Assemblage structure of stream fishes in the Kumaon Himalaya of Uttarakhand State, India

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Abstract: The fish assemblage structure was analyzed in the streams of Kumaon Himalaya of Uttarkhand State, India. Seven sites were sampled by using different fishing gears during Jan, 2007 to December 2008. The physical features like stream habitat, stream classifications, fish assemblage at different sites, habitat preference and riparian vegetations were registered for each site. In the present investigations a total of ten species belonging to three orders and four families were recorded, of which the cyprinides were the most dominant group at all the sites. According to Shannon Weaver diversity index the pool habitat support maximum fish diversity ('H' 0.164-0.292). [Life Science Journal 2010;7(2):69-74]. (ISSN: 1097-8135).

Key words: Classification, cyprinids, fish diversity, substrate, preference

1. Introduction

The highly complex functional and structural elements of running water are largely based on the system-inherent, dynamic genesis and development of those systems. Because of the very intricate interpretations with surrounding environments, running waters are among the most distinctive landscape elements. Especially in alluvial river floodplain systems, the high spatio-temporal heterogeneity and, therefore, the great diversity of complex habitat and ecotones in successional stages, represent key features. The diverse environment support species-rich fish communities that contribute to the overall high biodiversity of rivers/streams ecosystems (Schiemer & Waidbacher, 1992, Ward & Stanford, 1995a).

Importance of habitat is a major concern to fishery biologist. A common use of fish habitat indicates the physical and chemical characteristics of the environment, excluding biological attributed. Habitats for fish is place or for migratory fishes, a set place in which a fish population or fish assemblage can find the physical and chemical features needed for life, such as suitable water quality, migration routes, spawning grounds, feeding sites, resting sites and shelter from enemies and adverse weather. Habitat features have been identified as major determinants in the distribution and abundance of fishes from earlier times (Shelford, 1911) and later individual fish species as well as entire assemblage were studied for the patterns of North America (Baker and Ross, 1981). Fish species diversity is correlated with habitat complexity (Gorman & Karr, 1978; Schlosser, 1982) depth, flow and substrate types. The influence of these habitats attributes on the structure and function of fish assemblage in the streams has been studied in detailed at different latitudes (Mathew and Hill, 1980; Leveque, 1997). Extensive studies on freshwater fishes in India are available, but most of them are concern with taxonomy (Menon, 1992, Jayaram, 1999). Studies on fish assemblage structure and their requirements in Indian streams are lacking, though few initiatives started in the 1980's in south India (Arunachalam *et al*., 1997a), SriLanka streams (Wickramanayake, 1990); Western Himalaya (Johal *et al*., 2002 and Kumaon Himalaya (Negi *et al*., 2007). The present study aims to describe the habitat structure, and its availability to fish assemblage, as well as habitat use and habitat suitability preference in seven streams of Kumaon Himalayas of Uttarakhand State, India.

2. Study area

Kumaon Himalaya lying the latitudes 28^0 44' and 30^0 49' and longitude 78^0 45' and 81^0 1' E is situated at the disjunction of Nepal, Tibet and India in the state of Uttarakhand. A natural water divide separates it from Tibet, the Kali river defines its eastern border with Nepal, High transverse mountain spurs, separate it from Chamoli and Pauri district of Garhwal and the southern limit of the Tarai belt demarcates its southern boundary. Geographically Kumaon has the four longitudinal physiographic subdivisions namely the outer Himalaya with Tarai and Bhabar belt and Shivalik ranges, the lesser Himalayas and the Trans-Himalaya Tethyes domain of Bhotland. Seven study sites were selected for the present study. These sites varied in altitude from 800 msl to 1098 msl and varied geomorphologic characters, substrate and ecological conditions.

3. Material and methods

The parameters like water source, channel materials, dominant habitat type and stream type were taken into consideration for the Kumaon Himalayan streams. The geographic location i.e. longitude, latitude and altitude were determined with the help of Magellan Trailblazer XL GPS system. The habitat type and substrate material were classified after Armantrout (1999). The stream under report were classified following the works of Rosgen (1996).

Stream classification

This classification is based on morphological arrangement of stream characters like entrenchment ratio, width/depth ratio and channel material in the various landforms at level 1 and 2.This is only broad level delineation of stream types. Entrenchment ratio has been considered primary criteria for the present stream classification. Whereas, water shed features, channel features, sediment sources, riparian vegetations and large wood debris were estimated on the spot by stream reach characterization field data sheet. Water temperature, air temperature and water velocity were measure on the spot as per standard methods APHA (1998)

Fish collection

The fishes were caught at each sites with the help of cast net, gill net, drag nets, scoop nets. Samples were carried out for ten times in each habitat on a fixed day every month from Jan. 2007 to December, 2008. The represented specimens were identified upto species level in the laboratory using standard references of Jayaram (1999).

3. Results

Fish diversity

A total of ten species belonging to three orders namely cypriniformes , Mastacembelis ,and perciformes were recorded during the present investigation Table 1. Of these cypriniformes comprises the dominant group represented by 8 species belonging to 7 genera. *Tor putitora*, *Garra gotyla gotyla*, *Barilius bendelisis* were the most abundant fishes in all the study sites. Higher species richness were recorded from Kosi, Saigad and Suyal streams respectively with an altitude range of 1027 to 1398msl and lower values were recorded from the altitude range 860 to 1120msl. This is chiefly because of the severity of anthropogenic activities in the form of extraction of boulders, cobbles from streams habitat in lower altitude leading to decrease in fish assemblage whereas, at higher altitude have greater species richness.

Habitat preference

In total 345 cyprinids fishes were recorded in pool, pool edges, run and edges of riffles. The cascade was least preferred habitat by majority of fishes. The maximum fish diversity was reported in pool habitat H' 0.845 followed by run H' 0.764 and riffle H'0.196 at Kosi stream Table 2. In Saigad stream, it was H' 0.760 in pool, H' 0.590 in run, H' 0.244 in riffle, In Suyal stream it was H' 0.464 in pool, H' 0.461 in run and H' 0.292 in riffle, in Busal stream, it was H'0.423 in pool and H' 0.292 in run, in Garur ganga stream it was H' 0.457 in pool, H' 0.386 in run and H' 0.210 in riffle, in Gagas stream, it was H' 0.581 in pool, H'0.196 in run and H'0.275 in riffle, whereas, it was H' 0.594 in pool, H' 0.454 in run and H' 0.164 in riffle at Gomti stream. In Garur ganga stream, *Tor putitora*, *Barilius bendelisis* and *Schizothorax* preferred deep and shallow pools, while, was found in the shallow pools with low velocity, whereas,*Garra gotyla gotyla* preferred shallow pool with low to medium velocity. In Gomti stream,*Tor putitora* and *Barilius bendelisis* and *Barilius barla* preferred shallow pools with medium velocity.

Fish species richness vs altitude

At level 1, the altitude had been considered as primary criteria for differentiating the streams. High correlation coefficient was observed between altitude r= 0.71. The high altitude site >1000m, had higher FSR (5-10) as compared to lower altitude site<1000m.i.e. Gomti stream which had lower FSR (5). This is because of anthropogenic activities occurring in lower altitude as compared to higher altitude. The relative abundance also inverse relation with altitude. At level 2, the streams were further delineated according to the source of water glacial or spring fed. In the present study streams under report were spring fed and had fish species richness (3-10 and H' 0.778-1.694).

Stream substrate

In Kosi stream, the dominant stream substrate were big boulders, small boulders, and cobbles in Saigad stream, small boulders and cobbles, in the Suyal stream, bed rock, big boulders edge and small boulders were prevalent. In Garur ganga streams, big boulders, bed rock edge and gravel, in the Gagas streams, small stream. Small boulders, cobbles and pebbles, and in Gomti stream, substrate was dominated by big boulders, small boulders and cobbles Table 3. The streams having cobbles as dominant bed materials along with small boulders lead to formation of a more variable types of habitat leading to the greater species richness (5-10).

Stream classification

There was a great variation in channel width almost all selected streams. The minimum cannel width was recorded as (6.3 m) at Busal stream and maximum as (37.53 m) at Gomti stream. Maximum depth was recorded at Suyal (0.76 m) and minimum at Busal stream (0.25 m). The depth width ratio was recorded maximum 63.46 at Kosi stream and minimum 16.93 at Garur ganga stream Table 3. In the present study, entrenchment ratio was considered as primary criteria for the classification of streams. On the basis of entrenchment ratio all the streams has been classified as type 'B' streams with entrenchment ratio range from 1.46- 2.31. The width/depth ratio was very high in the streams of Kosi, Saigad, Gomti, whereas, rest of streams have moderate width/depth ratio.

Stream channel features

The channel features were found to be unstable at Kosi, Saigad, Garur Ganga and Gomti streams, whereas, they were moderately stable in Busal and Gagas streams. The proportion of stream reach morphology type was dominated by riffle, deep pools and runs at Kosi; shallow pools and run at Saigad and

Busal; deep pools, run and riffle at Suyal and riffle , run and cascade at Garur ganga; riffle, run and shallow pools at Gagas; run and riffles at Saryu and riffles and pools at Gomti streams. The local hydrological alterations in the form of channelization of water flow were more prominent in Kosi, Busal, Garur ganga and Saryu streams, leading to the formation of large side pools at different pockets of the streams reaches, which were responsible for sedimentation in the streams. The riparian vegetation was fragmentary with herbs, shrubs and trees at Kosi, Suyal Gagas and Gomti streams. Aquatic vegetation was mainly dominated by attach algae in most of the study sites. All the streams under reports were reported alkaline in nature.

Table 1. Fish species recorded from streams of Kumaun Himalaya of Uttarakhand State, India.

	Kosi	Saigad	Suyal	Busal	Garurganga	Gagas	Gomti
Order:Cypriniformes							
Family:Cyprinidae							
Genus: Tor							
Tor putitora	++	+	+	-	+	+	+
Genus:Barilius							
Barilius bendelisis	++	++	++	++	++	++	++
Barilius barila	+	+	+	-	-	-	+
Genus:Puntius							
Puntius conchonius	+	+	-	-	-	-	-
Genus:Garra							
Garra gotyla gotyla	++	++	++	++	++	++	++
Genus:Chrosochelus							
Chrosochelus latius	+	-	-	-	-	+	-
Genus:Schizothorax							
Schizothorax richardsonii	+	+	+	-	+	+	+
Genus:Nemachelius							
Nemachelius montanus	+	+	+	-	-	+	-
Order:Mastacembeliformes							
Family: Mastacembelidae							
Genus: Mastacembelus Mastacembelus armatus	+	+	+	+	+	+	-
Order: Ophiocephaliformes							
Family:Ophiocephalidae							
Genus: Channa							
Channa punctatus	+	+	-	-	-	-	-

++: Dominant; +Abundant; -: Not recorded

Table 2. Physical characteristic and channel morphology in the streams of Kumaun Hamalaya of Uttrakhand State, India.

Name Of Stream	Stream Width(m)	Stream Depth (m)	Entren-chment ratio	Habitat	Substrate	Longitude	latitude	Altitude	Water velocity	Riparian Vegetation

Kosi	16.5	0.26	2.12	Deep pools, Riffles, Runs	Big boulders	79^{0}30'22.9"E	29^{0}46'55.3"N	1381	0.9	Fragmentary, trees and shrub, Minimum encroachment in stream
Saigad	15.0	0.30	1.6	Shallow pool Runs	Cobbles, Pebbles, Sand	79^{0}36'03.2"E	29^{0}46'51.6"N	1398	0.43	Trees, shrubs, grasses, Moderate encroachment
Suyal	19.5	0.76	1.74	Deep pool, Cascade, Riffles	Dominant bed rock, Large boulders, Cobbles	79^{0}36'44.9"E	29^{0}33'21.5"N	1027	0.22	Shrub dominant, Fragmentary, Minimum encroachment
Busal	6.3	0.25	2.03	Runs, Pools	Cobbles, Pebbles	79^{0}36'59.9"E	29^{0}53'47.0"N	1122	0.39	Trees, shrubs, continuous, moderate encroachment
Garur ganga	8.3	0.49	2.31	Riffles, Cascade, Pool	Big boulders, Bed rock edge, gravels	79^{0}37'01.9"E	29^{0}53'49.2"N	1120	0.70	Shrubs, grasses dominant, Fragmentary
Gagas	7.8	0.36	2.05	Riffles, Runs, Shallow Pools	Cobbles, Small boulders	79^{0}27'28.2"E	29^{0}41'32.9"N	1061	0.51	Tress, shrubs, grasses, Fragmentary Minimum encroachment
Gomti	37.5	0.70	1.46	Runs, Riffles, pools	Big and small boulders	79^{0}46'10.9"E	29^{0}50'11.1"N	860	0.58	Trees, shrubs dominant, grasses, continuous, minimum encroachment

Table 3. Fish species diversity indices (Shannon and Weaver species Diversity) (H'), relative abundance and species richness in the streams of Kumaun Himalaya of Uttarakhand State, India.

Shannon and Weaver	(H')	(H')	(H')		
Streams	Pool	Riffle	Run	Relative Abundance	Species Richness
Kosi	0.845	0.196	0.764	11.62	10
Saigad	0.760	0.244	0.590	12.50	9
Suyal	0.464	0.292	0.461	13.20	7
Busal	0.423	--	0.292	4.91	3
Garur Ganga	0.457	0.210	0.386	8.33	5
Gagas	0.581	0.275	0.196	9.80	5
Gomti	0.594	0.164	0.454	8.62	5

4. Discussions

From the above observations it is clear that water depth and water velocity are the two major factors for the distribution of fish species in the different habitats. Similar observations were made by Gorman and Karr (1978); Arunachalam (2000); Johal *et al*. (2002)and Negi *et al*.(2007). Harvey and Stewart (1991) reported that minnows survives longer in pools. The large numbers of small fishes becomes increasingly restricted to stream margins, because the mid stream reaches are fast or too deep or both (Bains et al., 1988).

Most of the fishes in the small streams are habitat generalists (Horowitz, 1978). Other studies have also indicated a substantial overlap in the habitat utilizations in the cyprinid fishes communities. (Barker and Ross, 1981; Schlosser, 1987a). The studies on the Western Ghats fishes assemblage structure (Arunachalm, 2000) and other parts of the world (Finger, 1982; Schlosser, 1982; Bains *et al*. 1988 and Schlosser 1987a) also reported that the diverse group of small fishes are found to be primarily restricted to habitat that are shallow in depth and slow in current velocity and are concentrated along the stream margin in pools and riffles. Scot and Hall (1997) have stated that fish assemblage as indicator of environmental degradation in Maryland coastal plain streams. The relationship between habitat diversity and fish communities has been analyzed by Gorman and Karr (1978) in temperate area in which they include the diversity of current, depth and substrate, which determines the riverian fish communities. Several studies have supported this generalization for fish communities (Schlosser and Toth, 1984; Aadland, 1993; Mathew *et al.* 1994; Arunachalam, 2000). Physical gradients from unstable shallow to deep, stable pool areas with stream fishes are common in temperate latitudes (Sheldon, 1968. Arunachalam, 2000) reported that non cyprinids such as Balitorids occur mostly in pool edges and cyprinids in big pools with varied habitat heterogeneity. Similar results were observed during the resent investigations having the diverse group of small fish species is restricted primarily to habitat which are shallow in depth and slow in water current velocity, which are the areas along stream margins in rifles and pools. In the Kumaun region of Wester Himalayas, small *Puntius* spp are confined to shallow low flow area and juveniles of big sized *Tor putitora* and *Schizothorax* used the shallow areas with the speed velocity of riffles and riffles-pool transition especially in Suyal stream. Stream assemblages dominated by short lived, rapidly maturing water column fishes generally show greater variability corresponding to environmental fluctuations, such as documented by Grossman et al (1982) and Ross et al (1987).

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