Factors relating to decline of fisheries in the river Brahmaputra

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Central Inland Capture Fisheries Research Institute
(Indian Council of Agricultural Research)
Barrackpore - 743 101 West Bengal India

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Contents

MESSAGE

Brahmaputra, the lifeline of the North-Eastern India is, perhaps, the most awed and least charted water course of the sub-continent. Flowing through a vast tract, traversing three nations, the river weaves a rich tapestry of ethnic communities and their vivid cultures. China, India and Bangladesh share the bounties of this mighty river, often termed as a moving ocean. In the lower reaches in Assam and Bangladesh, the Brahmaputra forms a maze of floodplain lakes which form enormous resources of unparalleled magnitude.

The Central Inland Fisheries Research Institute's attempts to gauge the fisheries wealth of the river date back to late 1950s, when a rapid survey was undertaken from Sadiya to Dhubri in Assam. Subsequently, in the year 1972, the Institute establashid a regular centre at Guwahati to undertake long-term monitoring programmes on various aspects of limnology and fisheries ecology of the main river as well as some of its major tributaries.

This valuable document summarises the research highlights of the centre, covering all aspects of habitat vriables, biotic comunities, fisheres and the socio-economics of the fishing operations. Exhaustive coverage of this treatise is ample testimony to the untiring efforts of the group of scientists and other categories of staff who undertook the arduous task of working in the remoteness of the North-East. The editors of this document have done an equally commendable job, compiling and condensing the enormous data collected over the years into a very brief, crisp and highly informative document. This hand book will go a long way in accelerating the pace of fisheries development in the North-East.

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FOREWORD

The river Brahmaputra is the lifeline of the northeast, supporting a number of agricultural and economic activities. Often referred to as a moving ocean, the river it carries 510 450 million m^3 of water across the valley, which is much higher than the runoff of the river Ganga. Brahmaputra remains untamed due to the enormous quantity of water it carries and due to the seismic characteristics of the land through which it flows. Among the Indian rivers, the Brahmaputra is the least explored from a biological point of view. The Central Inland Fisheries Research Institute carried out investigations on the limno-chemical parameters, fish populations and the fishing methods in the river during the last few decades which form the basis of our current knowledge on the ecosystem processes and production functions of the Brahmaputra river system. However, despite this, the database remains still incomplete on account of the vastness of the resource and the logistic constrains in carrying out studies in the turbulent waters of this mighty river.

In recent years, in the wake of the growing awareness on the environment-friendly management of riverine ecosystem, a need has been felt from many quarters for a comprehensive document on the biological characteristics and fish production potential of the river Brahmaputra and this document is an attempt to fill this void. It contains the preliminary findings of the studies carried out by various scientists of CIFRI on the river Brahmaputra from time to time. It is hoped that the findings and the guidelines portrayed in this report will act as useful inputs for scientists, researchers, policy makers and developmental agencies.

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INTRODUCTION

The mighty Brahmaputra, termed as a moving ocean, drains the north-eastern states of Arunachal Pradesh, Nagaland, Meghalaya, Assam and Sikkim. The river rises from the snout of the Chemayungdung mountains near Tachhog (Tomchok) Khambab Chhorten, c. 100 km south east of lake Mansarovar. It runs eastwards for 1 250 km in a shallow valley through Tibet as the river Tsangpo, before making a sharp turn southwards to enter India near Tuting (Arunanchal Pradesh). Known as Dihang or Siang in Arunachal Pradesh, the river after its union with Dibang and Lohit near Sadiya (Assam), assumes the name of Brahmaputra. Fortified by tributaries, the river flows through the heart of the State and enters Bangladesh as the river Jamuna. Besides providing navigational facilities, the river plays a pivotal role in sustaining the variegated life, flora and fauna of the valley and its surroundings.

1. THE RIVER

1.1 *Physiography and fluvial dynamics*

The Brahmaputra valley, sandwitched between the eastern Himalayas and the Shillong plateau covers an area of *c.* 56 339 sq.km. Bisected by the river Brahmaptura, the valley extgends from Sadiya on the east to Dhubri on the west where the river turns southwards and skirts the western edge of Garo hills before entering the plains of Bangladesh. Touching all the districts in the valley, the river flows placidly in braided channels on a flat plain, dropping only 12 cm per kilometer.

The length of the river Brahmaputra from its origin is *c.* 2 880 km., within India 918 km. and within Assam 730 km. The river, alongwith its 47 major tributaries (Fig. 1) has a combined length of *c.* 4 000 km, a catchment of *c.* 5 80 000 sq.km. and an average annual discharge of 510 450 million cubic meter. The annual runoff of the river at Pandu (Guwahati) is 414 million acres feet and in Bangladesh, at a rate of 2.3 million cubic feet of water per second it flows into the sea.

The river and its tributaries maintain most unstable courses in the plains, there being constant movement of their channels. The geologically infant state of the Himalayas from which these rivers take off, substantially contribute to the high silt content in the main drainage. During the period 1937-1987, the Brahmaputra bed has risen *c.* 4.5 m due to accumulation of silt. Characteristically, the northern tributaries are large with steep, shallow, braided channels carrying high silt discharge (average 666.7 m^3 per km^2), whereas, those on the southern bank are deeper with meandering channels, low gradient and lesser silt load (66.7 to 95.7 m^3 per km^2). The maximum silt load in the river is observed during July and August.

The gradient of the river bed is steep in Arunachal Pradesh (0.62 meter km^{-1} between Kobo and Dibrugarh). In Assam it flows placidly on a gradient of *c.* 1 meter per 8.5 km (0.17 meter km^{-1} between Dibrugarh and Jorhat, 0.13 meter km-1 between Jorhat and Guwahati and 0.094 meter km^{-1} between Guwahati and Dhubri) and lays down during flood the blanket of fine silt that gives the valley its fertility.

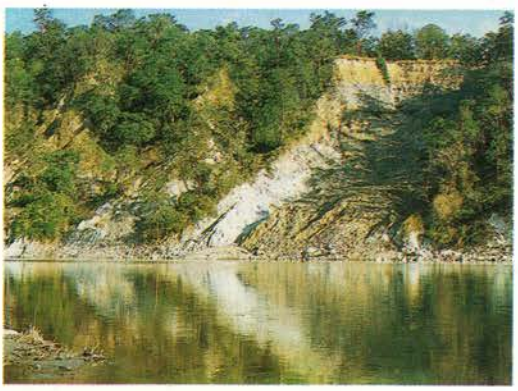
In Assam, the approximate average width of the river section for its entire length is 5.46 km (5.06 km between Jorhat to Tezpur, 6.1 km between Tezpur to guwahati, 3.78 km between Guwahati to Manas and 7.1 km between Manas to Dhubri). The depth in the upper reaches varies from 3.6 meter to 5.0 meters during the dry season, which becomes more than double during monsoon months. Near Guwahati, where the river is hugged by hills on either side, the depth during dry periods is *c.* 18.0 meters, which increases to more than 27.0 meters during high floods.

River Manas- a north bank tributary of the river Brahmaputra

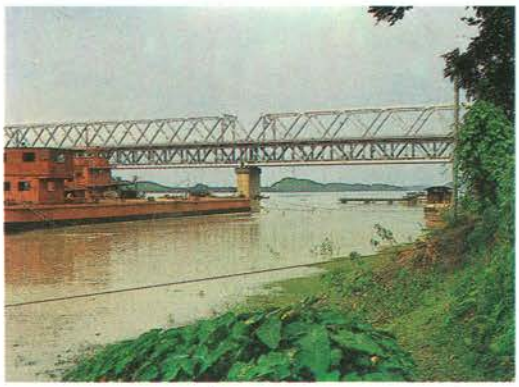
The river Brahmaputra at Guwahati

River Kulsi- a south bank tributary draining the Khasi Hills

Deforestation in the catchment



Industrial pollution



1.2 *Riverine environment and production functions*

Situated in the north of the tropic of Cancer, the regions is sub-tropical and is characterised by coolness and high humidity. Most distinguished feature of the area is copious rainfall between March and May, at a time when precipitation in other parts of the country is at its minimum (Fig. 2). Rainfall in the region is received under the influence of both north-east and south-west monsoon. Season distinctions is based on rainfall pattern, as in most tropical and sub-tropical regions and they are not sharply delimited - transitions are gradual and extremely dry periods do not normally occur. The hot and huimid summers and a prolonged monsoon gives way to the mild winters which last from November to February. Lowest temperature in the valley is experienced in early January.

Water level in the river fluctuates consequent to the snow-melt in the Himalayan reaches and precipitation in the region. The latter is responsible for the early floods in the valley as also for the maturity of commercial carps in the river basin. The river water exhibits optimum temperature regime (15.2 - 27.6°C), fluctuating in consonance with the prevailing air temperature (13.7 - 28.8 °C). Abundance of suspended particles, mainly silt, reduces the water clarity, rendering it less transparent (12.9 - 51.7 cm). Dissolved gases, in particular, oxygen and carbondioxide do not show pronounced seasonal variation except during periods of high turbidity when oxygen values decrease and carbondioxide concentration increases (Table 1).

Soil and water pH, fluctuating largely withing alkaline range, portray low amplitude of variation (7.1 - 8.6). The alkaliphobic nature of the region's water is characterised by low bicarbonate values, ranging in between 63.3 and 80.8 mg l^{-1}. However, optimum availability of major nutrients in the water phase reflect on the productive status.

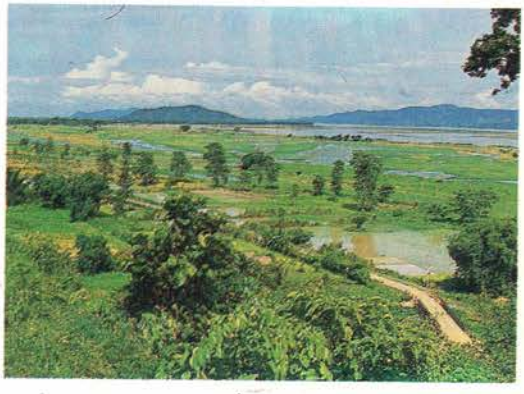
The river harbours a poor density of primary producers, which is adequately reflected in the primary production values. The average gross and net production range from 352.15 to 1 779.27 g C ha^{-1} d^{-1} and 228.43 to 1 205 89 g C ha^{-1} d^{-1}. Chlorophyceae (32.75%) and bacillariophyceae (30.81%) dominate the phyto-groups and account for an overwhelming 76.71% of the plankton composition (Fig. 3). Fast current and high silt contents primarily account for low density of the primary producers which is also depicted in their seasonality in the eco-system.

Based on the average primary production rates in the river, the estimated gross carbon synthesis has been estimated at 128.53 Kg C ha^{-1} yr^{-1} in September to 649.43 Kg C ha^{-1} yr^{-1} during February with an average production of 307.8 Kg C ha^{-1} yr^{-1}. The relatively low rate of carbon production coincides with the low transparency brought about by high silt levels in the river water (Fig. 4).

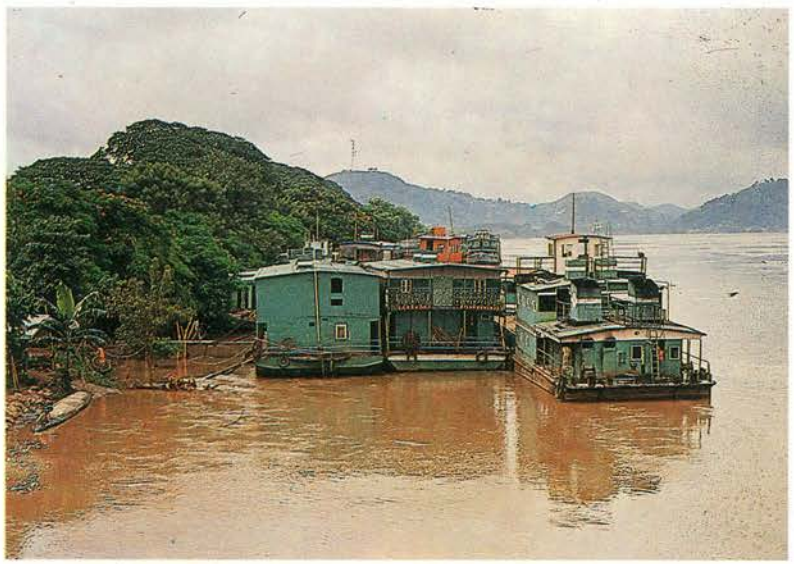
Table 1. Seasonal fluctuations in key limno-chemical variables in river Brahmaputra water

Months	Air temp (oC)	Water temp (oC)	Transp. (cm)	pH	DO (mg/l)	CO2 (mg/l)	Tot.alk.(mg/l)	NO3-N(mg/l)	PO4(mg/l)
January	15.80	15.20	45.2	7.9	8.19	4.27	76.1	0.07	0.07
February	18.80	19.90	51.7	7.6	8.69	3.83	79	0.08	0.08
March	21.60	22.00	38.7	7.7	8.43	4.13	79.2	0.1	0.09
April	24.90	24.20	25.7	7.6	7.53	3.79	75.8	0.07	0.15
May	27.30	25.70	19.9	7.7	7.66	3.25	63.42	0.09	0.1
June	27.80	26.60	16.3	7.7	7.04	3.25	78.4	0.08	0.11
July	28.60	27.30	15.4	7.6	6.56	2.83	80.8	0.08	0.17
August	28.80	27.60	13.9	7.6	6.86	3.75	78.2	0.1	0.12
September	27.70	26.60	12.9	7.6	7.13	4.17	65	0.09	0.11
October	25.50	25.20	20.5	7.8	7.5	3.5	63.3	0.09	0.09
November	21.30	21.90	26.4	7.7	7.7	3.58	68.9	0.08	0.09
December	13.70	18.30	33.9	7.8	8.23	3.93	76.6	0.07	0.09

The Floodplains of Brahmaputra
Top: An oxbow lake of river Jamuna on the south bank
Bottom: Floodplains of river Brahmaputra in Kamrup District



Anthropogenic activities in the Brahmaputra



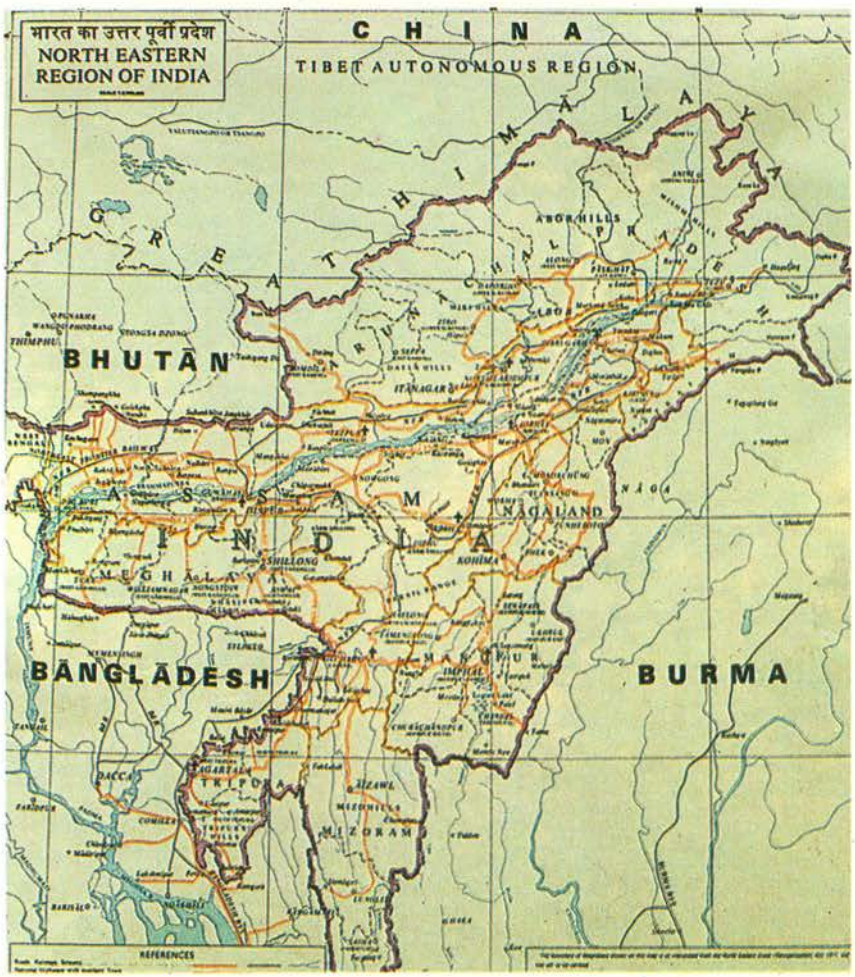


Fig. 1 River Brahmaputra

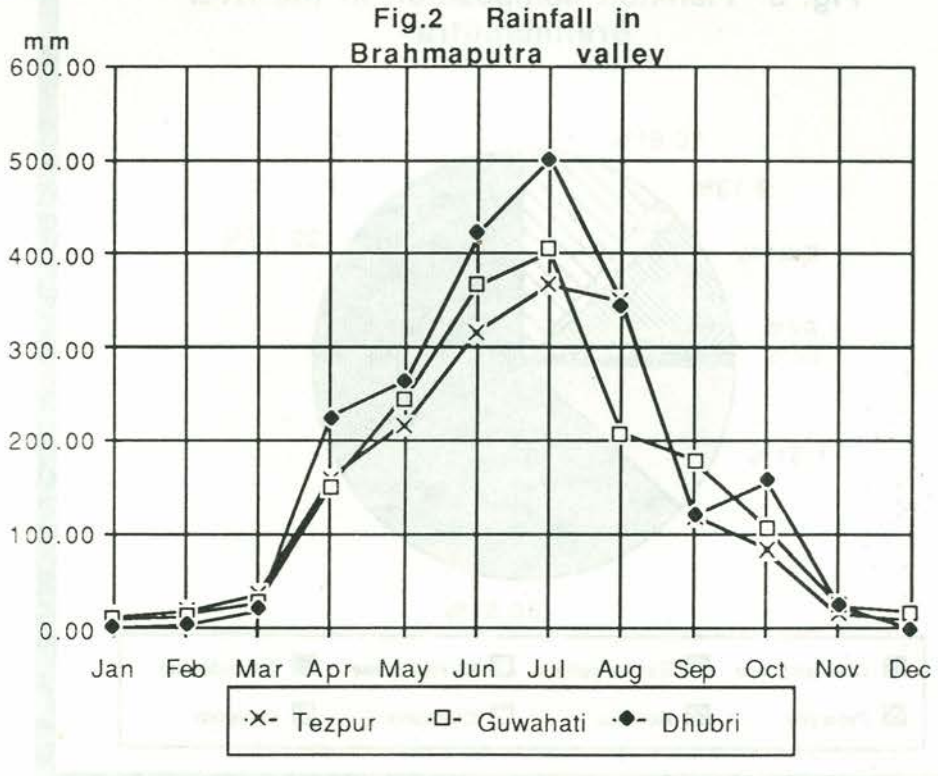
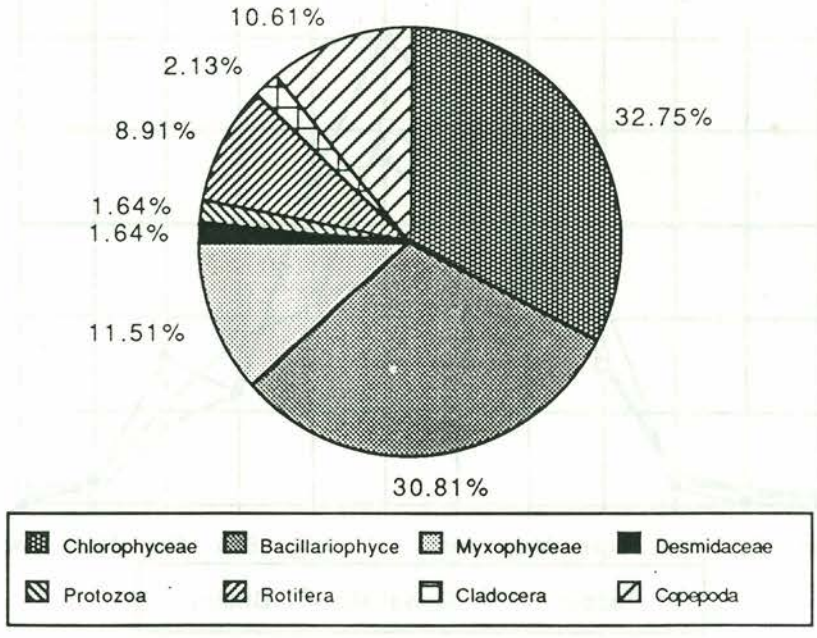


Fig.2 Rainfall in Brahmaputra valley
mm
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Tezpur
Guwahati
Dhubri

Fig. 3 Plankton composition in the river Brahmaputra



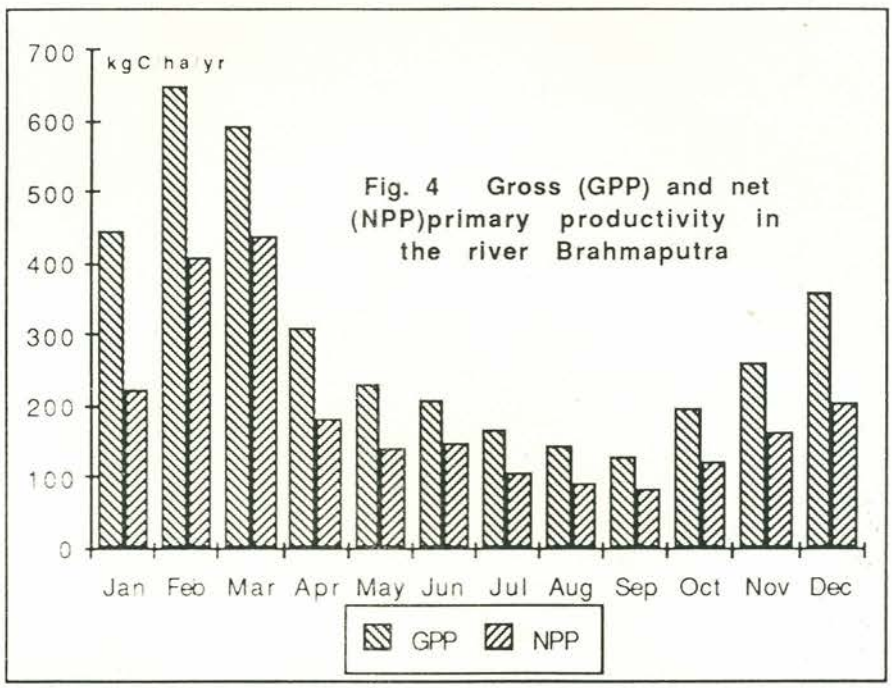


Fig. 4 Gross (GPP) and net (NPP)primary productivity in the river Brahmaputra

2. FISH AND FISHERIES

2.1 *Species spectrum*

The mixing up of the drainages in the geologic past has resulted in the amalgamation of the fish fauna of Indo-Gangetic origin and that of the South-Chinese origin. This admixture has rendered the Assam Himalayas very important from the faunistic point of view. The fish fauna of the Brahmaputra drainage consists of 126 species of fish belonging to 26 families, of which 41 species are of commercial significance (Annexure-1). The fauna has 33 representatives exclusively common with the Indo-Gangetic fauna, 19 common representatives with the Eastern Himalayan fauna and 11 representatives common with the Burmese fauna. There are 23 representatives which are restricted in their distribution to this region only.

The fish fauna of the drainage exhibits a combination of both torrential and plain water forms occupying diverse ecological regime in their distributional ranges. the tributaries draining the northern bank that receive snow-melt water provide distinct zonation such as the loach or headwater zone. However, the tributaries draining the southern bank of the Brahmaputra are not clearly divisible into such zones and as a result excepting for certain stretches in Naga hills it is difficult to get a rapid-clear water stream.

2.2 *Fish catch composition at major landing centres*

The rich and varied fish faunistic wealth is attributable to the spectacular topographic and climatic diversity of the region. commercial fisheries of the Brahmaputra drainage portrays multiplicity in both gear and resultant catch compositions. the pattern of species distribution and abunndance vary considerably in the different stretches of the river.

Collection of data on fish catch in major landing centres representing upper, middle and lower stretches in Assam was undertaken during 1972-80 and subsequently during 1986-90. The catch, although a fraction of the total landings provides a clue to the trend, both annual and seasonal, effort, species composition, size groups and related biological parameters of significance on important fish species.

Fishery of commercial significance comprises *c.* 35 species, clubbed into 5 major groups *viz.*, major carps, minor carps, catfishes, Hilsa and others.

Cyprinoids constitute the important fisheries in the valley, besides catfishes and engraulids. the dominance of different groups in the upper, middle and lower stretches of river Brahmaputra is very conspicuous. While catfishes are more abundant in the market arrivals in Jorhat, carps dominant the landings in Guwahati, representing the middle zone. Dhubri, in the lower reaches displays abundance of carps alongwith the prized Hilsa,

in the lower reaches displays abundance of carps alongwith the prized Hilsa, Tenualosa ilisha. However, the group others, which includes a number of important species, dominates the landings in all the four sampling stations.

The domination of catfishes in the upper and carps in the middle and lower stretches is more pronounced during the 1986-90 period. Hilsa, whose run commences from the Bay of Bengal, forms a formidable fishery around Dhubri, gradually diminishing as it moves up towards the middle and upper stretches. Landings in Jorhat constitute a meagre 0.18% of Tenualosa ilisha. Labeo rohita among Indian major carps and Wallago attu among the catfishes dominates the groups (Table 2). Most of the species, except hilsa, in the drainage undertake localized migration, mainly in pursuit of breeding and feeding pastures.

The abundance of Indian major carps in the middle and lower reaches of the river Brahmaputra focusses on the availability of suitable breeding grounds in the stretch. Surveys have also revealed a spawn quality index of 43.98% of IMC and 53.70% of minor carps. Interestingly, sites in between Goalpara on the south bank and Dhubri on the north bank are being regularly exploited to fill up the deficit in seed production in the state.

2.3 *Annual trend in fish catch, 1972-1980 and 1986-1990*

Water level is the basic determinant of fishing effort in the river Brahmaputra. The conventional fishing tackle, in vogue in the river, are highly constrained during high discharge periods, mainly June to August. the maximum effort, is thus concentrated during September to January, when maximum landings are recorded (Fig. 5). This coincides with the prevailing low water level and favourable fluvial propensities. High catch figures during September, unfortunately relate to large scale destruction of carp juveniles, which forms a thriving fishery in the valley. Total ban on this practice is warranted to improve the recruitment of carps in the commercial fishery of the river Brahmaputra.

Annual trend in the market arrivals in Guwahati during 1973-1979 portray a marked decline from 233.4 t in 1973 to 39.0 t during 1979. During the 1987-90 phase of assessment, an increase from 184.6 t in 1987 to 274.8 t during 1990 has been observed except the sharp fall (81.0 t) during 1988. The outbreak of the epizootic ulcerative syndrome disease in the valley badly ceripplled the fishery sector during the year, effects of which lingered on till the subsequent year.

Notwithstanding the marginal increase in fishing effort over the years, the increase in market arrivals during the 1987-90 phase is primarily due to the quantum leap in aquaculture practices in the valley. The 80s have witnessed a significant increase in aqua-farming activities in Assam and its share to the State's fish production cannot be ignored.

Fig. 5. Monthly fish arrivals (t) in selected landing centres of Assam

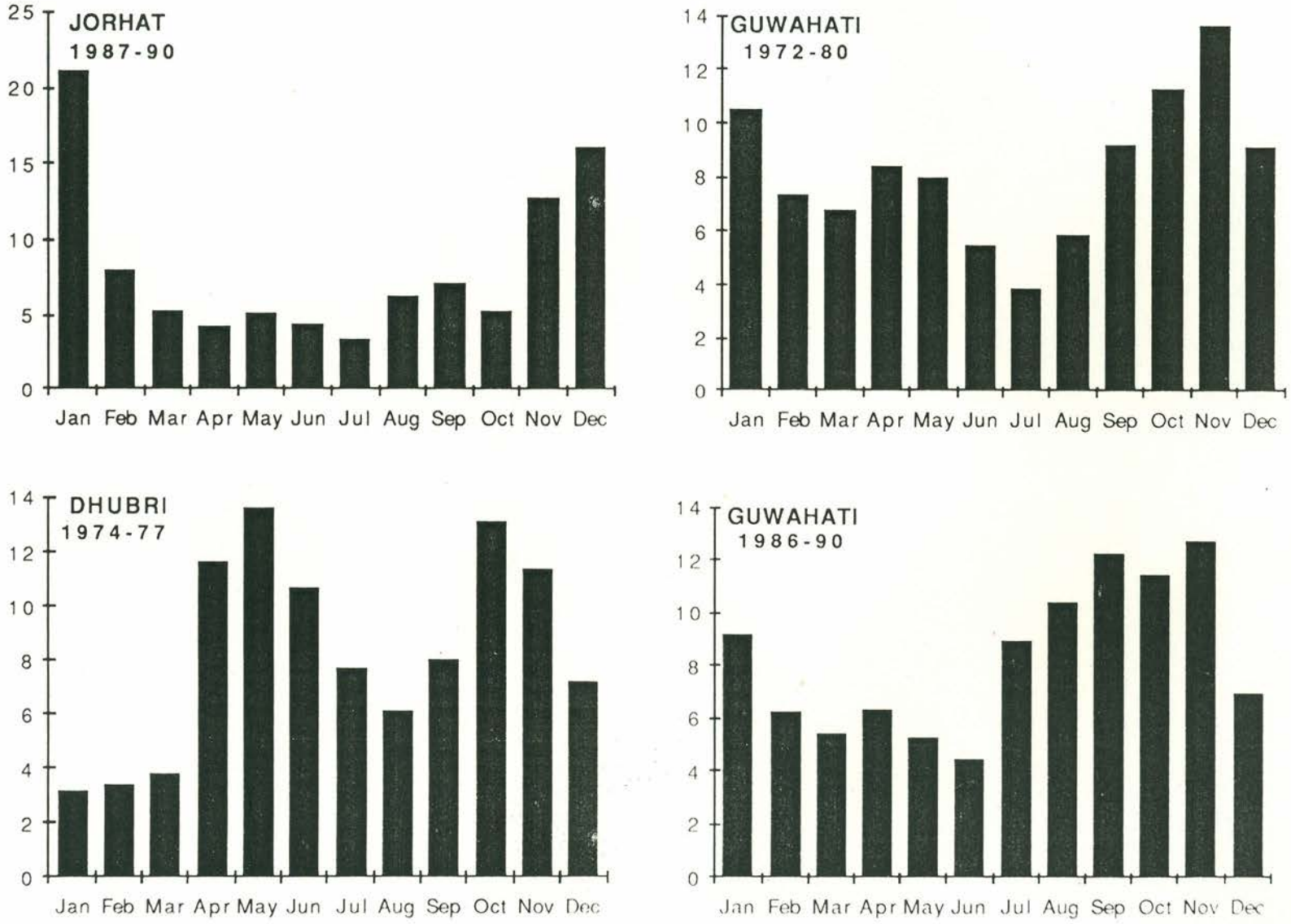


Table 2. Group-wise fish arrivals (%) in Jorhat, Guwahati and Dhubri fish markets

GROUPS	JORHAT	GUWAHATI		DHUBRI	
	1987-90	1972-80	1986-90	1974-77	1987-90
Major carps	11.84	18.40	28.62	16.41	30.42
Minor carps	19.18	13.96	14.03	14.23	00.94
Catfishes	24.03	22.13	10.04	24.11	14.99
Hilsa	00.18	12.92	08.03	15.51	20.66
Others	44.77	32.59	39.28	29.74	32.99

The fluctuating trend in the fishery of the Indian major carps, especially during the 1974-79 phase, is punctuated by striking qualitative changes. With the decline in IMC catch, the mean size of the fishes as registered an increasing trend over the years. the occurrence of inverse correlation coefficient r for *L. rohita* (-0.99), *C. catla* (-0.76) and *C. mrigala* (-0.88) do not conform to any known fishing patterns, except that with the waning of population, individuals tend to grow better (Table 3).

The decrease in the coefficient of variation suggests either selective fishing or inadequate recruitment to the fishery. Prevailing use of conventional gear rule out the hypothesis of selective fishing in the river system. hence, poor recruitment appears to be more logical. The declining trend of IMC spawn in the river also hint to the fact that recruitment of IMC species is not at all encouraging.

3. INVENTORY

3.1 *Crafts*

The fishing crafts are predominantly non-mechanised and range from large plank-built boats to small dug-out canoes. The crafts are custom made and their sizes vary from boat to boat. Wooden boats with outboard enginesx mainly constitute the mechanised crafts.

3.2 *Gear*

Vividity marks the fishing gear and tackle operated for exploiting the multi-species fishery of the river Brahmaputra. While some of them are selective for a particular species, others account for a large number of species. The gear encountered in the valley have been classified into the following major group; (1) Seine nets, (2) Gill nets (Drift and Set), (3) Bag nets, (4) Purse or Clap nets, (5) Cast nets, (6) Dipn nets and (7) Trawl nets (Table 4). Nylon yarn is gradually replacing cotton and sunhemp for gear fabrication.

The fishing gear also shows localization in their use along the entire course. In their upper reaches, where normally swift current prevails, cast nets and traps are common. In the pools, lines and gill nets of short depth are used. In the middle reaches, seine nets and gill nets are equally important. Cast nets, lift nets and barriers are of secondary importance. In the lower reaches, purse net is very common and is used for catching hilsa. this gear is common during April to October and it is estimated that more than 2 200 boats and 3 500 purse nets are used for hilsa fishing in the Brahmaputra. Bamboo traps, an inseparable paraphernalia of the fishermen, are innumerable in shape and size and are used throughout the length and breadth of the river system.

The 1982 livestock census in Assam enumerated a total number of 1 00 034 fishing gear excluding traps, hooks and lines. Cast nets (69 954) were maximum, followed by drag nets (12 157), gill nets (9 787) and trawl nets

Table 3. Mean length (mm) and coefficient of variation of major carps

Year	L.rohita		C. catla		C. mrigala	
	ML	*CV*	*ML*	*CV*	*ML*	*CV*
1974	717	22.4	541	53.8	664	35
1975	769	15.3	756	26.2	711	26.1
1976	808	12.4	839	25.5	780	21.5
1977	796	13.9	902	14.9	852	11.3
1978	815	11.1	907	15.9	830	13.1
1079	850	9	882	15.2	828	10.1

ML- Mean Length CV - Coefficient of variation

Table 4. Common fishing tackle used in Brahmaputra

Types	Mesh bar *mm*	Material	Length *m*	Height *m*	Local name
Drag net	15.0 - 50.0	Cotton 20/4/3, 20/18/1	200 - 400	20 - 25	Ber jal, Pana jal, Duttasai Gully jal, Aretona, etc.
Gillnet	12.5 - 165	Cotton/ Sun hemp/ Nylon/ Assam silk		0.80 - 2.50	Fissue jal, Phansi jal, Lungi jal
Bagnet		Cotton/	150 - 200		Kona jal
Purse nets	35.0 - 50.0	Cotton/ Sun hemp			Shangla jal
Cast net	10.0 - 42.0	Cotton/ Sun hemp		2 - 30	Kevali jal, Rekha jal Ottal jal, Asra jal, Posh jal
Dip net	7.5 - 25.0	Cotton			Khora jal, Kahj jal, Pah jal, Berhri jal
Trawl nets	15.0 - 25.0	Cotton/ Nylon			Fery jal, Bachru jal

Fishing activities in the river Brahmaputra

(8 136). Non-mechanised boats constituted almost the entire fishing fleet and their number was estimated at 35 508 in the state.

3.3 *The community*

A survey of the 600 km stretch of the Brahmaputra river between Biswanath Chariali and Dhubri on the north bank and Saikhowaghat and South Salmara on the south bank was carried out by the Central Inland Fisheries Research Institute. The survey also identified 140 important fishing villages, with 45 important landing centres on both the banks.

The maximum conmcentration of fishermen population is in Goalpara district, followed by Kamrup. Dibrugarh district records the lowest fishermen population. However, the number of family members actually engaged in fishing operations is highest in Kamrup district followed by Goalpara district.

4. ANTHROPOGENIC IMPACT ON ENVIRONMENT AND FISHERIES

4.1 *Deforestation and soil erosion in the catchment*

Severe threat to the environment emanates from the large scale deforestation in the region. Except Arunachal Pradesh, where 61.0% of the geographical area is still under forest cover, the existing coverage in Nagaland (17.34%), Meghalaya (37.0%) and Assam (26.4%) portrays a dismal picture. Besides wanton destruction of forests for timber and fire, jhum or shifting cultivation is another destructive practice, accelerating the pace of deforestation.

Shifting cultivation not only distrubs the delicate balance of forest ecosystem, it also leads to erosion of top soil, which alongwith the runoff silts the river basins. Observations in Assam hills indicate that at least 10 cms of soil is washed away even from moderate slope, in each jhum cycle. The soil erosion problem, particularly in the north bank is very acute due to heavy deforestation in Aurnachal and Bhutan foothills and the general topography of the land with 3-5% slope towards the Brahmaputra valley. Sound watershed management programmes, considerd useful in mitigating the multiple waves of floods every year, should be immediately enforced.

4.2 *Habitat destruction in floodplain lakes*

The problems and potentialities of the river Brahmaputra can be viewed in its entirely only with the inclusion of the floodplain lakes, locally referred to as beels. there are 1 392 beels, varying in size from a few hectares to more than 1 000 hectares. Covering anf enormous area of *c*. 0.1 million hectares, they represent *c*. 83% of the total lentic area in the states. The districts of Lakhimpur and Nagaon have the maximum number of ox-

bow lakes while lower Assam comprising the districts of Goalpara, Dhubri and Kokrajhar have batteries of the largest, commercial lake like beels with high fisheries potential.

The beels generally possess high potential for *in situ* fish production and where the topography allows, provide a collection sink for the fishf produced on neighbouring flooded catchments. Significantly, in contrast to average annual fish yield of *c.* 5 - 75 kg ha^{-1} yr^{-1} of the lakes and reservoirs recorded, the average annual yield from Assam beel is *c.* 180 kg ha^{-1} yr^{-1} and if small-scale subsistence fishing is taken into account, yields higher than this can be expected. The beels possess tremendous scope for enhancing (> 1 000 kg ha^{-1} yr^{-1}) their fish production. The floodplain lakes, in the process of inundation also serve as vital spawning grounds for Indian major carps. the easily accessible shallow areas of these lakes provide optimum breeding conditins and latter make available to the larvae ample nursery space and food in the inundable margins.

Traditionally, the fish harvest from the beels have been considered as a renewable natural resource, available for maximum exploitation. Unfortunately, a combination of the process of river bed evolution and the effects of extensive flood control and irrigation works in the river basin have annihilated many of the original features. Major factors responsible for the deterioration are :

- habitat destruction, especially siltation in the connecting channels and severing of links with the mainstream;
- isolation from the seasonal floods and natural stocks of juvenile and adult fish. Indiscriminate destruction of seed and brood fish during recruitment phase;
- large scale appropriation of nutrients by the thick mantle of undesirable macrophytes, especially water hyacinth;
- dumping of industrial effluents and washings of agricultural wastes from the catchment areas abetting in eutrophication and speedy swampification;
- conflicting patterns of land use, water management and deforestation in the catchment area;
- inadequate sector management policies like ineffective ownership and leasing system, regulation, control and implementation of fishing activities, transfer of technology, lack of entrepreneurship and a weak cooperative base;
- poor socio-economic status of the fishing community and
- legislative insecurity

4.3 *Environmental degradation and its effect on the riverine fisheries*

The effects of pollution, although not yet fully assessed are obvious from different studies and non-scientific assessments. Thirteen major industries, which include three operational refineries,f pulp and paper units and fertilizer plant, besides numerous other minor industries are located in the valley. With all the major towns of the state located on the river bank, the discharge of municipal waste alongwith runoff from the tea gardens and agricultural plots also adds to the magnitude of the problem. The effect may perhaps be more accentuated by the geographical features of the region, where the drainage is mainly through the Brahmaputra valley.

It is estimated that the river Brahmaputra receives *c.* 1 140 lakh litres pf waste water per day from the industries located in the valley. the average effluent discharge of Hindustan Paper Mill at Jagi Road (Nagaon district) alone discharges effluents to the tune of 72 000 m^3 day^{-1} in the Elanga group of beels, which are connected to river Kollong, an important south bank tributary of the river Brahmaputra.

The severity of pollution in the Elanga beel is witnessed in destruction of biotic communities and almost nil population of commercial species. The beel, once a suitable habitat for IMC breeding now harbours a small population of minnows and weed fishes. Similarly, the effect of sewage discharge at Bharalumukh (Guwahati) and oil effluent discharge at Saraighat (Guwahati) sites are conspicuously reflected in the water and soil quality.

Many north and south bank tributaries of the river Brahmaputra (River Dibang, R. Subansiri, R. Jia Bhorelli, R. Manas, R. Sankosh, R. Kulsi, R. Dhansiri and R. Lohit) harbour the prized Mahseer *(Tor tor, T. putitora* and *Acrossocheilus hexagonolepis)* fishery, now facing extinction. Habitat destruction and over exploitation are the chief causes and unless drastic steps are not taken the species may vanish from Assam waters in due course of time. Necessary regulations in this regard would encompass :

(i) enforcement of creel limit and size limit;
(ii) total ban during spawning period,
(iii) establishment of sanctuaries and safe havens in selected riverine stretches and
(iv) punitive measures to check use of dynamites, gelatin sticks etc.

5. ECO-CONSERVATION AND FISHERIES RESTORATION

Assam has a population of 25.87 million (projected 1990-91), compared to 14.6 millions as per 1971 census. Considering the fish eating population to be 75% of the total (19.40 million), the estimated fish requirement will be 213 476 tonnes, based on nutritional requirements of 11 kg per capita per annum. With the production of 76 000 t during 1990-91, a

shortfall of 64.4% thus remains. To bridge this gap in the comming years, it is imperative to conserve and restore the fast dwindling capture fishery resources.

5.1 *Eco-conservation*

Eco-conservation in the Brahmaputra basin necessitates a holistic approach extending beyond both state and International boundaries. The alarming rate of deforestation in the neighbouring hill states and in the foothills of Bhutan needs immediate check, coupled with massive afforestation programmes in the denunded hill ranges. management of watersheds is now accepted as an essential part of the full and integrated development of drainage basins. Its aims are manifold, *i.e.*, to conserve soils, to retard storm runoff, to reduce sediment production and its transport, and finally, to utilize the varied features of a drainage basin to the optimum.

The deleterious effects of pollution, especially in the floodplain lakes, are amply visible. These lakes provide valuable habitat linds which serve as breeding and nursery sites for carps and their subsequent recruitment to the commercial fishery of the river. Loss of this vital habitat may adversely affect the sustenance of carp stock in the river, giving way to catfishes and other species of lesser commercial significance.

The problem of pollution in the main drainage has not assumed serious dimensions as yet, though the rapid rate of urbanisation accompanied by increased growth of industries may change the situation in the foreseeable future. It is, therefore, necessary to exercise immediate check on dumping of untreated waste in the drainage.

5.2 *Restoration of the dwindling fisheries*

The Brahmaputra river forms the backbone of capture fisheries in the state of Assam. The scope for development of its fisheries rests on both short-term management strategies. Short-term measures that would bring immediate relief to the dwindling fisheries are :

(i) Complete ban on fishing and trade of carp juveniles, except origanised collection of IMC spawn for aquaculture practices,

(ii) Special care to prevent capture of major carp fingerlings from the stagnant pools of the floodplains,

(iii) Closed season and closed areas by way of protection to broodstock.

The mainstay of long-term measures for restoratin of the Brahmaputra fisheries is catchment conservation. this comprises prevention of deforestation, soil erosion and various other catchment abuses in the entire drainage. In order to sustain a healthy fish stock in the river

Brahmaputra and its tributaries, the following steps need careful consideration :

(i) *A systematic survey of the riverine stretches to obtain information on catch per km stretch, estimated cqtch per area (sq.km) along with an inventory of fishing crafts, gear and human resources. Catch per unit effort, in terms of standard units of gear and manpower, needs to be worked out to focus the present state of affairs. Data on fishing intensity and gear selectivity would help determine optimum levels of fishing in the river.*

(ii) *The relevance of imposition of mesh size regulation as a regulatory measure of stock management in a multi-species fishery is becoming suspect, and may be enforced alongwith fish-size limits of economic species, with immature fishes being released back in the river and their sale banned.*

(iii) *Maximum damage to the natural recuritment process occurs due to heavy exploitation of spawners (Ujaimara fishing) during the breeding season and subsequent fishing of juveniles. Such destructive practices should be permanently curbed for maintaining a balanced fishery in the river.*

(iv) *The State has a weak marketing and post-harvest infrastructure resulting in exploitation by the middlemen. Adequate transport network linking fishing and fish landing centres would make fishing more remunerative for the actual fishermen. Cold storage facilities should be developed in cities and district headquarters for minimising spoilage.*

(v) *Mechanised fishing to be introduced in a phased manner. Similarly, R & D support is necessary for gear fabrication, keeping in view, the fluviatile dynamics of the mighty river.*

(vi) *Restructuring of the leasing stretches, leaving identified sanctuaries and closed areas beyond the purview of commercial fishing.*

(vii) *The progressive deterioration of floodplain fisheries is adversely affecting the riverine fishery. floodplains, which serve as breeding grounds and nurseries for carp juveniles are fast becoming inaccessible due to siltation as well as construction of flood protection embankment. Sluice gates, wherever constructed, are oriented towards paddy crops, neglecting the fishery requirements. This trend needs to be reversed to safeguard the interests of floodplain fisheries in particular and the riverine fisheries in general.*

(viii) *Transfer of fishery rights from various departments like revenue, irrigation and forestry to the State Fisheries Department to overcome lack of coordination.*

(ix) *Despite proliferation of registered fisheries cooperative societies all over the state, their functioning leaves much to be desired. the ownership of most of the societies is in the hands of influential parties, having little stake in the improvement of the fishermen's lot. Attention is needed to induct genuine fishermen in the societies so that maximum benefits accrue to this weakest section of the society. A uniform and long-term leasing policy for fishing rights in riverine stretfches, keeping in view the need for settling small-scale fishermen, skilled in exploitation of the capture fishery resources.*

(x) *Resource conservation through revision of existing fishery legislation based on biological propensities of commercial fish species and strict implementation of the regulations. Close linkage with environment and wildlife departments for logical iteraction and coordinated efforts.*

The sustained development of the Brahmaputra fisheries needs a well defined integrated action plan ranging beyond fisheries *per se*. Besides project- oriented action programme to augment fish production, attenmtion is needed towards human resource development. Strengthening of the cooperative base, technology transfer, insurance schemes and related socio-economic considerations need prioritization. Thus, a holistic approach would go a long way in developing the fishery resources of the river Brahmaputra and its tributaries.

Annexure I

Table 1. Fish species recorded from the river Brahmaputra

Family CLUPIIDAE

Sub-family CLUPEINAE

1. Hilsa ilisha (Hamilton)
2. Gudusia chapra (Hamilton)
3. Gudusia variegata (Day)

Family ENGRAULIDAE

4. Notopterus chitala (Hamilton)

Family NOTOPTERIDAE

5. Notopterus chitala (Hamilton)
6. Notopterus notopterus (Pallas)

Family CYPRINIDAE

Sub-family ABRAMIDINAE

7. Oxygaster bacaila (Hamilton)
8. Oxygaster gora (Hamilton)
9. Chela atpar (Hamilton)
10. Chela laubuca (Hamilton)

Sub-family RASBORINAE

11. Raiamas bola (Hamilton)
12. Barilius barila (Hamilton)
13. Barilius barna (Hamilton)
14. Barilius bendelisis var. chedra (Hamilton)
15. Barilius shacra (Hamilton)
16. Barilius vagra (Hamilton)
17. Danio (Danio) aequipinnatus (McClelland)
18. Danio (Danio) dangila (Hamilton)
19. Danio (Danio) devario (Hamilton)
20. Danio (Brachydanio) rerio (Hamilton)
21. Esomus danricus (Hamilton)
22. Rasbora daniconius (Hamilton)
23. Rasbora elanga (Hamilton)
24. Rasbora rasbora (Hamilton)

Sub-family CYPRININAE

25. Amblypharyngodon mola (Hamilton)
26. Aspidoparia jaya (Hamilton)
27. Aspidoparia morar (Hamilton)
28. Accrossocheilus hexagonolepis (McClelland)
29. Tor putitora (Hamilton)
30. Tor tor (Hamilton)
31. Tor progenius (McCelland)
32. Puntius chagunio (Hamilton)
33. Puntius chola (Hamilton)
34. Puntius conchonius (Hamilton)
35. Puntius phutonio (Hamilton)
36. Puntius sarana (Hamilton)
37. Puntius stigma (Hamilton)
38. Puntius stetrarupagus (McClelland)
39. Puntius ticto ticto (Hamilton)
40. Catla catla (Hamilton)
41. Cirrhinus mrigala (Hamilton)
42. Cirrhinus reba (Hamilton)
43. Labeo bata (Hamilton)
44. Labeo calbasu (Hamilton)
45. Labeo dero (Hamilton)
46. Labeo dyocheilus (McClelland)
47. Labeo gonius (Hamilton)
48. Labeo pangusia (Hamilton)
49. Labeo rohita (Hamilton)
50. Osteobrama cotio cotio (Hamilton)
51. Semiplotus semiplotus (McClelland)

Sub-family
SCHIZOTHORACINAE

52. Schizothorax progastus (Hamilton)

Sub-family
GARRINAE

53. Crossocheilus latius latius (Hamilton)

Family PSILORHYNCHIDAE

54. Psilorhychus balitora (Hamilton)
55. Psilorhynchus sucatio sucatio (Hamilton)

Family HOMALOPTERIDAE

56. Balitora brucei brucei Gray

Family COBITIDAE

57. Noemacheilus beavani Gunther
58. Noemacheilus botia (Hamilton)
59. Noemacheilus corica (Hamilton)
60. Noemacheilus savona (Hamilton)
61. Noemacheilus scaturigina (McClelland)
62. Noemachielus sikmaiensis Hora
63. Noemachielus zonatus (McClelland)

Sub-family
BOTINAE

64. Botia dario (Hamilton)

Sub-family
COBITINAE

65. Lepidocephalichthys annandalei Chaudhuri
66. Lepidocephalichthys berdmorei (Blyth)
67. Lepidocephalichthys guntea (Hamilton)
68. Somileptes gongota (Hamilton)

Family SILURIDAE

69. Ompok bimaculatus (Bloch)
70. Wallago attu (Bloch & Schneider)

Family BAGRIDAE

71. Batasio batasio (Hamilton)
72. Mystus (Mystus) bleekeri (Day)
73. Mystus (Mystus) cavasius (Hamilton)
74. Mystus (Mystus) menoda (Hamilton)
75. Mystus (Mystus) vittatus (Bloch)
76. Mystus (Mystus) montanus var. dibrugarensis (Chaudhuri)
77. Mystys (Osteobagrus) aor (Hamilton)
78. Mystus (Osteobagrus) seenghala (Sykes)
79. Rita rita (Hamilton)

Family AMBLYCIPITIDAE

80. Amblyceps mangois (Hamilton)

Family SISORIDAE

81. Bagarius bagarius (Hamilton)
82. Erethistes pussilus (Muller & Troschel)
83. Erethistoides montana montana Hora
84. Gagata cenia (Hamilton)
85. Gagata nangra (Hamilton)
86. Gagata viridescens (Hamilton)
87. Glyptothorax rebeiroi (Hora)
88. Glyptothorax striatus (McClelland)
89. Glyptothorax telchitta (Hamilton)
90. Sisor rhabdophorus (Hamilton)

Family SCHILBEIDAE

91. Ailia coila (Hamilton)
92. Ailichthys punctatus Day
93. Clupisoma garua (Hamilton)
94. Eutropiichthys vacha (Hamilton)
95. Eutropiichthys murius (Hamilton)
96. Pangasius pangasius (Hamilton)
97. Pseudeutropius atherinoides (Bloch)
98. Silonia silondia (Hamilton)

Family HETEROPNEUSTIDAE

99. Heteropneustes fossilis (Bloch)

Family CLARIIDAE

100. Clarias batrachus (Linnaeus)

Family OPHICHTHYIDAE

101. Pisoodonophis boro (Hamilton)

Family BELONIDAE

102. Xenentodon cancila (Hamilton)

Family MUGILIDAE

103. Mugil corsula (Hamilton)
104. Mugil cascasia (Hamilton)

Family CHANNIDAE

105. Channa gachua (Hamilton)
106. Channa marulius (Hamilton)
107. Channa punctatus (Bloch)
108. Channa striatus (Bloch)

Family AMPHIPNOIDAE

109. Amphipnous cuchia (Hamilton)

Family CENTROPOMIDAE

110. Chanda baculis (Hamilton)
111. Chanda nama (Hamilton)
112. Chanda striatus (Hamilton)

Family SCIAENIDAE

113. Sciaena coitor (Hamilton)

Family NANDIDAE

114. Pama pama (Hamilton)
115. Badis badis (Hamilton)
116. Nandus nandus (Hamilton)

Family ANABANTIDAE

117. Anabas testudineus (Bloch)
118. Colisa chuna (Hamilton)
119. Colisa fasciata (Bloch)
120. Colisa lalius (Hamilton)

Family GOBIDAE

121. Glosogobius giuris giuris (Hamilton)

Family MASTOCEMBELLIDAE

122. Mastocembalus armatus armatus (Lacepede)
123. Mastocembalus pancalus (Hamilton)
124. Macrognathus aculiatus (Bloch)

Family TETRAODONTIDAE

125. Tetraodon cucutia (Hamilton)