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Distribution record on abundance of *Tor putitora* in Jammu waters

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Abstract
A detailed survey was conducted in some tributaries and streams of River Ravi and River Chenab during the period from March, 2012 to Feb, 2014 with a view to assess the status of *Tor putitora* in the Jammu region of Jammu and Kashmir State. The various water bodies scanned so far *Tor putitora* was recorded from River Tawi, Baba Dhansar stream, Banganga, Anji stream, Pahi stream, Jhajjar stream, Juni, Panjgrain, Duddhar nullah, Gambhir stream, Poni, Sunderbani of river Chenab and Ujh River, Basantar River Tarnah stream, Chadwal stream, Bheni and Ranjit Sagar dam of River Ravi. Over all the maximum percentage of mahseer population is recorded in Anji stream (37.54%) followed by Gambhir stream (34.46%), Pahi stream (34.20%), Ujh river (30.72), & Ranjit Sagar dam. In Jammu, present investigation however, emerges with a view point that *Tor putitora* is quite abundant in our local water bodies i.e., tributaries of Ravi and Chenab river which are otherwise also bestowed with great number of fish species. Also the effective conservation measures are suggested to sustain *Tor putitora* in Jammu region.

Keywords: Mahseer, population, diversity, *Tor*, Jammu, distribution

1. Introduction
Fresh water ecosystems harbour a rich diversity of species and habitats. In India, there are about 2,500 species of fishes, of which 930 freshwater and 1,570 marine, are estimated [1]. Cold water fishes refer to those members of the family Cyprinidae which inhabit streams, rivers, upland lakes and reservoirs having water temperature below 25 ^{0}C [2]. Indian uplands in the Himalayas and Peninsular Plateau harbour the incredible cold water fish community. The mahseer "The Anglers delight" is one of the important cold water fish groups that inhabit the pristine streams with high content of dissolved Oxygen [3]. India is blessed with some of the world's best game fishes like Mahseer. Mahseer is not a single biological species but an assortment of more than one genera including genus *Tor* being major component and *Neolissochilus* being other [3]. Mahseer (*Tor sp.*) are flagship fishes in south Asian Rivers. Taxonomy of the Mahseer is confusing due to the morphological variations they exhibit. In developing strategies for aquaculture and propagation assisted rehabilitation of mahseer species, there is a need to resolve taxonomic ambiguities. Due to large sizes they attain, mahseer find a place among 20 Mega Fishes of the World [5] (Stone, 2007), and have often been called Tiger of the Water [4], and the worlds hardiest fighting fish [6]. Langer *et al.* [7] while compiling the bibliography of Mahseer of Indian Sub–continent described this group as the "King of Indian Aquatic Systems".
Tor putitora is a widely distributed species in south and SE Asia with a restricted area of occurrence. The species has been reported from across the *Himalayan* region and elsewhere in South and SE Asia, ranging from Afghanistan, Pakistan, India, Nepal, Bangladesh, Bhutan, Myanmar, Sri Lanka, Western Iran to Thailand. As the name suggests *"Himalayan Mahseer"*, is restricted to montane and sub montane streams and rivers from north east to North West in the Indus, Ganga and Brahmaputra river basin, distributed at an altitude of 70-1891 msl and latitude of 8^{0}N to 36^{0}N [8].
Jammu and Kashmir is bestowed with abundant water resources and the peculiar geophysical conditions which offer a great scope to number of fish species to thrive well. Out of all the fish diversity found in the state, the Mahseer is having a great significance because of its size. The fish species is under continuous pressure of survival in natural conditions in streams and tributaries of Ravi and Chenab in Jammu region. The population of *Tor putitora* in Kashmir valley however have experienced a Mangla dam constructed on river Jhelum lacks fish ladder

which has cut the migratory route of Mahseer which earlier used to breed upstream of Kashmir valley [9]. The National commission on Agriculture [10] too has reported a general decline in the Mahseer fishery. Later a rapid decline of Mahseer fishery was reported by various workers [8, 11- 17].

In Jammu region of Jammu and Kashmir, very scanty data is available regarding the population status of *Tor putitora*. Presently, therefore a detailed survey of some major tributaries of river Chenab and Ravi have been undertaken to prepare a data record of Mahseer in water bodies of the Jammu region.

2. Methodology

Fish samples were collected by using cast nets, gill nets and hand nets. The fishes collected were measured for total length and abundance per catch. Majority of fish specimens were returned back to water after counting, and few fish samples were fixed in 10% formalin and brought to laboratory for their identification and further study. The fishes collected were identified using standard keys [3, 18-20]. Physico-chemical parameters, such as water temperature, pH, dissolved oxygen, free carbon dioxide, carbonates, bicarbonates, chloride, calcium and magnesium were analysed on monthly basis following APHA [21].

3. Results

The Mahseer fish acts as an indicator of ecosystem health because it is essentially a rheophilic species that inhabits fast flowing hill streams and rivers which are shallow and clear with a rocky and stony substrate, well distributed in South East Asia from Iran to Thailand (Map 3). Out of a total 24 species of Genus *Tor* (Gray) that exist in the world (Table 1 and Map 1), India is home to ten (Map 2). Menon [22] recognized the genus *Tor* as a distinct genus and described 5 valid species viz., *Tor putitora, Tor tor, Tor khudree, Tor progenius* and *Tor kulkarni but,* people in India are aware of three species of *Mahseer* i.e., *Tor putitora, Tor tor and Tor khudree,* since all the other species have only recently been added to scientific literature. The generic status of Genus *Tor* of southern and south-eastern Asia is poorly understood [23] and hence needs to be resolved. *Tor putitora* is the most widely spread and abundant among the Mahseer species recorded (Table 2 and Map 4). *Tor tor* on the other hand was poorly represented in the catch, very few specimens have been collected from Jhajjar stream, a tributary of river Chenab and river Ujh, tributary of river Ravi.

Presently, a systematic survey was conducted from March, 2012 to Feb, 2014 in the rivers and tributaries of Jammu region to assess the status of *Tor*. Table 2 reveals an overall picture of the size range and percentage contribution of *Tor putitora* in the catch. A look at the table 2 reveals that the maximum percentage of Mahseer population is recorded in Anji stream (40.09 %) followed by Baba Dhansar stream (37.54%), Gambhir stream (34.46%), Pahi stream (34.20%), Ujh river (30.72%), and Ranjit Sagar Dam (29.54%) as the river beds of these streams and tributaries vary from sandy and gravel to rocky and also the water level of these water bodies is quite high throughout the year. The physico chemical conditions are characterized by high DO, optimum pH and low pollution load thereby offering a suitable breeding environment for species. Streams which contributed less to the population of *Tor putitora* are flooded only in monsoons or rains and moreover, the physico chemical conditions are also not suitable characterized by high water temperature, low pH with high pollution load. Apart from the numerical abundance, the mean size of the fishes was also quite big in water of *Ranjit* Sagar Dam (11.7- 45cm) while other water bodies do not harbour a good size. In Anji stream, Baba Dhansar stream, Pahi stream, Ujh river, Gambhir stream and Ranjit Sagar dam, the population of *Tor putitora* is quite abundant in catches while in River Chenab, River Tawi, Jhajjar stream, Duddhar nullah, Poni, Sunderbani and Basantar the *Tor putitora* is common in catches whereas in Panjgrain, Bheni, Tarnah stream and Chenaini, the population of *Tor* is rare in catches. The values obtained for various physico chemical parameters have been summarized in table 3.

Table 1: List of *Tor* species found in the world

S. No	Species	Distribution	IUCN Criteria
1.	*Tor putitora* (Hamilton, 1822) (Golden Mahseer, Himalayan Mahseer)	India, Pakistan, Afghanistan, Nepal, Bangladesh, Bhutan, Myanmar, Iran, Sri Lanka and Thailand India: Assam, Bihar, Himachal Pradesh, Jammu Kashmir, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Uttaranchal, Uttar Pradesh, West Bengal, Punjab and Haryana.	Endangered
2.	*Tor tor* (Hamilton, 1822) (Tor Mahseer)	India, Myanmar, Bhutan, Bangladesh, Pakistan and Nepal India: Assam, Arunachal Pradesh, Manipur, Meghalaya, Sikkim, Uttar Pradesh, Uttaranchal, Nagaland, Punjab, Haryana and Bihar.	Near endangered
3.	*Tor Khudree* (Sykes, 1839) (Deccan Mahseer, Khudree Mahseer)	India and Sri Lanka India: Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra and Tamil Nadu.	Endangered
4.	*Tor progenius* (Mc Clelland, 1839) (Jungha Mahseer, Assamese Mahseer)	India (Assam, Manipur, Nagaland, Meghalaya and Arunachal Pradesh).	Near endangered
5.	*Tor kulkarni* (Menon, 1992) (Dwarf Mahseer)	India (Maharashtra).	Endangered
6.	*Tor mussullah* (Sykes, 1839) (Hump back Mahseer, Mussullah Mahseer)	India (Karnataka, Kerala, Tamil Nadu and Maharashtra)	Endangered
7.	*Tor macrolepis* (Heckel, 1838) (Indus Mahseer)	India and Pakistan.	Not evaluated
8.	*Tor barakae* (Arunkumar and Basudha, 2003)	India (Manipur).	Data deficient
9.	*Tor mosal* (Sykes, 1839) (Mosal Mahseer)	India (Orissa-Mahanadi)	Not evaluated
10.	*Tor remadevi* (Madhusoodana and Radhakrishnan, 2011)	India (Kerala)	Not evaluated

11.	*Tor tambroides* (Bleeker, 1854)	China, Indonesia, Laos, Malaysia, Thailand, Vietnam and Cambodia.	Data deficient
12.	*Tor douronensis* (Valenciennes, 1842) (Semah Mahseer)	Cambodia, China, Indonesia, Laos, Malaysia, Thailand and Vietnam	Not evaluated
13.	*Tor ater* (Roberts, 1999)	Laos	Vulnerable
14.	*Tor laterivittatus* (Zhou and Chu, 1985)	China (Main), Laos and Thailand	Data deficient
15.	*Tor hemispinus* (Chen and Chu, 1985)	China (Main)	Not evaluated
16.	*Tor polylepis* (Zhou and Cui, 1996)	China (Main	Not evaluated
17.	*Tor qiaojiensis* (Wu, 1977)	China (Main)	Not evaluated
18.	*Tor sinensis* (Wu, 1977)	China (Main), Laos and Thailand	Data deficient
19.	*Tor soro* (Valenciennses, 1842)	Indonesia, Myanmar and Thailand	Not evaluated
20.	*Tor tambra* (Valenciennes, 1842)	Cambodia, China (Main), Indonesia, Laos, Thailand, Vietnam and Malaysia	Data deficient
21.	*Tor yingjiangensis* (Chen and Yang, 2004)	China (Main)	Not evaluated
22.	*Tor yunnanensis* (Wang, Zhuang and Gau, 1982)	China (Main)	Endangered
23.	*Tor brevifilis* (Peters, 1881)	China, Laos, Myanmar, Hong Kong, Thailand and Vietnam	Data deficient
24.	*Tor zonatus* (Lin, 1935)	China (Main)	Not evaluated

Source: *IUCN Red List, www.fishbase.org*[*]

Table 2: Abundance of *Tor putitora* and other fish species in surveyed areas

Rivers	Abundance	Fish Size Range	Total no. of collected specimen	No. of *Tor putitora* specimen collected	% of *Tor Putitora*	% of other fish species
	River Chenab					
River Chenab		15-30 cm	95	17	17.89	82.11
River Tawi		5.5-23cm	121	27	22.31	77.69
Baba Dhansar stream		6.2-29cm	783	294	37.54	62.46
Banganga		-	-	-	-	-
Pahi stream		7.4-19.9cm	997	341	34.20	65.8
Panjgrain		3.5-7.7cm	92	7	7.60	92.4
Anji stream		6.3-17.1cm	217	87	40.09	59.91
Jhajjar Kotli stream		6.4-20.6cm	612	92	15.03	84.97
Juni stream		6.3-16.4cm	395	82	20.75	79.25
Duddhar nullah		8.1-17.7cm	236	32	13.55	86.45
Gambhir stream		4.2-22cm	975	336	34.46	65.54
Chenaini		8.2-39cm	75	7	9.33	90.67
Poni		5.1-15.7cm	145	18	12.41	87.59
Sunderbani		6.2-13.4cm	97	11	11.34	88.66
	River Ravi					
Ujh River		4.7-24.2cm	371	114	30.72	69.28
Basantar River		3.5-10.7cm	226	17	7.52	92.48
Bheni		5.9-8.4cm	58	10	17.24	82.76
Tarnah stream		8.4-9.2cm	217	3	1.38	98.62
Ranjit Sagar Dam		11.7-45cm	132	39	29.54	70.46

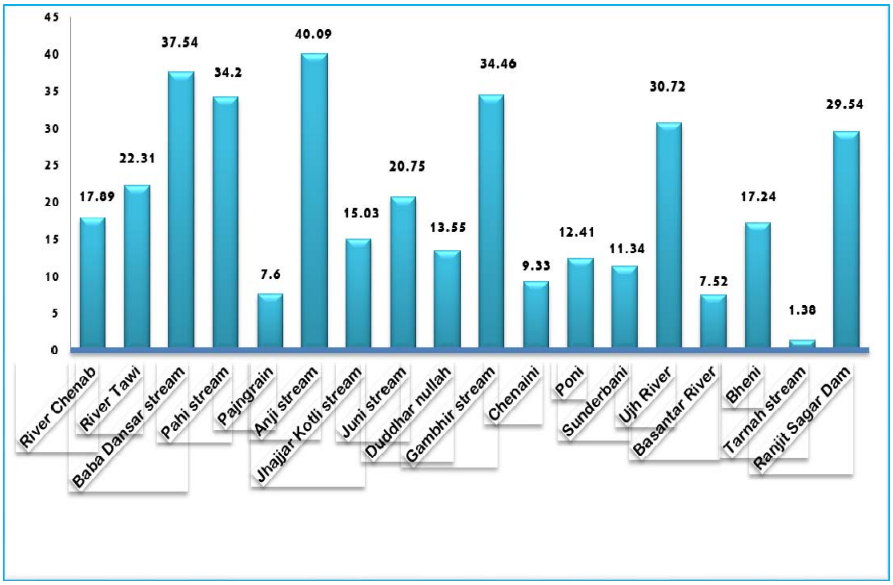
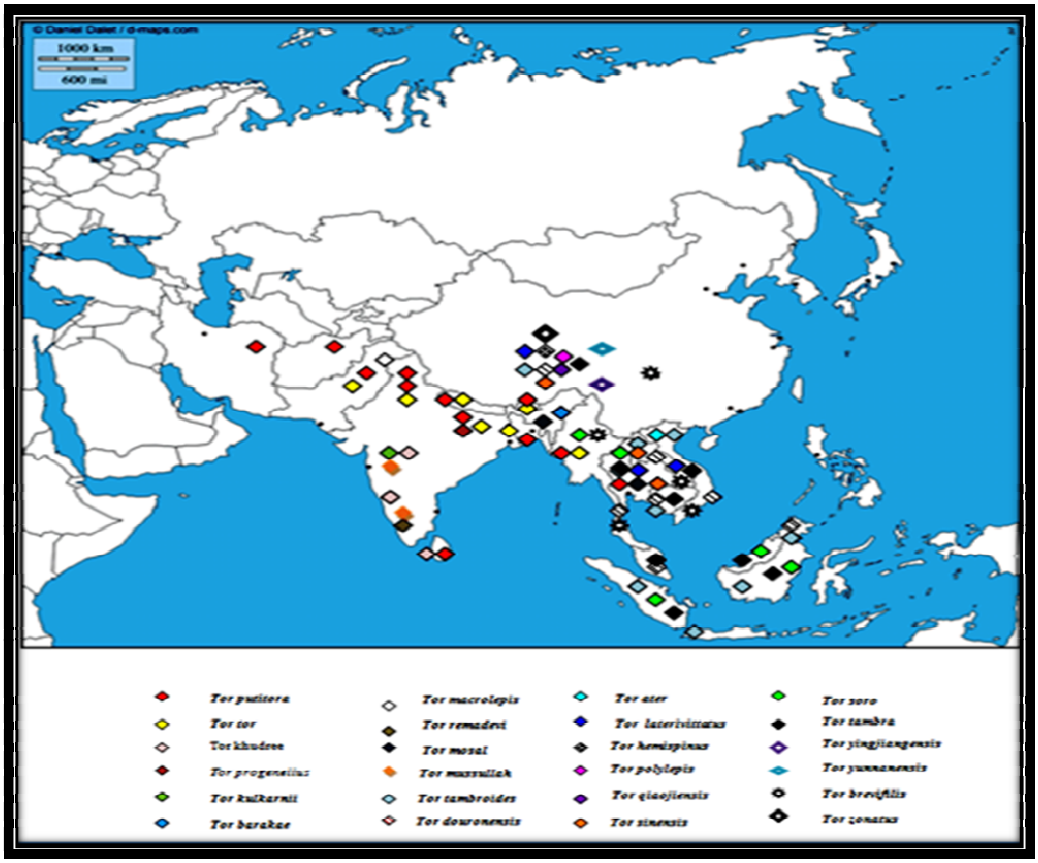
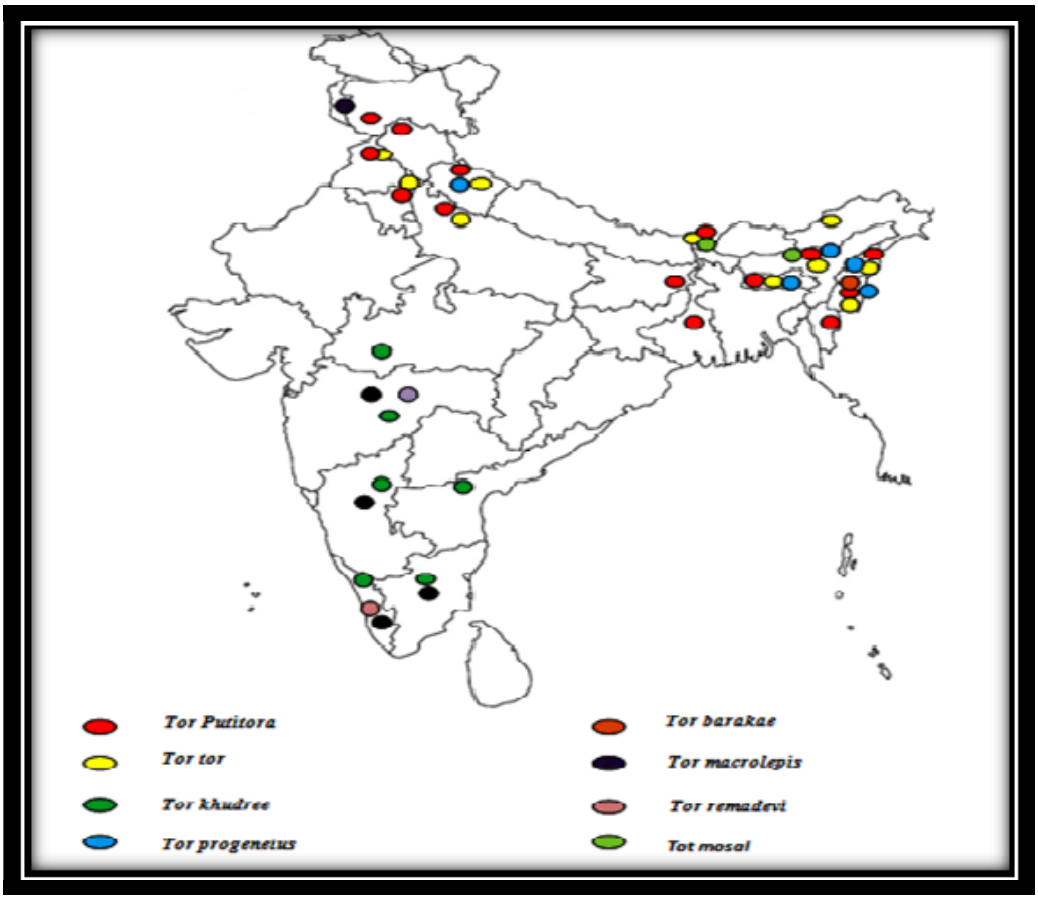


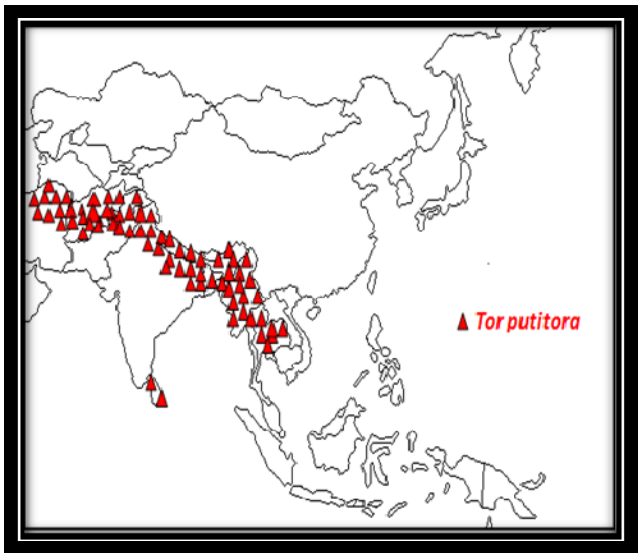
Fig 1: Percentage contribution of *Tor putitora* in different surveyed areas.



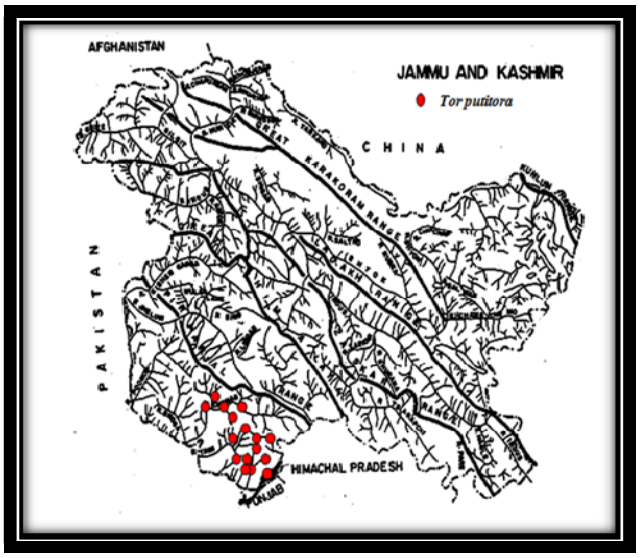
Map 1: Distribution of different species Genus *Tor* throughout world



Map 2: Distribution of different species of Genus Tor in India



Map 3: Geographical distribution of *Tor putitora* in world.



Map 4: Distribution of *Tor putitora* in Jammu region.

4. Discussion

4.1 Physico-chemical Parameters:

Temperature is one of the most important factors to determine the physico- chemical property of water. The water temperature mainly depends upon the fluctuation of climate, lux intensity and depth of water body. The value of water temperature varied from 12-27 ^{0}C in Chenab waters and 15-29 ^{0}C in Ravi waters. The temperature of Ravi remained comparatively higher in summers because of low water level and terrain being more plains. The surface water temperature varies according to the seasonal fluctuations of atmospheric temperature being higher in pre monsoons and lower in post monsoon as observed by Saxena and Chouhan [24]. The pH of the water bodies is mostly alkaline. As it is evident from table 3, the pH values are minimum in summers (7.6) in both the waters and maximum in winters i.e. 8.3 at Chenab waters and 8.7 at Ravi waters. As per findings of Dudroff and Kautz [25], alkaline waters are productive for fishes whereas pH below 4 and above 10 are hazardous to fish. Thus, the findings of present study are in permissible limits.

Lotic waters usually have a higher amount of DO due to high speed of water, turbulence and mixing of surface water with air which enhances the level of dissolved oxygen in the water body. Since the present study pertains to lotic waters where DO ranges between 4–8.8 mg/l in Chenab waters and 4–7.2 mg/l in Ravi waters, the minimum DO was recorded in summers due to decay of organic matter, reduced photosynthesis, high temperature etc whereas maximum level of DO was recorded in winter and monsoons.

The value of FCO_2 ranges from 4 – 18.2 mg/l. The FCO_2 level is very rare in lotic waters especially in waters of Chenab and its tributaries (0–10 mg/l) but is high in Ravi waters (0–18.2 mg/l). CO_2 is the end product of organic carbon degradation in almost all aquatic environments and its variation is often a measure of net ecosystem metabolism [26]. It is found to be in larger amount in polluted water bodies. Also the presence of FCO_2 is revealed in limited period in winters and springs. However, few water bodies reported its presence in monsoon as well. The carbonates range between 30-114 mg/l being comparatively higher in Chenab waters 0–114 mg/l as compared with Ravi waters 0–90 mg/l. The high values at Chenab are certainly due to withering of rocks while Ravi waters are more or less in plains with muddy/silt bottom. Table 3 reveals that bicarbonates were present throughout the study period at all study stations and their concentration fluctuated between 79.3-1630 mg/l in Chenab waters and 210.3–469.7 mg/l at Ravi waters. The values at Chenab are significantly higher than Ravi waters in monsoons and winters due to presence of FCO_2 and influx of water and surface runoff that generally leaches the surrounding sand rock of calcium carbonates which are subsequently converted into soluble bicarbonates [27, 28].

In present study, chloride ranges between 11.98–44.91 mg/l in Chenab waters and 13.97–27.94 mg/l in Ravi waters and are in permissible limits for survival of fishes. Chlorides are higher in summers and less in winters. The calcium in the present study ranges between 11.25–44.91 mg/l in Chenab waters and 12.03–42.08 mg/l in Ravi waters. Similarly magnesium values range 37.42 – 80.19 mg/l in Chenab and 18.95–47.63 mg/l in Ravi waters.

Table 3: Physico-chemical parameters range in Mahseer streams

Physico-chemical Parameters	Units	Chenab waters	Ravi waters
Water temperature	^{0}C	12-27	15-29
pH	-	7.6-8.3	7.6-8.7
Dissolved oxygen	Mg/L	4-8.8	4-7.2
Free carbon dioxide	Mg/L	0-10	0-18.2
Carbonates	Mg/L	0-114	0-90
Bicarbonates	Mg/L	79-1630	210.3-469.7
Chloride	Mg/L	11.98-47.9	13.97-27.94
Calcium	Mg/L	11.98-44.91	12.13-42.08
Magnesium	Mg/L	37.42-80.19	18.95-47.63

4.2 Distribution

Habitat changes in Himalayan waters have a major impact on the distribution and abundance of natural fishes [29]. When a comparison was drawn in the tributaries of both the rivers, river Chenab seems to support a better habitat for Mahseer fishery due to its fast flow, well aerated water and availability of plenty of food (algae, nymphs & larva of insects) while river Ravi has probably less supportive habitat (low abundance of food, low level of water, high water temperature & low DO). Apart from this, the substratum and tributaries of river Chenab viz., Baba Dhansar stream, Pahi stream, Gambhir stream and Jhajjar stream consists of gravel covered with sand, silt, detritus and of course algal vegetation which forms an

excellent environment for breeding of Mahseer. Similar results have also been reported by Sunder and Joshi [30]. During the present study, numerical abundance of both adult as well as juvenile specimens were reported from Baba Dhansar and Gambhir stream thereby indicating the prevalence of favourable environment for growth of fishes accompanied with less fishing pressure. This particular feature was lacking in rest of the water bodies because when a comparison was drawn these water bodies witnessed the presence of adults only that too in monsoon and breeding season. However, deep pools harboured the adults throughout the year.

The percentage contribution of *Tor putitora* is also high in waters of River Chenab specially the Anji stream (37.54%), arising from Vaishno Devi hills that carry crystal clear water throughout year. The bottom of stream is mainly composed of big rocks, boulders, gravel, sand etc with blooms of algae and optimum physico chemical parameters, all the prevailing features are in favour of good deal Mahseer fishery as has been referred by Sunder and Joshi [30]. Apart from favourable water characteristics, high numerical abundance of fish in Anji river is attributable to the fact that the place is near to the Anji fish farm from where stocks of Mahseer are introduced on regular basis. Following the Anji river are Baba Dhansar stream (37.54%), Gambhir stream (34.46%) and Pahi stream (34.20%) which basically act as Mahseer breeding ground thus, contributing to maximum population with a mixture of fingerlings, juveniles and adults of *Tor putitora*. In Baba Dhansar stream, the fishing is strictly prohibited because of temple of lord Shiva having immense religious importance and further the fish is worshipped as God (devta). Thus, the area remained unexploited and contributes to maximum population of the species (*Tor putitora*). In Ujh River (30.72%) and Ranjit Sagar dam (29.54%) of River Ravi, the population of *Tor putitora* is quite high when compared to the other tributaries of river Ravi which is all because of the barrage (Ujh river and Ranjit Sagar dam) thus acting as barrier for fish to migrate to downstream and therefore contribute to high population of Mahseer. The population that is in the immediate vicinity of barrage are less harboured by Mahseer and are found only in deep pools. The presence of adult specimens in these areas can be because of steep banks and the fact that these areas are prone to poaching.

In Jhajjar stream, the population reveals a significant decline. This decline is attributed to construction of fly over bridge along with highway renovation and collection of stones and sand which in turn has polluted the water body which otherwise in previous studies have been reported to support high population of *Tor*. Though the stream of Chenaini (Tawi) is rich in fish fauna but the abundance of *Tor putitora* is quite low in catch. The high water velocity, higher gradient, pebbly bottom and absence of epilithic phytobenthos algae and low population of benthos contributed to low percentage of *Tor putitora* in catch. In other remaining water bodies the contribution of *Tor putitora* is comparatively less particularly due high rate of fishing accompanied by pollution load, low water level, high water temperature (24-28) and low DO (5.8-8.0).

Reviewing the previous references it has been revealed that a major number of fish genera of the streams have declined. The major causes attributed includes consecutive floods of river, habitat disturbance and breeding ground destruction(due to silting and construction work at rood side) over exploitation of population, illegal fishing methods, fishing of juveniles and thus shows their decline. Apart this, pollution and water parameter plays significant role for their decline. It could be therefore, recommended that construction & management of aquatic natural habitat should be protected for enhancement of viable population size of Mahseer species and restore their genetic loss. However, further more detailed study is required to quantify the changes & check further loss of aquatic biodiversity.

5. Recommendations

- Enforcement of ban of illegal fishing.
- Ban on fishing of juveniles.
- Ban of fishing on breeding grounds and in breeding season.
- Special awareness programs to be organized for locals & fishermen.
- A comprehensive & unified strategy for conservation of fishes is to be designed and adapted to enhance the natural fish production which may prove beneficial.
- Mahseer sanctuaries to be made (Temples to be build across river & streams inhabiting Mahseer).

6. Conclusion

The present investigation depict a detailed distribution of Mahseer population in different tributaries of river Chenab and Ravi with special emphasis on two perennial tributaries of river Chenab (Baba Dhansar and Jhajjar streams). A common goal of study recorded the mapping distribution of different species of genus *Tor* world wise and its distribution in the states. Though the fish diversity and population is declining due to indiscriminate fish killing, over exploitation and habit degradation, but the status of Mahseer in Jammu region as per the present observations no way support the view point that this species is declining in these water bodies in Jammu region of Jammu and Kashmir State. The reasons that account significant abundance of Tor in Baba Dhansar and Gambhir stream, Anji stream etc are:

- Regular stocking of seed in Mahseer streams from Anji fish farm.
- Temples acts as religious sanctuaries prohibiting fishing in some areas.

Overall the abundance of *Tor putitora* show seasonal change with a minima in winters (low temp) and extreme summers (low water level), when fishes migrate to deep waters and maxima in monsoons and breeding season (Sept-Nov). A comprehensive & unified strategy for conservation of fishes however needs to be designed and adapted to enhance the natural fish production in order to stabilize its population in other streams of vital riverine system as well where the population of *Tor* is on decline due to one or other reason.

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