



## FISHERY IN THE TRIBUTARIES OF YAMUNA RIVER (KEN RIVER, PAISUNIRIVER) AND GANGA RIVER (TONS RIVER)

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**Abstract:** A study on the landings of various species recorded randomly from December 2003 to June 2004 from fish landing and marketing centers on the Ken at Banda, on the Paisuni at Karwi and Tons at Chakghat and Sadiapur (Prayagraj), revealed that the average catch day<sup>-1</sup> of the Ken river was dominated by *Cyprinus carpio* followed by *Aorichthys* spp. and miscellaneous fish. In contrast the Paisuni R. was dominated by *Labeo calbasu* followed by *Hypophthalmichthys molitrix* and miscellaneous while the latter group dominated over *Aorichthys* spp and *L. calbasu* in the Tons R. Among selected species *Labeo rohita* commands higher price (Rs 61.7), *Tor tor* moderate (Rs 52.5) and *L. calbasu* lower price (Rs 37.5).

**Keywords:** Fishery, Rivers, Ken, Paisuni, Tons

### Introduction

Freshwater fishes are vital and valued property for income, human food security, sport and ornaments. Overexploitation occurs around the world with the operation of more and more refined fishing equipment. Shrinkage of many wild fish stocks has been documented as a result of expanding fisheries (Allan et al 2005, Dwivedi and Nautiyal 2012, Pinder et al 2019). Illegal fishing using dynamite, pesticides, electrofishing, etc. are also major threats to fish stocks all over the world (Nautiyal et al 2013). Fishery resources are an economic activity (Dwivedi and Nautiyal 2010). In the Ganga basin, first instance of organized fishery happens at Prayagraj and at subsequent major cities of Uttar Pradesh, Bihar and West Bengal. The commercially important fishes are ritually categorised into major carps (high culinary preference), other important carps comprising indigenous and exotic carps, important catfishes such as bagarids, siluroids and other such as murrels, feather backs and eel. A survey was conducted during 2003-2004 to know the catch structure and price of selected major - minor carps (*Labeo rohita*, *Labeo. calbasu*, *Tor tor*) and

catfish in the fish markets to know how changes in catch composition have modified or influenced the pricing patterns and thus put pressure on the concerned fish species.

### Study area

The fishery samples were obtained from fishermen or from fish market at Banda in case of the Ken R. and Karwi in case of the Paisuni R. Additional information was obtained for *L. rohita*, *L. calbasu* and *T. tor*. Experimental fishing was also performed for obtaining the samples of *T. tor* from Chitrakoot Dham (Paisuni river). In case of the Tons R. fish samples were obtained from fish market at Sadiapur/Gaughat, Prayagraj there was no local market at Chakghat where fishery related observations were made. The fishermen sell their catch at Sadiapur/Gaughat, Allahabad. The species price was recorded throughout the sampling period from the vendors on sampling days. For the sake of convenience they were



categorised as follows <0.5 Kg, <1.0 Kg, <1.5 Kg, <2.0 Kg, <3.0 Kg, and <4.0 Kg and price was recorded for all fishes in these major categories. This helped in determining the price range and descriptive analysis were computed using MS Excel software

## Methods

### Catch Structure: Catch per day and its composition

The initial part of the study was to know the quantum of the catch and its composition to select suitable fishes for the study. Catch is a crude indicator of population size. Catch day<sup>-1</sup> gives an estimate of the quantum of fish catch and its components. Catch composition provides a break-up of the landings and quantum contribution of different species to this commercial activity. Change in the relative numbers of the different species is one measure of the abundance for the total populations of all species in a water body.

Catch day<sup>-1</sup>: Several types of collection systems are in use for the total catch (by numbers or weight). The chief types of collection system are the annual canvass, the sales slip, vessel landing, log books, daily delivery sheets, fixed gear records and sport fish records. A measure of fishing effort should satisfy various requirements. Important among them the effort should be a time and/or gear unit used by the fishermen or dealer in transacting business. If the dealer buys each day's catch from the fishermen, then a day may be a convenient unit of time (Rounsefell and Everhart 1985).

In order to obtain catch day<sup>-1</sup>, quantity of each fish species sold on that particular day by the vendors was obtained by weighing all fishes of one species. This was repeated for all vendors present on that particular day. Thus, the quantity of fishes from each vendor was added so as to obtain an estimate of the total catch on one day, hence forth termed as Catch day<sup>-1</sup>. A monthly value (mean, SE, median and others) was obtained by computing descriptive statistics (MS Excel 5.0) from the catch day<sup>-1</sup> recorded during the number of sampling days in the particular month.

## Results and discussion

Fisheries sector plays an important role in Indian economy by contributing to national income, exports, food, nutritional security and employment generation (Salim and Halawai 2005, Dwivedi and Nautiyal 2010). Marketing channels play a vital role in meeting the demand for fish (Masud 2004). Fish landings are conveniently categorized as commercially important fish species of large size which regularly form bulk of the catch and miscellaneous fishes which are regular but owing to their small size contribute very little to the total catch by weight.

Commercially important fish i. e. the species, which are in great demand in fish markets owing to their quality of flesh or due to demand generated by market forces, were divided into; major carps – *Labeo rohita* (Hamilton), *Catla catla* (Hamilton), *Cirrhinus mrigala* (Bloch) and *Labeo calbasu* (Hamilton), other carp- *Tor tor*, (Hamilton), exotic carps *Ctenopharyngodon idella*, (Valenciennes), *Cyprinus carpio* Linnaeus and *Hypophthalmichthys molitrix* (Valenciennes), important catfishes-*Aorichthys aor* (Hamilton), *A. seenghala* (Sykes), *Rita rita* (Hamilton) and *Wallago attu* (Bloch & Schneider), other important fishes- *Channa punctatus* (Bloch), *C. marulius* (Hamilton), *C. striatus* (Bloch), *Chitala chitala* (Hamilton), *Notopterus notopterus* (Pallas), *Mastacembelus armatus* (Lacepede) and miscellaneous. *T. tor* was given a specific category as it constitutes back bone of the fishery in the Narmada river and over years there has been a general decline in its abundance (Table 1). However, not much is known about them in the tributaries of the Yamuna and Ganga, which flow northward, compared to west flowing Narmada.

### Catch and its Structure

**The Ken River:** The total catch was dominated by *C. carpio* (9.36 to 24.95 Kg day<sup>-1</sup>), *Aorichthys* spp (11.35 to 15.8 Kg day<sup>-1</sup>) and miscellaneous group (9.88 to 12.55 Kg day<sup>-1</sup>) as they accounted for 12.4 to 22.4%, 9.69 to 21% and 10.7 to 13.1%, respectively (Table 2).



In the Ken river the monthly average catch of *L. calbasu* amounted for 7.07 to 14.15 Kg day<sup>-1</sup>, *L. rohita* 3.1 to 13.5 Kg day<sup>-1</sup> and *T. tor* 0.67 to 4.3 Kg day<sup>-1</sup>. Among these three species *L. calbasu* and *L. rohita* were dominant component of the catch accounting for 8.44 to 12.2% and 4.4 to 11.5% while *T. tor* share was low ranging from

0.8 to 3.67% (Table 2). The average obtained by pooling catch figures for the period of observation (Table 3, Fig. 1) were high for *L. calbasu* (11.0%), followed by *L. rohita* (6.21%) and *T. tor* (2.82%), suggesting the larger share of *L. calbasu* in the catch.

**Table 1** Commercial and miscellaneous component of the fish landings in the rivers of the Bundelkhand region-Ken, Paisuni and Tons rivers at Banda, Karwi and Sadiapur fish markets

Commercial component	Miscellaneous component
Major carps	Minor carps
<i>Catla catla</i> (Hamilton)	<i>Labeo boggut</i> (Sykes)
<i>Labeo calbasu</i> (Hamilton)	<i>L. fimbriatus</i> (Bloch)
<i>Labeo rohita</i> (Hamilton)	<i>L. bata</i> (Hamilton)
<i>Cirrhinus mrigala</i> (Bloch)	<i>L. dyocheilus</i> (McClelland)
Other carps	<i>L. goniuis</i> (Hamilton)
<i>Tor tor</i> (Hamilton)	<i>Cirrhinus reba</i> (Hamilton)
Exotic carps	<i>Puntius ticto</i> (Hamilton)
<i>Ctenopharyngodon idella</i> (Valenciennes)	<i>P. sophore</i> (Hamilton)
<i>Cyprinus carpio</i> Linnaeus	<i>P. chola</i> (Hamilton)
<i>Hypophthalmichthys molitrix</i> (Val.)	<i>P. conchoniuis</i> (Hamilton)
Important catfishes	<i>Barilius bola</i> (Hamilton)
<i>Aorichthys aor</i> (Hamilton)	<i>Osteobrama cotio cotio</i> (Hamilton)
<i>Aorichthys seenghala</i> (Sykes)	<i>Aspidoparia morar</i> (Hamilton)
<i>Rita rita</i> (Hamilton)	Catfishes
<i>Wallago attu</i> (Bloch & Schneider)	<i>Mystus vittatus</i> (Bloch)
Other important fishes	<i>M. tengra</i> (Hamilton)
<i>Channa punctatus</i> (Bloch)	<i>M. cavasius</i> (Hamilton)
<i>Channa marulius</i> (Hamilton)	<i>M. bleekeri</i> (Day)
<i>Channa striatus</i> (Bloch)	<i>Clarius batrachus</i> (Linnaeus)
<i>Chitala chitala</i> (Hamilton)	<i>Bagarius bagarius</i> (Hamilton)
<i>Notopterus notopterus</i> (Pallas)	<i>Clupisoma garua</i> (Hamilton)
<i>Mastacembelus armatus</i> (Lacepede)	<i>Ailia coila</i> (Hamilton)
	<i>Siloniasilondia</i> (Sykes)
	<i>Pangasius pangasius</i> (Hamilton)
	<i>Gagata cenio</i> (Hamilton)
	Others/Perch
	<i>Chanda nama</i> (Hamilton)
	<i>Parambassis ranga</i> (Hamilton)
	<i>Setipinna phasa</i> (Hamilton)
	<i>Goniolosa manmina</i> (Hamilton)
	<i>Colisa fasciata</i> (Schneider)
	<i>Anabas testudineus</i> (Bloch)



**Table 2.** Monthly catch (Kg. day<sup>-1</sup>) of important species in the river Ken.

Species	December		April		June	
	Kg.	%	Kg.	%	Kg.	%
<i>Labeo rohita</i>	3.68	4.4	13.5	11.5	3.1	4.11
<i>Catla catla</i>	2.27	2.71	5.4	4.61	1.3	1.73
<i>Cirrhinus mrigala</i>	6.43	7.68	12.55	10.7	1.76	2.34
<i>Labeo calbasu</i>	7.07	8.44	14.15	12.1	9.17	12.2
<i>Tor tor</i>	0.67	0.8	4.3	3.67	2.75	3.65
<i>Cyprinus carpio</i>	18.8	22.4	24.95	21.3	9.36	12.4
<i>Ctenopharyngodon idella</i>	1.83	2.19	1.8	1.54	3.28	4.35
<i>Hypophthalmichthys molitrix</i>	0	0	0	0	0	0
<i>Aorichthys</i> spp.	15.2	18.1	11.35	9.69	15.8	21
<i>Wallago attu</i>	7.87	9.39	7.2	6.15	7.4	9.82
<i>Rita rita</i>	0.46	0.55	2.2	1.88	5.14	6.82
<i>Channa</i> spp.	3.25	3.88	0.85	0.73	1.12	1.49
<i>Notopterus notopterus</i> and <i>Chitala chitala</i>	5.47	6.53	2.85	2.43	2.86	3.8
<i>Mastacembelus armatus</i>	0	0	3.45	2.95	2.42	3.21
Miscellaneous	10.8	12.9	12.55	10.7	9.88	13.1

**Table 3.** Variations in the average catch (Kg. day<sup>-1</sup>) of important species in the rivers Ken, Paisuni and Tons at Banda, Karwi and Sadiapur, respectively.

Species	Ken		Paisuni		Tons	
	Kg.	%	Kg.	%	Kg.	%
<i>Labeo rohita</i>	5.36	6.21	2.22	4.88	2.69	8.3
<i>Catla catla</i>	2.41	2.8	1.86	4.1	1.41	4.35
<i>Cirrhinus mrigala</i>	5.32	6.17	2.96	6.5	2.51	7.75
<i>Labeo calbasu</i>	9.54	11.0	6.72	14.8	3.93	12.1
<i>Tor tor</i>	2.44	2.82	0.58	1.27	1.86	5.75
<i>Cyprinus carpio</i>	15.3	17.8	2.93	6.43	1.32	4.06
<i>Ctenopharyngodon idella</i>	2.55	2.96	0	0	1.19	3.66
<i>Hypophthalmichthys molitrix</i>	0	0	6.17	13.6	0.12	0.36
<i>Aorichthys</i> spp.	14.7	17.1	3.89	8.53	4.64	14.3
<i>Wallago attu</i>	7.5	8.7	2.67	5.86	2.34	7.22
<i>Rita rita</i>	3.15	3.65	1.32	2.91	2.02	6.21
<i>Channa</i> spp.	1.71	1.98	0.77	1.69	0.98	3.03
<i>Notopterus notopterus</i> and <i>Chitala chitala</i>	3.64	4.22	3.94	8.64	2.05	6.33
<i>Mastacembelus armatus</i>	1.9	2.2	2.51	5.52	0.5	1.54
Miscellaneous	10.7	12.4	5.58	12.3	4.87	15

In terms of major groups of fishes, the major carps hence, accounted for 15.3 to 45.6 Kg day<sup>-1</sup>, the other carps 0.67 to 4.3 Kg day<sup>-1</sup> and the exotic carps 12.6 to 26.8 Kg day<sup>-1</sup>. The important catfishes comprised 20.8 to 28.3 Kg day<sup>-1</sup>, other important fishes varied from 6.4 to 8.72 Kg day<sup>-1</sup>

and miscellaneous group accounted for 9.89 to 12.55 Kg day<sup>-1</sup>. The major carps therefore formed 20.3 to 38.9% of the catch compared with 0.8 to 3.67% of other carp and 16.8 to 24.6% of the exotic carps. Other important fishes varied from 6.11 to 10.4% and miscellaneous group



constituted 10.7 to 13.1% (Table 4). However, the average catch for pooled data was slightly higher (29.4%) for important catfishes group (25.4 Kg day<sup>-1</sup>) compared with the major carps (22.6 Kg day<sup>-1</sup>, 26.2%). The exotic carps (17.9 Kg day<sup>-1</sup>) formed a sizeable part (20.7%) of the catch while other carps, *T. tor* only a small share (2.44 Kg day<sup>-1</sup>, 2.82%). Other important and miscellaneous fishes accounted for 7.25 Kg day<sup>-1</sup> and 10.7 Kg day<sup>-1</sup> thus contributing only 8.4% and 12.4%, respectively (Table 5, Fig. 2).

**The Paisuni River:** In the Paisuni R., the monthly average catch of *L. calbasu* varied from 3.64 to 10.4 Kg day<sup>-1</sup>, *L. rohita* 0.25 to 4.03 Kg day<sup>-1</sup> and *T. tor* 0.38 to 1.15 Kg day<sup>-1</sup>. Thus, *L. calbasu* was a dominant component in the Paisuni R. accounting for 9.63 to 24.0% compared with *L. rohita* 0.65 to 10.7% and *T. tor* 0.99 to 1.83%. Among other fish in the catch *Aorichthys* spp. ranged from 3.1 to 4.4 Kg day<sup>-1</sup> and miscellaneous group 3.71 to 8.68 Kg day<sup>-1</sup>, thus forming 7.02 to 10.7% and 9.83 to 16.2%, respectively of the total catch. *C. carpio* varied from 2.8 to 8.06% (Table 6). The average pooled catch was 6.72 Kg day<sup>-1</sup> for *L. calbasu* (14.8%), 2.22 Kg day<sup>-1</sup> for *L. rohita* (4.88%) and 0.58 Kg day<sup>-1</sup> for *T. tor* (1.27%). *Aorichthys* spp. (3.89 Kg day<sup>-1</sup>) formed a sizeable part (8.53%) of the total catch. *C. carpio* and miscellaneous group constituted 2.93 Kg day<sup>-1</sup> and 5.58 Kg day<sup>-1</sup> (Table 3), thus contributing only 6.43% and 12.3%, respectively (Fig. 3).

The major carps, other carp and exotic carps amounting to 10.7 to 15.2 Kg day<sup>-1</sup>, 0.38 to 1.15 Kg day<sup>-1</sup> and 5.59 to 17.4 Kg day<sup>-1</sup> constituted 22.5 to 40.2%, 0.99 to 1.83% and 14.8 to 27.8%, respectively, in the Paisuni R. Thus, carps were dominant component of the catch while the important catfishes comprised 6.51 to 11.5 Kg day<sup>-1</sup>. Other important fishes varied from 6.41 to 9.9 Kg day<sup>-1</sup> and miscellaneous group accounted for 3.71 to 8.68 Kg day<sup>-1</sup>. Thus, major carps dominated the catch (22.5 to 40.2%) while the important catfishes comprised 17.2 to 18.3% only. Other important fishes varied from 9.9 to 17.0% and miscellaneous group constituted 9.83 to 16.2% (Table 7). The average pooled catch was

hence higher (31.2%) for major carps (13.8 Kg day<sup>-1</sup>) compared with the exotic carps (9.11 Kg day<sup>-1</sup>, 20.6%). Important catfishes (7.88 Kg day<sup>-1</sup>) formed a sizeable part (17.9%) of the catch while other carp *T. tor* only a small share (0.58 Kg day<sup>-1</sup>, 1.31%). Other important fishes and miscellaneous group varied from 7.22 and 5.88 Kg day<sup>-1</sup> (Table 5), thus contributing only 16.4%, and 12.3% (Fig. 4).

**The Tons River:** In the Tons R., monthly (average) catch of *L. calbasu* accounted for 1.0 to 6.67 Kg day<sup>-1</sup>, *L. rohita* 0.0 to 9.55 Kg day<sup>-1</sup> and *T. tor* 0.0 to 9.0 Kg day<sup>-1</sup>. *L. rohita* and *T. tor* were not recorded in one and two months, respectively. Thus, *L. calbasu* was a dominant component in this river also amounting to 3.53 to 19.3% followed by *L. rohita* 0.0 to 20.7% and *T. tor* 0.0 to 28.1%. *Aorichthys* spp. comprised 1.0 to 7.75 Kg day<sup>-1</sup> of the catch compared with *C. carpio* (0.45 to 2.78 Kg day<sup>-1</sup>) and miscellaneous group 1.23 to 14.0 Kg day<sup>-1</sup> (Table 8) amounting to 3.53 to 22.1%, 0.23 to 7.81% and 2.67 to 49.5%, respectively.

Among the species under observation the average pooled catch was higher for *L. calbasu* (3.93 Kg day<sup>-1</sup>, 12.1%) than *L. rohita* (2.69 Kg day<sup>-1</sup>, 8.3%) and *T. tor* (1.86 Kg day<sup>-1</sup>, 5.75%). *Aorichthys* spp. 4.64 Kg day<sup>-1</sup> formed a sizeable part (14.3%) of the catch. *C. carpio* and miscellaneous group constituted 1.32 Kg day<sup>-1</sup> and 4.87 Kg day<sup>-1</sup> (Table 3), thus contributing 4.06% and 15%, respectively (Fig. 5).

Major carps accounted for 9.38 to 52.9%, other carp 0.0 to 28.1% and exotic carps 1.77 to 14.7% in the Tons R. Thus, the carps were a dominant component of the catch while the important catfishes comprised 11.4 to 45.4% only. Other important fishes varied from 0.0 to 8.48 Kg day<sup>-1</sup> and miscellaneous group 1.23 to 14.0 Kg day<sup>-1</sup> (Table 9), thus accounting for 0.0 to 18.4% and 2.67 to 49.5%, respectively.



**Table 4.** Monthly variations in the catch (Kg. day<sup>-1</sup>) of major fishery components from the river Ken.

Categories	December		April		June	
	Kg.	%	Kg.	%	Kg.	%
Major carps	19.5	23.2	45.6	38.9	15.3	20.3
Other carps	0.67	0.8	4.3	3.67	2.75	3.65
Exotic carps	20.6	24.6	26.8	22.8	12.6	16.8
Important catfishes	23.5	28	20.8	17.7	28.3	37.6
Other important fishes	8.72	10.4	7.15	6.11	6.4	8.49
Miscellaneous	10.8	12.9	12.55	10.7	9.89	13.1

**Table 5.** Variations in the average catch (Kg. day<sup>-1</sup>) of major fishery components in the rivers Ken, Paisuni and Tons.

Categories	Ken		Paisuni		Tons	
	Kg.	%	Kg.	%	Kg.	%
Major carps	22.6	26.2	13.8	31.2	10.6	32.5
Other carps	2.44	2.82	0.58	1.31	1.86	5.75
Exotic carps	17.9	20.7	9.11	20.6	2.62	8.09
Important catfishes	25.4	29.4	7.88	17.9	8.99	27.7
Other important fishes	7.25	8.4	7.22	16.4	3.53	10.9
Miscellaneous	10.7	12.4	5.58	12.3	4.87	15

**Table 6.** Monthly variations in fish catch (Kg. day<sup>-1</sup>) of important fish species in the river Paisuni.

Species	December		April		June	
	Kg.	%	Kg.	%	Kg.	%
<i>Labeo rohita</i>	4.03	10.7	0.25	0.65	0.58	0.92
<i>Catlacatla</i>	2.64	6.98	0.25	0.65	1.95	3.11
<i>Cirrhinus mrigala</i>	4.86	12.9	0.98	2.54	1.15	1.83
<i>Labeo calbasu</i>	3.64	9.63	9.23	24	10.4	16.6
<i>Tor tor</i>	0.38	0.99	0.41	1.08	1.15	1.83
<i>Cyprinus carpio</i>	2.8	7.41	1.08	2.8	5.05	8.06
<i>Ctenopharyngodon idella</i>	0	0	0	0	0	0
<i>Hypophthalmichthys molitrix</i>	2.79	7.38	6.78	17.7	12.4	19.7
<i>Aorichthys</i> spp.	4.03	10.7	3.1	8.08	4.4	7.02
<i>Wallago attu</i>	1.49	3.94	2.73	7.1	4.98	7.94
<i>Rita rita</i>	1	2.65	1.2	3.13	2.1	3.35
<i>Channa</i> spp.	0.45	1.42	0.85	2.22	1.15	1.83
<i>Notopterus notopterus</i> and <i>Chitala chitala</i>	3.89	10.3	2.85	7.43	5.13	8.18
<i>Mastacembelus armatus</i>	1.99	5.26	2.45	6.39	3.63	5.78
Miscellaneous	3.71	9.83	6.23	16.2	8.68	13.8



**Table 7.** Monthly variations in the catch (Kg. day<sup>-1</sup>) of major fishery components in the river Paisuni.

Categories	December		April		June	
	Kg.	%	Kg.	%	Kg.	%
Major carps	15.2	40.2	10.7	27.9	14.1	22.5
Other carps	0.38	0.99	0.41	1.08	1.15	1.83
Exotic carps	5.59	14.8	7.85	20.5	17.4	27.8
Important catfishes	6.51	17.2	7.03	18.3	11.5	18.3
Other important fishes	6.41	17	6.15	16	9.9	15.8
Miscellaneous	3.71	9.83	6.23	16.2	8.68	13.8

**Table 8.** Monthly variations in the catch (Kg. day<sup>-1</sup>, %) of important fish species from the river Tons.

Species	December	January	February	March	April	May	June
	Catch in weight (Kg.)						
<i>Labeo rohita</i>	0	4	9.55	1.67	1.77	1.5	0.36
<i>Catla catla</i>	0	0	4.5	1.5	3.63	0.1	0.14
<i>Cirrhinus mrigala</i>	0	5.5	3.75	3.67	1.88	2.32	0.483
<i>Labeo calbasu</i>	3	1	6.67	4.13	2.8	5.86	4.083
<i>Tor tor</i>	9	0	0	0	1.8	0.6	1.65
<i>Cyprinus carpio</i>	2.5	0.5	2.75	1.64	1.29	0.07	0.45
<i>Ctenopharyngodon idella</i>	0	0	4	1	0.87	0.92	1.52
<i>Hypophthalmichthys molitrix</i>	0	0	0	0	0	0.06	0.767
<i>Aorichthys</i> spp.	7	1	2	7.75	2.13	6.42	6.15
<i>Wallago attu</i>	2	0.9	1.13	2.4	1.07	4.12	4.767
<i>Rita rita</i>	0.6	1.4	2.13	3.33	2.23	1.76	2.65
<i>Channas</i> spp.	2	0	3.15	0.6	0.45	0.12	0.55
<i>Notopterus notopterus</i> and <i>Chitala chitala</i>	1.8	0	4.53	4.35	0.9	1	1.8
<i>Mastacembelus armatus</i>	0.1	0	0.8	0	1.3	0.44	0.85
Miscellaneous	4	14	1.23	3	3.18	5.06	3.65
	Catch in percentage (%)						
<i>Labeo rohita</i>	0	14.1	20.7	4.76	6.99	4.94	1.21
<i>Catla catla</i>	0	0	9.73	4.28	14.4	0.33	0.47
<i>Cirrhinus mrigala</i>	0	19.4	8.11	10.5	7.42	7.64	1.62
<i>Labeo calbasu</i>	9.38	3.53	14.4	11.8	11.1	19.3	13.7
<i>Tor tor</i>	28.1	0	0	0	7.12	1.98	5.52
<i>Cyprinus carpio</i>	7.81	1.77	6.0	4.68	5.12	0.23	1.51
<i>Ctenopharyngodon idella</i>	0	0	8.65	2.85	3.43	3.03	5.09
<i>Hypophthalmichthys molitrix</i>	0	0	0	0	0	0.2	2.56
<i>Aorichthys</i> spp.	21.9	3.53	4.33	22.1	8.40	21.2	20.6
<i>Wallago attu</i>	6.25	3.18	2.45	6.85	4.22	13.6	16.0
<i>Rita rita</i>	1.88	4.95	4.62	9.51	8.83	5.8	8.87
<i>Channa</i> spp.	6.25	0	6.81	1.71	1.78	0.4	1.84
<i>Notopterus notopterus</i> and <i>Chitala chitala</i>	5.63	0	9.81	12.4	3.56	3.29	6.03
<i>Mastacembelus armatus</i>	0.31	0	1.73	0	5.14	1.45	2.85
Miscellaneous	12.5	49.5	2.67	8.56	12.6	16.7	12.2



**Table 9.** Monthly variations in the catch (Kg. day<sup>-1</sup>) major fishery components from the river Tons.

Categories	Fish catch in Kg. day <sup>-1</sup>						
	December	January	February	March	April	May	June
Major carps	3.0	10.5	24.5	11	10.1	9.78	5.07
Other carps	9.0	0	0	0	1.8	0.6	1.65
Exotic carps	2.5	0.5	6.78	2.64	2.16	1.05	2.74
Important catfishes	9.6	3.3	5.27	13.5	5.43	12.3	13.6
Other important fishes	3.9	0	8.48	4.95	2.65	1.56	3.2
Miscellaneous	4.00	14.0	1.23	3.0	3.18	5.06	3.65
	Fish catch in percentage						
Major carps	9.38	37.1	52.9	31.3	39.8	32.2	17
Other carps	28.1	0	0	0	7.12	1.98	5.52
Exotic carps	7.81	1.77	14.7	7.53	8.54	3.46	9.16
Important catfishes	30	11.7	11.4	38.5	21.5	40.5	45.4
Other important fishes	12.2	0	18.4	14.1	10.5	5.14	10.7
Miscellaneous	12.5	49.5	2.67	8.56	12.6	16.7	12.2

The pooled average catch was little higher for the major carps (32.5%, 10.6 Kg day<sup>-1</sup>) compared with important catfishes group (27.7%, 8.99 Kg) and other important fishes (10.9%, 3.53 Kg day<sup>-1</sup>). Other carp formed a small share (5.75%, 1.86 Kg day<sup>-1</sup>). Exotic carps and miscellaneous group varied from 2.62 Kg day<sup>-1</sup> and 4.87 Kg day<sup>-1</sup> (Table 5), thus contributing 8.09% and 15.0%, respectively (Fig. 6).

Observations on the total landings show that the average catch day<sup>-1</sup> of the Ken river was dominated by *C. carpio* followed by *Aorichthys* spp. and miscellaneous fish. In contrast the Paisuni R. was dominated by *L. calbasu* followed by *H. molitrix* and miscellaneous while the latter group dominated over *Aorichthys* spp and *L. calbasu* in the Tons R. The fishery trend was quite distinct in the rivers under observation, owing to dominance of the exotic carp *C. carpio* in the Ken, *L. calbasu* in the Paisuni R while miscellaneous group in the Tons river. This difference can be attributed to the invasion of the exotic carp *C. carpio* in the Yamuna river which along with small share of other exotic carp formed 17.8% of the total landing at Allahabad (Anon 2003).

After common carp (*C. carpio*) and Nile Tilapia (*Oreochromis niloticus*), the miscellaneous and catfishes are emerging as the major fishery in indigenous format not only in the Ganga and Yamuna but also in the tributaries under observation (Anon 2002, 2003, Mayank and

Dwivedi 2015, Tripathi et al 2017). Earlier, the major carps (36.26%) and the cat fishes (36.17%) had a similar share and miscellaneous accounted for 26.33% only (Anon 1976). Later, Gupta and Tyagi (1992) recorded that the miscellaneous species comprised the major share (50.50%) while *Aorichthys aor* and *A. seenghala* together accounted for 16.81% at Allahabad. Few years ahead, Singh et al (1998) found that *A. aor* and *A. seenghala* were dominant species (45.2%) compared with miscellaneous (28.2%) and *L. calbasu* (14.6%) in the Ganga and the Yamuna at Allahabad. The *L. rohita*, *C. catla* and *C. mrigala* contributed small proportions 2.5%, 3.2% and 1.5%, respectively showing a decline in their fishery. The miscellaneous group, the share of which declined from 75.62% in 1985 to 48.33% in 1986, primarily dominated the fishery of the Ganga at Patna. *Aorichthys aor*, *A. seenghala* and *W. attu* which contributed in sizeable amounts among catfish increased from 1985 to 1986 (from around 10 to 15%, Kumar 1996). Mishra and Moza (2001) reported that the overall fish population in the Yamuna river (Delhi to Etawah), showed dominance of large size catfishes (49.26%) followed by major carp (28.54%). *Aorichthys* spp. and *W. attu* contributed 29.38% and 19.87%, respectively. At Kanpur too the catfishes (42.2%) and others (29.6%) have dominated the Indian major carps (18.9%) and exotic carps 9.3% in the Ganga.





The landing composition has fluctuated from year to year at Sadiapur, Allahabad (Anon 1976, 1991, 2002, 2003). In 1976 *L. calbasu*, *C. mrigala*, *C. catla*, and *L. rohita* contributed 15.68, 11.60, 3.30 and 4.72 tonnes, respectively while *Aorichthys aor* and *A. seenghala* 19.27 tonnes and miscellaneous 36.17 tonnes. At this point of time major carps and the cat fishes occurred in equal proportions (36.26%, and 36.17%, respectively). In 1990-1991 the share of *Aorichthys aor* and *A. seenghala* increased to 26.18% and 52.31%, respectively. *C. mrigala*, *C. catla*, *L. rohita* and *L. calbasu* contributed 2.53%, 2.82%, 2.76% and 10.81%, respectively (Anon 1991). During 2001-2002 the miscellaneous fish (72.0%) dominated over the catfishes (*A. aor* and *A. seenghala* 14.2%) and carps (*C. mrigala*, *C. catla*, *L. rohita* and *L.*

*calbasu*, 1.40%, 3.1%, 2.9% and 1.4%). *W. attu* and *Hilsa ilisha* contributed very small proportions 1.6% and 1.8%, respectively. In 2002-2003 the share of miscellaneous fish (62.7%) declined, that of the exotic carps increased to 17.8% while the catfishes (13.1%) and the Indian major carps (6.4%) remained stable. In the middle stretch of the Ganga river system (Agra to Bhagalpur) earlier also ‘others’ contributed sizeably (25.4%). *C. mrigala* was dominant (18.4%) in the carp catch. *A.aor* and *A. seenghala* 17.5% occurred in similar proportions and *L. calbasu* contributed small proportion (4.9%) of the total catch. *L. rohita* and *C. catla* contributed more or less similarly 8.5% and 8.6% (Jhingran 1982).

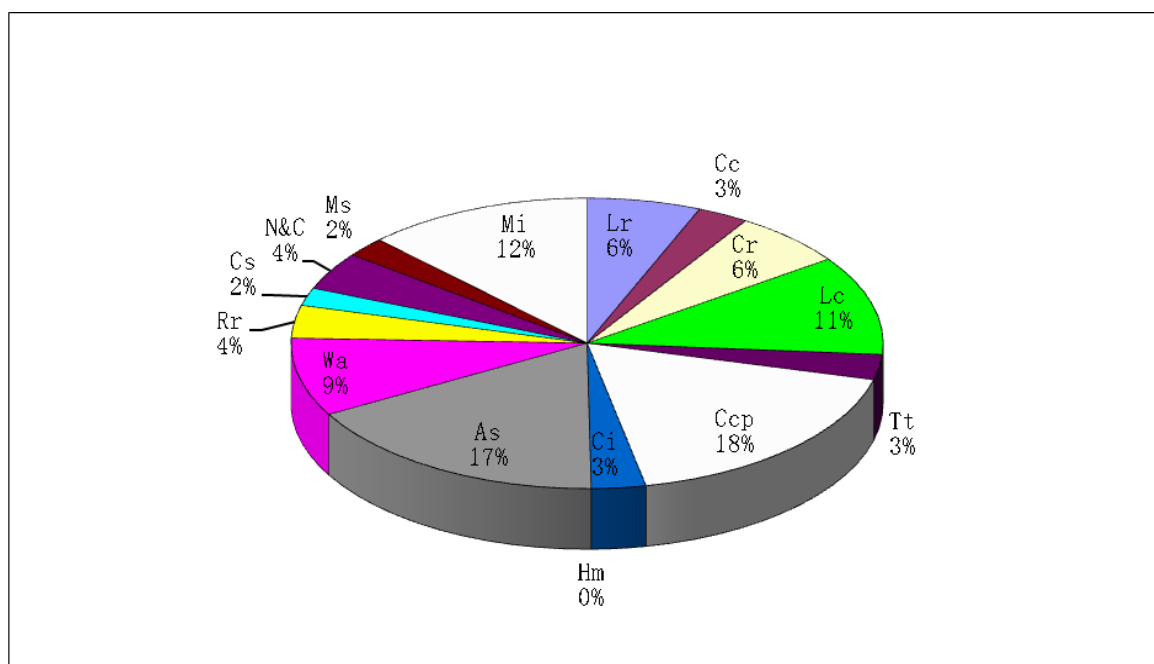


Fig. 1. Average annual catch day<sup>-1</sup> of fish species from the river Ken at Banda. Acronyms as in Table 11.

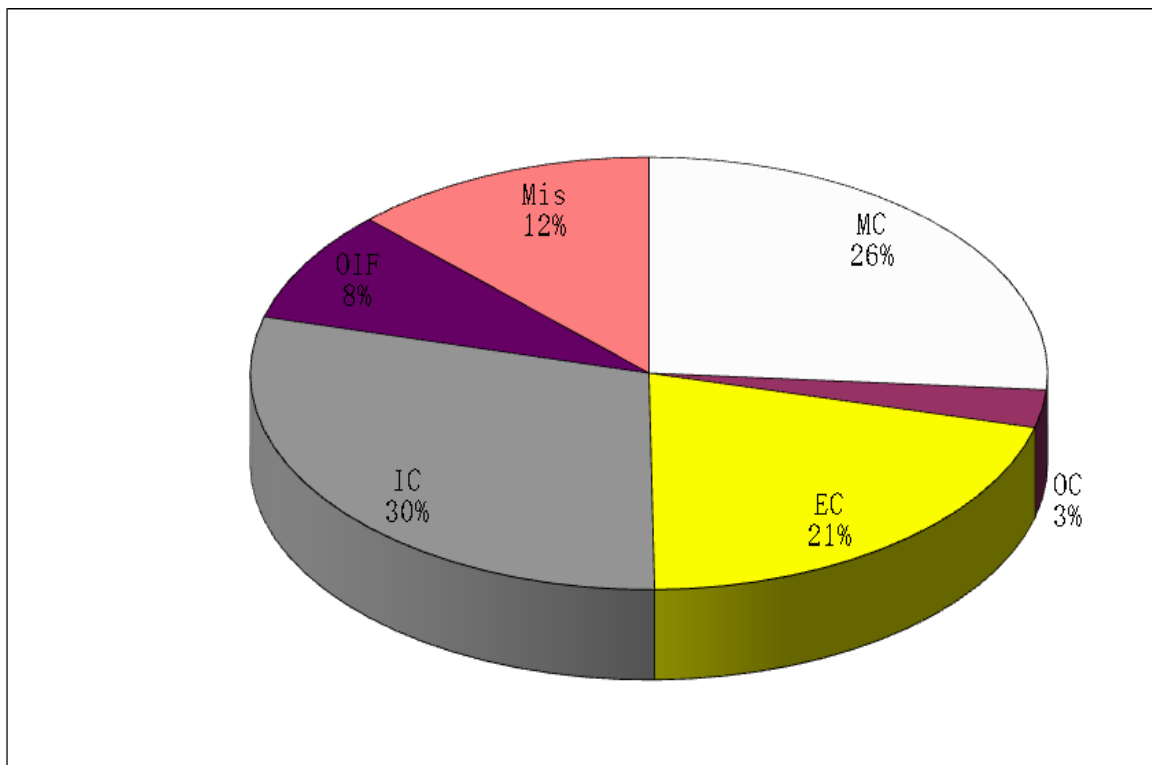


Fig. 2. Average annual catch day<sup>-1</sup> of major groups from the river Ken at Banda.

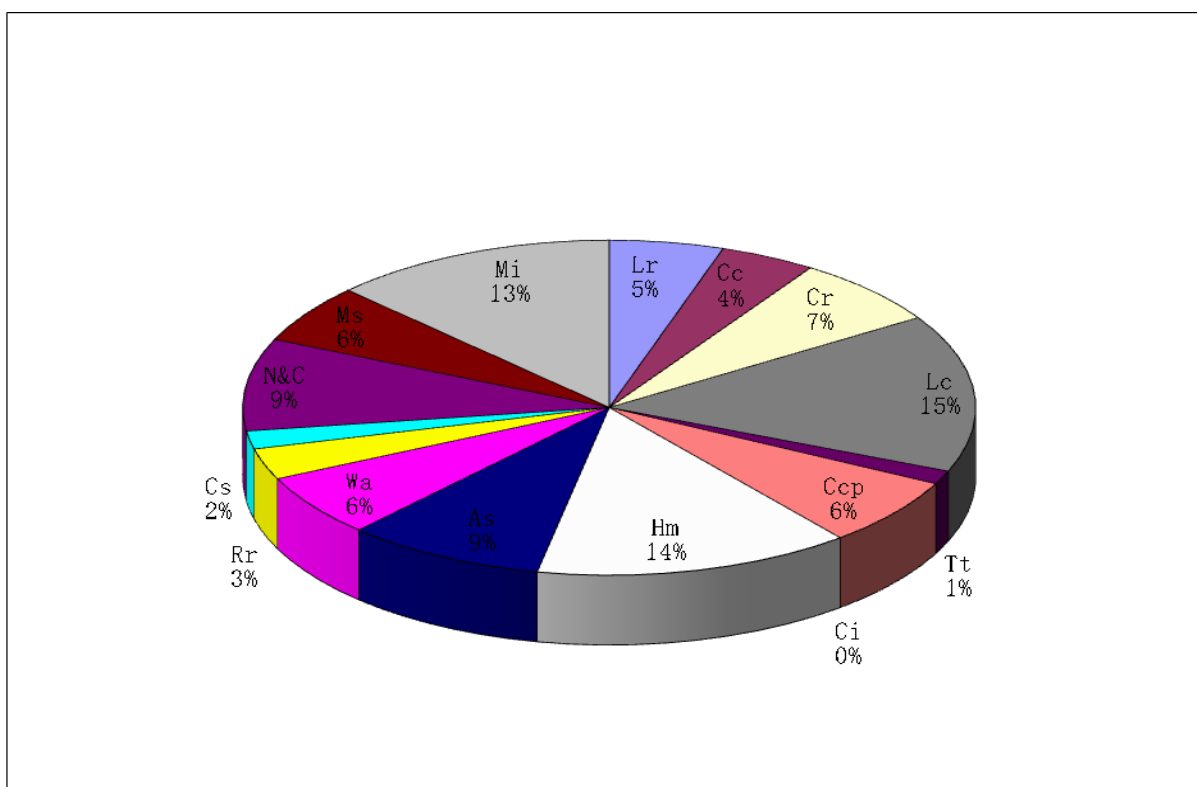


Fig. 3. Average annual catch day<sup>-1</sup> of fish species from the river Paisuni at Karwi. Acronyms as in Table 11.

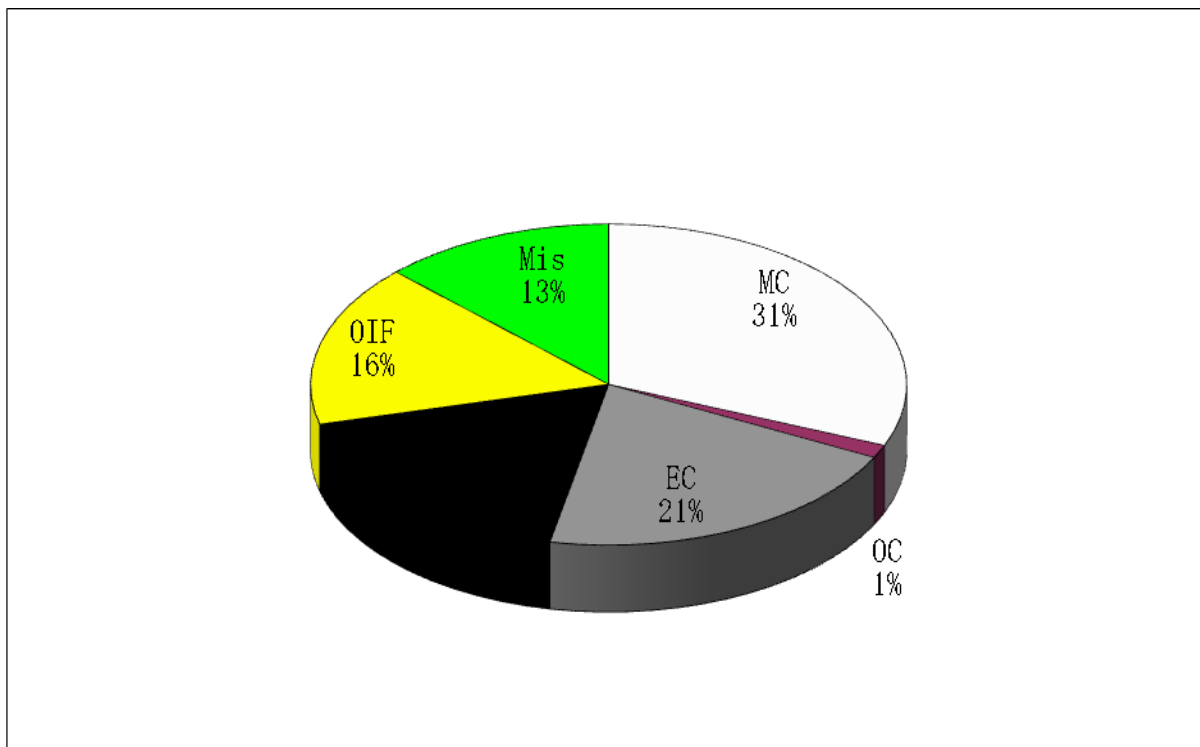


Fig. 4. Average annual catch day<sup>-1</sup> of major groups from the Paisuniriver at Karwi.

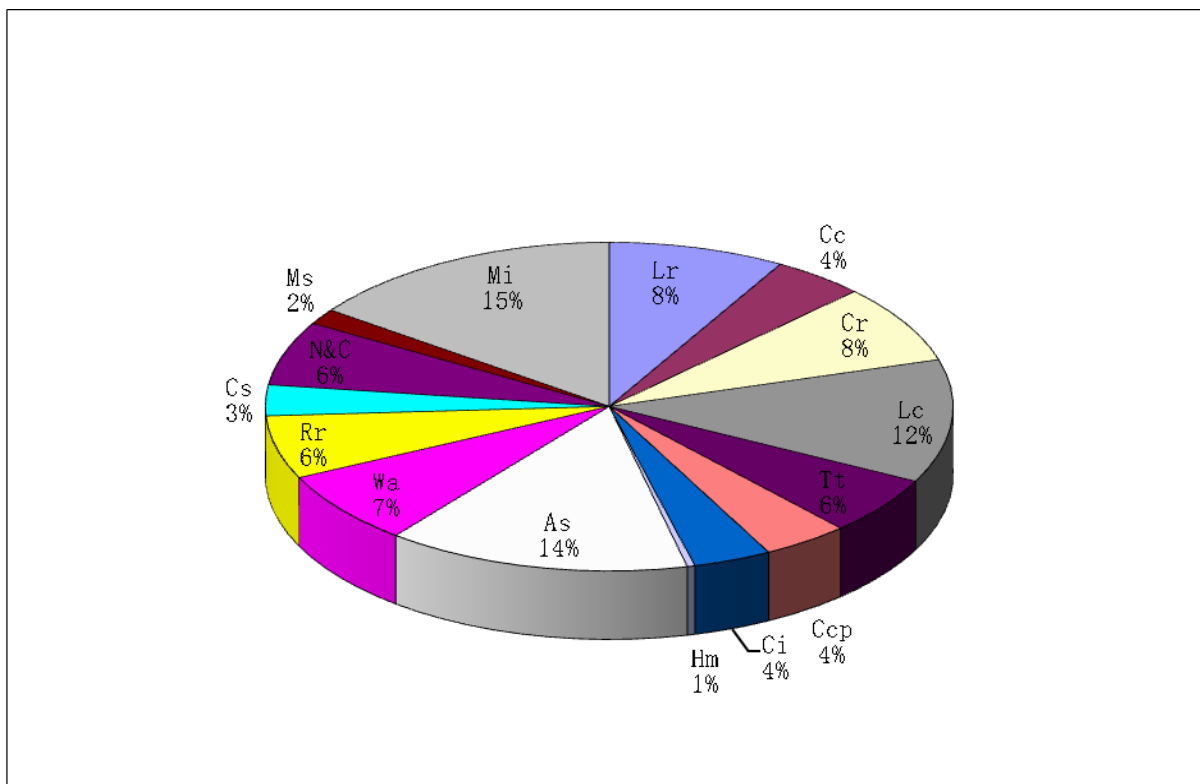


Fig. 5. Average annual catch day<sup>-1</sup> of fish species from the Tons river at Chakghat. Acronyms as in Table 11.

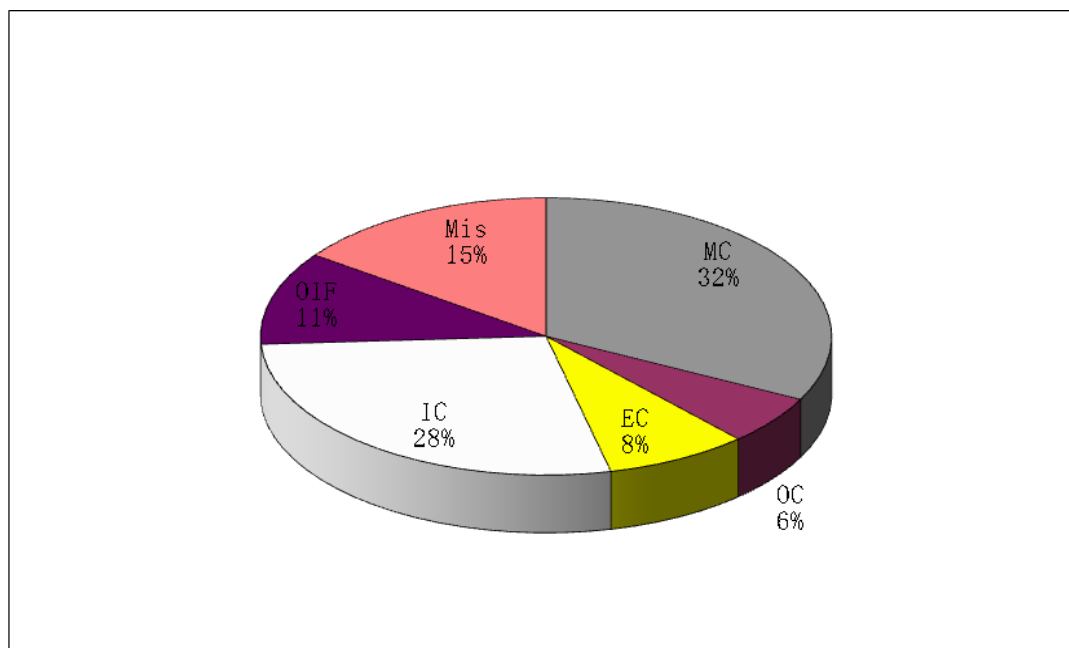


Fig. 6. Average annual catch day<sup>-1</sup> of major groups from the Tons river at Chakghat.

In the **major carp category** the average catch day<sup>-1</sup> of *L. calbasu* dominated over *L. rohita* and *C. mrigala* in the Ken, Paisuni as well as the Tons R. *T. tor* catch was recorded to be less than 3% in the Ken and Paisuni R. while 5.75% in the Tons. The average catch day<sup>-1</sup> of *L. calbasu* varied from 11.0 to 14.8% at the landing centers of these rivers compared with 6.17 to 7.75% in case of *C. mrigala* and much lower in other carps including *L. rohita* (4.88 to 8.3%) and *C. catla* (2.8 to 4.35%). Thus, *L. calbasu* was contributing immensely to carp catch in all these rivers. Among the carps *L. calbasu* has occupied a prominent position in the catch (Jhingran and Ghosh 1978) and has emerged as principal component (*L. calbasu* 17.15%) in the Allahabad region (Gupta and Tyagi 1992). *L. rohita*, *C. catla* and *W. attu* contributed very small proportions, 2.06%, 3.06% and 3.58% respectively. In the Ganga at Patna, the Indian major carp accounted for small proportion during 2.91%, 1.31%, 1.63% and 0.61% for *C. catla*, *L. rohita*, *C. mrigala* and *L. calbasu*, respectively while in 1986 proportion increased, *C. catla* (7.45), *L. rohita* (4.61%), *C. mrigala* (1.80%) and *L. rohita* (5.04%). The *L. calbasu* share increased nearly 8 times in 1986

(Kumar 1996). Mishra and Moza (2001) reported that *L. calbasu* had more share (11.23%) than the Indian major carp, *L. rohita* (5.41%) and *C. mrigala* (9.03%). Other catfish and murrels (*Channa* spp.) too formed substantial fishery (8.15% and 3.95%). Miscellaneous species contributed 7.36% of the total population, particularly *Puntius* sp. and *Chela* spp.

Thus, the catch structure has altered since 1970's. In the 5<sup>th</sup> decade the capture fishery of the Ganga river was dominated by *C. mrigala* among the major carp and *Aorichthys aor* among the catfishes. *Labeo calbasu* accounted for only 4.3% of total fishery at Buxar (Jhingran 1982). The contribution of miscellaneous group of fishes in total catch has almost doubled in the recent years in the Ganga and Yamuna rivers, as compared to sixties when it formed about 25% of the catch, signaling towards the substitution of economically important fishes by low priced fishes (Seth 1996, Seth and Panwar 2001).

Seth and Katiha (2001) opined that the decline of Gangetic carp population in the Ganga river system has brought tremendous fishing stress on its natural riverine stock. It points towards the Over exploitation of its riverine population



coupled with wanton killing of brood stock and in turn the young ones. The percentage share of carps, large siluroids and miscellaneous fish species has changed drastically and interchanged their position in total catch. In sixties, it favored carps with over 46% share. In seventies and eighties their share declined to around 32% as it was replaced mainly by miscellaneous fish species (42-49%) and to some extent by siluroids. During last one decade, the share of miscellaneous fish reached the highest at above 54%, while for carps it reduced to minimum of 12%.

The quantity of the fish caught in many of the world's rivers is declining and species assemblages are being modified with the disappearance of some native species and the established of exotics (Welcomme 2006 a, Pathak et al 2011, Dwivedi et al 2016, Mayank et al 2018). Capture fisheries have reached or passed their sustainable yield in many rivers (Welcomme 2006 b, Nautiyal et al 2013). Fishermen prefer to

land large sized fish as it fetches higher price, which goes to show that fishing is market oriented thus influencing the landing pattern. When large sized fish become few in the stock fishermen land even the smallest size as was evident in *L. rohita*. The minimum size in catch was 10.5 cm for *L. rohita* compared with 16.0 cm for *L. calbasu* and 18.0 cm for *T. tor*. Fishing is the primary income generating activity for most families living along the bank of river (Asante 2006, Tiwari et al 2016). Though the fish markets at Banda (Kenriver), Karwi (Paisuni river) and Sadiapur/Gaughat (Tons river) were located far from each other, the pricing patterns were similar. Market prices depend on the weight (size) of the fish. Large-sized fishes were sold at higher price indicating that they have more economic value than the small-sized fishes of the same species. The important catfishes commanded highest price ranging from Rs. 40 to 100 Kg<sup>-1</sup>. The feather back and eels had low price tags (Rs. 25 to 50 Kg<sup>-1</sup>).

**Table 10.** Price of fish Kg<sup>-1</sup> from the fish market at Banda, Karwi and Sadiapur for the rivers Ken, Paisuni and Tons, respectively.

Category\ Fishes	Categories based on weight of fishes (in Kg.)					
	<0.5Kg.	<1.0Kg.	<1.5Kg.	<2.0Kg.	<3.0Kg.	<4.0Kg.
Species						
Major carps						
<i>Labeo rohita</i>	40	50	55	60	75	90
<i>Catla catla</i>	35	45	50	55	60	75
<i>Cirrhinus mrigala</i>	35	45	50	55	60	75
<i>Labeo calbasu</i>	30	40	45	50	60	0
Other carp						
<i>Tor tor</i>	35	45	50	55	60	70
Exotic carps						
<i>Cyprinus carpio</i>	30	35	45	50	55	65
<i>Ctenopharyngodon idella</i>	35	40	45	50	60	70
<i>Hypophthalmichthys molitrix</i>	35	40	45	50	60	70
Important catfishes						
<i>Aorichthys</i> spp.	40	50	60	70	80	100
<i>Wallago attu</i>	35	45	50	55	60	80
<i>Rita rita</i>	35	45	50	55	60	0
Other important species						
<i>Channa</i> spp.	30	35	50	60	70	0
<i>Notopterus</i> spp	25	35	45	50	0	0
<i>Mastacembelus armatus</i>	25	40	0	0	0	0
Miscellaneous	15-40 Kg <sup>-1</sup>					



Among the major carps, maximum price was commanded by *L. rohita* followed by *C. catla* and *C. mrigala*. The market price of *L. rohita* varied from Rs. 40 to 90 Kg<sup>-1</sup> for fishes weighing < 0.5 Kg to < 4.0 Kg. In case of the exotic carps it varied from Rs. 30 to 70 for fishes < 0.5 to < 4.0 Kg, respectively. In miscellaneous group a range of Rs. 25 to 40 Kg<sup>-1</sup> was recorded according to the species and size (Table 10). Two measures of central tendency, the mean and the median were computed to ascertain that the value represented the data. Except for some species the mean was slightly higher than the median and their values differed slightly (Figs. 7 a-b). The *Aorichthys* spp. commanded the highest median price of Rs. 65.0 Kg<sup>-1</sup>. The carps had lesser market value. Among

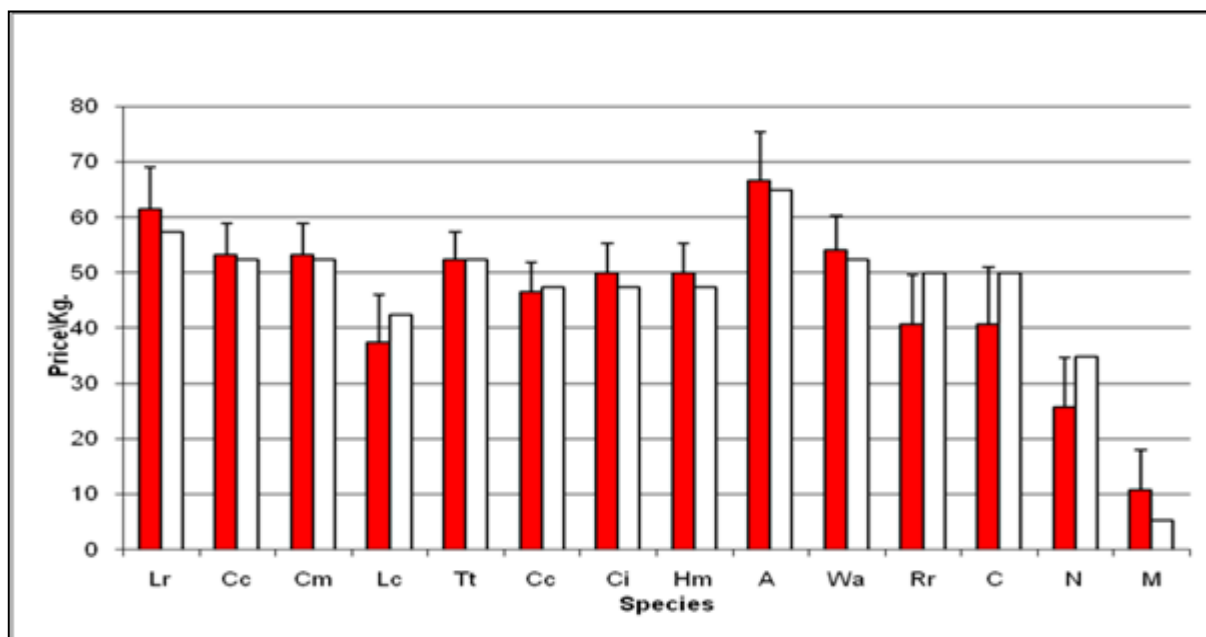
them *L. rohita* was sold at the median price of Rs. 57.5 Kg<sup>-1</sup> compared with Rs. 52.5 for the other carp, being least (Rs. 42.5 Kg<sup>-1</sup>) for *L. calbasu* (Fig. 7a). Steady pricing pattern i.e. less variation was observed for all carps except *L. rohita* among the major carps. Considerable variation was observed in the market price of each species, especially *Channa* spp, *R. rita*, *Aorichthys* spp., *L. calbasu* and *L. rohita*. This was reflected in the mean and standard error values (Fig. 7 b). The minimum-maximum and range were also indicative. Kurtosis shows negative value in *L. rohita* and *T. tor* while positive in *L. calbasu*. Skewness was negative in *L. calbasu* while positive in *L. rohita* and *T. tor* (Table 11).

**Table 11.** Descriptive statistics for pricing pattern in fish market at Banda, Karwi and Sadiapur in case of the Ken, Paisuni and Tons rivers, respectively.

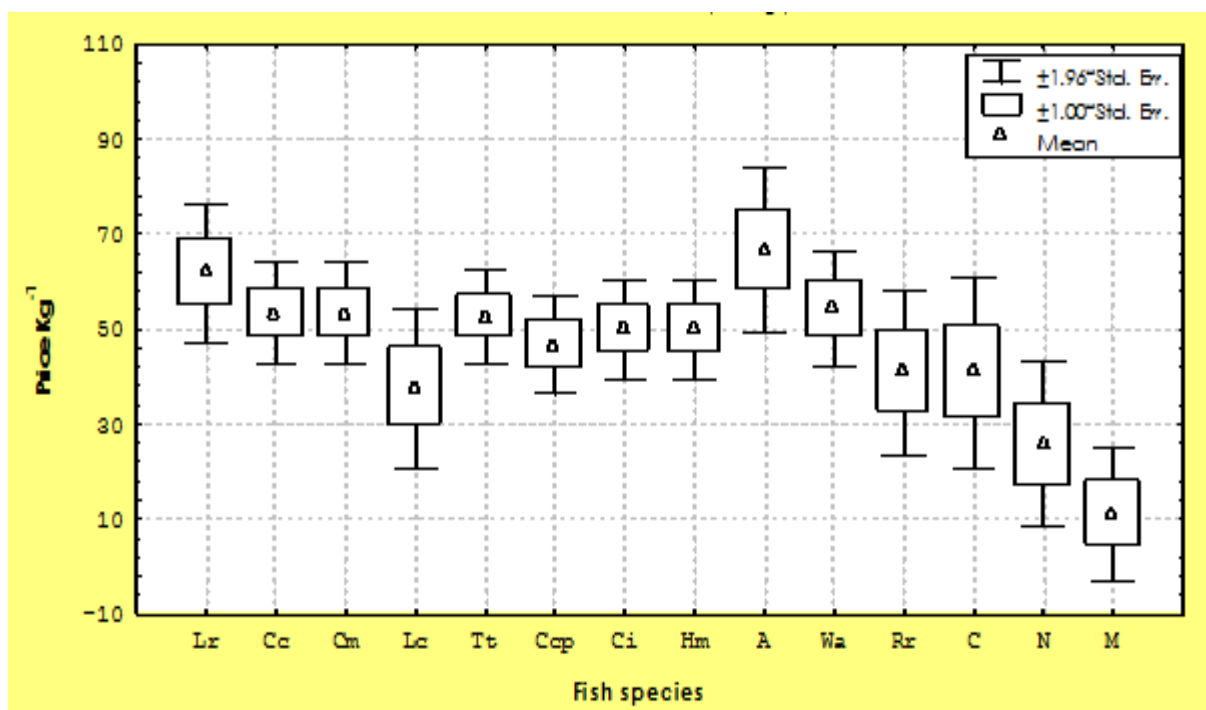
Descriptives	Lr	Cc	Cm	Lc	Tt	Cc	Ci	Hm	A s	Wa	Rr	C s	N&C	Mi
Mean	61.7	53.3	53.3	37.5	52.5	46.7	50	50	66.7	54.2	40.8	40.8	25.8	10.8
Standard Error	7.38	5.58	5.58	8.54	4.96	5.27	5.32	5.32	8.82	6.25	8.98	10.19	8.89	7.12
Median	57.5	52.5	52.5	42.5	52.5	47.5	47.5	47.5	65	52.5	47.5	42.5	30	32.5
Minimum	40	35	35	30	35	30	35	35	40	35	35	30	25	25
Maximum	90	75	75	60	70	65	70	70	100	80	60	70	50	40
Range	50	40	40	30	35	35	35	35	60	45	25	40	25	15
Kurtosis	-0.24	0.59	0.59	2.03	-0.01	-0.9	-0.65	-0.65	-0.3	1.27	2.97	0.33	-1.97	-0.05
Skewness	0.66	0.43	0.43	-1.29	0	0.08	0.61	0.61	0.46	0.8	-1.67	-0.71	-0.36	

**Acronyms**

Lr= *Labeo rohita*; Cc= *Catla catla*; Cr= *Cirrhinus mrigala*; Lc= *Labeo calbasu*, Tt= *Tor tor*; Ccp= *Cyprinus carpio*; Ci= *Ctenopharyngodon idella*; Rr= *Rita rita*; Hm= *Hypophthalmichthys molitrix*; A= *Aorichthys* spp; Wa= *Wallago attu*; Cs= *Channa* spp; N&C= *Notopterus* & *Chitala*; Ms= *Mastacembelus armatus*; M= Miscellaneous. MC= Major carps; OC= Other carp; EC= Exotic carps, IC= Important catfishes; OIF= Other important fishes; Mis= Miscellaneous; De= December; Jan= January; Feb= February; A= April; Ju= June



**Fig. 7a.** The bars depicting the mean (bars with error bars) and median price of fishes. The median price was higher than mean price in the *L. calbasu*, *C. carpio*, *R. rita*, *C.spp* and *N. notopterus* and *C. chitala*. Acronyms as in Table 11.



**Fig. 7b.** The box and whisker showing mean price of important fishes. Acronyms as in Table 1



Among the fish landings in the Ken, Paisuni and Tons R. maximum price was recorded for *L. rohita* among carps and *Aorichthys* spp. among catfishes. The mean price was 66.7 Kg<sup>-1</sup> for *Aorichthys* spp. The mean price for the major carps *L. rohita*, *C. catla*, *C. mrigala* and *L. calbasu* was estimated to be 61.7, 53.3, 53.3 and 37.5 Kg<sup>-1</sup> while that of *T. tor* and *C. carpio* was 52.5 and 46.7 Kg<sup>-1</sup>, respectively. In the present study *L. rohita* and *Aorichthys* spp. were highly priced (mean value) fish. *T. tor* and *L. calbasu* were considered to be of moderate economic value of which latter was least priced. *C. catla*, *C. mrigala* and *W. attu* were identically priced. The information on the market price was used to classify the fishes into three categories based on the median and mean price (i) high economic value *Aorichthys* spp, *L. rohita* (ii) moderate economic value, *C. catla*, *C. mrigala*, *T. tor*, *C. idella*, *H. molitrix*, *W. attu*, *R. rita* and (iii) low economic value, *L. calbasu*, *C. carpio*, *Channaspp*, *N. notopterus*, *C. chitala* and *Mastacembelus* spp. Since carps were the focus for the present study, one species from each category respectively, was considered viz. *L. rohita*, *T. tor* and *L. calbasu*. The preferences are indeed creating a pressure on the fishery leading to overexploitation.

Observation made during 1986-1990 and 1991-1995 (Katiha et al 1998) showed that the carps commanded higher price (Rs. 21.69 and 33.42) than catfishes (Rs 18.77 and 30.52). They found that among the commercially important species, the percentage increase in prices and annual growth rates were higher for the catfishes (62.59 and 10.69%) than carps (54.10 and 8.91%). Across different size groups of catfishes and carps, the highest increase in fish price was for large sized fishes at 13.91% and 9.13% as compared to 11.55% and 5.31% for medium and 10.88% and 8.49% for small sized fishes, respectively. The reduction in quantum of the landings and increase in prices for riverine fish harvest maintained almost status quo for its value. Sultan (2005) observed that the fish market of Uttar Pradesh suffer from a weakness in the most essential component, that of organized marketing.

The fishermen need to be paid remunerative prices on one hand and make fish product available to the consumer at reasonable price on the other. Wholesale markets are very few and retailing unorganized. The fishery sector is considered to be more organized where the catch comes to the whole-sale dealer and less organized or unorganized if fishermen or contractors dispose of the catch locally. There is an organized market for the sale of fishes in case of the Ken (at Banda) only, though some fishermen resort to direct selling of the catch. In case of Paisuni catch is disposed of locally or at fish market in Karwi, while in Tons the catch is brought to Allahabad (Sadiapur) or disposed of locally.

In India, the fish catch is primarily marketed in fresh condition in case of riverine fishery. At present, there is no organized body at national level to regulate and channelize fish market in the country. The fish trade is mostly dominated by the middlemen. The fresh water fish marketing is more or less constant (64.2 to 71.7%) from 1977 to 1999 (Sisodia 2001). Fish price depends on the weight (Dwivedi et al 2004). The increase in price across small to large size groups was also observed by Katiha and Chandra (1990) and Mayank and Dwivedi (2015).

The nutritive value of all species of fish may be almost same but there are different types of market demand and prices for various species (Kurien and Mathew 1982). The price of fish also affects the landing of the fishes through fishing preferences and they change the composition of species in the river (Singh et al 1998, Nautiyal et al 2005, Dwivedi and Nautiyal 2010). A species is harvested on a local scale and market is established, providing profit. Others then become interested in exploiting the species to get a share of the profit. As the stocks start to decline and become difficult to harvest, raising prices for the consumer and competition among the harvesters (Pullin, 2002).

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