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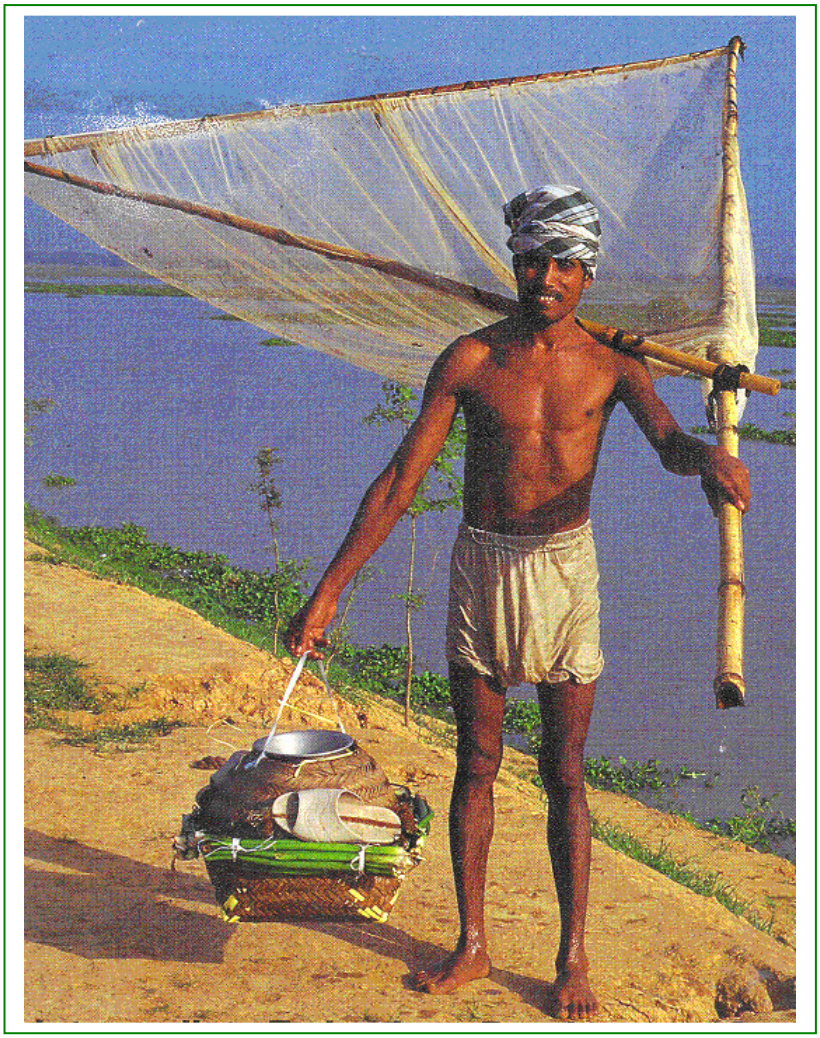
Food, Livelihood and Freshwater Ecology

The significance of small indigenous fish species



Practical Action Bangladesh

Food, Livelihood and Freshwater Ecology:
The significance of small indigenous fish species

Preface
Fisheries, an important mainstay of the people of Bangladesh, has been an area of special interest and significance for Practical Action Bangladesh (formally ITDG Bangladesh). The research report on Food, Livelihood and Freshwater Ecology: The Significance of Small Indigenous Fish Species bears special challenges relate particularly to key concerns such as food security, resource degradation and livelihood options of the poor. Food insecurity is a chronic problem for a vast majority of the people of Bangladesh, who do not have access to adequate food as required to lead an active life. The crisis is more pronounced amongst the income-poor landless and marginal households. Inadequate intake of fish/animal protein, fat/oil, fruits and vegetables is reflected in endemic malnutrition, under-nourishment, diseases, and high child mortality. Also the current state of the fisheries sector in Bangladesh is manifested in destruction further by water pollution, shrinking gene pool and loss of indigenous varieties. All these have grave consequence on the means if people to live, and use fishers resources in a sustainable manner.

I would like to express my gratitude to Zobaida Samina Heaven, Aquaculturist of ITDG [Practical Action] for her relentless effort to develop the Fisheries programme in ITDG [Practical Action] and for the overall coordination of the research successfully. I am also grateful to BASC and their team of researchers who made this possible by undertaking the assignment on behalf of ITDG [Practical Action].

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Contents

Abstract
Concerns over the continuing deterioration and degradation of the freshwater ecosystem, and associated decline in fish, particularly the Small Indigenous Species (SIS) prompted Intermediate Technology Development Group-Bangladesh – now Practical Action Bangladesh - to carry out some preliminary research in this area. The research was aimed at identifying the nutritional importance of SIS in the diet as perceived by their consumers, and importance to those who eke out a livelihood from their harvest. An inventory was made of SIS currently available in different aquatic environments. A review of the current knowledge of the freshwater ecosystem and its characteristics was conducted with particular reference to the status of SIS. The causes for the decline of SIS and its impact on human society as well as the aquatic environment were investigated. Finally, a series of options for sustaining the aquatic environment and SIS have been outlined, and recommendations made.

Fish and Food Issues

Bangladesh, classified by the United Nations as a low income (GNP around US$ 280) food-deficit (calorie consumption 80%) of requirement) country, has one of the highest population densities of any country (more than 800 inhabitants/sq. km). Most people of the country live in rural areas, and as a result there is a high degree of dependency on natural resources and agriculture for food, income and livelihood. Increasing population, pollution and environmental degradation are putting critical pressures on natural resources. This is threatening the livelihood and food security of millions of Bangladeshis. Two key priorities of the Bangladesh Government and the donor community (who finance up to 80% of the development budget) are therefore to develop the rural economy, and to increase food production. At the same time, major efforts are being made to reduce the impact of seasonal flooding through flood control and drainage projects. Ironically, it would seem that these development efforts are in fact threatening the sustainability of a key food resource in Bangladesh: the flood plain fishery.

Fish provides the main source of animal protein in Bangladesh (60-80%), but animal protein contributes only 10-15% of the protein intake. A diet of rice and lentils therefore provides for most of the protein and other nutritional need. Fish perhaps plays the most crucial role in the diet as a source of minerals and vitamins, essential for healthy growth and development. For, in addition to other nutrients, fish is a rich source of Vitamin-A, Calcium, Iron and Zinc. It is therefore a particularly important part of the diet for children and lactating mothers. Bangladesh has the highest level of malnutrition in the Asia-Pacific region. This affects 70-80 percent of the children in the country with a very high infant mortality rate (over 1 in 10 up to one year of age). Fish could play a key role in alleviating this problem.

Since 1960s, the country has placed considerable effort on enhancing its food production capacity and developing its rural economy through the "green revolution". Since 1980s, there has also been a significant development of aquaculture as an alternative to open water fish (the "blue revolution", which now produces around 30% of Bangladesh's fish supplies). Although from a production perspective the green and blue revolutions have achieved notable success, it is questionable how equitable the distribution of their benefits has been. It is also questionable whether the blue revolution is an appropriate strategy to address Bangladesh's protein needs. Rather, aquaculture has been more successful in producing fish as cash crop, thus improving the incomes of pond owners and increasing urban fish supplies.

There is increasing evidence that both the green and blue revolutions are having negative impact on traditional food production systems. Such systems are based on open access to seasonally diverse agriculture and fisheries activities, and use diverse common property flood plain resources. By contrast, the modern intensive and semi-intensive production systems of the green and blue revolutions are based on single or few crops, and restrict ownership and access rights of individuals or specific group's. The green and blue revolutions are therefore forcing a change in resource ownership and access regimes. A regime of open access (based on traditional rights) and common property flood plain resources is being replaced by restricted access to individual or group-owned resources. A move away from subsistence fishing and farming to cash based aquaculture and agriculture and purchase of food from the market is also being encouraged. Such changes have profound implications for the food and livelihood security of poorer households. The question therefore arises, will subsistence fishers and consumers be able to adapt successfully to this new regime, or will their fragile rights and survival strategies be eroded by forces beyond their control?

Freshwater Aquatic Resources

The flood plains of Bangladesh provide one of the most productive and diverse freshwater faunas in the world. Seven hundred rivers and numerous open water bodies seasonally amount to more than 50 percent of Bangladesh's land surface, providing an area of some 3 million hectares of permanent waters. This unique but vulnerable aquatic biodiversity is a precious national heritage, and the birth-right of both present and future generations. Over 300 species of plants and 400 species of fish and other aquatic fauna depend on wetlands for whole or part of their life cycle.

Freshwater fisheries in particular make an invaluable contribution to the national economy. They also form an intrinsic and essential part of Bangladesh's cultural traditions (mache bhate Bangalee - literally meaning Bengalees live on fish and rice). They provide a renewable food resource on which the nutritional well being and the livelihood of millions of rural Bangladeshi households depend. They also represent a unique resource of genetic material which must be safeguarded for the future nutritional and economic well being of generations to come. Forming an intrinsic part of the ecosystem, fish play a key role in recycling nutrients and in the complex flood plain food web.

The seasonal flood waters inundating the plains of Bengal have renewed this aquatic life support system for millennia, enriching the soils and washing away pollutants. This has enabled the rural population to enjoy open access rights to common property fishery resources - without having to worry about their future availability. Diversity of seasons and habitats (rivers, wetlands, water bodies, flood plain and dry land areas) provides for a seasonal diversity of available fish species. This in turn provides the basis for diverse livelihood and food production options. As this diversity is depleted, so becomes the food and livelihood security of the rural population increasingly vulnerable.

It is feared that these natural resources are in decline (in both diversity and number), thus jeopardizing the prospects for sustainable development. The transformation of the aquatic habitats and loss of wild species is increasing this vulnerability of Bangladesh's food production systems. It is further undermining the traditional rights of the rural population to open access to common property resources. The sustainable development of millions of people whose nutrition and livelihood depend on continued open access to the common property resources of the flood plain, is inextricably linked to protecting and conserving Bangladesh's renewable aquatic biological resources.

Small Indigenous Fish

Of the 260 species of freshwater fish in Bangladesh, over 140 species have been classified as "small indigenous species" (SIS). The term SIS would seem to be a recent re-interpretation of the Bangla word chotomach (literally, small fish), as opposed to boromach (literally, large fish). Chotomach are generally regarded as the small fish eaten by poorer households as a subsistence food. By contrast, boromach are generally considered to be a commercial crop, either wild caught species (like Hilsa) or produced in ponds (like the Indian major and Chinese carps).

However, equating the term SIS too closely with chotomach can be misleading. According to recent studies, SIS are not necessarily small: some species may grow up to 9 inches (or larger). Also chotomach is now a term commonly used for small exotic species (e.g. Chinese carps and tilapia), whereas SIS applies only to indigenous fish species. However, SIS (like chotomach) make a significant contribution to the diet, and nutritional surveys show that around 80% of the fish eaten in Bangladesh are small indigenous species. Their significance is however often overlooked by many observers.

The other value of SIS is that collectively they provide a flotilla of flagship species. Their relative abundance is an indication of a healthy ecosystem, whilst a decline in diversity and numbers warns that all is not well.

Human Impact

Freshwater ecosystems are highly vulnerable, and the impact of human activities can be profoundly damaging on them. In Bangladesh human interventions are the root cause of destructive impacts in 3 main areas: over exploitation of resources; habitat destruction and pollution. Also the introduction of several species of exotic fish to Bangladesh over the last 3 decades is providing an additional threat, of as yet unknown consequence.

Over exploitation: Population growth over the past three decades has increased pressure on aquatic resources: the need to provide both food and water to a growing population as well as a medium for domestic waste disposal is stretching the productive and self renewing capacity of aquatic resources to their limit. Although fish production over the past decade has shown an increasing trend, indications are that individual catch rates (catch/unit effort) have declined.

According to official sources (Government of Bangladesh), total fish production has increased from some 7.71akh tonnes in 1984, to 13.7lakh tonnes in 1996. Over this period catches from freshwater capture fisheries have increased by a factor of about 1.4, from 4.6 to 6.6 lakh tonnes. By contrast aquaculture production has increased by more than 3 fold, from 1.23 to 4.2 lakh tonnes. Over the same period, the population has increased from around 90 million to 115 million. Fish production would therefore seem to have grown at a faster rate than the population. What is not known is how much longer these production increases can be sustained. Fishing pressure has increased many-fold over the last decade, due to the entry of fishermen from outside the fishing sector, and through the use of more intensive (and non-selective) methods of fishing. Increasing competition for limited (and increasingly valuable) resources has also encouraged the use of non-selective fishing techniques such as the "current Jal", exacerbating an already acute problem.

Another potentially negative factor which this success story masks, relates to exotic species and genetic diversity. A significant proportion of the production increases has been based on the introduction of exotic species (mainly Chinese carps and Tilapia), which have now become a part of Bangladesh's freshwater fisheries. More recently, the introduction of African Magur, a large predatory fish, has set alarm bells ringing. There are no detailed record either of when these introductions were made, or the extent of their colonization, and its impact on the freshwater ecosystems. As most of the increases in aquaculture production have come from hatchery produced fish of exotic origin, it is possible that inbreeding and stock deterioration have taken place. This could result in negative future effects such as retarded growth, reduction in reproduction rate, and reduced disease resistance.

There are two further issues of concern which relate to aquaculture production. Firstly, hatchery produced fish have been stocked extensively in flood plains. In addition to the negative impact of exotic species on indigenous species (e.g. through competition and perdition), this could also cause the weakening of the gene pool of wild fish. Secondly, SIS are considered "weed fish" by the advocates of the blue revolution. Thus, most of the aquaculture systems promote poisoning of ponds

before stocking, in order to ensure the removal of competitors. Again, the impact of this on natural fish population and the wider environment is as yet unknown.

Habitat destruction: Flood control, drainage and irrigation projects have been designed to meet two key strategic objectives of the Bangladesh government: to mitigate the impacts of natural disasters caused by seasonal flooding, and to produce sufficient food for its growing population. These projects are effectively transforming the flood plains into dry land. Whilst the green revolution (started in the 1960s) has succeeded in placing rice self-sufficiency within reach, a parallel (but more recent) blue revolution in aquaculture (since the 1980s) has boosted the production of fish cash crops. The flood embankments, which restrict flooding, also restrict the seasonal migrations of fish essential for their reproduction and growth and the drying out of the flood plain has reduced their range. In southern Bangladesh, the inundation of vast areas by saline water for shrimp aquaculture has also had a major impact on the freshwater ecosystem, raising the question of whether such short-term benefits can be justified at the expense of Bangladesh's heritage and the long-term development of its population.

Pollution: The green revolution depends on intensive use of agrochemicals such as fertilizers, insecticides and herbicides. As a consequence, run off from the fields contain high levels of pollutants, exerting a considerable influence on aquatic resources. Waste from agricultural processing (e.g. jute retting), industry and municipal waste dumping is also contributing to the load.

Whilst the boom in agriculture and aquaculture has placed food self-sufficiency close to the target, it is debatable how sustainable the respective green and blue revolutions are, and how equitably their benefits are distributed.

Thus, for most people, pond-produced fishes are outside their economic reach, and are nutritionally less valuable than traditional SIS. Because of the way it is eaten" farmed carps have a relatively low Vitamin-A and calcium content. Furthermore, carps take at least 4-6 months to grow, whilst SIS may be continually harvested.

Rationale, Aims, Objectives and Methodology of the Study

Rationale
SIS raise major issues of concern but receive insufficient attention. There is a need to focus more attention on identifying and understanding the requisite social arrangements and environmental conditions for sustaining SIS. The study sets out to provide understanding of the current context and to identify options for action and research.

Aims and Objectives The study was carried out in order to:

- assess the existing knowledge on and status of SIS; the contribution it makes to society; its ecological niche and relative importance in the ecosystem;

- assess the contribution of social (local/traditional) and scientific knowledge, and indigenous practices in managing freshwater aquatic resources - particularly SIS.

- present the research findings to policy-makers' as a contribution to sustainable open water fisheries management; to researchers and academicians to assist in their research; to planners and practitioners to assist in formulating strategies for sustainable fisheries management.

The outputs planned included:
- an inventory of freshwater SIS;
- the identification of SIS under threat, extinct, declining, vulnerable etc.
- identify the environmental requirements (habitats etc.) and characteristics of SIS;
- the identification of causes of SIS' decline, and proposals for actions to halt/reverse such declines;
- the identification of options for aquatic resource management, and provision of recommendations for managing SIS resources sustainably.

Methodology
The study is based on a review of secondary data sources, and the use of rapid/participative rural appraisal (PRA) to gauge stakeholders' awareness of SIS related issues. Given the time constraint, the methodology was designed to be flexible. The particular methodology was chosen to enable easy interpretation of scientific information, social perceptions of the interconnections between human society, the environment, and the use of freshwater resources for food and livelihood.

The review of the secondary data embraced a wide range of issues and concerns. Information was obtained from a variety of sources, including ICLARM, BFRI, IFADEPSP2 and the FMS DFID library.

For the field level PRA, two locations (Tangail and Faridpur) were selected on the basis of the local significance of SIS, and the different agro-ecological conditions of the areas. In Faridpur, flood control and irrigation projects have been in progress for the last 30 years. In Tangail it is only recently (1992) that "compartmentalization" of flood affected land through flood control schemes are taking place. Both locations have considerable flood plain area, and therefore fish make significant contributions to the diverse food production system and livelihood in these areas. Indications are that the freshwater ecosystems of these two areas are among the most severely affected by human intervention.
These were therefore purposefully selected as areas where relatively recent changes have affected the status of SIS.

The PRA methodology was essentially designed by the research team. It comprised two main elements: focused group discussions with specific stakeholder groups, and individual interviews with selected socio-economic categories from primary stakeholder groups. In both areas, participants in both the focus group discussions and the individual interviews were selected on a random basis.

Group discussions and individual interviews were conducted using open ended questions and selected topics; diagrams were used to help understand changes over time. The PRA discussions were recorded for further reference and learning.

Timing:
This study was initially planned to take 6-weeks up to 25 March 1998. However, the time frame was extended by 4 weeks to enable further analysis of information generated, and to allow for further validation by the scientific and rural communities. The total study took 12-weeks.

PRA participants were selected from the following socio-economic categories:
(figures in bracket indicate numbers of respondants)

1. Full-time professional traditional fisherfolk (from Hindu and Muslim communities traditionally associated with fishing) (108);
2. Full-time professional non-traditional fisherfolk (relatively recent entrants to fishing, from mainly Muslim communities not traditionally associated with fishing (71);
3. Part-time fisherfolk (43);
4. Landless households (32);
5. Rural poor households catching for subsistence of additional seasonal income (47).
6. Households owning depression, kua, or beelland, etc. (7);
7. Fish traders (13);
8. Consumers (people eating fish) (27);
9. Customers (17); and
10. Housewives (23)

The following process was adopted:

- selection and recruitment of research team,
- finalizing TOR for work;
- review of secondary information relating to SIS and the significance to human society and aquatic ecology;
- listing freshwater SIS species;
- analysing data to identify key issues;
- conducting field level research using check lists (see section 5.2.);
- gathering primary data (observations, responses to interviews, and other information from various sources (fisherfolk, farmers, landless households, women, children etc.);
- analysing primary data generated by the study;
- verification of findings (through informal discussions with researchers and field practitioners (NGOs and field workers);
- identification of strategic options for the future, suggested by the study;
- making recommendations for policy-makers, planners, practitioners.

What are SIS?
According to Rahman (1989), there are 260 species of freshwater indigenous fish in Bangladesh. In the past, most of these have been classified as small and of little commercial or economic value (Ali, 1997). One source groups them together as "miscellaneous species of fish and prawn", describing them as "poor people's fish", and concludes that "subsistence fishing for small fish and prawns provide a cushioning effect on poverty" (FAP 6, 1993).

A recent study (Fells et al, 1996) implied that small fish are not so small, growing to a length of 25 cms. This study listed 45 species, including 18 species of carps and 9 each of catfishes, perches and other groups as SIS (see Appendix 2 for complete list). Felts et al (1996) further sub-categorized SIS into three main groups:

a. Species which reach a maximum length up to 7.5 cm (3 inches).

b. Species which reach a maximum length up to 15 cm (6 inches).

c. Species which reach a maximum length up to 25 cm (9 inches).

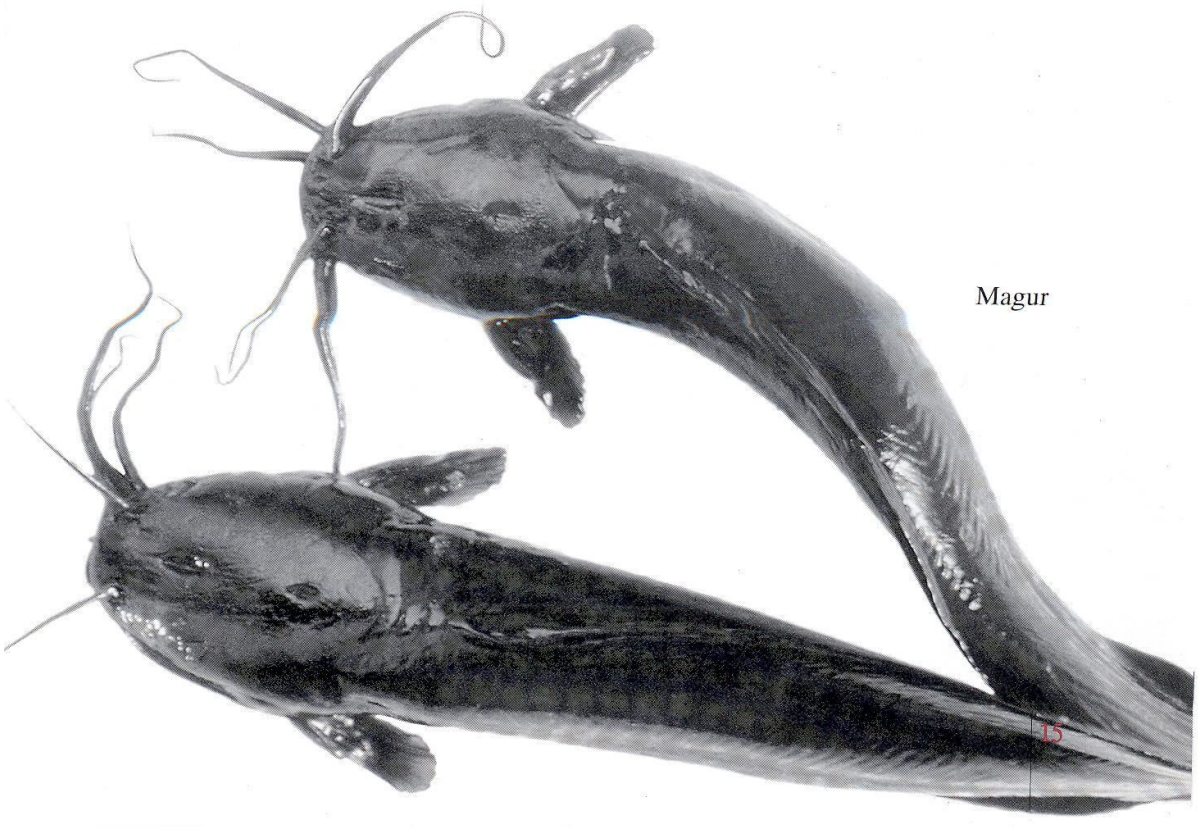
Another study (Ali, 1997) listed 143 species of SIS, some of which are shown in the table below:

Table showing main SIS species groups (Ali, 1997)

Species Group	**Local Name**	**Scientific Name**
Small catfishes	Magur	Clarias batrachus
	Singi	Hetropneus/es fossilis
	Pabda	Ompok pabda
	Tengra	Mystus tengra
Knifefishes	Foli	Notopterus notopterus
Snakeheads	Shoal	Channa striatus
	Taki	Channa punctatus
Needlefishes	Kaikka	Xenentodon cancila
Minnows, Rasboras and Bards	Puti	Puntills sarana
	Chela	Salmostoma phulo
	Mola	Amblypharyllgodon mola
	Jaya	Aspidoparia jaya
Loaches	Rani	Botia dario
Anchovies and Sardines	Phasa	Setipillla phasa
	Chapila	Gudusia chapra
Spiny eels	Bairn	Mastacembelus aculeatus
Climbing Perch	Koi	Anabas testudineus
Gobies	Bailla	Glossogobius giuris
Mud Perches	Meni/Royna	Nandus nandus
Glassfishes	Chanda	Chanda ranga
Fresh water prawns	Icha	

Puti

Tengra



Magur

The Nutritional and Socio-Economic Significance of SIS

SIS and Nutrition

Minkin et al (1993) noted that rural people consume between 56 and 73 species of SIS, among which Puti (Puntius sp.), Mola (Amblypharyngodon mola), Dhela (Rohtee cotio), Chanda (Chanda sp.), Kbolisha (Colisa sp.), Koi (Anabas testudineus), Foli (Notopterus notopterus) are the principal types. Several sources mention the importance of SIS in the diet

(FAP 16, 1992; Hossain and Afroze, 1991; Hossain et al, 1994; and Felts et al, 1996). Declines in abundance and reduction of access are therefore likely to have a negative impact on the food security and nutrition of poorer households. Particularly vulnerable are children below five years and lactating mothers.

Shakuntala (1996) questioned the strategy of promoting fish as a protein source. Rather, she argued that it is more important as a source of other essential nutrients and it should be promoted in this regard. Rice contributes 64% of the food that is eaten by Bangladeshis, vegetables (30%), followed by fruit, and animal protein (mainly fish) (6%). In such a food system dominated by rice, fish is the main source of nutrients.

Shakuntula emphasized the importance of SIS as a "whole food eaten whole", providing a balanced source of nutritional requirements. This is in contrast to larger fish from aquaculture, which are not eaten whole and hence are less nutritious. She highlighted the following particular nutritional advantages of SIS:

- SIS grow quickly and can be constantly harvested; carps take 4-6 months and may necessitate many more inputs;
- SIS can be dried more easily than large fish, and has a very high calcium content.
- SIS can be mixed easily with other food; larger fish may require special preparation and a different cooking pattern.

This means SIS can be eaten daily in low income households, whilst in such households larger fish are only eaten at festivals and on special occasions. Thus the role of SIS with respect to meeting food and nutritional security is very different from that of large fish.

Fish often provide the only source of animal protein for landless and small holding farmers. A household consumption study (FAP 6, 1993) in north-east Bangladesh found that communities living near beels consumed 60% more fish than those adjacent to rivers or from highland areas.

According to Villif and Jorgensen (1993), Puti (Puntius sp.) contains double the amount of iron compared to Silver Carp (Hypophthalmicthys molitri) and Rohu (Labeo rohita). They also found that Mo]a (Amblypharyngodon mola) contains 3 times more calcium and 50 times Vitamin-A than that of Silver Carp and Rohu.

It is therefore questionable whether pond aquaculture is an appropriate strategy to improve the nutrition of poorer people in Bangladesh, who have neither access to ponds for subsistence catches, nor sufficient income to purchase fish from markets.

SIS and Socio-Economic issues As well as providing an important source of nutrition, fishing of SIS and other species is an important source of income. It also provides the basis for a number of diverse livelihood options which landless people can fall back on. This is particularly important when other livelihood options fail. FAP 16 (1995) studied the contribution of SIS to household income directly and indirectly. On an average, landless households earned Tk. 484 from direct sales of fish, whilst within the household the value of SIS consumed was Tk. 966. Thus the total income from SIS was Tk. 1,450.

A study by CARE INTERFISH revealed that fish price varies from Tk. 20-90 kg for small fish, and Tk. 60-120/kg for larger fish.

In Bagerhat, catches from the beel fishery have declined, causing a reduction in fishing income. Fishers have blamed the decline on blockages in the migration routes.

Sorputi

Foli

Taki

FAP 6 (1993) also noted that low income of fisherfolk prevents accumulation of capital. This report also noted that without concrete and significant changes in the process of accessing fisheries resources for fishermen, ensuring their tenure, and financial, technological and marketing support, little positive change can be expected in the living conditions of fishing communities.

The Freshwater Ecosystem and Food Production

Land resources in Bangladesh may be defined according to their degree of inundation. Only 34% of the land area is above the level of inundation, so as much as 66% of Bangladesh's land area can be considered as a potential wetland zone. This provides a large potential habitat for SIS and other indigenous fish species.

Bangladesh: Distribution of Land According to Degree of Inundation

Land types	Characteristics	Area (hectares)
Total		12,305,581
Highland	Land above normal inundation	4,199,952
Medium Highland	Land normally inundated up to 90cm deep. MH1= inundated up to 30 cm deep MH2= inundated up to 90 cm deep	5,039,724
Medium lowland	Land normally inundated up to 90-180 cm deep	1,771,102
Low land	Land normally inundated up to 180-300 cm deep	1,101,560
Very lowland	Land normally inundated deeper than 300 cm	193,243

Such a high degree of inundation is seen by many as a major constraint to food production and rural development. In order to increase the area available for HYV agriculture and to reduce the negative impacts of flooding, various projects have been implemented to regulate the flow of water in the rivers and over the floodplains.

The Flood Action Plan (FAP) of Bangladesh has been a major donor supported project, designed to transform large areas of Bangladesh's floodplain into dry agricultural land. This development is also promoting a change in the access and property regime, and is establishing a new hierarchy of land owning people. Landless people who have traditionally relied on open access to common property floodplain resources for subsistence fishing and cultivation are finding themselves excluded. The new regime therefore, as well as having a major impact on Bangladesh's aquatic ecosystem, also has serious implications for the rights to livelihood and food security for large numbers of landless households.

The kinds of projects they are involved in, and the physical changes associated with them include:

- The construction of embankment and drainage facilities through Flood Control & Drainage (FCD) projects which has made land flood-free. This prevents water from entering the land, as well as not allowing quick drainage of water accumulated inside the embanked area.

- Submersible embankments to delay flooding in the deeply flooded areas of northeast region.

- Dams, closures, barrages, regulators across the rivers as in case of the Feni river in Noakhali; the Lohajang river in Tangail; regulator across Gorai river at its confluence with river Padma in Charghat, Rajshahi and the dam across Kumar river at its confluence with Kaliganga river in Jhenidah district.

The impact of measures undertaken by the Flood Control Projects on freshwater fisheries, particularly SIS, include:

- Overall fish production within the project area decreased by over 35% within two years of operation of flood control measures in Chandpur Flood Control & Irrigation Project.

- Eighteen fish of migratory species of tidal/estuarine origin can no longer enter South Dakatia river and into the floodplain. Thus catch rates have been drastically reduced in the freshwater capture fishery.

- A study carried out under the FAP (FAP 6, 1993) in the north eastern region of Bangladesh documented the fishery dynamics on the floodplain. During the rainy season the entire floodplain, rivers and khals become a single water body. Fish are widely dispersed, and people have open access to fishing. The replacement of productive open

access floodplain by high input agricultural land is having impact on a major food resource: fish. Such projects are jeopardizing future supplies of fish protein from wild stocks, the main source of animal protein for the poor.

Loss of Fish Production Based on the Loss of Inundated Area to Cropland, calculating the area actually lost in 1985, and projected to 2005
(Source: MPO Technical Report 17, 1987)

Area of Inundated Flood Plain Removed	Minimum Loss of Fish (Direct Flood Plain harvest @ 37 kg/ha/yr)	Maximum Loss of Fish (Direct Flood Plain Harvest Plus Contribution of Flood Plain to River and Beel Fish)
	Metric Tonnes	Metric Tonnes
814,441 Hectares (by June 1985)	30,133	44,793
2,000,000 Hectares (by 2005)	74,000	110.000

Projected Fish Requirement, Demand and Production Potential (Million Tonns)

Production During base year	Fish Requirement		Fish Demand		Achievable Production		Production Potential	
1990	2000	2010	2000	2000	2000	2010	2000	2010
0.843	1649	1998	1170	1803	1133	2200	2266	3831

The implications of the FAP on aquatic resource production, and on meeting a growing market demand and population requirement are therefore considerable.

Several authors have highlighted the linkages between the decline of previously common fish species in inland waters, the transformation of the habitat, and the reduction of water levels in beels and the floodplain. The FAP has produced a plethora of reports documenting such changes (FAP 1992 to 1994).

Whilst flood control embankments prevent the migration of fish and prawns from rivers to the floodplain and vice versa, drainage of the beels and flood plains reduces and eventually eliminates fish habitats (Ali, 1997).

Water pollution, much of it from industrial effluents, agrochemicals and domestic organic wastes is also a major threat. Tanneries, urea, newsprint, paper and pulp plants and jute mills are known to release untreated wastes into rivers and other water bodies. Pollutants discharged include mercury, lead, chromium, arsenic and iron. Even at relatively low concentrations, these pollutants can detrimentally effect the aquatic fauna (World Resources Institute, 1990).

Hossain et al (1996) have warned of the dangers of a shrinking gene pool, and loss of genetic diversity. The depletion of stocks and the loss of species reduces biodiversity, changes the biological and tropic structure of the ecosystem, increases vulnerability and undermines sustain ability. It also leads to increased fishing pressure being placed on the remaining species. He identified the following causes for the loss of biodiversity:

- reduction in floodplain ecosystems;
- expansion in HYV rice production;
- indiscriminate use of pesticides; and · pollution and siltation of the river system.

As a result of their cumulative impact, several species of floodplain, riverine and brackish water fish are threatened (Hossain et al 1997). Hossain (1997) also lists inter alia the following causes for the decline in SIS:

- over-exploitation to support the growing population;
- siltation of river beds and inland water bodies;
- fish disease;
- irrigation for agriculture;
- application of agro-chemicals;
- ecological factors;
- application of poison in the deep ponds to kill SIS fish;
- reckless use of current jal;
- water scarcity due to changing environment; and impact of FCD/I projects for agro cropping.

In north-western Bangladesh, Bhuiyan (1997) cites the following reasons for the overall decline in SIS:

- over fishing;
- wide use of insecticides and pesticides; and · insufficient inundation and siltation in the rivers.

FAP 6 (1993) identified the following reasons for the decline in flood plain production in the north-east region:

- siltation of river beds and deeper beels;
- over exploitation of fish;
- fine-meshed nets used in tributaries affect SIS breeding and juvenile growth;
- fishing in the beels by complete de-watering;
- deforestation of the haor area;
- industrial effluents;
- barriers to fish migration during the breeding season caused by FCD/I projects.

An environmental impact of freshwater prawn cultivation in Bagerhat district was carried out by CARE-GOLDA (1997). Prawn cultivation and Gher construction are considered to have negative environmental impacts and to have caused a reduction in SIS. They cited the following consequences:

- reduced recruitment of riverine species migrating to coastal areas to spawn;
- reduced wetland habitat;
- reduced beel area;
- reduced grazing land;
- water pollution;
- blockage of water ways; and decline in snails

Biological, Seasonal and Physical Diversity: a Dynamic Equilibrium
The freshwater ecosystem is a valuable component of Bangladesh's biodiversity heritage.
A wide variety of habitats and ecosystems, geographically and seasonally isolated and varied, provide basis of a highly diverse fauna and flora. This has adapted and evolved to fill the myriad of ecological niches. The seasonal cycle of flooding and drying out of the flood plain provides for a seasonal enrichment of the soils. The linking of many water bodies at this time, effectively forms a single (but highly diverse) biological production system. The migratory and reproductive behaviour of freshwater fish is finely tuned and adjusted to rhythm and amplitude of this seasonal cycle of flooding.

Freshwater Aquatic Ecosystems of Bangladesh

Rivers: There are about 700 rivers, with a total length of over 24,000 Kms. These include two of the world's largest rivers, the Ganges and the Brahmaputra which form an extensive estuary of 552,000 hectares.

Riverzone and Khals (Canals) cover an estimated area of 480,000 hectares.

Open Waters: Beels and Haors: Although their ecology is not identical, they are grouped as one category with a combined area estimated to be about 118,000 hectares, and classed as open waters. They become part of the flowing water system when inundated, during monsoon. Beels are swamp lands formed in the dead channels of former rivers which may contain water during part of the year only. Baoys are tectonic depressions filled with water for part of the year, with the deepest part containing water throughout the year. Baoys or oxbow lakes are formed in the meandering parts of old rivers which became cut off from the river system.
These are standing freshwater bodies and mainly situated in Jessore and Kushtia districts. The area of Baors is estimated at 5,500 hectares.

Ponds: Used for fish culture, they are mainly burrow pits, i.e. closed water bodies, excavated and filled with water, a rough estimate of pond area would be close to 200,000 hectares.

Burrowpits consist of a variety of innumerable excavated pits along with roads, highways, irrigation channels etc. Their area and length are unknown.

Lakes are large freshwater reservoirs, either constructed or natural. The three natural lakes in Bangladesh are the Rainkhyngkine lake, the Bogakine lake, and the Ahsula lake. The two artificial lakes at Kaptai and Feni have significantly different ecosystems because of different discharge system.

There is a dynamic equilibrium among physical environment, biodiverse aquatic resources and livelihood strategies that rural households have developed. The cycle of reproduction and growth of aquatic food resources is closely geared to the cycle of seasonal and physical change of the floodplains. The process of migration, the onset of breeding and reproduction are triggered by environmental signals, which bring a complex array of genetic, sexual, hormonal and behavioural factors into play. Environmental parameters include day length, turbidity, water temperature, oxygen and carbon dioxide levels, pH, currents, rain fall, wave action, availability of food etc. Other factors include intra and inter-specific competition (Hossain, 1989) between species.

Some SIS breed throughout the year, other species breed more than one between March and October, whilst others maintain more confined breeding seasons. A few prefer clean water and low temperature for breeding.

Many SIS breed in baors throughout the year. Haque et at (1996) identified 50 species in two oxbow lakes in southwest Bangladesh with a yield ranging from 78 kg/ha/month to 32 kg/ha/month.

In the case of small prawns in the Rajshahi area, Dutta et al (1996) found that they were present in the catch throughout the year, .put" with two peak seasons (December to February and June to early August). In beels and small rivers in Rajshahi, Dutta et al (1996) found relatively high densities of small prawns. They estimated the total prawn production for greater Rajshahi area s 8,391. 16 maunds (37 tonnes) per day.

Breeding behaviour can be broadly categorized into two types: Flood plain (and beel) breeders, and fish that breed in rivers. For many species breeding begins during the pre-monsoon floods. The optimal conditions are during the storms when flash floods, continuous rain and thunder storms stimulate fish breeding. Fish begin to move against the pre-monsoon flood waters as they enter the beels in search of a suitable spawning substrate. Thus the Ghollia, Boal, Foli, Pabda, Shoal, Gazar, Lati, Cheng, Koi, and Laso prefer to breed on freshly inundated grassy areas, where current is slow, water depth is shallow, and bush and reeds are present (FAP 6, 1993).

Miukin (1989) describes the up-river migration of fish, and their lateral rillgration into the flood plain~ during the rainy season. In rivers the timing of the spawning migration is between April and June. The survival of fish in beels is correlated to surface area of the wafer, and this determines how many spawns will survive to the following season (CIDA 1989). During the dry season food supply is limited, fishing pressure is high and growth is slow (Welcome 1985).

Hossain et al (1997) described the onset and progress of breeding cycle of SIS according to six parameters:

- percentage of females;
- gonadal length index (gonad length:body:length);
- gonadosomatic index (gonad length:body:length);
- diameter of ova;
- maximum egg bearing capacity;
- colouration of the gonads.

Artificial Breeding and Aquaculture:
Various attempts have been made to induce breeding in SIS, and to develop culture systems for them. Rajts et al (1996) attempted continuous culture and controlled breeding in Mola (Amblypharyngodon mola) and several other small species. They obtained a production of 386 kg/ha in 3 months, and mass breeding was successfully carried out between August and November.

Mustapha (1997) achieved similar success in the same species (mola -A. mola). He measured various parameters including intra-ovarian eggs, gonado-somatic index, relative condition factor and grading of spawn. He confirmed breeding three times a year in April, July and October. In monoculture, he obtained an average yield of 2,472.48 kg/ha/yr, at different stocking densities in "mini ponds".

In field trials in three districts in northwest and southwest Bangladesh, Akhtaruzzaman et al (1997) experimented with the culture of Mola, Bata (Labeo bata), Bhanga (Cirrhinus reba), and Dhela (Rohtee cotio). Obtaining 1,327.80 kg/ha in 5 months, he concluded that small and shallow water bodies are suitable for such species using low cost inputs.

Kohinoor et al (1997) carried out trials with Mola (Amblypharyngodon. mola), Chapila (Gudusia chapra), and Punti (Puntius sophore) in Mymensingh. Production rates of Chapila at 92.13 kg/ha were significantly higher than that of Mala at 57.88 kg/ha.
However, when grown in polyculture with carp, carps do less well than on their own.

Kabir (1997) experimenting with the polyculture of SIS (Mala, Punti and Chingri) and exotic carps (silver carp, grass carp and mirror carp) in Mymensingh, achieved a per decimal growth rate over 5 months of 2.55 kg for the SIS and 5.96 kg for the carps.

In a carp hatchery in Jessore, Hamilton and Tripathi et al (1997) successfully bred and produced large fingerlings of the Bhagna or Raik (Cirrhinus reba).

In northwest Bangladesh (Bhuiyan, 1997) a few attempts have been made to cultivate Magur (Clarias batrachus), Pabda (Ompak pabda) and Tilapia on a small scale. However, lack of availability of fish eggs, comparatively low price of fish in the market, poaching and lack of appropriate research are cited as major constraints to expanding such cultivation in the region.

Harvest and Marketing:
Floodplain fishing for SIS is characterised by a wide variety of gears. Ahmed (1956) described 116 nets, 26 traps, hooks and other devices. A study by Dutta (1983) in Rajshahi district listed 10 types of net, and 8 traps (types of dohar, anta, kholson, jangla etc.). Nets include cast nets, drag nets, and mosquito nets, and fish are also caught using bare hands!

Dutta (1983) also found a number of different kinds of boats used to carry fishermen, nets and their catch. These include the country boats called Kari-dingi, Kanai-dingi, Jailadingi etc.; crafts made of tree trunks (donga); and rafts made from various fibrous plants, including parts of banana trees.

Fishing gears show a great deal of geographical specificity, and fishing methods vary with the hydrobiological and physiographical conditions. Also in different regions the same device may be used, but of a different size and with a different name, Fishing is also carried out with hook and line, and by draining water (Dutta 1983, FAP 6 1993).

There is a great deal of seasonal and regional variation in the quantity and type of fish available in local markets. Rural markets are dominated by small fish such as puti, royna, and koi. The beel harvest peaks between January and April, whilst

the river harvest peaks during November and December. Floodplain species arrive in the markets between May and December, with a peak between October and December (FAP 17, vol 20 1994).

Mitigation:
Various measures have been suggested for conserving SIS. Hossain's (1998) suggestions include the following:

- aquaculture;
- conservation of wetland biodiversity;
- reforestation;
- preservation of surface area;
- germplasm preservation and
- public awareness of land use policies.

Awareness raising campaigns have been suggested (Ali] 997), focusing on the preservation of the habitat and maintaining biodiversity.

IFADEP-SP 2 have initiated some aquaculture trials in the Northwestern region of Bangladesh. This has shown some success with the breeding and rearing of Mola, Kholisa and Raik.

Research by the Bangladesh Fisheries Research Institute (Hossain et al 1998) to develop seed production and culture technologies for S]S has met with some success for the fo]lowing species:

Koi-Anabus testidineus;

Puti-Puntius sarana;

Cavashi Tengra-Mystus cavasius.

They also emphasised the importance of habitat improvement.

FAP 6 (1993) proposed sustainable water management and the involvement of fishers in fisheries management as an alternative to aquaculture production of SIS.

Field Survey: PRA Results

Rapid participatory rural appraisals (PRA) were carried out in two districts, namely Faridpur and Tangail for the reasons already discussed (see section 3.3:Methodology). PRA activities consisted of group discussions and individual interviews. This section of the report is divided into two parts: the first part deals with the group discussions, while the second deals with the individual interviews.

Group Discussions
Group discussions were carried out in fisherfolk communities, and in several thanas of rural Faridpur. Several socio-economic categories were covered and respondents! participants included:

- professional and traditional fisherfolk;
- part-time fisherfolk;
- subsistence fisherfolk;
- consumers;
- traders.

Three case studies are presented below which summarize the main issues raised during the group discussions.

Case Study 1: The Village of Dorjipara in Tangail District
There were 13 participants in this discussion group. All were members of a traditional Hindu Rajbangshi fishing community. Five of them were married women. The main message coming out of the discussion was: **No water, no fish, no livelihood.**

Discussions centred around 8 topics that were as follows:

On the Availability of Freshwater SIS in the Beels, Khals, Rivers and Flood Plain
General awareness and concern was expressed about the loss of traditional fish species. Concern was also expressed about the loss of access rights and the changing socio-economic context. Several respondents highlighted the increasing use of the current jal (monofilament net). The impact of this was seen as particularly negative during the monsoon when fish are caught that are full of eggs. Although this is illegal, officials take bribes and turn a blind eye to such practices.

A major set back for this community is the implementation of the Compartmentalization Pilot Project (CPP, or FAP 20). According to the respondents this has blocked the main rivers (Jamuna, Lohajang and others), and the sluice gates are controlled by the influential people who cultivate rice inside the embankments. They prevent the gates being opened to allow the fish to move in and out of the beels across the flood plain. As well as preventing the movement of fish to spawn, this project has effectively deprived the community of their traditional rights of access to fish in the flood plain. In the past, they harvested fish from a number of beels, including Gabadi beel, Singerkona beel, and Jugini beel. These are now leased to influential people, and if the community try to lease them, they are threatened by the mastans.

With the CPP and the entry of influential people, there have also been changes in traditional practices. In the past, in exchange of providing netting services, fishing groups were paid in both cash and kind. Today, they are only paid in cash: they no longer receive "gifts" of fish for their services.

Respondents claimed that the entry of influential people has also increased pollution through increased use of inorganic fertilizer. Also the soaking of jute was cited as causing the open waters to stagnate.

On small indigenous species considered depleted/endangered
Respondents were concerned about the increasing scarcity of several species in their catches. These include Baija, Mola, Nandan, Pabda, and Along. Likewise Sharputi is now seldom found. Other species which they get in limited number are Tengra, Shol, Taki, Icha.

On how SIS can become more available
Respondents proposed that the use of the current-jal should be banned; and that the Dhaleshwari river should be re-excavated and re-routed. A deeper river would retain water all the year round, and make fish more available.

On the culture of Small Indigenous Fish Species
Generally respondents were not positive about the culture of SIS, on the basis that:

- it would not be profitable;
- SIS would give a lower yield compared to carps;
- the growth of SIS would be lower than carps; and o SIS would transmit diseases to the carps.

On their Dietary Preference for Fish
SIS (chotomach) are far more popular than carps (boromach). Although they have less taste than chotomach, boromach are more popular in the market, where people buy them for 'social status'. The respondents preferred chotomach, describing it as "nature's blessing", and highlighted that people can buy more fish with less money.

On the Breeding and Lifecycle of SIS
The following extracts are taken from the discussions:

"Meni breed and spawn in beels. As it is a slow and foolish fish, it gets entrapped easily.
The current-jal is the major reason for the depletion of Meni in Tangail area."

"Pabda live in the river Jamuna. These are very clever evasive fish. This species has disappeared since water entry into the Jamuna has become restricted."

"Piali also live in the river Jamuna. This species also has disappeared for the same reasons as of Pabda."

"Puti, a dominant small indigenous fish species of the floodplain like the Mola, is also rarely found since the disease broke out (epizootic ulcerative syndrome in 1988). Taki and Shol are also less visible became of the diseases."

On the Limitations and Drawbacks of SIS as Food
Several issues were highlighted, which included:

- SIS has lot of bones, so it has to be eaten carefully;
- SIS gets rotten quickly, so it has to be consumed or marketed soon after capture;

Measures Needed to Revive SIS
a number of measures were suggested including:

- closure of fishing areas for up to 3 months (in rivers, beels and floodplains), corresponding with the months of Baishakh, loishtho, Ashar (early monsoon);
- during such a closure, traditional fishermen should be provided with some kind of support;
- ban the use of current and khoiya jal;
- increase the depth of the rivers-both the main ones and smaller ones.

Discussion Group 2: The Fish Bazar in Toolagram.
The meeting took place in the Bangla month of Falgun (mid-February). The participants were members of poor, landless and mid-income households. Key participants included fisherfolk, fish traders and community elders.

The main theme coming out of the discussion was: **Chotomach has become a sad memory of our past**.

"Once there was a beel in this locality called Shakull beel. Natural waters during monsoon inundated the area. This provided a natural stock of fish from which we caught what we wanted to eat. The sluice gates and embankments built over the last few decades have gradually surrounded (and cut off) the area where water used to come and enter the beel."

The discussants stated that the embankment controlling natural inundation of the low land has:

- reduced the availability of freshwater fish by over 90%;
- increased HYV culture in the land reclaimed from inundation;
- increased use of inorganic fertilizer, insecticide and pesticides for HYV;
- increased human settlement leading to increased catch effort;
- increased professional fisherfolk (Muslim new entrants); and o shakul1 beel is entirely dried out through December till February (as all land is privately owned). Thus fish cannot live throughout the seasons allowing them to grow, mature and breed.

The respondents believed that SIS (Chotomach) play an important role in maintaining the ecological balance of open water bodies. The main cause of SIS' decline was the control of the natural flow of water over the land. This used to make it fertile, providing sustenance for both terrestrial and aquatic flora and fauna.

The fisherfolk elders informed us about the habits of some fish species: "Melli and Puti consume organic debris. These were found in abundance in the open-waters before the embankment was constructed. Now debris has become less available, and these two species have suffered most."

- Some villagers buying fish from the bazar (small market) reflected that at present:
- Less fish is available in the bazar and in the locality;
- Less fish means less available to catch and consume;
- Price of Chotomach is increasing as less and less land is inundated, depriving SIS of habitat;
- Increased prices reduce the capacity of poor households to purchase fish;
- People are forced to buy cultured species (Silver Carp, Nilotica, Mirror Carp etc.) They prefer leol mach (Koi, Shingi, Magur), but these are much less available than any other fish these days;

- Fish do not grow to proper size prior to maturation due to shorter monsoon duration and short period of water retained in low lands;

- Siltation in the area and vicinity due to the embankment also has reduced water flow, reducing the aquatic habitat for fish;

- Chotomach feared to have disappeared are Kownia and Alenga;

- Sorputi and Meni are regarded as most endangered Chotomach;

- Many people, particularly the younger generation have forgotten or are not familiar with certain Chotomach due to their lack of availability in the locality.

As one of the villagers lamented, **"Chotomach is a memory of our past. Today, the only fish we find available are fingerling of fish species which are cultured."**

The specific actions recommended by the PRA participants were:

The government should arrange a minimum of 5 acres of land for every 100 acres to be used as perennial Chotomach habitat, so that SIS can mature, over-winter and breed.

Shakun Beel should be re-excavated. Feeding canals (khals), and the beels should be managed as a Fish Sanctuary.

Discussion Group 3: Canal-side Meeting with Fisherfolk
This meeting was conducted with a group of fisherfolk netting a canal, known locally as Bhangar Khat. There were 4 members of the Group, all who came from a village namely Toolagram.

The main theme arising out of this group was: Chotomach is disappearing.

On the Species of SIS they catch:

- Currently the catch consists mainly of Darkina, Puti, Bailla, Mola (Moa), Choika, etc. During monsoon they use Bheshal jal to catch Sarputi, Baim, Koi, Chela, Batashi, Pabda, Tengra and Gulsha. They also catch Mola and Darkina from ponds."

- They claimed that" the badh (embankment) prevents water from entering the lowlands. In addition, situtation of (he beels and khals also prevent water from remaining for long enough for the fish to grow and regenerate."

On the Subject of SIS and Nutrition:

- All agreed that: "Chotomach is good to eat", acknowledging that "Chotomach is full of many vitamins. They are good for the eyes."

- Using a Chela jal (a cross between a seine and gill net), costing about Tk. 7,000 to make, the four-member team's catch for the day (2 hours continuous team effort) totalled 2.15kg.
- This would sell for Tk. 50 at current market conditions.

- Benu Sardar, the oldest team member stated that "less than one anna (one part of sixteen) of fish is available compared to a decade ago."

- Waterbody (for fish to live) has reduced alarmingly due to the embankment;

- Increased pressure on fishing is due to increase in population;

- Increased use of pesticide and other chemicals is polluting water and hence degrading fish habitat;

- They also described how Chotomach contributed to aquatic ecology and plays a part in maintaining nature's balance:

- "Chotomach help clean the water in which it inhabits by eating organic debris."
- Chotomach also enrich the soil with their excreta.
- "Chotomach, which grow and graze in the open waters, feeding from nature, are tastier to eat than any mach cultured or captured from closed water bodies."

PERSONAL INTERVIEWS
Interviews were conducted using a check-list of questions with respondents selected from pre-determined socio-economic categories (see below). The rural settings where the interviews took place included the local hat or bazar, homes, fields etc. Over three hundred interviews were conducted with both male and female respondents.

Eleven topics were discussed, and information, opinions and experience sought.
Interviews started by asking respondents about local water bodies (beel, river, canal, etc.) and extent of flood plain during monsoon.

Interviews	**Total**	**Male**	**Female**
	312	178	134
Fisherfolk	182	101	81
Poor Rural Household	98	57	41
Poor Urban Household	32	20	12

Checklist of Questions/Issues Used for PRA Excercise

What is the availability of SIS in the locality (species wise)?
Are SIS declining or no longer available in the locality?
What are the reasons for decline/disappearance of SIS?
What is the role of SIS in maintaining the aquatic ecological balance?
Would stocking SIS in ponds used for culture be detrimental to the cultured species?
Do you have a preference for SIS (over other fish)?
Are there any benefits or problems from eating SIS?
What options are available for conserving SIS?
Do you know about, or are you interested in SIS aquaculture?
What is the seasonality of SIS in the open water?
What is the specific breeding period for SIS?

What is the availability of SIS in the locality?
Most respondents were immediately able to identify several SIS species, which often included fry or fingerlings of boromach (especially major Indian and exotic carps). On average respondents could name 9 species, and some could name up to 15 SIS found in local water bodies. Very few respondents could name as many as 25, and these were mainly fisherfolk. Some could only name very few-six or less, and these were generally younger people.

A total of 42 different species were identified, and these were ranked according to the relative abundance or prevalence in the catch. These are listed in the table below:

Local Name	Scientific Name	Rank (in order of prevalence
Chingri	Penaeus	01
Puti	Puntius sophore	01
Shingi	Heteropneustes fossilis	02
Taki	Channa punctatus	02
Tengra/Baija/Bajina	Mystus vittatus	03
Cavashi Tengra	Mystus cavasius	03
Mola/rnoochi	Amblypharyngodon mola	04
Darkina	Danio devario	05
Magur	Clarias batrachus	06
Bairn/Gucchi	Macrognathus aculeatus	07
Kholisha	Colisa fasciatus	08
Chanda	Chanda baculis	09
Koi	Anabus testudinaus	10
Bailla	Glossogobius giuris	11
Guturn	Lepidocephelus guntea	12
Kakila/Kaikka	Xenentodon cancila	13
Foli	Notopterus notopterus	13
Titputi	Puntius ticto	14
Raga	Channa orientalis	15
Betranga	Botia Dario	15
Shoal	Channa striatus	16
Gulsha	Mystus bleekeri	16
Lal Chanda	Chanda ranga	17
Chela	Chalmostoma phulu	18
Napeet Koi	Badis badis	19
Dhela	Rohtee cotio	19
Pabda	Ompak pabda	20
Guja Kata	Aorichthys seenghala	20
Chaka/ Gongonia	Chaka chaka	21
Gajar	Channa marulius	21
Bhangra	Labeo boga	22
Chata	Colisa sp.	23
Piali	Aspidoraria moral'	24
Dhalla chok/Kalapona	Aplocheilus panchaz	24
Chapila	Gadusia chapra	25
Ghaura	Chopisoma gaura	26
Chanda	Chanda nama	27
Shorputi	Puntius sarana	28
Nandan/Meni	Nadus nandus	29
Tarkata/Guitta Tengra	Mystus tengara	30
Tara Bairn	Macrognathus aculatus	30
Tatkini	Cirrhinus reba	31
Lal Puti	Puntius conchonius	32

Are SIS declining or no longer available in the locality?

SIS were classified into 3 categories according to their present availability compared to 10 years ago. Rank 1 were the most common, whilst Rank 2 included species which had declined to about one quarter (25%) of what they were 10 years ago. Rank 3 were those species whose numbers had declined the most, to about one tenth (10%) of what they were 10 years ago.

Relative Abundance of SIS Compared to 10 Years Ago

Local Name	Scientific Name	Less Available Rank
Nandan/Meni	Nadus nandus	1
Along	Rasbara elanga	1
Bashpata	Ailia eoila	1
Kakila	Xenentodon eaneila	1
Betranga	Botia dario	1
KajaJi	Aillіithys punetata	1
Ghaura	Chopisoma gama	1
Napeet Koi	Badis badis	1
Ghangra	Labeo boga	1
Rayek	Cirrhinus reba	1
Shorputi	Pllntius sarana	2
Pabda	Ompokpabda	2
Baijaffengra/Bejina	Mystlls vittatus	2
Baccha	Eutropliehthys vaeha	2
Titputi	Puntius ticto	2
Gooja/Gooja kata	Aorichthys seenghala	3
FoJi	Notopterus notopterlls	3
Koi	Anablls testlldineus	3
Gajar	Chmma marulius	3

In both the districts it was apparent that both men and women thought that the younger generation were less familiar with SIS. Young people, particularly those not engaged in fishing consider that fingerlings of boromaeh (Rui, Catla, and other carps, Jatka (Hilsa) and others) are chotomaeh.

Sixteen major reasons were given by respondents for the decline and disappearance of SIS. These are given in the table below:

Reason for Disappearance of SIS	Ranking
• Construction of flood embankments	1
• Siltation in Khals and Beefs	1
• Less place for fish to live and renew stock	1
• River flow regulated through structures (sluice gates)	1
• Increased catch of spawn, fry and fingerling	1
• Water not entering floodplains and beels at right time	2
• Increased use of destructive nets and fishing gears	2
• Increased catch effort throughout the year	2
• Increased catch effort during monsoon and water recession	2
• Use of pesticide	3
• Broodfish of SIS is being caught indiscriminately	3
• Water pollution causes fish not to breed properly	3
• Use of fertilizer	4
• No inundation at all	4
• Epizootic Ulcerative Syndrome (EUS) disease	5
• Less eggs fertile, less spawning due to water pollution	5

What is the role of SIS in maintaining the aquatic ecological balance?
Most respondents considered that SIS were a "blessing of nature", and that such fish had been available in abundance since time immemorial. This had been possible because the climate and other environmental conditions had been conducive to their survival. Some people said that because of their importance in the human diet, the diet of the fish must also have some significance to the environment.

Would stocking SIS in ponds used for aquaculture be detrimental to the cultured species?
The responses of the respondents to this issue may be summarised as follows:

- very few had any experience of such interaction;
- some said SIS could not be cultured in ponds;
- a few said that cultured SIS would not be so tasty as those caught in open waters;
- some thought that SIS would cause harm by spreading diseases from the open waters;
- some thought that the SIS would be eaten by the boromach;
- others said that SIS would compete with boromach for food;
- some said that there would be mutual benefit, as they co-existed in nature.

Do you have any preference for SIS (over other fish)?

- all respondents preferred SIS because each species has a particular taste;
- some women said that SIS were more nutritious than boromach;
- both men and women said they preferred SIS because these were more affordable;
- both men and women said that Mola, Dhefa, Kajoli, Kachki and other SIS were rich in vitamins;
- some said that eating SIS was good for the eyes;
- nearly all said that SIS is a good source of protein: boromach is too expensive;
- many said that with chotomach each family member was able to eat a whole fish.

Are there any benefits or problems from eating SIS?
The most widely claimed benefits were:

- SIS is available locally;
- SIS is tasty;
- SIS can be eaten with bones;
- SIS has many vitamins;
- SIS has many minerals;
- SIS is good for the eyes;
- SIS is easy to catch;

What are the options for conservation of SIS?
A number of options were discussed for how SIS could be conserved, and the main actions thought required are given below:

Recommended Actions

- total ban on the use of small mesh nets which catch spawn, fry and firgerlings of SIS;
- enforcement of the ban on using current jal and other destructive gears;
- regulate use of all nets and gears during breeding and spawning season;
- total ban on the catching and collection of carp spawn for culture, and the by-catch of SIS;
- ban the capture of SIS when the breeding season is on;
- ensure that brood stock is able to spawn by:
  providing fish sanctuaries (so SIS can have permanent habitat);
  allowing fish stocks to move between bee Is, floodplains and rivers:
- ensure entry of fish spawn, larve and fry;
- ensure entry of monsoon and natural water flow into floodplains, depressions and beels;
- opening the water entry point (between rivers and flood plain);
- ensure that fish are healthy and able to move safely inside the floodplain; and
- remove silt from khals, beels so SIS can live there.

Fishing Seasons for SIS in Open Waters

APRIL MAY JUN JULY AUG SEPT OCT NOV DEC JAN FEB MAR APRIL

Boishak Joshto Ashar Srabon Bhadro Ashwin Kartik Agrahan Poush Magh Falgun Choitro

Icha ,,,..... .... Koi ..... Icha ……..... Titputi Puti .... Magur ..... Puti ..... Taki ..... Piali ..... Darkil Tengra ..... Baila ..... Guilsha, Bairn .... Tatkini, Khoilsha ..... Shing .....

Mala .....

Dhela .....

Breeding Seasons of Some Important SIS

APRIL MAY JUN JULY AUG SEPT OCT NOV DEC JAN FEB MAR APRIL

Boishak Joshto Ashar Srabon Bhadro Ashwin Kartik Agrahan Poush Magh Falgun Choitro

Shol .....
Taki .....
Puti .....
Tengra ……
Koi ....
Shing ……
Magur .....
Chanda …….....
Mala ……
Dhela…….

Do you know about, or are you interested in SIS aquaculture?
Although most respondents had little knowledge about the potential of SIS for aquaculture, most of them were interested to know how this could be done. Some were anxious to know if SIS aquaculture could be commercially viable. Others said they would like to try to culture SIS, but had no access to a pond or other water body.

The following specific responses were given on how SIS culture could be achieved:

- arrange collection of SIS fry where available and stock these;
- culture SIS with carps;
- Mola is a preferred species for culture, as it breeds the year round;
- SIS can be cultured in permanent water bodies (i.e. which contain water the year round) ;
- some respondents did not believe SIS could be cultured;
- some thought that it would not be profitable.

Some general comments on people's knowledge & perception
From the sample survey carried out it would appear that there is a great deal of traditional and local knowledge about SIS, and their potential benefits. There is also a great deal of local folklore, and beliefs surrounding SIS. Unfortunately this wealth of knowledge is poorly understood and little valued. Two examples of local beliefs are given below:

- In ancient Bangal there were closed seasons when catching Hilsa was forbidden. Hilsa is the main fish species found in the coastal and estuarine waters which migrates up river to spawn. From Bijoya Dashami (September/October) to Sri Panchami (January/February) a ban of its capture used to be in force. This prevented the capture of immature hilsa during the winter season. Unfortunately, this practice has been discontinued, and large scale hi/sa fishing is carried out throughout the year.
- In some beels and haors fishermen refrained from fishing on Saturdays. They believed that on Saturdays fish commune with their gods, and should not be disturbed.

Such traditional practices are still found in some areas, but are dying out. Changes in economic, social and cultural circumstances are contributing to their disappearance.

Women's knowledge and views

- A total of 134 women were interviewed, most of whom buy or cook SIS. They were highly concerned about the decline of SIS, as they had few, if any, alternative sources of animal protein.

- Some women complained that SIS is difficult to clean, but most agreed that it was tastier than large fish.

- Most women agreed that local action was required to conserve and manage stocks of SIS.

- In the 9 PRA focused group discussions, 312 individual interviews based on information checklist, and other interactions revealed that conservation measures needed to benefit aquatic ecosystems and renewed SIS stock. Unfortunately, people's knowledge about local aquatic ecosystem and its potential to regenerate natural resources, both for subsistence as well as livelihood, remain unattended. There were several occasions when communities and individuals raised conservation issues and concerns as well as participated in search for viable options.

- The participatory problem identification also allowed people to compare historical situation, approaches and conventions practiced in the past.

Conclusions and Recommendations

The freshwater fish of Bangladesh represent an invaluable renewable natural resource, of highly significant socioeconomic potential. They constitute a precious national heritage of uniquely diverse species assemblage. The species groups which many people now widely refer to as Small Indigenous Species (SIS) comprise an important sub-set of this fauna. However, despite their perceived importance there is little documented information about their relative importance, life cycle, or even of which species actually belong to this category.

The terminology "small indigenous species" can be misleading. Many species which are clearly not small are often lumped together as SIS. In addition, SIS is often used synonymously with the popular term chotomach. This is also not satisfactory, as this popular term is often used to refer to the species which are harvested when small (like the fingerling of major carps), or exotic species (like Tilapia and Chinese carps).

Recommendation 1: A classification system needs to be established for SIS, and an inventory of species which are classified as SIS drawn up.

SIS, together with many other fresh water fish, make a vital contribution to the livelihood, income and nutrition of rural Bangladesh. Yet very little is known about the contribution that these different fish species make, and how this can be sustained.

There is a rich store of traditional and local knowledge on the freshwater fish, including SIS. But with the introduction of modern production systems, changes in social relations, and the disappearance of many species, this store of knowledge is declining.

Recommendation 2: The contribution of SIS to livelihoods, income and nutrition in rural Bangladesh needs to be documented. This should include the documentation of traditional and local knowledge as well as management and conservation practices of SIS and other freshwater fishes.

There is a great deal of indicative, anecdotal and circumstantial evidence which points to the decline of Bangladesh's freshwater fauna, including SIS. This preliminary study has identified the following causes:

- destruction of the aquatic environment through flood control, drainage and irrigation projects;
- siltation of the river systems, canals and beels;
- pollution of the aquatic environment by agrochemicals, industrial wastes, domestic sewage and other wastes;
- destruction of the fish stocks through increasing fishing pressure, and through the use of non-selective and environmentally damaging fishing techniques;
- the introduction of exotic species for aquaculture, which compete with and prey on the indigenous species. The introduction of such species also carries the danger of introducing new diseases (like EUS) to which the indigenous species have no resistance.

The access of rural households, particularly the low income and landless, to fishing is being restricted by:

- declines in the availability (quantity and diversity) of fish; and
- traditional rights of access to common property resources being replaced by restricted access to individual and group-owned resources.

Recommendation 3: To re-evaluate the food production and disaster mitigation strategies which place so much emphasis on transforming Bangladesh's flood plain into dry land, and on restricting traditional rights of access.

Recommendation 4: To develop procedures and introduce codes of practice for restricting further introduction of exotic species to Bangladesh.

Recommendation 5: To establish conservation areas for indigenous species.

Recommendation 6: To adapt green and blue revolution food production systems to enhance rather than destroy SIS, for example, through greater use of integrated pest management (IPM) systems, integrated fish and rice cultivation, integrated cultivation of SIS and commercial fish species.

Recommendation 7: To promote fishing technologies which are more selective and less damaging to the environment.

Issues Arising

The issues raised by the Study, along with the contributing factors identified are summarized below:

Issue 1: Limited and declining freshwater ecosystems Causative factors:

- Green revolution and Flood Control Drainage projects are reducing land area prone to seasonal inundation.
- Disruption and closure of river flows (caused by the dam projects).
- Siltation of rivers, beels and water bodies.

Practices:
Construction of dams, embankments, sluice gates, etc. Regulation of these by the land owners, who maximize the water available for irrigation, and restrict the flow of water and the movement of fish between rivers and flood plain.

Issue 2: Human Society - Natural Resource Interaction

Causative factors:

- Increased population puts increasing pressure on the environment and natural resources.
- Increasing competition for diminishing resources forces people (especially poorer rural households) to increase fishing effort in open freshwaters, in "a race to fish".
- Increasing pressure to generate income, as well as to meet subsistence (nutritional) needs.

Practices:

Use of non-selective catching methods, use of destructive gear, disregard for the reproduction cycle and growth of SIS.

Issue 3: Society & Freshwater Aquatic Environment Interaction

Causative factors:

- Loss of traditional knowledge on sustaining aquatic resources.
- Lack of understanding of the importance in maintaining a balanced aquatic ecosystem.
- Replacement of traditional extensive production systems with modern intensive production methods.
- Replacement of open access common property regime with restricted access and private ownership.

Practices:

Intensive use of agro-chemicals (fertilizer and pesticide) in crop farming;
Dumping household, commercial and industrial waste into openwaters;
Application of poison (Rotenone, Phostoxin) to kill SIS and other aquatic organisms. _

A great deal of further research is required, and information should be made available to ensure the sustainable management of SIS and its freshwater aquatic ecosystem.
Recommendations for further research are given below:

1. Research into the role and relative importance of SIS in nutrition:
- in its contribution to the diet; and
- the nutritional content (vitamins, minerals etc.) of both wild and cultured SIS stocks.

2. Information on SIS and the Freshwater Ecosystem:
- the habitat and environmental requirements of SIS in both open and closed water bodies;
- the reproduction cycle of SIS (behaviour, frequency, requirements etc.);
- the feeding regime and nutritional requirements of SIS; and
- the impact of pollution and environmental degradation on SIS.

3. Cultivation of SIS (for conservation and consumption):
- low input/low cost culture techniques for SIS pond culture;
- impact of direct (feeding) and indirect (fertilizing) methods/systems on growth and survival of SIS in ponds;
- determination of optimal species and species mix for SIS polyculture;
- determination of optimal methods for SIS culture (monoculture, poly culture, continuous harvesting etc.); and
- compatibility of growing SIS in ponds with exotic species.

4. Breeding techniques
- determine best methods for breeding SIS (induced/natural); and o determine best nursery production methods.

5. Stocking Regimes

6. Harvesting Methods _

Action Proposed

- Promote policies which facilitate sustainable management of freshwater Small Indigenous Fish Species;
- Enhance human understanding and knowledge concerning the role of SIS in freshwater ecosystems;
- Promote local initiatives to identify SIS habitat, and secure water bodies as SIS fish sanctuaries;
- Promote selective and environmentally friendly fish catching methods;
- Discourage use of non-selective and environmentally destructive gears;
- Promote awareness on the need for restricting fishing during certain seasons, particularly on the damage caused by fishing indiscriminately during the breeding season;
- Develop and implement participatory management of SIS involving key stakeholder groups;
- Identify researchable constraints toward sustainable culture of SIS.

Appendix - 1

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Appendix 2

Selected list of small indigenous fish species of Bangladesh

Sl.#	Local/ Common Name	Scientific Name	Max. size (mm)	Habitat	Food & Feeding habit	Breeding habit
01.	Chola puti	*Puntius ehola*	138	Ponds, ditches, rivers, canals, etc.	Omnivorous	Breeds in stagnant water several times during monsoon
02.	Sharputi	*Puntius sarana*	420	Rivers, beels, natural depressions and tanks	Omnivorous in habit and feeds on mainly higher aquatic plants, insects and crustaceans	Breeds in stagnant water during
03.	Puti	*Puntius sophore*	122	Abundant in freshwaters throughout Bangladesh	Omnivorous	Breeds in stagnant water during monsoon
04.	Tit puti	*Puntius tieto*	65	Abundant in freshwaters throughout Bangladesh	Omnivorous	Breeds in stagnant water during monsoon
05.	Mola puti	*Puntius guganio*	54	Abundant in freshwaters throughout Bangladesh	Omnivorous	Breeds in stagnant water during monsoon
06.	Gili puti	*Puntius gelius*	51	Abundant in freshwaters throughout Bangladesh	Omnivorous	Breeds in stagnant water during monsoon
07.	Phutani puti	*Puntius phutunio*	40	Abundant in freshwaters throughout Bangladesh	Omnivorous	Breeds in stagnant water during monsoon
08	Kanchan Puti	*Puntius conchonius*	99	Fairly common in all freshwater	Omnivorous	Breeds in stagnant water during monsoon
09	Teri puti	*Puntius terio*	63	Abundant in freshwaters throughout Bangladesh		Breeds in stagnant water during monsoon
10	Kosuati puti	*Puntius cosuatis*	60	Common in all freshwater in Bangladesh	Omnivorous	Breeds in stagnant water during monsoon

Sl.#	Local/ Common Name	Scientific Name	Max. size (mm)	Habitat	Food & Feeding habit	Breeding habit
11.	Madhu Pabda	*Ompok pabda*	240	Rivers, canals ponds, beels, floodplains	Omnivorous in nature, eating fishes, algae, insects, protozoa and debris	Naturally breeds in floodplains during monsoon
12.	Kani pabda	*Ompok bimaculatus*	240	Rivers, canals ponds, bee Is, floodplains	Omnivorous, feeding mainly on insects	Breeds during monsoon In floodplains
13.	Gulsha	*Mystus cavaS1US*	231	Rivers, bee Is, floodplains and canals	Carnivore in nature, feeding on insects larvae and small fishes	Breeds in haors, bee Is, rivers and streams
14.	Tengra	*Mystus vittatus*	117	Rivers, beels, floodplains and canals	Carnivore in nature, feeding on insects larvae and small fishes	Breeds in haors, beels, rivers and streams
15.	Bozari Tangra	*Mystus tengara*	62	Rivers & canals	Carnivorous	Breeds in rivers and canals
16	Batashi	*Pseudeutropius atherinoides*	140	Rivers throughout Bangladesh	No available information	Breeds during the monsoon in the flvers
17.	Kajoli	*Ailia coila*	154	Rivers throughout Bangladesh	No available information	Breeds during the monsoon in the flvers
18.	Taki	*Channa punctatus*	240	Abundant in ponds, ditches, beels and swamps	Voracious predator equipped with air breathing organ	Breeds in stagnant waters. Egg and Larvae receive parental care
19.	Chang Taki	*Channa orientalis*	135	Abundant in ponds ditches, beels and swamps	Voracious predator equipped with air breathing organ	Breeds in stagnant waters. Egg and Larvae receive parental care
20.	Tila shol puti	*Channa barca*	400	Found in holes on the banks of the rivers, beels and haors	Voracious predator equipped with air breathing organ	Breeds in stagnant waters. Egg and Larvae receive parental care
21.	Magur	*Clarius batrachus*	302	Can live in most types of habitat and found in stagnant muddy water	Predator fish equipped with air breathing organ	Breeds in stagnant waters during rainy season
22.	Shinghi	*Heleropneusl es jossilis*	279	Found in beels, jheels, ponds, ditches, floorplaind and canals	Predator fish equipped with air breath i ng organ	Breeds in stagnant water during rainy season, Fecundity very high in the range of 21,992-5,683

Sl.#	Local/ Common Name	Scientific Name	Max. size (mm)	Habitat	Food & Feeding habit	Breeding habit
23.	Koi	*Anabas testudineus*	176	Haors, ponds, ditches and paddy fields. Can travel over lands	Plankton feeder during early stage and soon becomes insectivorous	Breeds in paddy field and shallow water. Eggs float at the surface.
24.	Gulsha	*Mystus cavaslUS*	231	Rivers, beels, flood plains and canals	Carnivore in nature, feeding on insects larvae and small fishes	Breeds in haors, beels, rivers and streams
25.	Kholisha	*Colisa fasciata*	100	Ponds, ditches, floodplai ns, etc.	Omnivorous. effective in mosquito and malaria control	Breeds several times in stagnant waters during monsoon. Parental care of eggs and larvae.
26.	La] kholisha	*Colisa lalius*	88	Widely distributed in stagnant and shallow freshwater habitats	Herbivorous	Breeds several times in stagnant waters during monsoon. Parental care of eggs and larvae.
27.	Kholisha	*Colisa lalius*	42	Pools, ditches, inundated fields and ponds	Herbivorous	Breeds several times in stagnant waters during monsoon
28.	Kaikka/kakila	*Xenentodon cancila*	261	ponds, small rivers, inundated fields and ponds	Predator	Breeds in rivers during monsoon
29.	Mola	*Amblyphyrargodoll microlepis*	*40*	Rivers, ponds, cabals and ditches, abundant in rainy season	Omnivorous	Breeds in stagnant waters during monsoon several times
30.	Dhela	*Rohtee cotio*	J08	Floodplains, tanks and beels	Omnivorous	Breeds in stagnant waters during monsoon several times
31.	Chela	*Chela cachius*	60	Found in freshwater areas in Bangladesh. Not so abundant	Information not available	Information not available
32.	Nama Chanda	*Chanda nama*	100	Streams, canals, beels, ponds and inundated paddy fields, Abundant during rainy season	Information not available	Information not available
33.	Lal Chands	*Chanda ranga*	80	Streams, canals beels, ponds and inundated paddy fields. Abundant during rainy season	Information not available	Information not available

Sl.#	Local/ Common Name	Scientific Name	Max. size (mm)	Habitat	Food & Feeding habit	Breeding habit
34.	Chanda	*Chanda bacules*	50	Less abundant than other species of chanda	Information not available	Information not available
35.	Foli	*Notopterus notopterus*	355	Abundant in Stagnant and running waters	Carnivorous	Breeds in May and June. The eggs receive parental care
36.	Napit koi/ Bandi koi	*Badis badis*	63	Beels, ditches, ponds and swamps	Insect larvae Surface feeder,	Parental care
37.	Chapila	*Gudusia chapra*	200	Beels, ditches rivers and floodplains	Omnivorous	Breeds during monsoon in stagnant water
38.	Tara Bairn	*Macrognathus*	*240*	Rivers, beels and flood plains	Bottom feeder	Breeds during monsoon
39.	Guchi Bairn	*Mastacembelus pancalus*	*135*	Rivers, beels and flood plains. abundant during ramy season	Bottom feeder	Breeds during monsoon

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