



International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129

P-ISSN: 2394-0506

(ICV-Poland) Impact Value: 5.62

(GIF) Impact Factor: 0.549

IJFAS 2017; 5(5): 408-416

© 2017 IJFAS

www.fisheriesjournal.com

Received: 12-07-2017

Accepted: 13-08-2017

Asha Rayamajhi

Fisheries Research Division,
Godawari, Lalitpur,
Kathmandu, Nepal

Fish assemblage structure of Chitwan National Park, its buffer and adjacent zone, central Nepal with notes on macrohabitat

Asha Rayamajhi

Abstract

A comprehensive study of native fish species of five tribes, twenty families and seven orders were carried to identify and realign the genera and species during February, 2014. Cyprinids were the dominant group (43.64% out of 55 species) in the assemblage and almost all cyprinids were liberated to pools, riffles, run and with varied habitat diversity. Present work comprises of thirty-eight genera and fifty-five species. Order Cypriniformes constituted the highest species number 30 (54.55%) followed by Siluriformes 9 (16.36%), Perciformes 10 (18.18%), Synbranchiformes 3 (5.45%) whereas Order Osteoglossiformes, Beloniformes, and Tetradontiformes constituted lowest species number 1 (1.82%). A novel sp. *Pseudolaguvia nepalensis* was obtained from the stream, Kasara near to its confluence with Rapti River, central Nepal. Of the 55 species, *Tor tor* has characterized as near threatened in IUCN Red List. Macrohabitat assessment indicated that habitat volume was a major determining factor for species diversity and abundance.

Keywords: classification, fish diversity, substrate, preference

Introduction

Study on freshwater fishes in Chitwan National Park (CNP), its buffer zone and adjacent areas was carried out at extensive level. In 1984-1985, a team from the Edinburgh, Scotland, UK noted 70 fish species along the length of the Narayani River in Chitwan (Evans *et al.*, 1985)^[1]. Edds (1986a)^[2] reported 108 fish species at 19 sites along the Narayani in Chitwan. Ng and Edds (2005)^[3] described a new species, *Erethistoides cavatura*, from the Narayani River of the Gandak system. Edds (2007)^[4] has reported 36 fish species, including commonly *Opsarius sharcra*, *O. barnna*, *Puntius conchoniuis*, and *Aspidoparia jaya* from the CNP, Chitwan. Rayamajhi and Arunachalam (2016)^[5] described a new species, *Pseudolaguvia nepalensis* (family Erethistidae) from Kasara khola/stream near to its confluence with Rapti River of Gandak system, central Nepal. Fishes are challenging subjects for studies of resource partitioning (Ross, 1986)^[6]. The correlation between fish species diversity with their habitat in terms of flow and substrate has complexity (Gorman and Karr (1978); Schlosser (1982)^[7, 8]. To understand the reasons for this intricacy, in current study macrohabitat approaches was used to analyze the habitat requirements of the freshwater fish fauna. So far, joint studies on fish assemblage structure and their habitat requirements in Nepal streams are lacking. Therefore the main objective of this present study was to survey the assemblage of fish species associated with habitat types (macrohabitat) besides finding the novel species from surveyed streams, rivers and lakes in protected areas of CNP, its buffer and adjacent zone. Moreover to assess the existing conservation status of the all species collected.

Materials and Methods

Fish sampling was carried in CNP and its buffer and adjacent areas at an elevation from 122 m to 251 msl in Chitwan (Figs. 1 and 2) and Nawalparasi districts during 11-27 February, 2014. Fishes were sampled at each site using cast net with varying mesh sizes 6-10 mm and small fishes were caught using dip nets. Altogether twenty nine sites were selected in eight river basins (at length wise/broadly) including fish market and rice field (Table 1). Sampling sites were twenty five inside of Chitwan National Park and its buffer zone, the representative river basin are 1. Rapti River (n-8), 2. Reu River (n-5), 3. Narayani River (n-2) 4. Kasara Khola=stream

Correspondence

Asha Rayamajhi

Fisheries Research Division,
Godawari, Lalitpur,
Kathmandu, Nepal

(n-7), 5. Tamor Tal=lake (n-1), 6. Bishajari Tal (Ramsar Site) (n-1), 7. Tikoily Tal (n-1) and 8. Band khola (n-2). Since four fish sampling sites were in adjacent areas of CNP namely Tandi chowk fish market at Munispalti, Chitwan (fish source of the fish market was Budi Rapti River), Irrigation canal and rice field both at Gothaghat-Argauli VDC-5, Sherjung canal, Nawalparasi and confluence of the three rivers; Kaligandaki, Trishuli and Narayani at Devghat, Chitwan. Fish assemblage and macrohabitat were registered at each surveyed site. Macrohabitat features, such as stream depth, stream width, riparian cover, instream cover, habitat types and substrates, were assessed. Fishes were identified and photographed in the

field and then preserved in 10% formalin for morphometric and meristic studies. Larger specimens were injected with 15% formalin carefully through the vent prior to preservation. Specimens are preserved in Museum of Fisheries Research Division (FRDM) under Nepal Agricultural Research Council, Kathmandu, Nepal. The meristic and morphometric measurements are based on the methods by Silas (1958), Hubbs & Lagler (1964), Jayaram (2000), Jayaram (2002) and Jayaram (2010) [9, 10, 11, 12, 13, 14]. All the specimens including paratype and holotype are deposited to FRDFM with their vouchers.

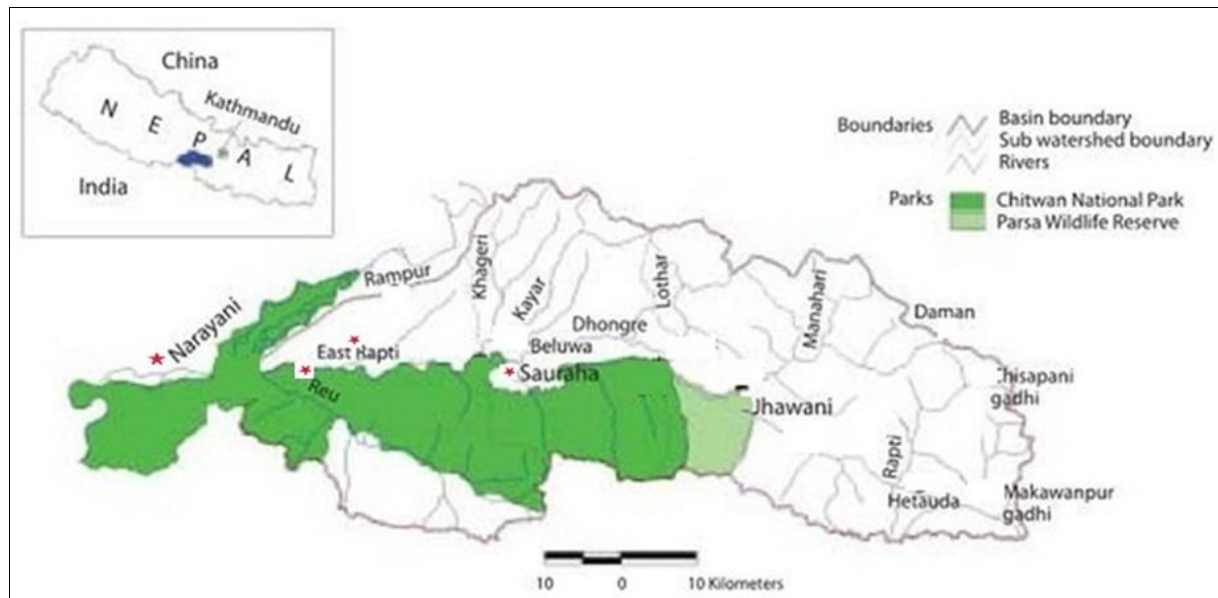


Fig 1: Map showing study area using the star (★); East Rapti River, Reu River, Rapti River at Sauraha at Chitwan National Park and Narayani River.

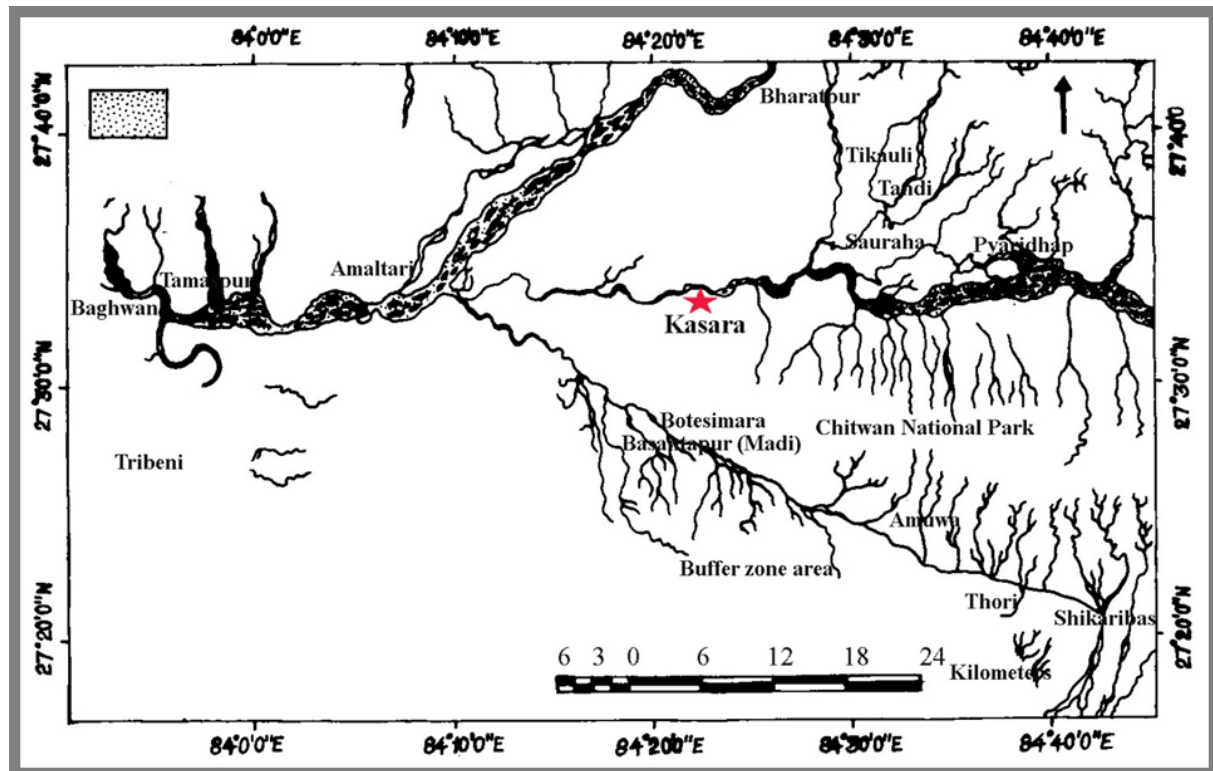


Fig 2: Map showing study area using the star (★): Kasara khola=stream at Chitwan National Park, central, Nepal

Table 1: Study sites with GPS co-ordinates and physical and chemical parameters

No	Collection site in Central Nepal, Chitwan and Nawalparasi District, Narayani Zone	River	Alt. (m)	Latitude	Longitude	AT. (°C)	WT (°C)	pH	DO	Cond. (ms)	TDS (ppt)
1	Rapti River at CNP										
1.1	Rapti River at Kasara Bridge, Jagatpur-1, Chitwan (CNP), 20 km south west from Bharatpur	NR	155	N 27° 32' 966"	E 084° 19'540"	18.5	20	7.1	8.9	0.14	0.14
1.2	Rapti River, Major Ghat, Patiyan (CNP), 3 km east of Rapti Kasara Bridge	NR	142	N 27° 33' 393"	E 084° 20' 158"	20	22	7.5	8.5	0.02	0.18
1.3	Rapti River, Androli-1 Chitwan (CNP), 28 km south west of Rapti Kasara Bridge	NR	141	N 27° 33' 952"	E 084° 11' 673"	16.5	21	7.2	9.1	0.02	0.18
1.4	Rapti Kasara junction- Rapti, old Kasara Ghat, Jagatpuri-1, Chitwan (CNP), 500 m east of RKB	NR	135	N 27° 33' 103"	E 084° 19' 875"	18.5	21	6.1	8.8	0.01	0.19
1.5	Rapti River, Bhanga Ghat, Migoli-1, Chitwan (CNP)	NR	128	N 27° 34'118"	E 084° 11' 967"	19.5	25	6.6	9.3	0.01	0.17
1.6	Rivers Rapti-Reu junction, Lokhariya-1, Migoli, Chitwan (CNP), 32 km south west of RKB	NR	133	N 27° 33' 230"	E 084° 10' 440"	22	27	7.3	6.5	0.01	0.26
1.7	Rivers Rapti and Narayani confluence at Golaghat, Lokhariya-1, Meghauri, Chitwan (CNP), 35 km south west of RKB.	NR	136	N 27° 33' 762"	E 084° 09'489"	20	26	7.1	7.2	0.01	0.19
1.8	Rivers Rapti and Dhungre confluence at VDC Bachauli-4, Sauraha, Chitwan, 45 km east of RKB	NR	184	N 27° 34'422"	E 084° 29'572"	23	27	6.9	9.2	0.02	0.24
2	Reu River at Chitwan (CNP)										
2.1	Reu River, Village Development Committee (VDC) Gardi - 4, Bhallai, 23 km south west of RKB.	RR, NR	135	N 27°31'388"	E 084° 14' 949"	22	23.5	7.2	8	0.19	0.29
2.2	Reu River, Gardi VDC-4, Pandu Nagar, 21 km south west of Rapti Kasara Bridge	RR, NR	142	N 27° 30' 562"	E 084° 15' 599"						
2.3	Reu River, Ayodhyapuri-9, Barai, Chitwan, 42 km south east of Rapti Kasara Bridge	RR, NR	251	N 27° 25.159'	E 084° 27. 314'	24.5	23	7.5	7.3	0.02	0.11
2.4	Rapti River and Reu River confluence Lokhariya-1, Migoli, Chitwan, 32 km south west of RKB	RR, NR	127	N 27° 33'181"	E 084° 10'484"	19	26	7.6	6.3	0.01	0.24
2.5	Reu River at Migoli-5, 1.5 km west of tiger tops, 26 km south west of Rapti Kasara Bridge, Chitwan	RR, NR	143	N 27° 32'487"	E 084° 11' 715"	22	25	7.6	9	0.01	0.28
3	Kasara Khola/Stream at CNP										
3.1	Kasara and Rapti River tributaries at Kasara, old Kasara Ghat, Jagatpur-1, CNP	RR	131	N 27° 33' 097"	E 084° 19' 955"	16	20	6.3	8.8	0.01	0.19
3.2	Kasara stream opposite of Ghadiyal Project, Jagatpur-1 Chitwan (a tributary of Rapti River), 400 m east of old Kasara Ghat up to wooden bridge	RR	156	N 27° 33' 236"	E 084° 20' 297"	19	21	7.4	7.2	0.01	0.19
3.3	Kasara stream on the fire lane, Jagatpur-1, Chitwan, 5 km east of old Kasara Ghat	RR	178	N27° 32'902"	E 084° 21' 034"	18.5	21	7.1	7.6	0.01	0.18
3.4	Kasara stream, site-4, 1.5 km east of old Kasara Ghat	RR	205	N27°33'009"	E 084°21'004"						
3.5	Kasara stream, site-5, 1.2 km east of old Kasara Ghat	RR	175	N27°31'192"	E 084° 21' 024"						
3.6	Kasara stream, site- 6, 1 km east of old Kasara Ghat	RR	166	N 27° 33'262"	E 084° 21' 533"						
3.7	Kasara stream near elephant stable, 800 m east of old Kasara Ghat	RR	159	N27° 33'197"	E 084° 20' 162"	20	21	6.8	7.6	0.02	0.2
4	Tamor Lake-Kasara, Jagatpur-1, CNP	RR	214	N 27° 31' 984"	E 084° 20' 014"	19	23	7.2	9	0.01	0.09
5	Baandh stream (Buffer zone of CNP)										
5.1	Baandh Khola=stream, at North of Home stay, Argoili village, VDC Amaltari, Nawalparasi (Buffer zone of CNP)	NR	123	N 27° 34' 073"	E 084°, 06'542"	22	25	6.4	7.1	0.01	0.19
5.2	Baandh stream, Amaltari, Nawalparasi, 3 km North from junction of Baandh and Danda Khola/stream	NR	122	N 27° 34' 462"	E 084° 06' 903"	26	23	7.1	7.4	0.01	0.2
6	Narayani River, Near Ghadiyal project, VDC Amaltari, Boundary of Nawalparasi and Chitwan, CNP buffer zone	Ganges River	133	N 27° 33' 258"	E 084° 07' 205"	21	28	7.7	8.4	0.01	0.2
7	Irrigation canal, Gothaghat- Argauli VDC-5, Sherjung canal, Nawalparasi District (Unprotected area)	Banndh khola	128	N 27° 34'920"	E 084° 06' 582"	26	28	7.1	5.3	0.01	0.28
8	Rice field Gothaghat- Argauli VDC-5, Nawalparasi	Banndh stream	128	N 27° 34'920"	E 084° 06'582"						
9	Tikoily Lake, Ratna Nagar, Nagarpalika, Chitwan, buffer zone of CNP	NR	168	N 27°37'838"	E 084° 28'779"	23	26	6.5	7.7	0.01	0.17
10	Bishajari Lake (Ramsar Site) (150 ha), Army post, Bharatpur NP-8, buffer zone of CNP, Chitwan District	NR	179	N27° 36'955"	E 084° 26' 221"	21	24	6.8	6.8	0.01	0.07
11	Narayani River at Devghat, confluence point of Kaligandaki, Trishuli and Narayani River, unprotected area, Chitwan District	Ganges River	170 & 158	N 27° 44' 519"	E 084° 25' 329"	19 & 21	17 & 18.5	7.3 & 7.2	9 & 8.8	0.01	0.13
12	Tandi chowk fish market, Ratana Nagar, Nagarpalika (Munisपाली) Chitwan	BR River									

NR=Narayani River, RR=Rapti River, CNP=Chitwan National Park, RKB-Rapti Kasara Bridge, Alt. (m) =Altimeter, AT.=Air temperature, WT=water temperature, DO=dissolve oxygen, Cond.=conductivity, TDS=total dissolved solids

Results

Fish assemblages-composition

Fifty five species were represented by thirty eight genera, twenty families and seven orders in the surveyed nature reserve possess to Chitwan National Park, its buffer zone and adjacent areas (Table 2). The Order Cypriniformes constituted the highest species number 30 (54.55%) followed by Siluriformes 9 (16.36%), Perciformes 10 (18.18%), Synbranchiformes 3 (5.45%) whereas Order Osteoglossiformes, Beloniformes, and Tetradontiformes constituted lowest species number 1 (1.82%). The percentage composition of the fishes of different orders is given in Figure 3. Among the families cyprinids were the most dominant group in the assemblage (43.64%) followed by Cobitidae, Sisoridae, Ambassidae and Channidae had 5.45% species and

Psilorhynchidae, Bagridae, Erethistidae and Mastacembelidae had comprises of 3.64% species. Rest of other families accounted for 1.82% were Notopteridae, Balitoridae, Siluridae, Heteropneustidae (Saccobranchidae), Belonidae, Synbranchidae, Nandidae, Badidae, Gobiidae, Osphronemidae and Tetraodontidae. In the fish assemblage, 35 species were common, 5 fairly common, 6 uncommon, 1 occasional, 3 insufficiently known, 1 rare and 1 species (*Tor tor*) has characterized as near threatened in IUCN Red. *Pseudolaguvia nepalensis* was new to science, was reported from Kasara khola near to its confluence with Rapti River, CNP and *Erethistoides cavatura* was reported as new record was collected from Reu River at locality Gardi VDC-4, Pandu Nagar and 1.5 km west of tiger tops, Migoli-5, CNP, central Nepal.

Table 2: Fish species recorded from the surveyed nature reserve possess to Chitwan National Park, its buffer zone and adjacent areas, Chitwan and Nawalparasi districts, central Nepal. 1. Rapti River (RR) at Kasara bridge, Jagatpur-1; 2. RR near Kasara bridge; 3. Rapti-Reu tributary-Rapti, Lokhariya-1; 4. Tributary of RR-Kasara Khola/stream-old Kasara Ghat, Jagatpur-1; 5. RR, Major Ghat, Patiyan; 6. RR, Bhanga Ghat, Migoli-1; 7. Tributary of RR and Dhungre River-Rapti River, VDC Bachauli-4, Sauraha; 8. RR, Androli-1, Barahi Hotel site, Meghauri-1; 9. Tandi Chowk fish market, Ratana Nagar, Nagarpalika; 10. Reu River, VDC Gardi-4, Bhallai; 11. Reu River, Ayodhyapuri-9, Barai; 12. Reu River, Gardi VDC-4, Pandu Nagar; 13. Reu River 1.5 km west of tiger tops, Migoli-5; 14. Reu River, Ayodhyapuri-9, Barai; 15. Kasara-Rapti junction, Kasara, old Ghat; 16. Kasara Khola opposite Ghadiyal Project, Jagatpur-1; 17. Kasara Khola on the fire lane, Jagatpur-1; 18. Kasara Khola Ghat, near elephant stable; 19. Narayani River at Devghat at confluence point of Kaligandaki, Trishuli and Narayani River; 20. Narayani River, Argoili-5, Near Ghadiyal project; 21. Baandh Khola/Stream, a tributary of Narayani, Argoili-5, Amaltari, Nawalparasi; 22. Band Khola/Stream, North of Home stay, Argoili village; 23. Baandh Khola Argoili-5, Amaltari, Nawalparasi, 3 km North from junction of Band and Danda Khola; 24. Bishajari Lake/Tal (Ramsar Site) (150 ha), Army post, Bharatpur Nagar Palika-8; 25. Tikoli Lake (12 ha), Ratna Nagar, Nagarpalika, Chitwan, buffer zone; 26. Rice field Gothaghat Nawalparasi, buffer zone CNP; 27. Tamor Tal/Lake, Kasara, Jagatpur-1; 28. Irrigation canal, Gothaghat-Argauli VDC-5, Nawalparasi district. Present: +; absent: -; New (novel) sp.: X

No	Fish species	Fish sampling sites (Stream/river/lake)													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Order: Osteoglossiformes														
	Family: Notopteridae														
	Genus: <i>Notopterus</i>														
1	<i>Notopterus notopterus</i> (Pallas)	+	-	-	-	-	-	-	-	+	-	-	-	-	-
	Order: Cypriniformes														
	Family: Cyprinidae														
	Tribe: Oxygastrini														
	Genus: <i>Aspidoparia</i>														
2	<i>Aspidoparia morar</i> (Hamilton)	-	-	+	-	-	-	-	-	-	-	-	-	-	-
	Genus: <i>Barilius</i>														
3	<i>Barilius barna</i> (Hamilton)	-	-	-	+	-	-	-	-	-	+	-	-	-	-
4	<i>Barilius bendelisis</i> (Hamilton)	-	-	-	-	+	-	-	-	-	-	+	-	-	-
	Genus: <i>Raimas</i>														
5	<i>Raimas bola</i> (Hamilton)	-	-	-	-	+	-	-	-	-	-	-	-	-	-
	Genus: <i>Chela</i>														
6	<i>Chela laubuca</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Genus: <i>Danio</i>														
7	<i>Danio dangila</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	+	-	-	-
	Genus: <i>Devario</i>														
8	<i>Devario devario</i> (Hamilton)		+	-	-	+	-	-	-	-	-	-	-	-	-
	Tribe: Torini														
	Genus: <i>Tor</i>														
9	<i>Tor tor</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	<i>Tor mosal</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Genus: <i>Osteobrama</i>														
11	<i>Osteobrama cotio cotio</i> (Hamilton)	-	+	-	-	-	-	-	-	-	-	-	-	-	-
	Tribe: Smiliogastrini														
	Genus: <i>Chagunius</i>														
12	<i>Chagunius chagunio</i> (Hamilton)	-	+	-	-	-	-	-	-	-	-	-	-	-	-
	Tribe: Smiliogastrini														
	Genus: <i>Puntius</i>														
13	<i>Puntius sarana</i> (Hamilton)	-	+	-	-	-	-	-	-	-	-	-	-	-	-
14	<i>Puntius tetrapagus</i> (Hamilton)	-	+	-	-	-	-	-	-	-	-	-	-	-	-

15	<i>Puntius conchoni</i> (Hamilton)	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
16	<i>Puntius sophore</i> (Hamilton)	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
17	<i>Puntius ticto</i> (Hamilton)	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
	Tribe: Labeoninae															
	Genus: <i>Cirrhinus</i>															
18	<i>Cirrhinus mrigala</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tribe: Labeoninae															
	Genus: <i>Labeo</i>															
19	<i>Labeo angra</i> (Hamilton)	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
20	<i>Labeo calbasu</i> (Hamilton)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
21	<i>Labeo dero</i> (Hamilton)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
22	<i>Labeo gonius</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23	<i>Labeo rohita</i> (Hamilton)	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
	Genus: <i>Crossocheilus</i>															
24	<i>Crossocheilus latius latius</i> (Hamilton)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tribe: Labeoninae															
	Genus: <i>Garra</i>															
25	<i>Garra mullya</i> (Sykes)	-	-	-	+	-	-	-	-	-	-	+	-	-	-	-
	Family: Psilorhynchidae															
	Genus: <i>Psilorhynchus</i>															
26	<i>Psilorhynchus sucatio</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	<i>Psilorhynchus nepalensis</i> Convey & Mayden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Family: Balitoridae															
	Genus: <i>Acanthocobitis</i>															
28	<i>Acanthocobitis botia</i> (Hamilton)	-	-	-	-	-	-	-	+	-	-	-	+	-	-	-
	Family: Cobitidae															
	Genus: <i>Botia</i>															
29	<i>Botia dayi</i> Hora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Genus: <i>Somileptes</i>															
30	<i>Somileptes gongota</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
	Genus: <i>Lepidocephalus</i>															
31	<i>Lepidocephalus guntea</i> (Hamilton)	-	-	-	-	-	-	-	-	-	+	-	-	-	-	+
	Order: Siluriformes															
	Family: Bagridae															
	Genus: <i>Mystus</i>															
32	<i>Mystus bleekeri</i> (Day)	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-
33	<i>Mystus vittatus</i> (Bloch)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Family: Siluridae															
	Genus: <i>Ompok</i>															
34	<i>Ompok pabda</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Family: Erethistidae															
	Genus: <i>Erethistoides</i>															
35	<i>Erethistoides cavatura</i>	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-
	Genus: <i>Pseudolaguvia</i>															
36	<i>Pseudolaguvia nepalensis</i> Rayamajhi, Arunachalam & Usharamalakshmi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Tribe: Glyptothoracini															
	Family: Sisoridae															
	Genus: <i>Glypthorax</i>															
37	<i>Glypthorax cavia</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38	<i>Glypthorax kashmirensis</i> Hora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
39	<i>Glypthorax pectinopterus</i> (McClelland)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Family: Heteropneustidae															
	Genus: <i>Heteropneustes</i>															
40	<i>Heteropneustes fossilis</i> (Bloch)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Order: Beloniformes															
	Family: Belonidae															
	Genus: <i>Xenentodon</i>															
41	<i>Xenentodon cancila</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Order: Synbranchiformes															
	Family: Synbranchidae															
	Genus: <i>Monopterus</i>															
42	<i>Monopterus cuchia</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Family: Mastacembelidae																		
	Genus: <i>Macrognathus</i>																		
43	<i>Macrognathus pancalus</i> (Hamilton)	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
	Genus: <i>Mastacembelus</i>																		
44	<i>Mastacembelus armatus</i> (Lacepede)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Order: Perciformes																		
	Family: Ambassidae																		
	Genus: <i>Chanda</i>																		
45	<i>Chanda nama</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Genus: <i>Parambassis</i>																		
46	<i>Parambassis baculis</i> (Hamilton)	-	+	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
47	<i>Parambassis ranga</i> (Hamilton)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Family: Nandidae																		
	Genus: <i>Nandus</i>																		
48	<i>Nandus nandus</i> (Hamilton)	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
	Family: Badidae																		
	Genus: <i>Badis</i>																		
49	<i>Badis badis</i> (Hamilton)	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
	Family: Gobiidae																		
	Genus: <i>Glossogobius</i>																		
50	<i>Glossogobius giuris</i> (Hamilton)	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Family: Osphronemidae																		
	Genus: <i>Colisa</i>																		
51	<i>Colisa fasciata</i> (Blotch and Schneider)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Family: Channidae																		
	Genus: <i>Channa</i>																		
52	<i>Channa orientalis</i> Blotch and Schneider	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
53	<i>Channa punctatus</i> (Blotch)	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
54	<i>Channa gachua</i> (Hamilton)	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
	Order: Tetraodontiformes																		
	Family: Tetraodontidae																		

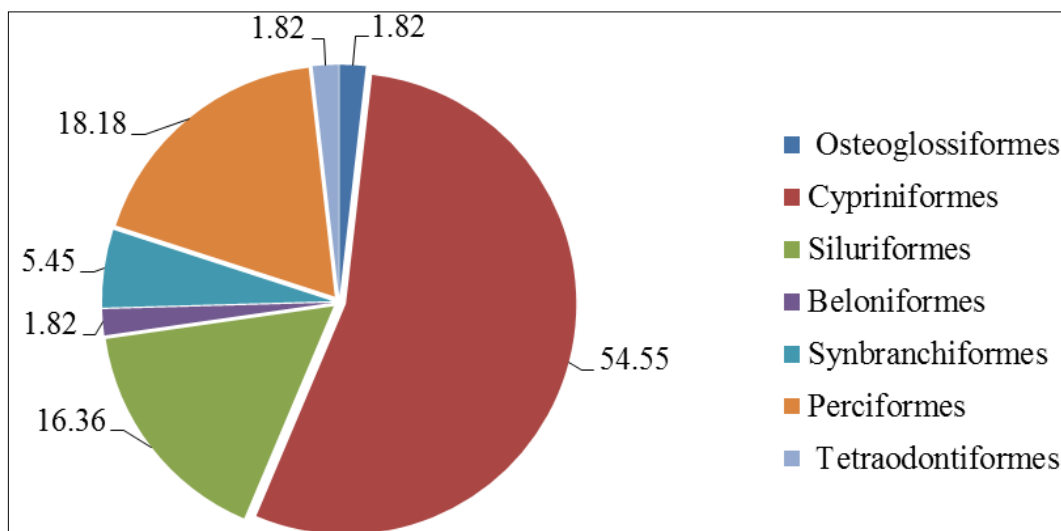


Fig 3: Percentage composition of collected fish species among different Orders

Macrohabitat availability and habitat preference

Macrohabitat assessment indicated that habitat diversity was associated with high species diversity, and that habitat volume was a major determining factor for species diversity and abundance. Instream cover or fish cover varied greatly according to the surveyed streams (Table 3). In Rapti River, the dominant cover types were mixed with sand and pebbles and in Reu River, undisturbed sandy river with mud, pebbles, gravels, logs and water hyacinth were prevalent. In Kasara khola/stream, undisturbed sandy stream was the major cover. In Tamor Tal=lake, silt and clay were dominant. In Baandh khola/stream, pebbles, sand, small boulders and logs were

dominant cover types. Sand and silt were the major fish cover in the Narayani River at Devghat. Substrates in Tikoli Tal were muddy and silty covered with leaf litter and irrigation canal possess 90% silt and rest of the clay. However, the riparian cover showed no significant relationship with stream gradient and fish density.

General habitat characteristics and morphology of stream, rivers and lakes of Chitwan National Park, its buffer zone and adjacent water bodies were mentioned in Table 3. Almost all cyprinid species were disturbed in pools, runs, riffles and wet land. Pools, runs and riffles were the preferred habitats for *Aspidoparia morar*, *Barilius bendelisis*, *Barilius barna*,

Barilius vagra, *Raiamas bola*, *Devario devario*, *Danio dangila*, *Osteobrama cotio cotio*, *Chagunius chagunio*, *Puntius sarana*, *Puntius conchoni*, *Puntius sophore*, *Puntius ticto*, *Barbus tetrapagus*, *Labeo calbasu*, *Labeo angra*, *Labeo dero*, *Labeo rohita*, *Labeo gonius*, *Crossocheilus latius latius*, *Garra mullya*, *Chela laubuca*, *Tor tor*, *Channa gachua*, *Channa punctatus* and *Cirrhinus mrigala* within Cypriniformes Order as well as for *Macrognathus pancalus* and *Mastacembelus armatus* of Order Synbranchiformes. Wetland was the least preferred habitat for cyprinid during fish sampling. Pools and runs were the preferred habitats for *Notopterus notopterus* (Order:

Osteoglossiformes) and *Glossogobius giuris* (Order: Perciformes).

Lower order riffles including run and pool were the preferred habitat for the *Mystus bleekeri*, *Mystus vittatus*, *Ompok pabda*, *Erethistoides cavatura*, *Pseudolaguvia nepalensis* novel sp., *Glyphorax cavia*, *Glyphorax kashmirensis*, *Glyphorax pectinopterus* of Order Siluriformes, *Tetraodon cutcutia* of Order Tetraodontiformes and *Xenentodon cancila* of Order: Beloniformes. *Chanda nama*, *Parambassis baculis* and *Parambassis ranga* occurred in smooth riffles including pools and runs where as the *Badis badis* occurred in stagnant water of irrigation canal.

Table 3: General habitat characteristics of streams /rivers/lakes in Chitwan National Park, its buffer zone and adjacent area, Chitwan and Nawalparasi districts, central Nepal

Name of surveyed stream/river/lake	River basin	Substrate	Habitat Type	Riparian cover	Mean width (m)	Depth (m)	Collected fish species
Rapti River at CNP Chitwan,	Ganges River	sand and pebbles (60+40%) along the wetted width of the river	pools and runs	both the banks of Rapti River formed by grasses, forest and natural plant communities	20-200	0.30-2.0	<i>Notopterus notopterus</i> , <i>Aspidoparia morar</i> , <i>Barilius bendelisis</i> , <i>B. barna</i> , <i>Raiamas bola</i> , <i>Devario devario</i> , <i>Osteobrama cotio cotio</i> , <i>Chagunius chagunio</i> , <i>Puntius sarana</i> , <i>P. conchoni</i> , <i>P. sophore</i> , <i>P. ticto</i> , <i>Barbus tetrapagus</i> , <i>Labeo calbasu</i> , <i>L. angra</i> , <i>L. dero</i> , <i>Crossocheilus latius latius</i> , <i>Garra mullya</i> , <i>Nemacheilus botia</i> , <i>Mystus bleekeri</i> , <i>Macrognathus pancalus</i> , <i>Parambassis baculis</i> , <i>Badis badis</i> , <i>Channa orientalis</i> , <i>Glossogobius giuris</i>
Reu River, CNP at Chitwan	Ganges River	undisturbed sandy river with mud, pebbles, gravels, logs & water hyacinth	lower order riffles run and pool	both the banks represented by, grasses, forest and native plants	10-25	0.3-0.61	<i>Barilius barna</i> , <i>B. bendelisis</i> , <i>Danio dangila</i> , <i>Acanthobotia botia</i> , <i>Garra mullya</i> , <i>Somileptes gongota</i> , <i>Lepidocephalus guntea</i> , <i>Erethistoides cavatura</i> , <i>Channa punctatus</i>
Kasara stream, Jagatpur-1, CNP, Chitwan	Rapti River to Ganges	undisturbed sandy stream	lower order riffles run and pool	riparian vegetation on both sides and represented by forestland, elephant grasses and natural plants communities.	3-10	0.61-0.82	<i>Chela laubuca</i> , <i>Danio dangila</i> , <i>Garra mullya</i> , <i>Psilorhynchus suctatio</i> , <i>P. nepalensis</i> , <i>Somileptes gongota</i> , <i>Mystus vittatus</i> , <i>Ompok pabda</i> , <i>Xenentodon cancila</i> , <i>Chanda nama</i> , <i>Tetraodon cutcutia</i> and <i>Pseudolaguvia nepalensis</i> sp. novel.
Tamor Lake, Kasara, Jagatpur-1, CNP, Chitwan	Rapti River	Mostly possessed by silt and clay	smooth riffles	riparian vegetation is the typical of wetlands			<i>Puntius chonchoni</i> , <i>P. ticto</i> , <i>Chanda nama</i> , <i>Parambassis ranga</i> .
Baandh stream, Argoili-5, Amaltari, Buffer zone of CNP, Nawalparasi district	Narayani River	pebbles, sand, small boulders and logs	lower order riffles, run and pool	aquatic vegetation; water hyacinth, and submerged plants	10-15	0.30	<i>Barilius vagra</i> , <i>Osteobrama cotio cotio</i> , <i>Chagunius chagunio</i> , <i>Puntius conchoni</i> , <i>P. sophore</i> , <i>Garra mullya</i> , <i>Mystus bleekeri</i> , <i>Macrognathus pancalus</i> , <i>Mastacembelus armatus</i>
Narayani River at Devghat, confluence point of Kaligandaki, Trishuli and Narayani River, adjacent area of CNP Chitwan	Ganges River	sand and silt	riffils and run	riparian vegetation is disturbed			<i>Tor tor</i> , <i>Chagunius chagunio</i> , <i>Labeo dero</i> , <i>Crossocheilus latius latius</i> , <i>Botiya dayi</i>
Narayani River near Ghadiyal project, Argoili -5, VDC Amaltari, boundary of district; Nawalparasi and Chitwan districts, buffer zone of CNP	Ganges River	small boulders and sand	pools and runs			0.5-1	<i>Tor mosal</i> , <i>Garra mullya</i> , <i>Botiya dayi</i> , <i>Glyphorax cavia</i> , <i>G. kashmirensis</i> , <i>G. pectinopterus</i> , <i>Macrognathus pancalus</i> , <i>Chanda nama</i>
Tikoily Lake, Ratna Nagar, Nagarpalika, Chitwan, buffer zone of CNP		muddy and silty	designated as a wetland	riparian forest are natural and undisturbed	12 ha		<i>Heteropneustes fossilis</i> , <i>Channa punctatus</i> .
Bishhajari Lake		lowland		vegetation all along	3200 ha		<i>Cirrhinus mrigala</i> , <i>Labeo gonius</i> ,

(known as twenty thousand lake), Devnagar, buffer zone of CNP, Chitwan		shallow lake with sandy and clayey		the banks are natural and undisturbed			<i>Parambassis ranga</i>
Irrigation canal, Gothaghat- Argauli VDC-5, Sherjung canal, Nawalparasi, unprotected area	Band stream	possess 90% silt and rest of clay	stagnant	grasses and rice field	1	0.6	<i>Colisa fasciata, Badis badis, Puntius ticto</i>
Rice field, Gothaghat- Argauli VDC-5, Nawalparasi, buffer zone of CNP							<i>Monopterusuchia</i>
Tandi chowk fish market, Ratana Nagar, Nagarpalika, adjacent area of CNP, Chitwan							<i>Notopterus notopterus, Labeo rohita, Mystus bleekeri, Nandus nandus, Channa gachua</i>

Discussion

Fish assemblages in the nature reserve possess at Ganges River basin at Chitwan National Park, its buffer and adjacent areas (unprotected areas) in Chitwan, central Nepal was utilized a patch-based approach to examine both assemblage structure and habitat use by streams, rivers and lakes fishes. Though there are a number of published studies on the checklist of fish assemblages in various streams possess Chitwan, central Nepal (Edds, 1986a; Edds 2007; Dhital and Jha, 2002; Edds, 1986b) [2, 4, 15, 16]. In Current study holotype (FRDFM 1) and Paratype (FRDFM 2) of *Pseudolaguvia nepalensis* was collected from Kasara khola/stream near confluence with Rapti River in the vicinity of CNP (N 27033'97" E 840 19'96") 500 m east of Rapti Kasara bridge; at 135 m above sea level (Ganges River basin) having unpolluted lower order riffles water Rayamajhi and Arunachalam (2016) [5]. Moreover *Erethistoides cavatura* was reported as new record from Reu River, Chitwan district at 26 km south west of Rapti Bridge Kasara, (N 27° 30' 562"E 084° 15' 599", 142 msl). Though earlier *Erethistoides cavatura* (holotype) (OSUS 15572) was collected from Dhungre River, Sauraha of Chitwan (Ng and edds, 2005) [3]. Fish sampling survey results showed that almost all cyprinid species of the four tribes (Torini, Smiliogastrini, Oxygastrini and Labeoninae) and 19 genera (*Aspidoparia, Barilius, Raimas, Chela, Danio, Devario, Tor, Osteobrama, Chagunius, Puntius, Cirrhinus, Labeo, Crossocheilus, Garra, Psilorhynchus, Acanthocobitis, Botia, Somileptes* and *Lepidocephalus*) were disturbed in pools, runs, riffles and wet land (Table 3). Habitat use analyses indicated that cyprinid species had very general patterns of habitat use, whereas featherback fish (*Notopterus notopterus*) of Osteoglossiformes order and Gobi fish (*Glossogobius giuris*) were particular in pool and run residents. Macrohabitat pattern such as stream depth, stream width, riparian cover, instream cover, habitat types and substrates were applied to characterize the fish assemblage structure in surveyed sites. Further the macrohabitat approach has provided the information about the habitat requirement of different category of fish species.

Since there is a need for intensive testing and use of patch-base approaches in stream systems. Because these approaches have the potential to significantly increase our understanding and ability to conserve stream fish faunas. As in the current surveyed fish assemblage one species (*Tor tor*) characterized as near threatened (Rayamajhi *et al.*, 2010) [17] and rest of 35

were common, 5 fairly common, 6 uncommon, 1 occasional, 3 insufficiently known and 1 was positioned in rare category (Shrestha, 2012) [18].

Conclusion

Present work comprises of thirty-eight genera and fifty-five species. The Order Cypriniformes constituted the highest species number 54.55% whereas Order Osteoglossiformes, Beloniformes, and Tetradontiformes constituted lowest species number 1.82%. In Siluriformes one novel species *Pseudolaguvia nepalensis* was identified was new to science. Macrohabitat assessment revealed that the habitat volume was a major determining factor for species diversity and abundance.

Acknowledgements

We are grateful to warden of Chitwan National Park, central Nepal for permission to survey fishes in their protected areas. We also thank anonymous reviewers who gave helpful comment on the manuscript.

References

- Evans M, Heardman C, Houghton S, Tiler C. An ecological survey of the Narayani River, within the Royal Chitwan National Park. Report to the King Mahendra, Trust for Nature Conservation, Nepal, 1985, 26.
- Edds DR. The fishes of Royal Chitwan National Park. Journal of the Natural History Museum (Nepal). 1986a; 10:1-12.
- Ng HH, Edds DR. Two new species of *Erethistoides* (Teleostei: Erethistidae) from Nepal. Ichthyological Exploration of Freshwaters. 2005; 16(3):239-248.
- Edds DR. Fishes in Nepal: ichthyofaunal surveys in seven nature reserves. Ichthyological Exploration of Freshwaters. 2007; 18(3):277.
- Rayamajhi A, Arunachalam M, Usharamalakshmi M. *Pseudolaguvia Nepalensis*, A New Catfish (Teleostei: Siluriformes: Erethistidae) from Central, Nepal. International Journal of Pure and Applied Zoology. 2016; 4(1):46-56.
- Ross ST. Resource partitioning in fish assemblages: a review of field studies. Copeia, 1986; 352-388.
- Gorman OT, Karr JR. Habitat structure and stream fish communities. Ecology. 1978; 59:507-515.
- Schlosser IJ. Fish community structure and function along two habitat gradients in a headwater stream. Ecological. Monographs. 1982; 52(4):395-414. DOI: 10.2307/2937352

9. Silas EG. Studies on the Cyprinid fishes of the Oriental Genus *Chela* Hamilton. Journal of the Bombay Natural History Society. 1958; 55(1):54-99.
10. Hubbs CL, Lagler KF. Fishes of the Great lakes region. Ann Arbor University of Michigan press. 1964, 213.
11. Jayram KC, Dhas JJ. Revision of the genus *Labeo* Cuvier from the Indian region with a discussion on its phylogeny and zoogeography (Pices: Cypriniformes Cyprinidae, Cyprininae). Zoological Survey of India, 2000; 183(i-iv):1-143.
12. Jayram KC. Fundamentals of fish taxonomy, Narendra publishing House Delhi, 2002, 53-65.
13. Jayaram KC. The Freshwater Fishes of the Indian Region. Revised second edition. Narendra Publishing House, Delhi, India, 2010, 614.
14. Ng HH, Kottelat M. The catfish genus *Akysis* Bleeker (Teleostei: Akysidae) in Indochina, with descriptions of six new species. Journal of Natural. History. 1998; 32(7):1057-1097.
15. Dhital RR, Jha DK. Fish fauna of the Narayani River system and their impact on the fishermen communities in Chitwan Nepal. In: Cold water fisheries in the Trans-Himalayan Countries, Fisheries Technical Paper, Ed. by Petr T, Swar SB, FAO. 2002; 431:119-128.
16. Edds DR. Fishes of the Kali Gandaki/Narayani River, Nepal. Journal of Natural History Museum. 1986b; 10(1-4):13-22.
17. Rayamajhi A, Jha BR, Sharma CM. *Tor tor*. The IUCN Red List of Threatened Species 2010: e.T166534A6231157. <http://dx.doi.org/10.2305/IUCN.UK.2010-4.RLTS.T166534A6231157.en>
18. Shrestha J. Threat status of indigenous fish species of Nepal. In: Proceeding of the Consultative Workshop on Fish Conservation in Nepal, Organizers; Fisheries Research Division (FRD), Godawari, Lalitpur, Nepal, 2012, 1-220.