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Environmental Studies

EFFECT OF FLOOD ON GANGA'S FISH ASSEMBLAGES (DEVPRAYAG TO HARIDWAR)

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ABSTRACT

The fish assemblage structure was analyzed in the streams of the river Ganga of Uttarakhand state, India. Four different sites (Kosi, Suyal, Gagas & Gomti) were sampled before (February 2013) and after flood (September 2013). In this study, we focused on fishes of order Cypriniformes, Mastacembelis and Ophiocephaliformes.We have examined how regular floods of river Ganga affect the structure of fish assemblage of abovementioned order of fishes.

Keywords: cypriniformes, fish assemblage, flood, Ganga, *mastacembelis*, Ophiocephaliformes,river system.

INTRODUCTION

A flood is defined as the submergence of land not normally inundated. Surely, one cannot describe flood as the regular inundation of lowlands from high tides. One should also not describe as flood the barrage of the flood plain during the monsoon when the rivers of the basin are normally expected to carry a volume of water several hundred times greater than the dry months. The behavior of the monsoon has never been uniform. Monsoon is characterized by the spatial and temporal variation in the rainfall.

In the deltaic region of the Ganga, floods occur very regularly in the form of high river discharges during the monsoons as well as when sudden cyclones in the Bay of Bengal whip up tidal waves. The Brahmaputra and the Ganga generally have peak floods in August and September, respectively. This flood is like a curse for the poor and the marginal hill farmers in the uplands. Such flood effect quantitative relationships and the qualitative aspects of several important natural populations namely, macro invertebrate communities, fish assemblage and river corridor vegetation.

Study of effect of flood on fish assemblage is a major concern to fish biologist. Extreme flooding is critical for maintaining ecological integrity and biological productivity of flood plain rivers (*Rasmussen* 1996, *Poff et al.,* 1997). In river systems, extreme floods are primarily source of environmental variability and disturbance. Disturbances arise from a broad array of physical and biological effect which varies in their size, frequency and intensity (*Michener*, 1998). Erosive flood can reduce the density of population (*Seegrist and Gard* ,1972). The immediate effect of flood on individual fish seems largely to depend upon the fish size, life stages and on habitat complexity (*Pearsons et al.*, 1992, *Laboncervia* , 1996). Flood can wash out larval and juvenile fish (*Harvey*, 1987, *Bishoff and Wolter*, 2001), while having little impact on adult life (*John* 1964, *Hoops* 1975). There is evidence that both the time of flood and the type of river habitat affected can influence the impact on fish assemblages (*Kushlan,* 1976, *Schlosser,* 1982; *Mathews,* 1998)

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Non-availability or food affect extremely on fish assemblage. Certain fish species take complete advantage from flood and acutely depend upon, seasonal or periodic extreme flooding. Seasonal flooding coordinates natural systems by providing environmental cues from spawning migration processes (*Leitmal el al* ., 1991; *John*, 1963; *Poff and Ward*, 1981). Effects of extreme events on fish assemblage are separable according to fish species, life stage and recovery period.

Fish of dissimilar species and life stage exhibit unique sets of characteristics counting a biotic tolerance, feeding, habitat, preference, spawning habitats, physical appearance and physical capabilities. Individual characters allow certain species of fish, particularly those that are adapted to wide range of conditions, to manage better with flood conditions. Moreover, this is observed that native fish that are naturally adapted to system extremes, tend to perform fairly better then exotic species during flood (*Adler*, 1996). Plentiful research has been done that juvenile life stage is particularly vulnerable to serious damage throughout extreme floods in high gradient systems. Great amount of young fish are even lost during average seasonal flooding in systems where the timing of high flows coincides with fragile life stages (*Nehring and Miller,* 1987). The impact of floods on adult population in upper Ganga is closely tied to extent of geomorphologic change linked with power of flows. No immediate changes in an adult population are reported by *Elwood and Walter*, 1969.

A study of fish assemblage structure and their requirement in Indian streams are lacking. Though few initiatives started in the 1980s in South India (*Arunchalam el al*., 1988; 1997a), Srilanka streams (*Moyle and Senanayke*, 1984; *Wikramanayke*, 1990); Western Himalaya (*Negi at al.,* 2007). The present study aims to throw light on how annual variation in the hydrograph affects species with distinct life history and influence the composition and structure of fish assemblage. In this study, we basically specify the effect of flood on fish species of upper Ganga Devprayag region of Uttarakhand state, that spawns in the stretches of the Ganga basin and use these areas as nurseries.

Study Area

Devprayag is located in 30.14° N, 78.59° E, in Tehri Garhwal District in the state of Uttarakhand, India and is one of the Panch Prayag of Alaknanda river where Alaknanda and Bhagirathi rivers meet and take the name Ganga. The original path of Ganga river is on the South west direction, then it moves through easterly direction and finally in the last lap, it flows again southwards and merge into the sea. During its middle course of easterly direction, a number of big and small tributaries join the northern side from the Himalayan sub-basin, namely, Ramganga, Gomati, Ghaghara, Gandak and Kosi, all of which have their origins within the mountain range of the Himalayas in Nepal. Therefore, the contribution of flow of these tributaries is from Nepal within the Himalayan range and also from the Indian soil on the southern side of the Himalayan foothills. There is another tributary, Mahayana which joins the river in Bangladesh.

The main reason behind selecting this area is that floods in river Ganga and its tributaries are very common. The main causes of flood are extensive heavy rainfall in the catchment areas and insufficient capacity of river channel to contain the flood within the banks of the river. In the tidal reach and delta area widespread inundation occurs where high flood in river synchronize with the high tidal level from the sea. The plains of Uttarakhand, Uttar Pradesh, Bihar and West Bengal are affected by the spills from either parent river Ganga or by the spills from the tributaries namely Ghaghara, Gandak, Kosi etc.

Four different sites namely, Kosi, Suyal, Ganga & Gomti were selected for the present study. These sites varied in altitude and geomorphological characters and ecological conditions.

Material and Methods

Fishes were collected during day light hours in the month of February before the flood and in middle of September after the flood, during period of comparable discharge from a boat along the shoreline and focused on the near shore zone where most fishes are found and where our sampling methods could be most efficient.

A selection of about 150 to 200 m was sampled upstream at every river kilometer marked within the study stretch. The four selective sites were sampled before and after the floods in upper Ganga region. Captured fish were stored in a big container in the boat. As sampling was done at each stretch, all fishes were identified, measured (SL) and dropped back to water. The relative density (catch per unit efforts) was explained as the number of individual per 100 meter of sampled shoreline, with a standard width 3.0 m of the sample area.

We used rare fraction method to study and compare species richness before and after flood, as sampling effort varied between seasons. This method standardized samples by estimating the number of species expected in a sub-sample of an individual recommended selection from a large sample. Because the relation between species richness and sampling of effort is not linear, this method compares samples of unequal sampling effort better than comparison of number of individuals and other indices. On the other hand Kendall coefficient of rank correlation was used to compare similarity in communities structure before and after flood in the Ganga.

The 10 species belong to 3 orders namely *Cypriniformes*, *Mastacembelis* and *Ophiocephaliformes.* These were used in the analysis. Quantitative data (CPUE) were transformed in (x+1) and subjected to two way factorial ANOVA, with season (pre-flood, post-flood) and river stretch, as effected.

RESULT AND DISCUSSION

Before Flood:

Total number of 50 samples from 4 different sites belonging to 3 different orders namely C*ypriniformes, Mastacembelis* and *Ophiocephaliformes* were recorded during research.

Table1: Availability of Fish species before Flood

Species	Kosi	Suyal	Ganga	Gomati
Order: Cypriniformes				
Family: Cyprinidae				
Genus: Tor				
Tor putitora	D	A	A	A
Genus: Bariliux				
Barilius bendelisis				
Barilius barila	D	D	D	D
Genus: Puntius				
Puntius conchonius	A	NR	NR	NR
Genus: Garra				
Garra gotyla gotyla	D	D	D	D
Genus Chrosochelus				
Crossocheilus latius	A	NR	A	NR
Genus: Schizothorax				
Schizothorax richardsonii	A	A	A	A
Genus: Nemachelius				
Nemachelius montanus	A	A	A	NR
Order: Mastacembelidae				
Family: Mastacembelidae				
Genus: Mastacembelus				
Mastacembelus armatus	A	A	A	NR
Order: Ophiocephaliformes				
Family: Ophiocephalidae				
Genus: Channa				
Channa punctatus	A	NR	NR	NR

D: Dominant

A: Abundant

NR: Not Recorded

After Flood

No Significant difference was observed in community structure before and after the flood on the basis of 10 different species (*Kendal t*, t=0.402, P< 0.045). *Tor putitora, Garra gotyla gotyla, Barilius bandelisis* were the most abundant species before and after the flood. The relative density (CPUE) of all fishes pooled was not significantly different before (mean +_ SD =27.625.7 incs/100m, n=17) and after flood (mean +_ SD = 16.0 +_ 12.4, n=17) (ANOVA, F=2.5, df=130, P=0.125)

However, a significant interaction between season and reach (F=6.4, df=2.30, P=0.069) showed that a decrease in CPUE occurred in all forms. Relative densities of the dominant species (*Tor putitora*, *Garra gotyla gotyla*) did not decrease following the flood, though the interaction effect on their density was similar to that for the total catch, with cube density decrease in all 4 sites. 2 species of fishes show increase in the density after the flood. Species like *Barilius bendelisis* and *Schizothorax richardsonii* show decrease in density after flood. Some species show variation in their sizes after the flood.

DISCUSSION

The extensive summer flood in the Ganga offered a unique opportunity to evaluate the immediate effect on fish assemblage in the deltaic region. Our research shows that the number of species has not significantly been affected by the flood. The difference in individual species occurrence before and after the flood was almost exclusively caused by rare fish species. The catch of more rare fish species before the flood was affected by unequal sampling effort rather than the flood itself, as concluded by the results of rare fraction analysis.

Due to floods, soil erosion took place and large amount of soil from the river bottom was displaced and the main channel habitat was heavily impacted by a high current velocity. These effects may decrease fish abundance, mainly in channel section without tributaries, which is the case for the study stretch. At the time of erosive floods with high discharges, fishes remain closed to submerged structures; seek low velocity stream margins of tributaries, and can remain in a given reach of river even during major flood (*Mathews* ,1998). This study shows that fish probably used submerged refuges along the channel margin and space between borders on the submerged shoreline, since no tributaries were present.

Fish assemblage structure was not significantly different before and after the flood. *Harrell* (1978) found that the species dominated before the flood also dominated after the flood and hypothesized that dominant species were well adapted to the flood prone environment. He also added that the long term effect of flood on structuring fish assemblage might be minimal. *Gerking* (1950) also concluded similar results that most individual species may remain in place during flood events in small streams, with floods having minimal effect on the fish assemblage as a whole. The fish assemblage at Devprayag region among all four sites shows similar results. In this region, fishes were adapted to floods, but it is notable that not much difference in abundance of fish from all four sites was measured before and after flood. CPUE of three sites were same before and after flood with exception of one site i.e. site II which shows slight difference in CPUE value which is higher in this site after flood. According to the view of *Gerking (*1950) and *Harrel* (1978), similarities of the assemblage before and after was due to fish remaining in place, or if fish swept downstream, were replaced by fish in steady stretches, remain unclear. This also shows that sheltered or native fishes were less effected by the flood, compared with open water species. *Malthews* (1998) explained that the immediate effect of flood on individual fishes may largely depend upon habitat complexity.

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