas of Bay of Bengal and extended up to 200-250 km from the coastline. Therefore, there is a chance of wider distribution of hilsa in the Bay of Bengal due to increased fishing activity.

Table 1. Geographical distribution and present status of the genus, Tenualosa and Hilsa in Bangladesh.

<table>
<thead>
<tr>
<th>Scientific and local name</th>
<th>Global distribution</th>
<th>Present status and distribution in Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Tenualosa ilisha</em></td>
<td>Myanmar to Arabian (Persian) Gulf, Indonesia, mainly in the Bay of Bengal.</td>
<td>Mainly captured in the lower Meghna, Tetulia, Arial kha and other major rivers of Southern Region and their estuarine parts and in the wider areas of Bay of Bengal.</td>
</tr>
<tr>
<td><em>T. toil</em></td>
<td>Bay of Bengal; Sarawark Province of Malaysia and Indonesia.</td>
<td>Now very rare in the sea water</td>
</tr>
<tr>
<td><em>Hilsa kelee/kangurta</em></td>
<td>Indo-West Pacific: all coasts of Indian ocean, Bay of Bengal, Gulf of Thailand, Java Sea and East to Papua New Guinea, Lower Mekong.</td>
<td>Catch status not available.</td>
</tr>
</tbody>
</table>

II) Distribution of hilsa in the inland waters

*T. illisha* was once versatile in Bangladesh waters. It is found available almost throughout the year in the major rivers e.g. the Padma, Meghna, Jamuna, Rupsa, Shibsa, Bishkhali, Pyra, Ilisha etc. mainly in the upper stretches of the rivers, toward the coastal areas of Bay of Bengal. In addition to these rivers, hilsa were also abundant in Karnafuly, Feni and Muhuri rivers and in most of the branches and tributaries of the Padma (Ganges) and the Brahmaputra (Ahsanullah, 1964; Quereshi, 1968 and Haldar *et al.*, 1992). Among the branches and tributaries of the Padma and Brahmaputra, Garai, Kumar, Madhumati, Arial Kha, Nabaganga, Dhaleswary, Kaliganga and Buriganga were important. According to Raja, 1985, the range of migration of hilsa was in the Brahmaputra up to Tezpur, a distance of 306 km from the border of Bangladesh. Pillay and Rosa 1963 reported that hilsa ascends the full span of the Gangetic delta system. Ahmed, 1954 reported that except the district of Rangpur, Dinajpur, Bogra and Chittagong Hill Tracts, which were not fed by large rivers, all other district got a good quantity of hilsa in some parts of the year.

In inland waters, hilsa and jatka occurred in about 100 rivers, but at present their main concentration is in the lower Meghna, Tetulia, Arial kha and other major rivers of southern region and in their estuarine parts. The distribution of hilsa mainly depends on water flow and flooding of the rivers. In the years of heavy flood, they are also caught in the small channels and even sometimes in the floodplains. Considerable amount of hilsa are also caught in the lower Arial kha, Madhumati and Padma and a little in the Jamuna and Brahmaputra. During the last 10-30 years, hilsa fishery has been completely lost from about 35 rivers and in another 8-10 rivers hilsa are rarely
caught. The estimated production loss from these rivers is about 20,000-25,000 tonnes and about 45,000-50,000 fishers have lost their works of hilsa fishing.

A2.4 Historical trends in hilsa catches

National hilsa landing ranged between 144,438 and 2,90,000 tonnes with an average of 211,249 tonnes during 1983-84 to 2007-08 (Fig. 1). The average landings from inland and marine sectors were 79,152 and 131,371 tonnes during this period. The total hilsa landings from Bangladesh waters have not decreased over this period; moreover the production has been increased substantially in the recent past years due to the adoption of different management interventions for this fishery since 2003. During last two decades hilsa production from inland waters declined about 12% with an increase of about two times from the marine sector. The number of marine fishing boats and gears has increased about four times since 1984-85 resulting in tremendous fishing pressure in marine sector. In addition, the intensity of marine catches have increased due to the introduction of nylon twine and mechanized boat. During the 1960s, the inland hilsa landings ranged between 125,000 and 147,000 with an average of 136,000 tonnes. In comparison with 1960s, the inland hilsa landing has been decreased about 41%. The marine catch of Myanmar is increasing significantly in the recent years. It is a matter of anxiety that if proper protective and conservative measures are not undertaken for this fishery in inland waters, the area of hilsa catch may move further down and be restricted to the sea only.

![Fig. 1. Trends in hilsa production during 1983-2008](image)

A2.5 Some biological attributes of hilsa and exploitation level.

I) Stock/Race of hilsa

Earlier, there was a controversy as whether all hilsa (*T. ilisha*) stocks of Bangladesh are migratory or not. Many thought that there are three different hilsa stocks as regards to their migratory behaviour. (1) A migratory (anadromous) stock living in the foreshores of the Bay of Bengal, which migrate far upstream into the rivers for spawning. (2) A stock which completes its entire life cycle within the river system. It does not migrate to the sea. (3) A marine stock living all its life in the foreshore of the sea and does not migrate to the river system (Quddus *et al.*, 1984 and Raham, 1997). Both genetic and otolith microchemistry data showed that hilsa from SE India and Myanmar were not significantly different from fish collected in coastal areas of Bangladesh and suggested that hilsa in the Bay of Bengal are a single stock (Hussain *et al.*, 1998). It may be concluded that hilsa in Bangladesh are a single population that is probably shared with India and Myanmar. Therefore this population should be managed as a single stock.
II) Movement and migration pattern

*Tenualosa ilisha* is a migratory fish. Most hilsa born in freshwater, live and grow in the sea and migrate to the upstream for breeding and feeding. The adults again return to the sea after spawning. The offspring of hilsa live in the rivers and streams for about 6-7 months and at the onset of monsoon, especially when the clear water of the rivers and streams began to get turbid, they migrate to the sea for maturation. After attaining maturity they again migrate to the freshwaters for breeding in order to complete their life cycle. It has been observed that in the Meghna River, jatka up to 13 cm remain in the upper part of the river and then they migrate to the deeper water. Earlier, the hilsa was considered as anadromous with two ecotypes - (i) a fluvial potamodromous and (ii) a marine type (Raja, 1985). Movement pattern studies of hilsa through otolith microchemistry also indicated that the fish move around in all three habitats, i.e. from marine water to freshwater through brackish water and vice-versa. The resident stock never migrate to the sea and completes its’ entire life cycle within the river system. But detailed studies, especially for juveniles and pre-adult hilsa, have not yet been done in Bangladesh.

III) Size and sex ratio

During the 90s the male to female sex ratio of hilsa was observed imbalanced at Goalundo (1: 0.24), Chandpur (1: 0.57), and Chittagong (1: 1.4) and only balanced at Khulna (1: 0.98) by the BFRI scientists. Recent study (Blaber and Mazid, 2001) indicated that the majority of hilsa over 30 cm and almost all over 40 cm standard length are females. Males predominate between 10 and 25 cm, but the sex ratio below 10 cm is more even. The biases in the sex ratio suggest that males may not live long as females. Unlike other Tenualosa species, there are no histological studies for sex change in *T. ilisha*, although there is a bias in the sex ratio. So, there is a chance of sex change of *T. ilisha* like *T. toli* and *T. macrura*. GEF study showed that the overall sex ratio of male-female hilsa was almost 1: 2. The sex ratio varies according to their sizes and time of capture. The males are predominant (above 50%) within 18-28 cm and the females from 28-30 cm size group (above 50%). More up to date information of sex ratio and possibility of sex change are required for management implications.

IV) Maturity and fecundity

Male and female hilsa reach sexual maturity at 20.0 cm size when they are one year old, and both the male and female are able to spawn at this size (Blaber and Mazid 2001). Currently smaller sized hilsa attain sexual maturity. Under GEF study (Haldar, 2004a) the minimum size and weight of mature male and female hilsa obtained from commercial landing centres were 18 and 101 g, and 20 cm and 216 g in length and weight respectively. From a beach seine catch at Tetulia River, the minimum size of maturing female hilsa was recorded 17 cm in length and 43 g in weight. The fecundity of hilsa is directly related to sizes and ages. Larger hilsa produce higher number of eggs. At present, relatively low fecund (one year age group) hilsa contributing mostly to egg production, which deserves conservation of more fecund larger hilsa. Historical information of hilsa fecundity is furnished in the Table 2.
Table 2. Historical information of hilsa fecundity (1968-2007).

<table>
<thead>
<tr>
<th>Habitat/area</th>
<th>Length size (cm)</th>
<th>Weight (g)</th>
<th>Fecundity (egg numbers)</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Padma - Meghna</td>
<td>22.5-48.3</td>
<td>-</td>
<td>900 000-2 000 000</td>
<td>Qureshi, 1968</td>
</tr>
<tr>
<td>Meghna</td>
<td>38.0-52.0</td>
<td>-</td>
<td>382 702-1 821 420</td>
<td>Shafi et al., 1977</td>
</tr>
<tr>
<td>Padma - Meghna</td>
<td>33.0-51.0</td>
<td>-</td>
<td>600 000-1 500 000</td>
<td>Quddus, 1982</td>
</tr>
<tr>
<td>Padma (Gualunda)</td>
<td>26.6-51.1</td>
<td>536-1 925</td>
<td>179 000-1 302 000</td>
<td>Moula, 1992</td>
</tr>
<tr>
<td>Meghna</td>
<td>28.7-52.3</td>
<td>-</td>
<td>226 000-1 931 000</td>
<td>Rahman, 1998</td>
</tr>
<tr>
<td>Av. Bangladesh</td>
<td>17.1-41.5</td>
<td>-</td>
<td>108 500-1 993 846</td>
<td>Blaber et al., 2001</td>
</tr>
<tr>
<td>Ramgoti (Luxmipur)</td>
<td>35.5-47.0</td>
<td>448-1 300</td>
<td>135 600-1 703 200</td>
<td>Haldar, 2004a</td>
</tr>
<tr>
<td>Chandpur/Ramgoti</td>
<td>24.0-48.0</td>
<td>220-1 130</td>
<td>112 554-950 625</td>
<td>BFRI, 2006-07</td>
</tr>
</tbody>
</table>

V) Age of hilsa reproduction

Usually, the population of hilsa become matured at the age of one year and dominated by one year old size group at present. Larger size group hilsa are rare in the population (Haldar, 2004a). In the 1960s hilsa was composed mainly of three years old size group. Due to present management interventions imposed in the recent years some balanced population is being observed.

VI) Spawning season and spawning grounds of hilsa

Spawning of hilsa occurs almost throughout the year from upstream to the coast at Chittagong and even in the sea off Cox’s Bazar. Gonado Somatic Index (GSI) value showed that the peak spawning period is September and October with a minor peak in January to February. The frequency of spawning is still unknown. The spawning cycle of hilsa is closely synchronized with lunar cycle and aggressive spawning is noticed during new moon and full moon. Spawning grounds of hilsa were identified by the occurrence of ripe and running (oozing) males and females and by catching hilsa larvae/fry with experimental fishing. The lower stretches and estuarine part of the Meghna River was found as the major spawning ground of hilsa in Bangladesh. Of this, (1) Kalirchar Island (down of Sandwip), (2) Moulavirchar (south of Hatia), (3) surrounding of Monpura Island (east of Bhola) and (4) Dhalchar Island (Charfashion, Bhola) were found as the most significant areas of hilsa spawning (Haldar, 2002).

VII) Nursery grounds of hilsa

Juvenile hilsa (jatka) are found in almost all the main rivers and sometimes even in the floodplains. Two major nursery grounds, one in riverine, and another in the coastal area have been identified. The largest riverine nursery ground has found in the Meghna River covering Shatnol (Gazaria/Munshiganj) in the upstream through Nilkamol in the downstream of Chandpur extended up to Char Alexander of Luxmipur. In these areas jatka are found during January to May with the peak in March to April. The coastal nursery ground is reported to extend from Kuakata (Patuakhali) to Dublar char (Khulna) (Haldar,2002). Within this area comparatively large (11 to 15 cm) jatka are caught during December to January. The most important spots of coastal nursery ground are - Ashar char, Sheolar char, Narikel baria, Fatrar jungle, Kochikhali, Laidiar char, Meherali and Kotka. Apart from the above areas, significant amount of jatka are caught in the different rivers such as the Ilisha, Karkhana, Pyra, Kirtonkhola, Tetulia and Bishkhali, of Barisal and Bhola districts. Combined recent result reflected inclusion of some more areas as nursery grounds of hilsa like Tetulia, Shabazpur channel, Arial kha, Dharmagonj and Andarmanik River. Jatka, from their birth in September-October remain in the riverine habitat for 7-8 months until the water become turbid due to first shower of monsoon (April/May).
VIII) Recruitment pattern
Jatka are the recruiting phase of hilsa. The recruitment of hilsa occurs more or less continuously throughout the year with one major peak during June and July for male and female combined. But the females have two peak recruitments, the major during March to May and the second during July to September and males have one major recruitment during July (Haldar, 2004a). This is supported by the occurrence of juvenile hilsa throughout the year.

IX) Population parameters and exploitation rate of hilsa
The exploitation rate (E) of hilsa during 1992-2000 was higher (0.52-0.66) than the theoretical optimum level (0.50). At the same period, the size of first capture (Lc) has been decreased chronologically (35.0 cm to 13.1 cm). With the reduction in first capture size and increasing trend in exploitation rate, indicating a greater catch of small/under size hilsa which is an alarming sign for sustainable hilsa production. GEF study (Haldar, 2004a) indicated that the rate of over exploitation of hilsa continued till 2003 with little increase in E max values (0.61-0.63). The size of first capture has been increased significantly (19.9-21.2) (Table 3). This is probably happened due to enforced protection of jatka in the recent past years.

Table 3. Estimated values of different population parameters of T. ilisha in Bangladesh waters during 1992-2000.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptotic length (L∞)</td>
<td></td>
<td>61.1</td>
<td>58.3</td>
<td>59.97</td>
<td>61.50</td>
<td>66.00</td>
<td>60.00</td>
<td>62.50</td>
</tr>
<tr>
<td>Growth constant (K)</td>
<td></td>
<td>0.74</td>
<td>0.74</td>
<td>0.99</td>
<td>0.83</td>
<td>0.67</td>
<td>0.82</td>
<td>0.72</td>
</tr>
<tr>
<td>Total mortality (Z)</td>
<td></td>
<td>2.41</td>
<td>2.61</td>
<td>3.19</td>
<td>3.29</td>
<td>3.43</td>
<td>3.77</td>
<td>2.79</td>
</tr>
<tr>
<td>Natural mortality (M)</td>
<td></td>
<td>1.16</td>
<td>1.18</td>
<td>1.41</td>
<td>1.28</td>
<td>1.25</td>
<td>1.28</td>
<td>1.17</td>
</tr>
<tr>
<td>Fishing mortality (F)</td>
<td></td>
<td>1.25</td>
<td>1.43</td>
<td>1.78</td>
<td>2.01</td>
<td>2.18</td>
<td>2.49</td>
<td>1.62</td>
</tr>
<tr>
<td>Exploitation rate (E)</td>
<td></td>
<td>0.52</td>
<td>0.55</td>
<td>0.56</td>
<td>0.61</td>
<td>0.63</td>
<td>0.66</td>
<td>0.58</td>
</tr>
<tr>
<td>Maximum yield/recruit (Emax)</td>
<td></td>
<td>-</td>
<td>-</td>
<td>0.71</td>
<td>0.69</td>
<td>0.60</td>
<td>0.59</td>
<td>0.46</td>
</tr>
<tr>
<td>Size at first capture (Lc)</td>
<td></td>
<td>35.0</td>
<td>30.0</td>
<td>30.34</td>
<td>30.25</td>
<td>27.06</td>
<td>22.80</td>
<td>13.12</td>
</tr>
<tr>
<td>Growth performance (Æ)</td>
<td></td>
<td>-</td>
<td>3.40</td>
<td>3.55</td>
<td>3.50</td>
<td>3.46</td>
<td>3.47</td>
<td>3.45</td>
</tr>
</tbody>
</table>

A2.6 Natural and anthropogenic impacts of hilsa fisheries in Bangladesh

I) Natural impacts
Bangladesh is a deltaic country and land locked by India and Myanmar. Among the 230 rivers of Bangladesh, 54 including the big rivers e.g. Padma, Brahmaputra (Jamuna), Meghna, Surma, Kuhsiara and Karnaphuli have originated in Nepal and India and are flowing through Nepal, India and Bangladesh. Siltation is a serious threat to the inland fishery of Bangladesh. The Meghna river system are carrying considerable amount of silt and deposing into the Bay of Bengal. Extensive erosion in the Hatia, Sandwip, Bhola, Noakhali and various major rivers are continuously changing the river hydrology, bottom topography and are creating many merged and submerged islands. In Bangladesh, about 2 179 million tons of sediment is carried by the Ganges-Brahmaputra river system creating merged and submerged islands and changing ecology and blocking migratory route (Curray and Moore 1971).

II) Anthropogenic impacts
Due to the construction of different Flood Control Dam (FCD), Flood Control Dam and Irrigation (FCDI) and barrage water flow in Bangladesh has reduced considerably, and hilsa fishery has been affected severely. About 1 500 km streams and rivers of hilsa habitat in the upper region of the
country has been lost (Haldar et al., 2001). In Bangladesh, 3.36 million ha of inundated floodplains have been protected by 7 024 km embankment, FCD and FCDI and 1 064 river closure has been made up to June 1990 (Haldar, 2002). The upper Padma and almost all of its branches and tributaries became shallow and some stretches have dried up completely. Haldar and Rahman 1998 reported that hilsa landing at Chandpur has lost about 25.8% from 1978-88 to 1989-94 due to the loss of freshwater discharge from the upstream international river. The hilsa fishery of a moderate magnitude that existed in the Kumar River is no longer available due to closure of Kumar River under Ganges-Kobadak project (Mahmood et al., 1994). Construction of the cross-dam in the mouth of Feni River under Muhuri Irrigation and Flood Control project has destroyed a commercial hilsa fishery of about 500 tonnes per year (Haldar et al., 1992). Due to low discharge of water from the River Ganges and consequently heavy siltation in most of the rivers, the feeding, spawning, nursery and migratory areas of hilsa have been reduced in the up streams.

In Bangladesh, it is almost a general custom to dispose all kinds of untreated waste/effluents into the rivers. Besides, the gradual growth of industries, growing urbanization, increased use of fertilizers, agrochemicals and pesticides and discharge of municipal waste continuously polluting the river system. Rivers like Buriganga and Sitalakhya are already polluted severely. About 2 750 tonnes of pesticides are carried into different rivers and polluting river system of Bangladesh (Haldar, 2002). Pollution in Bangladesh will be endemic and wide spread in the near future and this will affect hilsa fishery severely if proper management measures are not developed and implemented.

Also, the hilsa fishery is suffering from serious recruitment over-fishing (indiscriminate catching of jatka) and growth over-fishing (indiscriminate killing of gravid brood). The fishing mortality has increased with decrease in size at first capture. There are innumerable numbers of fishing gears are using in inland as well as marine environment. Their exact number is unknown. Some gears are identified as illegal, which indiscriminately killing jatka of small sizes. Once Jagot ber jal (large beach seine net) was the principal gear, which captured about 80% jatka of the total catch. At present, small mesh current jal, mosahri (mosquito net) seine net, behundi jal (set bag net) and char ghera jal (fence like net operation around the char) are the most harmful gears are being used illegally in the nursery grounds for capturing jatka of different sizes. In 1993, BFRI estimated the total captured jatka of 3 707 tonnes from Shatnom-Hazimara of Chandpur district in the lower Meghna River and Kuakata-Dublarchar area of South-west coastal belt. BFRI also estimated the total captured jatka of 6 380 tonnes from aforesaid areas. The total catch of jatka was estimated to be about 19 200 tonnes (1920 million) from all the jatka susceptible areas of county (BFRI 2002). If 10-15% of caught jatka could be protected (assuming average growth of 500 g/year and 10-15% survival), an additional production of 150 000-200 000 tonnes of adults (grown up) hilsa would be available.

A2.7 Socio-economics aspects of hilsa fishers

I) General features and demographic profile of hilsa fishers’ household

According to GEF study (Leterme et al., 2004) most of the hilsa fishers’ villages are situated along the river side. All the villages are accessible by road but only 1.5% of the villages are accessible by bus, the general mode of transport was found rickshaw (70%). In general, 60% of the villages are covered by electric supply, about 91% have primary school and post office was found in about 46% villages. Majority of the villages (72%) have no telephone facility and 85% have no bank.

Most of the fishers are professional fishermen and depend essentially on fishing or as labour fishermen. The mean family size of the fishers’ households was seven, of whom 3.6 male and 3.4 female, which is above the national average. About 83% of the fishers are illiterate (National average is 58.9) and 42% of the households are single earner. About 25% of the families live in chann hut (straw) house and 25% of the households have katccha (open) toilet. About 92% fishers live in their own house and 8% live in rented house. The majority of fishers (82%) use drinking water from tube well. Only around 52% of the households have sanitary latrine with a slab. About 88% of the fishers belong to the category of landless (below 0.5 acre), with some marginal (8.5%) and small
(2.51-4.50%) land holding. The family sizes of the landless fishermen are usually smaller (6.5%) than the marginal (7.4%) and medium (8.2%) category.

The average annual income (gross margin) of the hilsa fishers was found approximately Tk. 76 000 and show high dependency on hilsa fishing. On average, 70.4% of the respondents’ incomes were generated from hilsa fishing (approximately Tk. 53 000/year). The annual expenditure for livelihood (except capital cost) of the hilsa fishers was found to be Tk. 52 450 and for consumption it was Tk. 38 300. The mean debt amount of the hilsa fishers of all zones was Tk. 20 000 per household and concerned to 57% of the respondents. The loan amount was about 24% of their total incomes. As per land ownership category, the marginal farmers are more indebted than the landless, small and even medium farmers. Hilsa fishers have not reported yet any potential alternate job opportunities if the complete fishing ban is imposed or hilsa sanctuaries are declared.

II) Number of hilsa fishers and their geographical spread

The detailed list of the hilsa fishermen and family numbers up to village level in different districts are given in Table 4. From the table it appears that about 460 000 hilsa fishers belonging to 183 000 families exist in Bangladesh. They belong to 3700 villages in 1400 unions, 143 upazila and 40 districts of Bangladesh. Their main concentration (63.4 percent of the total hilsa fishermen) is in 6 districts of Barisal division followed by 8 districts of Chittagong division (28.6%) i.e. about 92% of the hilsa fishers belongs to these two divisions (Haldar, 2004). Because of unavailability of early base line data, the increasing or decreasing trend of the hilsa fishermen could not be determined. But from the increased numbers of mechanized and non-mechanized boats recently engaged in the marine artisanal gill net fishery, it could be assumed that the number of hilsa fishermen in marine sector has been increased many folds. During 1985-2000, the number of mechanized and non-mechanized boats and gears were around 6 000 and in 2001-02, it has increased to 25 000 and 106 000 respectively (Haldar, 2004). Therefore, with increase of boats and gears, the numbers of hilsa fishers have also been increased in the marine sector. The number of hilsa fishermen from the inland sector may have been decreased because of less abundance of hilsa in the riverine habitats and habitat loss. The number of boats in the riverine habitats has been decreased 37.6% in Dhaka; 54.9% in Rajshahi; 29.4% in Sylhet, and 96.7% in Khulna division respectively (Haldar, 2004); with the exception of Barisal and Chittagong divisions, where 0.75% and 61.8% boats have been increased in 2001 in comparison with 1984-85.

Table 4. Division wise list of hilsa fishers in Bangladesh

<table>
<thead>
<tr>
<th>Variable</th>
<th>District</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of division</td>
<td>Dhaka</td>
</tr>
<tr>
<td>Total district</td>
<td>12</td>
</tr>
<tr>
<td>Total upazila</td>
<td>34</td>
</tr>
<tr>
<td>Total union</td>
<td>374</td>
</tr>
<tr>
<td>Total Fishers</td>
<td>75 687</td>
</tr>
<tr>
<td>Total hilsa villages</td>
<td>579</td>
</tr>
<tr>
<td>Total hilsa fishers family</td>
<td>8 902</td>
</tr>
<tr>
<td>Total hilsa fishers</td>
<td>17 454</td>
</tr>
<tr>
<td>Full time (%)</td>
<td>26</td>
</tr>
<tr>
<td>Part time (%)</td>
<td>74</td>
</tr>
</tbody>
</table>
III) Crafts and gears of inland waters and Catch Per Unit Effort (CPUE)

The fishermen mainly used *Chandi, Khosa, Dingi* and mechanized boats for hilsa fishing. There are about 100,000 crafts are engaged currently for capturing hilsa. The gears used for capturing hilsa are mainly set gill net (*Chandi jat*), current gill net (*Gulti jat*), Behundi jat (set bag net), Chandi jat, Behundi jat (set bag net), and Drift gill net (*Gulti jat*). Fishers are also using some seine nets (*Jagot ber jat, purse seine net*) but recently operation of *Jagot ber jat* is very rare. Fishing gears i.e. small mesh current gill net, Behundi jat (set bag net), *moshari ber jat* and *Char ghera jat* are identified as harmful gears, which are being used for killing juvenile hilsa (*jatka*) indiscriminately in the particular regions. Trends in CPUE of gill nets during 1998-2008 are shown in Table-5.

IV) Mechanized and non-mechanized boats/gears of marine sector and their catch

The number of mechanized boats and gears in the marine sector was recorded as 3,347 in 1983-84. This figure decreased to 2,880 in 1987-88 and remained the same until 1998-99. From a census in 1999-2000, the number of mechanized boats and gears were found to be 18,992 and 75,968 i.e., 6.59 and 26.77 times higher than the previous years and indicates that the number of boats and nets were not assessed for the long 11 years. Catch/unit boat over the period did not increased significantly. These numbers of boats and nets are used for marine hilsa catch estimation. Therefore, the actual catch of the marine sector have not reflected in the catch statistics of FRSS (Haldar, 2004). The catch/mechanized boat/year was 16.7 tonnes in 1983-84, which apparently increased to 42.3 tonnes in 1998-99 and subsequently decreased to only 6.9 tonnes in 2001-02. The non-mechanized boat operation was recorded two years later than that for the mechanized boats and the number was found to be 3,802 in 1985-86. Almost the same numbers of boats (3,802 to 3,509) were recorded until 1998-99 and in 1999-2002, the boat number apparently increased to 7,177. Until 1998-99, only one net/boat was operated, during 1999-2002 about six nets/boat was found to be operated for hilsa fishing by artisanal non-mechanized fishermen in the marine sectors. The catch/non mechanized boat ranged from 2.08 to 5.03 with an average of 4.1 tonnes/year during 1983-84 to 1988-99 but decreased to 3.0 tonnes at the beginning of 2,000 when the updated figures were used.

V) Seasons of hilsa fishing

In Bangladesh, commercial hilsa fishing occurs in the marine and riverine areas throughout the year, but the peak fishing season is September-October every year. Majority of hilsa catch (60-70%) is taken during the peak breeding season. In this period, about 60-70 percent hilsa are found to be sexually mature and ripe. The second peak fishing season seems to be during January-February in the riverine areas. In the Sea off Cox’s Bazar, the fishery extends almost throughout the year but the activity is much reduced during the monsoon months (June-August) due to roughness of the sea. Hilsa fishing seems to be related to the lunar cycles, full moon and new moon periods.

Table 5. Catch per unit effort of gill nets during 1998-2007

<table>
<thead>
<tr>
<th>Gears</th>
<th>CPUE (kg/net/day)</th>
<th>Area covered</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gill net</td>
<td>45.7 (mean)</td>
<td>Meghna River (Chandpur-Hatia)</td>
<td>Rahman and Haldar, 1998</td>
</tr>
<tr>
<td>Gill net</td>
<td>33.0 (mean)</td>
<td>Meghna River (Chandpur-Hatia)</td>
<td>Rahman and Haldar, 1998</td>
</tr>
<tr>
<td>Set gill net</td>
<td>8.0-22.0</td>
<td>Meghna River (Chandpur-Alexander), Tetulia, Karkhana, Pyra</td>
<td>BFRI, 2004-05</td>
</tr>
<tr>
<td>Drift gill net</td>
<td>20.0-50.0</td>
<td>Meghna River (Chandpur-Alexander), Tetulia, Karkhana, Pyra</td>
<td>BFRI, 2004-05</td>
</tr>
<tr>
<td>Current net</td>
<td>10.8-22.6</td>
<td>Meghna River (Chandpur-Alexander), Tetulia, Karkhana, Pyra</td>
<td>BFRI, 2004-05</td>
</tr>
<tr>
<td>Set gill net</td>
<td>4.5-30.0</td>
<td>Meghna River (Chandpur-Sakuchia, Monpura)</td>
<td>Present study (2007-08 not published)</td>
</tr>
<tr>
<td>Drift gill net</td>
<td>5.8 - 50.0</td>
<td>Meghna River (Chandpur- Sakuchia, Monpura)</td>
<td>Present study (2007-08 not published)</td>
</tr>
<tr>
<td>Current net</td>
<td>4.0 - 9.0</td>
<td>Meghna river (Chandpur- Sakuchia, Monpura)</td>
<td>Present study (2007-08 not published)</td>
</tr>
</tbody>
</table>
A2.8 Present management measures of hilsa

To sustain as well as to increase hilsa production, several management measures have been undertaken by DOF under the Ministry of Fisheries and Livestock (MoFL) based on the research findings of BFRI. Among the different attempts, conservation of jatka through declaring four fish sanctuaries in the major nursery and spawning grounds of river system and protection of berried hilsa catches for ten days during the peak breeding season are the most important initiatives (DoF 2005-06).

I) Implementation of Hilsa Fisheries Management Action Plan (HFMAP)

Implementation of hilsa action plan has been initiated since 2003 with the view of protecting jatka properly. This action plan specified the activities to protect jatka, developed the implementation strategy, ascertained responsibility of relevant agencies and target community and fixed specific timeframe for implementation. The action plan involved variety of activities, these are as follows:

- District Ministers/Public representatives involvement
- Riverine rally
- Awareness creation through public media
- Distribution of leaflets and posters to protect jatka
- Enforcement of fish protection and conservation act
- Establishment of hilsa sanctuary
- Ten days fishing ban in major spawning grounds
- Alternate livelihood for jatka collectors

Special operation for jatka protection and conservation

Juvenile hilsa (jatka) (up to 23.0 cm size) catch, transportation, marketing, selling and possessing have been banned between 01st November and 31st May every year in Bangladesh under the Protection and Conservation of Fish Act-1950.

- Involved different agencies in jatka protection program (MoFL, DoF, Navy, Coast guard, Upazila administration, District and Upazila level officers of DoF);
- Introduction of fund allocation for special campaign for jatka protection programme;
- Identified special operation area for proper functioning and coordination of Navy and Coast guard;
- Special task forces formed by the DoF, District and Upazila administration;
- Implementation of awareness building programme;
- Rehabilitation and alternative income generating activities for jatka fishers

Declaration of hilsa sanctuaries

Four sites in the coastal areas of the country have been declared as hilsa sanctuaries under the “Protection and Conservation of Fish Act-1950” for the effective conservation of jatka in the major nursery areas and the maintenance of fish bio-diversity.

<table>
<thead>
<tr>
<th>Hilsa sanctuary area</th>
<th>Ban period</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Shatnol of Chandpur District to char Alexander of Laxmipur (100 km of lower Meghna Estuary)</td>
<td>March to April</td>
</tr>
<tr>
<td>Madanpur/Char ilisha to Char Pial in Bhola district (90 km area of Shahbajpur River, a tributary of the Meghna)</td>
<td>March to April</td>
</tr>
<tr>
<td>Bheduria of Bhola District to Char Rustam of Patuakhali District (nearly 100 km area of Tetulia River)</td>
<td>March to April</td>
</tr>
<tr>
<td>Whole 40 km stretch of Andharmanik River in Kalapara Upazila of Patuakhali District</td>
<td>November to January</td>
</tr>
</tbody>
</table>
**Hilsa sanctuary in the lower Padma River (Newly proposed)**

<table>
<thead>
<tr>
<th>Position</th>
<th>Sanctuary area with GPS point</th>
<th>Ban period</th>
</tr>
</thead>
<tbody>
<tr>
<td>North-East</td>
<td>Kasikata, Vedorgonj, Shariatpur (23°19.8' N, 90°32.6' E)</td>
<td>March to April every year</td>
</tr>
<tr>
<td>North-West</td>
<td>Vomkora, Noria, Shariatpur (23°18.4' N, 90°28.8' E)</td>
<td></td>
</tr>
<tr>
<td>South-East</td>
<td>Beparipara, Matlab, Chandpur (23°15.9' N, 90°37.7' E)</td>
<td></td>
</tr>
<tr>
<td>South-West</td>
<td>Tarabunia, Vedorgonj, Shariatpur (23°13.5' N, 90°35.1' E)</td>
<td></td>
</tr>
</tbody>
</table>

**Conservation of gravid hilsa for uninterrupted spawning**

Every year the highest number of ripe and running hilsa are caught during five days before and five days after the Full Moon of *Barapurnima* (Full Moon of *Durga Puja*) in October (Ashwin-Kartik). So, catch of hilsa has been banned each year in the following major spawning grounds during the highest breeding time (15-24 October). The shape of the banned area is tetragonal, which has been covered four major spawning grounds with an estimated area of 6,882 km².

<table>
<thead>
<tr>
<th>Position</th>
<th>Area</th>
<th>Peak spawning period</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-E</td>
<td>Shaher Khali / Haithkandi point, Mirersharai</td>
<td>15-24 October</td>
</tr>
<tr>
<td>N-W</td>
<td>North Tajumuddin / West Syed Awlia point</td>
<td>15-24 October</td>
</tr>
<tr>
<td>S-E</td>
<td>North Kutubdia / Gandamara point</td>
<td>15-24 October</td>
</tr>
<tr>
<td>S-W</td>
<td>Lata Chapili point / Kalapara</td>
<td>15-24 October</td>
</tr>
</tbody>
</table>

**A2.9 Comprehensive management plan for hilsa including regional initiatives**

Based on the recommendation of HFMAP of BFRI and recommendation of Fourth Fisheries Project, DoF the Hilsa Fisheries Management Action Plan for Bangladesh is finalized and the following areas of intervention have been identified for hilsa management and development. Implementation of some of the initiatives is in progress with some positive impact.

- Conservation of gravid hilsa for uninterrupted spawning and subsequent recruitment
- Conservation of jatka
- Rehabilitation of the jatka catchers
- Conservation of hilsa species diversity
- Regulation of over exploitation
- Protection and improvement of hilsa habitats
- Awareness building about the fishery and fish conservation rules
- Human resource development for implementing HFMAP
- Review and improvement of catch monitoring system of hilsa
- Identification and implementation of adaptive research projects
- Regional initiatives for hilsa management and conservation

I) Regional initiatives for hilsa management and conservation
Hilsa is a common resource of Bay of Bengal and Bangladesh, India and Myanmar harvest 90-95% global hilsa, but there is no regional initiative for its management. Recent study indicated that hilsa of these regions belong to the same stock. Therefore, sustainable production of hilsa requires joint management of the stock. Initially a Tri-country (Bangladesh, India and Myanmar) partnership has been proposed in the action plan.

**Scope of collaboration**
- Management of similar type spawning and nursery grounds of hilsa
- Development of Marine park/No Take Zone

**Area of collaboration**
- Exchange of sharing of information
- Collaborative research work
- Abatement of pollution of the common rivers and sea
- Development of regional management plan

A2.10 Conclusion
The BOBP could initiate for Tri-country partnership or cooperation development for sustainable management of this renewable hilsa resource of the Bay of Bengal.

A2.11 Acknowledgements
The authors are grateful to Dr G.C. Haldar, Director (Research and Planning), BFRI, Mymensingh, Bangladesh, for providing some basic data and information to prepare this manuscript. His utmost cooperation and support is highly acknowledged. The authors are also grateful to Mr M. Zaher, Chief Scientific Officer, BFRI, Riverine Station, Chandpur and Dr K.K.U. Ahmed, Principal Scientific Officer, M.A. Alam, Scientific Officer and T. Ahmed, Scientific Officer, BFRI, Riverine Station, Chandpur for their excellent guidance and cooperation during the research work and preparation of the manuscript.

A2.12 References

Appendix III  BOBP-IGO/RC-HF2/6: Status of hilsa fisheries in India
India-National Plan of Action (NPOA) for conservation and management of hilsa fisheries

A3.1 Preface
Regional consultation on preparation of management Plan for hilsa fisheries held during
14-15 March 2008 at Central Inland Fisheries Research Institute, Barrackpore, Kolkata has, besides
mining of information on distribution, biological status, migratory behaviour, habitat ecology, fishery
and its natural recruitment, also identified certain areas of great concern, which are directly or
indirectly effecting the sustainable development of hilsa fisheries in this region of BOB shared by us,
Bangladesh and Myanmar, the other neighbouring countries. The main areas of concern may be
broadly categorized as follows:

a. Irrational exploitation measures involving both adults and juveniles
b. Habitat modification due to water abstraction, river valley diversion/impoundments etc.
   leading to denial of in-stream flows required for sustainable development of hilsa fisheries
c. Increased pollutional load due to population explosion and accelerated industrial growth
d. Dearth of alternative livelihood opportunities
e. Lack of social awareness, and
f. Inadequate policy regulations

The above concerns have been aptly expressed and discussed in the above consultation but there
has been unanimous concern about the inadequacy of available biological information including
exploitation criteria vis-à-vis the stock of this important fish providing livelihood opportunities to
millions of people in this region. The surges and the downs in hilsa production experienced by
member countries of this region speak for a state of uncertainty and warrants immediate addressal.
Recent studies by Cheung, Pitcher and Pauly (2005) have corroborated our above concern by
categorizing Tenualosa ilisha under moderate vulnerable side. In view of the above eventuality,
there has been felt immediate necessity to derive a mechanism to further strengthen the data base
and if required, novel studies pertaining to population dynamics by involving latest tools should be
commissioned. The first consultation has also impressed upon the preparation of extension
materials for enhancing social awareness for promoting conservation and sustainable development
of hilsa fisheries in this region. With the eminent view to decide a road map for conservation and
management of hilsa fisheries in this region of BOB shared by us, Bangladesh and Myanmar, a
National Plan of Action (NPOA) is suggested:

A3.2 Present state of hilsa fisheries – assessment report
Past and present trends for effort
There has been recorded increased exploitation pressure on hilsa fisheries of east and west coast
over the years because of this being a prized fish, most relished in this continent. With continued
inclining demand of this fish in recent years and with the advent of efficient mechanized crafts and
improvised gears, the fishing pressure has further increased and fishers are tempted to exploit hilsa
stocks without caring for size and season. This has resulted into unsustainable growth of hilsa
fishery.

S. N. Singh and A.P. Sharma, Central Inland Fisheries Research Institute (ICAR), Barrackpore Kolkata-700 120,
W.B.; India
The above state-of-the-affairs may well be explained by tracing the hilsa catch scenario and the exponential increase in crafts and gears over the years.

Inventory of crafts and gears and effort computations are available dating back to 1956-58 in respect of Hooghly-Matlah estuarine system. Mitra et al.,(1987) have computed past information on fishing gears of Hooghly estuary which pertains to year 1982-83 and compared with their earlier availability, two and half decades back. Conspicuous decrease in seines, purse nets, lift and long lines have been recorded by them but there has been observed significant increase (from 36 966 in 56-58 to 98 083 in 82-83) in drift gill nets (265.33%) and other nets used for exploiting hilsa, over the years from 1956-58 to 1982-83. Switching over from purse nets to drift gill nets for catching hilsa is attributed to higher CPUE of the later so that the increased demand of this fish may be met. The information (Nath, Misra and Karamkar, 2004) pertaining to crafts and gears used for exploitation of hilsa during the period 1999-2000 revealed an overwhelming increase in numbers of drift gill nets to the tune of 44 1510 (size range-40‘x18’ to 60‘x30’). Regarding crafts, 1 572 numbers of trawlers with capacity varying from 15 to 105 HP and 22 992 numbers of non-mechanized boats were recorded operating for exploitation of hilsa during the period 1999-2000. Such a tremendous increase in numbers of gears very precisely indicated over-exploitation of this resource negating the sustainable development of hilsa fishery.

Remesan, Pravin and Meenakumari (2009) have dwelt upon the non-selective gears and sustainability issues relevant to Hooghly-Matlah estuary and inferred that gears i.e. Behunti Jal, a stationary bag net with a wide mouth of 27 m and with very small cod end of mesh size( about 2 mm), Char-pata Jal, a screen barrier having very small mesh operated for harvesting juveniles and Sitki Jal, a skimming net made up of polyethylene netting of mesh size of about 2mm for collecting fry and fingerlings, are non-selective and highly hostile for sustaining the fisheries. They have also offered certain suggestions for improvement in context of Code of Conduct for Responsible Fisheries (CCRF).

Wanton killing of Juvenile hilsa

Exploitation of hilsa young ones through very small meshed nets, particularly the bag nets and small seines is prevalent in rivers, estuaries and coastal waters of east and west coast. The estimated catch of hilsa juveniles from Hooghly estuary varied from 44.1 to 151.1 tonnes averaging 85.1 tonnes per year. The size and weight of these young ones fluctuated from 6.2 to 15.5 cm and 2.0 to 15.5 g respectively which would have otherwise considerably added to overall catch of the system.

A3.3 Yield: physical and economic

Hooghly-Matlah estuary

Hilsa constitutes prime fishery of Hooghly-Matlah estuarine system and two migratory runs during south-west monsoon and post-winter have been recorded. The monsoon runs contributed major chunk (80 to 90%) of fish catch of hilsa.

There has been recorded a wide fluctuation in hilsa catch over the years which may be attributed to a score of factors regulating the habitat ecology. There has been an anthropogenic invasion in the form of commissioning of Farakka Barrage in 1975 and this eventuality has changed the overall
scenario. The annual catch which varied from 678.0 to 6573.0 tonnes with annual average catch of 1754.9 tonnes during pre-Farakka period (1961-75) experienced more than three folds increase to an average of 5327.4 tonnes (1981-05) after construction of the Farakka Barrage which may be mainly attributed to hydrological changes and increase in fishing effort.

The contribution of hilsa in total catch of the Hooghly estuary were estimated at 15.4%, 11.5% and 7.4% thus indicating a decreasing trend during the successive years of 1966-1975, 1976-1978 and 1984-1994 respectively. In recent years 1995-2004 the percent contribution has almost touched the record of 1966-1975. The annual yield of hilsa increased from 1457.1 (1966-1975) to 9726.0 tonnes (1995-2004) in comparison to total fish yield ranging from 9481.5 to 64840.8 tonnes from the system during the corresponding period.
Upstream Ganges scenario vis-à-vis commissioning of Farakka Barrage

Hilsa used to contribute an annual catch of 42.23 tonnes (average) in middle and parts of the upper stretch of Ganga river system till 1975. However, the catch has declined after the Farakka Barrage was constructed across the river, at its bifurcation point to Bhagirathi-Hooghly River flowing through West Bengal and Padma leading to Bangladesh. The barrage as physical barrier coupled with non-functional fish-passage lock, blocked upstream migration of fishes to upper reaches thus the fishery in this part suffered a major setback declining to 1.0 tonnes per annum in subsequent years. Ghosh (1976) has observed that there has been drastic decline in hilsa catch (less than 1 kg/km) above Farakka Barrage after it’s commissioning in 1975 as compared to pre-Farakka (11.61 kg/km) scenario.

A comparison of the pre-Farakka trend and the trend pertaining to period, 1998-1999 to 2002-2003, revealed that that annual catch of hilsa varied from 6 448.2 to 15 799 tonnes during later period being highest in 2000-2001. This surge in fish yield is attributed to increase in efforts and mechanization of fishing vessels.

Hilsa catch (tonnes) from Ganga at Allahabad

There has been conspicuous reduction in size also. Large sized fishes corresponding to age group 3+, 4+ and 5 years were recorded in the length range of 20.5 to 55.0 cm during prime fishing season of monsoon and the average length of Hilsa was observed to be 35.6 cm during the period 1984-85 to 1993-1994. In recent years, the size has prominently declined to average 32.5 cm which is a matter of concern.

Narmada River system on the west coast experienced significant decline (68.24%) in hilsa catch in 2005-05 (4 866 tonnes) as compared to 1993-1994 (15 319 tonnes) and this decline was prominently
recorded from 1998-1999 onwards. As such, the hilsa population has been found vulnerable to measures being presently employed.

**Status of stocks**

Due to exponential increase in fish demand all over world, the fishing pressure has also tremendously enhanced. FAO has documented that world’s 17 major fishing grounds have either already reached to maximum or are being over-exploited (Christie, 1993). Resources on east and west coast of the country are no exceptions.

Mitra *et al.*, 1998 have undertaken the trend analysis of time series data of Hooghly-Matlah estuarine system for the period 1961-1962 to 1995-1996 and have concluded that the total yield has already touched the MSY and the system will attain overexploitation by 2000-2001. Nath *et al.*, 2004 have computed the maximum catchable potential yield C max being 67 855.1 tonnes by using time series data for the period 1998-1999 to 2002-2003 in absence of effort data based on calibration of gears. A peep into the average catch for the corresponding period revealed that the estuary is being exploited very near to C max and further increase in efforts will make the system unsustainable. MSY in respect of hilsa was computed to be 3 507.5 tonnes which indicated an overexploited state of hilsa fishery in Hooghly-Matlah system. The emerged state of hilsa stock in Hooghly-Matlah system and other resources indicate that no yard-stick has been prescribed for harvest management decision. No assessment is available regarding how many numbers of hilsa migrate to fresh water habitat and how many returns to marine habitat. The harvest management scenario is very foggy. For conservation and sustainable development of hilsa fishery in this region, there is exigent need to identify the tools for reaching to harvest management decisions, a pre-requisite for sustainable development. This is equally essential to verify the suitability of existing methodology to assess the stocks. Hilsa migrates from marine habitat to fresh water habitat through estuarine habitat, as such; this anadromy has made hilsa vulnerable to varied set of environmental conditions prevailing in these habitats and the stocks will have the impact of such conditions. This warrants studies pertaining to the impact of natural and anthropogenic factors on hilsa stock.

**A3.4 Existing management measures**

**Control of access to fishing grounds**

Fisheries are a state subject and practically there is no control on modes of fishing. Monofilamentous fishing gears having 80 to 85 mm and below mesh size are being used to exploit undersized hilsa below 500g (CIFRI News, Vol.14 (1), Jan-June 2009) at Fraserganj, in proximity to mouth of Hooghly estuary. This denies the fishes to breed and the very purpose of developing sustainable hilsa fisheries is greatly defeated. A peep in to the fish catch of five trawlers operating at Frasergang fishing harbour revealed that hilsa contributed to 56.3% of total catch of 3.2 tonnes and most of the fishes (96%) were female and 59.8% of fishes have attained 4th stage of maturity. A concern for bottom trawling has also been raised, since besides these exploiting hilsa, these are also ruining the breeding grounds of a number of fin and shell fishes. Bag net fishing is rampant and this is denying the juveniles to contribute towards hilsa fishery which is at high risk under the prevailing set of negative harvesting measures. There is practically no control on fishing efforts and compliance of observing closed season is very poor and there is hardly any gear restrictions due to open access, lack of social awareness, poor control and surveillance.

**Technical measures (including improved gear, the existence of sanctuaries and closed season)**

Technical measures for effecting improvisation in harvesting methods and employing conservational measures are State subject and the State Governments issue certain regulations and laws. An official fishing ban in marine fisheries sector exists from 15th April to 15th June in West Bengal which does not coincide with the period when it is most required. Similarly, on the west coast also, closed season which is observed from 10th June to 15th August in territorial waters, does not serve its purpose. There is a need to make these laws more realistic and user friendly. No sanctuaries for hilsa exist in east coast as well as in west coast resources. Fine meshed gears are employed which are
non-selective and cause comprehensive loss due to noncompliance of Code of Conduct of Responsible Fisheries (CCRF). As a matter of fact the compliance of measures towards conservation is very poor.

**A3.5 Monitoring, control and surveillance**

Monitoring, Control and Surveillance are state subject. The Statistical Wing of State Fisheries Departments estimate catch based on sample survey and compute total fish catch of different fisheries resources of the state but this statistical information does not provide adequate base for trend analysis. There is hardly any control of State Fisheries Department particularly on harvesting practices being practiced by fishers for exploiting the natural resources due to local political interferences. This is like open access to everyone but recently some efforts to issue licenses has been started. There seems to be inadequate resource management policies, the enforcement agency expresses their helplessness due to limited human resource and other infrastructure facilities. The fishers and other user groups due to prevailing socio-economic fabric find hard to comply with the rules and regulations. As such, the surveillance is poor.

**Possible modification of management measures**

Possible modifications in prevailing management practices may be exercised by bringing in holistic eco-system based approach of management since institutional management arrangements vested with various stakeholders do not adequately address the challenges, hilsa fishery faces today. A score of factors i.e. over-harvesting, negative habitat modifications, climate change etc. have contributed to the decline of hilsa fisheries but we need to give due impetus to human activities having an overriding effect on the management of hilsa fisheries. Habitat improvement following stock assessment, harvest management decisions including closed season declaration, closed area provision and ban on negative fishing methods and a strong MCS machinery in place is the need of the hour.

**Anthropogenic impacts**

Hooghly-Matlah estuarine system flows through highly industrialized area like Haldia complex and Calcutta metropolis and gets domestic refuse from thickly populated city areas, as such, the estuary has become the repository of municipal sewage and industrial effluents. This state-of-affair prevails at west coast also and fishes are in great stress. River valley modifications, construction of barrages, weirs without fish passages have proved physical obstruction to accessing the prospective spawning and nursery grounds and the downstream including estuarine environment are in great stress because in-stream flows/environmental flows are no more received due to prioritized use of water elsewhere. The lower estuarine expanse of Narmada estuarine system has mushroom of industries and a vast Dahej GIDC has come up and composite effluents are discharged in Narmada estuary on the west coast.

**A3.6 The objectives of hilsa plan**

Following objectives have been identified in commensurate to the prevailing causal factors effecting the conservation and sustainable development of hilsa fisheries:

a. To reach to a rational exploitation prescription to ensure sustainable development of hilsa fisheries
b. To identify the negative habitat modifications and suggest conservational measures
c. To map the “Hot spots” and suggest mitigation measures
d. To suggest alternative livelihood vocations pertaining to the gestation period of management plan for the already overexploited hilsa fishery, and
e. To keep in place the mechanism of sensitizing the stakeholders and their obligations for ensuring a healthy ecosystem
A3.7 Strategies for achieving the objectives

Reaching to a rational exploitation prescription to ensure sustainable development of hilsa fishery

The exploitation quota need to be computed based on MSY criteria which are the key to sustainable development of hilsa fisheries. Since the fish is anadromous and completes its life cycle in fresh water and marine environments, the catchable quota need to be computed for both the environments. It is worth mentioning that in Bangladesh, hilsa production since last two decades, has declined by about 12% from inland waters but the production of marine sector has doubled due to four times increase in boats and gear. This precisely indicated that the potential migratory population from marine environment is being overexploited leading to constrained migration to the fresh water environment. There is need to draw a balance by computing exploitation rate of marine population too. In the above context, a rational fishing policy need to be framed and implemented involving all stakeholders in participatory mode.

Habitat improvement-the key to conservation

There is exigent need to improve the habitat for hilsa since most of our river systems have experienced anthropogenic invasions in the form of commissioning of barrages/dams/weir, and pollution leading to negative habitat modifications. This is high time to reverse this negative habitat modification for sustainable development of hilsa fisheries. Hilsa is an anadromous fish and need free access to fresh water environment for breeding and using these habitats as initial nursery grounds but this free access is denied owing to construction of physical obstructions. Similar eventualities have also been faced by the American shad, *Alosa sapidissima*, a clupeid as well as anadromous fish, so we take cue from the management strategies adapted under Chesapeake Bay Program, the highlights of this program is portrayed as follows:

Historical information and highlights of Chesapeake Bay Program for American shad

- *A. sapididissima*, contributed a luxuriant fishery in Chesapeake Bay, U.S.A, distributed along Atlantic seaboard from Labrador to Florida.
- Juveniles spend their first summer in fresh water and by autumn, the young shad gather in schools and move back to ocean, live there for 3-6 years till sexual maturity.
- Over exploitation, pollution and habitat modification are main reasons for decline (17.5 million pounds production at the turn of century, declined to 2 million pounds by year 1970).
- Susquehana was most promising river for spawning; four hydro-electric dams eliminated shad runs in Pennsylvania.
- Earlier attempts for creating fish passages/fish ways around dam failed.
- All attempts of restoration by stocking hatchery reared shad into rivers failed because of over-fishing and spawning grounds were not accessible.
- By 1950, shad disappeared from Potomac River.
- By 1980, Maryland shad harvest fell to a record low and State placed a Fishing moratorium.
- Virginia also experienced similar failures and banned shad fishing in rivers and Chesapeake Bay.
- Restoration goals were identified which included maintenance of self-sustaining runs of shad and reopening of hundreds of miles of spawning habitats.
- Shad fishery management plan included harvest restrictions, restorations of stocks, provision of fish ways around dams and other barriers to spawning grounds.
- Two elevators or fish lifts were installed to lift the fish to the top of dam.
- Fish lifts were also provided at three other dams in Pennsylvania and fish passages on River Patapsco in Maryland and River James in Virginia. More than 170 miles of spawning habitats have been opened.
- Fish ladders may be required with a series of baffles or weirs, Baffles interrupt and slow down the flow of water and simulate pools and rapids.
- Larger dams need Fish lifts.
- Reintroduction of mature shad ready for spawning into newly opened spawning grounds.
- Establishment of sustainable harvests is critical to restoration.

**A3.8 Culture of hilsa in India**

Alternatively artificial propagation methodology which has been developed at Vadodara Centre may be tried (A detailed note and success story are annexed) for hilsa ranching in the depleted areas.

The pathway towards artificial propagation of *T. ilisha* portrayed below is based on its husbandry in fresh water as well as marine environment (marine cages). There is need to identify the stage (smolt) when this is required to be transferred to and initiate the marine lifecycle. This has significance to ranching of coastal waters where *T. ilisha* fishery has declined.

![Smoltification Diagram](image)

**Cue from endemic population thriving in Ukai Reservoir, Dist. Surat, Gujarat**

There is possibility of raising lacustrine fresh water population of hilsa. Our four years observations for confirming the endemic nature of *Tenualosa ilisha* population prevailing in Ukai Reservoir, Dist. Surat, Gujarat, a totally freshwater lacustrine environment without any connection with the marine environment, have proved that an endemic population thrive in this lacustrine environment. This may open new vistas in conservation of Hilsa fishery.

The scanning of fish landings at landing centres on the bank of reservoir and at important fish markets revealed the presence of young ones of size, varying from 60.0 to 86.0 mm in length and 0.94 to 5.91 g in weight during 1999-2000. The adult specimens encountered were in size range of 172 to 331 mm in length and 59.2 to 340.0 g in weight.

During 2000–2001, a score of campaigns to confirm the occurrence of *T. ilisha* in the fish catches of Ukai Reservoir confirmed the occurrence of young ones varying from 73 to 93 mm in length and 3.16 to 5.58 g in weight. The bigger specimens were encountered during the month of November and these ranged from 142 to 210 mm and 24.43 to 83.75 g in length and weight respectively.

The observations on the fish landings of Shelud village landing centre on the banks of Ukai Reservoir, Dist. Surat concluded the availability of young ones varying from 60 to 100 mm in length and 1.70 to 9.54 g in weight during 2001-2002. The fish landings arrived at important fish markets namely Navapura and Sonegarh confirmed the availability of adult specimens, varying in size from 113 to 275 mm. in length and 9.74 to 227.32 g in weight.

Endeavours were directed towards identifying the nursery grounds of *T. ilisha*. The drag netting undertaken in the bays and coves of Ukai Reservoir in proximity to Shelud and Narayanpur villages indicated greater congregation of young ones as inferred by the catch pattern. Efforts were also targeted towards mapping the breeding grounds of *T. ilisha* in the lotic sector of the reservoir but proved futile. Then the efforts were directed in the rivulet namely Neshu joining Ukai Reservoir at the tail end but this also did not prove helpful due to subdued fishing owing to high floods. Based on the secondary information collected from the fishers revealed rare occurrence of mature specimens and this led to conclude that a feeble population of *T. ilisha* thrived in Ukai Reservoir, Dist. Surat.
Scanning of fish landings continued during 2002-2003 and a multi-size fishery of *T. ilisha* was evident. The size group encountered during the month of August 02 varied from 130 to 252 mm in length and 15.12 to 122.77 g in weight. In September 02, abundance of young ones of *T. ilisha* was recorded in size group of 45 to 70 mm and 0.73 to 3.20 g in length and weight respectively. The adult specimens encountered from November 02 to January 03 varied in size from 182 to 285 mm in length and 57.26 to 202.80 g in weight.

The annual fish catch data of Ukai Reservoir procured from the Commissionerate of Fisheries, Gandhinagar, Gujarat revealed that the contribution of *T. ilisha* in the annual catch of this reservoir varied from 1 to 52 tonnes (0.06 to 1.76%) during the period 1989-1990 to 1996-1997. This contribution further increased to 119 tonnes (2.28%) during 1998-1999.

The abundance of multi-size fishery over the years under study and increasing contribution of this fish in the annual catch of Ukai Reservoir precisely indicated that an endemic population thrived in this totally freshwater lacustrine environment. There is need to confirm the genetic aberration leading to freshwater adoption of this fish taxa negating its anadromous behaviour.

**A3.9 Management measures to increase sustainability**

**Decrease/eliminate effort deployed for catching hilsa juveniles**

Negative exploitation methods, i.e. bag net fishing, use of 2 mm meshed nets deprive the system from the prospective recruits making the fisheries unsustainable. The fishers should be made socially aware for such negative exploitation methods and by appropriate regulations, all negative exploitation activities should be banned. The philosophy of MCS i.e. Monitoring, Control and Surveillance may prove potent tool of fisheries management, fisheries is a state subject and the state machinery should ensure strict implementation of Codes and Conducts for Responsible Fisheries. The period of downstream migration by the juveniles may be declared as closed season so as to ensure natural recruitment, a basic necessity for sustainable development.

**Improve data collection and monitoring of hilsa fisheries;**

The aquatic resources world-wide are subjected to comprehensive anthropogenic invasions with varied consequences. As such, there is exigent need to monitor the environmental variables and assess the stocks towards achieving management goals, a prerequisite for sustainable development. Stock assessment is the key and portrays the health of the population. There has been felt dearth of studies on population dynamics, other biological considerations for managing a sustainable hilsa population in this BOB region shared by us, Bangladesh and Myanmar.

**Ascertain the impact of changing climate on hilsa fisheries and identify adaptation strategies;**

Indian shad, *Tenualosa ilisha* completes its life-cycle in marine and fresh water environment. So, its fisheries shall be affected by the impacts of climate changes on marine and fresh water habitats. The major impacts of climate changes on seas pertain to:

a. Projected rise in temperature leading to melting of glaciers would cause flash floods and this may in turn affect the flow and temperature regime of the rivers and streams.

b. Aberration in the temperature regime would bring in variations in reproductive pattern, may lead to high growth, other metabolic activities and early gonad maturation in case of hilsa.

c. Ecosystem relations may also be affected due to aberrated temperature regime, and their match-mismatch happenings will greatly affect the energy dissipation from one trophic level to the succeeding level.

d. Anticipated sea level rise due to climate changes will push sea further inland making coastal habitats vulnerable to changes like comparatively high salinity regime at the inland sites. In case of hilsa, this would lead to crunch in prospective breeding grounds and cause higher competition for breeding.
e. Regarding the impacts during the freshwater life of hilsa, the biggest impact will be due to change in salinity regime (hyper), and crunch in prospective breeding and nursery grounds due to further inland invasion of sea owing to increase in sea level.

f. Temperature rise might have positive impact and lead to higher metabolic rate and accelerated growth; however, match-mismatch events may affect the whole ecosystem economy.

Facilitate and encourage research on population dynamics of hilsa fisheries, migratory patterns etc.

A comprehensive literature search revealed that there is dearth of information (refer to bibliography attached) on important aspects like population dynamics and migratory behaviour of this fish. As a matter of fact, we are not aware of the impact of biotic and abiotic factors coupled with exploitation pressure, acting under different set of climatic factors, more specifically monsoon conditions on the migratory patterns of hilsa. Use of improvised acoustic tools and tagging approach will be handy in delineating the migratory behaviour of the fish and helpful in conceiving rational management plan.

Population dynamics studies pertaining to west coast (Narmada Estuary) population with the prominent objective of delineating the impact of Sardar Sarovar Dam on its downstream including Narmada Estuary, is presently being undertaken by us under the ambit of a comprehensive program sponsored project of duration of three years.

We at CIFRI, Barrackpore have also an institute based research program dealing with migratory pattern, behaviour and other data synthesis relevant for designing fish passes for hilsa and other species for migration. Under the aegis of this project, we have already done with the preliminary information on the favourable conditions (>4 m depth, >20 m/minute current velocity) for hilsa migration.

A3.10 National Plan of Action (NPOA) - Hilsa

The proposed NPOA for restoration and management of hilsa fisheries in Bay of Bengal region shared by India, Bangladesh and Myanmar is based on eco-centric approach and have following areas requiring action:

Area – 1: Habitat improvement

<table>
<thead>
<tr>
<th>Actions</th>
<th>Time frame</th>
<th>Implementing agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Water quality improvement</td>
<td>01 year</td>
<td>MOEF/ NRCD</td>
</tr>
<tr>
<td>(b) Maintenance of In-stream flows/environmental flows at downstream of dam including estuary for migration</td>
<td>01 year</td>
<td>State Irrigation Dept.</td>
</tr>
<tr>
<td>(c) Provision of fish passages for accessing breeding and nursery grounds</td>
<td>06 months</td>
<td>State Planning/Irrigation Dept.</td>
</tr>
<tr>
<td>(d) Constitution of Trans-boundary council</td>
<td>01 month</td>
<td>BOB-IGO</td>
</tr>
<tr>
<td>(e) Community-based management decisions</td>
<td>01 month</td>
<td>Respective Govt. empowered committee</td>
</tr>
</tbody>
</table>

Area – 2: Socio-economic impacts and their mitigation

<table>
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<tr>
<th>Actions</th>
<th>Time frame</th>
<th>Implementing agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Sociological survey of fishers solely/partly dependent on hilsa fisheries for their livelihood</td>
<td>06 months</td>
<td>State Fisheries Dept.</td>
</tr>
<tr>
<td>(b) Detailed inventory of crafts and gears for their suitability towards sustainable development of hilsa fisheries</td>
<td>06 months</td>
<td>State Fisheries Dept.</td>
</tr>
</tbody>
</table>
### Status of hilsa (*Tenualosa ilisha*) management in the Bay of Bengal

(c) Facilitation of improvised crafts and gears under buy back/ swap scheme  
   **01 month**  
   State Fisheries Dept/ BOBP arrangements

(d) Alternative livelihood opportunities with special arrangements to discourage negative fishing methods and during gestation period  
   **01 month**  
   State fisheries Dept./ Financing Institutions/ BOBP arrangements

### Area – 3: Exploitation decision

<table>
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<tr>
<th>Actions</th>
<th>Time frame</th>
<th>Implementing agency</th>
</tr>
</thead>
</table>
| (a) Stock status assessment by sensitive tools like hydro-acoustics/tagging(radio) | 06 months | CMFRI, Kochi for marine habitat  
CIFRI, Barrackpore for riverine |
| (b) Sharing of stock assessment information with stakeholders/user group by developing user friendly formats/e-mails | 15 days | Trans-boundary council |
| (c) Sensitization of stakeholders about the risk associated with prevailing stock situation | 15 days | Trans-boundary council |
| (d) Racial studies | 06 months | CMFRI/CIFRI |

### Area – 4: Optimization of stock

<table>
<thead>
<tr>
<th>Actions</th>
<th>Time frame</th>
<th>Implementing agency</th>
</tr>
</thead>
</table>
| (a) Improvisation of artificial propagation methodology already developed by CIFRI for fresh water life | 01 year | CIFRI  
CIFRI/CIFRI |
| (b) Maintenance of genetic diversity | 01 year | CIFRI/CMFRI |
| (c) Marine cage culture | 01 year | CMFRI, Kochi |
| (d) Development of lacustrine population | 03 years | CIFRI |

### Area – 5: Institutional and regulatory structures

<table>
<thead>
<tr>
<th>Actions</th>
<th>Time frame</th>
<th>Implementing agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Make more relevant to institutional structures, legislation and regulation</td>
<td>06 months</td>
<td>Proposed MCS authority</td>
</tr>
<tr>
<td>(b) Establish Water shed council</td>
<td>01 month</td>
<td>Respective state govt</td>
</tr>
<tr>
<td>(c) Trans-boundary council</td>
<td>01 month</td>
<td>Respective federal govt</td>
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</tbody>
</table>

### Area – 6: Social awareness

<table>
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<tr>
<th>Actions</th>
<th>Time frame</th>
<th>Implementing agency</th>
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<tbody>
<tr>
<td>(a) Prepare awareness material with catchy slogans</td>
<td>01 month</td>
<td>State Fisheries Dept.</td>
</tr>
<tr>
<td>(b) Make the resource users aware about the fisheries act/regulations and penalty relevant to management decisions</td>
<td>01 year</td>
<td>Extension Wing/NGOs</td>
</tr>
<tr>
<td>(c) Sensitize the users with the CCRF. philosophy</td>
<td>01 year</td>
<td>State Fisheries Dept</td>
</tr>
</tbody>
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### Area – 7: Human Resource Development (HRD) and coordination

<table>
<thead>
<tr>
<th>Actions</th>
<th>Time frame</th>
<th>Implementing agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Identification of human resource gaps in research and management</td>
<td>05 years</td>
<td>Watershed council</td>
</tr>
<tr>
<td>(b) Place a consultation mechanism by Inviting experts and user groups</td>
<td>01 month</td>
<td>Trans-boundary council</td>
</tr>
<tr>
<td>(c) Strict Implementation of NPOA</td>
<td>01 year</td>
<td>State Fisheries Dept/ NGO’s</td>
</tr>
</tbody>
</table>

### A3.11 Annexure 1: Hilsa bibliography


Das, B. and P. Das (2004): Organochlorine pesticide residues in water, sediment, and muscle of river shad, Hilsa ilisha (Hamilton 1822) from the south patches of the Bay of Bengal, Bulletin of Environmental Contamination and Toxicology, Vol. 72, No. 3


Jhingran, V.G. (1957): Some observations on the Hilsa fishery at Buxar (Bihar, India) in the years 1952 to 1954. Indian J. Fish., 04(2): 336-339


Sarkar, H.L. (1957): Composition of Hilsa catches in the Sundarbans of West Bengal during the winter months. Indian J. Fish. 4(2): 340-343


A3.12 Annexure-II: Manuscript describing hilsa culture in NW India

Prospects of artificial propagation of Indian shad, Tenualosa ilisha in context of proposed impoundments on Marmada River system

S.N. Singh R.C. Mandi and S.K. Sarkar
Estuarine Fisheries Research Centre of Central Inland Fisheries Research Institute B-12,
Hans society, Behind Sangam bus stand, VADODARA-390 022; Gujarat

Abstract

Whole of the Narmada River valley has been proposed to undergo “Compound impounding” with a cascade of dams on the mainstream and a score of dams/other structures on its tributaries. With the pace of accomplishment of the impounding programme, the downstream environment including the estuarine extent will face the crunch of fresh water availability and this will adversely affect the anadromous migration of Tenualosa ilisha forming the prime fishery of the Narmada Estuarine system. A new “Hilsa hatchery” has been fabricated and its efficacy tested. The rate of hatching varied from 63.46 to 72.17%. The fresh water rearing experiments gave encouraging results, the constraints have been discussed. Two pronged strategy for artificial propagation has been identified and discussed; the first pertains to its husbandry in total fresh water conditions, which is based on the occurrence of land-locked population, while the other relates to its transfer to marine environment at an appropriate stage when the smolt window is open. Artificial propagation has added significance in view of its ranching in coastal waters, a measure towards eco-enhancement; besides, the establishment of T. ilisha in Ukai Reservoir, District Surat has opened new vistas in the annals of management and conservation of this threatened species in the backdrop of a number of anthropogenic inputs, the impoundment being the major.

Key words: Conservation, Artificial Propagation, Hilsa hatchery

Introduction

Owing to versatile topographic characteristics coupled with promising gradient for resource development, the Narmada River basin has been proposed to undergo “Compound impounding” leading to its transformation into a linear chain of dams on the mainstream and a series of impoundment on the tributaries. With the accomplishment of the envisaged plan of resource realization, the Narmada River valley hitherto free flowing, will get transformed into large, medium and small spreads of water bodies.

Sardar Sarovar Project (SSP), the ultimate impoundment is being commissioned on the mainstream at 5.6 km. upstream of Village Navagam under Taluka Nandod, District Narmada of Gujarat State. Commensurate with the pace of progress of the SSP dam and other overlying projects, the fresh water availability at the downstream of SSP dam shall be constrained. The fresh water availability at the downstream has been precisely documented in the Narmada Water Dispute Tribunal (NWDT) award which sounds chronological decline in fresh water availability at 10th to 45th year from the commencement of construction.

Tenualosa ilisha, the Indian shad contributes a sizable fishery (24.14 to 31.6%) of Narmada Estuarine system which is one of the most promising natural fishery resources of Gujarat State. During the monsoon season, this fish migrates in shoals to the fresh water for spawning and this anadromous fishery fetches great commercial value. The fresh water crunch in consonance with the developmental process will adversely affect the anadromous migration of T. ilisha constituting the prime fishery of the Narmada estuarine system. Depletion of hilsa fishery has been reported from a score of river systems which is attributed to the commissioning of impoundment, weirs and barrages. Jhingran, 1989 has projected adverse impact of Farakka barrage on the migratory hilsa fishery of Ganga which declined from 19 to 0.92 tonnes at Allahabad and from 4 to 0.8 tonnes at
Bhagalpur. Pantulu et al., 1967 have reported the adverse effect of construction of D.V.C dams namely Konar, Tilaiya, Panchet and Maithon on Damodar River leading to restricted fresh water availability in Hooghly River causing decline in hilsa catch. Ganapati, 1973 has also reported decline in hilsa fishery due to damming of the ultimate stretch of Cauveri and Godavari. Hynes, 1960 and Mansueti, 1961 have also documented the effects of dams in blocking the anadromous fish migration. Gaussle and Kelley, 1963 have observed the flow reversal being detrimental to the salmon migration into San Joaquin River. Moreover, ranching of coastal environment has also been identified as timely measure for supplementing the dwindling hilsa fishery.

Bearing in mind the environmental consequences of fresh water crunch at the downstream of the SSP dam as expressed above, a dire necessity was felt towards developing artificial propagation methodology for T. ilisha and this communication presents the prospects of efforts towards conservation and management of this threatened fish.

Material and methods

A base camp was established in the campus of the Fisheries School, Bhadbhut, District Bharuch, Gujarat during the monsoon season of 1990 and all the activities including installation and operation of the hilsa hatchery were regulated from here.

An extensive survey of the riverine extent in proximity to Bhadbhut Village was undertaken to assess the condition of brooders during second to third week of July. During this period, no female brooder was observed to be in oozing condition and the response of male brooders was also not very different. Again in fourth week of July and first week of August, 90, the condition of brooders was assessed and all the males were observed with running milt while only 27.58 to 41.20% of females were found to be in oozing condition. Abundance of brooders in right stage of maturity is a prerequisite for successful implementation of the artificial propagation programme.

Dry stripping method was employed for fertilization and depending upon the number of eggs, milt from two to five males was employed. The fertilization was followed by water hardening and the water hardened eggs were subjected to hatching operations in the designed hilsa hatchery.

A new hilsa hatchery has been designed (Plate 1) on the principle of water recirculation supplemented with constant aeration. The necessity of constant aeration was felt to disturb the oily film caused by the high oily hilsa eggs and this was also considered essential to improve functional efficacy of the hatchery system. The components of the newly designed hilsa hatchery are as follows:

a. A rectangular galvanized iron tank with inlets and overflows provided with an inner nylon lining for receiving the hatchlings, used as ground reservoir
b. Plastic perforated containers used as incubators with inner lining of nylon netting having mesh size of 1.428 mm. Separators made up of nylon netting of mesh size of 1.0 mm were provided inside these incubators
c. Two vertical tanks, each of 2000 Litres capacity, used as overhead tanks
d. Out let and inlet pipes with control provisions
e. Overflow storage tank
f. Water pump of 0.5 H.P as re-circulatory device
g. Aerator (Air pumps with sand stones)
h. Portable power generator as stand by to cope with any power failure

The incubators (plastic perforated containers) were installed in the ground reservoir and the water from the overhead tanks was circulated through the inlet pipes having control provisions at their feeding ends to the incubators. The outlet pipes enabled to take back the over flowing water back to the overhead tank through the over flow storage tank provided with a water pump for lifting the water. Thus, the re-circulation of water was maintained. The water hardened fertilized eggs were incubated on the separators and the rate of water circulation was maintained so as to provide an ideal thrust to the incubated eggs. The eggs slowly moved up and came down which is comparable
to the naturally occurring, drifting process. After the hatching is completed which took 18 to 20 hours depending upon the temperature, the incubators are removed and the hatchlings are salvaged from the inner sack of the ground reservoir.

Results

Four sets of *T. ilisha* were successfully bred during August and September, 1990. Artificial fecundation of first set was achieved by resorting to dry stripping; and altogether 5.41 lakhs of eggs were stripped out and milt from four males was thoroughly employed. This was followed by water hardening. The rate of fertilization was observed to be 77.08%. These water hardened eggs were subjected to the designed hatchery operation. The medium of hatchery was ground water which was collected from hand pump since there were practically drought conditions prevailing in this region. 3.01 lakhs of hatchlings (72.17%) were obtained after 18 hours of incubation. These hatchlings were transferred to two plastic pools of size 4 x 3'. After five days of rearing under continuous aeration, 41,292 numbers of spawn could only be recovered.

From the second set, 5.69 lakhs of water hardened eggs were obtained which were earlier fertilized by employing milt from five males. The rate of fertilization (36.67%) was poor due to availability of males preceding considerably to the availability of oozing females. The water hardened fertilized eggs were also subjected to the designed hatchery. 1.32 lakhs of hatchlings were procured and the rate of hatching (63.46%) was quite encouraging which once again proved the efficacy of the designed hatchery.

The artificial fecundation of third and fourth set of *T. ilisha* was accomplished and 4.41 lakhs of eggs were procured by dry stripping and water hardened fertilized eggs were considered for hatchery operations. Rate of fertilization was 71.43% in case of third set while fourth set recorded higher rate of fertilization (74.42%). The fertilized eggs obtained from third and fourth set were subjected to hatchery operation and 2.314 lakhs of hatchlings were procured from these two sets (Table 1). The rate of hatching was observed to be 71.41%. This has once again proved the efficient functioning of the designed hatchery. The spawn obtained from the above sets were stocked in fresh water nursery pond No. 4 of the Ukai Fish Farm, District Surat and the fresh water rearing for 148 days resulted into attainment of average size of 103.5 mm in length and 5.45 g in weight by the stocked spawn.

The physico-chemical attributes of the ground water used as hatchery medium is portrayed (Table 2). The important features of the used ground water were; pH in alkaline range, congenial D.O but Total alkalinity and T.D.S were towards higher side. The specific conductivity was also observed considerably high.

Discussion

Prospects of artificial propagation of any threatened taxa depend upon its acceptability to the 'in-situ' arrangement for the same. The designed hatchery encompassing re-circulatory device has proved its efficacy since the rate of hatching (63.46-72.17%) achieved has been promising. This rate of hatching has been accomplished under constrained condition since the ground water used as hatchery medium had high T.D.S and high specific conductivity. The fresh water rearing of spawn has not been encouraging due to poor recovery and as such, requires further improvisation.

Diadromy phenomenon in fishes enables them to access abodes with higher availability of food and better prospects for reproduction. Anthropogenic invasions meddle with the migrational route as physical obstruction otherwise; these may also lead to aberrations in hydrological regime. Such consequent state-of-the-affairs exert negative pressure on the environment. Sardar Sarovar Dam being commissioned at 162 km from the mouth of Narmada estuary will not act as physical barrier for *T. ilisha* anadromous migration but in consonance to the increase in height of this dam and execution of the overlying projects, severe fresh water crunch shall be felt particularly at 45th year from the commencement of the construction. At this stage fresh water availability from the dam will be practically insignificant restricting migration. Tapti estuary has met similar fate after commissioning of Ukai dam.
The prospects of artificial propagation of *T. ilisha* looks to be quite prominent in the light of occurrence of a sizeable fishery of *T. ilisha* (1 to 199 t) in Ukai reservoir (Table 3). This resident population has added a new dimension to the artificial propagation strategy as the fish is considered anadromous. This is worth mentioning that Atlantic salmon, *Salmo salar* is now totally adopted to the fresh water environment (Thorpe, 1987). Fresh water kokanee of sockeye salmon has been reported from Babine lake catchment, British Columbia (Mc Cart, 1970). The above observations lead to impress upon possible development of a totally fresh water population of *T. ilisha* in Sardar Sarovar reservoir.

The other pathway towards artificial propagation of *T. ilisha* is based on its husbandry in fresh water as well as marine environment. There is need to identify the stage when this is required to be transferred to and initiate the marine life-cycle. This has significance to ranching of coastal waters where *T. ilisha* fishery has declined due to a spectrum of reasons; the over-fishing might be the major one. Both the path ways require lots of research inputs at this stage and there is need to inculcate certain bio-chemical and biotechnological tools of study too to have a comprehensive insight into the physiological behaviour of this fish.

**Acknowledgement**

The authors are thankful to Dr A.G. Jhingran, The Director, Central Inland Capture Fisheries Research, Barrackpore for encouragement. We also wish to record our indebtedness to the Commissioner of Fisheries, Government of Gujarat, Gandhinagar for availing required facilities at village Bhadbhut, District Bharuch and at Ukai fish farm, District Surat for executing this collaborative programme.

**References**


Hynes, H.B.N. 1960 The biology of polluted water, Liverpool university Press, Liverpool


**Table 1. Details of artificial fecundation of Tenualosa ilisha accomplished at Bhadbhut, Dist. Bharuch, Gujarat**

<table>
<thead>
<tr>
<th>Set. no.</th>
<th>Date of stripping</th>
<th>Length/weight of the female</th>
<th>Number of eggs stripped</th>
<th>Number of males employed</th>
<th>Rate of fertilization (%)</th>
<th>Rate of hatching (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>05.8.90</td>
<td>416 mm/820 g</td>
<td>5.41 lakh</td>
<td>Four</td>
<td>77.08</td>
<td>72.17</td>
</tr>
<tr>
<td>2</td>
<td>19.8.90</td>
<td>565 mm/2200 g</td>
<td>5.69 lakh</td>
<td>Five</td>
<td>36.67</td>
<td>63.26</td>
</tr>
<tr>
<td>3</td>
<td>17.9.90</td>
<td>455 mm/960 g</td>
<td>3.11 lakh</td>
<td>Four</td>
<td>74.42</td>
<td>71.41</td>
</tr>
<tr>
<td>4</td>
<td>17.9.90</td>
<td>299 mm/355 g</td>
<td>1.31 lakh</td>
<td>Three</td>
<td>71.43</td>
<td></td>
</tr>
</tbody>
</table>

Rearing Period-148 days
Growth rate
0.96 to 1.14 mm day$^{-1}$ prior to winter
0.70 to 0.81 mm day$^{-1}$ during winter
Average size attained - 103.5 mm / 5.45 g

Table 2. Contribution of *Tenualosa ilisha* in annual fish catch (tonnes) of Ukai Reservoir, Dist. Surat; Gujarat

<table>
<thead>
<tr>
<th>Year</th>
<th>Annual fish production (tonnes)</th>
<th><em>T. ilisha</em> catch (tonnes)</th>
<th>Percentage contribution of <em>T. ilisha</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>1989-90</td>
<td>4 123</td>
<td>21</td>
<td>0.51</td>
</tr>
<tr>
<td>1990-91</td>
<td>5 284</td>
<td>22</td>
<td>0.42</td>
</tr>
<tr>
<td>1991-92</td>
<td>3 754</td>
<td>11</td>
<td>0.29</td>
</tr>
<tr>
<td>1992-93</td>
<td>2 693</td>
<td>9</td>
<td>0.33</td>
</tr>
<tr>
<td>1993-94</td>
<td>1 757</td>
<td>1</td>
<td>0.06</td>
</tr>
<tr>
<td>1994-95</td>
<td>1 549</td>
<td>9</td>
<td>0.58</td>
</tr>
<tr>
<td>1995-96</td>
<td>2 959</td>
<td>52</td>
<td>1.76</td>
</tr>
<tr>
<td>1996-97</td>
<td>4 598</td>
<td>28</td>
<td>0.61</td>
</tr>
<tr>
<td>1997-98</td>
<td>8 296</td>
<td>N.R</td>
<td>-</td>
</tr>
<tr>
<td>1998-99</td>
<td>8 732</td>
<td>199</td>
<td>2.28</td>
</tr>
<tr>
<td>1999-00</td>
<td>4 230</td>
<td>131</td>
<td>3.10</td>
</tr>
<tr>
<td>2000-01</td>
<td>7 885</td>
<td>168</td>
<td>2.13</td>
</tr>
</tbody>
</table>

Plate 1. Newly fabricated hilsa hatchery operated at Bhadbhut, Dist. Bharuch, Gujarat
Appendix IV  BOBP-IGO/ RC-HF2/7: Status of hilsa fisheries in Myanmar

The status of hilsa fisheries in Myanmar

A4.1 Introduction

The first regional consultation was held in Barrackpore, Kolkata, India from 14-15 March 2008. This regional consultation enabled better understanding neighbouring countries of Bangladesh, India and Myanmar.

At present, Myanmar Fisheries law has promulgated not to catch juvenile fish, regulating by mesh size and also prohibited to catch in breeding season. In reality, some local Fisheries Officers did not implement in freshwater fisheries law. There is no project implemented by the department of fisheries for hilsa fishery conservation and management purposes due to Cyclone Nargis.

Hilsa fisheries contributed a significant role in the economy of Myanmar. It is also stand up the first position amongst the marine products exported fish and fisheries items in the last three years. In 2007-2008, Myanmar Fisheries Companies exported 17 952.312 (tonnes) and 16 743.555 (tonnes) of hilsa in 2008-2009 were exported to nineteen countries (Table 1, 2, 3, 4). Table 5 showed amount of landing quantity from April 2008 to December 2009. There are 11 landing sites in Yangon, Myanmar. There are two peak season of hilsa. These are winter months of December, January and February which is a major peak season. March, April and May is the second peak season.

Table 1. The quantity and export value of the hilsa fishery.

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity (tonnes)</th>
<th>Value US$ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005-2006</td>
<td>15835.9</td>
<td>-</td>
</tr>
<tr>
<td>2006-2007</td>
<td>16964.575</td>
<td>22.63</td>
</tr>
<tr>
<td>2007-2008</td>
<td>17952.312</td>
<td>39.528</td>
</tr>
<tr>
<td>2008-2009</td>
<td>16743.555</td>
<td>29.140</td>
</tr>
</tbody>
</table>

Source: FIQC, DoF

Table 2. The exported marine fish (species wise) (2007-2008)

<table>
<thead>
<tr>
<th>No</th>
<th>Commodities</th>
<th>Quantity (tonnes)</th>
<th>Value US$ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hilsa</td>
<td>17952.312</td>
<td>39.528</td>
</tr>
<tr>
<td>2</td>
<td>White pomfret</td>
<td>7903.802</td>
<td>34.019</td>
</tr>
<tr>
<td>3</td>
<td>Ribbon fish</td>
<td>18895.869</td>
<td>20.158</td>
</tr>
<tr>
<td>4</td>
<td>Rosy jew fish</td>
<td>6381.545</td>
<td>15.062</td>
</tr>
<tr>
<td>5</td>
<td>Yellow croaker</td>
<td>6166.003</td>
<td>12.133</td>
</tr>
<tr>
<td>6</td>
<td>Tongue sole</td>
<td>4634.969</td>
<td>7.026</td>
</tr>
<tr>
<td>7</td>
<td>Big eye croaker</td>
<td>9499.727</td>
<td>6.150</td>
</tr>
<tr>
<td>8</td>
<td>Sea eel</td>
<td>3494.416</td>
<td>5.255</td>
</tr>
<tr>
<td>9</td>
<td>Black pomfret</td>
<td>1805.003</td>
<td>4.618</td>
</tr>
<tr>
<td>10</td>
<td>Thread fin brem</td>
<td>4474.445</td>
<td>4.186</td>
</tr>
<tr>
<td>11</td>
<td>Wolf herring</td>
<td>6119.919</td>
<td>4.110</td>
</tr>
</tbody>
</table>
Table 3. The exported marine fish (species wise) (2008-2009)

<table>
<thead>
<tr>
<th>No</th>
<th>Commodities</th>
<th>Quantity (tonnes)</th>
<th>Value US$ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hilsa</td>
<td>16 743.555</td>
<td>29.140</td>
</tr>
<tr>
<td>2</td>
<td>White pomfret</td>
<td>4 372.703</td>
<td>18.919</td>
</tr>
<tr>
<td>3</td>
<td>Rosy jew fish</td>
<td>5 232.055</td>
<td>13.527</td>
</tr>
<tr>
<td>4</td>
<td>Yellow croaker</td>
<td>5 063.189</td>
<td>9.721</td>
</tr>
<tr>
<td>5</td>
<td>Ribbon fish</td>
<td>6 855.578</td>
<td>8.502</td>
</tr>
<tr>
<td>6</td>
<td>Big eye croaker</td>
<td>4 127.447</td>
<td>4.552</td>
</tr>
<tr>
<td>7</td>
<td>Sea eel</td>
<td>2 253.985</td>
<td>3.858</td>
</tr>
<tr>
<td>8</td>
<td>Tongue sole</td>
<td>2 636.866</td>
<td>3.298</td>
</tr>
<tr>
<td>9</td>
<td>Black pomfret</td>
<td>1 321.885</td>
<td>3.207</td>
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<tr>
<td>10</td>
<td>Barra mundi (fillet)</td>
<td>559.199</td>
<td>2.040</td>
</tr>
<tr>
<td>11</td>
<td>Thread fin</td>
<td>372.696</td>
<td>0.726</td>
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</table>

Table 4. Country wise exported hilsa in 2008-2009

<table>
<thead>
<tr>
<th>Countries</th>
<th>Quantity (tonnes)</th>
<th>Value US$ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore</td>
<td>6 158.711</td>
<td>10.107</td>
</tr>
<tr>
<td>China</td>
<td>2 496.361</td>
<td>6.926</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>1 931.329</td>
<td>1.670</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1 931.525</td>
<td>2.953</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>1 837.982</td>
<td>3.015</td>
</tr>
<tr>
<td>Thailand</td>
<td>1 236.988</td>
<td>1.951</td>
</tr>
<tr>
<td>UK</td>
<td>265.091</td>
<td>0.956</td>
</tr>
<tr>
<td>Kuwait</td>
<td>123.920</td>
<td>0.141</td>
</tr>
<tr>
<td>Jordan</td>
<td>43.200</td>
<td>0.057</td>
</tr>
<tr>
<td>Vietnam</td>
<td>27.080</td>
<td>0.104</td>
</tr>
<tr>
<td>India</td>
<td>25.000</td>
<td>0.082</td>
</tr>
<tr>
<td>Qatar</td>
<td>8.604</td>
<td>0.018</td>
</tr>
<tr>
<td>Japan</td>
<td>7.000</td>
<td>0.022</td>
</tr>
<tr>
<td>Belgium</td>
<td>7.000</td>
<td>0.023</td>
</tr>
<tr>
<td>Australia</td>
<td>3.700</td>
<td>0.012</td>
</tr>
<tr>
<td>Korea</td>
<td>2.300</td>
<td>0.009</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2.000</td>
<td>0.001</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>0.420</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Source: FIQC, DoF
Table 5. Hilsa catches (tonnes) at the landing sites in Yangon. Source: One stop service

<table>
<thead>
<tr>
<th>Month</th>
<th>2008-2009 (tonnes)</th>
<th>2009-2010 (tonnes)</th>
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</thead>
<tbody>
<tr>
<td>April</td>
<td>1 347.44</td>
<td>2 106.48</td>
</tr>
<tr>
<td>May</td>
<td>1 875.53</td>
<td>206.20</td>
</tr>
<tr>
<td>Jun</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>July</td>
<td>0.30</td>
<td>-</td>
</tr>
<tr>
<td>August</td>
<td>2.90</td>
<td>-</td>
</tr>
<tr>
<td>September</td>
<td>1.27</td>
<td>-</td>
</tr>
<tr>
<td>October</td>
<td>2.11</td>
<td>-</td>
</tr>
<tr>
<td>November</td>
<td>3.57</td>
<td>461.28</td>
</tr>
<tr>
<td>December</td>
<td>1 737.94</td>
<td>1 184.64</td>
</tr>
<tr>
<td>January (2009)</td>
<td>2 588.78</td>
<td>-</td>
</tr>
<tr>
<td>February</td>
<td>3 259.63</td>
<td>-</td>
</tr>
<tr>
<td>March</td>
<td>3 156.01</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 6. Type of fishing gear and craft.

<table>
<thead>
<tr>
<th>No</th>
<th>Years</th>
<th>Trawler</th>
<th>Purse seine</th>
<th>Drift net</th>
<th>Long line</th>
<th>Stick held falling net</th>
<th>Traps</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2004-2005</td>
<td>884</td>
<td>89</td>
<td>1068</td>
<td>60</td>
<td>9</td>
<td>40</td>
<td>2 150</td>
</tr>
<tr>
<td>2</td>
<td>2005-2006</td>
<td>851</td>
<td>118</td>
<td>778</td>
<td>41</td>
<td>28</td>
<td>42</td>
<td>1 850</td>
</tr>
<tr>
<td>3</td>
<td>2006-2007</td>
<td>712</td>
<td>122</td>
<td>829</td>
<td>2</td>
<td>23</td>
<td>161</td>
<td>1 849</td>
</tr>
<tr>
<td>4</td>
<td>2007-2008</td>
<td>770</td>
<td>152</td>
<td>770</td>
<td>1</td>
<td>19</td>
<td>151</td>
<td>1 863</td>
</tr>
<tr>
<td>5</td>
<td>2008-2009</td>
<td>801</td>
<td>158</td>
<td>662</td>
<td>2</td>
<td>19</td>
<td>101</td>
<td>1 743</td>
</tr>
</tbody>
</table>

Source: Statistical Year book, DoF

Table 7. Small fishing boats

<table>
<thead>
<tr>
<th>No</th>
<th>Year</th>
<th>Small fishing boat</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Powered boat</td>
<td>Non-powered boat</td>
</tr>
<tr>
<td>1</td>
<td>2004-2005</td>
<td>14 176</td>
<td>16 687</td>
</tr>
<tr>
<td>2</td>
<td>2005-2006</td>
<td>14 097</td>
<td>16 352</td>
</tr>
<tr>
<td>3</td>
<td>2006-2007</td>
<td>14 284</td>
<td>16 284</td>
</tr>
<tr>
<td>4</td>
<td>2007-2008</td>
<td>14 289</td>
<td>15 219</td>
</tr>
<tr>
<td>5</td>
<td>2008-2009</td>
<td>14 052</td>
<td>14 645</td>
</tr>
</tbody>
</table>

Source: Statistical Year book, DoF

The objectives of hilsa-plan are as follow:

1. Reviewing existing conservation and management measures
2. Improving conservation and management measures
3. Changes to data collection
4. Research and development
5. Education or awareness raising and
6. Improved coordination and consultation
A4.2 Data collecting and reporting system

Southeast Asian Fisheries Development Centre (SEAFDEC) has a long history of collecting statistical data on fisheries in the region, and has organized several training courses and workshop to improve Myanmar’s statistical system.

The first national workshop on guideline and standard method of data collection and fisheries indicator was held on 25-29 August 2009 at Myanmar Fisheries Federation Building, Yangon in Myanmar. The conclusive national workshop on guideline and standard method of data collection and fisheries indicator was also held on 8-10 December 2009, Yangon, Myanmar. The SEAFDEC-TD collaborated with the Department of fisheries, Myanmar to organize the workshop sponsored by Japanese Trust Fund. The major objective of the workshop is to set up a standard method of data collection and fisheries indicator for fisheries management in Myanmar. The Department of fisheries will continue to collect statistical data to promote the implementation of effective fisheries management programs.

A4.3 Financial and technical assistance

Appropriate financial and technical assistance (including a human resource development program) should be provided the resources needed to collect new or additional data requirements under the fisheries statistic scheme, either nationwide or certain SEAFDEC localities.

Coastal environment and natural resources management

The Ayeyarwaddy and Yangon Division of the Irrawaddy Delta are among the most exposed areas along Myanmar’s southwest coast. These low-lying areas, interspersed with many tidal waterways are naturally exposed to storms and monsoon winds blowing from the southwest. Their vulnerability to natural hazards, like Cyclone Nargis and Typhoon however was significantly enhance by losses of natural mangrove forest cover and coastal vegetation that have accompanied transformation of the land for paddy cultivation, shrimp farming, charcoal production and woodcutting. A large number of artisanal fishermen, landless poor, and marginal farmers are depended on them for their direct and indirect incomes.

According to satellite and ground survey of forest cover pre and post Nargis, some 16 800 ha (30 %) of natural forest were lost as a result of the cyclone. In addition, an estimated 21 000 ha of forest plantations were damaged. The total damage forest is thus estimated at 37 800 ha in the Ayeyarwaddy and Yangon Divisions. The total value of damages to mangrove forest are estimated on
the basis of replanting costs of US$ 400/ha (Kyat 440 000/ha) for reserved and protected area forests and US$ 300/ha (Kyat 330 000/ha) for plantation forests. Myanmar laid down mangrove rehabilitation medium term and long term plans. At present, international organizations and agencies and local NGOs, have played an active part in protecting mangrove forests. Community forestry is being promoted by the government to manage remaining stands of reserve forests on a sustainable basis.

A4.4 Technical measures

Closed season/Closed area

The closed season is lasted from June to August annually both freshwater and brackish water. Commercial fishing vessels, like trawler, purse seine and long liner are prohibited from fishing at less than five nautical miles in the northern area, ten nautical miles in southern coast area of Myanmar.

The Department of fisheries took the action on restricted nursery areas are:

- One fishing ground (A 20) in Rakhine State.
- Five fishing grounds (B 15, B 20, B 10, C 3, C 4) in Ayeyarwaddy Division
- Two Fishing grounds (D 23, D 28) in Mon State
- Two fishing grounds (E 11, E 17) Tanintharyi Division

While need to protect the marine environment, habitats and marine ecosystems is generally recognized in recent fishery legislation. So far, protection and conservation of marine biodiversity and ecosystems through the establishment of sanctuaries or other types of protected areas have had limited success in developing countries (Myanmar). As most of them do not have the necessary to implement and enforce the conservation and management measures provided for in the management plans for these areas.

While there is general consensus on the need to improve fishing gear selectivity and to promote environmentally safe fishing gear and methods, little has been done so far to achieve these goals. Moreover, too many legal frame works still do not provide sufficient safeguards to prevent the introduction and use of harmful fishing gear or methods.

Table 8.8 Loss of mangroves in delta forest reserves (ha) from 1924 to 2001.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mangrove</th>
<th>Cultivation</th>
<th>Others</th>
<th>Total nine reserve area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1924</td>
<td>253 018.35</td>
<td>0.00</td>
<td>0.00</td>
<td>253 018.35</td>
</tr>
<tr>
<td>1954</td>
<td>234 510.05</td>
<td>18 508.30</td>
<td>0.00</td>
<td>253 018.35</td>
</tr>
<tr>
<td>1974</td>
<td>231 042.18</td>
<td>21 921.46</td>
<td>54.67</td>
<td>253 018.31</td>
</tr>
<tr>
<td>1980</td>
<td>181 059.86</td>
<td>69 217.22</td>
<td>2 741.23</td>
<td>253 018.3</td>
</tr>
<tr>
<td>1983</td>
<td>182 363.44</td>
<td>54 868.89</td>
<td>1 5786.06</td>
<td>253 018.59</td>
</tr>
<tr>
<td>1990</td>
<td>164 417.39</td>
<td>85 462.51</td>
<td>3 138.41</td>
<td>253 018.31</td>
</tr>
<tr>
<td>1995</td>
<td>161 013.92</td>
<td>90 763.13</td>
<td>1 241.29</td>
<td>253 018.35</td>
</tr>
<tr>
<td>2000</td>
<td>147 774.91</td>
<td>101 707.80</td>
<td>3 535.60</td>
<td>253 018.31</td>
</tr>
<tr>
<td>2001</td>
<td>111 938.51</td>
<td>140 581.47</td>
<td>498.37</td>
<td>253 018.35</td>
</tr>
</tbody>
</table>

Source: Maung Maung Than, Forest Department
Monitoring, control and surveillance

It is the duty of State to ensure compliance with and enforcement of conservation and management measures and establish effective mechanism to monitor and control activities of fishing vessels. Myanmar is conducting industrial fishing vessels to be registered and properly marked, maintain a logbook. Some measures can not afford such as undertake regular technical visit, embark observers on board and communicate their geographical position regularly. Satisfactory implementation of such measures has proved difficult to achieve to Myanmar due to well-known constraints, particularly lack of financial and human capacity. For a long time, monitoring and control measures were primarily directed at industrial fishing vessels, while little attention was paid to small scale fisheries. However, Myanmar needs to control and monitor the fishing effort of small-scale fishing fleets as well as has been increasingly recognized. So far, Myanmar has managed to systematically register and mark their small-scale fisheries combined with increasing competition result in very low compliance with conservation and management measures by small-scale fishers.

So far, Myanmar has failed to establish proper mechanism to coordinate actions by the fishery authority, the Navy and the Coast Guards. Myanmar is widely recognized that in port (Check point) monitoring and control of fishing fleets. Although Myanmar has enacted legislation providing for the protection of marine ecosystem and biodiversity from marine pollution and has designated competent authorities for administering such legislation, few actions have ensued. Regional cooperation is critical to improve monitoring, control, surveillance and enforcement of hilsa fisheries management measures. Increased efforts in Law enforcement and MCS would no doubt significantly improve existing fishery management systems throughout the region.

Possible modification of management measures

In small scale fisheries, high rates of illiteracy among fishers make it difficult to collect sufficient and reliable catch data. The awareness building and promotional activities to fishermen must be promoted. These include sensitization of local communities and other stakeholders to the use of devices to reduce catches of juveniles, seasonal and area closures should also be promoted where appropriate.

Increasing education and awareness building activities with fishing industries, through:

- Promoting of data collection and research to identify sensitive nursery areas and juvenile grounds where fishing should be avoided
- Helping all stakeholders to understand management decisions

Adequate protection of marine ecosystem, habitats and biodiversity can not be achieved unless all users of the marine environment cooperate with a view to reaching that goal. It is therefore the duty of DOF to facilitate the achievement of that goal through the establishment of proper consultation mechanisms and decision-making process and through the devising of effective linkages between all interested users and organizations.

Research work should focus on the development of cost effective method or techniques. These research activities should be conducted in line with regional and national priorities.

A4.5 Conclusion

The collaborative work with BOBP-IGO will be essentially to collect the information and ultimately promote sustainable hilsa fisheries.
Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand are working together through the Bay of Bengal Large Marine Ecosystem (BOBLME) Project to lay the foundations for a coordinated programme of action designed to better the lives of the coastal populations through improved regional management of the Bay of Bengal environment and its fisheries.

The Food and Agriculture Organization (FAO) is the implementing agency for the BOBLME Project.

The Project is funded principally by the Global Environment Facility (GEF), Norway, the Swedish International Development Cooperation Agency, the FAO, and the National Oceanic and Atmospheric Administration of the USA.

For more information, please visit www.boblme.org