



Studies on Ichthyofaunal Diversity with special reference to Monthly and Seasonal variations of Fish Landings in glacial fed mountainous Goriganga River of Kumaun Himalaya, Uttarakhand, India

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Available online at: www.isca.in, www.isca.me

Received 26th February 2014, revised 6th March 2014, accepted 15th April 2014

Abstract

Freshwater Ichthyofaunal diversity and fish landings status of glacial fed Goriganga river, a major tributary of Kaliganga River of Pithoragarh district, Uttarakhand was studied from July 2006 to June 2008. Monthly sampling was carried out at three sampling stations (i.e. sampling station 1-Jauljibi, 600msl; Sampling station 2 -Baram 900msl and sampling station 3-Madkot 1300msl). The results and observations of the present study reveals that apart from being glacial fed, Goriganga river harbours colourful ichthyo-fauna. Some 20 (Twenty) indigenous fish species belonging to twelve genera (Schizothorax, Tor, Barilius, Labeo, Punctius, Garra, Nemacheilus, Pseudecheneis, Glyptosternum, Homaloptera, Barbus and Mastacembelus) and five families (Cyprinidae, Botinae, Sisoridae, Homalopteridae and Mastacembelidae) were identified in the collection. The family Cyprinidae was dominant with 13(65%) fish species followed by Botinae with 3 (15%) species, Sisoridae with 2(10%) species and Homalopteridae and Mastacembelidae with 01(5%) species each. Monthly, seasonal and site wise variations in fish landings including similarity and dissimilarity index among different fish species collected from selected sampling stations have also been discussed in the paper.

Keywords: Ichthyofaunal, diversity, fish landings, variations, goriganga, kumaun Himalaya.

Introduction

The Goriganga river originates from a dual source in a glacier near south of Untadhura ridge feeding the eastern branch and another glacier near Milam (3600 msl) just north east of Nanda Devi, feeding the western branch. This mixed glacier system offers breathe taking views that abounds in natural beauty. Goriganga is also fed by glaciers and streams flowing from the eastern slopes of the east wall of Nanda Devi sanctuary and those flowing west from the high peaks of Panchachuli, Rajramba and Chaudhara, including Ralamgad and the Pyunsmi gadhera. The Kalabaland- Burfu Kalganga glacier also flows in to the Goriganga valley from the east. Goriganga captures the entire gradient of Himalayan habitats ranging from subtropical sal to alpine meadows with in a distance of about 100 km of the river from its confluence to source. The breath taking beauty of Goriganga River, roaring down the zig-zag course, wide expanses of grassy meadows, a stupendous variety of flora and fauna, above all, pure nature unsullied, seem to beckon the beholder in to its folds in to a charmed world of virgin beauty. The total catchment area of the river is about 2230 sq.km. Out of which 346 sq.km is snow bound Joshi et.al.¹ and the whole stretch of river is 100 km. and the Goriganga River runs through the entire length of the valley.

Variety of fish species in any aquatic ecosystem is termed as ichthyo-diversity. Ichthyo-diversity is essential for stabilization of an aquatic ecosystem, protection of overall environmental

quality and for understanding the intrinsic worth of all species in water as well as on the earth and in crude way, it is referred to listing of species, their number and status in a particular region. Millions of human beings suffer from hunger and malnutrition and fishes form a rich source of food and provide a meal to tide over the nutritional difficulties of man. In addition to serving as an important item of food, fishes provide several by-products to us. Fishes have formed an important item of human diet from time immemorial and are primarily caught for this purpose. Fish diet provides proteins, fat and vitamins A and D. A large amount of phosphorous and other elements are also present in it. They have a good taste and are easily digestible. However, it is an ephemeral phenomenon and is more related to the social and economic development of the region. In fact Fishes are such biotic components of the aquatic ecosystem which makes shuttle between aquatic ecosystem and socio economic sector of the people of the catchments. The fishery industry with its products and byproducts also gives a large scope for employment and socio-economic welfare of the society. From economic point of view, fish stands as the important source of protein food for the increasing population of world, especially for protein starved developing countries. Fishes are treasured resource both in terms of utility of food and as material for scientific study. Fishes occupy several different levels of the aquatic food chain, make up to over 40 % of the earth's vertebrate species and are preyed upon by a few predatory animals and one another.

Leveque et.al.² have studied the global diversity of fish (Pisces) in fresh waters. According to them maximum 14035 fresh water fish species were reported from continent South America followed by 3553 species from Asia, 2945 species from Africa, 1411 species from North America, 330 species from Europe, 260 species from Oceania and minimum 206 fresh water fish species were reported from Russia. It is therefore, clear from the above observation made by Leveque et.al.² that continent Asia ranks second in fresh water fish diversity being South America ahead of it. Continent-wise fresh water fish diversity according to Leveque et.al.² shows the following distributional pattern as:

South America (14035 species) > Asia (3553 species) > Africa (2945) > North America (1411) > Europe (330 species) > Oceania (260 species) > Russia (206 species).

A considerable amount of literature is available on the fish and fishery of India by Jhingran^{3,4}, Mishra et.al.⁵; Mishra and Sharma⁶; Sharma et.al.⁷; Anon.⁸; and Sharma et.al.⁹. While Badola and Pant¹⁰ reported 18 species of fishes from some districts of Uttaranchal, Badola¹¹ reported 43 species of fishes from some districts of Garhwal, Badola and Singh^{12,13} reported 33 species of fishes from Chamoli districts of Uttaranchal, India. On the other hand Sing et.al.¹⁴ have published a geographical and distributional list of ichthyofauna and reported a total of 68 species of fishes from Garhwal Himalaya. Das and Pathani¹⁵ have also reported fish fauna of Kumaun lakes; Uniyal¹⁶ reported 132 species of fishes from Uttaranchal State. While as per CAMP-1998, 10 species are in the category of endangered and need immediate protection and 10 species are exotic in nature and introduced in the state for various reasons. While 11 species are endemic to the Uttarakhand State, which act as a flag ship for balancing the aquatic ecosystem. Although a few recent literature on fish diversity have been consulted Pandey¹⁷, Thirupathiah¹⁸, Gohil and Mankodi¹⁹, Kumar and Kumar²⁰ and sunita and Kanhere.²¹ But there is a little information available on the fish and fisheries of the Goriganga river. Therefore, the present venture is an attempt to study and to throw light on ichthyofaunal diversity, with monthly and seasonal variations of fish landings in the glacial fed mountainous Goriganga river of Kumaun Himalaya.

Material and Methods

Fishes were caught from different strata and mainly, the collections were made with the help of local fisher men and villagers using cast net, gill net, fatela jal, by hitting stones, angling using various types of bait viz. flour pellets, insects, earthworms etc. and various types of local traps and Teep method (a very popular method in the local area used for capturing fishes after rainy season). The different types of fishing methods were used in different seasons. Fishes soon after collection were brought to the laboratories of Zoology department S. S. J. Campus Almora and preserved in 10% formalin solution in separate jars according to the size of the species. Small fishes were directly placed in the 10% formalin

solution, while large fishes were giving and incision in their abdomen and preserved. Meristic and morphometric characters were measured and identified up to the species level, with the help of standard keys and books by Day²², Mishra²³, Jayaram^{24,25}, Qureshi and Qureshi²⁶, Srivastava^{27,28}, Talwar and Jhingran²⁹ and Jhingran³⁰. Monthly and seasonally, fish landing data were recorded from the local markets falling within the vicinity of respective sites and the percentage of fish production was done on the basis of fish catch during the entire course of study.

Results and Discussion

Identification of fish: It is interesting to note that apart from being glacial fed, Goriganga river harbours colourful ichthyofauna. Some 20 (Twenty) indigenous fish species belonging to twelve genera (*Schizothorax*, *Tor*, *Barilius*, *Labeo*, *Punctius*, *Garra*, *Nemacheilus*, *Pseudecheneis*, *Glyptosternum*, *Homaloptera*, *Barbus* and *Mastacembelus*) and five families (Cyprinidae, Botinae, Sisoridae, Homalopteridae and Mastacembelidae) were identified in the collection from July-2006 to June-2008 in the Goriganga river table-1.

Among these 20 fish species, four species of *Schizothorax* (*S. richardsonii*, *S. plagiosomus*, *S. progastus* and *S. kumaonensis*) exhibits 20.0 %; two species of *Tor* (*Tort or and T. putitora*) exhibited 10.0 %; two species of *Barilius* (*Barilius bendelisis* and *B. vagra*) have constituted 10.0 %; one species of *Barbus* (*Barbus chillinoides*) constituted 5.0 %; two species of *Labeo* (*Labeo dyocheilus* and *L. dero*) constituted 10.0 %; one species of *Punctius* (*Punctius ticto*) constituted 5.0 %; one species of *Garra* (*Garra gotyla*) constituted 5.0 %; three species of *Nemacheilus* (*Nemacheilus rupicola*, *N. monatus* and *N. beavani*) constituted 15.0 %; one species of *Glyptosternum* (*Glyptosternum pectinopterum*) constituted 5.0 %; one species of *Pseudecheneis* (*Pseudecheneis sulcatus*) constituted 5.0 %; one species of *Homaloptera* (*Homaloptera brucei*) constituted 5.0 % and one species of *Mastacembelus* (*Mastacembelus armatus*) constituted 5.0 % in the present study. During first year (2006-07), the maximum 20 fish species were recorded at spot-1 Jauljibi followed by 15 fish species at spot-2 Baram and the minimum 8 fish species were recorded at spot-3 Madkot table-1; while during the second year (2007-08), the maximum 15 fish species were again recorded at spot-1 Jauljibi, 12 fish species at spot-2 Baram and the minimum 8 species were again recorded at spot-3 Madkot table-1. During both the years ichthyofaunal diversity of Goriganga river at three spots followed the distributional pattern as: spot-1 (20 and 15 fish species) > spot-2 (15 and 12 fish species) > spot-3 (8 and 8 fish species) during 2006-07 and 2007-08, respectively table-1.

The spot-1 (Jauljibi) appeared to be the richest site of ichthyofaunal diversity (20 and 15 fish species) while spot-3 Madkot appeared to be the poorest site of ichthyofaunal diversity (08 and 08 fish species) during 2006-07 and 2007-08 respectively in the study table-1.

Table-1
Qualitative composition of ichthyofauna at three spots in the Goriganga river during 2006-07 and 2007-08

S.No	Genera / species	July 2006- June 2007			July 2007- June 2008		
		Spot-1. (Jauljibi)	Spot-2. (Baram)	Spot-3. (Madvot)	Spot-1. (Jauljibi)	Spot-2. (Baram)	Spot-3. (Madvot)
1.	<i>Schizothorax richardsonii</i>	+	+	+	+	+	+
2.	<i>S. plagiostomus</i>	+	+	+	+	+	+
3.	<i>S. progastus</i>	+	+	+	+	-	-
4.	<i>S. kumaonensis</i>	+	-	-	-	-	-
5.	<i>Tor tor</i>	+	+	-	+	-	-
6.	<i>Tor putitora</i>	+	+	+	+	+	+
7.	<i>Barrilius bendelisis</i>	+	+	+	+	+	-
8.	<i>B. vagra</i>	+	+	-	+	+	-
9.	<i>Labeo dero</i>	+	+	-	-	-	-
10.	<i>L. dyocheilus.</i>	+	-	-	+	-	-
11.	<i>Puntius ticto</i>	+	-	-	-	+	-
12.	<i>Barbus chillinoides</i>	+	+	+	+	+	+
13.	<i>Garra gotyla</i>	+	+	-	+	+	+
14.	<i>Nemacheilus rupicola</i>	+	+	-	+	+	+
15.	<i>N. monatus</i>	+	-	-	+	-	-
16.	<i>N. beavani</i>	+	+	-	-	-	-
17.	<i>Pseudecheneis sulcatus</i>	+	+	+	+	+	+
18.	<i>Glyptosternum pectinopterum</i>	+	+	+	+	+	+
19.	<i>Homaloptera brucei</i>	+	-	-	-	-	-
20.	<i>Mastacembelus armatus</i>	+	+	-	+	+	-
Total		20	15	8	15	12	8

{+ = present and - = absent}.

Table-2
Seasonal distribution of ichthyofauna in the Goriganga river during 2006-07 and 2007-08

S.No	Genera / species	Summer	Monsoon	Winter
1.	<i>Schizothorax richardsonii</i>	+++	+++	+++
2.	<i>S. plagiostomus</i>	+++	++++	+++
3.	<i>S. progastus</i>	++	++	++
4.	<i>S. kumaonensis</i>	++	++	++
5.	<i>Tor tor</i>	++	++	++
6.	<i>T. Putitora</i>	++	++	++
7.	<i>Barrilius bendelisis</i>	+	+	+
8.	<i>B. vagra</i>	+	+	+
9.	<i>Labeo dero</i>	++	-	-
10.	<i>L. dyocheilus.</i>	++	-	-
11.	<i>Puntius ticto</i>	+	-	-
12.	<i>Barbus chillinoides</i>	+	-	-
13.	<i>Garra gotyla</i>	++	++	++
14.	<i>Nemacheilus rupicola</i>	+	+	+
15.	<i>N. monatus</i>	+	+	+
16.	<i>N. beavani</i>	+	+	+
17.	<i>Pseudecheneis sulcatus</i>	*	+++	*
18.	<i>Glyptosternum pectinopterun</i>	*	+++	*
19.	<i>Homaloptera brucei</i>	-	-	+
20.	<i>Mastacembelus armatus</i>	+	+	+

{+ = present; ++ = normal; +++ = abundance; - = absent and * = very rare}

Table-3
Monthly variations in fish landings / production at three spots in the Goriganga river during 2006-07 and 2007-08

Months	Fish landing / Production (kg/month)					
	July -2006 to June- 07			July-2007 to June-2008		
	Jauljibi. (Spot-1)	Baram. (Spot-2)	Madkot. (Spot-3)	Jauljibi. (Spot-1)	Baram. (Spot-2)	Madkot. (Spot-3)
July	120.00	60.00	12.00	90.00	36.00	0.00
Aug	90.00	30.00	15.00	90.00	30.00	12.00
Sept	105.00	45.00	18.00	105.00	90.00	18.00
Oct.	90.00	30.00	24.00	90.00	60.00	15.00
Nov	90.00	60.00	24.00	90.00	51.00	30.00
Dec	90.00	60.00	15.00	90.00	30.00	12.00
Jan	90.00	45.00	27.00	105.00	45.00	15.00
Feb	75.00	30.00	15.00	120.00	75.00	24.00
Mar	108.00	60.00	24.00	75.00	30.00	18.00
Apr	90.00	60.00	24.00	96.00	30.00	09.00
May	120.00	75.00	30.00	126.00	87.00	30.00
Jun	135.00	60.00	12.00	75.00	30.00	0.00
Total	1203	615	240	1152	594	183
Annual Mean	100.25	51.25	20.00	96.00	49.5	15.25
Annual (%)	58.45%	29.88%	11.66%	59.72%	30.79%	9.48%
S.D.	17.420	14.943	6.179	15.666	23.185	9.780

Table-4
Seasonal variations in fish landing / production at three spots in the Goriganga river during 2006-07 and 2007-08

Seasons	Fish landing / Production (kg/month)					
	July -2006-June- 07			July-2007-June-2008		
	Jauljibi (Spot-1)	Baram (Spot-2)	Madkot (Spot-3)	Jauljibi (Spot-1)	Baram (Spot-2)	Madkot (Spot-3)
Monsoon	112.5	48.75	14.25	90.0	46.5	7.5
Winter	90.0	48.75	22.5	93.75	46.5	18.0
Summer	123.25	56.25	23.25	104.25	55.5	20.25

Table-5
Similarity and dissimilarity index among the different fish species identified in Goriganga river during 2006-07 and 2007-08 at all the spots in the study

Genera	Similarity index		Dissimilarity Index	
	2006-07	2007-08	2006-07	2007-08
1.Schizothorax	0.6	0.57	0.4	0.43
2. Tor	0.34	0.5	0.66	0.5
3. Barilius	0.4	0.0	0.6	1.0
4. Barbus	0.6	0.66	0.4	0.34
5. Labeo	0.6	0.0	0.4	1.0
6. Punctius	0.0	0.0	1.0	1.0
7. Garra	0.0	0.66	1.0	0.34
8.Nemacheilus	0.0	0.5	1.0	0.5
9. Pseudecheneis	0.6	0.66	0.4	0.34
10.Glyptosternum	0.6	0.66	0.4	0.34
11. Homapoptera	0.0	0.0	1.0	1.0
12. Mastacembelus	0.0	0.0	1.0	1.0

Monthly qualitative composition of ichthyo-faunal diversity at different spots in the Goriganga river during 2006-07 and 2007-08 has been depicted in tables-6,7,8 and figures 1 and 2.

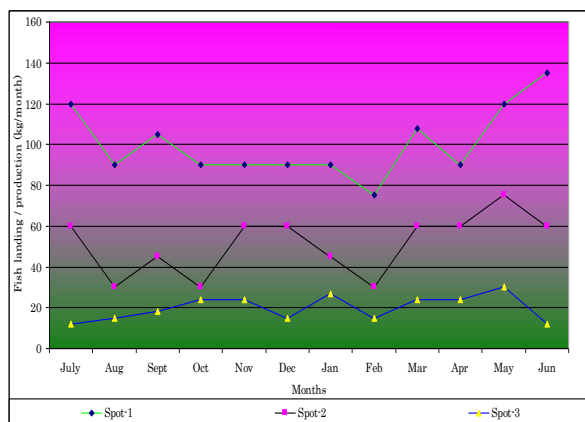


Figure-1

Monthly variations in fish landings / production at three spots in the Goriganga river during 2006-07

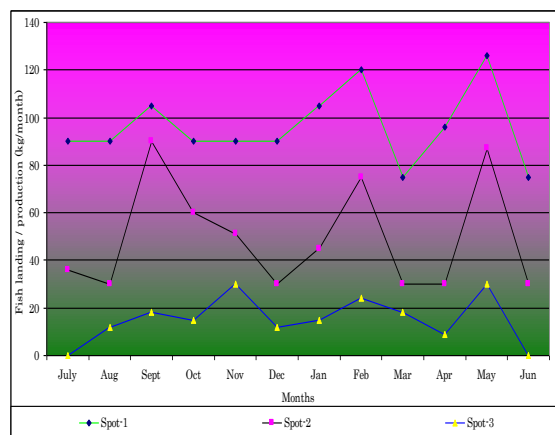


Figure-2

Monthly variations in fish landings / production at three spots in the Goriganga river during 2007-08

During first year (2006-07), the maximum (13) fish species were recorded in the month of July followed by December and September (12), January and April (11), August and May (9), October, February, March and June (8) and the minimum (06) fish species were recorded in the month of July at spot-1 Jauljibi, table-6 and figure 1; at spot-2 (Baram), the maximum (12) fish species were recorded in the months of December and April followed by November and May (11), October (10), September and February (9), August, January and June (8), March (06) and the minimum (05) fish species were recorded in the month of July table-7 and figure-1, whereas at spot-3 (Madkot), the maximum (06) fish species were recorded in the months of August and June followed by September, November and December (05), July, October, January and March (04) and the minimum (03) fish species were recorded in the month of May table-8 and figure-1.

During second year (2007-08), the maximum (12) fish species were recorded in the month of October followed by September, November and December (10), August, January and May (09), June (08) and the minimum (07) fish species were recorded in the months of July, February, March and April at spot-1 Jauljibi, table-6 and figure-2; at spot-2 (Baram), the maximum (11) fish species were recorded in the month of April followed by November and December (10), January and May (08), July, October, February and March (07), September and June (06) and the minimum (05) fish species were recorded in the month of August table-7 and figure-2, while at spot-3 (Madkot), the maximum (06) fish species were recorded in the months of July, October, April and June followed by September, November, December March and May (05), January and February (04) and the minimum (03) fish species were recorded in the month of August table-8 and figure-2 in the present study.

A maximum 13 (65.0 %) fish species belong to family Cyprinidae followed by 03 (15.0 %) species to Botinae, 02 (10.0 %) species to Sisoridae, and the minimum 01 (5.0 %) species to Homalopteridae and Mastacembelidae each were recorded in the present study tables 6,7 and 8. On the basis of present survey it was observed that maximum number of fish species were recorded from downstream as compared to the upstream or in other words, it was observed that ichthyofaunal-diversity increased from upstream to downstream (i.e. from high altitude to low altitude) in Goriganga river during 2006-07 and 2007-08 in the study table-1. Altitudinal distributions of Himalayan fishes are clearly distinguished by their body built modifications. The movement of fishes upwards and downwards from their natural habitats is affected by the water current (flood), temperature, nature of substrate, availability of food and their breeding activity. Extensive and intensive ichthyo-faunal surveys in Goriganga river depicted enormous potential of colourful ichthyo-fauna in its selected sampling stations and tributaries (Routes gad / Gargia gad, Gossi gad, Shera gad etc.). The occurrence of fish species in different seasons of the year at all the selected spots is not same table-2. The fish species *Schizothorax richardsonii*, *S. plagiostomus*, and *T. putitora* were in abundance throughout the study period at all the selected spots, while cat fishes (*Pseudecheneis sulcatus* and *Glyptosternum pectinopterus*) were recorded more in numbers during rainy (monsoon) season than any other season of the year in the study table-2. Some species of fishes (*Schizothorax richardsonii*, *S. plagiostomus*, *Tor putitora*, *Barbus chillinoides*, *Pseudecheneis sulcatus* and *Glyptosternum pectinopterus*) were commonly present at all the selected spots table-2 during the entire course of study.

Fish Landings: Monthly, seasonal and site-wise variations in fish landing have been recorded at three selected spots in the Goriganga river from June 2006 to July 2008 in the present study tables-3 and 4.

The monthly fish landing (catch data) of two years (2006-07 and 2007-08) are furnished in the tabl-3. The total fish landing

were recorded as 2058 kg (20.58 quintals) and 1929 kg (19.29 quintals) for 2006-07 and 2007-08, respectively in the Goriganga river. During first year (2006-07), monthly fish landing ranged from 75.0 kg (February) to 135.0 kg (June) at spot-1, 30.0 kg (August, October and February) to 75.0 kg (May) at spot-2 and from 12.0 kg (June and July) to 30.0 kg (May) at spot-3; while during second year (2007-08) it ranged from 75.0 kg (March and June) to 120.0 kg (February) at spot-1, 30.0 kg (August, December, March, April and June) to 90.0 kg (September) at spot-2 and from 0.0 kg (June and July) kg to 30.0 kg (November) at spot-3 in the Goriganga river Table-3. The maximum fish landings during 2006-07 was recorded at spot-1 Jauljibi (1203 kg-58.45%) followed by spot-2 Baram (615 kg- 29.88%) and the minimum fish landings was recorded at spot-3 (240 kg- 11.66%), while during second year (2007-08), the maximum fish landing was again recorded at spot-1 Jauljibi (1152 kg- 59.72 %) followed by spot-2 Baram (594 kg- 30.78%) and the minimum (183 kg- 9.48 %) were again recorded at spot-3 Madkot Table-3. It was observed that, the maximum fish landing was recorded at spot-1 (Jauljibi) and the minimum at spot-3 (Madkot) during 2006-07 and 2007-08 in the study and on the basis of this observation it is concluded that spot-1 (Jauljibi) appeared to be the richest site of fish landing and spot-3 (Madkot) appeared to be the poorest site of fish landing table-3. The highest annual mean values were recorded at spot-1 Jauljibi (100.25 kg/month and 96.00 kg/month), while the lowest annual mean was recorded at spot-3 Madkot (20.00 kg/month and 15.25 kg/month) during 2006-07 and 2007-08, respectively table-3.

It is also observed that the fish landings decreased from downstream to upstream or altitudinally fish landings increase with the decrease in altitude in the Goriganga river table-3. It was also observed that the fish landings was high during the summer season (123.25 kg/month, 56.25 kg/month and 23.25 kg/month) and (104.25 kg/month, 55.5 kg/month and 20.25 kg/month) at spo-1, spot-2 and spot-3 during first year (2006-07) and second year (2007-08), respectively table-4 and Figs-3,4. While it was low in winter at spot-1(90.00 kg/month) and in monsoon at spot-2 (48.75 kg/month) and spot-3 (14.25 kg/month) during 2006-07 table-4 and figure-3. The low fish production was recorded during monsoon season (90.00 kg/month, 46.5 kg/month and 7.5 kg/month) at spot-1, spot-2 and spot-3, respectively during second year in the study table-4 and figure-4. The fish landing data showed fluctuations of fish catches in different months and seasons of the year, as well as year to year also tables-4. On the basis of present fish landing data, a slightly decreasing trend of fishery was observed in the Goriganga river which needs proper and immediate attention to save the colourful ichthyo-fauna of glacial fed mountainous Goriganga river of Kumaun Himalaya.

Similarity and dissimilarity index among the different fish species identified at selected sampling stations in the Goriganga river during 2006-07 and 2007-08 has been attempted in the present study and depicted in the table-5 and figs-5 and 6. On

the perusal of table-5, it is clear that the maximum similarity ($s = 0.6$) was observed among the species of *Schizothorax*, *Barbus*, *Labeo*, *Pseudecheneis* and *Glyptothorax*, while the minimum ($s = 0.00$) was among the species of *Punctius*, *Garra*, *Nemacheilus*, *Homaloptera*, and *Mastacembelus* during 206-07 figure-5. During 2007-08, the maximum similarity ($s = 0.66$) was among the species of *Barbus*, *Garra*, *Pseudecheneis* and *Glyptothorax*, while the minimum similarity ($s = 0.00$) was among the species of *Barilius*, *Labeo*, *Homaloptera*, and *Mastacembelus* figure-6 in the present study.

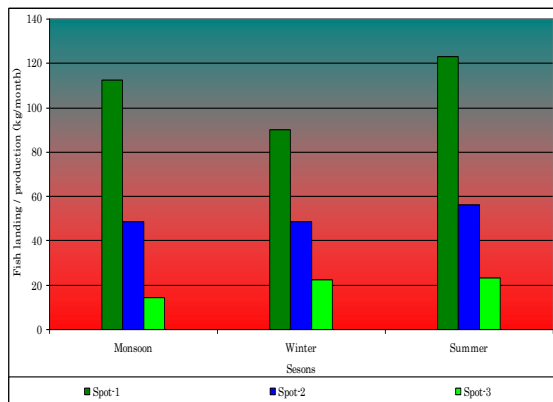


Figure-3
 Seasonal variations in fish landings / production at three spots in the Goriganga river during 2006-07

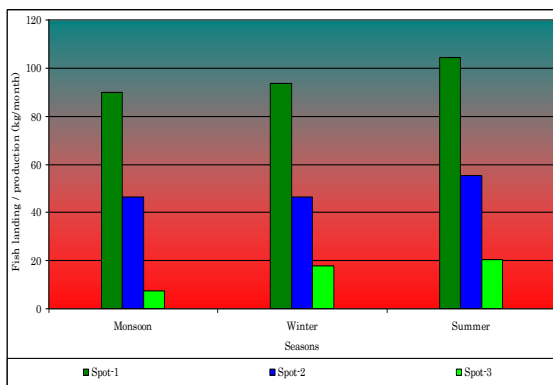


Figure-4
 Seasonal variations in fish landings / production at three spots in the Goriganga river during 2007-08

Discussion: The observations made on the ichthyofaunal-diversity and variations of fish landings of Goriganga river from July 2006 to June 2008, showed monthly, seasonally, yearly and altitudinal variations in the present study. During the course of study, some 20 indigenous fish species which belong to coldwater species of fishes have been recorded from the different selected spots of Goriganga river, belongs to 12 genera (*Schizothorax*, *Tor*, *Barilius*, *Labeo*, *Punctius*, *Garra*, *Nemacheilus*, *Pseudecheneis*, *Glyptosternum*, *Homaloptera*, *Barbus* and *Mastacembelus*) and 05 families (Cyprinidae, Botinae, Sisoridae, Homalopteridae and Mastacembelidae. The

Cyprinidae family is richest (13 species-65.00%) followed by Botinae (03 species-15.00%), Sisoridae (02 species-10.00%) and Homalopteridae and Mastacembelidae (01 species each-5.00%). It is interesting to note that the *Schizothorax richardsonii*, *S. plagiostomus*, *Tor putitora*, *Barbus chillinoides*, *Glyptosternum pectinopterum*, *Pseudecheneis sulcatus* found and caught from all the spots but in different seasons of the year. Economically important fishes of the area are *Schizothorax richardsonii*, *S. plagiostomus*, *Tor tor*, *T. putitora* and *Garra gotyla*, the most relished fishes of the Kumaun Himalaya. It was observed that approximately 29 families of fishermen from different villages of Goriganga basin (13 at Jauljibi, 9 at Baram and 7 at Bangapani and Sheraghat) and 04 families of fish farmers (one at Jauljibi, 02 at Gargia and 01 at Baram) are involved in fishing for their livelihood on these food fishes of the river.

quintals-51.61%) while it was 1929 kg (19.29 quintals-48.25%) during 2007-08. A slight decreasing trend of fish landing / production was observed during second year in the study.

Maximum fish landing / production (1203 kg – 30.17% and 1152 kg – 28.895) was recorded at Jauljibi (spot-1), while minimum fish landing / production (240 kg – 6.01% and 183 kg – 4.58%) was noticed at Madkot (spot-3) during 2006-07 and 2007-08, respectively. Jauljibi appeared to be the richest site whereas Madkot to be the poorest site of fish production during both the years in the study. Spot wise variations of fish landing / production in Goriganga river from July 2006 to June 2008 followed the pattern as: spot-1 (2355 kg-59.06%) > spot-2 (1209 kg- 30.32%) > spot (423 kg- 10.60%). Altitudinally, fish landing / production decreases with the increase in altitude (increases from upstream to downstream).

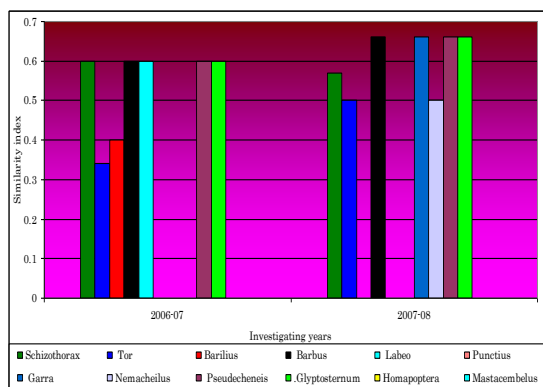


Figure-5

Similarity and index among different species of fishes in the Goriganga river during 2006-07

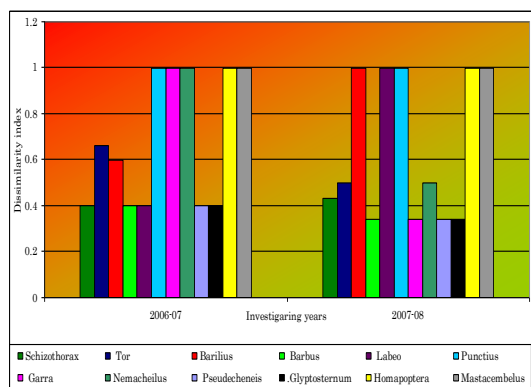


Figure-6

Similarity and index among different species of fishes in the Goriganga river during 2007-08

Various data on fish landing have been recorded to access the monthly, seasonal and annual variations in their production at different selected sites from July, 2006 to June, 2008 in the Goriganga river. Total fish landings / production during both the years at all the sites was recorded as 3987 kg (39.87 quintals). Fish landing / production during 2006-07 was 2058 kg (20.58

Seasonally, maximum fish landing / production was observed in summer while minimum was in monsoon and winter, due to the reason that fish landing / production was greater during moderate water level (summer) than during increased water level (monsoon). Most of the fishes in Uttarakhand state are potamodromous and few are migratory which are struggling hard to survive due to fragmentation of their aquatic habitats Sharma³¹. The fishery operations in Goriganga river are curtailed due to very fast water flow and the fisheries include only the fish species with either strong power of locomotion or special organs of attachment. Therefore, snow trout, Mahseer and some minor carps constitute the major fishery of the Goriganga river. Fish species belonging to *Schizothorax* genera makes the maximum contribution to the fishery of the concerned water body at all the spots during both years (2006-07 & 2007-08). It is well known that *Schizothorax richardsonii* is highly esteemed as food fish in most of the Himalayan states and highly preferred by fish eaters.

The species of *Labeo*, *Pseudecheneis*, *Barbus* and *Glyptosternum*, also forms small part of the fish community of the Goriganga river. The species of *Noemacheilus*, *Puntius*, *Barilius*, *Homaloptera* and *Mastacembelus* are rare in the main river, but they occur in abundance in its tributaries such as Routes gad, Gossi gad, Shera gad etc.

The glacial fed Goriganga river flow with high speed among boulders between the hard rocks at high altitude. The rocky bottom which results in the occurrence of rare fishes hiding under crevices and boulders. The siluroid fishes (cat fishes- *Pseudecheneis* and *Glyptosternum*) are found in these conditions and they have developed special adhesive organs for attaching to any hard surface, so these fishes hide themselves below boulders with the help of such specialized organs. It was observed that the catch percentage of such fishes were high during the rainy season. The reason behind this is that during rainy season due to furious flow of the river the fishes are detached from the boulders and come to the surface, so caught easily. After rainy season the flow becomes moderate and the

fishes again inhabits the crevices of rocky bottom and becomes difficult to catch these siluroid fishes. In the winter months when the water level comes down hammering method, hand

pinking, diversion of rivulets water are used to catch fishes from the river and its tributaries.

Table-6

Monthly qualitative composition of ichthyo- faunal diversity at spot-1 (Jauljibi) in the Groriganga river during 2006-07 and 2007-08

	Monthly qualitative composition of ichthyo- faunal diversity at spot-1 (Jauljibi) in the Groriganga river during 2006-07 and 2007-08.																							
	July		Aug		Sept		Oct		Nov		Dec		Jan		Feb		March		Apr		May		Jun	
Cyprinidae:	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
<i>Schizothorax richardsonii</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>S. plagiostomus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>S. progastus</i>	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-	+	+	-	-	-	-	-	-	-
<i>S. kumaonensis</i>	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tor tor</i>	-	+	+	+	+	-	+	-	+	+	-	+	+	-	-	-	-	+	-	+	-	-	-	-
<i>Tor putitora</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Barrilius bendelisis</i>	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	-	-	-	-
<i>B. vagra</i>	-	-	-	-	+	-	-	+	-	+	+	-	-	-	-	-	-	+	+	+	+	-	-	-
<i>Labeo dero</i>	-	-	+	+	+	+	+	-	-	-	-	-	+	-	+	-	-	+	-	-	+	-	-	+
<i>Labeo dyocheilus</i>	-	-	-	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	+	-	+	+	+	+
<i>Puntius ticto</i>	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	+	+	+	+	-	-
<i>Barbus chillinoides</i>	+	+	-	-	+	+	-	+	+	-	+	+	-	+	+	+	-	+	+	-	+	-	+	+
<i>Garra gotyla</i>	+	-	+	+	+	+	+	+	+	+	+	+	+	-	+	-	+	+	+	-	+	-	+	-
Botinae:																								
<i>Nemacheilus rupicola</i>	-	-	-	+	+	+	+	+	+	+	+	+	+	-	-	+	+	+	-	+	-	+	-	-
<i>N. monatus</i>	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-
<i>N. beavani</i>	-	-	-	-	-	+	-	+	+	-	+	-	-	-	+	-	+	-	-	-	-	-	-	-
Sisoridae:																								
<i>Pseudecheneis sulcatus</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
<i>Glyptosternum pectinopterun</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Homapopteridae:																								
<i>Homaloptera brucei</i>	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mastacembelidea:																								
<i>Mastacembelus armatus</i>	-	-	-	+	+	+	-	+	+	+	+	+	+	-	-	+	-	+	-	+	+	-	-	-
Total	07	07	09	09	12	10	08	12	13	10	12	10	11	09	08	07	08	07	11	07	09	09	08	08
(I = during 2006-07; II = during 2007-08; + = present and - = absent)																								

Table-7
Monthly qualitative composition of ichthyo- faunal diversity at spot-2 (Baram) in the Groriganga river during 2006-07 and 2007-08

Genera / species	Monthly qualitative composition of ichthyo- faunal diversity at spot-2 (Baram) in the Groriganga river during 2006-07 and 2007-08																							
	July		Aug		Sept		Oct		Nov		Dec		Jan		Feb		March		Apr		May		Jun	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Cyprinidae:																								
<i>Schizothorax richardsonii</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>S. plagiostomus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>S. progastus</i>	-	-	+	-	+	-	+	+	+	+	+	+	-	+	+	-	+	-	+	-	-	-	+	-
<i>S. kumaonensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tor tor</i>	-	-	+	-	-	-	-	-	-	-	+	-	+	-	+	-	+	+	+	-	+	+	-	-
<i>Tor putitora</i>	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>Barrilius bendelisis</i>	-	-	-	-	+	-	+	-	+	-	+	+	-	+	-	+	-	+	+	+	+	-	-	-
<i>B. vagra</i>	-	-	-	-	+	-	-	-	+	-	-	+	+	-	-	-	-	+	-	+	-	+	-	-
<i>Labeo dero</i>	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	-	-	+	-	+	-	-	-
<i>L. dyocheilus</i>	-	+	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	-	+	-	+	-	-
<i>Puntius ticto</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Babbus chillinoides</i>	-	+	-	+	+	+	+	+	+	+	+	+	+	-	+	+	-	-	+	+	+	+	+	-
<i>Garra gotyla</i>	-	+	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+	+	+	-
Botinae:																								
<i>Nemacheilus rupicola</i>	-	-	-	-	+	-	+	-	+	-	+	+	-	-	+	+	-	-	+	+	+	-	-	+
<i>N. monatus</i>	-	-	-	-	-	+	-	+	-	+	-	-	-	+	-	-	-	-	-	+	-	-	-	-
<i>N. beavani</i>	-	-	-	-	-	-	+	-	-	-	+	-	+	-	-	-	-	-	+	-	+	-	-	-
Sisoridae:																								
<i>Pseudecheneis sulcatus</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
<i>Glyptosternum pectinopterun</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Homapopteridae:																								
<i>Homaloptera brucei</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mastacembelidea:																								
<i>Mastacembelus armatus</i>	-	-	-	-	+	-	-	-	+	-	+	+	-	-	-	+	-	-	+	+	+	-	-	-
Total	05	07	08	05	09	06	10	07	11	10	12	10	08	08	09	07	06	07	12	11	11	08	08	06

(I = during 2006-07; II = during 2007-08; + = present and - = absent)

According to Dwivedi et.al.³² “In inland fisheries of India and future prospectus”, they reported that at global level 85 % of the world fish production comes from the ocean and only 15% is contributed by fresh water. However, in India the picture is different. During 1950s marine fisheries contributed about 70 % and inland fisheries only 30 %. Now after over 50 years, inspite of low investments in inland fisheries sector, inland fish production has grown at a faster rate as compared to marine fisheries. During the year 2003, it was estimated that the contribution of fish production from inland waters had increased from 30 % to 50 % and contribution of marine fish production to total Indian fish production has come down from 70 % to 50 %. It is estimated that in next ten years inland fisheries of India will contribute 60 % of total Indian fish landings.

Further it may be noted that the average selling price of fresh water fishes varies between Rs. 40 to Rs. 90 per kg., whereas marine fishes are sold at around Rs. 30 to Rs. 50 per kg, indicating that fresh water fishes are priced high as compared to marine fishes. Few years ago ICAR had made a comparative study of income from different sectors, which showed that

agriculture, dairy and fishery were most productive, providing a return of the order of Rs. 72,000 per ha. Dwivedi et.al.³³

It seems that glacial fed Goriganga river is suitable for fish diversity and its population even at the present time but the size of large fishes is dwindling in the river. it may have many causes (pollution, dynamiting, mass fish killing, low meshed nets, poisoning, fish catch during breeding season, water diversion, use of agricultural biocides, unawareness to fishermen etc.). In Kumaun Himalaya, development of fisheries have not been taken up seriously by the concerning authorities. A large number of derelict water bodies are untouched and are in the verge of swampification. These water bodies require urgent attention for demonstration and extension of scientific fish culture techniques to make people aware towards the fish farming to enhance fish production Pathani³³. Goriganga river harbours rich fish fauna at present and if the present status of the river system is maintained through strategic water quality management measures (because fishes live in intimate contact with their environment and are therefore, very susceptible to physical and chemical changes), it will ensure a sustainable aquatic environment capable of producing the fish protein food of the populace and enhance the people’s livelihood.

Table-8
Monthly qualitative composition of Ichthyo- faunal diversity at spot-3 (Madkot) in the Goriganga river during 2006-07 and 2007-08

Genera / species	Monthly qualitative composition of Ichthyo- faunal diversity at spot-3 (Madkot) in the Goriganga river during 2006-07 and 2007-08.																							
	July		Aug		Sept		Oct		Nov		Dec		Jan		Feb		March		Apr		May		Jun	
	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Cyprinidae:																								
<i>Schizothorax richardsonii</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>S. plagostomus</i>	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
<i>S. progastus</i>	-	-	-	-	+	-	+	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	-	-
<i>S. kumaonensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tor tor</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tor putitora</i>	-	+	+	-	+	+	+	+	+	-	+	-	+	+	-	+	+	+	-	+	+	+	+	-
<i>Barrilius bendelisis</i>	-	-	-	-	-	-	-	-	+	-	+	-	+	-	-	-	-	+	-	-	-	-	-	-
<i>B. vagra</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Labeo dero</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>L. dyocheilus.</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Puntius ticto</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Barbus chillinoides</i>	-	-	+	-	+	+	-	+	+	+	-	+	-	+	-	+	+	+	-	+	-	+	+	-
<i>Garra gotyla</i>	-	+	-	+	-	-	-	+	-	+	-	+	-	-	-	-	-	+	-	+	-	+	-	+
Botinae:																								
<i>Nemacheilus rupicola</i>	-	-	-	-	-	+	-	+	-	+	-	+	-	-	-	-	-	-	-	+	-	-	-	-
<i>N. monatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>N. beavani</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sisoridae:																								
<i>Pseudecheneis sulcatus</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
<i>Glyptosternum pectinopteron</i>	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Homapopteraidae:																								
<i>Homaloptera brucei</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Mastacembelidea:																								
<i>Mastacembelus armatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total.	04	06	06	03	05	05	04	06	05	05	05	05	04	04	03	04	04	05	03	06	03	05	06	05

(I = during 2006-07; II = during 2007-08; + = present and - = absent)

For conservation of dwindling fish diversity, ecological as well as anthropogenic stresses must be removed at the first phase, scientific gear and mesh sizes needs to be regulated to protect the juvenile fishes. Mass awareness for conservation of valuable fish stocks may be explored through extension and by voluntary agencies. Further the involvement of entire scientific community in the drive is quite necessary and the involvement of voluntary organizations would always remain highly significant in accomplishing the task. Causes of decline of fish and fishery in Kumaun rivers with various suggestions have already been made by Pathani^{34,35}.

Various causes like unscientific methods of fish catching, unscientific human interferences, over fishing, dynamiting, fishing during spawning season, use of bleaching powder and ichthyotoxic plants in the shallow breeding grounds of tributaries were assessed to be responsible for declining trend of fishery in the Goriganga river. These are the cruel methods by

which not only the adults of edible size are killed, but all the stages of fish life are destroyed and the natural habitat of the fish is also polluted. The pollution of the river by flash floods, landslides, and soil erosion etc. have also been responsible for the depletion of the fish fauna Badola and Singh³⁶. Habitat destruction, alteration in ecological conditions of aquatic resources, deforestation, soil erosion, silting, water currents alterations, forest denudation, unscientific developmental activities and over-grazing along slopy catchments erode soil structure and cause decline in fish production. Siltation from catchment areas of the river has destructed breeding and feeding grounds of many fishes. Pesticides washing from agricultural fields have also been created detrimental environment for fish life in the water.

The fragile mountain ecosystems and native fish germplasm resources are our national wealth and pride. All flora and fauna of the upland water system have coevolved during the course of

organic evolution for their mutual benefit. Any species getting extinct would upset the ecological balance causing detrimental to each and every other species. Let us all join in protection and conservation of fish diversity in particular and biodiversity in general not only in Goriganga river but in the country as a whole, because it is the need of the hour. On the behalf of the present study, it was observed that for proper fishery management, it is desirable to impose a ban on illegal fishing and fishing during the breeding season (pre-spawning and spawning season) should be strongly prohibited and the most important thing is that provisions should be made by the concerned authorities or department to educate the people especially the fishermen, fish farmers and fish vendors of the catchment area (Goriganga basin) for the conservation of existing colourful ichthyofana of the Goriganga river.

Conclusion

The present study would give preliminary knowledge on the Ichthyofaunal diversity and reasons for monthly, seasonal and site wise variations of fish landings at different sampling stations. In the present investigation the qualitative composition of fish species during July-2006 to June-2008, it was cyprinidae 13 species 65%, Botinae 3 species 15%, Sisoridae 2 species 10% and Homalopteridae and Mastacembelidae with 01 species each 5%. The fish species *Schizothorax richardsonii*, *S. plagiostomus*, and *T. putitora* were in abundance throughout the study period at all the selected spots, while cat fishes (*Pseudecheneis sulcatus* and *Glyptosternum pectinopteron*) were recorded more in numbers during rainy (monsoon) season than any other season of the year in the study. Some species of fishes (*Schizothorax richardsonii*, *S. plagiostomus*, *Tor putitora*, *Barbus chillinoides*, *Pseudecheneis sulcatus* and *Glyptosternum pectinopteron*) were commonly present at all the selected spots during the entire course of study. It was also observed that ichthyofaunal-diversity including quantitative estimation increased with the decrease in altitude in the river. Fish landings was high in the summer season during 2006-07 and 2007-08, While it was low in winter at spot-1 in monsoon and at spot-2 and spot-3 during 2006-07, whereas during 2007-08, low fish production was recorded during monsoon season at all the selected stations, in the study.

Acknowledgements

The author is thankful to the Utrakhnad Council of Science and Technology (UCOST), Dehradun for providing financial support to carry out this work very successfully.

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