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Status of Fish and Fisheries of Ganga River

GRB EMP : Ganga River Basin Environment Management Plan

by

Indian Institutes of Technology



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Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government has constituted National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Government for effective abatement of pollution and conservation of the river Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin: Environment Management Plan (GRB EMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin Environment Management Plan (GRB EMP) by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. Memorandum of Agreement (MoA) has been signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This report is one of the many reports prepared by IITs to describe the strategy, information, methodology, analysis and suggestions and recommendations in developing Ganga River Basin: Environment Management Plan (GRB EMP). The overall Frame Work for documentation of GRB EMP and Indexing of Reports is presented on the inside cover page.

There are two aspects to the development of GRB EMP. Dedicated people spent hours discussing concerns, issues and potential solutions to problems. This dedication leads to the preparation of reports that hope to articulate the outcome of the dialog in a way that is useful. Many people contributed to the preparation of this report directly or indirectly. This report is therefore truly a collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team. Lists of persons who have contributed directly and those who have taken lead in preparing this report is given on the reverse side.

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1. Introduction

The Ganga river basin is one of the largest inland river basin of India, draining a catchment of 0.86 million km² and supporting 43% of India's population. The Ganga rises as Bhagirathi in Himalyas at 'Gaumukh' at the height of 4255 m in Uttrakashi region in Uttarakhand. The basin lies between Longitude 73° 30' and 89° East and Latitude 22° 30' and 31° 30' North and covers eleven states viz. Uttarakhand, Uttar Pradesh, Delhi, Madhya Pradesh, Rajasthan, Haryana, Himachal Pradesh, Chhattisgarh, Jharkhand, Bihar and West Bengal. During its course of 2525 km, it is joined by numerous tributaries, large and small with varying flows with characterstic flora and fauna. Some of the important tributaries include Alaknanda (Mandakini, Pindar, Nandakini), Ramganga, Kali, Yamuna (Chambal, Sind, Betwa and Ken), Gomti, Ghagra, Gandak, Tons, Son, Punpun, Burhi Gandak and Kosi. Plate 1, shows the flow chart of the river Ganga.

The river Ganga supports a copious biological growth with rich flora and fauna represented by producers (periphyton and phytoplankton), consumers (zoobenthos and zooplankton), fishes and higher aquatic vertebrates. The fish population of the river Ganga includes the Indian Major Carps, other Carps, Mulletts, Clupeids, Feather backs, large/ small Catfishes and miscellaneous fishes.

The main stem of Ganga has been differentiated into three stretches and ten sub-stretches based on habitat, substrate and ecology. The upper stretch is mountainous with cold water, high velocities and low nutrient concentration. The middle and lower reaches are in plains with river meandering, flood plains, comparatively moderate water temperatures, reduced velocity and increased sediment load with nutrients present in sufficient quantities due to large human interventions. The salient features of each reach and subreach has been described in the GRBEMP report number 001_GBP_IIT_GEN_Dat_01_Ver_1 Dec 2010.

Stretch 1: Upper Ganga ***Gangotri to Haridwar (294 km)***

UG-1. Gangotri-Gangnani
UG-2. Gangnani-Devprayag
UG-3. Devprayag-Haridwar
(U/s of Bhimgauda barrage)

Stretch 2: Middle Ganga ***Haridwar to Varanasi (1082 km)***

MG-1. Haridwar-Bijnor
MG-2. Bijnor-Narora
MG-3. Narora-Fatehgarh
MG-4. Fatehgarh-Allahabad
MG-5. Allahabad-Varanasi

Stretch 3: Lower Ganga ***Varanasi to Ganga Sagar (1134 km)***

LG-A | **LG-1.** Varanasi-Patna
LG-2. Patna-Bhagalpur
LG-3. Bhagalpur-Farakka

LG-B |

LG-4. Farakka-Ganga Sagar



Plate 1: Line diagram of river Ganga with major tributaries

2. Habitat

The river in the upper reach flows on steep bed and narrow terrain. The substrate is mostly bedrocks, boulders and cobbles. The water is very cold, having turbulent flow, and high velocities, sometimes up to 2.0-3.0 m/sec. Rapids are the major habitat, followed by deep pools and riffles. The water is pristine or near pristine with little or no pollution from anthropogenic sources except bathing and cremation on the banks of urban agglomerates. The flow in the river has been obstructed due to the construction of hydroelectric projects at Maneri Bhali I and II, Tehri and Koteshwar.

The middle reach is in plains. The river bed is wide with extensive flood plains, meandering streams on sand and pebbles. The temperature of water is moderate (15-25°C) and low velocities (20-30 cm/sec). The river habitat consists of pools and run of the river. In the upper portions of the stretch the pollution level is less and, as the river traverses down the urban centres the pollution increases gradually. Downstream of Fatehgarh upto Allahabad, passing through Kannauj, Kanpur, Fatehpur and Allahabad, it becomes intensely polluted. The reach is also characterized by large abstractions of water for multiple purposes at Haridwar, Bijnor and Narora. The flows in the river downstream of abstractions are small and critical during lean-season.

The river in lower reach has problems of sediment load, flooding and silt deposition through a meandering water course. The flows are comparatively higher after the confluence of major tributaries. The substrate is usually of silt over sand. A significant length of the stream lies in the Hooghly estuary where varied levels of salinity and tidal frequency determine biodiversity.

3. Biological communities

The fish population of Ganga is largely dependent on the flora and fauna produced in the system including phytoplankton, zooplankton, periphyton and zoobenthos which establishes itself in the form of food chain. Appendix-I represents the comparative account of the available flora and fauna in river Ganga. The perusal of the data in other reports and summary tabulated in Appendix-I reveals that diatoms (Bacillariophyceae) are predominantly present throughout the river with increase in diversity through upper Ganga, middle Ganga and lower Ganga. The green algae (Chlorophyceae) appear scantily in upper Ganga, gradually increases in species richness in middle Ganga and becomes dominant in Lower Ganga (LG-A). The blue green algae (Cyanophyceae) are poorly represented in the upper Ganga. The forms, however, increase in middle Ganga and lower Ganga and shows up as dominant group in Lower Ganga stretch (LG-B).

The zooplanktons are scanty in upper Ganga. They are represented by Protozoans, Rotifers, Copepods, Cladocera and other Crustaceans/ Arthropods in middle and lower Ganga. The notable contributors in LG-B, in addition to those mentioned earlier, are the Cnidarians and Chaetognaths (common in estuarine environment).

The zoobenthos type is dependent on the substratum. Larvae of Insecta are common on hard substrates (upper Ganga) while Annelids, Nematodes and Molluscs on soft substrate (silt over sand) in middle and lower Ganga.

4. Fishes in the Ganga river

The river Ganga supports a large number of indigenous and exotic species of fishes (record of 268 fishes from the river Ganga was first ever documented by Hamilton 1822). Vass *et al.* (2008) reported the presence of 218 species in inland fresh waters and waters of Hooghly estuary. However, the compilation of records from other reports, research papers, dissertations and thesis of academic institutes add up to 297. A compendium of species and families is given at the end of the report as Appendix-II. These fishes are grouped under 81 families and 167 genera (Table 1).

Table 1: Total number of fishes (taxa) in river Ganga			
Categories	Species	Genus	Families
(a) Number of fish from fresh water (UG-1 to LG-A)	178	89	37
(b) Number of fish from brackish waters (LG-B)	103+72*	69	37
(c) Common cartilaginous fishes (Chondrichthyes)	13	9	7
Total	294	167	81

* Common in fresh water zone

Out of 297 species recorded from the river, more than 100 species are reported to have commercial importance. Following species are known for their high commercial value:

I. Species (fresh water) of varying commercial importance (Misra, 1959; Jhingran, 1991):

(A). Indian Major Carps

- 1) *Cirrhinus mrigala*
- 2) *Catla catla*
- 3) *Labeo rohita*
- 4) *L. calbasu*

(B). Other Carps

- 5) *Cirrhinus reba*
- 6) *Labeo bata*
- 7) *L. dero*
- 8) *L. pangusia*

(C). Large Cat fishes

- 9) *Sperata aor*
- 10) *S. seenghala*
- 11) *Silonia silondia*
- 12) *Wallaga attu*
- 13) *Pangasius pangasius*
- 14) *Bagarius bagarius*
- 15) *Rita rita*

(D). Other Cat fishes

- 16) *Ailia coila*
- 17) *Clupisoma garua*
- 18) *Eutropiichthys vacha*
- 19) *Ompok bimaculatus*
- 20) *Ompok pabda*

(E). Clupeoides

- 21) *Gudusia chapra*
- 22) *Setipinna phasa*
- 23) *Tenuulosa (Hilsa) ilisha*

(F). Feather backs

- 24) *Notopterus chitala*
- 25) *N. notopterus*

Other fish

- 26) *Channa punctata*
- 27) *C. marulius*
- 28) *Puntius sophore*
- 29) *P. conchoni*

II. Commercially important fish/shrimp of Hooghly estuary:

- 1) *Tenuulosa (Hilsa) ilisha*
- 2) *Polynemus paradiseus*
- 3) *Liza parsia*
- 4) *Pama pama*
- 5) *Lates calcarifer*
- 6) *Penaeus indicus* (Indian prawn)
- 7) *Harpodon nehereus*
- 8) *Setipinna phasa*
- 9) *Trichiurus* spp.
- 10) *Sciaena biauritus*
- 11) *Ilisha elongata*
- 12) *Arius jella*
- 13) *Stromateus cinereus*
- 14) *Coilia* spp.

4.1 Fishes in the upper Ganga

The upper Ganga represents the mountainous reach where temperature is low, habitat is strong snow melt currents, with rocks and boulders as substrate. The fallout of lignocellulosic materials from forest canopy is supportive to some insect larvae which grow underneath boulders and rocks as zoobenthos. This zone is ultra-oligotrophic and does not support biological growth. The reach Gangotri to Gangani (UG-1) has been referred as **NO FISH ZONE** by Singh (2008).

As per records, 60 fish species belonging to 27 genus and 12 families have been reported from the upper stretch of the river. Cyprinidae is the largest family with 35 species.

The reach between Gangnani to Devprayag (UG-2) is inhabited by hill stream fishes. The most prominent, being snow-trouts, *Schizothorax* and *Schizothoraichthys*. The nine species of both the genera have been reported out of which seven species of *Schizothorax*: *Schizothorax curvifrons*, *S. plagiostomus*, *S. richardsonii*, *S. sinuatus*, *S. niger*, *S. micropogon* and *S. intermedius* and two species of *Schizothoraichthys*: *S. esocinus* and *S. progastus* are prominent. Other fishes reported are *Pseudecheneis* (1 sp.), *Crossocheilus* (1 sp.), *Clupisoma* (1 sp.), *Labeo* (2 sp.), *Tor* (3 sp.), *Garra* (3 sp.), *Glyptothorax* (5 sp.), *Barilius* (5 sp.), *Nemacheilus* (6 sp.). **The snow trout *Schizothorax richardsonii* is the characterstic species of this stretch of Ganga.**

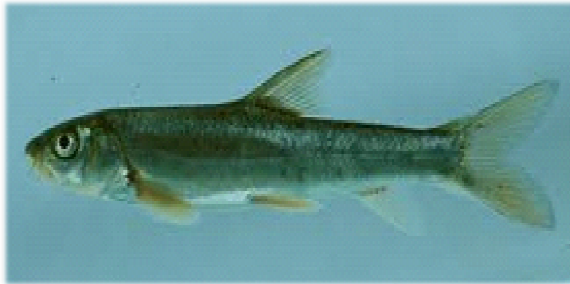
The population of some hill stream fishes (UG-2), their migration for breeding and over-wintering (Snow trout) has been severely impeded by a series of hydro-electric projects. The flow conditions in the river have been interrupted (Plate 2) and often the stretch (86 km) remains without water. The snow-trout, which are known to migrate upwards against current to safer places to breed, are stranded.

From Devprayag to Haridwar (UG-3) a few species of Mahseer (*Tor tor*, *T. putitora*) and few catfishes make their appearance. Golden Mahseer (*Tor putitora*) is the keystone species of the reach. Besides Mahseer, the other carps reported are *Crossocheilus latius latius*, *Esomus danricus*, *Garra gotyla gotyla*, *Raiamas bola*, *Rasbora daniconius*, *Salmostoma bacaila*, *Schizothoracthys progastus*, *Danio* (2 sp.), *Schizothorax* (2 sp.), *Puntius* (3 sp.), *Barilius* (4 sp.) and *Labeo* (5 sp.) (Plate 3). Some other members of the stretch are *Bagarius bagarius* (Sisoridae) and *Nemacheilus* (Balitoridae). The distribution of fish families and genus (UG-2 and UG-3) is given in Figures 1a and b. Some other fishes (*Clarias*, *Clupisoma*, *Myxus*, *Rita*, *Rhinomugil*, *Salmostoma*), not commonly inhabiting cold, clear and rapid streams of hilly terrain, have also been reported by Singh *et al.* (1983), Sharma (1988), Negi and Malik (2005) and Nautiyal *et al.* (2009). They have been taken as rare/stray catch in the stretch.



Plate 2: River Ganga at Maneri Bhali I

Hill stream fishes of Ganga river



Snow-trout (*Schizothorax* sp.)



Mahseer (*Tor* sp.)

Cat Fishes

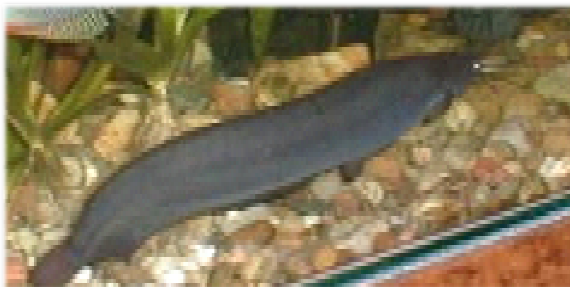


Bagarius bagarius

Major Carps



Catla catla



Heteropneustes fossilis



Cirrhinus mrigala



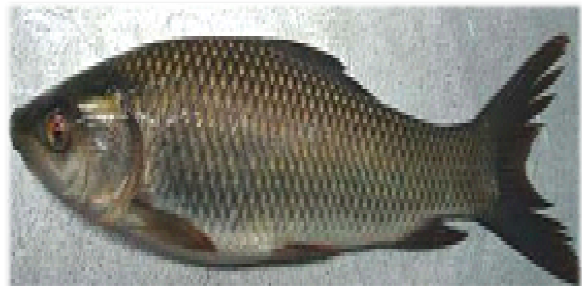
Sperata seenghala



Labeo calbasu



Mystus tengara



Labeo rohita

Plate 3: Snow-trout and Mahseer of upper Ganga and Major carps and Catfishes of middle and lower Ganga

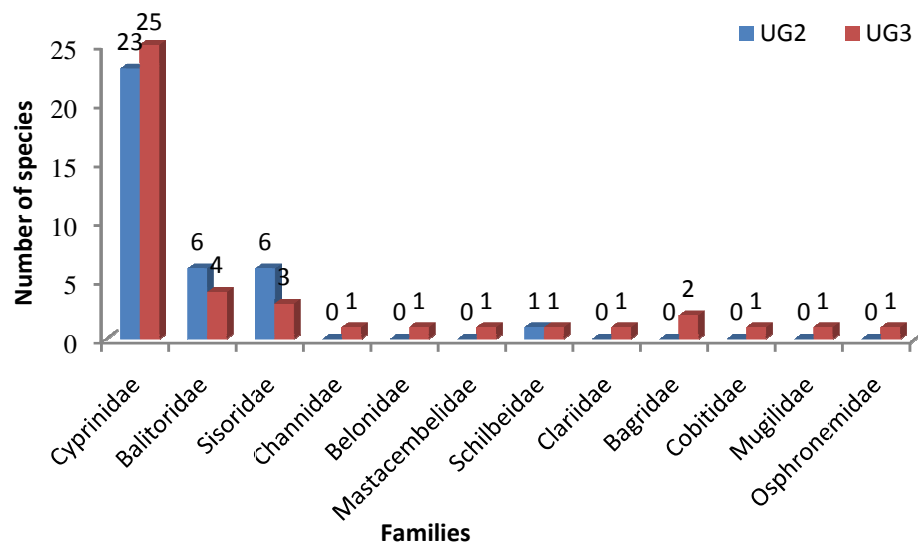


Figure 1a: The distribution of fish families in the two sub-stretches of the upper Ganga

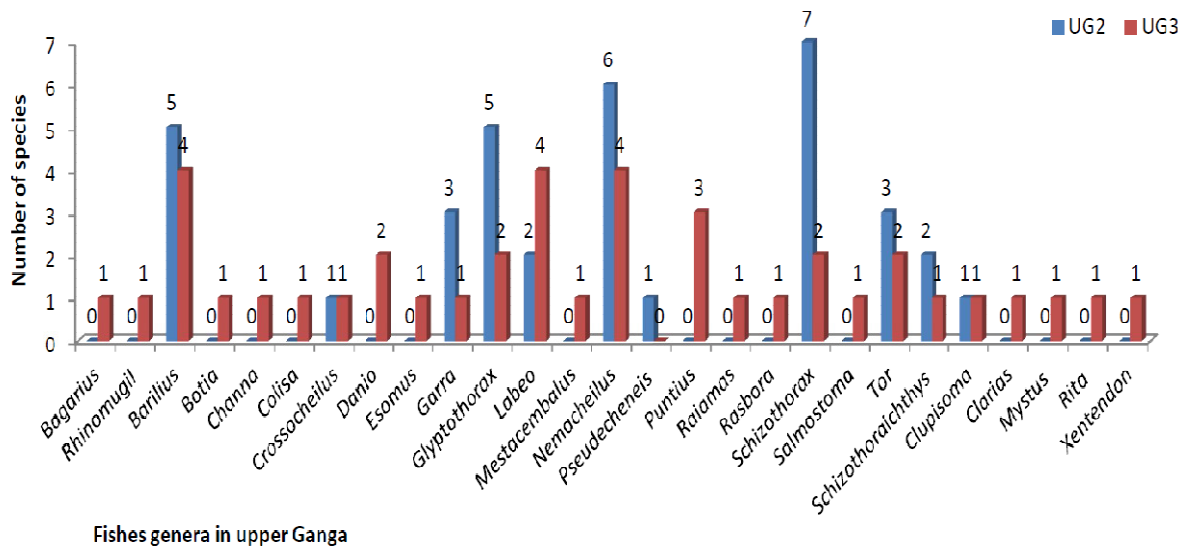


Figure 1b: The distribution of fish genera in the two sub-stretches of the upper Ganga (UG-2 and UG-3)

4.2 Fishes in the middle Ganga

The middle reach is a very long stretch of river Ganga and is about 1082 km long. The important tributaries (Song and Suswa) debouch into the river Ganga between Rishikesh and Haridwar; Ramganga and Kali at Kannauj and Yamuna at Allahabad. Ram Ganga and Kali are much degraded rivers and bring in large quantities of domestic and industrial wastes while Yamuna is the most important tributary of river Ganga.

The water abstraction from Ganga at three places, Haridwar, Bijnor and Narora in Upper Ganga Canal, Madhya Ganga Canal and Lower Ganga Canal reduces the flow in the main stem of Ganga, considerably.

bimaculatus, *Ompok pabda*, *Rita rita*, *Pangasius pangasius*, *Silonia silondia* and *Wallago attu* are the reported groups of catfishes. Exotic fishes- *Cyprinus carpio* and *Oreochromis niloticus* are also present in the stretch in sizeable population. Another commercially important fish of the reach is *Hilsa ilisha*. The fish is now disappearing after the construction of Farakka barrage. The other species reported are *Notopterus notopterus* and *N. chitala* (Notoptidae), *Setipinna phasa* (Engraulidae), *Glossogobius giuris* (Gobiidae), *Heteropneustes fossilis* (Heteropneustidae), *Clarias batracus* (Clariidae), *Xenentodon cancilla* (Belontiidae) and *Mastacembalus armatus* (Mastacembalidae). The family-wise distribution of fishes is given in Figure 3 and the distribution of economically important genera (commercially important) is given in Table 3.

Table 2: Distribution of economically important fishes in middle Ganga

		MG-1	MG-2	MG-3	MG-4	MG-5
IMC						
	<i>Catla catla</i>	+	+	+	+	
	<i>Cirrhinus mrigala</i>	+	+	+	+	+
	<i>Labeo calbasu</i>	+	+	+	+	+
	<i>L. rohita</i>	+	+	+	+	+
Other Carps						
	<i>Cirrhinus reba</i>	+	+	+	+	+
	<i>Labeo bata</i>	+	+		+	+
	<i>L. dero</i>	+				
	<i>L. pangusia</i>	+		+		+
Large Cat fish						
	<i>Bagarius bagarius</i>	+	+	+	+	+
	<i>Pangasius pangasius</i>			+	+	
	<i>Rita rita</i>	+	+	+	+	+
	<i>Silonia silondia</i>		+		+	
	<i>Sperata aor</i>		+	+	+	+
	<i>S. seenghala</i>	+	+	+	+	+
	<i>Wallago attu</i>		+	+	+	
Other Cat fish						
	<i>Ailia coila</i>			+	+	+
	<i>Clupisoma garua</i>	+	+	+	+	+
	<i>Eutropiichthys vacha</i>		+	+	+	+
	<i>Ompok bimaculatus</i>			+	+	
	<i>O. pabda</i>			+	+	
Clupeoides						
	<i>Gudusia chapra</i>		+	+	+	+
	<i>Setipinna phasa</i>				+	+
	<i>Tenulosa ilisha</i>				+	+

Table 3: Distribution of economically important fishes in lower Ganga

		LG-1	LG-2	LG-3	LG-4
IMC					
	<i>Catla catla</i>	+	+	+	+
	<i>Cirrhinus mrigala</i>	+	+	+	+
	<i>Labeo calbasu</i>	+	+	+	+
	<i>L. rohita</i>	+	+	+	+
Other Carps					
	<i>Cirrhinus reba</i>	+	+	+	+
	<i>Labeo bata</i>	+	+	+	+
	<i>L. dero</i>	+			
	<i>L. pangusia</i>	+	+	+	
Large Cat fish					
	<i>Bagarius bagarius</i>	+	+	+	+
	<i>Pangasius pangasius</i>		+	+	+
	<i>Rita rita</i>	+	+	+	+
	<i>Silonia silondia</i>		+	+	+
	<i>Sperata aor</i>	+	+	+	+
	<i>S. seenghala</i>	+	+	+	+
	<i>Wallaga attu</i>	+	+	+	+
Other Cat fish					
	<i>Ailia coila</i>	+	+	+	+
	<i>Clupisoma garua</i>	+	+	+	+
	<i>Eutropiichthys vacha</i>	+	+	+	+
	<i>Ompok bimaculatus</i>	+	+	+	+
	<i>O. pabda</i>	+	+	+	+
Clupeoides					
	<i>Gudusia chapra</i>	+	+	+	
	<i>Setipinna phasa</i>	+	+	+	+
	<i>Tenuulosa ilisha</i>	+	+	+	+

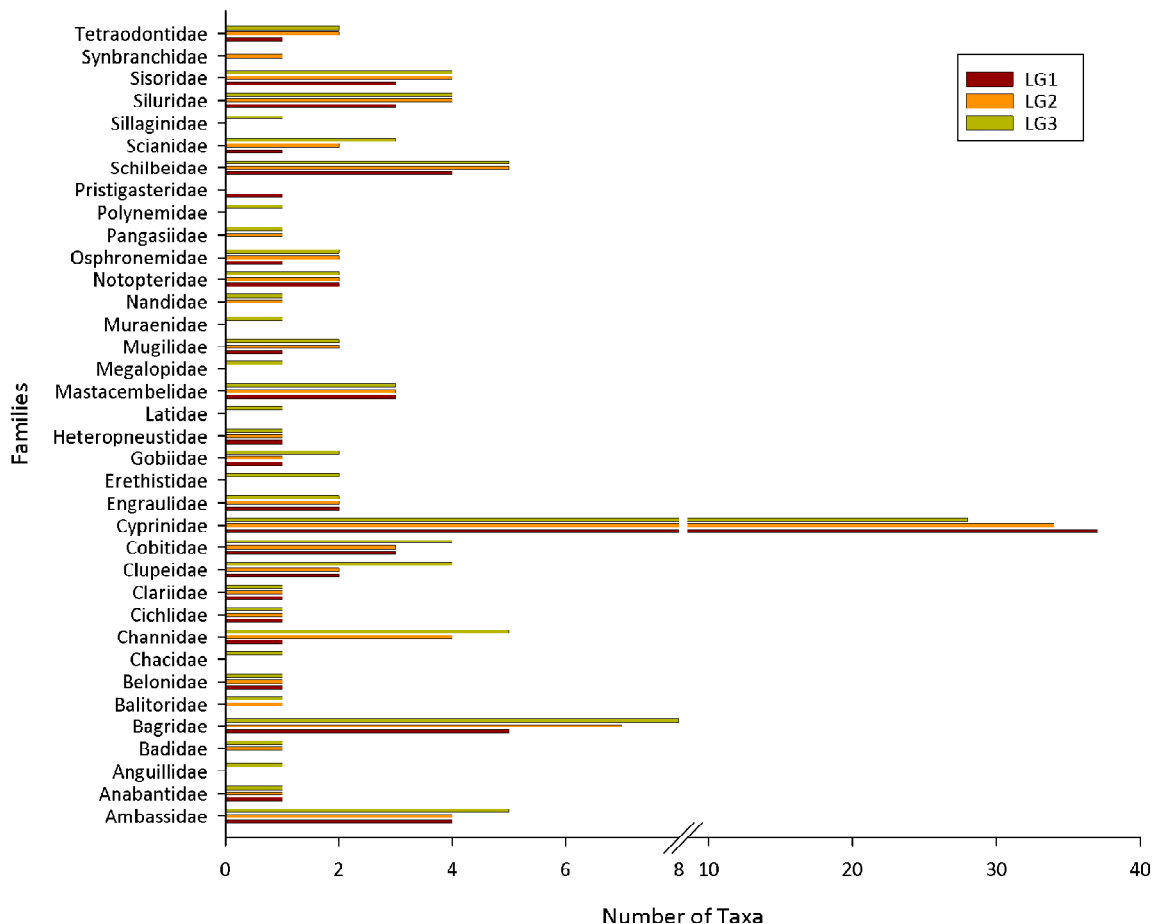


Figure 3: The family wise distribution of fishes in lower Ganga (LG-A)

4.4 Fishes in lower Ganga Hooghly-Matlah estuary (LG-B)

Hooghly Matlah estuary is the largest estuary spanning to about 0.8 million ha with conditions of fresh water, brackish water and marine water present alongwith. The fresh water system is represented by river Hooghly and its tributary Rupnaryan and many estuarine distributaries and creeks. The Hooghly-Matlah estuary is known for its faunastic richness.

Salinity is a critical chemical factor in governing the faunal distribution in this zone. The changes in salinity pattern of the Hooghly estuary have led to changes in the biodiversity of the estuary, including fish diversity in different regions. The estuary now been re-zonated from the water salinity point of view (Plate 4a and b). The fresh water zone has extended to almost Diamond Harbour from Baranagar earlier, a transition zone upto Kakdwip, while the high salinity zone is restricted to Sagar and Frazergunj-Bakkhali in the lower most part of the estuary. The 12 km stretch in the fresh water zone of the Hooghly estuary between Bichalighat and Barrackpore (Ghosh, 2007) revealed a change in the fish fauna, compared to the Pre-Farakka period, with a shift of most of the brackish water fish species to further downstream. *Sicamugil cascasia*, a small Mullet, could be recorded for the first time from the fresh water zone of Hooghly eustuary (Mitra *et al.* 1997). On the other hand the Spotted Codlet, *Bregmaceros mccllellandi*, which was regarded rather a rare species, has now been

found to be well available in the lower most part of Hooghly estuary and also in Sunderbans estuary. *Oreochromis niloticus* has been recorded for the first time from the fresh water zone of the Hooghly estuary which is probably the first record of any exotic species from the tidal zone of the river Ganga (Ghosh, 2008).

The ichthyo-fauna is represented by 175 species, out of which 103 species, under 69 genera and 37 families are strictly estuarine in nature, which is evidenced by annual (average) catch of about 40,000 tons. The estuary is large (290 km) and is influenced by tides. It is believed that the ecology of the Hooghly estuary has significantly changed after commissioning of Farakka barrage in 1975. It is reported that fresh water zone has extended and there is decline in salinity patterns by squeezing and intermingling with marine water. Plate 4a and b show Hooghly estuary and its various ecological zones, Zone I Nawadip-Baranagar; Zone II Baranagar-Diamond Harbour; Zone III Diamond Harbour-Ganga Sagar; Zone IV Containing Rupnarayan tributary, Birampur, Gobindapur and Kolaghat (Adopted from CIFRI Report of Mitra *et al.* (1997). Zone I, II and IV together constitute the upper estuary and zone III the lower estuary (Nath *et al.* 2004; Ghosh, 2008).

Among the 175 species, 72 species occur in fresh water zone. 26 species are mainly represented in the catches. Among the major contributors are *Tenulosa ilisha*, *Sciaena bauritus*, *Colia* sp., *Pama pama*, *Ilisha elongata*, *Setipinna* sp., *Tachysurus jella*, *Trichiurus* sp., *Harpodon nehereus*, *Stomateus cinereus*, Prawns and miscellaneous.

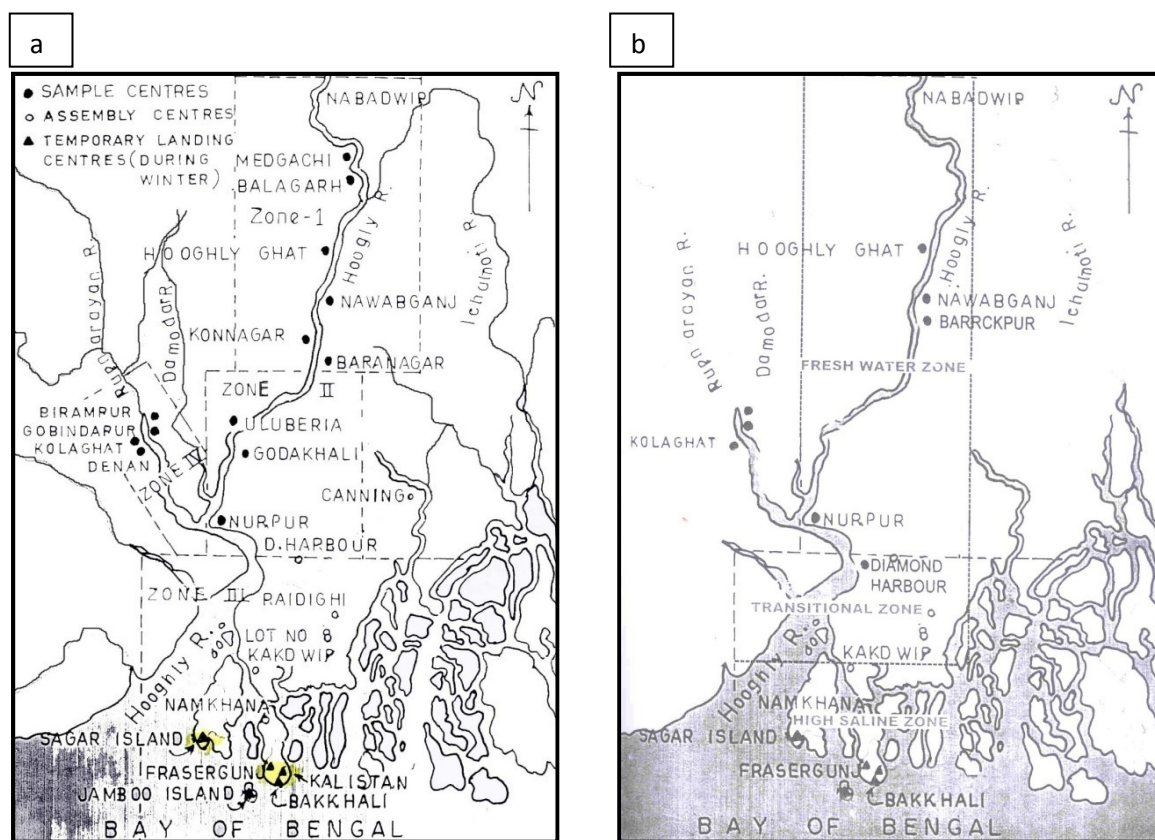
(Mitra *et al.* 1997)(Nath *et al.* 2004; Ghosh, 2008)

Plate 4: Hooghly estuary

The important families are Cyprinidae 15 sp. (*Catla catla*, *Labeo rohita*, *L. calbasu*, *L. bata*, *Cirrhinus mrigala*, *C. reba*, *Puntius ticto*, *P. conchonus*, *P. sarana*, *P. sophore*, *Salmostoma bacaila*, *Danio devario*, *Esomus danricus*, *Rasbora daniconius*, *Amblypharygodon mola*), Gobiidae 8 sp. (*Brachygobius nusus*, *Glossogobius giuris*, *Pseudapocryptus lanceolatus*, *Stigmatogobius sadanundio*, *Periopthalmadon schlosseri*, *Boleophthalmus dussumiere*, *Gobiopterus chuno*, *Bathygobius orbicularis*), Clupeidae 8 sp. (*Tenulosa ilisha*, *Hilsa kelee*, *Gudusia chapra*, *Gonialosa manmina*, *Corica soborna*, *Anodontostoma manmina*, *A. chachuna*, *Sardinella melasura*), Engraulidae 8 sp. (*Coilia dussumieri*, *C. ramcorti*, *C. reynaldi*, *Setipinna phasa*, *S. taty*, *S. brevifilis*, *Stolephorus indicus*, *Thryssa purva*), Mugilidae 7 sp. (*Liza parsia*, *L. tade*, *L. macrolepis*, *Mugil cephalus*, *Valamugil cunnesius*, *Sciamugil cascasia*, *Rhinomugil corsula*), Schilbiidae 4 sp. (*Ailia coila*, *Eutropiichthys vacha*, *Clupisoma garua*, *Silonia silondia*), Siluridae 4 sp. (*Wallago attu*, *Ompok bimaculatus*, *O. pabo*, *O. pabda*), Bagridae 6 sp. (*Sperata aor*, *S. seenghala*, *Myxus cavasius*, *M. vittatus*, *M. gulio*, *Rita rita*), Notopteridae 2 sp. (*Notopterus notopterus*, *N. chitala*), Sisoridae 2 sp. (*Bagarius bagarius*, *Gagata cenia*); Aridae 7 sp. (*Arius jella*, *A. sona*, *A. arius*, *A. gagora*, *A. sagar*, *Batrachcephalus minor*, *Osteogobius militaris*); Channidae 4 sp. (*Channa striatus*, *C. marulius*, *C. punctatus*, *C. orientalis*). A combined list of fishes from the eustary is given in Appendix-III. Some exotic and commercially important fishes of Hooghly estuary are presented in Plate 5.

In addition, 13 species of Chondrichthys or Cartilaginous fishes belonging to 9 genus and 7 families have also been recorded in the estuarine zone. Of these genus Dasyatidae (5 sp.) is the most common (Appendix-IV).

5. Fishing gears

Hook and line are the main gear used in the upper Ganga where no organized fisheries exist. Nets and other gadgets can not be used as the river flows in narrow hilly terrain with high velocities. Since game fishes exist in the reach, the only possibility is angling.

Fishing is not permitted in down stream stretch of the river Ganga upto Haridwar. Use of fishing gear is operative in the middle Ganga and lower Ganga stretch. The variously designed gears are used to suit local conditions such as depth of water, water velocity and type of fish to be caught. Dragnets, gill nets, purse net, scoop net, cast nets, set barriers, traps and long lines are normally used in fresh water stretches. In estuarine system, trawl nets, seine nets, purse nets, drift nets, lift nets, cast nets, bag nets, set gillnets, set barrier nets and traps are used. A compilation of gears used, area of operation, season of operation and probable catch (after CIFRI, 1970) is given in Appendix-V and Plate 6.

Exotic fishes



Ctenopharyngodon idella



Cyprinus carpio



Hypophthalmichthys molitrix

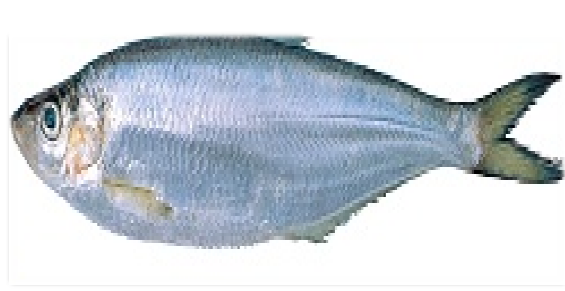


Aristichthys nobilis



Oreochromis niloticus

Hooghly estuary fishes



Ilisha elongate



Setipinna phasa



Hilsa ilisha

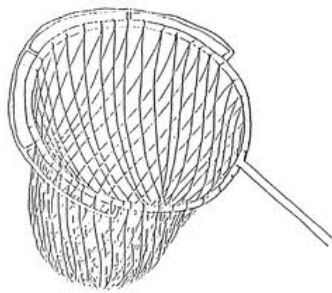
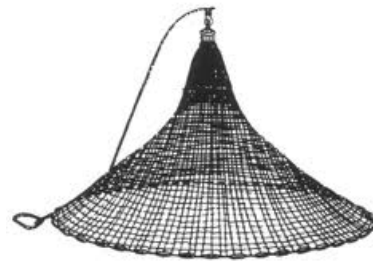
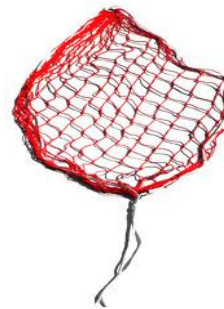


Tachysurus jella



Harpodon nehereus

Plate 5: Some exotic and commercially important fishes of Hooghly estuary

**Scoop Net****Cast Nets****Sine nets****Gill Nets****Drag Net****Purse Net****Plate 6: Different types of gear and net used in Ganga river**

6. Riverine fisheries of the river Ganga

The river Ganga is the most important source of livelihood for a large community of riparian population. A very large variety of fish have been reported which are of commercial importance.

The 1600 km of river from Haridwar to Lalgola ghat (West Bengal) is beset with large deep pools in the silt covered sand bed. Commercial fisheries are mainly observed in this stretch starting from Bulandshahr (Uttar Pradesh). Though there are 22 landing centres recognized for fish catch only seven of them were active viz. Kanpur, Allahabad, Varanasi, Buxar, Ballia, Patna and Bhagalpur and more recently the data is available at Allahabad only. All other centers have dispensed with the regular data collection on fish catch. Most of the records of fish catch/ landings, yield and species composition are based on records maintained by Central Inland Fisheries Research Institute, Regional Centre, at Allahabad.

6.1 Fish landings

The annual market arrivals at the seven landing centres are shown in Table 4a (Jhingran, 1975). Supplementary data beyond 1965-66, as and where available (CIFRI annual reports), have been compiled in Table 4.

The perusal of data reveals that the annual average catch during the decade 1955-1956 to 1965-1966 at Allahabad was high of 243.25 tons as compared to other centers Patna, Bhagalpur, Varanasi, Ballia, Buxar and Kanpur (Figure 4). The highest ever was 485 tons at Allahabad in 1956-1957 and the lowest at Kanpur 29.71 tons in 1961-1962 (Table 4). The downward trend continues and the values of decadal annual average have reached a value of 162.24 tons at Allahabad.

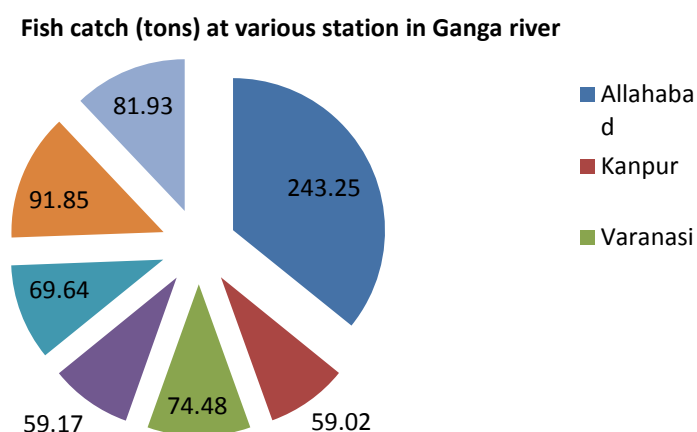


Figure 4a: Average fish landings at seven important centres during (1955-56 to 1965-66)

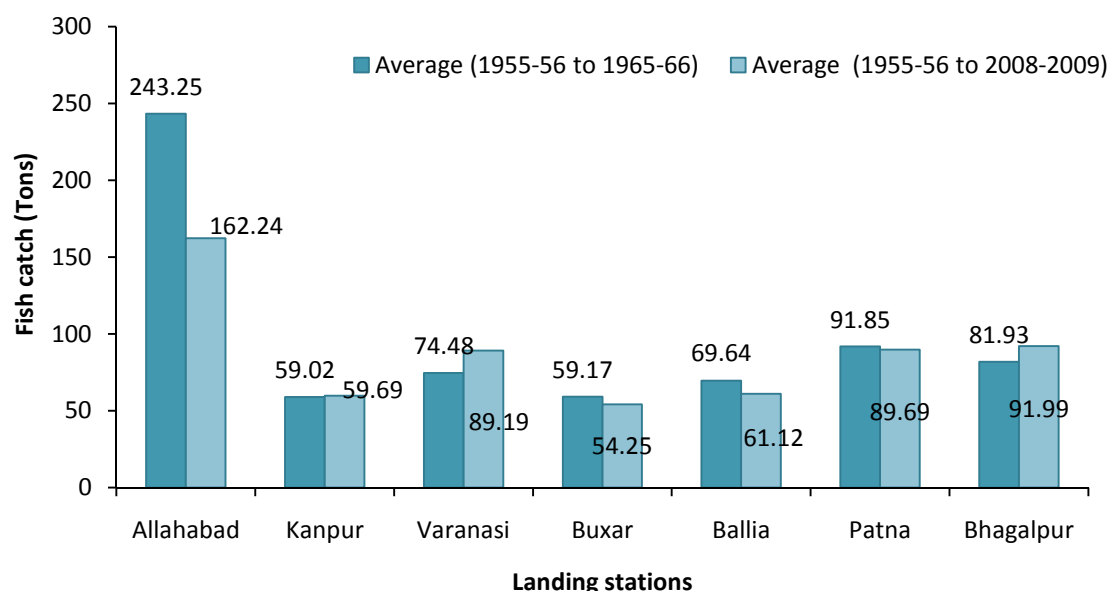


Figure 4b: Comparison of average fish landings at seven important centres between the period of (1955-56 - 1965-66) to (1955-56 - 2008-09)

Table 4: Fish landing at important landing centres (1955-56 to 1965-66) tons/year

Landing Centre	1955-56	1956-57	1957-58	1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69	1970	1971	1973	1975	1980-81
Allahabad	316.42	<u>485</u>	200.1	145.35	193.58	200.11	202.82	263.08	200.41	256.35	212.49	186.2	169.2	228.9	-	-	72.47	83.78	130.5
Kanpur	-	-	-	93.35	105.62	81.76	<u>29.71</u>	52.43	43.09	33.72	32.62	48.6	25.2	39.9	-	-	-	-	-
Varanasi	-	-	-	46.71	47.16	69.38	71.14	105.36	75.18	71.02	109.92	98.0	133.9	153.4	-	-	-	-	-
Buxar	-	-	-	108.62	71.77	54.27	-	-	32.58	31.63	56.12	64.5	48.3	125.4	-	-	14.6	-	16.49
Ballia	-	-	-	45.38	50.24	84.40	51.37	72.37	114.23	-	-	51.0	39.8	41.3	-	-	-	-	-
Patna	-	-	-	54.60	40.11	96.39	106.31	129.28	115.38	76.96	114.95	108.3	98.8	110.2	-	-	-	-	-
Bhagalpur	-	-	-	41.51	59.88	85.98	120.55	98.36	77.65	76.35	94.92	83.4	121.8	139.9	103.16	113.82	100.0	-	-

Landing Centre	1982	1985-89	1992-97	1996-01	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	Average (1955-56 to 2008-2009)
Allahabad	125.3	125.4	69.58	77.88	69.65	68.37	94.67	-	74.25	86.85	115.9	88.1	<u>162.24</u>
Kanpur	-	-	-	-	-	101.5	88.54	-	-	-	-	-	59.69
Varanasi	-	-	-	-	-	-	-	-	-	-	-	-	89.19
Buxar	-	26.75	-	-	-	-	-	-	-	-	-	-	54.25
Ballia	-	-	-	-	-	-	-	-	-	-	-	-	61.12
Patna	-	25.1	-	-	-	-	-	-	-	-	-	-	89.69
Bhagalpur	-	62.54	-	-	-	-	-	-	-	-	-	-	91.99

There is paucity of data at many centres and the average data as available is shown in the pie diagram (Figure 4a) and bar diagram (Figure 4b). The values of fish landing at Allahabad were available for almost the entire period whereas for other centers the information is very little and it does not show up in the average values.

6.2 Catch composition

The fish yield of major Carps and other selected Catfishes during the period 1958-59 to 1968-69 was reported by Jhingran and Ghosh (1978) (Table 5) and comparative analysis of change in the catch composition at Allahabad and Patna between 1958 and 1994 was reported by Payne *et al.* (2003) (Table 6). The data compiled from Annual Reports of CIFRI, Barrackpore, for Kanpur during the period 2002-03 and 2003-04, Allahabad upto 2009, Buxar upto 1985-89, Patna upto 1985-89 and Bhagalpur upto 1985-89 has been reproduced in Table 5. The major Carps (MC) include *Cirrhinus mrigala*, *Labeo rohita*, *Labeo calbasu* and *Catla catla*. The Catfishes (CF) include *Wallaga attu*, *Sperata aor*, *Sperata seenghala* and Hilsa (H) as *Hilsa ilisha* while the other species were grouped under others (O).

Based on data reported, there is a constant decline not only in fish (catch) landing but also a shift in species composition. Vass *et al.* (2010) observed a declining pattern in the total fish catch to almost half (during the period where data was available) at different landing centres located at Allahabad, Buxar, Patna and Bhagalpur (Figure 5).

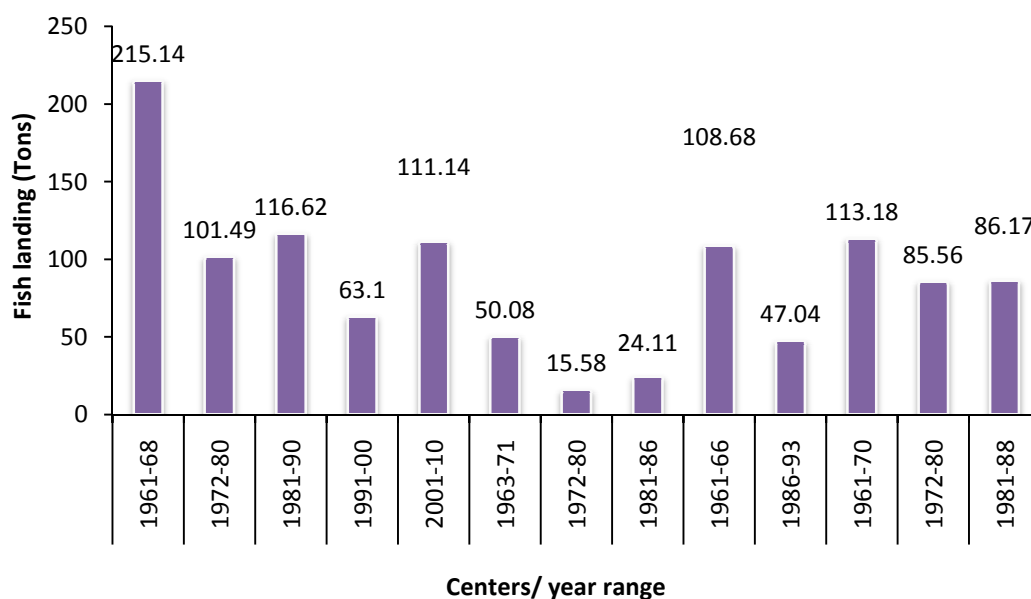


Figure 5: Fish landing at various centers in the river Ganga

Table 5: Market arrivals (tons) of major carps (MC), selected catfishes (CF), Hilsa (H) and other (O) fishes during the period 1958-69

Zones		1958-59	1959-60	1960-61	1961-62	1962-63	1963-64	1964-65	1965-66	1966-67	1967-68	1968-69
Kanpur	MC	51.0 (85.0)	54.8 (91.3)	44.5 (74.2)	12.3 (20.5)	23.9 (39.8)	20.2 (33.7)	20.3 (33.8)	12.9 (21.5)	19.2 (32.0)	8.0 (13.3)	9.8 (16.3)
	CF	30.4	36.9	20.4	8.3	14.2	13.4	8.6	11.7	15.6	12.1	18.0
	H	-	-	-	-	-	-	-	-	-	-	-
	O	12.0	13.9	16.9	9.1	14.3	9.5	14.9	8.0	13.8	5.1	12.1
Allahabad	MC	54.0 (11.7)	74.9 (16.3)	86.9 (18.9)	91.7 (19.9)	108.3 (23.5)	95.9 (20.8)	131.3 (28.5)	98.3 (21.4)	98.6 (21.4)	77.2 (16.8)	87.7 (19.1)
	CF	42.4	42.5	42.9	50	68.7	40.0	51.0	37.1	37.6	40.4	50.6
	H	7.9	14.7	24.0	9.9	22.3	19.9	30.0	32.5	12.5	15.1	30.6
	O	42.1	61.5	46.3	51.2	53.7	44.6	44.1	44.7	37.5	36.5	60.0
Varanasi	MC	5.6 (2.9)	7.0 (3.6)	2.3 (1.2)	2.3 (1.2)	1.7 (0.9)	1.7 (0.9)	2.4 (1.2)	6.6 (3.4)	4.90 (2.5)	2.4 (1.2)	2.3 (1.2)
	CF	7.9	7.7	9.6	14.1	18.2	21.0	20.5	28.3	19.6	24.8	27.0
	H	7.4	12.4	27.9	14.4	36.5	14.9	17.3	18.8	24.0	32.8	71.8
	O	25.8	20.1	29.5	4.5	48.9	37.6	30.4	59.1	49.5	73.9	52.3
Buxar	MC	13.7 (30.4)	7.5 (16.7)	1.8 (4.0)	-	-	1.4 (3.1)	1.3 (2.9)	3.0 (6.7)	2.1 (4.7)	0.6 (1.3)	1.5 (3.3)
	CF	14.4	10.4	3.2	-	-	3.8	5.8	2.2	2.4	2.0	2.3
	H	29.4	19.9	33.8	-	-	8.0	7.4	36.8	48.6	34.1	112.7
	O	51.1	34.0	55.4	-	-	19.3	17.1	14.2	11.4	11.6	8.9
Ballia	MC	9.4 (13.4)	8.4 (12.0)	4.1 (5.9)	5.2 (7.4)	2.3 (3.3)	4.9 (7.0)	-	-	4.9 (7.0)	4.2 (6.0)	4.5 (6.4)
	CF	6.9	3.8	4.6	15.9	4.7	14.1	-	-	4.1	7.2	6.0
	H	10.9	17.3	15.7	4.5	54.1	73.1	-	-	32.7	15.5	24.0
	O	18.2	20.8	60.0	25.6	11.2	22.2	-	-	9.3	12.9	6.8
Patna	MC	19.0 (12.7)	17.2 (11.5)	24.0 (16.0)	26.8 (17.9)	17.9 (20.6)	17.9 (11.9)	18.9 (12.6)	20.2 (13.5)	16.8 (11.2)	12.8 (8.5)	14.6 (9.2)
	CF	9.0	3.5	15.5	22.1	22.9	34.1	17.8	14.3	10.7	23.0	24.9
	H	2.8	1.7	21.8	14.4	26.5	9.9	8.2	11.4	13.6	4.8	4.2
	O	23.8	17.7	35.2	42.0	49.4	53.5	32.2	67.0	67.2	58.2	66.5
Bhagalpur	MC	9.0 (3.5)	9.6 (3.7)	9.2 (3.5)	10.6 (4.1)	15.6 (6.0)	10.9 (4.2)	17.9 (6.9)	26.1 (10.0)	19.80 (7.6)	28.6 (11.0)	25.6 (9.8)
	CF	8.2	10.9	24.6	36.9	39.0	16.9	7.9	14.1	8.8	19.6	26.8
	H	4.8	2.4	5.1	4.0	2.1	2.2	2.4	3.9	3.1	5.3	9.6
	O	19.5	37.1	47.1	69.0	41.8	47.7	48.1	50.8	51.7	68.3	77.9
Zones		1970	1971	1973	1975	1980-81	1982	1985-89	1992-97	1996-01	2001-02	2002-03
Kanpur	MC	-	-	-	-	-	-	-	-	-	-	19.18
	CF	-	-	-	-	-	-	-	-	-	-	42.83
	H	-	-	-	-	-	-	-	-	-	-	-
	Exotic	-	-	-	-	-	-	-	-	-	-	9.44
Allahabad	MC	-	-	27.5	28.02	36.63	49.75	35.87	8.02	7.07	7.28	4.37
	CF	-	-	17.1	20.44	25.40	21.18	22.33	19.01	14.47	11.06	8.96
	H	-	-	2.9	0.45	0.20	0.46	1.71	0.31	0.38	1.24	0.008
	Exotic	-	-	-	-	-	-	-	-	-	-	12.17
Buxar	MC	-	-	3.14	-	3.11	-	3.26	-	-	-	-
	CF	-	-	4.8	-	4.62	-	5.41	-	-	-	-
	H	-	-	1.96	-	0.50	-	2.60	-	-	-	-
	O	-	-	4.7	-	8.26	-	15.48	-	-	-	-
Patna	MC	-	-	-	-	-	-	1.473	-	-	-	-
	CF	-	-	-	-	-	-	4.55	-	-	-	-
	H	-	-	-	-	-	-	0.13	-	-	-	-
	O	-	-	-	-	-	-	18.93	-	-	-	-
Bhagalpur	MC	17.55	12.62	11.85	-	-	-	4.89	-	-	-	-
	CF	30.75	35.82	30.03	-	-	-	22.26	-	-	-	-
	H	1.47	3.95	2.30	-	-	-	0.18	-	-	-	-
	O	53.39	61.43	55.82	-	-	-	35.21	-	-	-	-

Table continued to next page

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Zones		2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11			
Kanpur	Total (T)	88.54	-	-	-	-	-	-	-			
	MC	-	-	-	-	-	-	-	-			
	CF	-	-	-	-	-	-	-	-			
	H	-	-	-	-	-	-	-	-			
	Exotic	-	-	-	-	-	-	-	-			
	Misc	-	-	-	-	-	-	-	-			
Allahabad	Total (T)	94.67	-	74.25	86.85	115.9	88.1	-	-			
	MC	-	-	10	9.0	24	-	-	-			
	CF	-	-	10	9.0	7.2	-	-	-			
	H	-	-	-	-	0	-	-	-			
	Exotic	-	-	-	-	-	-	-	-			
	Misc.	-	-	-	-	34.6	-	-	-			

*No data was available for the Varanasi and Balia centers after the year 1968-69 and for Buxar, Patna and Bhagalpur after the year 1985-89

Table 6: Change in the catch composition downstream from Allahabad between 1958 and 1994

	Allahabad				Patna	
	58-66	72-76	79-80	93-94	58-66	93-94
MC	38.0	29.0	21.6	16.4	26.5	4.0
CF	22.6	23.7	21.8	44.3	17.5	7.5
H	9.4	4.9	1.3	0.1	12.1	0.6
O	30.0	42.2	55.5	39.2	43.9	87.9

Payne *et al.* (2003)

There has been gradual decrease in total catch of major carps where as there is increase in other fishes and marginally of cat fishes at the following centres at different time domain (1958-86) (Figures 6-10).

Table 7: Fish landing (m tons) at different centres (compiled from CIFRI Reports: 1961-2010) (values in parenthesis depict % catch)

Centres	Year	Major Carps	Cat fishes	<i>T. ilisha</i>	Exotic	Others	Total
Allahabad	1961-68	97.73 (45.0%)	46.31 (21.5%)	22.35 (10.3%)	0.0	48.75 (22.6%)	215.14
	1972-80	31.09 (30.6%)	22.67 (22.3%)	2.22 (2.18%)	0.0	45.51 (44.8%)	101.49
	1981-90	35.82 (30.8%)	22.86 (19.6%)	0.99 (0.85%)	0.0	56.95 (48.8%)	116.62
	1991-00	6.65 (10.53)	14.43 (22.87)	1.04 (0.16)	0.0	40.99 (64.96)	63.1
	2001-10	14.7 (13.23)	10.41 (9.37)	0.18 (0.16)	39.18 (35.26)	46.68 (42.0)	111.14
Patna	1961-66	23.35 (21.4%)	22.43 (20.6%)	14.08 (12.9%)	0.0	48.82 (44.9%)	108.68
	1986-93	7.10 (15.09)	11.67 (24.8%)	0.08 (0.17%)	0.0	28.18 (59.9%)	47.04
Bhagalpur	1961-70	18.66 (16.4%)	31.23 (27.5%)	4.27 (8.7%)	0.0	59.02 (52.1%)	113.18
	1972-80	11.76 (13.7%)	24.67 (28.8%)	0.68 (0.8%)	0.0	48.45 (56.6%)	85.56
	1981-88	5.98 (6.9%)	26.75 (31.0%)	0.93 (1.07%)	0.0	52.52 (60.9%)	86.17

The data (Table 7) reveals that at Allahabad the % catch of carps reduced from 45.0% in 1961-68 to a mere 13.23% in the period (2001-2010) where as catfishes declined from 22.87 (1991-00) to 9.37% (2001-10). Hilsa, the migratory clupeid which used to be a good fishery at Allahabad as 10.3% (1961-68) dropped to a meagre 0.16% (2001-2010).

Similar trends were also reported at Patna and Bhagalpur. The carps decreased at Patna and Bhagalpur. Hilsa nearly disappeared and other fishes of less commercial importance value increased to 44.9 (1961-66) to 59.9% (1986-93) at Patna and 52.14 (1961-70) to 60.9% (1981-88) at Bhagalpur.

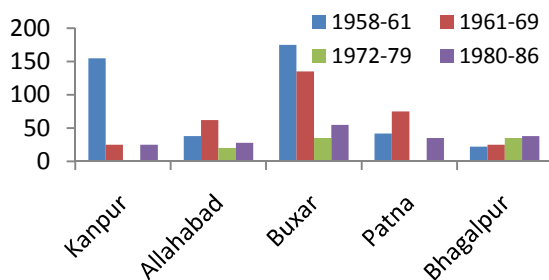


Figure 6: The trend in fish yield (kg/ha) from different stretches of the river Ganga during 1958-86

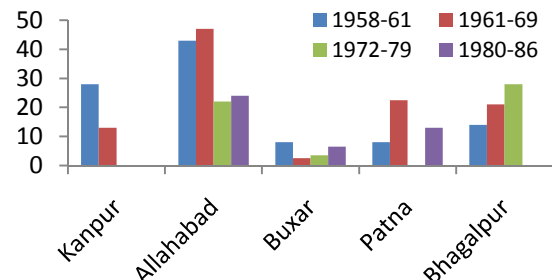


Figure 8: Average annual yield (tons) of catfishes from various stretches of river Ganga during 1958-86

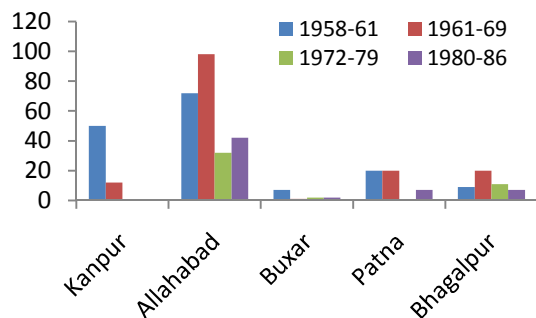


Figure 7: Average annual yield (tons) of major carps from various stretches of river Ganga during 1958-86

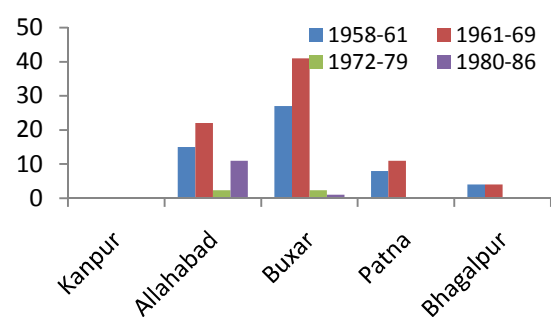


Figure 9: Average annual yield (tons) of Hilsa from various stretches of river Ganga during 1958-86

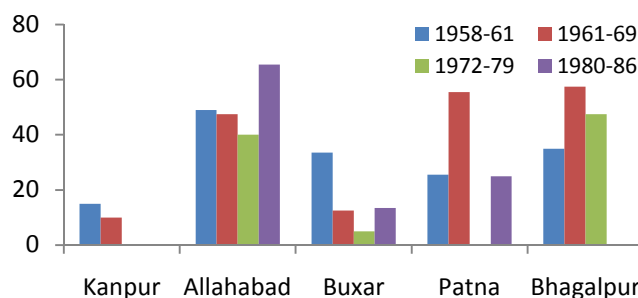


Figure 10: Annual average yield (tons) of miscellaneous fishes from various stretches of river Ganga during 1958-86

With the construction of Farakka barrage, the fishery scenario at Lalgola center about 45 km below Farakka, showed a major change in stock structure. Prior to Farakka, the Hilsa used to be the main fishery (92.02%). With the commissioning of the barrage, Hilsa contribution came down to merely 16.8% and the niche was replaced by other species. The details are depicted in Table 8. The market arrivals (in tons) of major carps, selected catfishes at Bhagalpur, Rajmahal, Farakka and Lalgola centers during the period (1968) - (2002-03) are reported in Table 9.

Table 8: Catch composition (%) at Lalgola, pre and post Farakka period

Centre	Major carps	Large catfishes	Hilsa	Others	Total (t)
1963-76	0.33	0.12	92.02	7.53	121.43
1980-90	4.47	9.34	29.68	56.51	57.31
1991-00	9.76	13.58	16.80	59.86	106.35

Table 9: Market arrivals (tons) of major carps (MC), selected catfishes (CF), Hilsa (H) and other (O) fishes during the period 1968-03

		1968	1970	1971	1973	1974	1981	1982	1985-89	2000-01	2002-03
Bhagalpur	MC	-	17.55	12.62	11.85	8.11	-	-	4.89	-	-
	CF	-	30.75	35.82	30.03	15.96	-	-	22.26	-	-
	H	-	1.47	3.95	2.30	0.01	-	-	0.18	-	-
	O	-	53.39	61.43	55.82	43.33	-	-	35.21	-	-
Rajmahal	MC	2.04	1.12	2.33	8.5	1.94	-	-	-	-	-
	CF	3.21	4.32	7.52	17.54	3.68	-	-	-	-	-
	H	22.48	13.75	8.80	17.66	2.83	-	-	-	-	-
	O	53.95	38.65	38.51	54.10	24.35	-	-	-	-	-
Farakka	MC	-	-	6.95	7.11	1.44	-	-	-	-	-
	CF	-	-	9.45	9.9	4.15	-	-	-	-	-
	H	-	-	24.32	51.85	17.83	-	-	-	-	-
	O	-	-	18.75	31.14	19.23	-	-	-	-	-
Lalgola	MC	0.15	0.07	-	-	-	3.16	4.34	1.25	13.62	14.59
	CF	0.06	0.03	-	-	-	3.65	27.49	4.73	16.62	17.60
	H	92.27	72.37	89.27	94.33	97.92	11.06	2.18	20.53	20.78	16.79
	O	9.91	8.59	21.34	5.63	7.50	46.36	72.76	29.66	61.84	66.82

(Pathak and Tyagi, 2010)

6.3 Exotic fishes

Of late, the total fish catches have registered some increase mainly due to increased foothold of exotic fish species, especially *Cyprinus carpio* and *Oreochromis niloticus*. An increase in the growth of exotic fisheries down stream of Allahabad has been observed. Singh *et al.* (2010) indicated that *Cyprinus carpio* and *Oreochromis niloticus*, has almost replaced the other major carps. The percentage which used to be 97.13 (1961-68) of IMC has come down to 14.7 (2001-10) while the population of exotic carps has risen from 0.0% (1961-68) to 39.18% (2001-10). A comparison of data from Singh *et al.* (2010) reveals that the growth of exotic fishes increased while that of local fishes declined in the 250 km stretch between Kanpur to Varanasi (Figure 11).

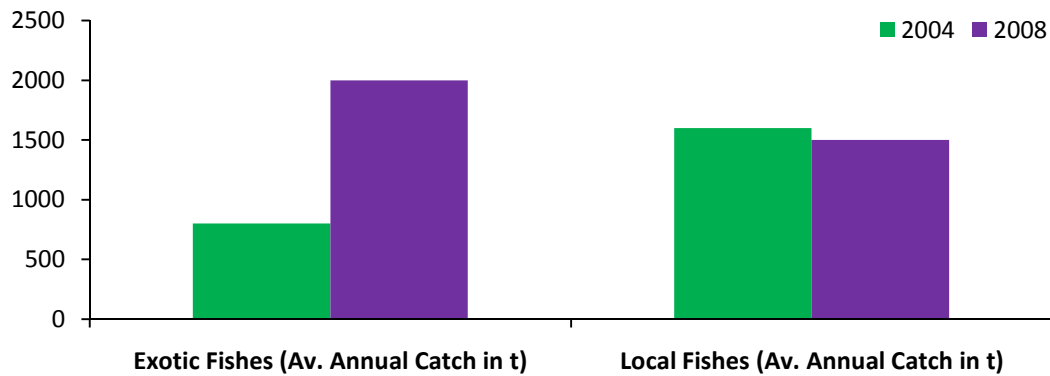


Figure 11: Comparison of data at Kanpur: carps vis-à-vis exotic fishes in the Ganga between Kanpur-Varanasi (2004-2008) (Singh *et al.* 2010)

6.4 Fisheries at Allahabad

Allahabad is a very important station for the potential fish production and catch in the Ganga river. At Allahabad, major carps were main component of fishery in comparison to cat fishes during the period of 1961-1980. Other fishes were the main fishery during 1991-2000. Hilsa was recorded the fourth major component of fishery during 1961-1968 (Figure 12). The catch from the river Ganga is declining gradually. The average catch per kilometer of stretch depict that in 1950s the catch was as high as 1343 kg whereas catch declined to 361 kg during 2000s and to a mere 300 kg/km in 2010 (Figure 13).

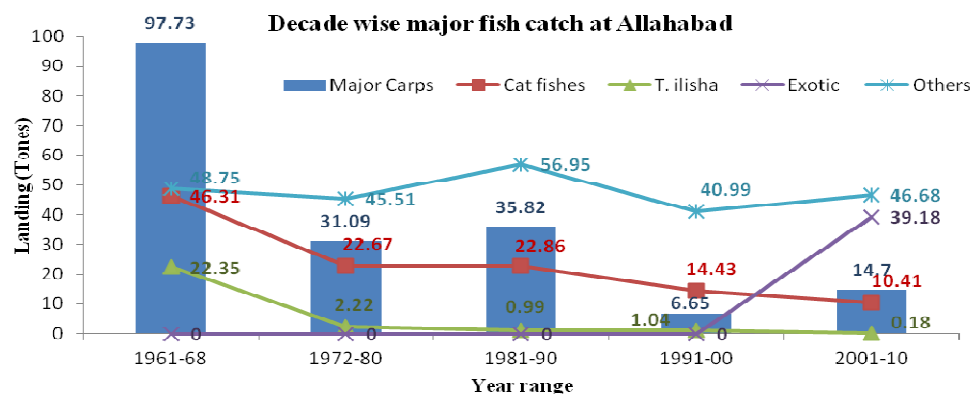


Figure 12: Fish landing at Allahabad (CIFRI Annual Reports 1961-2007)

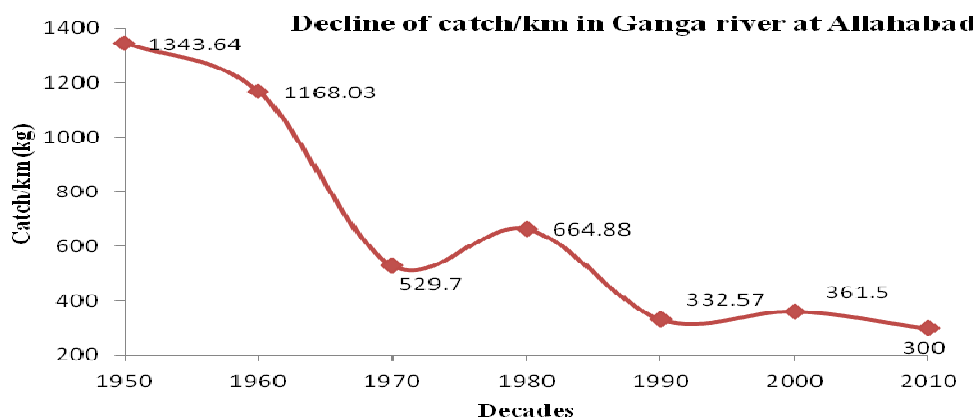


Figure 13: Decline of fish catch/km at Allahabad during 1950s to 2010s

7. Estuarine fisheries

Hooghly Matlah estuarine system is one of largest system of the world and is known for its faunastic richness. It is an important source of fisheries and sustains a large population of fishermen and its supporting trade. The system has fresh water system consisting of main riverine and tributary system, brackish water zone and tidal influence. The Central Inland Fisheries Institute, Barrackpore conducted a survey during 1960-61 to 1977-78 and have noticed significant changes due to:

- (i) Commissioning of Farakka barrage in April 1975 which changed the ecology of delta in terms of decline in salinity (greater extension of fresh water zone) and changes in species spectrum of the fish catch, greater abundance of fresh water species and decline in marine species.
- (ii) The income from fishing vis-a-vis other sectoral engagements in the fast developing urban complex of Calcutta has undergone a change in ~~depending~~ operational costs and returns of gear and their catch structure.

During pre-Farakka period, the tidal effect was felt upto Nabadwip. The entire region was demarcated into four zones (Figure 7a).

1. Nabadwip to Baranagar zone I: Salinity between 0.11-0.36 ppt.
2. Middle zone between Baranagar and Diamond Harbour zone II: Salinity ranged between 0.2-0.59 ppt.
3. Lower zone below Diamond Harbour on the main channel zone III: Salinity varied between 0.2 ppt to near marine values.
4. Zone containing the Rupnarayan tributary joining the main channel (19 km above Diamond Harbour) zone IV: Salinity ranges between 0.43-10.25 ppt.

Zone I, II and IV constitute the upper estuary and zone III the lower zone.

The current situation of the Hooghly estuary has changed entirely. Hooghly estuary extends to a total length of 300 km, with tidal extent reaching upto Nabadwip from seamount. Based on the salinity distribution, the entire Hooghly estuary has been divided into 3 zones- the 36 km stretch from Fraserganj to Kakdwip as saline zone, the 40 km stretch from Kakdwip to Diamond Harbour as transition zone and the rest 230 km from Diamond Harbour to Nabadwip as freshwater zone (Figure 7b).

1. Freshwater zone (Nabadwip to Diamond Harbour): Salinity 0.04-0.06 ppt.
2. At Diamond Harbour: Salinity 0.09-0.90 ppt.
3. At Kakdwip: Salinity 5.6-26.0 ppt.
4. Saline zone (at Fraserganj): Salinity 22.2-36.3 ppt.

Transition zone

7.1 Total fish yield

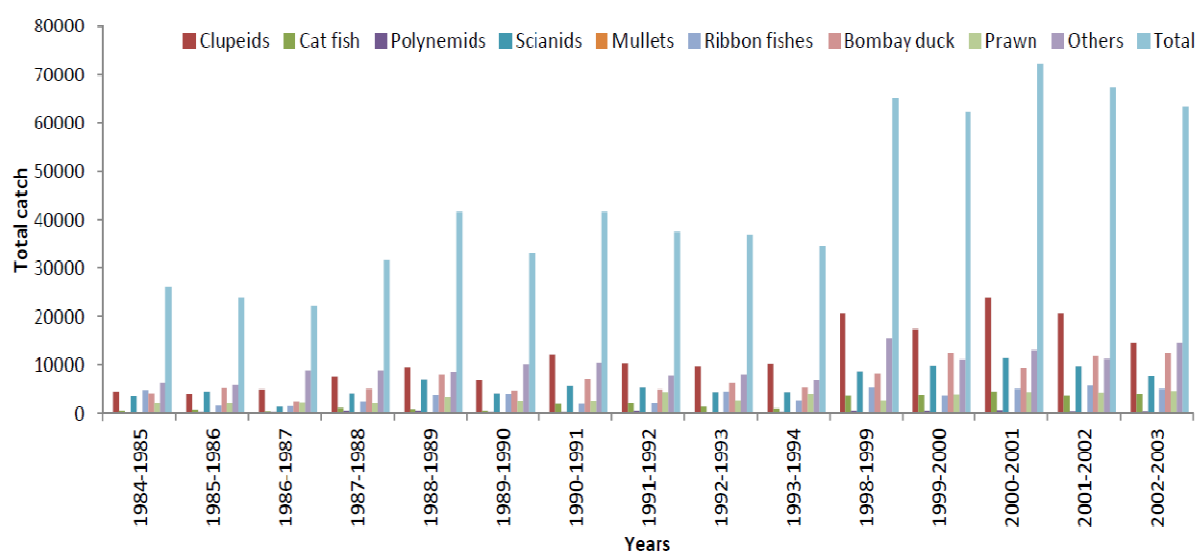
The Hooghly Matlah estuary is biologically very productive. The total estimated catch fluctuated between 22,143- 41,564 m tons per year during 1984-85 to 1993-94 and 72098.7 and 63319.8 tonnes during 1998-99 and 2002-2003 (Table 10, Figure 14).

Table 10: Group wise yield (in tons) from Hooghly Matlah estuary (adopted from CIFRI, Barrackpore report of Feb. 1997)

Fish Species Group	1984-1985	1985-1986	1986-1987	1987-1988	1988-1989	1989-1990	1990-1991	1991-1992	1992-1993	1993-1994	Average/Year	Percentage (%)
Clupeids	4492.1	3984.6	4948.4	7581.6	9454.8	6791.9	11958.1	10325.7	9621.1	10181.5	7933.98	24.1
Cat fish	550.9	718.4	425.4	1021.2	895.3	477.1	1811.7	2148.2	1304.1	975.1	1032.74	3.14
Polynemids	152.7	248.1	262	463.5	486.3	266.5	323.2	517.4	100.8	276.2	309.67	0.94
Scianids	3503	4484.9	1264.9	4091	6956.8	4058.3	5520.1	5207.8	4351.7	4291.6	4373.01	13.30
Mulletts	10.7	36.4	25.8	25.7	21	12.3	18.2	11.9	9.6	16	18.76	0.05
Ribbon fishes	4812.2	1471.8	1449	2487.3	3784.7	3974.5	1858.1	2151.8	4461.4	2798.6	2924.94	8.9
Bombay duck	4143.5	5179	2548.9	4994.7	7998.9	4713.9	7064.4	4860.7	6247	5276	5302.7	16.13
Prawn	2135	2050	2303	1997	3344.2	2686.5	2618.7	4366.2	2761.8	3973.7	2823.61	8.59
Others	6244.8	5768	8915	8930	8580	10042.7	10391.9	7815.5	8042.5	6789.8	8152.02	24.80
Total	26044.9	23941.2	22142.4	31592	41522	33023.7	41564.4	37405.2	36900	34578.5	32871.43	100

Table cont....

Fish Sp. Group	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	Average/Year	Percentage (%)
Clupeids	20608.3	17243.5	23883.2	20600.2	14583.7	19383.9	29.4
Cat fish	3702.9	3739.9	4435.1	3696.3	3975.2	39.9.9	5.9
Polynemids	558.3	481.7	659.3	447.1	434.1	516.1	0.8
Scianids	8731.1	9761	11340.1	9571.5	7729.5	9426.6	14.3
Mulletts	22	19	18.2	32.5	69.4	32.2	0.0
Ribbon fishes	5223.1	3655.5	4979	5735.7	5031.3	49.249	7.5
Bombay duck	8318.2	12302.8	9275.9	11815.1	12358.6	10814.1	16.4
Prawn	2729.9	3916.2	4359.4	4170.6	4615.1	3958.2	6.0
Others	15363.1	11045.8	13148.5	11224.4	14523.8	13061.1	19.8
Total	65258.9	62165.4	72098.7	67293.4	63320.7	66027.0	100

Mitra *et al.* (1997); Nath *et al.* (2004)**Figure 14: Group wise yield (tons) from Hooghly Matlah estuary**

The perusal of the data reveals that the fish catch has increased from 1986-97 to 1992-93 with minor fluctuations. The catch further increased from 1998-99 to 2002-2003.

The fishing takes place throughout the year but increases manifold with onset of monsoon (July to Oct.) to winter months (Nov. to Jan.). The catch is minimal during summer months.

7.2 Zone wise catch

Zones I, II and IV (upper estuarine system) contribute together 6 to 10% of the annual catch and zone III (Lower estuarine system) 90-94%. Marine and neritic species viz. *Harpodon nehereus*, *Tachysurus jella*, *Osteogeniosus militaries*, *Polynemus indicus*, *Eleutheronem tetradactylum*, *Coilia* sp., *Sciaena biauritus*, *Tenualosa ilisha*, *Lates calcarifer* and *Mullet*s forms the bulk of the catch in zone III.

T. ilisha, *Polynemus paradiseus*, *Pama pama* and *Sillago panijus* contribute to the fisheries of the middle zone. All these fishes migrate to fresh water and low saline zones. Zone wise annual landings are given below in Table 11.

Table 11: Zone wise annual landings (m tons) from estuary

Year	Zone 1	Zone 2	Zone 3	Zone 4	Total
1984-85	545.6	457.2	24333	708.8	26045
1985-86	718.4	406.3	22057	760.3	23942
1986-87	505.5	693.6	20285	658.9	22143
1987-88	1034.1	692.6	29277	588.2	31592
1988-89	620	372.6	40000	529.7	41522
1989-90	638.3	407.9	31430	595.3	33078
1990-91	700.8	449.1	39869	550.9	41569
1991-92	691.1	437.4	35574	702.3	37405
1992-93	705.3	391.5	35229	574.3	36900
1993-94	614	450.1	32865	622.2	34557
1998-99	589.5	693.1	63361.8	612.5	65256.9
1999-2000	603.8	686.5	60367.9	507.2	62165.4
2000-2001	595.6	528.7	70264.2	710.2	72098.7
2001-2002	562.3	483	65670.8	577.3	67293.4
2002-2003	828.7	498	61356.7	637.3	63320.7

Mitra et al. (1997)

7.3 Species composition of the estuary

The year wise catch, species wise catch, average catch are given in Table 10. The dominant species in order of abundance comprised *Harpodon nehereus* (16.4%), *Tenualosa ilisha* (15.7%), *Pama pama* (11.2%), *Settipina* spp. (8.3%), *Trichiurus* spp. (7.5%), Prawns (6.0%), *Arius jella* (5.4%), *Sciana biauritus* (3.1%), *Coilia* sp. (2.7%), *Pampus argenteus* (3.1%), *Ilisha megaloptera* (1.9%) and *Mackerel* sp. (1.2%). These species together accounted for (82.0%) of the total catch.

Tenualosa ilisha, *Harpodon nehereus*, *Trichiurus* spp., *Ilisha megaloptera*, *Pomadasys argenteus* and prawns constitute the major portion (72.5-81.5%) of the lower zone catches.

Fresh water species were *Rita rita*, *Sperata aor*, *Glossogobius giuris*, *Eutropiichthys vacha* and *Rhinomugil corsula* constituted 2.5-5.1% of the total catch.

7.4 Fishery of important species

The most prized species are *Tenulosa ilisha*, *Liza parsia*, *Liza tade*, *Penaeus monodon*, *P. indicus*, *Metapenaeus monoceros*, *M. brevicornis*, *Leander styliferus* and *Acetes indicus*.

Tenualosa ilisha (Hilsa) is the most important commercial species. The Hilsa are prominent catch in monsoon (July to Oct.) and winters (Nov. to Jan.). It is reported that Hilsa follows a decadal fishery when they are higher in catch. viz.

Years	Hilsa catch in m tons
1971-72	6573.3
1981-82	6886.0
1991-1992	6256.5
2001-2002	11547.7

The Hilsa catch varies between 3.9-16.0% of total catch from the estuary.

The annual contribution of *Polynemus paradiseus*, also an important fish, varies between 105.6 to 314.1 m tons with an average of 187 m tons. The fish though constitutes a very small percentage (<1.0%) but, its economical value is high. This fish contributes in large quantities from zone IV and zone II (50-76%). The main season of its availability are April to July and Oct. to Nov.

The Bombay duck *Harpodon nehereus* (Mitra *et al.*, 1997) is also a very important commercial species constituting about 11.5-19.3%. The catch varies between 2,549 and 1,999 m tons per year. It is a typical marine and neritic species. It remains totally absent from upper fresh water stretches.

8. Summary statement

The procurement of sufficient secondary data from different sources and collation of information presented in the status report sums up the following (summary) statements:

1. The fresh water fish population from Gangnani to Farakka is represented by 181 species under 89 genera and 37 families.
2. The Hooghly-Matlah estuary is represented by 103 brackish water fish species belong to 67 families of Osteichthyes and other 13 species belong to 7 families of common fin fishes (Chondrichthys).
3. More than 100 fish species including fresh water and Hooghly estuary have commercial importance.
4. Gill nets drag nets and cast nets are most commonly used as commercial fishing gears. Other nets being used are scoop nets, traps, trawls and purse nets.
5. (i) The upper Ganga is characterized by the presence of snow-trout *Schizothorax richardsonii* (Gangnani to Devprayag) and Mahseer *Tor putitora* and *Tor tor* (Devprayag to Haridwar).

(ii) Indian major carps: *Labeo rohita*, *Labeo calbasu*, *Cirrhinus mrigala* and *Catla catla* are the important fishes of middle and lower Ganga (upto Farakka) and can be taken as indicators of system health.

(iii) Ganga also supports a good population of catfishes.

(iv) Exotic-species (*Cyprinus carpio* and *Oreochromis niloticus*) have started competing with carps especially in lower Ganga downstream of Allahabad (latest reports indicate that exotic fishes are moving upstream and have been sighted upstream of Allahabad also).

(v) Hilsa is a characteristic fish of Hooghly estuary along with *Harpodon nehereus* and *Polynemus paradiseus*.

7. There is a remarkable reduction in the production capacity of fresh water fishes, attributed mainly due to anthropogenic activities viz.
 - Flow interception due to large Hydro-electric projects in upper Ganga.
 - Abstraction of large quantities of water for irrigation in the form of canals (Upper, Madhya and Lower Ganga canals).
 - Transport of large quantities of industrial pollution in rivers (Ram Ganga and Kali).
 - Increase of pollution load from urban areas along the river (domestic, industrial, treated and untreated).
 - Increase in the sediment load due to deforestation.
 - Indiscriminate fishing in middle and lower Ganga.
 - Fishing of important juvenile species especially of Indian major carps.
8. The catch composition of commercially important fishes has under gone significant change.
 - The total catch of fresh water species has gone down significantly at Allahabad. The total catch in year 1961-68 was 215.14 tons has been reduced to 111.14 in year 2001-2010 tons at Allahabad center, while at Patna center 108.68 tons (1961-66) to 47.04 tons (1986-1993) and at Bhagalpur center the value reduced from 113.18 tons (1961-70) to 86.17 tons (1981-88).
 - At Allahabad the catch/km declined from 1343.64 to 300 kg between 1950-2010.
 - The IMC at Allahabad decreased from 97.73 tons to 14.7 tons between 1961-68 to 2001-10.
 - There is a gradual change in the large catfish population (but not as much as the fall of major carps).
 - There is sufficient increase in other fishes of low commercial value.
9. In the Hooghly Matlah estuary the catch and catch composition has changed significantly. The total catch has gone up in the years between 1984-85 (26044.9 tons/year) to 2002-03 (63319.8 tons/year) ≈ 2.43 times and also the Hilsa fish in the years between 1984-85 (4492.1 tons/year) to 2002-03 (14583 tons/year) ≈ 3.2 times.

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Appendix-I

Comparative account reflecting the available flora and fauna as food chain:

Ecological groups	Taxonomic categories	Ecological Stretch	Name of organisms
Phytoplankton	Bacillariophyceae	UG1	<i>Achnanthes, Amphipleura, Bacillaria, Ceratoneis, Cyclotella, Cymbella, Denticula, Diatoma, Fragilaria, Hantzschia, Meridion, Navicula, Nitzschia, Pinnularia, Rhoicosphenia, Stephanodiscus, Synedra</i>
		UG2	<i>Achnanthes, Amphipleura, Amphora, Bacillaria, Ceratoneis, Cocconeis, Cyclotella, Cymatopleura, Cymbella, Denticula, Diatoma, Epithemia, Fragilaria, Frustulia, Gomphoneis, Gomphonema, Hantzschia, Melosira, Meridion, Navicula, Nedium, Nitzschia, Pinnularia, Rhoicosphenia, Stauroneis, Stephanodiscus, Synedra, Tabellaria</i>
		UG3	<i>Achnanthidium, Amphipleura, Amphora, Aulacoseira, Bacillaria, Ceratoneis, Cocconeis, Cyclotella, Cymbella, Denticula, Diatoma, Diploneis, Encyonema, Fragilaria, Frustulia, Gomphoneis, Gomphonema, Gyrosigma, Hantzschia, Melosira, Meridian, Navicula, Nedium, Nitzschia, Pinnularia, Planothidium, Rhoicosphenia, Stauroneis, Stephanodiscus, Synedra, Tabellaria</i>
		MG	<i>Achnanthes, Achnanthidium, Amphora, Anomoeoneis, Asterionella, Aulacoseira, Bacillaria, Caloneis, Ceratoneis, Cocconeis, Craticula, Cyclotella, Cymbella, Cymbopleura, Diatoma, Diploneis, Encyonema, Epithemia, Fallacia, Fragilaria, Frustulia, Gesslaria, Gomphonema, Gyrosigma, Hantzschia, Luticola, Mastogloia, Melosira, Meridian, Navicula, Nitzschia, Pinnularia, Placoneis, Planothidium, Reimeria, Rhopalodia, Sellaphora, Stauroneis, Stephanodiscus, Surirella, Synedra, Tabellaria</i>
		LGA	<i>Achnanthes, Achnanthidium, Amphora, Asterionella, Caloneis, Chaetoceros, Cocconeis, Cyclotella, Cymatopleura, Cymbella, Diatoma, Eunotia, Fragilaria, Gomphonema, Grammatophora, Gyrosigma, Hantzschia, Leptocylindrus, Mastogloia, Meridian, Melosira, Navicula, Nitzschia, Pinnularia, Pleurosium, Sellaphora, Surirella, Synedra, Tabellaria, Thalassiosira, Terpsinoe</i>
		LGB	<i>Achnanthes, Amphiprora, Amphora, Anomoeoneis, Asterionella, Asteromphalus, Bacillaria, Bacteriastrium, Biddulphia, Caloneis, Campylodiscus, Chaetoceros, Climacodium, Climacosphenia, Cocconeis, Corethron, Coscinodiscus, Cyclotella, Cymbella, Diatoma, Diploneis, Ditylum, Eucampia, Eunotia, Fragilaria, Frustulia, Gomphonema, Gyrosigma, Hemiaulus, Hemidiscus, Isthmia, Lauderia, Leptocylindrus, Lithodesmium, Melosira, Navicula, Nitzschia, Paralia, Pinnularia, Planktoniella, Pleurosium, Rhizosolenia, Rhopalodia, Skeletonema, Stauroneis, Stephanopyxis, Surirella, Synedra, Thalassiosira, Thalassiosira, Thalassiothrix, Thalassionema, Triceratium, Tropidoneis</i>
	Chlorophyceae	UG1	<i>Gonatozygon, Ulothrix</i>
		UG2	<i>Characium, Cladophora, Closterium, Cylandrocystis, Desmidium, Genicularia, Gonatozygon, Hydrodictyon, Microspora, Oedogonium, Protococcus, Sphaeroplea, Spirogyra, Stigeoclonium, Ulothrix, Zygnema</i>
		UG3	<i>Cladophora, Chaetophora, Closterium, Cosmarium, Eudorina, Hydrodictyon, Oedogonium, Pandorina, Pediastrum, Scenedesmus, Spirogyra, Ulothrix</i>
		MG	<i>Actinastrum, Ankistrodesmus, Botryococcus, Bumillaria, Celastrum, Chlamydomonas, Chlorella, Chlorobotrys, Chlorococcum, Chlorogonium, Cladophora, Coelastrum, Closterium, Cosmarium, Crucigenia, Desmidium, Dictyosphaerium, Diaspora, Eudorina, Gonatozygon, Hormidium, Hydrodictyon, Kirchneriella, Micractinium, Microspora, Mougeotia, Netrium, Oedogonium, Oocystis, Palmella, Pandorina, Pediastrum, Pleurodermus, Protococcus, Scenedesmus, Selenastrum, Sphaerocystis, Spirogyra, Staurastrum, Stigeoclonium, Tetrahedron, Tetraspora, Treubaria, Tribonema, Ulothrix, Volvox, Zygnema</i>
		LGA	<i>Actinastrum, Ankistrodesmus, Bulbochaete, Chaetophora, Chara, Chlamydomonas, Chlorella, Chlorococcum, Chodatella, Cladophora, Closteriopsis, Closterium, Coelastrum, Cosmarium, Crucigenia, Cylandrocapsa, Desmidium, Enteromorpha, Euastrum, Eudorina, Golenkinia, Gloeotanium, Hydrodictyon, Kirchneriella, Microspora, Nitella, Oocystis, Oedogonium, Pandorina, Pediastrum,</i>

		LGB	<i>Protococcus, Schroederia, Selenastrum, Scenedesmus, Sorastrum, Sphaeroplea, Spirogyra, Stigeoclonium, Tetraedron, Treubaria, Ulothrix, Volvox, Zygnema</i> <i>Bambusina, Boodleopsis, Chaetomorpha, Chara, Chlorella, Cladophora, Cladophorella, Closterium, Cosmarium, Desmidium, Dictyosphaerium, Enteromorpha, Euastrum, Eudorina, Franceia, Gonatozygon, Heterosiphonia, Hyalotheca, Lola, Micrasterias, Netrium, Nitella, Oedogonium, Onychonema, Pediatrism, Phyllobium, Pleurotaenium, Radiococcus, Rhizoclonium, Scenedesmus, Sphaeroplea, Spirogyra, Spirotaenia, Spondylosium, Staurostrum, Stigeoclonium, Tetradinium, Triplastrum, Triplaceras, Ulothrix, Ulva, Uronema, Zygnema</i>
	Cyanophyceae	UG1 UG2 UG3 MG LGA LGB	NO <i>Anabaena, Oscillatoria, Phormidium, Rivularia</i> <i>Anabaena, Chroococcus, Gloeocapsa, Lyngbya, Microcystis, Nostoc, Oscillatoria, Phormidium, Rivularia, Spirulina</i> <i>Agmenellum, Anabaena, Anacystis, Aphanocapsa, Chroococcus, Cylindrospermum, Lyngbya, Merismopedia, Microcystis, Nostoc, Oscillatoria, Phormidium, Raphidiopsis, Rivularia, Spirulina,</i> <i>Anabaena, Anabaenopsis, Anacystis, Aphanocapsa, Aphanothece, Arthrospira, Aulosira, Calothrix, Chroococcus, Cylindrospermum, Gloeocapsa, Gloeotrichia, Lyngbya, Mastigocladus, Merismopedia, Microcoleus, Microcystis, Myxosarcina, Nostoc, Nodularia, Oscillatoria, Phormidium, Pseudanabaena, Raphidiopsis, Rivularia, Schizothrix, Spirulina, Symploca, Synechococcus, Synechocystis, Trichodesmium, Tolypothrix</i> <i>Anabaena, Anabaenopsis, Aphanocapsa, Aphanothece, Arthosporia, Arthrospira, Aulosira, Calothrix, Camptylonemopsis, Chamaesiphon, Chlorogloeal, Chroococcus, Crinalium, Cylindrospermum, Dermocarpa, Fischerella, Gloeocapsa, Gloeotrichia, Hapalosiphon, Homeothrix, Hydrocoleum, Johannesbaptistia, Katagnymene, Lyngbya, Mastigocladus, Merismopedia, Microchaete, Microcystis, Myxosarcina, Nostoc, Nostocopsis, Oscillatoria, Phormidium, Plectonema, Porphyrosiphon, Pseudanabaena, Raphidiopsis, Schizothrix, Scytonema, Spirulina, Stichosiphon, Stigonema, Symploca, Synechocystis, Trichodesmium, Wollea, Xenococcus</i>
	Euglenophyceae	UG1 UG2 UG3 MG LGA LGB	NO NO <i>Euglena, Genicularia</i> <i>Euglena, Phacus, Trachelomonas</i> <i>Euglena, Heteronema, Phacus</i> <i>Euglena, Phacus</i>
	Dianophyceae	MG LGA LGB	<i>Cirratium, Peridinium, Gymnodinium</i> <i>Cirratium, Peridinium</i> <i>Ceratium, Dinophysis, Noctiluca, Peridinium, Protoperidinium, Pyrophacus</i>
	Synurophyceae	LGA	<i>Synura</i>
	Chrysophyceae	MG LGA LGB	<i>Botryococcus</i> <i>Chrysococcus, Dinobryon</i> NO
	Xanthophyceae	UG1 UG2 UG3 MG LGA LGB	<i>Voucheria</i> <i>Voucheria</i> <i>Voucheria</i> <i>Tribonema</i> <i>Tribonema, Voucheria</i> <i>Tribonema, Voucheria</i>

	Cryptophyceae	LGA	<i>Chroomonas</i>
	Rhodophyceae	LGA	<i>Batrachospermum, Compsopogon</i>
		LGB	<i>Bostrychia, Caloglossa, Catenella, Ceramium, Compsopogon, Gelidium, Gelidiella, Polysiphonia, Porphyra, Pterosiphonia</i>
	Phaeophyceae	LGB	<i>Colpomenia, Dictyota</i>
Periphyton	Bacillariophyceae	UG1	<i>Achnantheidium, Amphora, Cymbella, Diatoma, Fragilaria, Frustulia, Gomphonema, Hippodonta, Nitzschia, Reimeria, Tabellaria</i>
		UG2	<i>Achnantheidium, Adlafia, Amphora, Caloneis, Ceratoneis, Cocconeis, Cyclotella, Cymbella, Denticula, Diatoma, Diatomenella, Encyonema, Encyonopsis, Fallacia, Frustulia, Gomphoneis, Gomphonema, Gyrosigma, Hantzschia, Hippodonta, Melosira, Meridion, Navicula, Nitzschia, Opephora, Pinnularia, Planothidium, Reimeria, Sellaphora, Staurasira, Stauroneis, Surirella, Synedra, Tabellaria, Tetracyclus</i>
		UG3	<i>Achnantheidium, Amphora, Cocconeis, Cymbella, Diatoma, Diploneis, Encyonema, Fragilaria, Gessleria, Gomphonema, Gyrosigma, Hantzschia, Luticola, Melosira, Meridion, Navicula, Nitzschia, Planothidium, Reimeria, Sellaphora, Staurasira, Surirella, Synedra</i>
		MG	<i>Achnanthes, Achnantheidium, Amphora, Anomoeoneis, Asterionella, Aulacoseira, Caloneis, Cocconeis, Cyclotella, Cymbella, Diatoma, Encyonema, Fragilaria, Frustulia, Gomphonema, Gyrosigma, Mastogloia, Melosira, Navicula, Nitzschia, Pinnularia, Placoneis, Planothidium, Pleurosium, Stauroneis, Surirella, Synedra, Tabellaria</i>
		LGA	NO
		LGB	NO
	Chlorophyceae	UG1	NO
		UG2	<i>Chlorococcum, Cladophora, Closterium, Cosmarium, Desmidium, Hydrodictyon, Microspora, Oedogonium, Stigeoclonium, Ulothrix, Zygnema</i>
		UG3	<i>Cladophora, Oedogonium, Spirogyra, Stigeoclonium, Ulothrix</i>
		MG	<i>Chlorella, Chlorogonium, Cladophora, Closterium, Cosmarium, Dictyosphaerium, Draparnaldia, Hydrodictyon, Kirchneriella, Oedogonium, Oocystis, Pandorina, Pedastrum, Scenedesmus, Schizogonium, Spirogyra, Ulothrix, Zygnema</i>
		LGA	NO
		LGB	NO
	Cyanophyceae	UG1	NO
		UG2	<i>Anabaena, Coccochloris, Oscillatoria, Phormidium</i>
		UG3	<i>Lyngbya, Oscillatoria, Phormidium, Spirulina</i>
		MG	<i>Anabaena, Coelosphaerium, Lyngbya, Merismopedia, Microcystis, Nostoc, Oscillatoria, Phormidium, Rivularia</i>
		LGA	NO
		LGB	NO
	Euglenophyceae	UG1	NO
		UG2	NO
		MG	<i>Euglena</i>
		LGA	NO
		LGB	NO
	Xanthophyceae	MG	<i>Tribonema, Voucheria</i>

		LGA	NO
		LGB	NO
Zooplankton	Protozoans	UG1	NO
		UG2	NO
		UG3	NO
		MG	<i>Actinophrys, Actinosphaerium, Amoeba, Arcella, Colpidium, Diffugia, Euglena, Euplotes, Paramecium, Vorticella</i>
		LGA	<i>Arcella, Centropyxis, Diffugia, Paramecium, Vorticella</i>
		LGB	NO
	Rotifera	UG1	NO
		UG2	NO
		UG3	NO
		MG	<i>Asplanchna, Brachionus, Euchlanis, Filinia, Gastropus, Hexarthra, Keratella, Lecane, Notholca, Philodina, Platyas, Polyarthra, Rotaria, Testudinella</i>
		LGA	<i>Asplanchna, Brachionus, Euchlanis, Filinia, Keratella, Lecane, Monostyla, Polyarthra, Rotaria, Synchaeta, Testudinella, Trichocera</i>
		LGB	<i>Anuraeopsis, Ascomorpha, Asplanchna, Beauchampiella, Brachionus, Cephalodella, Colurella, Conochilus, Dicranophorus, Dipleuchlanis, Euchlanis, Filinia, Hexarthra, Horaella, Keratella, Lecane, Lepadella, Macrochaetus, Mytilina, Platyas, Polyarthra, Pompholyx, Rotaria, Scardium, Testudinella, Trichocerca, Trichotria, Ttripleuchanis</i>
	Copepoda	UG1	NO
		UG2	NO
		UG3	NO
		MG	<i>Cletocamptus, Cyclops</i>
		LGA	<i>Cyclops, Diaptomus, Mesocyclops, Neodiaptomus</i>
		LGB	<i>Acartia, Acartiella, Heliodiaptomus, Labidocera, Mesocyclops, Microcyclops, Neodiaptomus, Paracyclops, Phyllodiaptomus, Pseudochydorus, Pseudodiaptomus, Tropocyclops, Tropodiaptomus,</i>
	Cladocera	UG1	NO
		UG2	NO
		UG3	NO
		MG	<i>Anura, Bosmina, Ceriodaphnia, Daphnia, Diaphanosoma, Diaptomus, Leydigia, Mesocyclops, Moina, Moinodaphnia, Nauplius, Simocephalus</i>
		LGA	<i>Alona, Bosmina, Bosminopsis, Ceriodaphnia, Daphnia, Diaphanosoma, Moina, Simocephalus</i>
		LGB	<i>Alona, Alonella, Bosmiopsis, Ceriodaphnia, Daphnia, Diaphanosoma, Dunhevedia, Eschinisca, Euryalona, Graptoleberis, Grimaldina, Guernella, Ilyocryptus, Kurzia, Latonopsis, Leydigia, Macrothrix, Moina, Moinodaphnia, Notoalona, Oxyurella, Pleuroxus, Pseudosida, Scapholeberis, Simocephalus</i>
	Other Crustaceans	LGB	<i>Conchoecete, Dorippe, Euryalona, Metopograpsus, Pachygrapsus, Ptychognathus, Pyxidognathus, Susarma</i>
	Cnidarians	LGB	<i>Acromitus, Aequorea, Blackfordia, Bougainvillia, Cassiopea, Diadumene, Edwardsia, Limnognathia, Liriope, Moerisia, Netrostoma, Nevada, Obelia, Paracondylactis, Pelocoetes, Phytocoeleopsis, Phytocoeles, Pseudodiaptomus, Tamoya, Versuriga</i>
	Chaetognatha	LGB	<i>Krohnittia, Sagitta</i>
	Miscellaneous	MG	Chironomus larva, Mosquito larvae, Nematodes, Oligochaetes
Zoobenthos	Plecoptera (nymph)	UG1	Perlodidae (<i>Arcynopteryx, Isoperla</i>), Nemouridae (<i>Nemoura</i>), Chloroperlidae,

	of stone flies)	UG2	Peltoperlidae <i>Arcynopteryx, Isoperla, Nemoura</i>
		UG3	PRESENT
		MG	Chloroperlidae (<i>Alloperla</i>), Perlidae (<i>Neoperla</i>), Perlodidae (<i>Isoperla</i>)
		LGA	NO
		LGB	NO
	Odonata (nymphs of dragon flies)	UG1	NO
		UG2	<i>Argia</i>
		UG3	Agrionidae, Gomphidae
		MG	Aeshnidae (<i>Aeshna</i>), Corduliidae (<i>Epicordulia, Helocordulia, Macromia</i>), Gomphidae (<i>Hagenius</i>), Lestidae (<i>Lestes</i>)
		LGA	<i>Asiagomphus, Cordulegaster, Ischnura, Macrogomphus, Paragomphus, Potomarcha</i>
		LGB	NO
	Ephemeroptera (mayfly, nymphs)	UG1	Ameletidae (<i>Ameletus</i>), Baetidae (<i>Baetis</i>), Heptageniidae (<i>Iron</i>), Caenidae (<i>Caenis</i>), Ephemeridae (<i>Ephemera</i>)
		UG2	<i>Ameletus, Baetis, Caenis, Cynigma, Ephemera</i> , Ephemerellidae (<i>Ephemerella</i>), <i>Iron</i> , Leptophlebiidae (<i>Leptophlebia</i>)
		UG3	Baetidae, Heptageniidae, Leptophlebiidae
		MG	Baetidae, Caenidae, Ephemerellidae, Heptageniidae (<i>Epeorus, Rhithrogena</i>), Leptophlebiidae, Neophemeridae, Siphonuridae
		LGA	<i>Baetis, Cloeon, Ephemerella</i>
		LGB	NO
	Trichoptera (caddis larvae)	UG1	Hydropsychidae (<i>Hydropsyche</i>)
		UG2	<i>Brachycentrus, Glossosoma, Hydropsyche, Leptocella, Limnephilids</i>
		UG3	Psychomyiidae, Hydropsychidae
		MG	Brachycentridae, Glossosomatidae, Helicopsychidae (<i>Helicopsyche</i>), Hydropsychidae, Hydroptilidae, Limnephilidae (<i>Hesperophylax, Limnephilus</i>), Leptoceridae (<i>Mystacides, Leptocella, Triaenodes</i>), Polycentropodidae (<i>Cyrnellus</i> sp.), Rhyacophilidae
		LGA	<i>Glossosoma, Hydropsychidae, Limephilus, Triaenodes</i>
		LGB	NO
	Diptera	UG1	Athericidae (<i>Atherix</i>), Blephariceridae (<i>Bibiocephala</i>), Chironomidae (<i>Chironomus</i>), Dixidae (<i>Dixa</i>), Simuliidae (<i>Simulium</i>), Tipulidae (<i>Megistocera</i>)
		UG2	<i>Antocha, Atherix, Bibiocephala, Chironomus, Dixa, Megistocera, Psychoda, Simulium</i>
		UG3	Helidae, Chironomidae, Tabanidae, Tipulidae
		MG	Athericidae (<i>Atherix</i>), Chironomidae, Culicidae (<i>Culex</i>), Dixidae (<i>Dixa</i>), Heleidae, Limoniidae (<i>Antocha</i>), Muscidae (<i>Limnophora</i>), Simuliidae (<i>Simulium</i>), Syrphidae (<i>Eristalis</i>), Tabanidae (<i>Tabanus</i>), Tipulidae (<i>Megistocera</i>)
		LGA	<i>Anopheles, Chironomus, Clinotanytus, Culex, Monopelopia</i>
		LGB	NO
	Coleoptera (water beetles)	UG1	Emidae (<i>Promoesia</i>)
		UG2	<i>Dytiscus, Hydrophilus, Promoesia, Psephenus</i>

		UG3	Elmidae, Dytiscidae, Psephenidae
		MG	Amphizoidae (<i>Amphizoa</i>), Chrysomelidae (<i>Donacia</i>), Dytiscidae (<i>Cybister</i> , <i>Dytiscus</i>), Elmidae (<i>Stenelmis</i>), Gyrinidae (<i>Dineutus</i>), Hydrochidae (<i>Hydrochus</i>), Hydrophilidae (<i>Hydrophilus</i>), Noteridae (<i>Hydrocanthus</i>), Psephenidae (<i>Psephenus</i>)
		LGA	NO
		LGB	NO
	Hymenoptera	UG1	NO
		UG2	NO
		UG3	NO
		MG	Agaonidae
		LGA	NO
		LGB	NO
	Nematodes & Molluscs	UG1	NO
		UG2	PRESENT
		UG3	PRESENT
	Molluscs (Gastropoda)	MG	Bithyniidae (<i>Bithynia</i>), Lymnaeidae (<i>Lymnaea</i>), Pleuroceridae (<i>Goniobasis</i>), Planorbidae (<i>Gyraulus</i> , <i>Indoplanorbis</i>), Subulinidae (<i>Subulina</i>), Thiariidae, Viviparidae (<i>Bellamya</i> , <i>Vivipara</i>)
	Pelycepeoda		Corbiculidae (<i>Corbicula</i>)
	(Gastropoda)	LGA	<i>Amnicola</i> , <i>Assiminia</i> , <i>Bellamya</i> , <i>Brotia</i> , <i>Digoniostoma</i> , <i>Ferrissia</i> , <i>Gangetia</i> , <i>Glessula</i> , <i>Gyraulus</i> , <i>Haitia</i> , <i>Hydrobia</i> , <i>Indoplanorbis</i> , <i>Lymnaea</i> , <i>Mekongia</i> , <i>Melania</i> , <i>Melanoides</i> , <i>Pila</i> , <i>Planorbis</i> , <i>Quickia</i> , <i>Stenothyra</i> , <i>Thiara</i>
	Pelycepeoda		<i>Corbicula</i> , <i>Lamellidens</i> , <i>Novaculina</i> , <i>Parreysia</i> , <i>Pisidium</i> , <i>Scaphula</i>
	Gastropoda	LGB	<i>Amalda</i> , <i>Architectonica</i> , <i>Assimineae</i> , <i>Asthenotoma</i> , <i>Bellamya</i> , <i>Brotia</i> , <i>Cassidula</i> , <i>Cerithidea</i> , <i>Clithon</i> , <i>Columbella</i> , <i>Iravadia</i> , <i>Larina</i> , <i>Natica</i> , <i>Olivancillaria</i> , <i>Pila</i> , <i>Polinices</i> , <i>Potamacmaea</i> , <i>Pseudanachis</i> , <i>Septaria</i> , <i>Stenothyra</i> , <i>Telescopium</i> , <i>Terebra</i> , <i>Thais</i> , <i>Thiara</i> , <i>Tubiola</i> , <i>Umbonium</i>
	Pelycepeoda		<i>Barnea</i> , <i>Corbicula</i> , <i>Cuspidaria</i> , <i>Gafrarium</i> , <i>Glauconome</i> , <i>Lamellidens</i> , <i>Laternula</i> , <i>Mactra</i> , <i>Martesia</i> , <i>Meretrix</i> , <i>Novaculina</i> , <i>Nucula</i> , <i>Paphia</i> , <i>Parreysia</i> , <i>Pitar</i> , <i>Solen</i> , <i>Sphenia</i> , <i>Theora</i> , <i>Trachycardium</i>
	Cephalopoda		<i>Loligo</i> , <i>Octopus</i> , <i>Sepia</i> , <i>Sepiella</i>
	Scaphopoda		<i>Dentalium</i>
	Annelids	UG1	NO
		UG2	NO
		UG3	NO
		MG	Present (Glossoscolecidae)
	Polychaete	LGA	<i>Alboglossiphonia</i> , <i>Asiaticobdella</i> , <i>Aulodrilus</i> , <i>Aulophorus</i> , <i>Barbronia</i> , <i>Branchiodrilus</i> , <i>Branchiura</i> , <i>Chaetogaster</i> , <i>Dero</i> , <i>Glyphidrilus</i> , <i>Limnodrilus</i> , <i>Nais</i> , <i>Namalycastis</i> , <i>Nephtys</i> , <i>Odontobdella</i> , <i>Ozobranchus</i> , <i>Perionyx</i> , <i>Placobdelloides</i> , <i>Pristina</i> , <i>Salifa</i>
		LGB	<i>Barantolla</i> , <i>Capitella</i> , <i>Ceratonereis</i> , <i>Chloeia</i> , <i>Dendronereides</i> , <i>Dendronereis</i> , <i>Diopatra</i> , <i>Eteone</i> , <i>Eunice</i> , <i>Ganganereis</i> , <i>Gattyana</i> , <i>Glycera</i> , <i>Hesione</i> ,

	Oligocheata		<i>Heteromastus, Hyalinoecia, Isolda, Laonome, Lumbrineris, Lycastonereis, Lysidice, Marphysa, Mastobranchus, Minuspio, Namalycastis, Neanthes, Owenia, Perinereis, Pherusa, Polydora, Prionospio, Pseudopolydora, Sabellaria, Spio, Sternaspis, Talehsapia</i>
	Hirudinea		<i>Aelosoma, Allonais, Aulodrilus, Branchiodrilus, Branchiura, Chaetogaster, Dero, Dichogaster, Drawida, Eutyphoeus, Lampito, Lennogaster, Limnodrilus, Metaphire, Nais, Octochaetona, Pellogaster, Perionyx, Polypheretima, Pontodrilus, Priatina, Slavina, Stylarias, Tubifex</i>
			<i>Glossiphonia, Haemadipsa, Helobdella, Hemiclepsis, Hirudinaria, Ozobranchus, Pontobdella</i>
	Arthropoda	UG1	NO
	Crustacea and others	UG2	NO
		UG3	NO
		MG	Cyprididae (<i>Cypris, Hetrocypris</i>)
		LGA	<i>Barythelphusa, Caridina, Gangemysis, Hymenicoides, Macrobrachium, Neorhynchoplax, Parathelphusa, Tachaea</i>
		LGB	<i>Achaearanea, Aculops, Anilocra, Aphis, Araneus, Arctosa, Argiope, Artema, Bomis, Calappa, Catantops, Cheiracanthium, Cirolana, Clubiona, Conchoecete, Crossopriza, Cyclasa, Cymothoa, Cyrtophora, Diplatys, Dorippe, Euborellia, Euophrys, Exosphaeroma, Forcipula, Gasteracantha, Geocoris, Gerenia, Hersilia, Heteropoda, Hippasa, Hysteroneura, Labidura, Larinia, Leucauge, Lutica, Lycosa, Lyssomanes, Marpisa, Matuta, Melanaphis, Mesambria, Metisolabis, Myrmarachne, Nala, Neoscona, Nephila, Nerocila, Nysius, Oecobius, Oedignatha, Oligonychus, Oxyopes, Pachygrontha, Paraconophyma, Paradiplatys, Parawixia, Pardosa, Paromius, Phidippus, Plexippus, Poekilocerus, Pseudopachybrachius, Pyrgomorpha, Rhene, Salticus, Scalopidia, Schizotetranychus, Scytodes, Simalio, Singa, Spariolenus, Sphaeroma, Sphingius, Stegodyphus, Tagasta, Toxoptera, Uloboru, Zygeilla</i>
	Echinodermata	UG1	NO
		UG2	NO
		UG3	NO
		MG	NO
		LGA	NO
		LGB	<i>Acaudina, Amphioplus, Astropecten, Chaetodiadema, Clypeaster, Echinodiscus, Goniopecten, Labidoplax, Laganum, Luidia, Ophiactis, Ophiocnemis, Synaptula, Temnopleurus, Thorsonia</i>

NO: Not reported in the stretch.

Appendix-II

Fishes in all stretches of river Ganga (UG1-LG4): (Compilation from secondary data)

Species	Families	U G 1	U G 2	U G 3	M G 1	M G 2	M G 3	M G 4	M G 5	L G 1	L G 2	L G 3	L G 4
<i>Acanthopagrus latus</i>	Sparidae												+
<i>Ailia coila</i>	Schilbeidae						+	+	+	+	+	+	+
<i>Ambasis baculis</i>	Ambassidae												+
<i>A. commersoni</i>	Ambassidae												+
<i>Amblyceps mangois</i>	Ambyceptidae				+								
<i>Amblypharyngodon melettinus</i>	Cyprinidae						+						
<i>A. microlepis</i>	Cyprinidae							+					
<i>A. mola</i>	Cyprinidae					+	+	+	+	+	+	+	+
<i>Anabas testudineus</i>	Anabantidae						+		+	+	+	+	+
<i>Andontostaoma chacunda</i>	Clupeidae												+
<i>A. manmina</i>	Clupeidae												+
<i>Anguilla bengalensis</i>	Anguillidae											+	+
<i>Apocryptes bato</i>	Gobiidae												+
<i>Aplocheilichthys panchax</i>	Aplocheilidae												+
<i>Arius arius</i>	Aridae												+
<i>A. gagora</i>	Aridae												+
<i>A. jella</i>	Aridae												+
<i>A. sagar</i>	Aridae												+
<i>A. sona</i>	Aridae												+
<i>Aspidoparia jaya</i>	Cyprinidae							+		+	+	+	
<i>A. morar</i>	Cyprinidae				+			+	+	+			
<i>Badis badis</i>	Badidae						+				+	+	+
<i>Bagarius bagarius</i>	Sisoridae			+	+	+	+	+	+	+	+	+	+
<i>Barilius barila</i>	Cyprinidae		+	+	+	+	+		+				
<i>B. barna</i>	Cyprinidae		+										
<i>B. bendelisis</i>	Cyprinidae		+	+	+				+	+			
<i>B. bola</i>	Cyprinidae		+	+	+	+	+	+	+	+	+		
<i>B. dimorphicus</i>	Cyprinidae				+								
<i>B. modestus</i>	Cyprinidae						+						
<i>B. tileo</i>	Cyprinidae								+				
<i>B. vagra</i>	Cyprinidae		+	+	+	+	+						
<i>Bathygobius orbicularis</i>	Gobiidae												+
<i>Batrachocephalus mino</i>	Aridae												+
<i>Batrachthys grunniens</i>	Batrachoidae												+
<i>Boleophthalmus dussumieri</i>	Gobiidae												+
<i>Botia almorhae</i>	Cobitidae				+								
<i>B. dario</i>	Cobitidae			+	+		+	+	+	+	+	+	+
<i>B. dayi</i>	Cobitidae								+			+	
<i>B. lohachata</i>	Cobitidae				+					+	+	+	+
<i>Brachygobius natus</i>	Gobiidae												+
<i>Bregmaceros maclellandi</i>	Bregmacerotidae												+
<i>Carangoides malabaricus</i>	Carangidae												+
<i>Caranx carangus</i>	Carangidae												+
<i>Catla catla</i>	Cyprinidae				+	+	+	+		+	+	+	+
<i>Chaca chaca</i>	Chacidae						+					+	
<i>Chagunius chagunio</i>	Cyprinidae				+				+	+	+	+	
<i>Chanda baculis</i>	Ambassidae											+	

<i>C. nama</i>	Ambassidae						+	+	+	+	+	+	+
<i>C. ranga</i>	Ambassidae						+	+	+	+	+	+	
<i>Channa orientalis</i>	Channidae											+	+
<i>C. gachua</i>	Channidae			+	+		+	+	+		+	+	
<i>C. marulius</i>	Channidae				+	+	+	+	+		+	+	+
<i>C. punctatus</i>	Channidae					+	+	+	+		+	+	+
<i>C. stewartii</i>	Channidae						+	+					
<i>C. striatus</i>	Channidae				+	+	+	+	+	+	+	+	+
<i>Chela atpar</i>	Cyprinidae						+			+			
<i>C. bacaila</i>	Cyprinidae									+	+	+	
<i>C. laubuca</i>	Cyprinidae						+		+	+	+	+	
<i>Chirocentrus dorab</i>	Chirocentridae												+
<i>Cirrhinus mrigala</i>	Cyprinidae				+	+	+	+	+	+	+	+	+
<i>C. reba</i>	Cyprinidae				+	+	+	+	+	+	+	+	+
<i>Clarias batrachus</i>	Clariidae			©		+	+	+	+	+	+	+	+
<i>Clupisoma garua</i>	Schilbeidae		©	©	+	+	+	+	+	+	+	+	+
<i>C. montana</i>	Schilbeidae				+								
<i>Coilia dussumiere</i>	Engraulidae												+
<i>C. ramcorli</i>	Engraulidae												+
<i>C. reynalidy</i>	Engraulidae												+
<i>Colisa chuna</i>	Osphronemidae								+	+	+	+	
<i>C. fasciata</i>	Osphronemidae			+	+		+	+	+		+	+	+
<i>C. lalia</i>	Osphronemidae						+						+
<i>Corica soborna</i>	Clupeidae												+
<i>Crossocheilus latius latius</i>	Cyprinidae		+	+	+		+		+				
<i>Cyanoglossus arel</i>	Cyanoglossidae												+
<i>C. cyanoglossus</i>	Cyanoglossidae												+
<i>C. lingua</i>	Cyanoglossidae												+
<i>Cyprinus carpio</i>	Cyprinidae								+	+	+	+	
<i>Dactylopterus orientalis</i>	Dactylopteridae												+
<i>Danio dangila</i>	Cyprinidae												+
<i>D. devario</i>	Cyprinidae			+	+		+		+	+	+		+
<i>D. rerio</i>	Cyprinidae			+	+		+		+	+	+		
<i>Drepene punctata</i>	Ephippidiidae												+
<i>Eleutheronema tetradactylum</i>	Polynemidae												+
<i>Eleotris fusca</i>	Eleotrididae												+
<i>Erethistes hara</i>	Erethistidae											+	
<i>E. pusillus</i>	Erethistidae											+	
<i>Esomus danricus</i>	Cyprinidae			+	+	+		+	+	+	+	+	+
<i>Euryglossa orientalis</i>	Soleidae												+
<i>Eutropiichthys murius</i>	Schilbeidae							+	+				
<i>E. vacha</i>	Schilbeidae					+	+	+	+	+	+	+	+
<i>Gagata cenia</i>	Sisoridae							+	+		+		+
<i>G. gagata</i>	Sisoridae										+		
<i>Garra annandalei</i>	Cyprinidae										+	+	
<i>G. gotyla gotyla</i>	Cyprinidae		+	+	+		+	+	+			+	
<i>G. lamta</i>	Cyprinidae		+										
<i>G. prashadi</i>	Cyprinidae		+				+						
<i>Gazza minuta</i>	Leiognathidae												+
<i>Gerres filamentosa</i>	Gerridae												+
<i>G. oyena</i>	Gerridae												+
<i>Gerreomorpha setifer</i>	Gerridae												+
<i>Glossogobius giuris</i>	Gobiidae				+		+	+	+	+	+	+	+

<i>Glyptothorax cavia</i>	Sisoridae		+										
<i>G. conirostris</i>	Sisoridae		+										
<i>G. dakpathri</i>	Sisoridae				+								
<i>G. indicus</i>	Sisoridae				+								
<i>G. lineatus</i>	Sisoridae			+									
<i>G. madraspatanum</i>	Sisoridae		+										
<i>G. pectinopterus</i>	Sisoridae		+	+	+								
<i>G. telchita</i>	Sisoridae								+				
<i>G. trilineatus</i>	Sisoridae		+										
<i>Goniolosa manmina</i>	Clupeidae								+			+	+
<i>Gobiopertus chuno</i>	Gobiidae											+	+
<i>Gudusia chapra</i>	Clupeidae					+	+	+	+	+	+	+	+
<i>G. variegata</i>	Clupeidae											+	
<i>Hara hara</i>	Sisoridae											+	+
<i>Harpodon nehereus</i>	Harpadontidae												+
<i>Heteropneustes fossilis</i>	Heteropneustidae				+	+	+	+	+	+	+	+	+
<i>Hilsa kelee</i>	Clupeidae												+
<i>Hypophthalmichthys molitrix</i>	Cyprinidae								+				
<i>Hyporhamphus limbatus</i>	Hemirasmphidae												+
<i>Ilisha elongata</i>	Pristigasteridae												+
<i>I. filigera</i>	Pristigasteridae												+
<i>I. megaloptera</i>	Pristigasteridae								+	+			+
<i>Johnius coitor</i>	Sciaenidae							+	+		+	+	+
<i>J. gangeticus</i>	Sciaenidae									+	+	+	+
<i>Kurtus indicus</i>	Kurtidae												+
<i>Labeo angra</i>	Cyprinidae			+									
<i>L. bata</i>	Cyprinidae				+	+		+	+	+	+	+	+
<i>L. boga</i>	Cyprinidae				+		+			+	+		
<i>L. boggut</i>	Cyprinidae									+	+	+	
<i>L. calbasu</i>	Cyprinidae			+	+	+	+	+	+	+	+	+	+
<i>L. dero</i>	Cyprinidae		+	+	+					+			
<i>L. dyocheilus</i>	Cyprinidae		+	+	+	+							
<i>L. fimbriatus</i>	Cyprinidae									+	+	+	
<i>L. gonius</i>	Cyprinidae			+	+	+	+	+	+	+	+		
<i>L. pangusia</i>	Cyprinidae				+		+		+	+	+	+	
<i>L. rohita</i>	Cyprinidae				+	+	+	+	+	+	+	+	+
<i>Lates calcarifer</i>	Latidae											+	+
<i>Leiocassis rama</i>	Bagridae							+					
<i>Leiognathus equulus</i>	Leiognathidae												+
<i>Lepidocephalus guntea</i>	Cobitidae				+		+		+	+	+	+	+
<i>Liza macrolepis</i>	Mugilidae												+
<i>L. parsia</i>	Mugilidae												+
<i>L. tade</i>	Mugilidae												+
<i>Lobotes surinamensis</i>	Lobotidae												+
<i>Lutjanus argentimaculatus</i>	Lutjanidae												+
<i>L. johni</i>	Lutjanidae												+
<i>Lycodontis tile</i>	Muraenidae											+	+
<i>Macrognathus aculeatus</i>	Mastacembelidae					+			+				+
<i>M. aral</i>	Mastacembelidae									+	+	+	
<i>M. pancalus</i>	Mastacembelidae				+		+		+	+	+	+	+
<i>Mastacembelus armatus</i>	Mastacembelidae			+	+	+	+	+	+	+	+	+	+
<i>M. pancalus</i>	Mastacembelidae												+
<i>Megalaspis cordyla</i>	Carangidae												+
<i>Megalops cyprinoides</i>	Megalopidae											+	+

<i>Microphis cunocalus</i>	Syngnathidae												+
<i>Minous coccineus</i>	Synbranchidae												+
<i>Monopterusuchia</i>	Synbranchidae										+		+
<i>Mugil cephalus</i>	Mugilidae												+
<i>M. corsula</i>	Mugilidae					+							
<i>Mystus bleekeri</i>	Bagridae					+	+	+	+		+	+	
<i>M. cavasius</i>	Bagridae					+	+	+	+	+	+	+	+
<i>M. gulio</i>	Bagridae											+	+
<i>M. menoda</i>	Bagridae							+				+	
<i>M. tengara</i>	Bagridae			©	+	+	+	+	+		+		
<i>M. vittatus</i>	Bagridae					+	+	+	+	+	+	+	+
<i>Nandus nandus</i>	Nandidae				+		+	+	+		+	+	+
<i>Nangra nangra</i>	Sisoridae						+					+	
<i>N. punctata</i>	Sisoridae								+	+	+	+	
<i>N. viridescens</i>	Sisoridae								+				
<i>Nemacheilus beavani</i>	Balitoridae		+	+			+						
<i>N. botia</i>	Balitoridae			+	+		+	+	+		+	+	
<i>N. corica</i>	Balitoridae				+		+						
<i>N. montanus</i>	Balitoridae		+	+	+		+						
<i>N. multifasciatus</i>	Balitoridae		+				+						
<i>N. rupicola</i>	Balitoridae		+		+								
<i>N. savona</i>	Balitoridae		+	+			+						
<i>N. scaturigina</i>	Balitoridae						+						
<i>N. zonatus</i>	Balitoridae		+				+						
<i>Notopterus chitala</i>	Notopteridae				+	+	+	+	+	+	+	+	+
<i>N. notopterus</i>	Notopteridae				+	+	+	+		+	+	+	+
<i>Odontamblyopus rubicundus</i>	Gobioididae												+
<i>Ompok bimaculatus</i>	Siluridae						+	+		+	+	+	+
<i>O. boopis</i>	Siluridae						+						
<i>O. pabda</i>	Siluridae						+	+		+	+	+	+
<i>O. pavel</i>	Siluridae							+			+	+	
<i>O. pabo</i>	Siluridae												+
<i>Ophiocephalus punctatus</i>	Channidae				+								
<i>Oreochromis niloticus</i>	Cichlidae									+	+	+	+
<i>Oryzias melastegma</i>	Oryziidae												+
<i>Osteogeneiosus militaris</i>	Aridae												+
<i>Osteobrama cotio</i>	Cyprinidae						+	+	+	+	+	+	
<i>Otolithoides biauritus</i>	Sciaenidae												+
<i>Oxygaster bacaila</i>	Cyprinidae					+	+	+					
<i>O. gora</i>	Cyprinidae					+				+			
<i>Pama pama</i>	Sciaenidae											+	+
<i>Pangasius pangasius</i>	Pangasiidae						+	+			+	+	+
<i>Parambassis ranga</i>	Ambassidae									+	+	+	
<i>Parastromateus niger</i>	Parastromateidae												+
<i>Parupeneus indicus</i>	Mullidae												+
<i>Periophthalmodon schlosseri</i>	Gobiidae												+
<i>Platycephalus indicus</i>	Platycephalidae												+
<i>Plotosus canius</i>	Plotosidae												+
<i>Polynemus paradiseus</i>	Polynemidae											+	+
<i>Pomadasy argenteus</i>	Haemulidae												+
<i>P. maculatus</i>	Haemulidae												+
<i>Pompus argenteus</i>	Stromateidae												+
<i>Pseudoambassis ranga</i>	Ambassidae									+	+	+	+

<i>P. lala</i>	Ambassidae													+
<i>Pseudecheneis sulcatus</i>	Sisoridae		+											
<i>Pseudapocryptes lanceolatus</i>	Gobiidae													+
<i>Pseudotropius atherinoides</i>	Schilbeidae							+		+	+	+		
<i>Psidodonophis boro</i>	Ophichthidae													+
<i>Pterois russellii</i>	Scorpaenidae													+
<i>Puntius sp.</i>	Cyprinidae							+						
<i>P. chagunio</i>	Cyprinidae					+		+						
<i>P. chola</i>	Cyprinidae				+		+			+	+	+		
<i>P. chrysopterus</i>	Cyprinidae									+	+			
<i>P. conchoniis</i>	Cyprinidae				+					+	+	+	+	
<i>P. sarana sarana</i>	Cyprinidae			+	+		+	+		+	+	+	+	
<i>P. sophore</i>	Cyprinidae			+	+		+	+	+	+	+	+	+	
<i>P. ticto</i>	Cyprinidae			+	+		+	+		+	+	+	+	
<i>Raconda russeliana</i>	Pristigasteridae													+
<i>Raiamas bola</i>	Cyprinidae			+	+				+					
<i>Rasbora daniconius</i>	Cyprinidae			+	+		+			+	+	+	+	
<i>R. elanga</i>	Cyprinidae						+							
<i>Rhinomugil corsula</i>	Mugilidae			©	+			+	+		+	+	+	
<i>Rita rita</i>	Bagridae			©	+	+	+	+	+	+	+	+	+	
<i>Salmostoma bacaila</i>	Cyprinidae			©	+				+	+	+	+	+	
<i>S. phulo</i>	Cyprinidae										+			
<i>S. untrahi</i>	Cyprinidae								+	+	+	+		
<i>Sardinella melanura</i>	Clupeidae													+
<i>Saurida tumbil</i>	Synodontidae													+
<i>Scatophagus argus</i>	Scatophagidae													+
<i>Schizothoracthis esocinus</i>	Cyprinidae		+											
<i>S. progastus</i>	Cyprinidae		+	+	+									
<i>Schizothorax curvifrons</i>	Cyprinidae		+											
<i>S. intermedius</i>	Cyprinidae		+											
<i>S. micropogan</i>	Cyprinidae		+											
<i>S. niger</i>	Cyprinidae		+											
<i>S. plagiostomus</i>	Cyprinidae		+	+	+									
<i>S. richardsonii</i>	Cyprinidae		+		+									
<i>S. sinuatus</i>	Cyprinidae		+	+	+									
<i>Sciaena biauritus</i>	Sciaenidae													+
<i>Sciamugil cascasia</i>	Mugilidae								+	+	+	+	+	
<i>Securicula gora</i>	Cyprinidae								+	+	+	+		
<i>Secutor insidiator</i>	Leiognathidae													+
<i>S. ruconis</i>	Leiognathidae													+
<i>Setipinna brevifilis</i>	Engraulidae									+	+	+	+	
<i>S. phasa</i>	Engraulidae							+	+	+	+	+	+	
<i>S. taty</i>	Engraulidae													+
<i>Sillago sithama</i>	Sillaginidae													+
<i>Sillaginopsis panijus</i>	Sillaginidae											+	+	
<i>Silonia silondia</i>	Schilbeidae					+		+			+	+	+	
<i>Sisor rabdophorus</i>	Sisoridae							+		+				
<i>Sperata aor</i>	Bagridae					+	+	+	+	+	+	+	+	
<i>S. seenghala</i>	Bagridae				+	+	+	+	+	+	+	+	+	
<i>Stigmatogobius sadanundio</i>	Gobiidae													+
<i>Stolephorus indicus</i>	Engraulidae													+
<i>Stromateus cinereus</i>	Stromateidae													+
<i>Strongylura strongylura</i>	Belonidae													+
<i>Synapyura albomaculata</i>	Soleidae													+

<i>Taenioides anguillaris</i>	Gobioididae													+
<i>T. cirraatus</i>	Gobioididae													+
<i>Tenualosa ilisha</i>	Clupeidae							+	+	+	+	+	+	+
<i>Terapon jarbua</i>	Teraponidae													+
<i>T. theraps</i>	Teraponidae													+
<i>Tetraodon cutcutia</i>	Tetraodontidae				+					+	+	+	+	+
<i>T. fluviatilis</i>	Tetraodontidae										+	+		
<i>Triacanthus brevirostris</i>	Triacanthidae													+
<i>Triturus haumala</i>	Trituridae													+
<i>T. savala</i>	Trituridae													+
<i>Thryssa purava</i>	Engraulidae													+
<i>Tor chilinoideis</i>	Cyprinidae		+											
<i>T. putitora</i>	Cyprinidae		+	+	+	+	+							
<i>T. tor</i>	Cyprinidae		+	+	+		+	+						
<i>Upeneus sulphureus</i>	Mullidae													+
<i>U. vittatus</i>	Mullidae													+
<i>Uranoscopus congnatus</i>	Uranoscopidae													+
<i>Valamugil cunnesius</i>	Mugilidae													+
<i>Wallago attu</i>	Siluridae					+	+	+		+	+	+	+	+
<i>Xenentodon cancila</i>	Belonidae			+	+		+	+		+	+	+	+	+

© Species indicated are rare/ stray catch.

Besides the above list few taxas were reported for which no conformation was available. The list of the same is given below:

Fish*	Family	Zone
<i>Rasbora elanga</i>	Cyprinidae	MG3
<i>Puntius sp.</i>	Cyprinidae	MG4
<i>Nangra viridescens</i>	Sisoridae	MG5
<i>Mugil corsula</i>	Mugilidae	MG2
<i>Leiocassis rama</i>	Bagridae	MG4
<i>Glyptothorax telchita</i>	Sisoridae	MG5
<i>Colisa chuna</i>	Belontiidae	MG5
<i>Barilius modestus</i>	Cyprinidae	MG3
<i>Barilius tileo</i>	Cyprinidae	MG5
<i>Amblypharyngodon microlepis</i>	Cyprinidae	MG4

*The list of fishes which were reported from only one substretch in middle Ganga for which confirmation could not be ascertained.

Appendix-III

Combined list of fishes from the estuary:

ANGUILLIDAE	<i>B. dario</i> *	<i>Gazza minuta</i>
<i>Anguilla bengalensis</i> *	<i>Lepidocephalus guntea</i> *	<i>Secutor ruconis</i>
OPHICHTHDAE	BAGRIDAE	<i>S. insidiator</i>
<i>Psidodonophis boro</i>	<i>Mystus vittatus</i> *	GERRIDAE
NOTOPTERIDAE	<i>M. cavasius</i>	<i>Gerres filamentosa</i>
<i>Notopterus notopterus</i> *	<i>M. gulio</i> *	<i>G. oyena</i>
<i>N. chitala</i> *	<i>Rita rita</i> *	<i>Gerreomorpha setifer</i>
CLUPEIDAE	<i>Sperata aor</i> *	LUTJANIDAE
<i>Andontostaoma manmina</i>	<i>S. seenghala</i> *	<i>Lutjanus johni</i>
<i>A. chacunda</i>	SCHILBEIDAE	<i>L. argenti maculates</i>
<i>Corica soborna</i>	<i>Aila coila</i> *	NANDIDAE
<i>Gadusia chapra</i> *	<i>Clupisoma garua</i> *	<i>Nandus nandus</i> *
<i>Gonealosa manmina</i> *	<i>Eutropiichthys vacha</i> *	BADIDAE
<i>Hilsa kelee</i>	<i>Silonia silondia</i> *	<i>Badis badis</i> *
<i>Sardinella melanura</i>	PANGASIDAE	ANABANTIDAE
<i>Tenuulosa ilisha</i> *	<i>Pangasius pangasius</i> *	<i>Anabastes testudineus</i> *
CHIROCENTRIDAE	SILURIDAE	OSPHRONEMIDAE
<i>Chirocentrus dorab</i>	<i>Ompak bimaculatus</i> *	<i>Colisa fasciatus</i> *
PRISTIGASTERIDAE	<i>O. pabo</i> *	<i>C. lalius</i>
<i>Ilisha elongata</i>	<i>O. pabda</i> *	SCATOPHAGIDAE
<i>I. feligera</i>	<i>Wallaga attu</i> *	<i>Scatophagus argus</i>
<i>I. megaloptera</i>	SISSORIDAE	POLYNEMIDAE
<i>Raonda russeliana</i>	<i>Bagarius bagarius</i> *	<i>Eleutheronema tetradactylum</i>
ENGRAULIDAE	<i>Gagata cenia</i> *	<i>Polynemus paradiseus</i> *
<i>Coilia dussumiere</i>	CLARIIDAE	URANOSCOPIIDAE
<i>C. ramcorti</i>	<i>Clarius batrachus</i> *	<i>Uranoscopus cognatus</i>
<i>C. reynalidy</i>	HETEROPNEUSTIDAE	GOBIIDAE
<i>Setipinna phasa</i> *	<i>Heteropneustis fossilis</i> *	<i>Apocryptes bota</i>
<i>S. taty</i>	ARIDAE	<i>Brachygobius nusus</i>
<i>S. brevifilis</i>	<i>Arius arius</i>	<i>Boleophthalmus dussumieri</i>
<i>Stolephorus indicus</i>	<i>A. gagora</i>	<i>Glossogobius giuris</i> *
<i>Thryssa purava</i>	<i>A. jella</i>	<i>Gobiopterus chuno</i>
CYPRINIDAE	<i>A. sagar</i>	<i>Pseudapocryptes lanceolatus</i>
<i>Amblypharyngodon mola</i> *	<i>A. sona</i>	<i>Periophthalmodon schlosseri</i>
<i>Catla catla</i> *	<i>Batrachcephalus mino</i>	<i>Stigmatogobius sadanundio</i>
<i>Cirrhina mrigala</i> *	<i>Osteogeneiosus militaris</i>	GOBIODIDAE
<i>C. reba</i> *	HARPADONTIDAE	<i>Bathygobius orbicularis</i>
<i>Dani devario</i> *	<i>Harpodon nehereus</i>	<i>Odontamblyopus rubicundus</i>
<i>D. dangila</i>	SYNODONTIDAE	<i>Taenioides anguillaris</i>
<i>Esomus danricus</i> *	<i>Saurida tumbil</i>	<i>T. cirraatus</i>
<i>Labeo bata</i> *	BREGMACEROTIDAE	ELEOTRIDIDAE
<i>L. calbasu</i> *	<i>Bregmaceros maclellandi</i>	<i>Eleotris fusca</i>
<i>L. rohita</i> *	CENTROPOMIDAE	SILLAGINIDAE
<i>Puntius conchonijs</i> *	<i>Lates calcarifer</i> *	<i>Sillago sithama</i>
<i>P. sarana sarana</i> *	AMBASSIDAE	<i>Sillaginopsis panejus</i>
<i>P. sophore</i> *	<i>Ambasis baculis</i>	CARANGIDAE
<i>P. ticto</i> *	<i>A. commersoni</i>	<i>Carangoides malabaricus</i>
<i>Rasbora daniconius</i> *	<i>Pseudombasis ranga</i> *	<i>Caranx carangus</i>
<i>Salmostoma bacaila</i> *	<i>P. lala</i> *	<i>Megalaspis cordyla</i>
COBITIDAE	LEIOGNATHIDAE	PARASTROMATEIDAE
<i>Botia lohochata</i> *	<i>Leiognathus equulus</i>	<i>Parastromateus niger</i>

STROMATEIDAE	<i>L. macrolepis</i>	SYMBRANCHIDAE
<i>Pompus argenteus</i>	<i>Mugil cephalus</i>	<i>Monopterusuchia</i>
<i>Stromateus cinereus</i>	<i>Rhinomugil corsula*</i>	CYANOGLOSSIDAE
EPHIPPIDIDAE	<i>Sciamugil cascasia*</i>	<i>Cyanoglossus arel</i>
<i>Drepene punctata</i>	<i>Valamugil cunnesieus</i>	<i>C. cyanoglossus</i>
MULLIDAE	MASTACEMBELIDAE	<i>C. lingua</i>
<i>Parupeneus indicus</i>	<i>Mastacembelus armatus*</i>	SOLEIDAE
<i>Upeneus vittatus</i>	<i>M. pancalus</i>	<i>Euryglossa orientalis</i>
<i>U. Sulphureus</i>	<i>Macragnatus aculeatus*</i>	<i>Synaptura albomaculata</i>
TERAPONIDAE	<i>M. puncalus</i>	SCORPAENIDAE
<i>Terapon jarbua</i>	TETRADONTIDAE	<i>Pterois russellii</i>
<i>Terapon theraps</i>	<i>Tetradon cutcutia*</i>	SYNANCELLIDAE
TRITURIDAE	TRIACANTHIDAE	<i>Minous coccineus</i>
<i>Triturus haumala</i>	<i>Triacanthus brevirostris</i>	PLATYCEPHALIDAE
<i>T. savala</i>	HEMIRASMPHIDAE	<i>Platycephalus indicus</i>
SCIAENIDAE	<i>Hyporhamphus limbatus</i>	BATRACHOIDAE
<i>Johinus coitor</i>	BELONIDAE	<i>Batrachthys grunniens</i>
<i>J. gangeticus</i>	<i>Xentodon cancila*</i>	PLOTOSIDAE
<i>Pama pama*</i>	<i>Strongylura strongylura</i>	<i>Plotosus canius</i>
<i>Otolithoides biauritus</i>	ORYZIIDAE	KURTIDAE
<i>Sciaena biauritus</i>	<i>Oryzias melastegma</i>	<i>Kurtus indicus</i>
LOBOTIDAE	APLOCHEILIDAE	MURAENIDAE
<i>Lobotes surinamensis</i>	<i>Aplocheilius panchax</i>	<i>Lycodontis tile</i>
HAEMULIDAE	SYNGNATHIDAE	MEGALOPIDAE
<i>Pomadasys maculatus</i>	<i>Microphis cuncalus</i>	<i>Megalops cyprinoides</i>
<i>P. argenteus</i>	DACTYLOPTERIDAE	TRICHIURIDAE
SPARIDAE	<i>Dactylopterus orientalis</i>	<i>Trichiurus spp.</i>
<i>Acanthopagrus latus</i>	CHANNIDAE	
CICHLIDAE	<i>Chanda nama*</i>	
<i>Oreochromis nloticus</i>	<i>Channa marulius*</i>	
MUGILIDAE	<i>C. orientalis*</i>	
<i>Liza parsia</i>	<i>C. punctatus*</i>	
<i>L. tade</i>	<i>C. striatus*</i>	

* The species marked were also recorded in fresh water zone (UG-LG3)

Appendix-IV

Cartillngineous fishes (Class- Chondrichthyes) of Hooghly estuary:

Families	Species
Carcharhinidae	<i>Aetobatus narinari</i>
Carcharhinidae	<i>Carcharhinus limbatus</i>
Carcharhinidae	<i>Glyphis gangeticus</i>
Dasyatidae	<i>Dasyatis bleekeri</i>
Dasyatidae	<i>D. marginata</i>
Dasyatidae	<i>D. stephen</i>
Dasyatidae	<i>D. uarnak</i>
Dasyatidae	<i>D. zugei</i>
Hemiscylliidae	<i>Chiloscyllium griseum</i>
Pristidae	<i>Pristis microdon</i>
Rhinobatidae	<i>Rhinobatos annandalei</i>
Sphyrnidae	<i>Eusphyra blochii</i>
Stegostomalidae	<i>Stegostoma fasciatum</i>

Appendix-V

Gears used in the Ganga river:

Gear Used In The Ganga River (Fresh Water Zone)			
(Major Drag Net)			
Gear with mesh Size	Area of Operation	Season of Operation	Probable catch
Mahajal (5-12 cm)	Haridwar d/s	Intensively used in winter Oct./Nov. to March/April	Large size <i>Catla</i> , <i>Rohu</i> , <i>Mrigal</i> , <i>Calbasu</i> , <i>Sperata</i> , <i>Pangus</i> .
Paundhi Jal (like Mahajal)(4-8 cm)	Varanasi to Patna at middle stretch only	October-July	Mostly Major Carps, Cat fishes, <i>Hilsa</i> , <i>Pangus</i> , <i>Silondia</i> etc.
Kadhiya Jal (Similar to Mahajal) (12-15 cm)	Operated mostly in deep waters during summer around Allahabad, Mirzapur & Varanasi	Summer	Mainly Major Carps and larger catfishes.
Par Jal (5-8 cm)	Yamuna	–	Mostly Major Carps and Catfishes.
Darwari (1.5-3.5 cm)	Allahabad Zone	Winter and summer November-June	Small fishes like <i>Garua</i> , <i>Vacha</i> , <i>Banspati</i> , <i>Juveniles of Carps</i> .
Chaundhi Jal (8-10 cm)	Most prevalent in stretches of Ganga around Allahabad	Whole year except during monsoon, Maximum in summer	Besides <i>Mystus</i> sp., <i>Mrigal</i> is also captured.
Chhanta Jal (4-8 cm)	Because of its entangling properties it is suitable even in deep waters.	Whole year except during monsoon, Maximum in summer	All species, but mostly juveniles of Carps and Cat fishes.
Joha Jal (4-8 cm)	Deep pools of Ganga where currents are mild	November to April	Mostly <i>Mrigal</i> , <i>Catla</i> , <i>Aor</i> and <i>Seenghala</i> .
Ghanaili Jal (1-4 cm)	Restricted to monsoon season only in Bihar and in UP-round the year	–	Almost all fishes that come in the sweep.
Berjal (largest of dragnets 5-10 cm)	Below Rajmahal in Bihar	After monsoon when water starts receding	Mostly <i>Hilsa</i> , <i>Silondia</i> , <i>Pangus</i> and Major Carps.
Tana Ber Jal- (Smaller dragnet 4-8 cm)	Lower reaches of Ganga around Bhagalpur.	–	–
Chandi Jal (2-3 cm)	Upper Ganga system, shallow clear and calm water towards mid river.	–	Mulletts, <i>Garua</i> , <i>Vacha</i> , <i>Chela</i> spp. etc.
Patia Jal	Upper stretches of Ganga narrow and shallow nalas		Only small sized fishes caught.
(Minor Drag Net)			
(a) Dondi Jal (2 cm)	–	–	Carp juveniles, smaller Catfish and others like <i>Chela</i> etc.
(b) Hala Jal (2-3 cm)	West Bengal	–	Carp juveniles, smaller, Catfish and others like <i>Chela</i> etc.
Chote Jal	Lower reach of Yamuna around Allahabad Narrow sheet of water	During first monsoon when breeders ascend the fields to breed	Mostly matured <i>Mrigal</i> , <i>Catla</i> , <i>Rohu</i> , <i>Calbasu</i> , <i>Mystus</i> spp., <i>Wallago</i> etc.
Bayali Jal	Stretch of Yamuna around Allahabad.	–	<i>Calbasu</i> and <i>Rita</i> taking shelter in creeks of rocky bed.
Jhingur Jal	Middle Stretch of Ganga	October to May	–
(Gill Nets)			
Gochhali Jal (10-30 cm)	–	January to July also during monsoon	Big Catfishes and Carps, <i>Bagarius</i> , <i>Wallago</i> , <i>Silondia</i> , <i>Mystus</i> sp.

Dharmo Jal (20-30 cm)	Ganga around Allahabad	Monsoon	Major Carps move for spawning.
Tiar Jal (15-30 cm)	Shallow waters	December to July	Mystus sp. Commonly captured.
Phasla Jal (16-25 cm)	Entire Ganga system	–	<i>Rohu, Catla, Mrigal, Aor, Wallago</i> and other bigger fishes are captured.
Chandi Jal (4-5 cm)	Mostly in West Bengal for <i>Hilsa</i> fishing	–	<i>Hilsa</i> fishing
Panjia Jal (15-20 cm)	Patna and Bhagalpur of Bihar		Major Carps and Catfishes.
Saraila Jal (15-30 cm)	Between Varanasi and Patna.	–	Cat fishes. Sometimes <i>Catla, Rohu</i> and Mrigal.
Phansa Jal (5 cm)	Buxar- <i>Hilsa</i> (Bihar)	November-March	<i>Hilsa</i>
Phans Jal (15-25 cm)	Lower Stretch in Murshidabad Dist.	–	Large size <i>Rohu, Catla</i> and other fishes.
Bhasa Kona Jal (5 cm)	–	July-October	Primary <i>Hilsa</i> .
(Purse Net)			
Sangla Jal (5-10 cm)	Near Allahabad increases in concentration along Ganga down stream	Mostly monsoon and early winter months	Exclusively for <i>Hilsa</i> . Besides <i>Phasa, Garua</i> and <i>Vacha</i> are also rarely caught.
Sangila Jal (8-18 cm)	Middle and lower stretches of Ganga	October-December	Mostly bigger specimens of Major Carps and Cat fishes.
Kharki Jal similar to Sangla Jal	–	During monsoon	<i>Hilsa</i>
(Scoop Net)			
(a) Ghanch Jal (4-8 cm)	Below Confluence (Allahabad)	–	Main catch- <i>Hilsa</i> .
(b) Kharra Jal (Similar to Ghanch Jal in measurement)	–	October-March	
Paunti Jal (5-8 cm)	Lower stretch of Ganga below Patna	Fast current during monsoon and post monsoon months	<i>Hilsa, Goonch, Silondia</i> , Major Carps.
Farhara Jal like Ghanch Jal (1-1.5 cm)	Allahabad and Varanasi	Round the year	Carp minnows and other small fishes.
Mang Bisara Jal (Biggest scoop net) (1-3 cm)	Buxar-Patna	–	All fishes big and small sizes.
Thehra Jal (Big scoop net)	Santal Parganas and Murshidabad districts of Bihar & W. B.	During monsoon when <i>Hilsa</i> ascend for spawning	Mostly <i>Hilsa</i> .
Bisari Jal (Common scoop net) (0.5-2 cm)	Entire stretch of Ganga.	Off seasons in shallow waters near bank.	<i>Chela, Morar, Chapra</i> , and other small fishes like carp, smaller Cat fishes shrimps etc.
Lokani Jal	Around Allahabad	Summer and Winter	Mulletts only.
Bhesal Jal	Lower stretch of Ganga in West Bengal	–	Major Carps, <i>Hilsa</i> , Cat fishes occasionally.
(Cast Nets)			
Jhinguri jal (0.5-2 cm)	Throughout the Ganga, generally from bank also		Small fishes like Carp minnows, Catfishes, <i>Chela</i> spp. Shrimps etc.

	from below Varanasi & Ballia.		Fingerlings of major carps and bigger prawns.
Adhaukhi Jal (5-8 cm)	River Yamuna and also between Patna-Baichal and West Bengal.		<i>Rita, Silondia, Calbasu.</i>

(Traps)

Kuriyar (5-10 cm)		–	Mainly major carp, carp, cat fishes, shrimps, Chela etc.
Sirki	Common in the middle stretch of Ganga from Allahabad-Patna.	–	Exclusively used for capture of <i>Mrigal, Chela</i> spp. <i>Aspidoparia morar</i> & other Carp minnows are also occasionally caught.

(Long Lines)

Gear with mesh Size	Area of Operation	Season of Operation	Species Caught with sizes
Jor	Used when most of the gears become in effective	–	<i>Garua, Vacha, Rita, Notopterus, Seenghala</i> and some times <i>Silondia</i> and <i>Pangus</i> .
Dori	–	–	All Major carps.
Dauni	Ganga near Bhagalpur	–	Exclusively for <i>Garua</i> catch.

Gear Used In The Estuarine Zone

Gear with local name	Area of Operation	Season of Operation	Species Caught
1. Trawl nets : (Moi, Ketta, Buro, Kantni & kachhi)	LG	Nov./ June	Prawns, also miscellaneous.
2. Sine nets : (a) Large : (Jungla, Kachal and Jagatber) (b) Medium & small (1) Ber (2) Charchers, (3) Kachal and (4) Chatber	LG	Nov.-Feb. (Occasionally in Monsoon) (1) All seasons, (2) All seasons, (3) March- July, (4) Nov.- August	<i>H. ilisha, T. jella, P. pama, Setipinna</i> spp. & <i>S. biauritus</i> (1) Mullet, Perches, Polynemids and sciaenids (<i>P. pama</i>) (2) Mullet, perches (<i>S. panijus</i>), Polynemids & Sciaenids (<i>P. pama</i>) (3) <i>H. ilisha</i> , (young) and Others (4). <i>H. ilisha</i> (young). <i>S. phasa</i> , Prawns and other fishes.
3. Purse nets : (sanglo, Dar and Khorke)	LG	July-Oct. and Jan-March.	<i>H. ilisha</i> only.
4. Drift nets : (1) Chhandi, (2) Dholi (3) Kona (Bhasa-Kona, Ghai-Kona, Ghalo-Kona (4) Shele and Bhasa-larang	LG	(1) Monsoon and Winter (intensity in Monsoon) (2) Nov.-May (3) Feb.-Sept. (4) Nov.-May	(1) <i>H. ilisha</i> , other (<i>I. elongata, H. toli, Setipinna</i> spp.) and <i>S. cinereus</i> (2) <i>H. ilisha</i> & <i>S. phasa</i> (3) <i>H. ilisha</i> (4) <i>P. indicus</i> and <i>S. biauritus</i>
5. Lift nets : Bhesal, Garabheal, Naukabhesal, Pata, Thela, Seitki, Thapa, Dhain, Tana, Char and Koli	LG	All seasons	Mullet, <i>I. elongata, Setipinna</i> spp. and Prawns.

6. Cast nets : Bachari & Kepla	LG	All seasons	<i>P. paradiseus</i> , <i>P. pama</i> , <i>P. pangasius</i> and Prawns.
7. Bag nets : (Stationary) (1) Been (2) Behundi (3) Thor (4) Atone (5) Gopa	LG	All seasons	(1) (2) and (3) Almost all species especially, <i>H. nehereus</i> , Prawns, <i>P. pama</i> , <i>Trichiurus</i> spp., <i>Setipinna</i> spp. <i>I. elongata</i> , mullets & <i>S. paningus</i> (5) <i>L. Calcarifer</i> and <i>S. biauriturs</i> .
8. Set gill nets : (1) Barang (3) Khota (4) Khuti (5) Patang (6) Geba-Chandi	LG	(1) Nearly all seasons (2)–(5) Monsoon and Winter	(1) <i>L. calcarifer</i> and <i>S. biauriturs</i> (2) – (5) <i>H. ilisha</i> & other clupeids.
9. Set- Barrier nets : (1) Pata (2) Char-para (3) Khat pata, (4) Khal ghera (5) Kumor	LG	All seasons	All species, particularly Prawns, <i>M. parsia</i> , <i>Setipinna</i> spp., <i>P. pama</i> , <i>E. tetradactylum</i> , <i>L. calcarifer</i> , and <i>I. elongata</i> .
10. Traps : Bitti, Dwarbitti, Chaibitto and Bhasapata	LG	Monsoon May-Oct.	Prawns
11. Hooks & Lines (Barsi)	LG	All seasons	Catfishes, Perches, Polynemids, Scienids and <i>Setipinna</i> spp.