



DIVERSITY OF SELECTIVE AND NON-SELECTIVE FISHING GEARS AND THEIR IMPACT ON GANGA FISHERY IN BIHAR

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Abstract: Application of fishing gears in fishery is the result of experiences gained over a long period of time. Every water body has a unique pattern of fishing activity. There is a well-defined pattern and distribution of fishing technique in the riparian sectors of the River Ganga based on topography, ecology and habitat of the resources available. Operation of fishing gears is also an indication of economic condition of the fishermen community where they use locally available, less costly materials to make substances of technological delight giving maximum return. The paper describes wide range of traditional as well as modernized fishing gears used by subsistence and professional fishers in the River Ganga and their impact on the fisheries and ecosystem of the same. The minute mesh size fishing gears, like shooting gears used for the collection of spawns of the economically important fishes especially spawns of major carps, in breeding season also impacting the fisheries of the river. The use of this kind of fishing gears is also the major cause of sharp decline of the Indian Major Carps i.e. *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala* and *Labeo calbasu* in the stretch of the river. The negative impacts indicate the need of season and time based regulation of specific type of fishing gear. An awareness/training programs should be extended amongst the fishermen to create awareness of the long-term effects of their fishing practices. The fishing gears are variously designed to suit the local conditions such as, depth of the water, prevalent current, seasons, and size of the desired fishes. Some of them are selective for a particular species, but mostly multispecies types of gear. The present account is an attempt to document the occurrence of 28 different kinds of commonly used gears, lines and nets in the lower middle stretch of the Ganga. The objective of study is to present the recent data of fishing gears and net operated for fishing in Ganga and their impact on the Ganga fishery.

Keywords: Ganga, Fishing gears, Gill nets, Cyprinids

INTRODUCTION

India is blessed with vast diversified inland waters. The river Ganga is no exceptions of them. It is also a vast natural water body and tremendous source of fish and fisheries. Present survey revealed the finding of 106 fish species in the stretch of the Ganga indicates rich source of fishery. The river Ganga has been the cradle of Indian civilization and life line of India since the time immemorial. The basin of river Ganges, which has very high cultural, heritage and religious values drains about 1,060,000 Km² areas and is the fifth largest river basin in the world (Welcomme, 1985) out of which 81, 6000 km² is in India; The river Ganga, originating in the Garhwal Himalayas from Gaumukh (30°55'N/70°7'E) glacier at an elevation of 4100 m. During its sea wards journey of 2,525 km from the Himalayas, (about 2700 km, Pers. Communication by R. K. Sinha) to the Bay of Bengal, the river passes through the densely populated north Indian states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal. The river breaks into a number of interlaced channels in the plains forming meanders, oxbow lakes and swamps in its northern tributaries.

The basin (70° to 88°30'E longitude 22° to 31°N latitude) receives an annual run off 48.96 million ha m from a catchment area of 96.6 million km² carries an annual load of 1.46 million tons of sediment (Natarajan, 1989), second only to the Yellow River of China (Lisitzen, 1972). The river has suffered environmental

degradation and has almost lost its originality, in terms of ecological balance, due to several factors. Natural as well as anthropogenic activities have altered the topographical structure of the Ganga resulting wide habitat loss. This also causes decline of the population of the fish species. Any species if single in number present in the aquatic environment has significant role in ecology. Every species in a food chain is significant to maintain the ecological balance, fishes are also in them.

Approximately 500 Km stretch of the River Ganga passes through the State of Bihar and several tributaries join to it. These tributaries also play an important role in ecology and fishery of the Ganga. The Ganga fisheries resources have played a significant role in the economy, culture, tradition and food habits of the people of India and Bihar too. It provides sustenance to local fishing communities as well as other riparian population. The river provides sufficient fish production for consumption in Bihar. However due to various natural and man-made changes the catch from the river has declined alarmingly over the last few decades. During the present study in a large stretch of the river Ganga in Bihar ten broad categories of fishing devices besides one spawn trapping device were recorded. Altogether 28 different types of nets and gears were recorded in which some of the nets were found to be very selective. Thirty eight different types of fishing gears were recorded in the rigorous fish

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survey in Ganga during 1993-95 in and around Patna (Table.1).



Fig.1: Different types of Nets. A. Fisherman operating the Cast Net in the shore line of the river Ganga, B. Fishermen removing the fishes from Simple drag Net (Chhannti jal) sitting on the sand island, C. Multifilament gill (Bhansa jal) keeping on the boat to dry it in sun after operation, D. Fisher showing the fish species (*Rita rita*) in hooks, E. *Anguilla bengalensis* trapped in Mosquito Net during flooded season, F. A child of fisher family removing the fishes (*Clupisoma garua* and *Eutropiichthys vacha*) Monofilament Gill Net (36mm), G. Researcher Rajesh K. Sinha with fisherman showing the catfish at one of the sampling site.

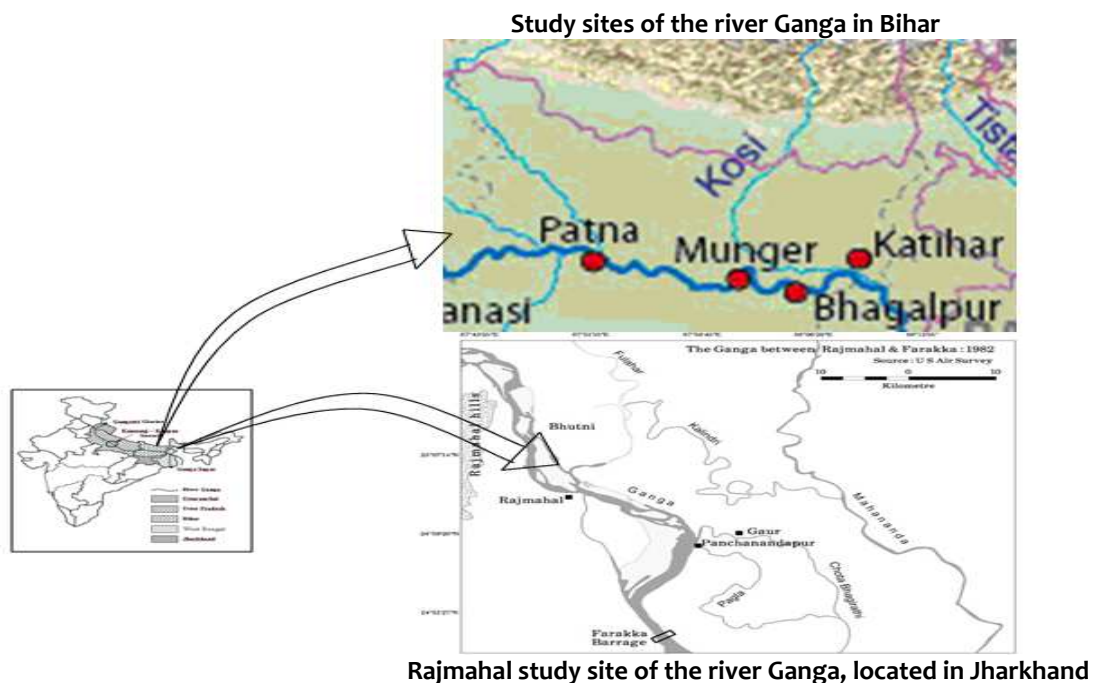


Fig.2: Map showing study sites in lower middle stretch of the river Ganga

Table.1: Types of fishing gears with detail mesh size used in the river Ganga between Patna and Rajmahal with their common and local Names.

Nets and gears	Sl. No.	2007-09		1993-95	
		Common name/local name	English Name	Common name/local name	English Name
A. Drag nets/Seine net	1	Barsatijal or Ghannijal	Multifilament net	Barsatijal or Ghannijal	Multifilament net
	2	Chattjal/ Kaprajal	Monofilament net of Nylon	Chattjal/Kaprajal	Monofilament net of Nylon
	3	Mahajal/ Paurijal	Multifilament net	Mahajal/Paurijal	Multifilament net
B. Simple Drag nets	4	Chhantijal	A kind of monofilament simple dragnet	Chhantijal	A kind of monofilament simple dragnet
	5	Johajal or Jharlka Chhantijal	A kind of monofilament simple dragnet	Johajal or Jharlka Chhantijal	A kind of monofilament simple dragnet
C. Gill nets	6	Espee jal	A bottom set gill net	Espee jal	A bottom set gill net
	7	Chondhi jal	Adrift gill net	Chondhi jal	Adrift gill net
	8	Dherijal or Sutrailijal	A column drifting gill net)	Dherijal or Sutrailijal	A column drifting gill net)
	9	Current jal (A monofilament drift gill net)		Current jal (A monofilament drift gill net)	
	10	A Gochhailjal or Barka Bhansajal	A multifilament drift fill net	A Gochhailjal or Barka Bhansajal	A multifilament drift fill net
	11	Bhasonajal	A surface drift gill net	Bhasonajal	A surface drift gill net
D. Purse Net	12	Bhasona jal or Phasajal	A fixed gill net	Bhasona jal or Phasajal	A fixed gill net
	13	Pachaondhijal	A kind of gill net	Pachaondhijal	A kind of gill net
	14	Satavnajal	A kind of gill net	Satavnajal	A kind of gill net
	15	Sunghailjal or Shanghalajal	A kind of Purse net	Sunghailjal or Shanghalajal	A kind of Purse net
E. Lift nets or Dip net	16	Pelni jal	A kind of lift net	Pelni jal	A kind of lift net
	17	Dondi jal	A kind of dip net	Dondi jal	A kind of dip net
	18	Pelni jal	A triangular push net or lift net	Pelni jal	A triangular push net or lift net
F. Cast net	19	Scoop net or Bishar jal	A kind of scoop net	Scoop net or Bishar jal	A kind of scoop net
	20	Phekail or Bhauri jal	A kind of cast net	Phekail or Bhauri jal	A kind of cast net
G. Longlines	21	Bansi or Kanta	A kind of Hooks	Bansi or Kanta	A kind of Hooks
	22	Bansi - Hazara	A kind of longlines	Bansi - Hazara	A kind of longlines
	23	Bansi - Doni	A kind of set longlines	Bansi - Doni	A kind of set longlines
	24	Lahka or Lapkaooach	Hook fishing with use of Dolphin oil	Lahka or Lapkaooach	Hook fishing with use of Dolphin oil
	25	Chhip or Lagga	Lines fishing with bamboo stick	Chhip or Lagga	Lines fishing with bamboo stick
	26	Beerti Chilon	A plunge basket barrier trap	Beerti Chilon	A plunge basket barrier trap
H. Plunge basket Trap & Bamboo barrier trap	27	Jhangijal	A small plunge basket bottom set trap	Jhangijal	A small plunge basket bottom set trap
	28	Beerti	A kind of plunge basket trap	Beerti	A kind of plunge basket trap
	29			Korwa	A fine split trangular basket trap
	30			Bari jal or Pinjra	A cage with screen barrier trap
	31			Jhapa or Tapi	A cover pot or plunge basket trap
	32			Pinjra or Janjir	A rectangular trap
	33			Lumba Janghi	A conical trap
I. Shooting Nets (Spawn trapping net)	34			Chilon or Chilman	A Bamboo screen
	35			A kind of gear	A very fine nylon net
	36			Ghaila or Hariya	Spawns ready for transport in earthen hundies
J. Other Kind of Fishing method	37			Bhala or Gargoj	A kind of Harpooning
	38			Kholnin Dengi	A white screen with shallop trap

Indication:-

D = Diameter, L = Length, W = Width, WMG = Width of mouth Gap
 GLS = Gap between two longitudinal strip, LMG = Length of mouth Gap,

In the survey a number of fishing methods and gear types observed and their impacts on the fisheries and environment were also recorded. Since there is availability of mechanized and modernized fishing gears in the market that attracts the non-traditional fishers for fishing in the river. So the number of fishers also increased resulting sharp decline of total catch per unit effort of the fishes. Tremendous use of mosquito nets and habitat alteration adversely affecting the population of fishes. Involvement of more fishers, habitat alteration, encroachment of exotic fishes, wide use of mosquito nets and fall in catch per unit effort of

more economically important fishes especially major carps affecting reluctant approach of new generation fishers fishing in the river. The above reasons accounted fall in use of fishing gears in the Ganga for fishing by 10 (Table.1). Fishermen are very skilled in operating the fishing gears as they know how and what kind of fishing gears should be used to catch maximum fishes in minimum effort. They use the gears according to the topography and conditions of the river. The fishing methods, the types of gear encountered and their impacts on the fishery are described below.

Table.2: Showing the percent of fishers with gear types, seasonal distribution and their prohibition to use in the River Ganga.

Sl. No	Fishing gear	Season	Percent of fishers with types of gear	Gears prohibited to use
A	Drag nets/Seine net	Winter & Summer	6.82	June to September
B	Simple Drag nets	Summer	2.27	June to September
C	Gill nets	Summer (Maximum) Onset and offset of Monsoon (Minimum) Winter (Moderate)	68.18	June to September
D	Purse Net	Winter & Summer	2.27	June to September
E	Lift nets or Dip net	Winter & Summer Dondi jal in Monsoon	1.14	June to September
F	Cast net	Throughout year	1.14	June to September
G	Longlines	Summer	2.73	June to September
H	Plunge basket Trap & Bamboo barrier trap	Monsoon	14.77	June to September
I	Shooting Nets	Offset of Monsoon	0.68	June to September

MATERIALS AND METHOD

Eleven landing sites Digha ghat, Adalat ghat, Ghagha ghat, Gai ghat, Lallupokhar ghat, Kastherny ghat, Hanuman ghat, Barari ghat, LCT ghat, Mahajantolil ghat and Gudara ghat) at five different sampling stations (Patna, Munger, Bhagalpur, Kahalgaon and Rajmahal) were selected for study in the lower middle stretch of the river Ganga between Patna and Rajmahal. The study area in the stretch of river Ganga ranges longitudinally and latitudinally from Patna (85°06'55"E / 25°40'06"N) to Rajmahal (87°50'21"E / 25°03'21"N). Seasonal field surveys at (Munger, Bhagalpur, Kahalgaon and Rajmahal) and monthly field surveys at Patna were conducted to study the ichthyofaunal diversity and types of fishing gears used by the fisher in the River Ganga. Sampling and data were collected from the landing sites while taking out the fishes from the nets. Collection of fishes and types of gears in which the species were trapped also recorded with the help of skilled fishermen. Fishing gears and devices used in fishing operation were moving nets (Drag nets/ Seine nets, Gill nets, a monofilament drift nets, multifilament gill nets, Lift nets, dip nets, Purse nets, Scoop nets, and Split bamboo cage), hooks and lines (Iron hooks and kos) to catch fishes in different seasons (Table.1). The percentage use of these gears varies with locations (Table.4). A multifilament column drift gill net (250-300mm) used by fishermen in monsoon when river is flooded. This net is left floating

along the water current with the help of motorized boat and after few hours it dragged out from the river. They use this net to catch large size fishes (>10kg) whereas in summer and winter fishermen like to use different kinds of gill nets (10-60mm) mostly. The mesh size of the nets was measured with help of measuring scale at the landing site by itself. This was done after removing the fishes from the nets by the fishers at boat or fishing crafts. In the months of March to May most of the fishermen use a column of drifting gill nets of mesh size 20-40mm (Derhi or Sutaraili jal and Current jal) to catch fish species viz: *Ailia coila*, *Eutropiichthys vacha*, *Eutropiichthys murius*, *Clupisoma garua*, *Setipinna phasa*, *Setipinna brevifilis* etc because these species are in abundance in summer due to low water level and low flow rate in the river. Since these species have good economic value and their abundance presence in the river attracts the fishers to use drifting gill nets in this period. Moving nets (gill nets) were used throughout the year, while stationary nets (gill nets) are extensively used in monsoon especially in flood plane channel. Maximum fishing were done at night and brought to the landing sites at wee hours.

Experimental fishing was also conducted in day times at different locations by cast nets, monofilament gill nets and scoop nets. Since monofilament gill nets were the extensively used gears throughout the year

so experimental fishing was also done by the same by skilled fishermen. In day hours *Clupisoma garua*, *Eutropiithys vacha*, *Eutropiichthys murius*, *Labeo bata*, *Mystus* spp. and *Setipinna phasa* were trapped by this gear. With the use of cast net *Puntius phutino*, *Puntius sophore*, *Puntius ticto*, *Parambassis ranga*, *Prambassis nama*, *Botia dario*, *Pseudeutropius antheronoids* and other small fishes as well as *Labeo calbasu*, *Catla catla* and *Cirrhinus mrigala* were trapped in evening hours at the river bank. More than 2.5 kg only *Pseudeutropius antheronoids* were collected in single operation of the cast net in mid-day at Hanuman ghat at Bhagalpur. The fishes *Labeo calbasu*, *Notoperus notopterus* and *Ailia coila* were collected at Mahajan toli ghat in Rajmahal after several operation of the cast net in dusk time. Catch of *Labeo calbasu* (36.4cm) and *Notopterus notopterus* (17.3 cm) indicate that large size fishes come over the water surface after sunset in search of food. Scoop net were always operated at river bank to collect small fishes like *Puntius* spp, *Botia dario*, *Mystus vittatus*, *Mystus bleekery*, *Ompok papda*, *Osteobrama cotio* etc. at low depth. This is most common in monsoon period. Experimental fishing also helped in the study of spatial and temporal variations of the fishes.

RESULTS

Classification of fishing gears:

Various classifications have been proposed in the past, generally as a prelude to the systematic description of the fishing gear of a limited area. The present classification is based on the precise manner in which capture is affected, the method by which the fish is brought into relationship with the gear, the actual method by which the gear is operated, location of operation and the species are captured. Gears are basically of two types – active and passive. Fishing with active gears depends on the movement of gears, whereas passive gears rely on the movements of the fishes. Both active and passive gears were observed to be used traditionally to harvest maximum fishes from the River Ganga. The active gears (drag net, Purse net and Lift net) operated both in flood plain lakes and main stem of the river while passive gears (gill nets) are always used in the main stem of the river along the water current. The present surveys conducted for one and half year in the lower middle stretch of the River Ganga between Patna and Rajmahal. Different types of fishing gears were recorded during the survey which is explained below (Table. 1 to 3):-

Table.3: A detailed list of selective and non-selective fishing gear used in the River Ganga.

Types of fishing gear	Local Name	English Name	Operation period	Habitat
A. Drag nets/Seine net	Barsatijal/ Ghanni jal	A kind of Seine net/ Drag net	Day+Night	Mid channel
	Chattjal/Kaprajaj	A kind of Seine net/ Drag net	Day+Night	Mid channel
	Mahajal/Paurijal	A kind of deep seine net	Day+Night	Mid channel
B. Simple Drag nets	Chhantijal	A kind of simple dragnet	Day+Night	Mid channel
	Johajal or Jharlka Chhantijal	A kind of simple dragnet	Day+Night	Mid channel
C. Gill nets	Espee jal	A bottom set gill net	Day+Night	Mid channel
	Chondhi jal	A drift gill net	Day+Night	Mid channel
	Dherijal or Sutrailijal	A column drifting gill net	Day+Night	Mid channel
	Current jal	A monofilament drift gill net	Day+Night	Mid channel
	A Gochhailjal or Barka Bhansajal	A multifilament drift fill net	Day+Night	Mid channel
	Bhasonajal	A surface drift gill net	Day+Night	Mid channel
	Bhasona jal or Phasajal	A fixed gill net	Day+Night	Mid channel
	Pachaondhijal	A kind of gill net	Day+Night	Mid channel
	Satavnajal	A kind of gill net	Day+Night	Mid channel
	D. Purse Net	Sunghailjal or Shanghalajal	A kind of Purse net	Day+Night
E. Lift nets or Dip net	Pelni jal	A kind of lift net	Day+Night	Shore line
	Dondi jal	A kind of dip net	Day	Shore line
	Pelni jal	A triangular push net or lift net	Day+Night	Shore line
	Scoop net or Bishar jal	A kind of scoop net	Day	Flood plain
F. Cast net	Phekail or Bhauri jal	A kind of cast net	Day	Shore line
G. Longlines	Bansi or Kanta	A kind of Hooks	Day+Night	Mid channel
	Bansi - Hazara	A kind of longlines	Day+Night	Mid channel
	Bansi - Doni	A kind of set longlines	Day+Night	Mid channel
	Lahka or Lapkaoach	Hook fishing with use of Dolphin oil	Day+Night	Shore line
	Chhip or Lagga	Lines fishing with bamboo stick	Day+Night	Shore line
	H. Plunge basket	Beerti Chilon	A plunge basket barrier trap	Day+Night
Trap & Bamboo barrier trap	Jhangijal	A small plunge basket bottom set trap	Day+Night	Shore line
	Beerti	A kind of plunge basket trap	Day+Night	Shore line
I. Shooting Nets	A kind of gear		Night	Shore line

Table.4: Site wise percent use of fishing gears in the stretch of the River Ganga

Sl. No	Fishing gear	Patna	Munger	Bhagalpur	Kahalgaon	Rajmahal
A	Drag nets/Seine net	4.75	0.50	4.00	1.50	4.00
B	Simple Drag nets	2.10	1.10	1.00	3.50	1.50
C	Gill nets	67.80	87.50	76.5	75.5	68.5
D	Purse Net	3.50	0.30	2.50	2.20	2.50
E	Lift nets or Dip net	2.50	0.10	1.50	4.60	6.30
F	Cast net	5.50	4.50	4.50	4.20	3.50
G	Longlines	1.20	1.00	2.50	7.50	12.7
H	Plunge basket Trap & Bamboo barrier trap	2.15	5.00	5.50	1.00	1.00
I	Shooting Nets	10.5	No data	No data	No data	No data

Seine nets/ Drag nets:

'Barsatijal', 'Ghannijal', and 'Mahajal' (a kind of seine net or drag net called in local parlance) of varying dimensions and sizes are operated by a group of fishermen with the help of 2 to 5 boats in the river and highly inundated areas in the stretch. They are characterized by the absence of a bag or bunt at mid-length; there are no sinkers but a stout foot rope is provided. The net is carried by one or more boats, laid out in a semi-circle, and hauled by 7 to 20 numbers of fishermen. Almost all types of fishes are caught by these nets. The length of these nets is 90 to 112 m and width 5.5 m. Such nets are arranged in several pieces. The soak hour and fishing hour varied according to season. The brooders are also caught with the help of this gear in the breeding period. 'Chattjal' or 'Kaprajal' is made of mosquito net. This net is a very effective net and should be banned by the Government because of its potential to overexploit juvenile carp. It is very harmful net and is responsible for the decline in fish populations in rivers and floodplains. Unfortunately this net is widely operating in the entire stretch of the River Ganga throughout the year. During the study its maximum operation was observed at Rajmahal (Jharkhand) in onset of monsoon.

Simple drag nets:

'Chhantijal' and 'Jharalka' chhantijal is a kind of indigenously pocketed simple drag net operated by 2 or 4 men, one stands on dry land and remaining on the boat. The general soak hour of nets and fishing hour varied with seasons. Small cyprinids and small clupeids were caught by 'chhantijal' while marketable size of fishes including *Tenualosa ilisha*, Indian Major Carps, catfishes and spiny eels are trapped in 'Jharalka Chhantijal'. It is operated throughout the year except in monsoon.

Gill nets:

Different mesh size was observed in the gill net used in the stretch of the River Ganga. There was no regulation of mesh size to get rid of juveniles. It is wall like nets of various mesh sizes for selected species made up of hemp, nylon, cotton etc. and provided with or without sinkers and floats (either fixed, drifted and floated) to keep them vertical. Gill nets are panels of netting held vertically in the water column by a series

of floats attached to their upper edge (the float line or cork line) and weights attached to their lower edge (the foot rope or lead line). As passive gear, their catching ability relies on the movement or migration of fish through the area where the nets are set and the operculum of fishes get entangled into the meshes of nets, when the fishes try to pass through it. Fish gilling depends upon the mesh sizes, and the size must be somewhat smaller than the girth of fish. Fishes like *Ailia coila*, *Clupisoma garua*, *Glossogobius giuris*, *Eutropiichthys vacha*, *Eutropiichthys murius*, *Silonia silondia*, *Labeo bata*, *Crossocheilus latius* were trapped in this net.

Fishes are generally gilled in 'Espeejal' (a bottom set gill net) 'chaondhijal' (a drift gill net), 'Dherijal' or 'Sutrailijal' (a column drifting gill net) 'Current jal' (a monofilament gill net), 'Gochhailjal' or 'Barka bhansajal' (a surface drift gill net), 'Phansajal' or 'Bhansajal' a fixed gill net and others Pachaondhijal and 'Satavnajal' of varying length, width and mesh sizes. The average number of hauling, soak hour and fishing hours per gill net varied with seasons. Large brooder fish were gilled by larger mesh size gill nets.

The 'Current jal' is a small mesh (25-50mm) monofilament fixed gill net usually used to catch small species. Current jal with larger mesh sizes (50-160 mm) were used mainly for capturing Indian Major Carps, *Bagarius bagarius*, *Chitala chitala*, *Pangasius pangasius* and *Sperata spp* while nets with small mesh size (10-20mm) were used for catching *Macrornathus spp*, *Mastacembelus armatus*, *Polycanthus fasciatus*, *Cirrhinus reba* and fingerlings of common carps, Indian Major Carps and others in winter and summer. Being light weighted and almost invisible in nature the 'Current jal' is extremely dangerous not only for juveniles of Indian Major Carps but also for the National aquatic animal i.e. Gangetic Dolphin (*Platanista gangetica gangetica*) that maintains the ecology of the river. *Platanista gangetica gangetica* is blind freshwater aquatic mammal. With the help of echo mechanism it determines the distance and types of its prey when the sound rebounds from the prey. This animal feeds very small fishes especially juvenile *Clupisoma garua*. This fish species mostly trapped in monofilament gill net

and during the catch of *Clupisoma garua* the snout of Dolphin non-intentionally entangles in the net. Thus, sometimes monofilament net becomes the reason of Dolphin killing. A monofilament drifts gill net is maximum in use in the main stem in entire stretch of the river Ganga in Bihar.

Espeejal (A bottom sets gill nets): It is of various sizes gill net having mesh size 12 mm to 160 mm. Marker floats of rubber or thermocol and sinkers of metal, to keep the nets vertically straight, usually used in the nets. This net always set 1.5-2.0 ft. above from the bottom of the river. The sinker touches the bottom of the river bed. This is generally operated to catch the bottom feeder fishes (*Sperata aor*, *Sperata seenghala*) in winter seasons (October to February).

Bhansa jal (a surface drift gill net): There is use of vertical wooden stick as a sinker to the vertically straight inside the water body. This wooden stick is set at equal distance of the upper half of the width of the net and rest lower portion of the net is left to float freely to the bottom of the river. The float markers are tied after every 1 kg weight of the net. This is used to catch large size major carps (≥ 10 Kg weight) of the fishes.

Gochhail jal or 'Barka bhansajal' (a surface drift gill net): It is similar to Bhansa jal but less widens (up to 1-1.5 m) and there is no use of wooden or bamboo sticks as sinker. This is also used in the main stem of the river along the current.

Purse net:

It is widely used to capture marketable size *Tenualosa ilisha*, *Pangasius pangasius*, Featherback, Indian Major Carps, Whiskered catfish, and other migratory fishes. This net is locally called as 'Sunghailjal' or 'Shanglajal'. The purse is opened or closed by means of weighted cord. The mesh size of this net is approximately 220-300mm. The length is around 4.32m while width 3.60m. The opening of mouth is 13.5cm radius. It is generally used in ebb season between middle of October and mid of July (Table.2). This net is always used in midstream of the river.

Lift nets/Dip nets:

The fish swim or are maneuvered over a flat or bag-like piece of netting and are then caught by lifting the net.

1. Dondijal' and 'Bhesajal' or Helajal:

It is generally used during monsoon and post monsoon season. It is locally called as Dondijal' and 'Bhesajal' or 'Helajal'. These are small hand operated active nets. 'Tingoria' is a triangular net made up of nylon and cotton twine. In this, webbing is tied on a

triangular bamboo poles or light wooden pieces at an angle of 45°. The frame is supported by a long bamboo strip tied in the middle. The length of frame varies from 5 to 6 feet. The mesh size of webbing varies from 4-8mm. The fishes generally caught are small size Cyprinids, small Mulletts, Shrimp and Prawn while all kinds of fishes are trapped in 'Dondijal'. It is operated by two persons at the river bank. They generally catch very small fish and shrimps drifting down with the water current, being lifted around every 10 minutes by a single operator. 'Dondijal' are used during monsoon in which a wide rectangle of nets is suspended across the current while two fishermen hold the front corners to feel for fish bumping into the net.

2. Scoop net or Bisharjal:

This is a triangular lift net fixed with bamboo poles operated from a bamboo platform built along the river that brings in or drains out water from a beels or in a floodplain area with gentle flowing water. This net is locally called 'Bisharjal'. Two sides of the net are attached to two long bamboos are bent and tied together. The two bamboo poles act as fulcrum so that when the net is lifted by applying weight at its base, its central portion stands about 1.5m above the water surface. A thread is attached to the front side of the net and bent with two front ends of the two bamboos. During fishing the fishers drop the net into the water against the gentle current. The front portion set in water while conical remains about 2 meters above the water surface. The net forms a conical bag under pressure of water current. This gear operated both by day and by night. This gear is harmful to stocked carp populations and its use should be restricted during the breeding period. Small sized Clupids, Cyprinids, *Rhinomugil corsula*, *Mystus cavasius*, *Mystus tengra*, *Crossocheilus latius* species were caught in shallow water. It is lifted at an interval of nearly every 10 minutes by a single operator and the catch is stocked in 'hapa' like structure. The mesh size of 'bisharjal' varied between 6-10mm. The length of this net is about 10 meter. This net is generally used between February and July. An average of 3-7 kg fish catch was recorded in 8-10 hours of effort.

Cast Net:

The cast nets, 'Phekailja' or 'Bhaurijal', are commonly used which spreads when thrown out to catch fishes. It is hand operated. Cast net requires considerable expertise to handle it effectively and are usually liked by the most professional fishermen. They employed this gear in the river channel or other areas where natural congregation of fish takes place. These nets are not important as it contributes only 1% of the total catch in the River Ganga. The range of mesh size is 6-22mm. Some fishermen were found operating this net in the River Ganga throughout the year. During Investigation, small Clupeids, Cyprinids, *Crossocheilus*

latius, Croaker, *Rita rita*, *Macrobrachium rosenbergii*, *Mystus* spp., *Parambassis* spp., and *Labeo calbasu* were observed in the catches. The net is lifted every 5 minutes of interval. The fisherman able to collect fishes an average of about 100-150gm per haul. Sometimes large size fishes such as *Labeo calbasu*, *Catla catla* also trapped in it easily during the operation. The number of hauling was approximately 200 per day.

Hooks and long-lines:

Generally long-lines are operated with a series of 800 to 1000 hooks in the river. Various baits are used, e.g. earthworms, mollusks, small fishes, shrimps, and frogs suspended at close to the surface for pelagic predators.

In entire lower stretch of the river Ganga hooks were used on long-lines, particularly along the river channel. Maximum use of line fishing was observed at Rajmahal. At this sampling site 20 to 25 boats were found to engage per day in fishing with this gear. Almost every fisherman interested to catch *Rita rita* only with these hooks. The amount of *Rita rita* was observed an average of 2-3 kg per boat. Every boat having 1000 hooks approximately. Both long-lines and simple hooks are used. Long-lines ('Bansidoni' or Bansi hazara' or Bansi sunni') in which, lines are generally made of nylon or cotton. Line fishing is done in a variety of ways using baited hooks. Using earthworm as living bait and snail flesh (mainly bivalvia) as dead flesh fishermen used to catch *Rita rita* at Rajmaha. Species caught from this gear were *Wallago attu*, *Sperata aor*, *Sperata seenghala*, *Mastacembelus* spp., *Rita rita* and some other kinds of fishes.

The bamboo pole is used about 2 to 3 meters long. The size of hooks commonly used is 3,4,6,7,8,10 and 19 (in number form). The operation of this gear start from middle of April and last up to November, however, at Rajmahal fishermen use this gear throughout the year except in monsoon in the main stem of the river Ganga. In fact, long-lines are the dominant gear in the open water of the Ganga with Mollusks, freshwater Shrimp, and Crabs preferred as bait.

The catch from longlines and hooks mainly include predatory fishes although some are omnivores. The large snakeheads (*Channa marulius*, *Channa punctata*, *Channa gachua*), spiny eels (*Mastcembelus armatus*), *Rita rita*, *Clupisoma garua*, small and large whiskered cat fish, and of many other smaller species were caught with optimum effort.

Line fishing with one bamboo stick is locally known as 'chhip' or 'laggha'. This gear is used in shallow water exactly near the bank of the river during rainy and post-monsoon season. The bamboo stick is about 2 to 3 meters long whereas the length of the line varies from

2 to 2.5 meters with a hook. Small boat (shallop) is used by a single fisherman and is operated in the middle of the river.

'Lahka' or Lapkooah' is a local fishing with dolphin oil as fish lure. The dolphin oil is used to lure some commercially important catfishes e.g. *Eutropiichthys vacha* and *Clupisoma garua*. Fishermen mix dolphin oil with the fat body and minced roasted gut of goat and prepare a paste which in turn called bait. The oil is also sprinkled on river water to attract the fishes near the static fishing boat. The paste is slowly released into the water and also it is applied on a simple hook. The fishes feed on the floating paste and when large number of fishes gathers near the secured fishing boat, the fishermen keep on catching fish using hooks and paste. Fishermen used such techniques during two periods from August to November, and March to June.

Plunge basket trap and bamboo barrier trap:

Plunge basket trap, triangular basket trap, cage, screen barrier cover pot, rectangular trap etc. all are made up of bamboo strips. These traps are generally used in floodplain, 'chaur', 'dhab', 'moan' etc and bank of the river during monsoon and post-monsoon. Individual traps are made in many different shapes, size and with different materials which is employed according to the suitable water condition for getting a significant catch with minimum effort. Traps are fixed under water for whole day and night. These are lifted once in 24 hours. Individual 'Beerti' (Plunge basket trap) constituted by chilaon (screen) was fixed in a series at confluence of rivers like the Gandak and the Ganga river. The size of the chilaon (screen) is 3.15m in length and 1.35m in width. Sometimes fishermen face problems because all the traps are damaged or washed away due to high current and water level. The 'Beerti' and 'Chilaon' are most common in monsoon.

Fishermen used 'Jhangijal' (a small plunge basket traps) in series secured by one rope in the middle stretch of the river. The number of this trap was 30-40 in series. The length of this trap is 0.68m and width around 23m. 'Jhangijal' was operated in between middle of April to mid-September. The length-width 100cm and gap between two longitudinal strips of 'Beerti' trap is 10mm respectively. The length and width of mouth gap of Beerti is 45cm and 14cm respectively. Generally, 15-25 number of 'Beerti' was found to be operated by single fishermen. The use of this trap is very common in the Ganga at Patna. The fishermen from Ghagha ghat and Gaighat also used rectangular trap, conical trap, cover pot and cage with screen barrier trap. Migrated fishermen catch Gangetic fish with the input of minimum effort. 'Arsi' is a bamboo screen which is made up of bamboo strips and joined together closely with each-other in either side with the help of ropes. The length of screen is generally 8 -10

meters and width 1.5 - 2.0 meters. 'Pinjra' is kind of cage which is placed on the bottom near the base of 'Arsi' for trapping mud dweller and bottom dweller fishes like snakeheaded, *Labeo calbasu*, *Cirrhinus mrigala*, *Heteropneustus fossilis* (Singhi) and *Clarias batrachus* (Thai magur). Such practice lasted for about four months during monsoon and post-monsoon. Some fisherman used dip net or simple drag net, cast net in place of cage to capture the fish with the help of encircled screen. It is operated by a group of 4 to 6 fishermen. This is generally used in floodplain on north bank of the River Ganga when the flood water starts receding. At that time, the screen was observed fitted near the narrow mouth of the flowing water channel. This device helps in trapping all kinds of fishes of the flooded area.

The length and diameter of conical trap is 60 to 130cm and 27 to 175cm respectively. It is made up of bamboo strips which are tied closely by means of ropes. The interior end or the mouth generally remained opened by the rearmost end and is kept closed at the time of operation. It was applied near the banks or paddy field during the rainy season.

Rectangular trap locally 'Janjir' or 'Pinjra' is a box like structure. Fine bamboo strips weaved in a way such that each strip is fixed very close to one another. It is made into a rectangular shape keeping mouth on the slide. Normally, the length of the trap is 45 to 75cm and height 60 to 90cm while width 25 to 30cm. Such trap was hauled early in the morning containing *Channa spp*, *Puntius spp*, minor carps and spiny eels. It was operated during rainy and post-monsoon near right bank of Ganga.

Cover pot or plunge basket is a simple form of falling gear locally termed as 'Jhanppa' or 'Tappi'. The fishes were covered by the basket in turbid and muddy water of floodplain area where aquatic weeds and plants grow. It is weaved by bamboo splits tied together with the help of coir rope in a ball shaped structure. It has two opening one at the top and another at the bottom. The diameter of the top opening is about 14.5cm and that of bottom is 54cm. The height of the basket is 60cm and the gap between two longitudinal strips is 4mm. Snakeheaded, Magur, Singhi and Spiny eels were covered through the use of 'Jhanppa' or 'Tappi'. Another plunge basket is locally called 'Dholak' which is widely used in floodplain of rural areas.

'Korwa' is a kind of triangular trap made of fine bamboo split used for catching shrimp and small *Puntius* species. The trap was fixed in the flow direction of water and arranged in series to trap small fish and crustaceans which moves on the mercy of water

current. It is widely used during monsoon and post-monsoon season at Patna and Rajmahal.

Other kinds of fishing methods:

Some fishermen used mono-,bi-,and tri-pronged iron harpoon fitted on bamboo pole for killing very large sized Indian major carps, Whiskered catfish, Silond, Pungas, Boal as well as freshwater mammal the Gangetic dolphin during lean season when water level was very low. Such practice was generally noticed during night time.

'Kholnai-Dengi' is a kind of shallop constituting white screen on one side. It is operated by two fishermen during night at the bank of the river to trap mainly surface dweller fishes of Cyprinidae and Clupeidae family e.g. *Aspidoparia morar* (Chipua), *Salmophasia bacaila* (Chelhawa), *Sicamugil cascasia* (Lorhia or Thurri) and *Gudusia chapra* (khaira). It is quite interesting that fishes are attracted with light reflection and keep on jumping into the slow moving shallop. This is a recent technique. The length of shallop is 7-8 m and width 0.6m. The length of white screen ('Chilaon' or Safed Patta) is 5.4 m and width 0.45m. Generally, shallop floated down in the River Ganga for 6-7 hrs in a day. The maximum catch of small fishes was 5 to 6 kg observed during peak season.

Gear Selectivity:

Mesh size of the gears were found to be highly variable from site to site and gears to gears. Most of the gears (seine/drag nets) with small mesh size (upto 20 mm) were found near Digha ghat, Gai ghat (Patna), Kastharny ghat (Munger), Hanuman ghat, Barari ghat (Bhagalpur), Raj ghat (Kahalgaoon), and Gudara ghat (Rajmahal) landing sites. Such gears were capable of retaining fish fry and fingerlings, and also fishes of smaller size varying from 2-5 cm, besides, some larger fishes. Smaller fishes were regarded as undesirable and usually discarded by the fishermen at these sites.

Similarly, gape size of hooks varied from 3-6 mm at Adalat ghat and Ghagha ghat landing sites whereas at Mahajantoli ghat (Rajmahal) it was found to be 10 mm in size. Plunge baskets of 22.5x67.5 cm and 8 mm mesh size were observed at Ghagh ghat. It was found that at Ghagha ghat, Gaighat (Patna) and Gudara ghat (Rajmahal) landing sites nets with smaller mesh size (20 to 40 mm) were used whereas at other locations gill nets with both smaller and larger mesh size (40 to 250 mm) were in operation for fishing. The selectivity's of the different gears depend on their mesh sizes. Certain gears are more effective at catching particular age classes of fish than others. Such gears thus demonstrate a strong qualitative 'catch ability' towards those age classes.

During monsoon the larger fishes were mostly caught by large gape size of hooks. Later in the ebb/dry season, the larger fish were mostly caught in large mesh size gill nets while smaller and medium fish were caught by active fishing and a few by cast nets and others. Several gears were capable of catching many species of fishes, shrimps, eels and small *Puntius* in the stretch of the Ganga. Similarly, the species like *Ailia coila* was found to be caught maximum by 20 to 28 mm mesh size gill net and *Eutropiichthys vacha*, *Eutropiichthys murius* and *Clupisoma garua* were caught with 26-40mm mesh size gill nets. However, this was not the case with every species, i.e. the gear selectivity was not valid for every species and for every gear. Thus to some extent gear selectivity was observed in area of study.

DISCUSSION

Hornell (1924) discussed the fishing methods of the Ganges and has described all the possible devices of fishing in Ganga employed during the first quarter of this century. Hornell (1924) reported that due to swift and deep waters the major fishing operations were carried on from boats and the principal nets employed were purse net, dip nets, dragnets, driftnets and gilling nets. He reported that fishing were going on whole year round and was especially active in the rains. *Tenuulosa ilisha* (Hilsa) fish was the most dominant fishery during those days and overall the riverine fishery used to contribute double the total weight of all the fish caught in estuaries, lakes and tanks. Hornell (1924) classified the Gangetic fishing methods into (i) hunting and trapping devices (ii) angling (iii) netting and (iv) miscellaneous which includes bush fishing

Brandt (1984) reviewed fishing methods all over the world. He opined that it was impossible to review all fishing gears operated anywhere in the world, now or in earlier times. Surprisingly, he found that the methods of catching are limited to a relatively small number of basic techniques and reported that there are about a dozen and a half ways of fish catch.

Varieties of fishing gears and tackles are operated round the year in different parts of Hooghly estuary for commercial exploitation of the fishery resources (Mitra et al 1986). Some of them are selective in nature, but, a gear mostly capture multispecies fishery (Karamkar et al 1994). Saxena (1988) discussed fishing methods in river systems in India and opined that due to highly diverse nature of riverine habitat, the fishing methods range from catching with hands to the operation of large and indigenously designed nets for fishing. He also described the fishing gears of Ganga and has reported that mesh size of gill nets varied from 18 to 26 cm and for most of the dragnets more than 2 cm. These are drag net, gill net, purse net, cast net, scoop net, hook and line, and trap. The fishing gears of middle

reaches of Ganga river system on the basis of the manner by which the capture was affected was classified into seven categories (Saxena, 1965).

John and Hameed (1996) reported various types of fishing crafts and gears operating nature of the trained manpower in the fisheries sector together with the traditional as well as modern craft and gear combinations has increased the fish production of India including inland fish production. Riverine spawn collection on commercial scale for culture of carps is prevalent in Bihar, West Bengal and Uttar Pradesh (Datta Munshi et al, 1979). He also pointed out that spawning started earlier in the Kosi River belt in northern Bihar as this river gets flooded earlier than the Ganges and such early produce spawn is of superior quality. He also described that fishermen generally operate the spawn-collecting net in shallow margins of the flooded river with the mouth of the net facing the current. The spawn moving also with the current, pass into the net and get accumulated in the bag (locally called as hapa).

Hoggarth and Kirkwood (1996) studied the various types of fishing gears used in rivers of Indonesia, Bangladesh and Thailand. At the most riverine Indonesia site, exploitation was observed by the extensive use of efficient barrier trap to catch migrating fish in the river system, whereas gill nets took more than 50% of total catch in Thailand lacustrine calm waters. All gears in Bangladesh site were mainly small meshed as a result the catches in Bangladesh comprised of many more small fishes with even the largest species often being caught as fry of only 2-3 cm in length.

Mesh size of around 75% dragnets, was up to 1.5 cm operating in Bihar. In fact in Bihar, and Varanasi, Ghazipur and Balia districts in U.P., use of large dragnets of mosquito net clothing is common. These gears are highly destructive as water gets filtered and due to dragging the river bed is completely cleaned leaving only sand and thus developing ecological desert. In a village of Balia district dragging activity of such a gear was observed and output was hardly a few kg of smaller sized species and quintals of algal material (Vass et al. 2008). Another study in different stretches of Ganga river systems under various fisheries management regimes revealed that most prevalent gear under all the regimes were gill nets (67.06%) followed by hook and lines (24.37%) in case of open access and co-operatives (Vass et al., 2008). In present the prevalent gear was gill nets (69%) followed by plunge basket net and drag net in Ganga in Bihar.

The seasonality of the fisheries was also determined by flow regime, with each gear being best adapted to certain in the flood cycle. Seine nets were

found to be effective in Indonesia River during the drought. In Bangladesh, different methods are used in each season, such as hooks in the flood and seine and dewatering in the drought. Interestingly, many fishes are caught at all the times and fairly constant total catch was observed throughout the year in Bangladesh River (Hoggarth and Kirkwood 1996). Certain gears are more specific than others, and many of the smaller gear, such as fish traps and hooks, are strongly targeted at individual guild of fish. It was observed that barriers and seines in Indonesia and the gill nets in Bangladesh and Thailand caught any species they intercepted. Some of the gears in the stretch of the Ganga were found to be season specific depending on flow regime and gears technicalities. As for example purse net is used in winter and summer, while lift net, plunge basket trap, fine split bamboo trap, bamboo barrier trap, and cover pot are used specially in monsoon and post-monsoon. Harpooning generally observed in summer and winter season. It was interesting to note that non-mechanized boat is used for operation of nets and gears in this stretch of the river.

The overall objective of increasing fish production by stocking the floodplains with carp is being undermined by indiscriminate use of non-selective fishing gear. The present study recorded a decrease in catch per unit effort and in the profitability of the fisheries.

A large number of different types of fishing gear are used some of which catch large numbers of undersized carp (which is illegal), some catch a few illegal carp and others catch only legal-size carp. Some gear does not catch carp but are very destructive for wild fish population. The indiscriminate exploitation of fish spawn, fry and fingerlings by using the 'chattjal' or 'Kaprajal' from the main stem of the river, floodplains, and natural depression (beels) results in loss of the entire populations of wild fish species, including brood fishes and juveniles. This behaviour suggests that biodiversity is sacrificed for short-term economic benefits. Though the use of several types of fishing gear is limited and regulated under the fishery laws, they are still in use.

As the operation of all types of gear cannot simply be suspended to allow the stocked fingerlings to grow out, it is important to identify the gear that can be operated without exploiting undersized fingerlings stocked under the government plan and the gear should be regulated. The operation of all types of fishing gears should also be restricted in breeding period i.e. from June to September/October. The use of 'chattjal' or 'kaprajal' and undersize 'current jal' should be completely banned.

An awareness/training program should be organized to fishers to create an awareness of the factors affecting the health of the fisheries and the rationale for the restrictions on a particular fishing gear in a particular season. This will improve compliance with the regulations and improve yields in the long term.

The above observation shows that multigear fisheries are practiced in Ganga which is not in the interest of long term management of fish stock of the river. Also due to the pronounced technical interaction between different fishing gears it is clear that no fishing gear or fish species should be managed in isolation from the others.

CONCLUSION

The present work aimed to investigate the diversity of fish fauna in association with abundance, richness, assemblages, composition, distribution and their biological aspects to ascertain the current status of fish diversity in the river Ganga. About 28 different types of fishing gears and nets with varied length, diameter and mesh sizes were used in the river Ganga at Patna. Varieties of indigenous non-mechanized (Sturdy plank built) boats are used for operating larger nets in high as well as low water currents small riverine and estuarine crafts known as 'Denghis' or 'Nao' are extensively employed shallop with white screen were also used to lure jumping fish. The operation of nets and gears varied with current, depth of water or river, nature of fish to be captured and availability of raw material. Nearly, all riverine fishing gears were found to be artisanal, small scale and labour intensive and are traditionally been employed at Patna for many decades. Nevertheless, with the advancement of technical knowledge, certain gears have been replaced by nylon nets. Many of the fishing gears were employed for short-time when water level found to be suitable for their use. As a result, fishermen used a series of gears especially when the water level starts increasing with the onset of monsoon or when flood starts receding. During monsoon, some of the nets like shooting nets were used for the collection of spawn while other nets for fry, fingerlings and brooders. Application of bamboo reeds and stripes for forming barriers 'bari' across the width of narrow channels were also very common.

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