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Effect of impoundment on fish abundance and distribution in Kishanganga River (J&K)

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Abstract
The Kishanganga hydroelectric project constructed across river Kishanganga are in operation from several years. The impoundment have changed the hydrological features which have directly effected the fish abundance and distribution in the river. Therefore the impact of hydroelectric project on fishery resources of Kishanganga river is a matter of great concern. The change in different parameters of water body might have brought fishes under stress and thus directly effected there abundance and distribution across the river.

Keywords: Impoundment, Fish distribution and abundance, Kishanganga

Introduction
The Kishanganga Hydroelectric Project is located on river Kishanganga, a tributary of river Jhelum, in Bandipora district of Jammu & Kashmir. The project involves a 37m high concrete faced rockfill dam and an underground powerhouse. A maximum gross head of 665 m is utilized to generate 1350 Million Units of energy, in a 90% dependable year with an installed capacity of 3x110 MW. An additional energy generation of 312.62 MUs at Uri-I and Uri-II HE Projects would be available after completion of Kishanganga HE Project

Morphometric features of Kishanganga River	
Region	Kashmir
Tributaries	Left – Sindh river, Lidder River
Source	Krishnasar Lake at Sonamarg, India

Devi *et al.*, (1979) [2], has envisaged thermal pollution as one of the factors responsible for causing environmental hazard. Most researchers have worked on the fish fauna of Jammu and Kashmir. Some of the recent works are that of (Quresh*i et al., 2006,* Salman *et al., 2006,* Arjumand *et al., 2006 and* Qureshi *et al., 2007,)* [7, 8, 1, 9]. Scientists have also worked on the temperature regime of the water bodies of Kashmir valley (Wanganeo *et al*., 1992, Yousuf *et al.*, 1995) [13, 15] but very less work is available on the effect of thermal pollution on the fish abundance and distribution in this area. Therefore, this piece of work was undertaken for investigating the same in river Kishanganga in Jammu and Kashmir

Material and Methods
Study Sites
Study Sites
For the present investigation, following sampling sites were selected on the basis of accessibility, vegetation, and nearness below and above the dam site. Two sampling stations were selected from each site. The description of study sites is given as under:

Above Dam Site
Sampling site A
It was located above the dam site on the left bank. The site is about 6 kms downward from Astan Nallah (a tributary of Kishanganga River). The site is marked by clear surroundings without any dense forest cover at the coherence of tributary with the main river course.

Sampling site B

It was notified on the right bank of the river Kishanganga above the dam site. The site is around 9 kms down from the Barzil Nallah (a tributary of the Kishanganga river). The confluence is minimum because of dam spread area.

At Dam Site

Sampling site C

The site was notified at the Malikpora bridge, which is near the out flow of the dam. The site is located on the left bank of the dam outlet. The flow is minimal pertaining to diversion above the dam site towards turbine.

Sampling site D

The site was notified at the right bank of the Malikpora bridge, which is near the out flow of the dam. The flow at this site is also minimal pertaining to diversion above the dam site towards turbine.

Below Dam Site

Sampling site E

The site was notified at Kazarwan, which is around 5 kms down the dam site. The site has a confluence of tributary, where Kurbul Nallah meets the main course of river

Sampling site F

The site was notified on right bank at Kazarwan, which is around 5.5 kms down the dam site. The site has free ends, without dense forestation.

Results

The results of the ichthyofaunal diversity study were carried out in Kishanganga river for 18 months. The present study revealed that 5 species from Upper and Lower stretches of the Kishanganga river. The types of species were almost alike in all the stretches of the river, but quantitatively there was a significant difference, which was calculated through diversity index as depicted in table 1. For better interpretation of the species distribution, Lincoln-Petersen, Bailey's and modified versions of indices were calculated. In case of rainbow trout (*Oncorhynchus mykiss*), L-P index (N) was 229.09±22.69, with upper and lower 95% confidence limits of 184.62 and 273.56 respectively. For the same species the Bailey's index (N_B) was calculated as 226.79±22.46, with upper and lower 95% confidence limits of 182.76 and 270.81 respectively. The modified index (N_C) was 228.05±22.59, with upper and lower 95% confidence limits of 183.79 and 272.32 respectively.

Table 1: Fish species abundance and distribution indices at the study sites in Kishanganga river

Species		Lincoln-Petersen (N)		Bailey's (N_B)		Modified (N_C)	
Rainbow trout *Oncorhynchus mykiss*	N	229.09		226.79		228.05	
	S_N	22.69		22.46		22.59	
	CI	184.62	273.56	182.76	270.81	183.79	272.32
Brown trout *Salmo trutta fario*	N	229.09		226.79		228.05	
	S_N	20.16		19.99		20.10	
	CI	184.62	273.56	182.76	270.81	183.79	272.32
Snow trout *Schizothorax plagiostomus*	N	245.71		241.67		243.09	
	S_N	30.93		30.42		30.60	
	CI	185.09	306.33	182.05	301.29	183.11	303.05
Triplophysa marmorata	N	360.00		308.33		313.50	
	S_N	124.55		106.67		108.46	
	CI	115.89	604.11	99.26	517.41	100.92	526.08
Glyptothorax pectinopterus	N	650.00		450.00		458.00	
	S_N	306.41		212.13		215.90	

In case of brown trout (*Salmo trutta fario*), L-P index (N) was 229.09±20.16, with upper and lower 95% confidence limits of 184.62 and 273.56 respectively. For the same species the Bailey's index (N_B) was calculated as 226.79±19.99, with upper and lower 95% confidence limits of 182.76 and 270.81 respectively. The modified index (N_C) was 228.05±20.10, with upper and lower 95% confidence limits of 183.79 and 272.32 respectively. In case of snow trout (*Schizothorax plagiostomus*), L-P index (N) was 245.71±30.93, with upper and lower 95% confidence limits of 185.09 and 306.33 respectively. For the same species the Bailey's index (N_B) was calculated as 241.67±30.42, with upper and lower 95% confidence limits of 182.05 and 301.29 respectively. The modified index (N_C) was 243.09±30.60, with upper and lower 95% confidence limits of 183.11 and 303.05 respectively.

On the other hand two less commercially important species showed a diverse gap between lower and upper confidence intervals. In case of *Triplophysa marmorata*, L-P index (N) was 360.00±124.55, with upper and lower 95% confidence limits of 115.89 and 604.11 respectively. For the same species the Bailey's index (N_B) was calculated as 308.33±106.67, with upper and lower 95% confidence limits of 99.26 and 517.41 respectively. The modified index (N_C) was 313.50±108.46, with upper and lower 95% confidence limits of 100.92 and 526.08 respectively. In case of *Glyptothorax pectinopterus*, L-P index (N) was 650.00±306.41, with upper and lower 95% confidence limits of 49.43 and 1250.57 respectively. For the same species the Bailey's index (N_B) was calculated as 450.00±212.13, with upper and lower 95% confidence limits of 34.22 and 865.78 respectively. The modified index (N_C) was 458.00±215.90, with upper and lower 95% confidence limits of 34.83 and 881.17 respectively. Mark-recapture method was followed for the estimation of abundance coordinates for the five species in various sections and sites of Kishanganga river system, above below and near the dam site. From the above values it can be concluded that the smaller value of N, NB and NC for rainbow trout, brown trout and snow trout implies that the three species show seasonal migratory behavior corresponding to breeding or feeding. These species have the chance of being susceptible and vulnerable in future. The construction of dam across the Kishanganga river will create a dry spell (although with ecological flow), which will compel fishes to migrate to water abundant spaces. The access to the waters is a matter of concern. Hence it could be concluded that the three fish species of commercial importance are going to hit in the future time, when the fish will be restricted to move to safer zones because of the low or highest high flows.

Discussion

More or less similar parameters as observed in the present study, have been recorded by Swedish Ministry of Agriculture, 1982; [12] Oklandand Okland, 1986 [6]. Sharma, 1986 [10]; & Svensson *et al*, 1995 [11]. The River Jhelum river has already lost one fish species, the migratory Golden Mahaseer, *Tor putitora,* due to Mangla Dam down stream in Pakistan part of Jhelum river. Earlier, the Mahaseer migrated upstream to Kashmir valley for spawning (Mirza and Bhatti, 1986) [4]. The project area is in a climatic zone described as Himalayan dry temperate forest where January is the coldest month & July the warmest. In the main Kashmir valley the temperature fluctuates between -5 °C to above 30 °C. At higher altitudes the snow remains on the peaks almost all throughout the year. Lakes above 3000 m.s.l. are covered with ice, for eight months of the year and those at 2000 m.s.l four months of the year while ice in the valley only occurs on some nights in small ponds. The maximum temperature during the summer ranges from 15 °C in mountains to 30 °C in the valley lakes (Wanganaeo *et al.,* 1992) [13]. The fish fauna of this region is adapted to lower temperature regime and therefore also to other parameters prevailing in such condition.

Menon *et al.(*2000) have described cold water fisheries as the one occurring in water bodies having temperature not more than 18-20°C and the lower temperature may be anywhere from 0-5 °C or slightly more depending upon the altitude, topography and climatic factors of area. They also stated along with water temperature factors like dissolved oxygen etc. control the occurrence and abundance of fish in cold water. In the present study the water temperature has crossed this limit and has been recorded upto 24 °C. Wikipeda (2008) [14] stated that the temperature change of even one to two degree Celsius can cause significant change in organism metabolism and other adverse cellular biology effect. Principal adverse changes can include rendering cell walls less permeable to necessary osmosis, coagulation of cell protein and alteration of enzyme metabolism. These cellular level effects can adversely affect reproduction and also cause mortality. Lenntech (2008) [3] opined that species that are intolerant to warm water conditions may disappear, while others preferring this condition may thrive so that the structure of the community changes. Respiration and growth rates may be changed. An increase of temperature may result in the loss of sensitive species. Menon *et al.* (2000) have also stressed on the influence of certain parameters which exert profound influence on the distribution and availability, in which temperature is stated to be first. The present study points out that the hydroelectric projects have adversely affected the natural stocks of cold water fish. The activities

Pertaining to the projects under construction are responsible for increase in the silt load and destruction of fish food organisms in streams. The increased silt load along with changed temperature regime of channel adversely affected the feeding and spawning of fish (Menon *et al.*, 2000).

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