Nepalese Journal of Zoology
Special Issue: International Conference on Zoology 2021

ISSN: 2705-4403 (Print) & 2705-4411 (Online)
www.cdztu.edu.np/njz

Volume 6 | Issue S1 | December 2022

https://doi.org/10.3126/njz.v6iS1.50525

Research Article

Ichthyofaunal diversity of Bhagairia Lake in Bardiya District, Nepal

Abhishekh Bista [1*] | Ram Bhajan Mandal [1] | Choudhary Nagendra Roy Yadav [1] | Asha Rayamajhi [2*] | Gun Bahadur Gurung [3]

[1] Department of Aquaculture, Institute of Agriculture and Animal Science (IAAS), Tribhuvan University, Kritipur, Kathmandu, Nepal
[2] National Fishery Research Center, Godawari, Lalitpur
[3] Directorate of Agricultural Research, Lumbini Province, Khajura, Nepal

*** Correspondence:** abhishekhbista042@gmail.com

Suggested citation: Bista, A., Mandal, R. B., Roy Yadav,C. N., Rayamajhi, A. and Gurung, G. B.. 2022. Ichthyofaunal Diversity of Bhagairia Lake in Bardiya District, Nepal. Nepalese Journal of Zoology **6**(S1):12–19. https://doi.org/10.3126/njz.v6iS1.50525

Article History:
Received: 24 December 2021
Revised: 12 October 2021
Accepted: 30 October 2022

Publisher's note: The editorial board and the publisher of the NJZ remain neutral to the opinions expressed and are not responsible for the accuracy of the results and maps presented by the authors.

Abstract

This study was conducted to assess the ichthyofaunal diversity of Bhagairia Lake located in Bardiya district, Nepal from August 2019 to February 2020. For this research monthly sampling was done to assess ichthyofaunal diversity and water quality parameters i.e. water temperature, water transparency, total dissolved solids, dissolved oxygen, pH, alkalinity, total hardness, ammonia, phosphate and nitrate from six sites around the lake. A total number of 30 species of fish belonging to 8 orders, 13 families and 23 genera were recorded. Among these, Cypriniformes and Cyprinidae were the dominant order and family covering 50% and 44 % of fish species, respectively. *Puntius sophore* was found to be the dominant fish species with a catch composition of 12%. Maximum fish catch (214 individuals) was recorded in February whereas, minimum fish catch (140 individuals) was recorded in August. The fish catch was found to be positively correlated with dissolved oxygen (r= 0.912), pH (r= 0.876), alkalinity (r= 0.840) and total hardness (r= 0.876). Shannon diversity index was the highest in August (3.14) and lowest in November (2.87). Margalef's richness index was highest in the month of August (5.276) and lowest in February (3.727) whereas, Sheldon evenness index was highest in February (0.925) and lowest in September (0.823). This study revealed that Bhagairia Lake is rich in fish faunal diversity and consists of native, cultivable, ornamental and rare species of fish.

Keywords: Correlation coefficient; Cypriniformes; Ichthyofauna; Sheldon evenness index; Water quality

1 | Introduction

There are 252 species of fish recorded in Nepal, with 236 native species and 16 exotic species (Shrestha 2019). Fishes are the most diverse vertebrate in the world and nearly 40% of them live in freshwater (Ghorbani et al. 2013). Nepal is a natural laboratory to understand physiological and morphological variations in organisms in relation to changes in altitude (Gurung et al. 2011b). Fishes are specific in distribution exhibiting specificity for cold and warm waters. Such a pattern suggests the specific adaptation and physiological status of species for dissolved oxygen, temperature, torrent, lentic and lotic habitats (Gurung 2011). Only freshwater bony fishes are available in the country. In Nepal, fisheries are an age-old and traditional practice whereas, aquaculture was introduced in the mid-1940s (DoFD 2017).

Wetland types in Nepal include rivers, lakes, reservoirs, marshy swamps, village ponds, irrigation canals and paddy fields. The estimated area covered by wetlands in Nepal is 8,28,171 ha (CFPCC 2022). Wetlands are

crucial for their rich biodiversity and also for maintaining various sources of underground water, preventing landslides and controlling the nutrient loss (Shrestha 2011). The role of wetlands in conserving fish diversity is widely acknowledged as these wetlands are used by the various fish species as a refuge for breeding, feeding and spawning purposes at one stage or the other in their life cycle (Krishna et al. 2016). Around 17% of wetlands are located in the terai, mid-mountains and Siwalik (MoFE 2018). The land use and cover change influence the distribution and dynamics of terrestrial biodiversity, ecosystem structure and functioning leading to the alternation of ecosystems and critical habitats for many of the threatened species worldwide including freshwater ecosystems (Hooper et al. 2012).

The lakes are categorized into 3 types on the basis of their origin. i) Glacial ii) Oxbow and iii) Tectonic (Devkota 2011). Cutoffs are highly effective geomorphological events that produce long-lasting changes in river morphology, and also strongly influence the three-dimensional sedimentary architecture of floodplains through the subsequent formation and infilling of oxbow lakes (Peakall et al. 2007; Constantine et al. 2010). Bardiya district lies in Lumbini Province and is rich in water resources. It comprises four lakes i.e., Bahraiya Lake, Tara Lake, Bhagairia Lake and Gonaha Lake. Bhagairia Lake (28° 20' 25" N 81° 13' 16" E) is located in Dhanaura and Bipadpur-3 of Madhuban municipality, Bardiya. Around 2030 B.S. it had an area of 40 ha. Slowly, because of the encroachment, siltation and with no permanent inflow of water it has shrunk down to 10 ha. The ichthyofaunal diversity of Bahraiya Lake is only known which comprises 35 species of fish (Budha, 2010). No such work has been done in case of Bhagairia Lake.

2 | Materials and methods

2.1 | Study area

The present study was carried out in Bhagairia lake (280 20' 25" N 810 13' 16"E) of Dhanaura and Bipadpur-3 of Madhuban municipality, Bardiya (Figs. 1 & 2). It lies in an elevation of 144 masl. The area of this lake is 10 ha but only 4.5 ha contains water. It is a shallow oxbow lake with an average depth of 1.30 m having the highest depth of 2.12 m at the center and the lowest depth of 0.95 m. The southern side of the lake is deeper compared to the northern side. It is a perennial lake and receives water from rainfall and surface flow of the Karnali (Geruwa) river. This lake is rich in aquatic flora and fauna. The climate of the area is hot and humid. This study was conducted from August 2019 to February 2020.

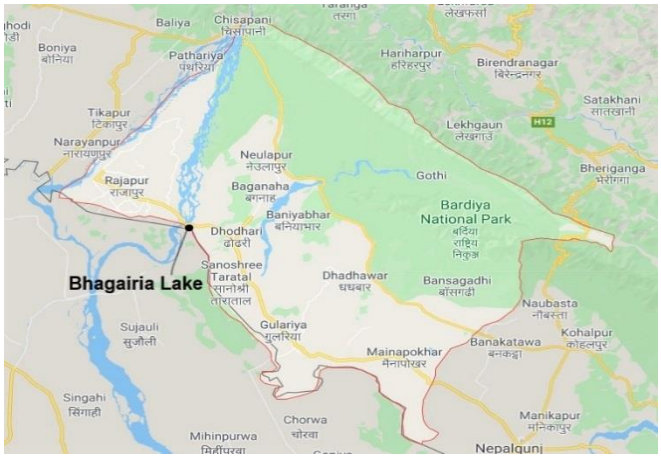

Figure 1. Map showing Bardiya District and area of study (Source: Google)

Figure 1. Bhagairia Lake

2.2 | Water Sampling

Water sampling was done from 6 sites around the lake at an equal interval of 170 m. For water sampling, a plastic sampling bucket of 10 L volume was used. Water was collected from 30cm below the water surface and then transferred into sterilized sampling bottles. Dissolved oxygen (DO), pH, water temperature, total dissolved solids (TDS) and water transparency were recorded on the spot while collecting water with help of a DO meter (Lutron PDO-519, Taiwan), pH meter (PH-030, HANNA Instruments, U.S.A), alcohol thermometer (Nike, India), TDS meter (HANNA Dist1-HI 98301, U.S.A) and secchi disc, respectively. While analyses of other water quality parameters i.e., alkalinity, total hardness, ammonia, phosphate and nitrate were done using Exact Eco Check kit, Industrial Testing Systems, Inc. U.S.A in the aquaculture laboratory of Directorate of Agricultural Research, Lumbini Province, Khajura, Banke.

2.3 | Fish sampling

Fish sampling was done from all 6 sites around the lake throughout the study period. Fish were collected using different types of crafts and gears with the help of local fishermen. The used fishing gears were pakhai (2.75 x 2.52 m) with mesh size 5mm, helka (0.90 x 0.84 m) with mesh size 5 mm and gill net (10 x 0.65 m) with mesh size 10 mm. Fish captured from different sites were photographed and mentioned. The fish caught were immediately kept in the bottle containing 10% formalin. The preserved fish species were brought to the laboratory of the National Fishery Research Center, Godawari for identification. These collected fish samples were identified using standard literature of fish taxonomy after Talwar and Jhingran (1991) and T.K. Shrestha (2019).

2.4 | Data analysis

The relation of fish with dissolved oxygen (DO), pH, water temperature, total dissolved solids (TDS), water transparency, alkalinity, total hardness, ammonia, phosphate and nitrate were analyzed through SPSS (Statistical Package for Social Sciences) 15.0 and Microsoft excel 2010.

Diversity indices

Species diversity index

The diversity of species was calculated by using Shannon-Weiner diversity index (1949)

$$H' = -\sum_{i=1}^{s} (pi).(In\ pi)$$

Where, S is the number of species in the sample, and pi is the proportion of i^{th} species in total sample.

Species richness index

The species richness was calculated by using Margalef's richness index (1959)

$$R_1 = \frac{(S-1)}{\ln(n)}$$

Where, S is the number of species in sample, and n is the number of individuals

Species evenness index

The species evenness was calculated by using Sheldon evenness index (1969)

$$E_2 = \frac{e^{H'}}{S}$$

Where, H' is the diversity index and S is the total number of species in the sample.

The catch compositions of individual fishes were determined using the following formula:

$$\text{Catch composition}(\%) = \frac{\text{Total catch of an individual species X 100}}{\text{Total catch of all species}}$$

3 | Results

A total number of 30 species of fish belonging to 8 orders, 13 families and 23 genera were recorded during the study (Table 1). Cypriniformes as the dominant order with 50% fish species followed by Synbranchiformes, Anabantiformes, Siluriformes, Perciformes, Gobiiformes, Beloniformes and Osteoglossiformes with 14%, 14%, 10%, 3%, 3%, 3% and 3%, respectively (Fig.3).

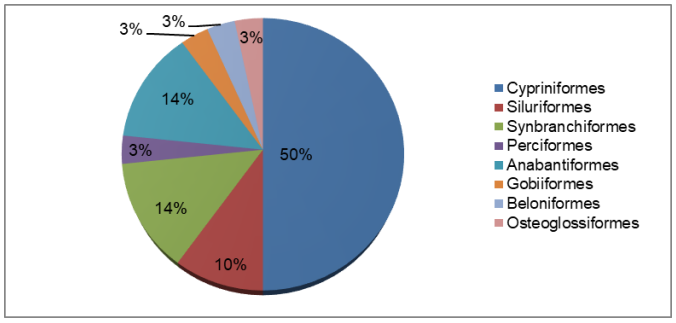

Figure 3. Fish species according to order of total ichthyofaunal diversity in Bhagairia Lake

Cyprinidae was the dominant family with 44% of fish species followed by Mastacembelidae, Bagridae, Channidae, Osphronemidae, Cobitidae, Nemacheilidae, Sisoridae, Synbranchidae, Ambassidae, Gobiidae, Belonidae and Notopteridae with 10%, 7%, 7%, 7%, 4%, 3%, 3%, 3%, 3%, 3%, 3% and 3%, respectively (Fig. 4).

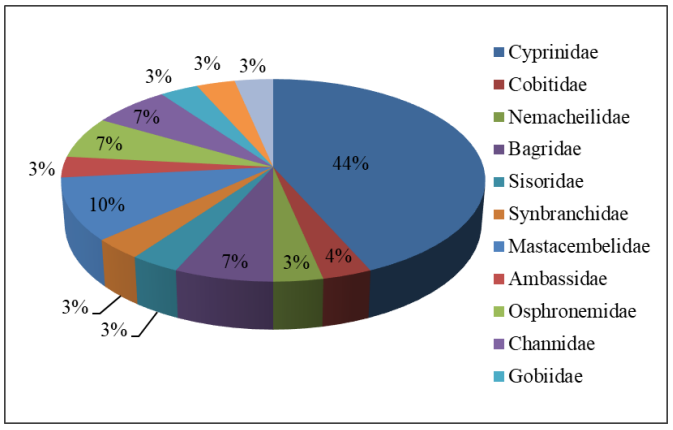

Figure 4. Fish species according to family of total ichthyofaunal diversity in Bhagairia Lake

The highest fish catch (214 individuals) was in February (winter) and the lowest fish catch (140 individuals) in

Table 1. Fish species collected from Bhagairia lake. Here, C= common, LC= least concern, E= endangered, CD= conserve dependent, R= rare, PRO= Data deficient pristine rare ornamental. ater lids

Order	Family	Scientific Name	Local name	IUCN Status
	Cyprinidae	*Puntius sophore*	Pate sidhra	C
	Cyprinidae	*Puntius terio*	Pothi	LC
	Cyprinidae	*Puntius ticto*	Sidhra	LC
	Cyprinidae	*Opsarius barna*	Titer kane faketa	C
	Cyprinidae	*Salmostoma bacaila*	Chilwa	C
	Cyprinidae	*Amblypharyngodon microlepis*	Dhawai	C
Cypriniformes	Cyprinidae	*Barilius bendelisis*	Fageta	C
	Cyprinidae	*Danio devario*	Chitharipothi	C
	Cyprinidae	*Esomus danrica*	Dedhawa	C
	Cyprinidae	*Labeo angra*	Thed	LC
	Cyprinidae	*Labeo bata*	Bata	C
	Cyprinidae	*Tor putitora*	Sahar	E
	Cyprinidae	*Cabdio morar*	Chakale	C
	Cobitidae	*Lepidocephalicthys guntea*	Goira	CD
	Nemacheilidae	*Paracanthocobitis botia*	Pate gatela	PRO
Siluriformes	Bagridae	*Mystus bleekeri*	Tengra	C
	Bagridae	*Mystus tengra*	Tengra	C
	Sisoridae	*Glyptothorax alaknandi*	Kapre	R
	Synbranchidae	*Monopterus cuchia*	Andha bam	LC
Synbranchiformes	Mastacembelidae	*Mastacembelus armatus*	Chusi bam	C
	Mastacembelidae	*Macrognathus pancalus*	Kathgainchi	C
	Mastacembelidae	*Macrognathus aral*	Bami	C
Perciformes	Ambassidae	*Pseudambassis baculis*	Chanari	C
Anabantiformes	Osphronemidae	*Colisa lalius*	Khesri	LC
	Osphronemidae	*Colisa fasciatus*	Gaurami	C
	Channidae	*Channa punctata*	Garai	C
	Channidae	*Channa orientalis*	Bhoti	C
Gobiiformes	Gobiidae	*Glossogobius giuris*	Bulle	C
Beloniformes	Belonidae	*Xenentodon cancila*	Kauwa maccha	C
Osteoglossiformes	Notopteridae	*Notopterus notopterus*	Golhai	LC

October. The ichthyofaunal diversity was found high in August with 28 species and low in December with 20 species. *Puntius sophore* was the dominant fish species with 12% catch composition followed by *Esomus danrica* with 8%, *Colisa fasciatus* with 7%, *Puntius terio* and *Pseudambassis baculis* with 6%. *Puntius ticto*, *Paracanthocobitis botia*, *Mystus bleekeri* and *Mystua tengra* with 5%, *Salmostoma bacaila*, *Barilius bendelisis* and *Notopterus notopterus* with 4%. *Opsarius barna*, *Danio devario*, *Labeo bata*, *Lepidocephalicthys guntea*, *Channa punctate* and *Channa orientalis* with 3% while other fish were caught in very few numbers (Table 3). The fluctuation in water quality parameters of the Bhagairia 96.58-136.83 ppm, dissolved oxygen 5.7- 6.31 mg/L, pH 6.8-8.4, alkalinity 82-153 ppm, total hardness 52-119 ppm, ammonia 0.05-0.14 ppm, nitrate 0.01-0.06 ppm and phosphate 0.07-0.13 ppm. In the study, 20 fish species were listed under common category, 6 fish species (*Puntius ticto*, *Puntius terio*, *Labeo , cuchia*, *Colisa lalius* and *Notopterus notopterus*) were listed under least concern and 1 fish species (*Lepidocephalicthys guntea*) was listed under conserve dependent, 1 fish species (*Paracanthocobitis botia*) was listed under data deficient pristine rare ornamental, 1 fish species (*Tor putitora*) was listed under endangered and 1 fish species (*Glyptothorax alaknandi*) was listed under rare categories according to IUCN red list status for Nepal (Fig. 5).

Table 2. Water quality parameters recorded during the study

Parameters	Range
Water temperature	20.31°C - 32.8°C
Water transparency	55.49 - 65.33 cm
Total dissolved solids	96.58 - 136.83 ppm
Dissolved oxygen	5.7 - 6.31 mg/ L
pH	6.8 - 8.4
Alkalinity	82 - 153 ppm
Total hardness	52 - 119 ppm
Ammonia	0.05 - 0.14 ppm
Nitrate	0.01 - 0.06 ppm
Phosphate	0.07 - 0.13 ppm

Shannon diversity index was highest in the month of August (3.14) and lowest in November (2.873). Margalef's richness index was highest in the month of August (5.276) and lowest in February (3.727) whereas, Sheldon evenness index was highest in February (0.925) and lowest in September (0.823). The correlation between fish catches and physicochemical parameters was analyzed. Fish catch was found to be positively correlated with dissolved oxygen (r= 0.912), pH (r= 0.876), alkalinity (r = 0.840) and total hardness (r= 0.876) whereas, negatively correlated with water temperature (r=- 0.868), water transparency (r =- 0.898), ammonia (r =- 0.705), nitrate (r =- 0.469), phosphate (r =- 0.935) and total dissolved solids (r =- 0.852). Variation in the fish catch during different months was found to be significant ($p< 0.05$).

4 | Discussion

Cypriniformes and Cyprinidae were the dominant order and family with 50% and 44% fish species during the study. Pokharel (1999) has reported Cypriniformes as a dominant order holding a maximum number of species and contributing a maximum catch in percentage in the lakes of Pokhara valley. Joshi and KC (2017) have also reported Cypriniformes as a dominant order and Cyprinidae as a dominant family from Ghodagodi Lake. The ichthyofaunal diversity was highest in the month of August because of the monsoon which brought about plenty of flood water along with different fish species from Karnali river into Bhagairia Lake. The ichthyofaunal diversity was lowest in December because of overfishing of selective fish species i.e. Cyprinidae family in winter months because of their good taste by the local fishermen. Shannon diversity index was highest in the month of August (3.14) while Margalef's richness index was highest in the

Table 3. Fish catch composition of Bhagairia Lake

Fish species	Catch Composition (%)
Puntius sophore	12%
Puntius terio	6.26%
Puntius ticto	4.73%
Opsarius barna	3.05%
Salmostoma bacaila	3.61%
Barilius bendelisis	3.61%
Danio devario	2.65%
Esomus danrica	7.79%
Labeo bata	3.29%
Lepidocephalicthys guntea	3.13%
Paracanthocobitis botia	4.81%
Mystus bleekeri	4.90%
Mystus tengra	4.57%
Macrognathus aral	0.32%
Pseudambassis baculis	5.46%
Colisa lalius	3.85%
Colisa fasciatus	6.90%
Channa punctata	2.97%
Channa orientalis	2.65%
Xenentodon cancila	0.16%
Macrognathus pancalus	0.48%
Motopterus cuchia	2.89%
Mastacembelus armatus	3.37%
Glyptothorax alaknandi	0.16%
Glossogobius guirius	0.16%
Labeo angra	0.16%
Tor putitora	0.16%
Cabdio morar	0.16%
Notopterus notopterus	4.34%
Amblypharyngodon microlepis	0.16%

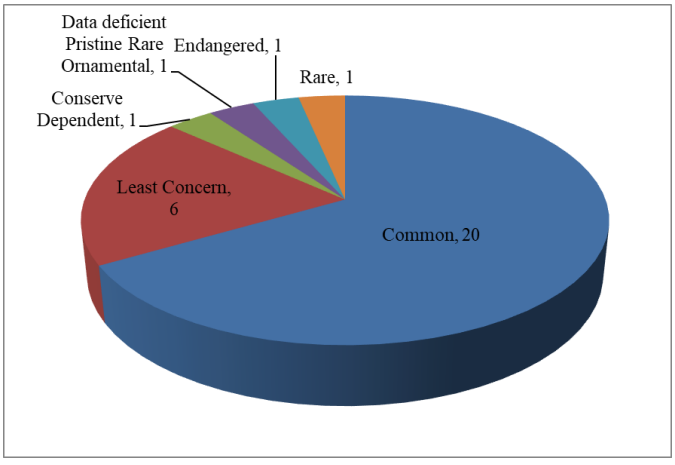

Figure 5. Fish species categories according to IUCN red list status for Nepal from Bhagairia Lake

Figure 6. Fish species of Bhagairia Lake

month of August (5.276) and Sheldon evenness index was highest in February (0.925). A community becomes more dissimilar as the stress increases. Gray (1989) stated that the dominance of relatively few species in the community indicates environmental stress. The water quality parameters of Bhagairia Lake were found to be within the suitable range for fish growth and development (Table 3). The fish catch was high in the month of February because of the increase in plankton population. The physicochemical parameters influence the distribution and abundance of the phytoplankton and zooplankton (Chukwu & Afolabi 2017). There is a correlation between the abundance of fish and the plankton (Balachandran & Peter 1987). Phytoplankton and zooplankton development (plankton-rich water) leads to the flourishment of the fouling community (Abo-Taleb 2019). Whereas, the lowest in October due to overfishing in lake remaining only the small fingerlings which were difficult to differentiate into different order and families.

5 | Conclusions

A total of 30 species of fish belonging to 8 orders and 13 families and 23 genera were recorded from Bhagairia Lake. The highest fish catch was observed in February and the lowest in October whereas, the highest ichthyofaunal diversity was observed in August with 28 species and the lowest in December with 20 species. Puntius sophore was the dominant fish species with 12% catch composition. In the study, 20 fish species belonging to common category, 6 fish species belonging to least concern, 1 fish species belonging to conserve dependent, 1 fish species belonging to data deficient pristine rare ornamental, 1 fish species belonging to endangered and 1 fish species belonging to rare categories was found according to IUCN red list status for Nepal. The water quality parameters were within the suitable range for fish diversity and fish production. This study indicates that Bhagairia Lake is rich in fish faunal diversity and consists of native species, cultivable, ornamental and rare species of fish. Sustainable strategies need to be explored to understand fish stocks and their utilization in order to protect the native fish species of Bhagairia Lake.

Acknowledgements

We are highly indebted to Mrs. Neeta Pradhan and Prem Timalsina of the National Fishery Research Center, Godawari for providing necessary guidance and invaluable suggestion. We would like to thank Mr. Krishna Rawal, of the Directorate of Agricultural Research, Lumbini Province, Khajura, Banke for his continuous help during field activities. Besides, our heartfelt thanks go to Jitram Dagaura, a local fisherman of Dhanaura village for his help in fish sampling and collection.

Conflicts of interest

Authors declare no conflict of interest.

References

Abo-Taleb, H. 2019. Importance of Plankton to Fish Community. In Biological Research in Aquatic Science. IntechOpen. https://doi.org/10.5772/intechopen.85769

Balachandran, T. and Peter, K. J. 1987. The role of plankton research in fisheries development. In CMFRI Bulletin: National Symposium on Research and Development in Marine Fisheries Sessions I & II, Central Marine Fisheries Research Institute, 1987, Kochi, India, pp 163-173.

Budha, P. B. 2010. Inventory of wetland fauna and sustainable resource utilization of Bahraiya Lake, Bardiya, mid-Western Nepal: issues and future prospects. Tigerpaper, Regional Quarterly Bulletin on Wildlife and National Park Management. pp 10-20.

CFPCC. 2022. Fisheries Data and Annual Progress Report, 2021/22. Central Fisheries Promotion and Conservation Center, Balaju, Kathmandu, Nepal, p 17.

Chukwu, M. N. and Afolabi, E. S. 2017. Phytoplankton abundance and distribution of fish earthen ponds in Lagos, Nigeria. Journal of Applied Sciences and Environmental Management, 21(7): 1245-1249. https://doi.org/10.4314/jasem.v21i7.3

Constantine, J. A., Dunne, T., Piégay, H. and Mathias Kondolf, G. 2010. Controls on the

alluviation of oxbow lakes by bed-material load along the Sacramento River, California. Sedimentology 57(2): 389-407. https://doi.org/10.1111/j.1365-3091.2009.01084.x

Devakota, S. 2011. Study on the impact of fisheries on Jalari community of Phewa lake Region Pokhara with a note on its ethnoichthyological. M.Sc. Thesis, Tribhuvan University, Central Department of Zoology, Kathmandu, Nepal.

DoFD. 2017. Fisheries Data and Annual Progress Report, 2016/17. Directorate of Fisheries Development, Balaju, Kathmandu, Nepal. p 1.

Ghorbani, R., Abbasi F., Molaei M. and Naeimi, A. 2013. Identification and distribution of fish fauna in Kaboodval Stream (Golestan Province, Iran). World Journal of Fish and Marine Sciences 5(5): 467-473. https://doi.org/10.5829/idosi.wjfms.2013.05.05.73142

Gray, J. S. 1989. Effects of environmental stress on species rich assemblages. Biological Journal of the Linnean Society 37(1-2): 19-32. https://doi.org/10.1111/j.1095-8312.1989.tb02003.x

Gurung, T.B. 2011. Prospects of cold water fisheries in high altitude wetlands. Proceedings of Eighth National Workshop on Livestock and Fisheries Research, Nepal Agriculture Research Council, 2011, Lalitpur, Nepal, pp 1-9.

Gurung, T. B., Rayamajhi A., Lamsal G., Dhakal R.P. and Basnet S.R. 2011b. Mid hill river fish and fisheries: resilience to food and nutritional security among hill communities in upper Trishuli, Nepal. Proceedings of Eighth National Workshop on Livestock and Fisheries Research, Nepal Agricultural Research Council, 2011, Lalitpur, Nepal, pp 10-20.

Hooper, D. U., Adair, E. C., Cardinale, B. J., Byrnes, J. E., Hungate, B. A., Matulich, K. L., O'Connor, M. I. 2012. A global synthesis reveals biodiversity loss as a major driver of ecosystem change. Nature 486 (7401):105-108. https://doi.org/10.1038/nature11118

Joshi, D. and Bijaya, K. C. 2017. Fish diversity of Ghodaghodi lake in Kailali, far-west Nepal. Journal of Institute of Science and Technology 22(1): 120-126. https://doi.org/10.3126/jist.v22i1.17762

Krishna, P. V., Panchakshari, V., Suresh, P., Prabhavathi, K. and Kumar, K. A. 2016. Ichthyofaunal diversity of Siluriformes from Kolleru Lake, Andhra Pradesh, India. International Journal of Fisheries and Aquatic Studies 4(6): 420-424.

MoFE 2018. Nepal's Sixth National Report to the Convention on Biological Diversity. Singha Durbar, Kathmandu, Nepal. P 58.

Peakall, J., Ashworth, P. J. and Best, J. L. 2007. Meander-bend evolution, alluvial architecture, and the role of cohesion in sinuous river channels: a flume study. Journal of Sedimentary Research 77(3):197-212. https://doi.org/10.2110/jsr.2007.017

Pokharel, K. K. 1999. Fish Bio-diversity of Lakes in Pokhara Valley. Proceedings of Third National Conference On Science and Technology, Royal Academy of Science and Technology (RONAST), 8 March 1999, Kathmandu, Nepal. pp 920-950.

Shrestha, J. 2011. Threat status of indigenous fish species of Nepal. Proceedings of the consultative workshop on fish conservation in Nepal, Fisheries Research Division (FRD), 4 July 2011, Godawari, Lalitpur, Nepal. P 220.

Shrestha, T. K. (Ed.) 2019. Ichthyology of Nepal. A study of fishes of the Himalayan waters. Himalayan Ecosphere. Kathmandu, Nepal, p 4.

Talwar, P. K. and Jhingran, A. G. 1991. Inland Fishes of India and Adjacent Countries. Oxford-IBH Publishing Co. Pvt. Ltd., New Delhi, India. p 1158.