

Fish Diversity at Pancheshwar Multipurpose Project Area in Mahakali River

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Abstract

A study was carried out to prepare a baseline information on water quality and freshwater fish diversity at Pancheshwar Multipurpose Project area in Mahakali river. The study was conducted in autumn (October 2008) and summer (June 2009). A total of 24 fish species belonging to 3 orders, 4 families and 13 genera were recorded during the investigation period. Cypriniformes was the most dominant order accounting 75% of total fish species. Siluriformes and Synbranchiformes accounted for 21% and 4% of fish species composition respectively. Spawning and rearing areas in study sites were evenly distributed providing a suitable habitat for both cold and warm water fish species. The water quality parameters, i.e., water temperature (20.50-22.63 °C), DO (8.58-11.85 mg/l) and pH (6.93-7.20) were found within the suitable range supporting diverse fish species.

Key words: fish diversity, fish habitat, water quality parameters

Introduction

Nepal, a Himalayan country, is well known for its running and standing waters which support about 200 species of fish, which are described from the Himalayan drainage system of Nepal (Shrestha 1995). Shrestha (2001) recorded 182 indigenous fish species from Nepal. Shrestha (2003) studied the fishes of Nepal from their recent taxonomic point of view and reported 186 species. Ng (2006) has listed 6 new species and 11 new records from Nepal which further increased the total number of fish species of Nepal. Rajbansi (2005) prepared a checklist from the published literature and reported 187 species, while Saund and Shrestha (2007) reported 199 species. Similarly, Shrestha (2008) reported 217 indigenous fish species from Nepal.

The vicarious habitat changes in many river systems of Nepal have caused a precipitous decline of native game fish stock and ornamental fish stock (Shrestha 1990). Numbers of many game fishes such as Mahseer (*Tor tor* & *T. putitora*) and Copper Mahseer (*Neolissochilus hexagonolepis*) are declining due to barrier effects of dam, water quality changes, erratic flow fluctuations in water levels and destruction of spawning beds (Shrestha 1997).

The Mahakali river where the present study area is located harbours a variety of fishes comprising 69 species (Shrestha 1990). Shrestha (1992) reported 71 fish species in the Mahakali river system. According to Shrestha (2002), fish species in danger of extinction in Mahakali river include *Tor putitora* (Mahaseer), while the threatened species are *Schizothorax richadsonii* (Spotted snow trout), *Schizothorax esocinus* (Mountain trout) and *S. progastus* (Point-snouted snow trout). Similarly, a preliminary study on fish and fisheries in Pancheshwar High Dam and upstream areas reported 15 major species of fish in Mahakali river. Among them, 3 species (i.e., *Tor tor*, *Tor pictutoria*, *Barilus jalkapoori*) were long-distant migratory species, 3 species (i.e., *Accrossocheilus hexagonolepis*, *Schizothorax plagiostomos* and *Schizothorax progastus*) were short distance migratory species and the remaining 9 species were resident species (PACO 1991). The present study also intended to assess fish diversity, habitat and water quality in Mahakali river focusing on different components of Pancheswar Multipurpose Project (PMP). The findings from the study will benefit the planning and management of sustainable fisheries and conservation of natural resources at national level.

Study area

Mahakali river is a perennial, torrential river at its upper headwater. The river bed is rocky and sandy with a poor algal growth (Shrestha 1990). The proposed PMP is a Nepal-India bi-national scheme on Mahakali river that forms the international border between Nepal and India. The project has been identified as a huge storage scheme to maximize power benefits of 6,720 MW peak power from 315 m high Pancheshwar High Dam and 83 m high Rupali Gad Re-regulating Dam with an annual average energy production of 12,333 GWh. The additional power generation potential of 158 m high Poornagiri Re-regulating Dam is estimated to be 1000 MW (DPR 1995). These proposed dams of PMP across the river will create substantial changes on the river habitat and block the migratory route of various fish species. The project area lies between 29° 07' 30" and 29° 48' North latitude and 79° 55' and 80° 35' East longitude in the Mahakali zone of the Far Western Development Region of Nepal covering some parts of Darchula, Baitadi and Dadeldhura districts (Fig. 1).

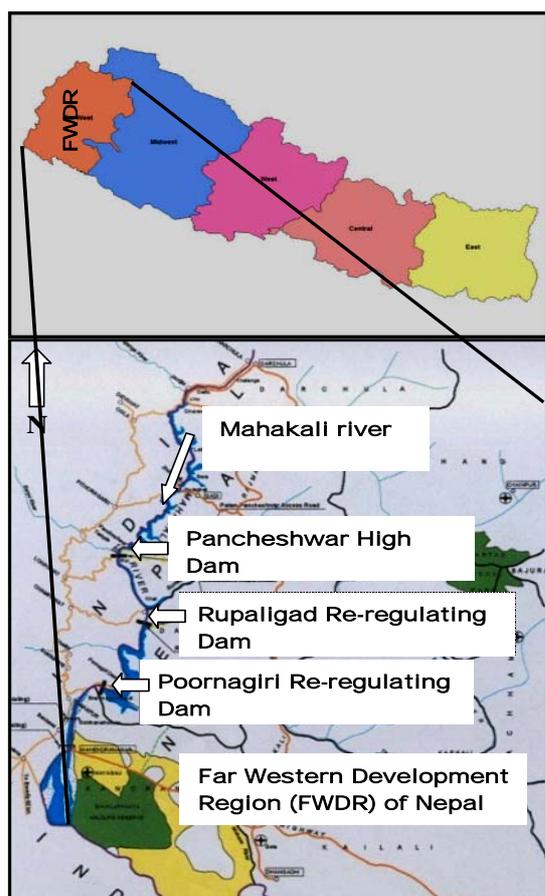


Fig. 1. Map of the study area

Methodology

Sampling sites and time schedule of the study

Three sampling sites (i.e., Pancheshwar High Dam area-I, Rupaligad Re-regulation Dam area-II and Poornagiri Re-regulating Dam area-III) were selected considering three components of Pancheshwar Multipurpose Project. The study was conducted in Mahakali river in autumn (October 2008) and summer (June 2009).

Site I: Pancheshwar high dam area

The proposed Pancheshwar High Dam on Mahakali river is located 2.5 km downstream from the confluence of Saryu river with Mahakali river at Pancheshwar Village Development Committee (VDC) of Baitadi District. This sampling site ranges from 426 msl (Site office of PMP) to 435 msl (Confluence of Saryu river and Mahakali river).

Site II: Rupaligad re-regulation dam area

The proposed Rupaligad Re-regulating Dam across Mahakali river is located at 25 km downstream of Pancheshwar High Dam near Rupal VDC and about 300m downstream from the confluence of Rupaligad, in Dadeldhura district. The site ranges from 396 msl (1 km downstream from Rupaligad confluence to Mahakali river) to 407 msl (1 km upstream from Rupaligad confluence to Mahakali river).

Site III: Poornagiri re-regulating dam area

Poornagiri Re-regulating Dam on Mahakali river is proposed near Jogbudha VDC, which is situated at 64 km downstream of Pancheshwar High Dam and about 7 km downstream from the confluence of Rangoon khola with Mahakali river in Dadeldhura district. There is no settlement at the proposed dam site however Karali settlement is located about 1 km upstream from the dam site. The sampling site ranges from 295 msl (1 km downstream from Karali khola confluence to Mahakali river) to 305 msl (1 km upstream Karali khola confluence to Mahakali river).

Fish sampling

Cast net was mostly used to collect the fish during field visit from each site. However, gill net and other local techniques were also used. Trained local fishermen were hired for this purpose. Fish species available at the local market and caught by local fishermen were also purchased.

Information on local name and behaviour pattern was obtained from fishermen. Fish species collected during the field survey were noted and excess fishes were released to their original habitat. The collected fish species were preserved in 8-10%

formaldehyde solution for further study. They were identified using standard method of Talwar and Jhingran (1991), Jayaram (1999) and Shrestha (1981, 1994).

Water quality analysis

Physico-chemical analysis of water was conducted to determine the water quality of the river. Portable water analysis kit (Hach Chemical CO. Ames., Iowa, USA;

Table 1. Fish species recorded at sampling sites

S.N.	Fish Species	Site I		Site II		Site III	
		Autumn	Summer	Autumn	Summer	Autumn	Summer
	ORDER: CYPRINIFORMES						
	Family: Cyprinidae						
	Sub Family: Cyprininae						
	Genus: Neolissochilus Rainboth 1985						
1	<i>Neolissiochilus hexagonolepis</i> (McClelland) 1839		+		+	+	+
	Genus: Tor Gray 1834						
2	<i>Tor tor</i> (Hamilton-Buchanan) 1822	+		+		+	+
3	<i>Tor putitora</i> (Hamilton-Buchanan) 1822			+		+	+
	Genus: Chagunius Smith 1945						
4	<i>Chagunius chagunio</i> (Hamilton-Buchanan) 1822				+	+	+
	Genus: Labeo Cuvier 1817						
5	<i>Labeo pangusia</i> (Hamilton-Buchanan) 1822	+			+	+	+
6	<i>Labeo dyocheilus</i> (McClelland) 1839				+	+	
7	<i>Labeo angra</i> (Hamilton-Buchanan) 1822	+			+		+
8	<i>Labeo dero</i> (Hamilton-Buchanan) 1822					+	+
	Sub family: Schizothoracinae (Oreinae)						
	Genus: Schizothorax Heckel 1838						
9	<i>Schizothorax sinuatus</i> (Heckel) 1838	+	+	+	+	+	
10	<i>Schizothorax richardsoni</i> (Gray) 1832	+	+		+		
	Genus: Schizothoraichthys Misra 1959						
11	<i>Schizothoraichthys progastus</i> (McClelland) 1839	+	+	+	+		
12	<i>Schizothoraichthys esocinus</i> (Heckel) 1938	+	+	+			
	Sub family: Garrinae						
	Genus: Garra Hamilton-Buchanan 1822						
13	<i>Garra gotyla gotyla</i> (Gray) 1832			+	+	+	+
14	<i>Garra annandalei</i> Hora 1921			+	+	+	+
	Sub family: Rasborinae (Danioninae)						
	Genus: Barilius Hamilton-Buchanan 1822						
15	<i>Barilius bendelisis</i> (Hamilton-Buchanan) 1822		+		+	+	+
16	<i>Barilius barila</i> (Hamilton-Buchanan) 1822		+		+		+
17	<i>Barilius barna</i> (Hamilton-Buchanan) 1822		+			+	+
	Family: Balitoridae						
	Sub family: Nemacheilinae						
	Genus: Nemacheilus Bleeker 1863						
18	<i>Nemacheilus corica</i> (Hamilton-Buchanan) 1822		+			+	
	ORDER: SILURIFORMES						
	Family: Sisoridae						
	Genus: Glyptothorax Blyth 1861						
19	<i>Glyptothorax trilineatus</i> Blyth 1860		+	+	+		
20	<i>Glyptothorax alaknandi</i> Tilak 1969	+		+			
21	<i>Glyptothorax telchilta</i> (Hamilton-Buchanan) 1822	+	+				
	Genus: Pseudecheneis Blyth 1860						
22	<i>Pseudecheneis crassicauda</i> Ng and Edds 2005					+	
	Genus: Bagarius Bleeker 1853						
23	<i>Bagarius bagarius</i> (Hamilton-Buchanan) 1822		+	+	+	+	
	ORDER: SYNBRANCHIFORMES						
	Sub order: Mastacembeloidei						
	Family: Mastacembelidae						
	Sub family: Mastacembelinae						
	Genus: Mastacembelus Scopoli 1777						
24	<i>Mastacembelus armatus</i> (Lacepede) 1800					+	+
	Total species		16		18		18

Model: Dr. el/2) was used to analyze temperature, DO and pH of water in situ condition in the field following the standard methods prescribed by APHA (1976).

Results and Discussion

Fish diversity

Altogether 24 fish species belonging to 3 orders (i.e., Cypriniformes, Siluriformes and Synbranchiformes), 4 families (i.e., Cyprinidae, Balitoridae, Sisoridae and Mastacembelidae) and 13 genera (i.e., *Neolissochilus*, *Tor*, *Chagunius*, *Labeo*, *Schizothorax*, *Schizothoraichthys*, *Garra*, *Barilius*, *Nemacheilus*, *Glyptothorax*, *Pseudecheneis*, *Bagarius*, *Mastacembelus*) were recorded from the study area (Table 1).

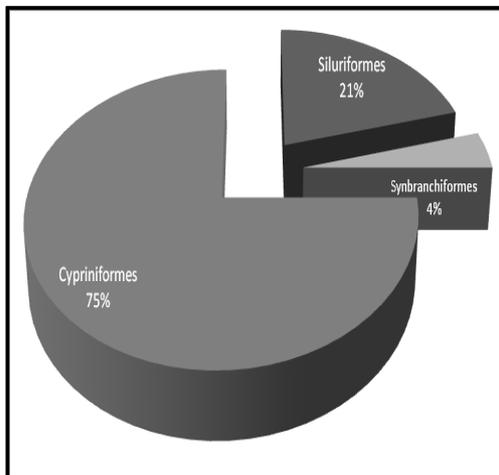


Fig. 2. Composition of collected fish

Based on field observation & information from local fishermen, fish species like *Tor* sp., *Labeo* sp., *Bagarius bagarius* were observed in deep water area. The species such as *Schizothorax* sp., *Garra* sp., *Glyptothorax* sp.

and *Neolissocheilus hexagonolepis* were recorded in fast flowing and running water.

Fish species such as *Labeo* sp., *Bagarius bagarius*, *Barilius* sp. and *Neolissocheilus hexagonolepis* which are also known for warm water species were found at upstream of Pancheshwar High Dam area during summer when the water temperature exceeded 20°C. This indicates that these fishes migrate to upstream only for grazing purpose when the water temperature is favorable for them. Besides, some steeper gradient above the Rupaligad Dam area, most of the area possesses gentle gradient with suitable habitat for fish species. The region above Poornagiri Dam area has a gentle gradient, relatively low velocity, plenty of boulder, pebble, gravel, sand, pool and backwater providing favorable condition for rearing and grazing.

Spawning and rearing area

Field observations reveal that the Mahakali river and its tributaries have boulder, pebble, gravel, sand, riffles, pools & backwaters in some places, provide appropriate spots for spawning and rearing grounds for diverse fish species. The evenly distributed spawning and rearing sites were observed at both sides of the river. However, the deep pools near the confluence point of Rupaligad and Mahakali river were found to be more suitable for feeding rather than spawning area. Comparatively, upper reaches of study area possesses medium spawning and rearing area. On the other hand, confluence of Karali khola and upstream from Poornagiri Dam area were observed as productive habitats having maximum spawning and rearing areas (Table 2).

Water quality analysis

The mean values of water quality parameters are presented in Table 3.

Table 2. Spawning and rearing areas at different sampling sites

S.N.	Study site	Spawning area	Rearing area
I	Pancheshwar High Dam area		
1	Confluence of Saryu river & Mahakali	+	+
2	Pancheswar Dam area	++	++
3	Downstream from Pancheswar Dam area	++	++
II	Rupaligad Re-regulation Dam area		
1	Upstream of Rupaligad Dam area	++	++
2	Rupaligad Dam area	+	++
3	Downstream from Rupaligad Dam area	++	+++
III	Poornagiri Re-regulation Dam area		
1	Upstream from Karali confluence area	+++	+++
2	Karali khola confluence area	++	++
3	Downstream from Karali khola confluence	+++	+++

+ = Low; ++ = Moderate; +++ = Maximum

Table 3. Water quality of the study area

Parameters	Pancheshwar Dam area	Rup ali gad Dam area	Poornagiri Dam area
Water temp. (°C)	20.50 ± 2.04	20.88 ± 1.75	22.63 ± 1.80
pH	7.20 ± 0.57	6.93 ± 0.51	7.20 ± 0.68
DO (mg/lit.)	8.58 ± 0.90	11.85 ± 1.91	9.0 ± 1.03

The average water temperature ranged from 20.50 to 22.63°C. Temperature in the range 20 to 32°C is ideal for majority of freshwater fishes (Boy 1990). Natural bodies of water may exhibit a seasonal and diurnal variation and is closely related with the change in atmospheric temperature (Kundanagar *et al.* 1996).

The average pH value varied from 6.93 to 7.20. Generally low pH value is harmful to fishes. Water having pH value below than 5.0 and above 9.5 are not suitable (APHA 1976). The pH is considered as a measure of environmental suitability and a range of 7.0 to 8.5 is considered to support a rich biota and fish (Bell 1971).

The average dissolved oxygen ranged from 8.58 to 11.85 mg/l. Dissolved oxygen above 5mg/l is suitable for the support of diverse biota (APHA 1976). Lower oxygen concentration kills the fish and other organisms that are present in the water. DO > 5 mg/l is considered favorable for growth and activity of most aquatic organisms; DO < 3 mg/l is stressful to most aquatic organisms, while DO < 2 mg/l does not support fish life (USEPA 2000).

The physical and chemical characteristics of water bodies affect the species composition, abundance, productivity and physiological conditions of aquatic organisms (Bagenal 1978).

Twenty four freshwater fish species were recorded from different sampling sites of Pancheshwar Multipurpose Project area during the investigation period. Evenly distributed spawning and rearing area of sampling site provides a suitable habitat for both cold and warm water fish species. The controlling factors (pH, temperature and DO) were within the suitable range to support good fish production.

Appropriate numbers of fish hatcheries should be developed in the possible area of the project to minimize the impact of dams on fish population. The fishlings thus produced should be left towards the

upstream of dams on regular basis. Similarly, riverine ecology should be maintained by releasing at least 10 % of water for downstream of each dams.

Further and in-depth studies at all seasons on migratory ecology with fish behavior & habitat should be carried out in Detailed Environmental Management Plan (DEMP) of PMP so that finding may be directly applied for the conservation of native species. Potentiality of cage fish culture of indigenous fishes in the reservoir should also be analyzed thoroughly in DEMP.

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