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Role of small tributaries in ichthyofaunal diversity of rivers in Uttarakhand

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ABSTRACT

An attempt has been made to assess the ichthyofaunal diversity of the major rivers of Uttarakhand state with main focus for subsidiary tributaries. The estimated total length of river network is 10927.9 kms including streams, tributaries and rivulets, which support occurrence of 83 fish species belonging to 39 genera. Conservation and restoration efforts on large rivers often focus on the main streams, but not for subsidiary tributaries, which provide unique habitat and serve as spawning sites and nursery grounds. Despite their abundance on the landscape and important role in ecosystem, tributaries are ignored in commonly used cartographic depictions, but play an important role in the ichthyofaunal diversity.

Keywords: Tributaries, Ichthyofaunal diversity, Spawning sites, Nursery ground

Introduction

Uttarakhand is located between latitude $28^0$40'-$31^0$29'N and longitude $77^0$35'-$81^0$5'E covering an area of 53,566 km² in North West Himalayan region. The state has unique ecosystem and bestowed with vast and varied water resources in the form of rivers, rivulets, streams, streamlets, lakes. Biodiversity is essential for stabilization of ecosystems (Ehrlich and Wilson, 1991). Himalayan ecosystem is unique in its biodiversity and it is the origin point of two mightiest river systems in Uttarakhand i.e. Ganga river system from Gangotri glacier and Yamuna river from Yamunotri glacier having so many rivers like Alaknanda, Bhagirathi, W-Ramganga, Kosi, Yamuna, Saryu, Mandakini and Sharda along with many small streams and tributaries.

Fish is an indicator of habitat suitability and health of any aquatic system (Goreman and Karr, 1978) however; thermal regime is an important limiting factor affecting distribution pattern and abundance of fish. Various abiotic and biotic factors are the key factors for determining the fish diversity, community structure and species assemblages in the stream and rivers (Minns, 1980). Suitable spawning ground, shelters and feeding ground play important role in the life cycle of fish and consequently in the sustainability of fish population. Scanty information is available on the aquatic faunal diversity and density for the study area as majority of the earlier studies were focused on the main river course and its major tributaries. In the Himalayan streams, the distribution of fish depends upon the flow rate, type of substratum, water temperature, and availability of food and the hydrographical features of the basin (Sehgal, 1988). Sunder *et al.* (1999) enlisted total of 218 fish species for the entire Himalayan region. Himalayan fish fauna was classified under subsistence and commercially important fish groups *i.e.* Carps (*Labeo* and *Tor* spp.), lesser barils (*Barilius* spp.), schizothoracines (*Schizothorax* & *Schizothoraichthys* spp.), garrids (*Garra* spp.) and sisorids (*Glyptothorax* & *Glyptosternum* spp.) (Vass, 2005). Coldwater species inhabiting in the Himalayan rivers belong principally to 5 different families, Salmonidae, Cyprinidae, Cobitidae, Sisoridae and Mastacembelidae; out of which fishes comprising major commercial fishery belong to Cyprinidae represented by 3 sub-families, i) Cyprininae-Mahseers and minor carps, ii) Rasborinae-Indian trouts, and iii) Schizothoracinae-Snow trouts (Moza, 2002). The exotic brown trout (*Salmo trutta*) is an introduced fish (Sehgal, 1999) which has been established in some uplands streams of the state. Owing to complex microclimatic conditions coupled with thermal variables, the capture fishery in the state is still at very low pace. Though the ecological information and ichthyofaunal diversity of the main rivers are available, but fish diversity in small tributaries and their defined role in biodiversity conservation is still lacking in the sustainable fishery of the state. Hence, an attempt has been done to describe the role of small streams and tributaries in the ichthyofaunal diversity of the aquatic ecosystem of the state.

Study area and methods

The entire drainage of State including Ganga basin, Yamuna and Tons basin and Kali-Sharda along with their tributaries has been covered for resource mapping. The

rivers in these areas have been digitized in GIS platform by using ArcGIS v.10.1 (The Environmental System Research Institute, USA). The ichthyofaunal diversity of the different tributaries was worked out by field survey; however, available literature was also used for the major rivers and streams. Sampling for fish fauna was carried out using cast net and drag net in the sample sites to represent wide range of habitat conditions with the study area. The density of species wise fish fauna were recorded wherever fish occurred. The biomass of the fish species was calculated based on the total fish catch. A minimum of 15 netting was made for the period of 2 hours in the sampling area to collect the available fish specimen. The percentage catch composition was calculated based on the total weight.

$$\%\,\text{Biomass} = \frac{\text{Total weight of the fish species (gm)}}{\text{Total fish catch (gm)}} \times 100$$

Catch per unit effort (CPUE) is the number or weight of fish taken during defined period of effort. The CPUE was calculated as;

$$\text{CPUE} = \frac{\text{Total weight of the fish (kg)}}{\text{Time (hr)}}$$

Fish including their spawns, fry and fingerlings caught from the tributaries were identified up to genera/species level with the help of keys given in Jayaram (1999), Menon (1987) and Talwar and Jhingran (1997). Samples of periphyton were collected by scraping of 3cm^2 area of the boulders and preserved in 1ml of Lugol's solution. The keys of Ward and Whipple (1959) and Trivedy and Goel (1984) were used for identifying the algae. Horizontal and vertical hauling was carried out by 0.25mm pore size plankton net to assess the species richness of phytoplankton and zooplanktons. Quantitative and density estimation of plankton were made using plankton net and preserved in Lugol's solution for identification using keys given by Pennak (1989); Fitter and Manuel (1986) and Edmondson (1992). Enumeration of plankton samples were done following methods given in APHA (1998). Density of phytoplankton was assessed by counting in Sedgwick Rafter cell. Benthic macro-invertebrates were collected from the designated sampling sites using Surber's Square Foot Sampler device or Eckman dredge depending on bottom types through random sampling (Welch, 2003). Simpson's Diversity Index (D) and Shannon-Weaver index (Shannon-Weaver, 1949) was calculated following the standard procedure.

Results and discussion

The state has a dense network of glacier fed, snow fed and spring fed tributaries of varying magnitudes from snowline to foothills, thus providing habitats defined by ice-cold and normal temperature regimes (Nautiyal 2001). The estimated total length of the main river courses in the state is about 2057.1 kms, while it is 10927.9 kms along subsidiary tributaries (Table-1).

Table 1. Length of Rivers, streams and tributaries of Uttarakhand state

River	Length of main rivers (km)	length of subsidiary tributaries (km)
Alaknanda	191	1648.2
Dhauliganga	91.9	293.8
Pindar	106.6	242
Mandakini	91	1143
Bhagirathi	184	1039.2
Bhilangna	74.1	281.1
Nayar	69.5	252.9
Yamuna	183	149.2
Tons	209	302.8
Kosi	183	408
Ramganga -W	168.5	420
Kali	233	213.7
Dhauliganga	42.9	86.5
Goriganga	97.7	322
Ramganga-E	99.3	423.2
Gomti	32.6	108.8
Other drainage network		1536.4
Total River length (km)	2057.1	8870.8
Overall Length (km)	10927.9	

Ichthyofaunal diversity and distributional pattern

About 64 fish species have been reported from Garhwal region, while Kumaon region is reported to have 31 fish species (Kumar, 2002). The dominant species reported are *Schizothorax richardsoni* and *Tor putitora*. Badola and Pant (1973) reported 18 species of fish from District Uttarkashi. Singh *et al.,* (1987) published a geographical and distributional list of ichthyofauna and reported a total of 68 species from Garhwal Himalaya. The present review and field survey reveals that Uttarakhand possess 83 species belonging to 39 genera, 14 families out of which 40 species have food value, 8 species are of exclusively ornamental value and 5 species are of sport fishery including world famous sport fish, Golden Mahseer (Table-2).

The Ganga river basin is one of the largest inland river basin of India draining a catchment area of 0.86 million km^2. The Ganga rises as Bhagirathi in Himalayas at 'Gaumukh' at the height of 3892 m. Most of the tributaries are glacial or spring origin, while a few have catchments in the high reaches without snow. In Upper stretch, some of the important tributaries include Bhagirthi, Bhilangna,

Table 2. Fish Species recorded in Rivers and their tributaries of Uttarakhand state.

Sr. No.	Scientific Name	IUCN Red List Status	Importance
Family : Cyprinidae			
1	*Barilius barna* (Ham.)	Least Concern	Ornamental/food value
2	*Barilius bendelisis* (Ham.)	Least Concern	Ornamental/food value
3	*Barilius barila* (Ham.)	Least Concern	Ornamental
4	***Barilius vagra* (Ham.)	Vulnerable	Ornamental/food value
5	*Barilius shacra* (Ham.)	Least Concern	Ornamental
6	****Raiamas bola* (Ham.)	Endangered	Ornamental
7	*Danio aequipinnatus* (McClelland)	Least Concern	Ornamental
8	*Devario devario* (Ham.)	Least Concern	Ornamental
9	*Danio rerio* (Ham.)	Least Concern	Ornamental
10	*Chagunius chagunio* (Ham.)	Least Concern	Food value/ornamental
11	*Cirrhinus mrigala* (Ham.)	Not Evaluated	Food value
12	*Garra prashadi* (Ham.)	Least Concern	Ornamental
13	*Garra lamta* (Ham.)	Least Concern	Ornamental
14	***Garra gotyla gotyla* (Gray)	Vulnerable	Ornamental
15	***Schizothorax richardsonii* (Gray)	Vulnerable	Ornamental
16	*Schizothorax progastus* (McClelland)	Least Concern	Food value
17	*Schizothoraichthys labiatus* (McClelland)	Not Evaluated	Food value
18	*Schizothoraichthys esocinus* (Heckel)	Not Evaluated	Food value
19	*Schizothorax sinuatus* (Heckel,)	Not Evaluated	Food value
20	*Schizothorax plagiostomus* (Heckel)	Not Evaluated	Food value
21	*Schizothorax curvifrons* (Heckel,)	Not Evaluated	Food value
22	*Schizothorax niger* (Heckel,)	Not Evaluated	Food value
23	*Schizothorax intermedius* (McClelland)	Not Evaluated	Food value
24	**Schizothorax micropogon* (Regan)	Near Threatened	Food value
25	*Bangana dero* (Ham.)	Least Concern	Food value
26	*Labeo dyocheilus* (McClelland)	Least Concern	Food value
27	*Labeo boga* (Ham.)	Least Concern	Food value
28	*Labeo rohita* (Ham.)	Least Concern	Food value
29	*Labeo calbasu* (Ham.)	Least Concern	Food value
30	*Labeo gonius* (Ham.)	Least Concern	Food value
31	*Cyprinus carpio* var. communis	Not Evaluated	Food value
32	*Oxygaster bacaila* (Ham.)	Least Concern	Food value
33	*Puntius chola* (Ham.)	Least Concern	Food value/ornamental
34	*Puntius ticto* (Ham.)	Least Concern	Food value/ornamental
35	*Puntius conchonius* (Ham.)	Least Concern	Food value/ornamental
36	*Puntius sarana* (Ham.)	Least Concern	Food value/ornamental
37	*Puntius phutunio* (Ham.)	Least Concern	Food value/ornamental
38	*Puntius sophore* (Ham.)	Least Concern	Food value/ornamental
39	**Tor tor* (Ham.)	Near Threatened	Food value/sports
40	****Tor putitora* (Ham.)	Endangered	Food value/sports
41	***Naziritor chilinoides* (McClelland)	Vulnerable	Food value/sports
42	*Rasbora daniconius* (Ham.)	Least Concern	Ornamental

Sr. No.	Scientific Name	IUCN Red List Status	Importance
43	*Esomus danrica* (Ham.)	Least Concern	Ornamental
44	*Crossocheilus latius latius* (Ham.)	Least Concern	Ornamental
Family : Cobitidae			
45	*Botia dario (*Hamilton, 1822*)*	Least Concern	Ornamental
46	*Lepidocephalichthys guntea* (Ham.)	Least Concern	Ornamental
47	*Nemacheilus beavani* (Günther)	Least Concern	Ornamental
48	*Nemacheilus corica* (Ham.)	Least Concern	Ornamental
49	*Nemacheilus botia* (Ham.)	Least Concern	Ornamental
50	Nemacheilus denisoni (Ham.)	Least Concern	Ornamental
51	*Schistura rupecula* (McClelland)	Least Concern	Ornamental
52	*Schistura savona* (Ham.)	Least Concern	Ornamental
53	*Schistura multifasciata* (Day)	Least Concern	Ornamental
54	*Schistura scaturigina* (McClelland)	Least Concern	Ornamental
55	*Acanthocobitis botia* (Ham.)	Least Concern	Ornamental
56	*Paraschistura montana* (McClelland)	Not Evaluated	Ornamental
57	**Balitora brucei (*Gray)	Near Threatened	Ornamental
Family : Amblycipitidae			
58	*Amblyceps mangois* (Ham.)	Least Concern	Ornamental
Family : Sisoridae			
59	*Glyptothorax cavia* (Ham.)	Least Concern	Ornamental
60	*Glyptothorax pectinopterus* (McClelland)	Least Concern	Ornamental
61	****Glyptothorax madraspatanus* (Day)	Endangered	Ornamental
62	*Glyptothorax trilineatus* (Blyth)	Least Concern	Ornamental
63	*Glyptothorax telchitta*	Least Concern	Ornamental
64	*Glyptothorax brevipinnis*	Data deficient	Ornamental
65	*Glyptothorax conirostris* (Steindachner)	Data deficient	Ornamental
66	*Pseudecheneis sulcata* (McClelland)	Least Concern	Ornamental
67	**Bagarius bagarius* (Ham.)	Near Threatened	Food value
Family : Bagridae			
68	*Mystus vittatus* (Bloch)	Least Concern	Food value
69	*Mystus bleekeris* (Day)	Least Concern	Food value
70	*Mystus seenghala* (Sykes)	Least Concern	Food value
71	*Mystus tengra* (Ham.)	Least Concern	Food value
Family : Belonidae			
72	*Xenentodon cancila* (Ham.)	Least Concern	Food value
Family : Claridae			
73	*Clarius batrachus* (Linn.)	Not Evaluated	Food value
Family : Mastacembilidae			
74	*Mastacembelus armatus* (Lacepède)	Least Concern	Food value/ ornamental
75	*Mastacembelus punctatus* (Ham.)	Least Concern	Food value/ ornamental
Family : Channidae			
76	*Channa punctatus* (Bloch)	Least Concern	Food value/ ornamental
77	*Channa gachua* (Ham.)	Least Concern	Food value/ ornamental

Sr. No.	Scientific Name	IUCN Red List Status	Importance
Family : Anabantidae			
78	*Colisa fasiatus* (Bloch)	Least Concern	Food value/ ornamental
Family : Nandidae			
79	*Nandus nandus* (Ham.)	Least Concern	Ornamental
Family : Schilbedae			
80	*Clupisoma garua* (Ham.)	Least Concern	Food value/ ornamental
Family : Siluridae			
81	**Ompok bimaculatus* (Bloch)	Near Threatened	Food value
Family : Salmonidae			
82	*Salmo trutta fario* (Linn.)	Least Concern	Food value/ sports
83	*Oncorhynchus mykiss* (Wal.)	Least Concern	Food value

*Near Threatened, ** Vulnerable, ***Endangered

Alaknanda, Pindar and Nandakini. Habitat structure in these tributaries have substrata consisting of boulders, stones and sands mixed with pebbles in the upper reaches and mixture of mud and sand in lower reaches. 52 species were recorded in the five rivers and their tributaries of Ganga river system, of which *Schizothorax richardsonii, Tor putitora, Tor chelynoides, L. dyocheilus, Bangana dero, Barilius bendelisis, Schizothoraichthys progastus and S. plagiostomus* are important food fishes while others though smaller in size and of low economic value are significant for biodiversity. As per the drainage wise distribution in the sampling, 52 species in Alaknanda, 32 in Bhagirthi, 29 in Bhilangna 48 in Pinder and 21 in Nandakini were recorded with richness in the subsidiary tributaries of these rivers. Snow trout, *Schizothorax* spp. (80-98%) and Mahseer, *Tor* spp. (1-3%) are the dominant species observed in the main river course and in different tributaries along with minor fishes. These species in the normal course of its life cycle migrate within the stream/river from higher elevation to lower elevation during winter months and *vice-versa* during summer.

Fishery resources of river Yamuna and Tons are not well known and most of the studies reported on the fish diversity and density in the foot hills of Garhwal Himalaya (Nath *et al*., 1994; Moza *et al.,* 2005). As mentioned, upper Himalayan stretch of the river Yamuna has not been explored in detail and according to Sehgal (1992) Yamuna was known to hold fish mostly in the middle and lower segment which have been evaluated by CIFRI and documented by Jhingran (1975), Mishra and Moza (2001) and Moza and Mishra (2001). A total of 26 fish species were mentioned in the river Yamuna at the foot hills of Garhwal Himalaya by Mallik (2011). Ishaq and Khan (2013) have reported a total of 24 species belonging to 6 families from Kalsi to Asan in the river Yamuna. Similarly river Tons has also not been explored above Kalsi, the confluence point of river Yamuna and Tons. In the lower stretch of river Tons a total of 19 species were reported by Negi and Mamgain (2013). Cypriniformes comprises the dominant group represented by 19 species belonging to 9 genera in Yamuna and Tons. *Schizothorax* spp., *Barilius* spp. and *Tor* spp., was the common species. However, the population of these species is fragmented but the occurrence of juveniles of all the species reflects the environment conducive for the breeding activities to sustain the population. The places having steep slopes and fast water current have been observed with the presence of *Garra gotyla* gotyla and *Glyptothorax* sp. such as Bhadri gad. The density of the fish occurrence was observed increasing in the downstream of Yamuna and Tons. Snow trout (Schizothoracins) and barils prefer the snow fed streams where suitable water temperature supports their life cycle. These species are available throughout the Yamuna basin mainly confined in the side tributaries of the main river course and adjoining places of the tributaries. The juveniles of *Schizothorax* and *Barilius* spp. were recorded in most of the side tributaries in the shallow areas and also where the water temperature was observed in the range between 9-21°C.

W. Ramganga and its tributaries were recorded for the presence of 32 fish species belonging 7 families. Barils, snow trout, minor carp and loaches were the major contributory groups of fish in the catch composition. Near Kheeda presence of good number of mahseer was observed. This location might be serving as shelter ground and possibly breeding ground for mahseer. Near Bhikayasen, minor carps mainly *Bangana dero* and *Labeo dyocheilus* are found in abundance. *Raiamas bola* is also found however, the occurrence was occasional. Near Masi, Mahseer is found in abundance in different size ranges (75-200 g). Based on the sampling it was found that the diversity is low in upper and middle stretches of the main river courses and Shannon index indicated towards the moderately stress condition of the

Table 3. Rivers, streams and their tributaries of Uttarakhand state

Rivers	Tributaries
Alaknanda River (1839.2 kms)	Madhyamaheshwar, Kali Ganga, Vasuki Ganga, Byung Gad, Baram Gad, Nauna Gad, Ata Gad, Pindar & Mandakini.
Bhagirathi River (1223.2 kms)	Hunuman Ganga, Bingsi Gad, Ganwan Gad, Pilang Gad, Kola Gad, Kundl Gad, Lod Gad, Bhela River, Son Gad , Syalam Gad & Rishi Ganga.
W-Ramganga River (588.5 kms)	Ram Ganga River , Bhelichin Nala, Bagri Gad, Bhojpatri Gad, Mehar gad, Jhiniya Ga, Lathiya Gad, Dokanna Nala, Kalapani Gad, Hari Gad, Sauron Gad & Tanar Ki Gad.
Kosi River (591 kms)	Lamgada Gad, Ban Gad, Dhaula Gad , Nariye Gad, Kali Gad, Ghatt Gad, Swal Nadi, Sakuni Gad, Ghat Gad, Kaluwa Gad, Taklari Gad, Gaunchhil Gadhera, Baurar Gadhera & Khalgari Gad.
Yamuna & Tons River (844 kms)	Supin , Pabber River, Khaneda Gad, Pali Gad, Badyar Gad, Rikhnar gad, Badri Gad, Aglar Nadi, Asan, Patar, Dogra Khad, Dogra Khad & Bajhetu Nala.
Saryu River (619.1 kms)	Gomati River, Khir Ganga, Revti Ganga,Gason Gad, Lahor Nadi, Galipatal Gad, Belang Gad, Chhira Gad, Galasar Canal, Kaplani Gad, Saran Gadhera, Gainar Gad, Lamtara Gad, Tuspati Gad & Bhadrapati Nala.
Mandakini River(1234 kms)	Madhyamaheshwar River, Kali Ganga,Vasuki Ganga, Byung Gad & Sone Ganga.
Sharda River (1608.5 kms)	E –Ramganga, Goriganga, Dhauliganga, Sarju River, Jakula river, Bagri Gad, Bhojpatri Gad, Jhiniya Gad, Sil Gad, Titar Gad, Mangarh Gad, Shilang Gad & Kalapani Gad.

Table 4. Simpson's Diversity Index (D) and Shannon-Weiner index in major streams and tributaries of Uttarakhand state

Index	Bhagirathi	Bhilangna	Alaknanda	Ganga	Yamuna & Tons	tributaries of Alaknanda	tributaries of Yamuna
Shannon_H	1.532	1.486	1.564	2.502	2.180	2.354	2.468
Simpson_1-D	0.734	0.7223	0.7743	0.8730	0.6754	0.8790	0.8980

main rivers. However, both the index reflects comparatively better diversity and low stress condition in the subsidiary tributaries of these rivers (Table-4).

Catch per unit effort (CPUE)

Catch per unit effort (CPUE) is proportional to the average density of the location fished. CPUE was calculated during different months/season at different locations in main rivers & their tributaries during the survey. The data of CPUE indicated decrease in trend with increasing altitude in the basin; indicative of low fish occurrence/density in the middle and higher reaches of the river basin. CPUE data also revealed that fish catch is higher during post-monsoon to pre-monsoon. Monsoon season has minimum catch record. The CPUE recorded in the range of 0.02 kg/hr - to 0.38 kg/ hr in the middle zone of Ganga & Yamuna basin, while it ranged from 1.12 kg/hr to 5.24 kg/hr in the lower zone of these rivers. In side tributaries of upper zone of these rivers, the CPUE was recorded in the range of 0.04kg/hr to 2.70 kg/ hr. Earlier studies (Moza *et al.* (2005) also indicate that fish biomass range between nil-10 kg/day (pre-monsoon) and nil-20 kg/ day (winter) in Yamuna.

Major breeding/spawning sites and spawning season

The presence of larvae, juvenile and adult of different species indicated the suitability of the sites for fish spawning, nursery for larval development, growth and survival of fish species. The larvae/juvenile of indigenous species spotted at different places in Yamuna and Tons & its tributaries (*e.g*. Near Paligad, Sari gad, Barni gad, Aglar khad, Bhadri gad, Gadu gad, Kedar Ganga and near Rupin) indicated its wide presence at different altitudes and its breeding in the streams. The juveniles of *Schizothorax* spp. was in abundance at many locations particularly at confluence points of Alaknanda, Yamuna and Tons with the favorable conditions prevailing in the area in terms of water flow, food availability, less turbidity and suitable shelters available for growth and survival. The presence of gravid female fish at few locations (*e.g.* Kedar Ganga) also confirmed its natural breeding in the stream. Certain isolated pools created at meandering of the river also provide the spawning habitat such as breeding pools of minor carp near Bhikiyasen. About 30 spawning grounds were observed in tributaries of Alaknanda basin such as the Birahi Ganga, Bal Ganga (Bal khila), Nandakini and Pinder Rivers.

Food and feeding ground

The Benthic macro-biota in highland streams play important role in distribution of fishes and other aquatic organisms. The population density of micro biota is in the range of nil-1.26 million units/cm^2. Bacillariophyceae (52.9-87.0%) is the dominant group of the algae followed by green algae, Chlorophyceae (1.0-8.2%) and blue green algae, Cynophyceae (0.2-15.5%). In periphyton community, *Gomphonema* contributes more than 60% of the total periphytic population. In fast flowing streams, phytoplanktons are present in dominance with least occurrence of zooplankton. The density of the plankton is in the range of 0-422 unit/L in upper reaches of the rivers to 116-14320 units/L in middle and lower reaches. Bacillariophyceae (12.4-89%) is the dominant group of phytoplankton followed by green algae and blue green algae. The decreasing temperature supports higher percentage of the Oligochaete. Occurrence of dipterans as dominant group is present in the middle reaches of the rivers. Trichoptera are well represented in all river basins. The wet biomass of these invertebrates ranged between 0.432-34.0 g/m^3 (23-656 nos./m^2) with higher occurrence of juveniles of Plecoptera in the upper reaches of the rivers.

Conclusion:

Habitat features such as suitable water quality, migration routes, spawning grounds, feeding sites, resting sites and shelter from enemies and adverse weather are determining factors for the propagation and survival of riverine fish species in uplands. In this context, small streams and side tributaries, which occur across or in sides of the main rivers and remain differ from the main steams for temperature gradient, water chemistry, hydrological regime, substrate type, food resources and riparian pools, all of which support the abundance and diversity of the biota. The confluences of these resources serve a source of colonists, providing spawning sites and rearing area having rich food sources. These small water sources also contribute in environmental flow in the downstream of the dams. Tributaries also provide shelters and protected areas to the local migratory species during natural calamity and high turbidity in the main river course. These resources are important for ichthyofaunal diversity and sustainability of aquatic ecosystem.

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