Framework and sustainable audit for the assessing of the Ganga river ecosystem health at Allahabad, India

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ABSTRACT : Fishes are a prominent feature in most national economics and employments. Riverine ecosystems present unique opportunity to employment of fishers and youth community in the Ganga basin, India. Present study was undertaken to fish catch from the middle stretch of the Ganga river at Allahabad, India during the period July 2014 to June 2015. Annual fish landing demonstrated that the catch was dominated by miscellaneous group (22.16 kg day^{-1}) followed by *Oreochromis niloticus* (12.76 kg day^{-1}) and *Sperata seenghala* (12.63 kg day^{-1}) and they accounted for 23.19 per cent, 13.36 per cent and 13.21 per cent, respectively. In case of Indian major carps, *Cirrhinus mrigala* shared maximum contribution with 7.73 kg day^{-1} (8.09%). *Catla catla* and *Labeo rohita* shared 1.45 (1.51%) and 2.35 kg day^{-1} (2.46%), respectively. The landing of fishes fluctuated from season to season from the Ganga river at Allahabad, India. For conservation point of view *Cyprinus carpio* and *O. niloticus* species should be monitored in the Ganga river. Both species are very harmful for the Ganga river ecosystem.

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Allahabad forms a crossway between upper and lower stretch of the Ganga river because largest tributary of the river (the Yamuna river) confluent here. Due to its topography (e.g. low altitude) and zoography, the Allahabad exhibits large differences in upper and lower stretches (Pathak *et al.,* 2015 and Mayank *et al.,* 2016). Productivity of river and species richness is classically increased with decreasing altitude (Dwivedi *et al.,* 2004; 2007; Zhao *et al.,* 2006 and Anupama *et al.,* 2006), climatic factors (Davies *et al.,* 2010; Dwivedi and Nautiyal, 2010 and Koehn 2015), choice of capture (Deiner *et al.,* 2015 and Mayank and Dwivedi 2016a) and largest size of fishes (Tripathi *et al.,* 2015 and Imran *et*

al., 2015 and Dwivedi and Mayank, 2017). The Ganga river has two most important fish species (e.g. *Cyprinus carpio* and *Oreochromis niloticus*) for homogenization of worldwide freshwater fisheries (Rahel, 2000 and 2007; Pathak *et al.,* 2015; Dwivedi and Jha, 2013; Mayank and Dwivedi, 2015 and Villéger *et al.,* 2014). The story of non-native species has been powerfully advocated as a leader of biodiversity loss (Sagoff, 2007; Gozlan and Newton, 2009; Dwivedi *et al.,* 2011 and Kumar *et al.,* 2013). *C. carpio* is well established in the Ganga river basin (Dwivedi *et al.,* 2016b). Furthermore, *C. carpio* have the highest probability to increase their stability in other Indian river basin.

Due to industrialization day by day more and more industrial waste and effluent enters into water which pollute streams/rivers as well as other inland water bodies (Tiwari *et al.,* 2013 and 2016). Due to pollution in the river, the species composition, abundance and landing of fishes are frequently changed in huge degree (Pathak *et al.*, 2015; Dwivedi *et al.*, 2007, Tiwari and Dwivedi, 2014 and Dwivedi *et al.,* 2016c). The productivity of fishes is good indicator for the health of the river. Fish is rich source of protein, vitamins and minerals (Tiwari *et al.*, 2014 and Dwivedi *et al.*, 2015) with food security (Dwivedi *et al.*, 2014 and Pathak *et al.*, 2014). The world natural fishery systems are collapsing as a direct result of overfishing and overcapacity of fishing fleets (Yakubu *et al.*, 2011; Mayank and Dwivedi, 2016b and Dwivedi and Mayank, 2017). The fish species contributing significantly to fishery have always been assessed through landings, largely to explain the fishery trends well exemplified by the riverine landings monitored regularly for the Ganga river as well as Yamuna river at Allahabad by Gupta and Tyagi (1992); Singh *et al.* (1998); Vass *et al.* (2010); Pathak *et al.* (2011; 2013 and 2015), Mayank and Dwivedi (2015b); Jha *et al.* (2016) and Dwivedi *et al.* (2016c). The objective of the present study was to give recent landing data regarding the Ganga river ecosystem health at Allahabad.

EXPERIMENTAL METHODOLOGY

Study was undertaken during the period July 2014 to June 2015. For the purpose of collection of data on fish landing Teliarganj fish market was chosen it is a major landing center for the Ganga river at Allahabad .Fishing was conducted by local fisherman with the help of using drag net, gill net, cast net, scoop net and hook and line. For collection of data Teliarganj fish market was visited evening time. The data was collected species-wise (in case of commercially important fishes *viz., Catla catla, Labeo rohita, Cirrhinus mrigala, L. calbasu, C. carpio, O. niloticus, Sperata aor, S. seengala, Clupisoma garua, Eutropiicthys vacha, Wallago attu, Rita rita, Bagarius bagarius* and *Mastacembelus armatus*) and rest recorded miscellaneous. For the purpose of collection of data a stratified sampling design was adopted (Tyagi and Mandal, 2008). A month was divided in four strata of seven or eight consecutive days, depending upon the month and from each stratum data was collected for two randomly selected days. Data was

collected day unit.

Catch structure :

Catch is a suitable indicator of population size. Catch day^{-1} 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^{-1}:

Catch day^{-1} was hence, assessed to understand the exploitation patters (landings). In the present study day unit vendor was used to determine the Catch day^{-1}. The sampling day and pooled. The landings of that day were represented by pooled data. In order to obtain catch day^{-1}, 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 vendors was added so as to obtain an estimate of the total catch on one day, hence forth termed as catch day^{-1}. A monthly value (Mean, SE, median and others) was obtained by computing descriptive statistics (MS Excel 5.0) from the catch day^{-1} recorded during the number of sampling days in the particular month.

EXPERIMENTAL FINDINGS AND DISCUSSION

The fish landing data was recorded from Teliarganj fish market on sampling day and estimates were derived. According to groups, catfishes were dominated as compared to miscellaneous and exotic carps in winter, summer and monsoon seasons, respectively (Fig. 1). Catfishes group was also dominated in annual landing (41.75%) from the Ganga river at Allahabad, India. Exotic carp and miscellaneous groups were shared also massive proportion (Fig. 2). Indian major carp stocks overexploited from the Ganga river at Allahabad. Global fishery resources are facing various threats, which have predominantly been attributing to the commercial and profitable exploitation (Watson *et al.*, 2003; Pauly *et al.*, 2003 and Dwivedi *et al.*, 2014).

Miscellaneous fishes was a dominant component in winter season (21.94 kg day^{-1}, 24.38) followed by *S. seenghala* (16.48 kg day^{-1}, 18.31%), *O. niloticus* (11.42
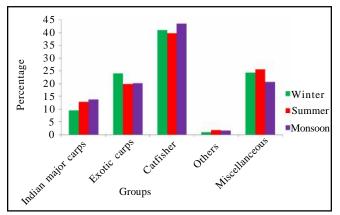
Fig. 1 : Seasonal variation of landing structure of fishes from the Ganga river at Allahabad
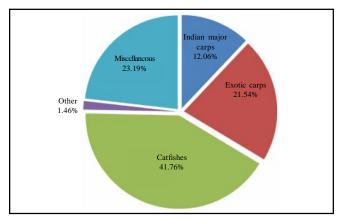

Fig. 2 : Catch structurea accoding to groups from the Ganga river at Allahabad

kg day^{-1}, 12.68%) and *C. carpio* (10.21 kg day^{-1}, 11.35%) in total catch. Miscellaneous fishes was constituted one fourth of the total landing in winter season (Table 1). In case of Indian major carps, seasonal average catch of *C. mrigala* shared maximum (5.79 kg day^{-1}). Winter season average catch was 1.35 kg day^{-1} for *C. catla* (1.51%) and 1.47 kg day^{-1} (1.63%) for *L. rohita*. The *S. aor* 7.70 kg day^{-1} formed a sizable part (8.55%) in total catch. *R. rita, B. bagarius, L. calbasu* and *M. armatus* accounted small proportion (Table 1). Miscellaneous was dominant fishes in summer season (28.67 kg day^{-1}, 25.57%) followed by *O. niloticus* (14.47 kg day^{-1}, 12.90%) and *C. carpio* (7.79 kg day^{-1}, 6.95%) in total catch. In case of Indian major carps, average catch of *C. mrigala* shared maximum contribution (8.47 kg day^{-1}, 7.55%). *E. vacha* was contributed (10.19 kg day^{-1}, 9.09%) maximum in important catfishes group. Seasonal average catch was 1.37 kg day^{-1} for *C. catla* (1.23%) and 4.70 kg day^{-1} for *L. rohita* (4.19%). *S. aor* formed a sizable part of the total catch (Table 1). Miscellaneous fishes were dominated in monsoon season (19.21 kg day^{-1}, 20.71%) followed by *O. niloticus* (13.20 kg day^{-1}, 14.23%) and *Sperata seenghala* (11.73 kg day^{-1}, 12.65%). In case of Indian major carp, *C. mrigala* was contributed maximum (37.65 kg day^{-1}). *C. garua* contributed 7.10 kg day^{-1} (7.66%) maximum in important catfishes group. *S. aor* (4.36 kg day^{-1}), *R. rita* (4.43 kg

Table 1 : Seasonal variation in the catch (%age) of important species in the Ganga river at Allahabad

Fish species	Winter		Summer		Monsoon		Annual	
	Av. catch /day (kg)	%	Av. catch /day (kg)	%	Av. catch /day (kg)	%	Annual av. catch /day (kg)	%
C. Catla	1.35	1.51	1.37	1.23	1.57	1.69	1.45	1.51
L. rohita	1.47	1.63	4.70	4.19	2.03	2.19	2.35	2.46
C. mrigala	5.79	6.43	8.47	7.55	9.20	9.92	7.73	8.09
C. carpio	10.21	11.35	7.79	6.95	5.57	6.00	7.82	8.18
O. niloticus	11.42	12.68	14.47	12.90	13.20	14.23	12.76	13.36
S. seenghala	16.48	18.31	7.00	6.24	11.73	12.65	12.63	13.21
S. aor	7.70	8.55	1.41	1.26	4.36	4.70	5.06	5.30
C. garua	2.31	2.57	9.76	8.71	7.10	7.66	5.78	6.04
E. vacha	2.86	3.18	10.19	9.09	6.66	7.18	5.89	6.17
W. attu	4.03	4.48	7.19	6.41	5.21	5.62	5.15	5.39
R. rita	1.97	2.18	4.15	3.70	4.43	4.78	3.42	3.58
B. bagarius	1.57	1.75	4.92	4.38	0.91	0.98	1.97	2.06
L. calbasu	0.66	0.73	0.81	0.72	1.28	1.38	0.94	0.99
M. armatus	0.22	0.24	1.23	1.10	0.27	0.29	0.44	0.46
Miscellaneous	21.94	24.38	28.67	25.57	19.21	20.71	22.16	23.19

day^{-1}), *W. attu* (5.21 kg day^{-1}), *R. rita* (4.43 kg day^{-1}) formed a sizeable fisheries of the total catch. *B. bagarius, L. calbasu, Mastacembalus armatus* accounted small proportion (Table 1).

Analysis of annual data on fish landing showed that *O. niloticus* and *C. carpio* have powerfully invaded in the middle stretch of the Ganga river at Allahabad in a bigway. The estimated annual catch was dominated by miscellaneous group (22.16 kg day^{-1}) followed by *O. niloticus* (12.76 kg day^{-1}) and *S. seenghala* (12.863 kg day^{-1}) and they accounted for 23.19 per cent 13.36 per cent and 13.21 per cent, respectively (Table 1). Annual estimates of landing data indicated that the Ganga river at Allahabad region was most suitable for the miscellaneous group. In case of Indian major carps, *C. mrigala* showed maximum contribution (7.73 kg day^{-1}, 8.09%). *Catla catla* and *L. rohita* shared (1.45 kg day^{-1}) and 2.35 kg day^{-1}, respectively (Table 1) in total catch. The average catch was 5.89 kg day^{-1} for *E. vacha* (6.17%), 5.78 kg day^{-1} for *C. garua* (6.04%), 5.15 kg day^{-1} for *W. attu* (5.39%), 5.06 kg day^{-1} for *S. aor* 5.3 per cent 3.42 kg day^{-1} for *Rita rita* (3.58%) and 1.97 kg day^{-1} for *B. bagarius* (2.06%). The *L. calbasu* was contributed low amount (0.94 kg day^{-1}, 0.99%) of the total catch. The contribution of *M. armatus* was also very low quantity 0.44 kg day^{-1} (0.46%).

Singh *et al.* (1998) found that *A. aor* and *A. Seenghala* were dominant fish species (45.2%) compared with miscellaneous (28.2%) and *L. calbasu* (14.6%) in the Ganga and Yamuna rivers at Allahabad. The *L. rohita*, *C. catla* and *C. mrigala* contributed small proportions 2.5 per cent, 3.2 per cent and 1.5 per cent, respectively showing a decline in their fishery. The miscellaneous group, the share of which declined from 75.62 per cent in 1985 to 48.33 per cent in 1986, primarily dominated the fishery of the Ganga at Patna *A.aor, A. seenghala* and *W. attu* which contributed in sizeable amounts among catfish increased from 1985 to11986 (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., *W. attu* contributed 29.38 per cent and 19.87 per cent, 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 per cent in the Ganga. Pathak *et al.* (2011) also reported that the *O. niloticus* and *C. carpio* well stable in 2008

and 2009. Due to miscellaneous stressor operation on the Ganga river, remarkable alterations have been listed in its fisheries and landing (Jha *et al.*, 2016 and Dwivedi *et al.*, 2016b).

It may be concluded that the Ganga river at Allahabad mainly roofed by miscellaneous fishes and one exotic fish species (*O. niloticus*). The Landing data of the Ganga river also indicated that the ecological condition of the river is very suitable for small size of fishes including *O. niloticus* (upto 38 cm). The river Ganga is known as original adobe of the valuable Indian major carp. The landing of Indian major carp has significantly declined through step wise. The seasonal variation is also highly monitored to the landing from the river. *C. carpio* and *O. niloticus* species are provide proper occupation and food security for fishermen community from the Ganga river at Allahabad. For the physical condition of the river and native fish stock restoration (e.g. habitat restoration) is very immediately require for Indian major carp at Allahabad, India.

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