

PRESENT STATUS OF FISH DIVERSITY AND POPULATION ABUNDANCE OF SELECTED FISH SPECIES IN BHAGIRATHI RIVER AT UTTARAKHAND

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Abstract: Bhagirathi River is one of the largest tributaries of river Ganga in India and sustains a rich fish biodiversity as cold water fishery resources. The present study aimed to study the current status of fish species and population abundance of selected fish species in the Bhagirathi River at Uttarakhand. During the present study, a total of 19 fish species belonging to 4 families were reported. *Schizothorax* and *Tor* fish species (Cyprinidae family) were the dominant species (>50 % of the total fish catch) in the riverine segments of the river Bhagirathi, while *Cyprinus carpio* (common carp) is the dominant species in the impoundment segment of Tehri reservoir. Few other fish species of *Barilius*, *Garra*, and *Glyptothorax* etc. also have been recorded during the study. The comparison of the present result with earlier reports delighted that endemic fish fauna have to be diminished with the progression of time in the Bhagirathi river system, which may be because of debasement and fractures of riverine natural habitats caused by various natural and anthropogenic activities. The environmental change in the natural water flow pattern of rivers and hydrological characteristics, including indiscriminate fishing practices and other natural calamities is the main factors for decline the fishery resources in Bhagirathi River.

Keywords: Fish diversity, abundance, Bhagirathi River, Uttarakhand.

INTRODUCTION

Biodiversity is basic for adjustment of a biological system, ensuring of general condition, quality and for understanding the natural worth of all species on earth. The fish fauna diversity has its significance like other aquatic and terrestrial animals. Fishes involve all the conceivable natural habitats of the aquatic ecosystem. The Ganges river system along with its tributaries forms the single largest riverine system in India. The main stream of the river Ganga, the Bhagirathi originates from the ice cave of Gaumukh (33° 55'N, 79°07'E) at the snout of the Gangotri glacier in the Garhwal portion of Western Himalaya, at an elevation of about 4100 meters. The Alaknanda, the sister streams of Bhagirathi rises beyond Mana pass, 8 km from Badrinath (33° 44'29''N, 79°29'41''E, and 3123 m above msl) joins at Devprayag. It is below this confluence, the united stream is known as Ganga. The lotic ecosystem of Bhagirathi river is characterized by cold water, high water velocity, low productivity and distinct aquatic biodiversity with abundant rapids, runs, riffles and few deep pools. The bottom substrates are mostly bedded rocks, boulders, cobbles, pebbles and coarse sand, which is quite different from the lentic region. Ichthyofauna of Garhwal region have been carried out by many workers, Badola, 1975^[3]; Dobriyal, 1983^[6]; Tilak and Baloni, 1983^[20]; Sharma, 1984^[14]; Singh *et al.*, 1987^[17]; Lakra *et al.*, 1987^[9]; Dobriyal 1991^[6]; Khanna and Badola, 1991^[8]; Singh *et al.*, 1993^[18]; Agarwal *et al.*, 2005^[1]; Agarwal *et al.*, 2011^[2]; Bisht *et al.*, 2009^[4]; Malik and Negi, 2007^[10]; Malik, 2011^[11]. Construction of dam and barrages on rivers for hydroelectric power generation, irrigation, and navigation purposes have interfered with the riverine environment, inevitably affecting the fishery resources of the rivers. The existing dam or barrages are an alarming threat to food and feeding habits, spawning biology and fish migration. They are altering magnitude, chronology, quality of streams flows below dams and affecting fish stocks. Considering this, the present study is made to reevaluate the status of fish diversity of the Bhagirathi River, due to degradation and fragmentation of river habitats due to natural and anthropogenic activities.

MATERIALS AND METHODS

Study area: The present study was carried during the period of one year from September 2016 to August 2017. Four sampling (Z1, Z2, Z3, and Z4) zones were selected on upstream and downstream of the Tehri dam of Bhagirathi River at the distance of about 136 Km.

Zone	Name of sampling zone	Distance
Z1	Upper Bhagirathi river Basin	35Km
Z2	Pre impoundment of Tehri reservoir	36Km
Z3	Post impoundment of Tehri reservoir	21Km
Z4	Lower Bhagirathi river Basin	44Km

Sampling zone Z1 (Upper Bhagirathi river Basin) was selected from Bandra koti (30°30'16.99 N longitude, 78°23'04.08 E latitude) to Jhinwali (30°27'01.96 N longitude, 78°25'51.41 E latitude), Sampling zone Z2 (Pre impoundment of Tehri reservoir) is from Jhinwali to Tehri (30°24'29.03 N longitude, 78°27'30.08 E latitude), Sampling zone Z3 (Post impoundment of Tehri reservoir) from Tehri to Koteshwar (30°15'12.90 N longitude, 78°31'27.11 E latitude), Sampling zone Z4 (Lower Bhagirathi river Basin) from Koteshwar to Devprayag (30°14'63.15 N longitude, 78°59'82.51 E latitude) as in fig.1 .

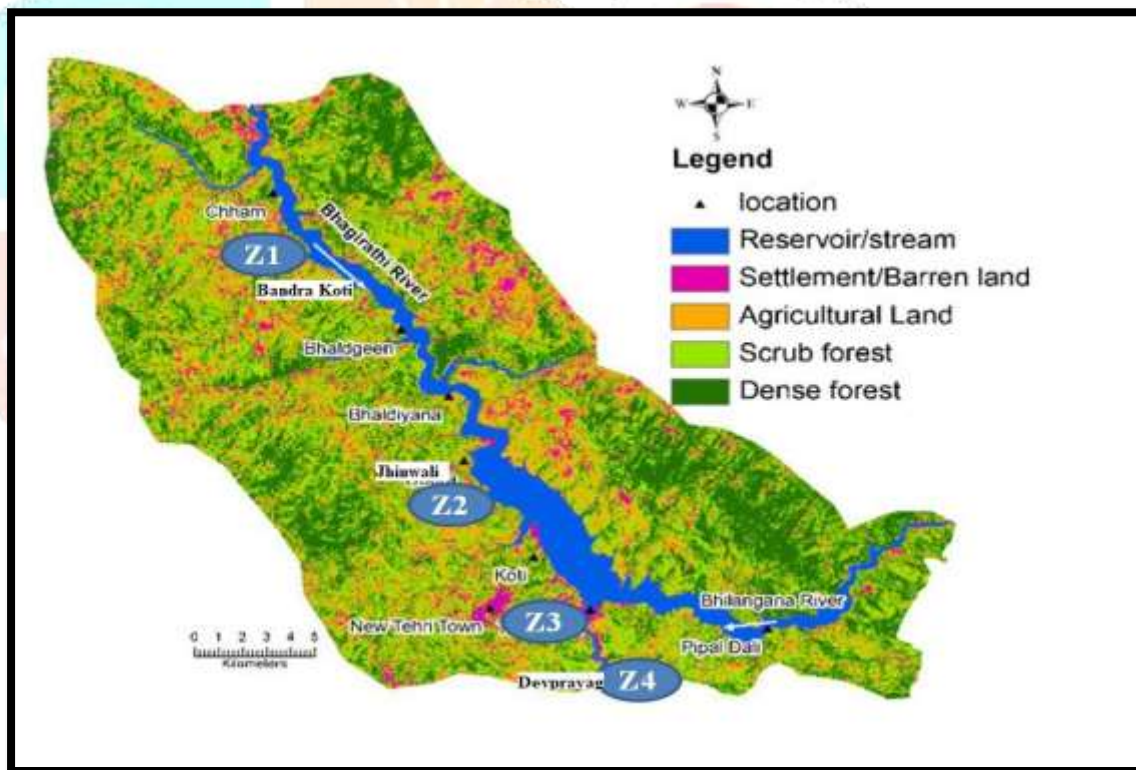


Fig. 1: LULC Map of selected sampling zones on Bhagirathi River

Sample collection and Identification

Experimental fishing was carried out in all sampling zones with the help of a locally hired professional fisherman. Fish species were collected with gill nets (mesh size 2.5 × 2.5cm; 3 × 3cm; 7 × 7cm; length × breadth = 75 × 1.3m; 50 × 1m), cast nets (mesh size 0.6 × 0.6 cm), drag nets or locally called mahajal and indigenous nets using nylon mosquito nets tied to the bamboo in both ends. At all zones, all the gears except cast nets were used at least ten times during each sampling occasion. The cast nets (5.5 m²) were operated 20 times at each zone covering about 100² meter of river segment allowing 3-5 minutes settled times in each cast. The relative

abundance (percent of catch) of fish across different zone was calculated. Relative abundance of individual species was calculated by the following formula.

$$RA = \frac{\text{Number of sample of particular species} \times 100}{\text{Total number of samples}}$$

The catch composition and catch per unit effort were estimated applying following method.

$$\text{Catch per unit effort (CPUE)} = \frac{\text{total weight of catch}}{\text{Number of persons} \times \text{hrs. of fishing}}$$

Captured fish samples were released after recording the data except for a few individuals which needed to confirm species identifications in the laboratory. The fish caught were collected and preserved in 10% formalin solution and transferred to the laboratory and stored in specimen jars. All the specimens were identified in the laboratory using standard references like Day (1994)^[5], Talwar and Jhingran (1991)^[19], Jayaram (1999)^[7] and scientific names were verified using <http://www.fishbase.org>^[21]. The colour spot, if any, maximum size and other characters (morphometric and meristics) of the fish sample caught were measured. The fish finder model-GARMIN -160C was also operated in the reservoir area, which is helpful to found fish species in different depth of the reservoir. The percentage cover of different sized substrate within Surber quadrat was estimated visually using the substrate size classes (Boulders >256mm; cobbles: 64-256mm; gravel: 2-64mm and Sand: 0.06-2.0mm).

RESULTS

Table.1: Physiographic variables of Bhagirathi river at the selected sampling zones.

Physiographic variables	Zone 1	Zone 2	Zone 3	Zone 4
Embankment	Good riparian vegetation	Devoid of riparian vegetation	Devoid of riparian vegetation	Good riparian vegetation
Boulders (>256mm)	30%	65%	50%	39%
Cobbles (64-256mm)	36%	17%	15%	32%
Pebbles (16-64mm)	24%	8.0%	7.0%	7.0%
Gravels (2-16mm)	9%	3.0%	3.0%	7.0%
Sand (<2mm)	1.0%	2.0%	2.0%	3.0%

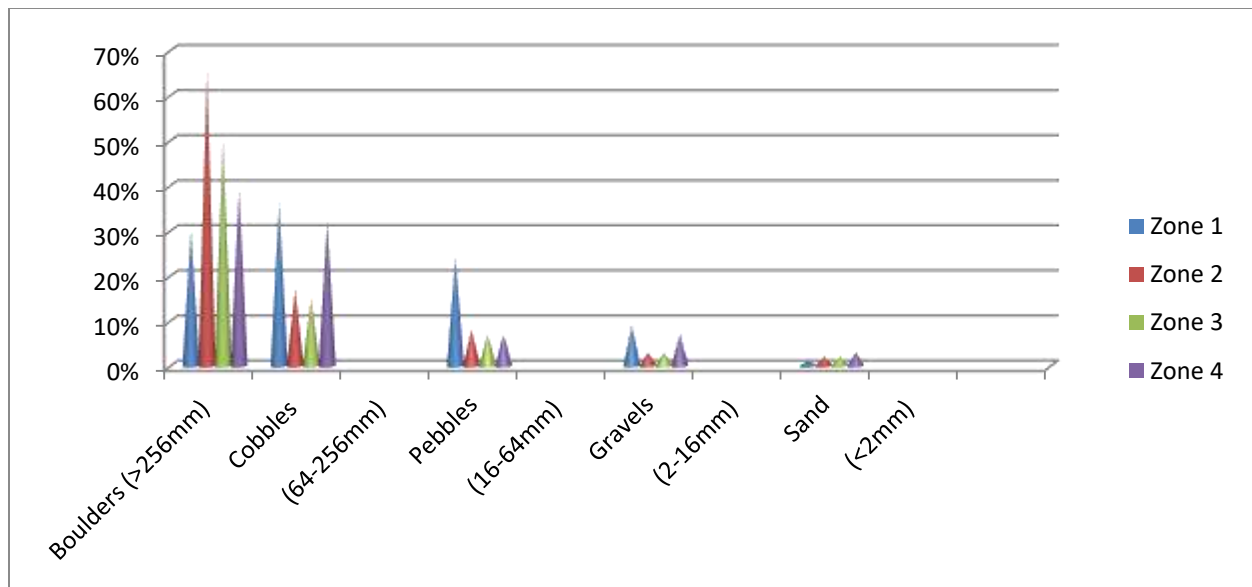


Fig.2: Graph depicting physiographic variables of selected sampling zones

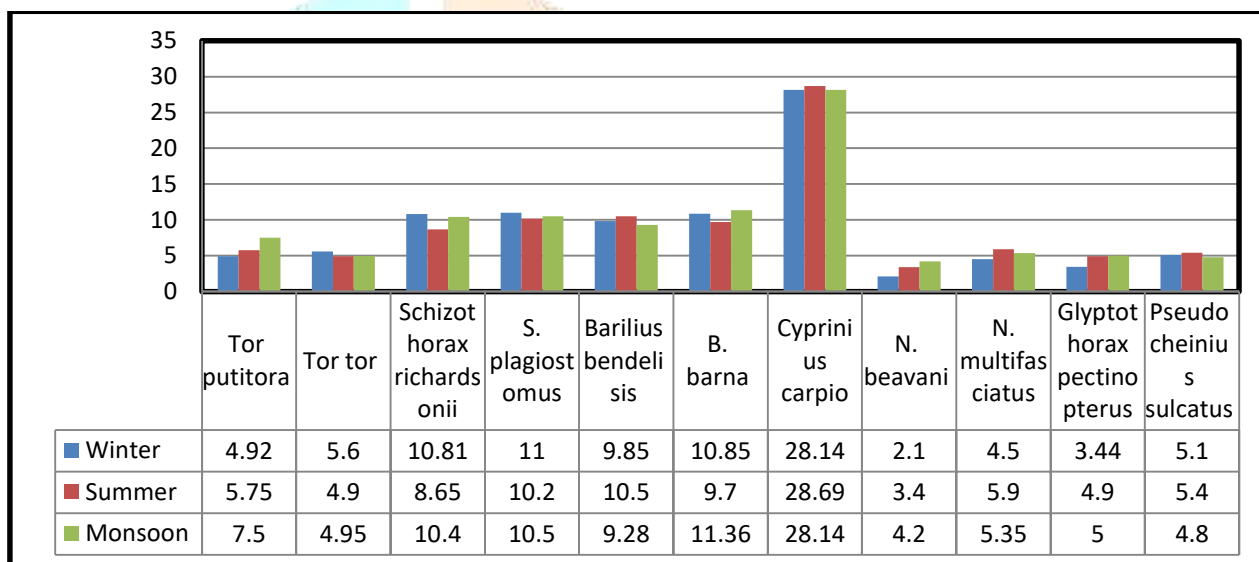
Table.2: Status of Piscine faunal diversity in selected zones of river Bhagirathi

Name of fish Species	Local name	Sampling zones			
		Zone 1	Zone 2	Zone 3	Zone 4
Family – Cyprinidae					
<i>Tor puitora</i>	Mahseer	c	c	c	c
<i>Tor tor</i>	Mahseer	r	r	r	r
<i>Schizothorax richardsonii</i>	Maseen	a	n	n	c
<i>S. plagiostomus</i>	Maseen	a	n	n	a
<i>S. sinatus</i>	Asala	a	n	n	a
<i>S. progastus</i>	Maseen	r	r	r	r
<i>S. curviformes</i>	Chongu	r	n	n	r
<i>Barilius bendelisis</i>	Fulra	c	n	n	c
<i>B. barna</i>	Gunthala	c	n	n	r
<i>B. vagra</i>	Fulra	r	n	n	c
<i>Garra gotyla goytla</i>	Gunthala	r	n	n	r
<i>Cyprinus carpio</i>	Common carp	n	a	a	n
Family – Cobitidae					
<i>Noemachelius rupicola</i>	Gadiyal	c	n	n	c
<i>N. multifasciatus</i>	Gadiyal	c	n	n	c
<i>N. beavani</i>	Gadiyal	c	n	n	c
<i>N. montanus</i>	Gadiyal	c	n	n	c
<i>N. Savone</i>	Gadiyal	c	n	n	c
<i>Botia dario</i>		c	n	n	c
Family- Sisoridae					
<i>Glyptothorax pectinopterus</i>	Kathruo	c	n	n	c
<i>Pseudocheinius sulcatus</i>	Kathruo	c	n	n	r

a= Abundant, c= Common, r= Rare, n= Nil

Table.3: Relative abundance (%) of fish species in selected zones of Bhagirathi river in different seasons.

Name of fish Species	Relative abundance		
	Winter	Summer	Monsoon
Family – Cyprinidae			
<i>Tor putitora</i>	4.92	5.75	7.50
<i>Tor tor</i>	5.60	4.90	4.95
<i>Schizothorax richardsonii</i>	10.81	8.65	10.40
<i>S. plagiostomus</i>	11.0	10.20	10.50
<i>Barilius bendelisis</i>	9.85	10.50	9.28
<i>B. barna</i>	10.85	9.70	11.36
<i>Cyprinius carpio</i>	28.14	28.69	28.14
Family – Cobitidae			
<i>N. beavani</i>	2.10	3.40	4.20
<i>N. multifasciatus</i>	4.50	5.90	5.35
Family- Sisoridae			
<i>Glyptothorax pectinopterus</i>	3.44	4.90	5.00
<i>Pseudocheinius sulcatus</i>	5.10	5.40	4.80

**Fig.3: R.A. (%) of fish species in selected zones of Bhagirathi river during a different season.****Table.4: Monthly CPUE (catch per unit day) kg of fish species in selected zones of river Bhagirathi**

Months	Zone 1	Zone 2	Zone 3	Zone 4
September	2-5	5-7	1-2	4-5
October	5-7	10-12	2-4	5-6
November	-	10-15	-	6-12
December	-	13-16	-	10-15
January	1-2	15-20	3-5	12-15
February	4-6	17-24	3-4	13-19
March	6-10	18-25	5-10	15-25
April	5-6	19-32	2-3	15-25
May	8-10	15-20	4-5	16-26
June	10-12	10-15	5-7	22-28
July	2-4	10-13	3-5	10-15

DISCUSSION

Physiographic characteristics of sampling zones

The physiographic variable of Bhagirathi river at all the four sampling zones has been presented in table 1. The zone Z1 was covered with good riparian vegetation and the bottom substrate covered with 30% boulders, 36% cobbles, 24% pebbles and 1% sand. The sampling zone Z4 was also covered with good riparian vegetation and the bottom substrate covered with 39% boulders, 32% cobbles, 7% pebbles and 3% sand. But the sampling zones Z2 and Z3 devoid of riparian vegetation and varying with bottom substrate, 65% boulders, 17% cobbles, 8% pebbles and 2% sand in zone Z2 while 50% boulders, 15% cobbles, 7% pebbles and 2% sand in zone Z3 as in fig. 2. Similar observation has been made by Sharma *et al.*, (2008)^[15] while working on the Preimpoundment study of Tehri reservoir.

Diversity, abundance, and CPUE of fish species

In the present investigation 19 fish species belonging to 4 families and 9 genera have been recorded from the different natural habitat of rapids, riffles, run, falls and pools in a different section of river Bhagirathi (Table 2). Nautiyal *et al.*, (2013)^[13] reported fragmented information of the fish fauna in the Ganga river. Studies revealed that there is heterogeneity in habitat and natural attributes of all the selected zones. In zone Z1, water flow exuberantly because of high inclination, the river has a rough substratum with of all shapes and sizes estimated stones. Similar observation has been made by Malik *et al.*, (2018)^[12]. The torrentially flowing river has become almost stand still downstream to Jhinwali as it is impounded for the Tehri dam reservoir. The pattern of fish species dissemination and plenitude very fluctuated in this distinctive environment (lotic and lentic). Bist *et al.*, (2009)^[4] has reported that seasonal distribution and R.A. (%) of fish fauna are directly related to changes in water discharge, flow pattern and geometry of the river. During the study period family Cyprinidae was found dominant over Cobitidae family (representing total 6 species) and Sisoridae (representing total 2 species). The *Schizothorax* fish species was recorded most abundant fish species through all season. Species of *Tor* and *Pseudochenus* were also reported along with *Schizothorax* fish species but in minimal number, Species of the genus *Schizothorax* were observed abundantly while *Tor* and *Pseudochenus* species were procured in limiting the number (Agarwal *et al.*; 2011)^[2]. *Cyprinus carpio* (common carp) is also recorded overwhelming from the lentic habitat of this stream. Further *Noemacheilus* and *Barilius* spp. were also reported in some catch during the study. But the species of *Garra*, *Botia*, and *Glyptothorax* were found rarely only in few catches. The factors responsible for this decline are the unscientific and unsustainable angling strategies. Some formative exercises such as dam and road construction and other natural calamities like the antagonistic climate condition particularly in monsoon season which flow all eggs and small sized fish species. Cyprinidae family was dominant in the past and is still dominant at present, but the total fish catch has radically diminished with the progression of time. The fish catch of impounded zones of the river Bhagirathi (lentic environment) is found dominant by *Cyprinus carpio* followed by *Tor* fish species and the occasional occurrence of snow trout (Fig. 3). However, 19 species are found in the upstream as fast flowing meandering river having a rough bed with stones and rocks underpins the survival of different ways of life of fish species. During all season the relative abundance (%) of *Cyprinus carpio* was highest (in winter, 28.14%, in monsoon 28.69% and in summer 28.14%) as in table 3. In the zone Z1 the maximum catch (10-12 Kg) was in June and minimum catch (1-2 Kg) was in January. The catch was maximum 19-32 Kg) in April and minimum (5-7 Kg) in September at zone Z2. Similarly, in the zone Z3 the catch was maximum (5-10 Kg) in March and minimum (1-2 Kg) in September. At zone Z4 the catch was maximum (22-28 Kg) in April and minimum (4-5 Kg) in September (Table 4). The change in the river habitat (from riverine to lacustrine) has led the drastic changes in the fish species composition and distribution. Though in the lower zone stream has shallow run with stony, pebbly substratum perfect for small sized *Barilius* and *Noemacheilus* fish species. Similarly, observation has been made by Singh and Kumar (2000)^[16] while working on the ichthyofauna and ecology of hill stream of Garhwal Himalaya.

CONCLUSION

Based on the present study, it may be concluded that the Bhagirathi river hosts a number of fish species. During the study, nine genera and twenty species were recorded. The family Cyprinidae constituted the highest species number (11 species) in all the season followed by the family Cobitidae (6 species) whereas family Sisoridae constituted lowest species number (2 species). Fish catching percentage indicated the maximum relative abundance of *Cyprinus carpio* in the river. The Bhagirathi River is a good source of indigenous fish species. However, the fish fauna is at risk due to several anthropogenic activities like deforestation, overfishing, sand mining, and recreational activities. It was also observed that anthropogenic activity altering the fine tune of the river ecosystem and established as a major cause of habitat alteration and fish stock depletion and thus many of the species were rare. The present research data will be contributed significantly to assess the status of fishery resources and their fish population abundance in relation to design the fish conservation policies in the upland aquatic ecosystem.

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