E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(5): 267-271

www.fisheriesjournal.com
Received: 24-07-2018
Accepted: 25-08-2018

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Ichthyofaunal diversity of Bakraha River of Morang district, Nepal

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Abstract
Fish samples were collected with water quality parameters from three sampling stations of the Bakraha River from October 2017 to June 2018 by using cast net, bamboo fish traps and mosquito nets. We collected nine species of Cypriniformes in two families: Cyprinidae with six species and Cobitidae with single species, and Perciformes in single family: Cobitidae with single species, and six genera. Order Cypriniformes constituted the highest species number 8 (88.88%) followed by Perciformes (11.12%). The most common species of Bakraha River were *Barilius bendelisis*, *Barilius barila*, *Puntius sophore*, *puntius gonionotus* and *Garra rupecula*. The highest diversity index (1.58) was recorded in January, and lowest diversity index (1.27) was recorded in April. Fish diversity of Bakraha River has been dwindled. It might be due to overexploitation, illegal electro-fishing, stupefied poison herbs, climate change, and sudden change of environmental variables.

Keywords: fish diversity, Bakraha River, freshwater, morang

1. Introduction
Morang district is situated in the eastern part of the country. It covers an area of 1,855km^2 with elevation of below 300 meters to 2000 meters. Ratuwa, Bakraha, Lhandra, Singia and Budhi are the five major rivers of the Morang district. The Bakraha River, originates from Sakfara and Surges southwards which crosses Madumalla, Mangalbare, Govindapur and finally that enters the west Bengal of India. Study on fish diversity of eastern Nepal is scanty however, some authors have conducted their research to survey the fishes of different regions of eastern Nepal and have reported their status. For instance (Shrestha *et al*., 2009) [1] have reported 30 fish species from Tamor River, Subba (2017) [2] recorded 118 fish species from Morang district, Shrestha (2016) [3] reported 48 fish species from Triyuga River, and Limbu *et al*., (2016) [4] recorded 16 fish species from Deumai Khola. Nepal is endowed with many forms of water resources scattered through the country. The water bodies are in the form of rivers, streams, lakes, reservoirs, ponds, swamps and paddy fields. Among the different types of water resources, the rivers are the most important which represents 49% of the total water body (Swar, 2002) [5]. Nepal is not connected with the oceans so, it is home for only fresh water fish species. Until recently, the ichthyological activity of Nepal is in the increasing trend. Shrestha (2001) [6] reported 182 fish species from Nepal. Rajbanshi (2005) [7] listed 187 fish species from Nepal. Similarly, Saund and Shretha (2007) [8] recorded 199 fish species from Nepal. Shrestha (2008) [9] reported 217 indigenous and 15 exotic fish species, while Shrestha (2013) [10] reported 228 indigenous fish species from Nepal. The Bakraha River is situated in the eastern part of the district is rich in water resources. The water of Bakraha River is used for irrigation, drinking water supply, and micro-hydropower generation. In the contest of Nepal, limited works has been carried out regarding the fish diversity profile of Nepal. Before our study, the present study area Bakraha River was still virgin, because we had not found any literature resources of Bakraha River. Therefore, the main aim of this work was to address the present fish species of Bakraha River.

2. Materials and methods
2.1 Study area
The present study area; Bakraha River of Morang district of eastern Nepal has selected for the study. It is perennial and torrential river which originates from Sakfara.

The water of river is crystal clear except the rainy season. To study the fishes, four permanent sampling stations were established: Chandane area (26.633159E, 87.603963N), Bridge area (26.663808, 87.614750) and Thapadagi area (26.700307, 87.621668) (Fig. 1) were chosen. The river bed consists of cobbles, pebbles, and sand. Sampling stations were categorized on the basis of different features such as human intervention, water current, confluence spots etc. The field survey started on 5 October, 2017 and ended on 12 June, 2018 to cover four seasons (autumn in October, Winter in January, Spring in April and Summer in June).

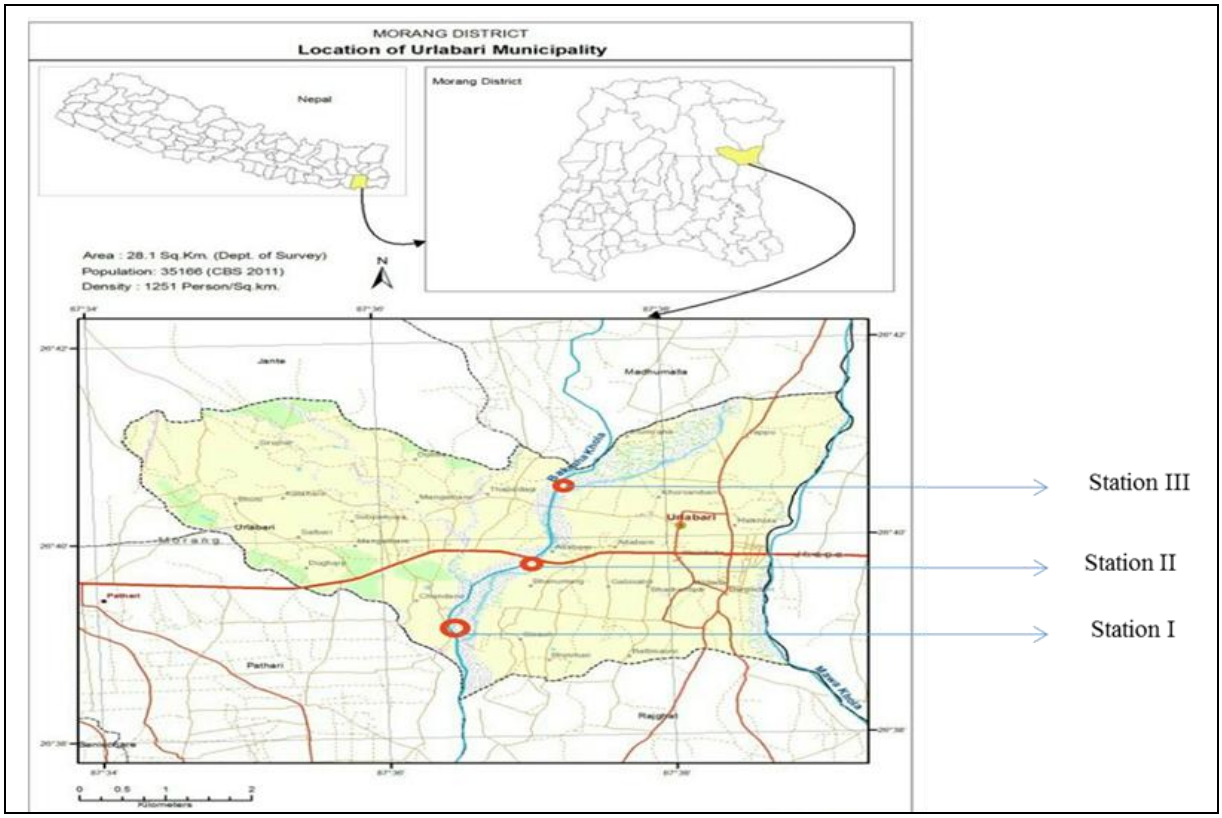

Fig 1: Map of Bakraha River showing three sampling stations, Source google

2.2 Fish sampling

Fishes were collected with the help of well-trained local fisherman by using cast net, bamboo fish traps and mosquito nets. Cast net of 6 mm × 6 mm mesh size was used for the collection of fishes. Fish sampling was done at 8 am to 10 am in every station. Habitat (pools, riffles, stagnant, running water) and morphological characters (color pattern in the fresh conditions) of fishes were recorded at the time of collection for the taxonomic confirmation. Before preservation collected fishes were photographed with Nikon Digital Camera. Collected fishes were preserved in 10% formalin solution for further study, and the specimens were taken to the laboratory of the Central Department of Zoology (CDZ) for identification. The identification was done with the help of taxonomic references Jhingran and Talwar (1991) [11], Shrestha (1981) [12], Jayaram (2010) [13], and Shrestha (2008) [9] to the species level.

2.3 Water quality

The following physico-chemical parameters were analyzed during each field visit: water temperature, dissolved oxygen (DO), pH, Hardness, water velocity, and total alkalinity. Water temperature as measured with digital thermometer by placing it in the water at a depth of 1feet. DO was measured by the Winkler titra-metric method. pH was measured by using a pH meter. Total hardness was determined by using EDTA titrametric method. 100 ml of sample was titrated by 0.01 m EDTA solution after the addition of indicator. Total alkalinity was determined by titration method, using indicators such as phenolpthalein and methyl orange. Water velocity was measured by the float method with the help of a stop watch and measuring tape. For float, small size ball was used.

2.4 Data analysis

The relationship between fish diversity and temperature, velocity, dissolved Oxygen, total hardness, total alkalinity, and pH were calculated by correlation analysis. Shannon-Wiener diversity index, evenness index and species richness were calculated. Correlations of fish diversity and physiochemical parameters were analyzed Pearson's correlation coefficient by MS EXCEL.

3. Results

A total of 9 species were collected, belonging to 2 orders 3 families and 6 genera. Order Cypriniformes comprisesed 2 families: Cyprinidae and Cobitidae with 7 species while order Perciformes comprised of single family: Channidae with one species. According to this study, order Cypriniformes was found to be a dominant which comprised of 88.88% while order Perciformes comprised of 11.12%. Similarly, Cyprinidae, Cobitidae and Channidae comprised of 77.77%, 11.11% and 11.11%. The dominant fish species of Bakraha River were *Barilius bendelisis, Barilius barila, and Puntius sophore* (Table 1). Table 1 explains the fish diversity of Bakraha River.

Table 1: Fishes collected from Bakraha River

S.N.	Order	Family	Scientific name	Local name
1.	Cypriniformes	Cyprinidae	*Barilius barila* (Hamilton-Buchanan, 1822)	Faketa
			Barilius bendelisis (Hamilton-Buchanan, 1807)	Faketa
			Barilius vagra (Hamilton-Buchanan, 1822)	Faketa
			Garra rupecula (McCelland, 1839)	Buduna
			Puntius sophore (Hamilton-Buchanan, 1822)	Sidhre
			Puntius gonionotus (Bleeker, 1850)	Sidhre
			Labeo boga (Hamilton-Buchanan, 1822)	Rahu
		Cobitidae	*Lepidocephalus guntea* (Hamilton-Buchanan, 1822)	Lata
2.	Perciformes	Channidae	*Channa striatus* (Bloch, 1793)	Helae

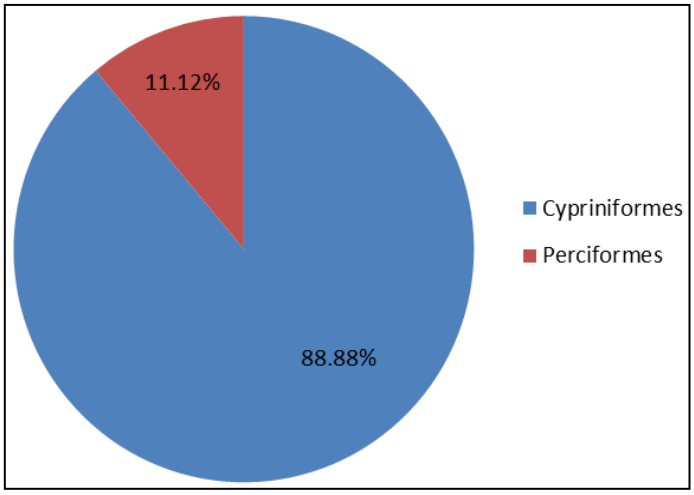

Fig 2: Order-wise percentage composition of fishes of Bakraha River

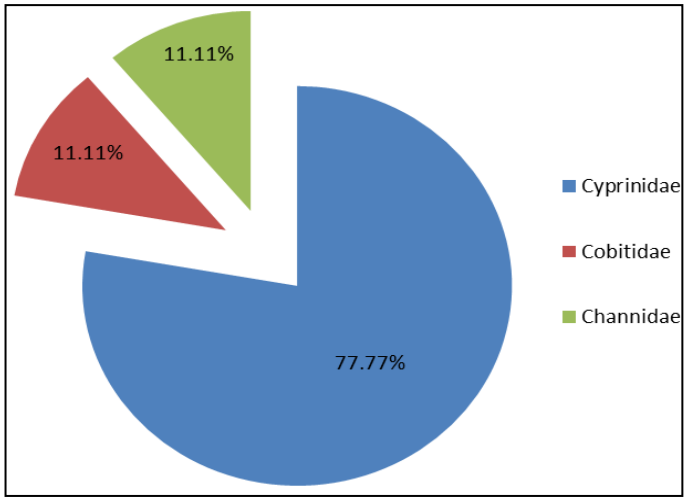

Fig 3: Family-wise percentage composition of fishes

3.1 Shannon-Wiener index

The Shannon-Weiner fish diversity index of four months ranged from 1.27 to 1.58. In the present study, maximum diversity index was recorded in January (1.58) while minimum diversity index was recorded in April (1.27) (Fig 4).

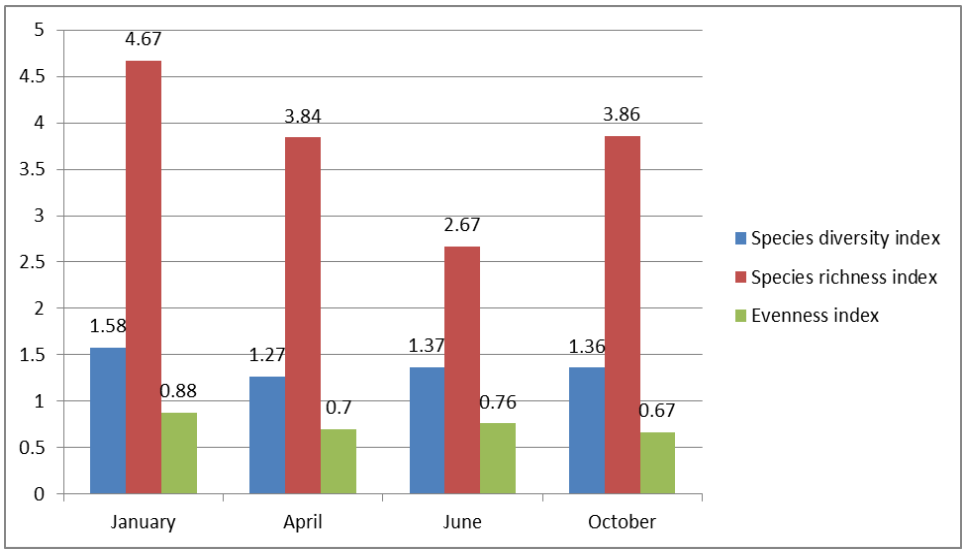

Fig 3: Month wise diversity index, species richness index and evenness index

3.2 Species richness

The species richness in four months showed considerable variation and higher richness was found in January (4.67) and lowest (2.67) was found in June. Similarly, species richness in April (3.84) and October (3.86) was comparatively higher than in June.

3.3 Evenness index

The evenness index of four months ranged from 0.6 to 0.88. The highest evenness index (0.88) was found in January, and lowest (0.67) was found in October. In April and June, evenness index was found almost same which is lower than January and higher than October.

3.4 Statistical analysis of fish diversity with physic-chemical parameters

The correlation between hardness and fish diversity was positively correlated in all the stations (0.723, 0.397, and 0.569). Station I shows highly correlated with fish diversity than in station II, and station III. Similarly, the correlation

between pH and fish diversity was negative (-0.943, -0.912, and -0.546) in all stations. There were high degrees of negative correlation between fish diversity and pH at station I and II except station I. The correlation between fish diversity and temperature were positively correlated (0.133, 0.946 and 0.117) in all stations. Station II showed the high degree of positive correlation between temperature and fish diversity while station I, and station III showed low degree positive correlation (Table 2). The correlation between dissolved oxygen and fish diversity was positively correlated in station I (0.791), and station II (0.812) while station I was negatively correlated (-0.436). The correlation between alkalinity and fish diversity were negatively correlated (-0.157, -0.121, and -0.823). Station III was significantly higher than station I, and II.

Table 2: The relationship between fish diversity and water quality parameters

S.N.	Variables	Station I	Station II	Station III
		r	r	r
1	Dissolved oxygen and fish diversity	-0.436	0.791	0.821
2	pH value and fish diversity	-0.943	-0.912	-0.546
3	Hardness and fish diversity	0.723	0.397	0.569
4	Temperature and fish diversity	0.133	0.946	0.117
5	Alkalinity and fish diversity	-0.157	-0.121	-0.823

4. Discussion

We collected fishes of 2 orders (i.e Cypriniformes, and Perciformes), 3 families (Cyprinidae with 7 species, Cobitidae with single species, and Channidae with single species. Cypriniformes was domineering order which consistent with the findings of Edds (1986) [14], Pokharel (1999) [15], Shrestha (2008) [9], and Limbu *et al*., (2016) [4]. Pre-eminence family was Cyprinidae which comprised of 77.77% followed by Cobitidae (11.12%), and Channidae (11.12%) similar to Shrestha *et al*., (2009) [1] as their study shown same family comprised higher percentage.

A total of nine fish species were recorded during the study. Among them, *Barilius bendelisis, Barilius barila, Puntius sophore, and puntius gonionotus* were the most abundant. All of those species were recorded throughout the study period. At station I, only *Channa punctatus* was found. At station II following fishes were found *Barilius vagra, Barilius Barila, Barilius bendelesis, Puntius sophore, Puntius gonionotus, Lepidocephalus guntea Labeo boga, Channa stiatus* and *Garra rupecula* while at station III *Barilius barila, Barilius bendelisis, Puntius sophore, Puntiius gonionotus, Barilius vagra*, and *Garra rupecula* were found. According to local fisherman and community, some fish species of Bakraha River has not been found like *Aanguila, catla*, and *Semiplotus* are dwindled, and are not found in our collection too. There might be some other reasons for depleting fish species of Nuwa Khola. It might be due to over population, irrigation, use of different poison herbs, and illegal electro-fishing which needs further study. The values obtained for the Shannon-Weiner diversity index of present study was not very high. The reason for showing lower species diversity is that fishing gears used have high selectivity effect (Keskin and Unsal 1998) [16]. The maximum species diversity index value was observed in January where as minimum value was observed in April. Major threats can be classified into overexploitation, water pollution, flow modification, destruction of habitat and invasion by exotic species (Dudgeon *et al*., 2006) [17].

5. Conclusion

A total of nine fish species were collected, belonging to 2 orders, 3 families, and 6 genera. The order Cypriniformes constituted the highest species number 88.88% whereas Order Perciformes constituted lowest species number 11.12%. Species such as *B. bendelisis, B. vagra, B. barila, Puntius sophhore, P.gonionotus*, and *Garra rupecula* were the common fish species. Fluctuation of environmental variables may have great impact on fish species diversity.

6. Acknowledgement

We are very thankful to Mr. Samir Rai for fish collection during the whole study period. We are also thankful to Suman Rai, Chhavi limbu, Razina Sherma Limbu, Chandra Kala Idingo, Priti Kala Idingo, Prema Idingo, Kumar Biswakarma, Sangita Biswakarma, Binod BK, Nar Bahadhur Youngyang, Aindra idingo, Hasta Bahadhur Limbu, and Kangaroti Limbu for their valuable suggestion. We would like to thank Central Department of Zoology for laboratory facility.

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