# FISH DIVERSITY OF SHUKLAPHANTA NATIONAL PARK, KANCHANPUR, NEPAL

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A thesis submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in Zoology with special paper Fish Biology and Aquaculture

(Course Code-Zoo 653)

**Submitted to:**

Department of Zoology

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Thamel, Kathmandu

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August, 2021

## DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the authors or institutions.

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## RECOMMENDATION

This is to recommend that the thesis titled **"FISH DIVERSITY OF SHUKLAPHANTA NATIONAL PARK, KANCHANPUR, NEPAL"** has been carried out by **Bishal Poudyal** for the partial fulfillment of Master's Degree of Science in Zoology with special paper **Fish Biology and Aquaculture (Course code: Zoo-653)**. This is his original work and has been carried out under my supervision. To the best of my knowledge, this thesis work has not been submitted for any other degree in any institutions. I recommend that the thesis be accepted for partial fulfilment of the requirements for the Degree of Master of Science in Zoology.

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## LETTER OF APPROVAL

On the recommendation of supervisor **Dr. Ganesh Bahadur Thapa,** this thesis submitted by **Bishal Poudyal** titled **"FISH DIVERSITY OF SHUKLAPHANTA NATIONAL PARK, KANCHANPUR, NEPAL"** is approved for the examination and submitted to Tribhuvan University in partial fulfillment of requirements for Master's Degree of Science in Zoology with special paper in Fish Biology and Aquaculture (Course code: Zoo-653).

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## CERTIFICATE OF ACCEPTANCE

This thesis work submitted by **Bishal Poudyal** titled **"FISH DIVERSITY OF SHUKLAPHANTA NATIONAL PARK, KANCHANPUR, NEPAL"** has been accepted as a partial fulfillment for the requirements of Master's Degree of Science in Zoology with special paper Fish Biology and Aquaculture (Course code: Zoo-653).

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## ACKNOWLEDGEMENT

I would like to thank my supervisor Assoc. Prof. Dr. Ganesh Bahadur Thapa for supervising my thesis research. My gratitude goes to Assit. Prof. Dr. Rakshya Thapa, for providing me the opportunity to get associated with the research project. I would further like to thank Natural History Museum, Swayambhu, Kathmandu, Nepal for coordinating with Shuklaphanta National Park, Kanchanpur, Nepal to make this project possible.

I would also like to thank Campus Chief Kedhar Nath Chhatkuli, Head of Department of Zoology Assoc. Prof. Mr. Shambhu Prasad Shah, and Assit. Prof. Mrs. Babita Maharjan (M.Sc Coordinator). My gratitude goes to Mrs. Renuka Shrestha, Mr. Man Bahadur Gole and other staffs of Amrit Campus for their help in providing me with necessary equipment and laboratory reagents for this research.

To the then warden of Shuklaphanta National Park, Mr. Laxman Prasad Poudyal, I am extremely grateful for organizing a place for me and my team to stay during the research, providing transportation facilities, fishing gears, fishermen and forest rangers for carrying out the research in Shuklaphanta National Park without whom this thesis research would not have been possible. For that, I am forever grateful.

My gratitude goes to forest ranger Mr. Yam Rawat and Dharjit Saud, staff of NTNC Mr. Devraj Joshi, fishermen Mr. Umesh Sunaha, Mr. Prakash Rana, Mr. Sunil Dagaura and driver Mr. Rabindra Chaudhary for their help in the field. I am extremely grateful towards Ms. Suyatra Ghimire for her help in data collection during this research project and her help in writing and proofreading this manuscript. I would also like to thank Ms. Avril Rawal for her help in the first field trip. Furthermore, my gratitude goes to Mr. Jash Hang Limbu for his help in analyzing the research data and proofreading this thesis.

Last but not the least, I am forever thankful towards my parents and family for their perpetual help and support in my every endeavors. I am highly obliged to all the individuals who have directly or indirectly contributed their valuable suggestions, guidance and coordination for the completion of my research work.

Bishal Poudyal

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## LIST OF ABBEREVIATIONS

| Short Form | Full Form | Short Form | Full Form |
|---|---|---|---|
| DoFD | Department of Fisheries Development | ℃ | Degree Celsius |
| FAO | Food & Agriculture Organization | ANOSIM | Analysis of similarities |
| Apr | April | Ppm | Parts per million |
| AAPA | Aquatic animals protect Acts | R | Rare and threatened |
| APHA | American public Health Association | CDR | Conservation dependent and Rare |
| D.O | Dissolved oxygen | UN | Least Concern |
| Fig. | Figure | C | Common |
| pH | Percentage ion of Hydrogen | Sep | September |
| Ha | Hector | CE | Critically Endangered |
| CCA | Canonical Correspondence Analysis | VU | vulnerable species |
| GPS | Global Positioning System | PRO | Pristine Rare Ornamental |
| IUCN | International Union for Conservation of Nature | CLO | Colorful fish through life history |
| TDS | Total dissolved solid | EN | Endangered |
| Mar | March | Oct | October |
| Mg/l | Milligram per liter | Mm | Millimeter |

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## ABSTRACT

Shuklaphanta National Park lies in the extreme south far western terai region in Kanchanpur district, Sudurpaschim Province, Nepal. This study was conducted between 2076/12/06-2076/12/16 (first survey) and 2077/06/23-2077/07/02 (second survey). The study area was divided into ten stations for fish sampling and physicochemical parameters were also analyzed. Cast net of different mesh size, scoop net, hook and line, flow modification, trap and gill net were used for fish collection. A total of 1,848 fish were captured belonging to 6 orders, 17 families, 31 genera and 53 species. Cypriniformes was the dominant order comprising 60% of species, Anabantiformes had second highest species composition (17%) that is, 4 families, 4 genera and 9 species followed by order Siluriformes (15% species composition) belonging to 5 families, 6 genera and 8 species and the order Synbranchiformes, Perciformes and Beloniformes had lowest species composition (4%, 2% and 2%) respectively. During the study the smallest fish species; *Botia geto*, the biggest sized fish species; *Labeo rohita* and longest*; Sperata seenghala* was reported. Among the recorded species, *Puntius chola* had highest frequency (6.11%). Among the recorded species, twelve species were Least Concern (UN), six species were Data deficient/pristine rare ornamental species (PRO), three species were vulnerable species (VU), two species were Endangered (EN) and one species Rare and threatened (R). An analysis of similarity (ANOSIM) indicated that there is a significant difference between the fish assemblage structure in study seasons (*R= -0.833, P= 0.985*). Throughout the study period, water temperature ranged from 18-29 $^{0}$C, pH value ranged in between 7.9- 9.8, DO ranged from 3.5 to 13.6 mg/l, TDS was 20- 432 ppm. CCA ordination was analyzed to find the relation between fish species with environment variables. Comparing the station wise fish diversity, species richness and evenness were highest in Station 2 and 1 and results from the CCA hinted that water parameters DO and TDS were the influencing factors to determine fish community structure in water bodies of Shuklaphanta National Park.



*Keywords*: Fish diversity, Shuklaphanta National Park, Far-West Nepal

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# 1. INTRODUCTION

## 1.1 Background

Nepal is a land locked country situated on the southern slopes of the mid Himalayan range. It is bounded on the North by Tibetan region of China and on the South, East and West by India. Nepal is roughly rectangular and elongated in shape with a total area of 1,47,516 sq. km. Its geographic position lies between 26.22" to 30.27" north latitudes and 80.4" to 88.12" east longitude. Topographically, Nepal can divided into three distinct regions: Himalayan region, Sub Himalayan region and Terai region (K.C, 2015).

Fish are cold-blooded, jawed, streamlined, aquatic vertebrates which breathe by means of pharyngeal gills and propel and balance themselves by means of fins which are supported by dermal fin rays (Shrestha & Pandit, 2017). Fish occupy water bodies from Antarctic water below freezing point to hot springs of approximately 40-44°C (Shukla & Pandey, 2005). Fish exhibit enormous biodiversity, inhabiting variety of habitats and are important indicators of water quality (Hussain, 2016). Fish assemblage is a crucial element in aquatic ecosystem which provides a good biological indication for the quality of freshwater ecosystem since it is sensitive to a broad range of stressors (Karr, 1981; Oberdorff et al., 2002).

The Himalayan region is always covered with snow and generally lies above the altitude of 4,800 m from the sea level (Amatya & Shrestha, 1967). Fish distribution is not reported so far in this region. The sub- Himalayan region is located in between Himalayan and Terai region and has massive mountain running from East to West. This region lies between 500 m and 4,800 m.

### 1.1.1 Water Resources of Nepal

Nepal is a small land locked country which extends 885 km along the east-west, and lies between India and China. Being landlocked, Nepal only has inland water resources including both lotic, that is, running (raceways, fountains, glaciers, springs, rivulets, tunnels, streams, and rivers) and lentic, that is, confined or stagnant (ponds, pools, ditches, dahas, reservoirs, swamps or marshy lands, and nullahs) habitats (Gubhaju, 2012). Nepal

has remarkable altitudinal variation of plain, mountain region and himalayan region with tropical climate, temperate climate and alpine climatic condition respectively (Bhusal & Chitrakar, 2016). Nepal is rich in water resources with more than 6,000 rivers, rivulets and streams. The natural water resource of Nepal consists of rivers, lakes and reservoirs comprising approximately 49.14% of the total existing water area of Nepal (DoFD, 2014).

**Table 1**: Freshwater types, respective surface area and percentage coverage in Nepal.

| SN | Resources | Area (ha) | Coverage (%) |
|---|---|---|---|
| 1 | Rivers | 39500 | 47.77 |
| 2 | Lakes | 5000 | 0.6 |
| 3 | Reservoirs | 1500 | 1.38 |
| 4 | Ponds | 11396 | 1.4 |
| 5 | Marginal swamps | 12500 | 1.51 |
| 6 | Irrigated paddy fields | 398000 | 48.14 |
| 7 | Irrigation canals | 3160 | 0.38 |
| 8 | Highway side ditches | 262 | 0.03 |
| Total | | 826818 | 100 |

Source: Directorate of Livestock and Fisheries Development (2073/74 B.S)

### 1.1.2 Fishes of Nepal

First scientific report on fish fauna of Nepal was provided by Hamilton (1822) with 267 fish species. Only after middle of the 20$^{th}$ century, with the concern of development as well as academic institutions related to fish and fisheries, study on fisheries and fish fauna was initiated. Prior to that, the political boundary of Nepal was left unknown as it was then closed to outer world (Rajbanshi, 2012). The current status of fish shows there are 252 fish species in Nepal belonging to 15 orders and 41 families (Shrestha, 2019). Among them two are endangered species (EN), nine vulnerable species (VN), twenty-three rare or near threatened (R/NT), thirty-two data deficient pristine rare ornamental (PRO), twenty-seven conservation dependent and rare species (CDR), fifty-three uncommon or lower risk/ least concern (UN), seventy-one common species (C) and sixteen exotic species. Till date, no

species of fish is identified as Critically Endangered (CE) or Extinct (EX) in Nepal (Shrestha, 2019).

### 1.1.3 River System of Nepal

Based on their origin, the rivers of Nepal are broadly classified into three categories: rivers originating from High Himalayan regions, rivers originating from Mahabharat region and rivers originating from Siwalik/Churia region. The major river systems of Nepal are Mahakali, Karnali, Gandaki and Koshi.

**Mahakali River System**

The Mahakali is a river between Nepal and India. Mahakali river system lies to the western most borders (Sudurpashim Pradesh) of Nepal. The river has its origin in Api Himal within the Himalayas. The river originates from Lipulekha of Nepal and Milan glaciers of India and flows south along the border of Nepal and India (Bist, 2014). The length of Mahakali River is 223 km and is named Sharada or Kaliganga in India and Mahakali or Kali in Nepal (Poudel, 2008).

### 1.1.4 Shuklaphanta National Park

Shuklaphanta National Parks lies in the extreme south western terai region in Kanchanpur district. It was established as a hunting reserve in 1969 and allocated as a wildlife reserve in 1976. By extended buffer zone, it changed into national park in 2017. Recently, it is in Sudurpaschim Province and lies between 28º 45' 47" – 29º 45' 47" latitudes and 80º 05' 45" – 80º 21' 43" longitudes at an altitude of 170-1,300m occupying 305 $km^2$ area. Shuklaphanta National Park boasts a lot of water resources like river (Mahakali, Chaudhar and Syali), stream/khola (Radha, Jhari, etc), more than 20 natural lakes and above 10 artificial ponds. Lake (Taal) are fed by rivers, khola and rainwater, where the quality and quantity of water fluctuates with respect to the season i.e., dry season, water depth, transparency, DO, etc. During rainy season, flood water enters in lake resulting more water depth and volume. There is variation of morphology i.e. (riverbed are muddy, sandy and gravels or boulders, riparian vegetation are present mostly around taal) of rivers, lake, pond etc.

This is the first scientific study on fishes of Shuklaphanta National Park. This study assesses the present status of fish community, diversity, and inter-relationships with physico-chemical parameters in the different water bodies of Shuklaphantan National Park.

### 1.2 Objectives of the study

The main objective of the study was to record the diversity of fish species in Shuklaphanta National Park.

**Specific Objectives**

-To analyze the physico-chemical parameters of water bodies

-To identify the relation between fish species abundance, seasons and water quality parameters

### 1.3 Rationalae of the study

This is the first scientific study so it provides the knowledge regarding the diversity of fish species in the Shuklaphanta National Park to the biologist and for the further management to the authority.

### 1.4 Limitations of the study

This study is limited within the area of Shuklaphanta National Park and only the major water bodies were selected for sampling. One of the major limitations during the study was the difficulty in capture of fish in ponds or taal like Tara taal, Kalikich and such, due to the presence of excessive aquatic vegetations in and around the water bodies. Another limitation was only the use of locally available fishing gears as some species of fish could not be captured with them.

## 2. LITERATURE REVIEW

Aquatic habitat and water quality parameters affect the fish structure, distribution and development. Alteration in water quality parameters such as water temperature, dissolved oxygen, pH, transparency and depth influence the aquatic environment and fish breeding (Kathiresan & Bingham, 2001; Rashleigh, 2004), along with profusion and allotment (Maes et al., 2004), migration and distribution (Vega-Cendejas et al., 2013) and survival of fish fauna (Whitfield, 1999) ultimately alter fish assemblage and structure. Biodiversity indicators i.e., dominance, evenness, Margalef and Shannon-Weiner diversity indices are used as pointer to discern status of aquatic residents (Magurran, 1988; Vyas et al., 2012).

The aquatic habitat and water quality parameters affect the fish growth and development and ichthyofaunal diversity. Temperature is an important factor for the aquatic biota. According to FAO report (FAO, 2010), the increase of temperature directly or indirectly impacts species distribution and the seasonality of production in fishes.

### Fish diversity

Sixtynine fish species belonging to 7 orders, 20 families and 39 genera were collected by Mishra, S.P et al. (2021) from various districts of eastern Uttar Pradesh, India. Ghimire et al. (2020) recorded 87 fish species in the Sudurpaschim Province, Nepal. Shrestha (2019) reported 252 fish species from Nepal among which 236 fish species are native species and 16 are exotic species. Thapa (2017) studied fish fauna of upper and middle Tamor River and found 11 and 28 species of fishes respectively. Raymajhi (2017) studied fish assemblage structure of Chitwan National Park and its adjacent zones and reported 55 fish species belonging to 7 orders, 20 families and 38 genera.

Raymajhi et al. (2016) reported new species *Pseudolaguvia nepalensis* belonging to family Erethistidae from Kasara Khola near to the confluence of Rapti River. Gautam et al. (2016) studied fish faunal diversity and species richness of Rupa Lake by using local fishing gears and documented 23 fish species belonging to 5 orders, 6 families and 18 genera. Shah (2016) studied fish diversity of Koshi River and reported 59 species of fish.

Jha & Bhujel (2014) studied the fish diversity of Narayani River and reported 108 species of fish belonging to 9 orders, 27 families and 70 genera. Saud et al., (2012) found 24 fish species belonging to 3 order, 4 families and 13 genera, in Mahakali river where Cypriniformes was the dominant order accounting for 75% of the total fish species followed by Siluriformes and Synbranchiformes which accounted for 21% and 4% fish species respectively.

Pokharel (2011) studied fish diversity of West-Rapti River and recorded 24 fish species belonging to 4 orders, 6 families and 16 genera. Thirumala et al. (2011) mentioned that species diversity is peak in post monsoon because of favorable conditions such as sufficient water, ample food resources and low diversity in pre-monsoon probably due to the shrinkage of water spread.

Conway & Mayden (2010) again reported a new species of hill stream loach *Balitora eddsi* sp. nov. from Karnali River. Gautam et al. (2010) reporteg 42 species of fish belonging to 6 orders, 18 families and n34 genera from Jagadishpur reservoir.

Shrestha (2008) recorded 232 fish species with 1 new species (*Neoanguilla nepalensis*). Conway and Mayden (2008) redescribed *Psilorynchus balitora* and reported a new species *Psilorynchus nepalensis* sp. from Rapti River and a tributary of Narayani River.

Edds & Ng (2005) reported 4 new species of fish of which 2 species fall under the family Erethistidae and other 2 species under the family Sisoridae from rivers of Sapta-koshi and Gandaki River System. Edds & Ng (2005) further reported additional 10 fish species from the water of Nepal as a new recorded. Dhital & Jha (2002) conducted study on Narayani River and recorded 69 fish species. Shrestha (2001) in the book "Taxonomic Revision of Fishes of Nepal" reported 182 fish species in Nepal. Karki (2000) studied biodiversity and fishery resources of lower Karnali, Nepal and recorded 50 species of fish belonging to 29 genera under 15 families and 8 orders.

Shrestha (1999) contributed to the Nepal Country Report on Biological Diversity in which he recorded 185 fish species of which 8 fish species were endemic to Nepal. Lack of knowledge on ichthyofauna of Nepal always caused vast difficulties in drawing conclusion on their geographical distribution in relation to the recorded fish from Eastern and Western

Himalayan Regions. Shrestha (1996) reported 57 fish species in the EIA report of Hydropower Project on Kali Gandaki. Edds (1985) reported 8 new fish species from Nepal and 111 species of fish from Kali Gandaki River. Terashima (1984) reported 3 new species of genus *Schizothorax* from Rara lake of Far-Western Development Region and further claimed them as endemic to Nepal.

Shrestha (1990) recorded 108 species of fish from Koshi River, 74 species from Karnali River, 102 species from Gandaki River, 69 species from Mahakali River, 82 species from Bagmati River and 34 species from Trishuli River. He further stated that more than 130 fish species reside in the snow fed rivers and mountain lakes of the Nepalese highlands but did not mention specific water bodies. Rajbansi (1982) prepared the first compilation of reported fish fauna for the boundary of Nepal between the period of 1793-1982 which contained 171 species of fish among which 164 species were indigenous and 7 were exotic.

Jayaram (1981) described 742 species of freshwater fish belonging to 233 genera, 64 families and 16 orders in India among which 106 species under 61 genera, 21 families and 8 orders are also found in Nepal and one species from the list i.e., *Myersglanis blythi* (Day, 1870) has been specified as endemic to Nepal. Shrestha (1978) conducted a detailed study and reported 118 fish species from Nepal which included two new species and 19 new records.

**Physico-chemical parameters of water**

Saund et al. (2012) recorded the water quality parameters and found water temperature (20.50-22.63 $^0$C), DO (8.58-11.85 mg/l) and pH (6.93-7.20) to be within the suitable range, supporting diverse fish species in Mahakali River. Water temperature is a physical property expressing hotness or coldness of water. It plays a major role in the quality of aquatic life and habitat (Fondriest Environmental Inc. "Water Temperature", 2014). According to Santosh and Singh (2007), suitable water temperature for fish is between 24$^0$C to 30$^0$C. Speer (1997) defined water temperature as the "abiotic master factor" due to its effect on aquatic organisms. The meteorological conditions are responsible for water temperature change. Water temperature largely influences the physical, chemical and biological factors of an ecosystem (Hutchinson, 1957).

The pH of water is defined as the logarithm of the reciprocal of hydrogen ion concentration. Hydrogen ion concentration of water determines the acidity, alkalinity and neutrality of water. The suitable pH range for fish is 6.5-9 and pH more or less than this is not suitable, though some can survive outside of this range (Swingle, 1967).

The dissolved oxygen (DO) refers to the level of free, non-compound oxygen present in water. The value of DO increases in winter due to circulation of cold water as well as high solubility of $O_2$ at low temperature (Praveen & Mudasir, 2014). It is an important parameter in assessing water quality because of its influence on the organisms living within a body of water (Fondriest Environmental Inc. "Dissolved Oxygen", 2013). Higher the temperature, lower will be the amount of dissolved oxygen and vice versa in the water (Dutta & Patra, 2013). DO concentration is the most important factor and DO above 5mg/l is suitable to support diverse biota (APHA, 1998).

## 3. MATERIALS AND METHODS

### 3.1 Study Area

The present study was carried out in various water bodies of Shuklaphata National Park. The sites were divided into ten stations for the collection of fish species. Sampling stations were selected on the basis of major water bodies inside the national park.

**Table 2**: Information on different stations

| Station | Sampling stations | Location |
|---|---|---|
| **1** | Mahakali River (A) | Downstream of Mahakali river at Pipariya post |
| **2** | Mahakali Nahar | Near to Hattikhadda |
| **3** | Bahune khola | Bahune khola pool |
| **4** | Syali River | Hirapur post |
| **5** | Swami Taal | Swami taal |
| **6** | Tara Taal | Tarapur post |
| **7** | Kalikich Taal | Beldandi post |
| **8** | Chaudhar River | Near to Masanghat |
| **9** | Mahakali River (B) | 4 Number ghat |
| **10** | Chure | Badepani and Khargat |

**Station 1: Mahakali River (A)**

Mahakali River in this area is wide and bifurcated. Shallow pool and fast flowing with numerous branches were occupying major stretches of river. Several fry and fingerlings were observed in bankside and pool of the main river channel. Pebbles and boulders were found in downstream stretch. The river in this section receives anthropogenic stress. Mixing wastes and illegal fishing were observed during study period as well as removal of boulders, vehicle movement, construction of road near the village and maintenance of bridge were observed.

**Station 2: Mahakali Nahar**

This Nahar is suitable for developing fries and is a spawning ground for many fishes. Pebbles with sandy bottom is present to home different fish. Availability of fish food for all types of fish support the fish diversity. People use this water for irrigation, cleaning, as well as washing due to which fishing stress were observed during sampling period. This Nahar supplies spawning ground in which eggs, fries, fingerlings and adult fish were present.

**Station 3: Bahune khola**

The bottom of this area was muddy containing log of wood and likely too much humus. The velocity of water was low but with high depth having greenish water. Bahune khola was noted as the spawning and rearing site of many fish. Due to availability of fish food, and the site of undisturbed area in the national park, most fish choose it as a rearing area.

**Station 4: Syali River**

River in this stretch is narrow, shallow and broken into runs and riffles with sandy bottom. Somewhere pool is present which has more depth and supports spawning and rearing ground for fish. Crystal clear water and algal pool after riffles were present.

**Station 5: Swami Taal**

This wetland's bottom is sandy with pebbles which support spawning and rearing of fish. This taal is fed by spring waters. Although it is artificial lake, it provides drinking water for animals in which due to availability of food and suitability of bottom, fish choose it as a rearing ground. Vegetation covers all sides of this taal.

**Station 6: Tara Taal**

Tara taal has abundance of algal bloom occurring everywhere and some invasive plants (locally: kamal ko ful, Besaram, Chilaune jhar, Polne jhar, etc.). Depth of taal is high in the middle area but shallow towards the edges. Tara taal has narrowed down by vegetation present on the bank, deposition of agricultural overflow that support agal bloom, sand and mud. Water quality parameters are not suitable for fish.

**Station 7: Kalikich Taal**

This taal covers large area full of aquatic plants and riparian vegetation like Narkot, Beshram, Kamal, etc. The bottom of this Taal is sandy and muddy. Edge area was shallow and middle part had high depth. Rainy season increases the water level as well as deposition of mud and sand from forest. The water quality parameters show suitability of rearing fish.

**Station 8: Chaudhar River**

This perennial river lies in the eastern side of National Park. It has sandy bottom containing mud and gravel. It has riparian vegetation with tree canopy on the riverbank. Sampling sites were selected on the basis of anthropogenic activities and undisturbed areas. One sampling site was near the downstream and upper stream of Masanghat.

**Station 9: Mahakali River (B)**

This site was selected because of the fast-flowing water with presence of riffles, and pools having high depth. It was an undisturbed site within the national park. River bottom consisted of sand, pebbles and boulders which support the habitat for different fish.

**Station 10: Chure**

This area is covered with boulders, gravels and pebbles. During monsoon, seasonal flood causes flow of water to be modified and small pool like standing water is seen in many areas. There is scarcity of fish food due to fast flow and less amount of water in summer.

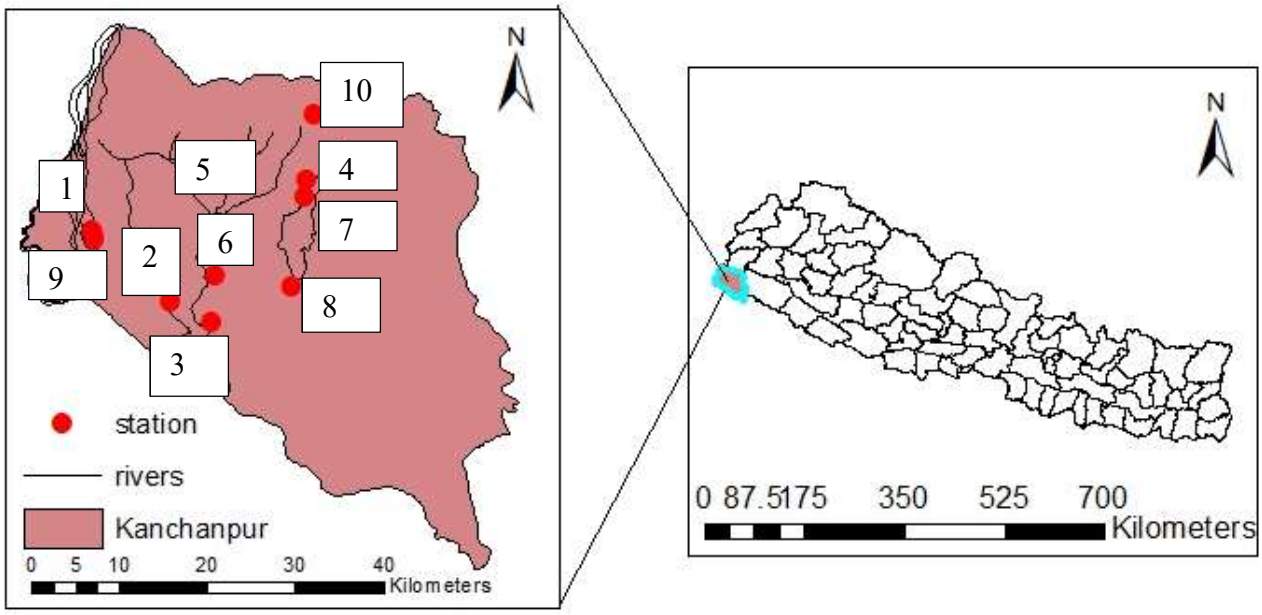


**Figure 1**: Map of study area showing stations

### 3.2 Materials

1. Cast net
2. DO meter
3. Formalin
4. Thermometer
5. Camera
6. GPS
7. $p^H$ meter
8. Secchi disc
9. Measuring tape
10. Rope
11. Hook and lines
12. Scoop net (Helka)
13. TDS meter

### 3.3 Sampling Method

#### 3.3.1 Sample Collection

Fish survey was conducted twice a year between 2076/12/06-2076/12/16 and 2077/06/23-2077/07/02. For sample collection, local fishermen were hired. Cast net of different mesh size, scoop net, hook and line, flow modification, trap and gill net were used for fish collection at each sampling station. 1-2 hours was spent in each sampling station in order to cover maximum area (about 300m up and down stream of rivers). Excess live fish were released back to the river after required investigation. Information on local name and their special behavior was obtained from the fishermen and field guidebook. Fish species available at the local market caught by local fishermen were also purchased and detail information was recorded.

#### 3.3.2 Identification of specimens

The fish species collected from the sampling site were identified in the field using standard field guide of Shrestha (2008, 2019), Shrestha (1981, 2001), and Jayaram (1981).

#### 3.3.3 Preservation of specimens

The collected samples were preserved in 10% formalin solution and stored in glass jar. All set of fish species are kept in the Natural History Museum, T.U, Swayambhu and some of them are kept at Zoology Department of Amrit campus.

### 3.4 Statistical analysis

Physicochemical parameters were analyzed and interpreted in Microsoft Excel 2019. The relation of fish species with water temperature, pH, DO, and TDS were calculated using R software (Oksanen et al. 2019). One-way analysis of similarities (ANOSIM) (Clarke, 1993) was used to test the significant differences between the seasonal scales.

### 3.5 Calculation

#### 3.5.1 Diversity indicators

Fish diversity of the study area was assessed using different indices such as:

**Shannon-Weaver diversity index (Shannon and Weaver, 1949)**

The diversity of collected species was calculated using Shannon-Weiner diversity index. It is designated as H'.

Mathematically, H' = $\sum_{i=1}^{S} Pi \times logPi$

where,

Pi= ni/N = relative abundance of each species, calculated as the proportion of individual of a given species to the total number of individuals in the community.

N= the total number of individual observed.

ni= the number of individuals in each species/ the abundance of each species.

**Pielou's evenness (Pielou, 1966)**

To calculate whether species are distributed evenly across seasons and landscape elements, Pielou's evenness equation was used.

Mathematically, E=H'/log S

Where,

H'=Shannon-Weiner's diversity index,

S=total number of species,

**Simpson's dominance index (Simpson, 1949)**

Simpson's dominance diversity index gives the more weight to common or dominant species, generally it is used to calculate community diversity. To calculate Simpson's dominance diversity index following equation were used:

D =1-∑n (n-1)/N (N-1)

Where,

n=number of individuals of each species

N= total number of individuals of all species.

### 3.5.2 Frequency

Frequency of every fish species were obtained by using formula:

$$\text{Frequency(f)} = \frac{\text{Total no. of individual species}}{\text{Total no. of all the species}} \times 100\%$$

**Physico-chemical Parameters Analysis of water**

Different physico-chemical parameters such as temperature, pH, dissolved oxygen and total dissolve solid (TDS) were tested at every sampling station. The main physico-chemical parameters that were analyzed in-situ are given below:

**Water temperature**

Temperature of surface water of the study area was recorded with the help of standard digital thermometer. The recording was simply done by dipping the thermometer (about 10cm) bulb directly into the water till constant reading was observed.

**Hydrogen-Ion concentration (pH)**

The pH of the water sample was measured using pH meter. The probe of pH meter was dipped in the water of sampling sites and held for some time and recorded when the values became constant.

**Dissolved oxygen (DO)**

DO was measured by the help of DO meter. First, the probe of DO meter was dipped in the water of sampling sites and held for some time and then the values were recorded.

**Total Dissolve Solid (TDS)**

Total Dissolve Solid (TDS) was measured using conductivity meter. First, the probe of TDS meter was dipped into the water of sampling sites followed by clicking the function key and withhold key in that order, held for some time and finally recorded.

## 4. RESULTS

### 4.1 Physical Parameters of water

### Water temperature

Water temperature ranged from $18^0$C to $29^0$C. The highest temperature recorded was $29^0$C during spring season of (March/April) and lowest temperature was $18^0$C during autumn of (September/ October). (Appendix II, Table 8).

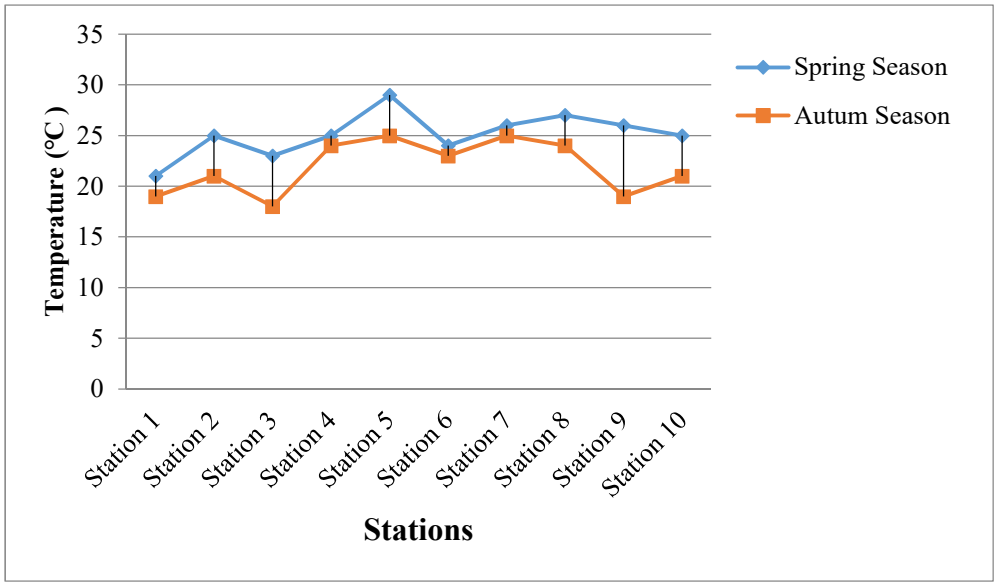


**Figure 2**: Variation in temperature ($^0$C) at spring and autumn season

### 4.2 Chemical Parameters of water

#### Dissolved Oxygen (DO)

The concentration of dissolved oxygen ranged from 3.5 to 13.6 mg/l. The lowest dissolved oxygen concentration recorded was 3.5 mg/l during spring and the highest dissolved oxygen concentration was 13.6 mg/l during autumn (Appendix II, Table 10).

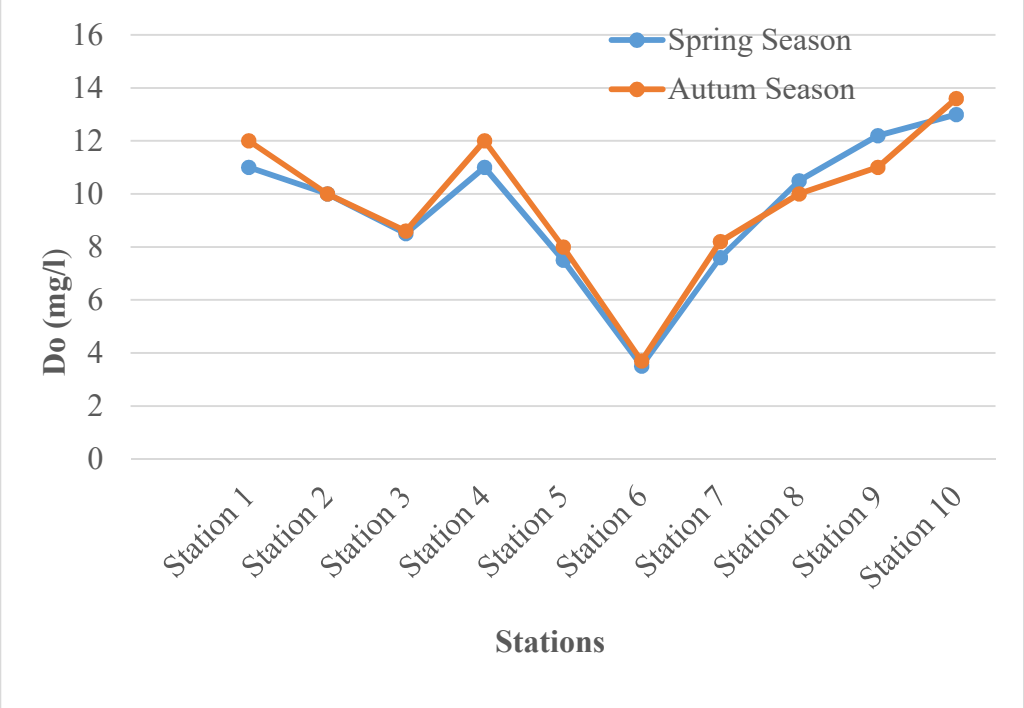


**Figure 3:** Variation in dissolved oxygen (mg/l) at different stations in spring and autumn seasons

**Hydrogen ion concentration**

The pH of water was slightly basic during both the study periods in all stations. The hydrogen ion concentration ranged from 7.9 to 9.8 ppm (Appendix II, Table 9). The highest value of pH was 9.8 ppm at station 5 and lowest value was 7.9 ppm at station 4 (Figure 4).

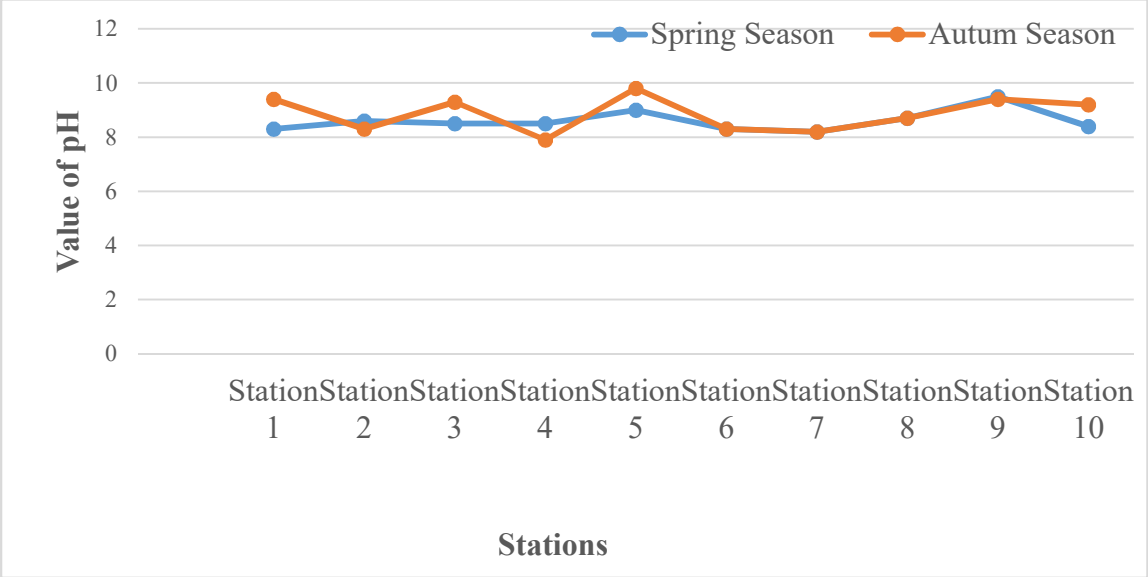


**Figure 4**: Variation in pH value at different stations in different stations in spring and autumn seasons

**Total Dissolve Solid (TDS)**

The TDS of water ranged from 20- 431 ppm (Appendix II, Table 11). The lowest TDS of water was found at station 6 (20ppm) and the highest was found at station 4 (431 ppm) (Figure 5).

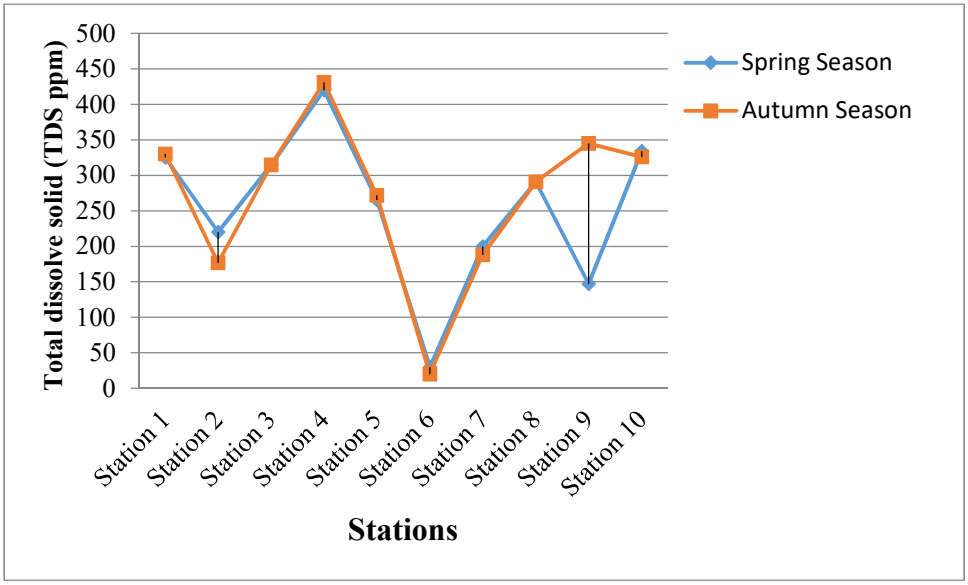


**Figure 5**: Variation in TDS value at different stations in different stations in spring and autumn seasons

**4.3 Fish Diversity, Distribution and Frequency occurrence of fish in study area**

During the study period, total 1848 individual fishes belonging to 6 orders, 17 families, 31 genera and 53 species were recorded **(**Table 5**)**. Monthly, the captured fishes were 1028 fishes belonging to 49 species in Mar/Apr 820 fishes belonging to 50 species in Sep/Oct (Appendix II, Table 5). Number of captured fish was highest at station 5, Station 1, Station 2, Station 3, Station 9, Station4, Station 8, Station7, Station 10 and Station 6 had the lowest capture count (Figure 2) whereas, species diversity was highest at Station 7 and lowest at Station 4 (Appendix I, Table 3). During the study the smallest fish species; *Botia geto*, the biggest sized fish species; *Labeo rohita* and longest*; Sperata seenghala* was reported. Among the recorded species 12 species were Least Concern (UN), 6 species were Data deficient/pristine rare ornamental species (PRO), 3 species were vulnerable species (VU), 2 species were Endangered (EN) and 1 species Rare and threatened (R)

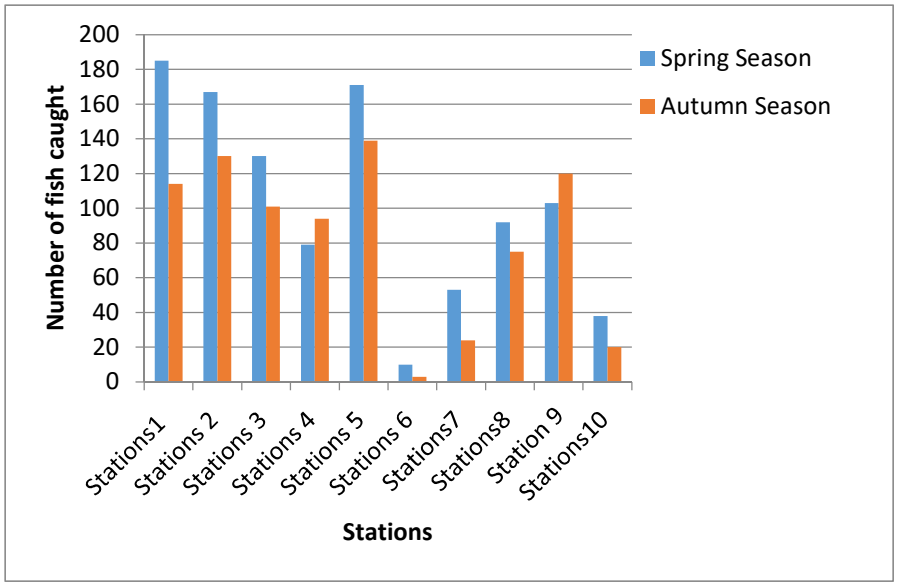


**Figure 6**: Fish caught during study period at different stations in different months.

### 4.4 Order wise fish diversity

Altogether 53 species of fish belonging to 6 orders were recorded during study period. There were 32 fish species belonging to order Cypriniformes of 4 families, 17 genera. Likewise, in order Siluriformes belonging to 5 families, 6 genera and 8 species, Synbranchiformes included 2 species belonging to 2 family, 2 genera, Perciformes belonging to 1 family, 1 genus and 1 species, Beloniformes belong to 1 family,1 genus and 1 species and 9 species belonging to order Anabantiformes of 4 families, 4 genera. The result revealed that Cypriniformes is most prevalence followed by Anabantiformes, Siluriformes, Synbranchiformes, Perciformees and Beloniformes. (Figure 7).

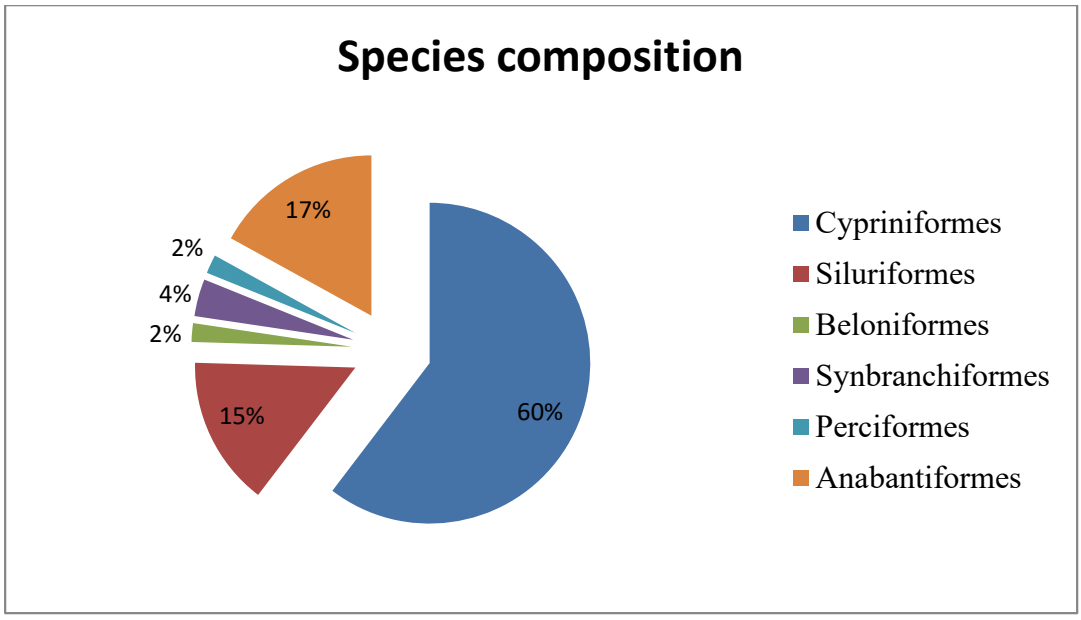


**Figure 7:** Total fish species diversity based on species composition (%) at order level

### 4.5 Family wise fish diversity

Recorded 53 species of fish represented 17 families. The study revealed that the most abundant fish species is of Cyprinidae family (29) which is followed by Channidae (5), Bagridae (4), Osphronemidae (2), Nemacheilidae (1), Cobitidae (1), Botiidae (1), Siluridae (1), Sisoridae (1), clariidae (1), Heteropneustidae (1), Belonidae (1), Symbranchidae (1), Mastacembelidae (1), Ambassidae (1), Anabantidae (1), and Nandidae (1) (Figure 8).

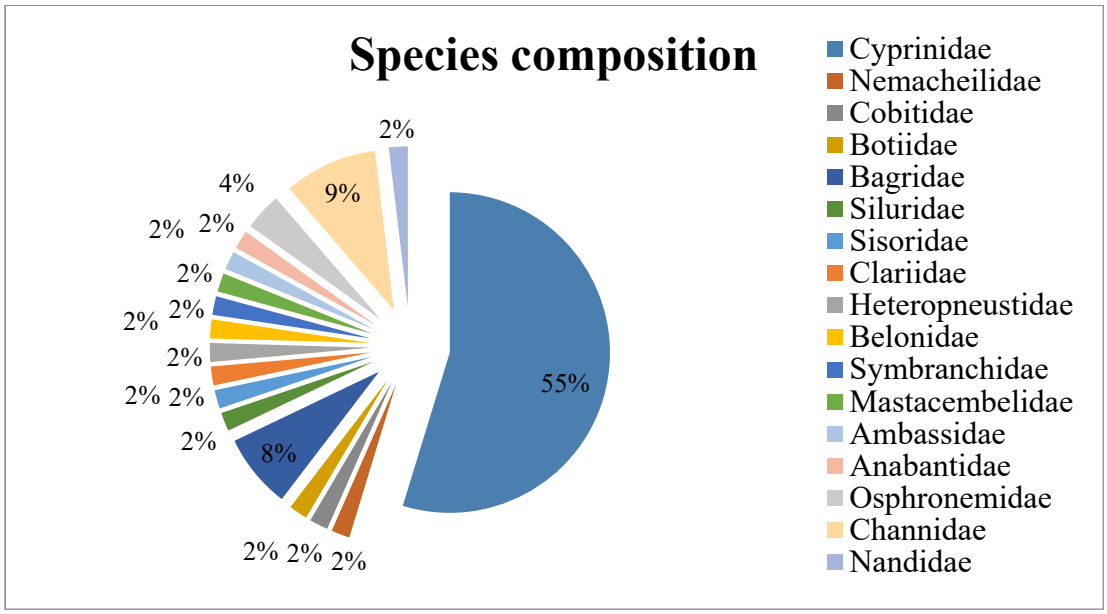


**Figure 8:** Total fish species diversity based on species composition (%) at family level

### 4.6 Relationship between fish species and environmental variables

The canonical correspondence analysis (CCA), of the plot showed the relationship between fish species and environmental variables (Figure 1). The fish species of C32, C49, C43, C27, C23, C52, C35, C44, C48, and C23 are positively related to water temperature but negatively related to dissolve oxygen. Fish species of C24, C17, C26, C6, C30, C38, C7, C1, C18, C11, C8, and C10 are highly associated with TDS but are negatively related to pH. Similarly, species of C19 C9, C4, C2, C20, C21, C21, C25 and C28 showed positive relationship with dissolved oxygen but negative to water temperature. In contrary, species of C34, C13, C33 and C53 are highly associated with pH but negative to TDS. Results from the CCA hinted that water parameters i.e., DO and TDS are the influencing factors to determine the fish community structure of Shuklaphanta National Park (Figure 9).

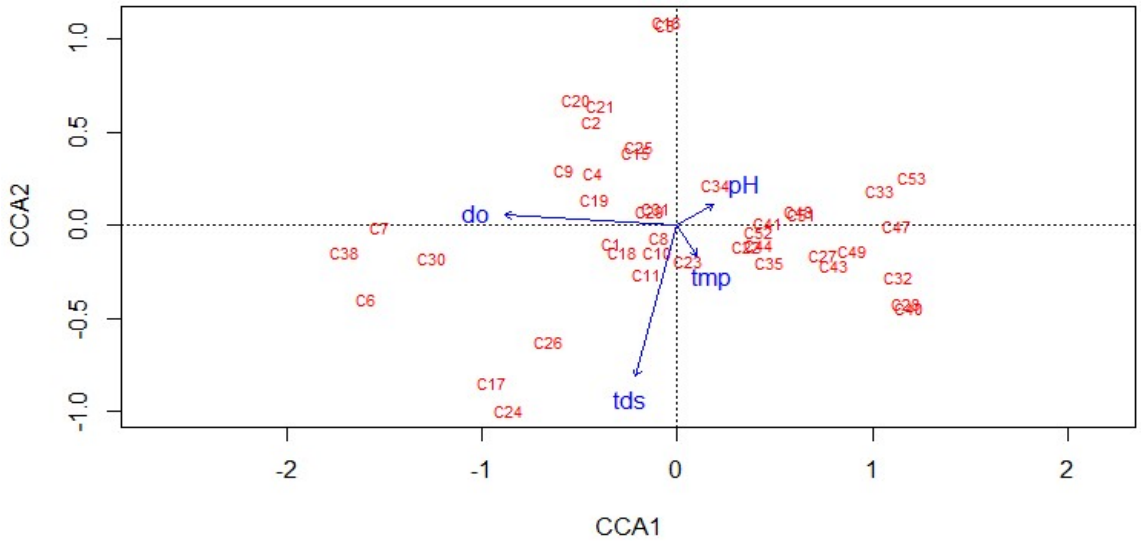


**Figure 9:** CCA ordination between fish species and environmental variables

**Table 3**: Station-wise diversity indices.

| Stations | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Shannon-weaver index | 3.02 | 3.15 | 2.86 | 2.52 | 2.99 | 1.05 | 2.01 | 2.43 | 2.83 | 1.23 |
| Simpson Dominance index | 0.99 | 0.95 | 0.93 | 0.91 | 0.94 | 0.59 | 0.83 | 0.90 | 0.93 | 0.68 |
| Evenness index | 0.54 | 0.55 | 0.54 | 0.52 | 0.54 | 0.34 | 0.48 | 0.52 | 0.54 | 0.39 |

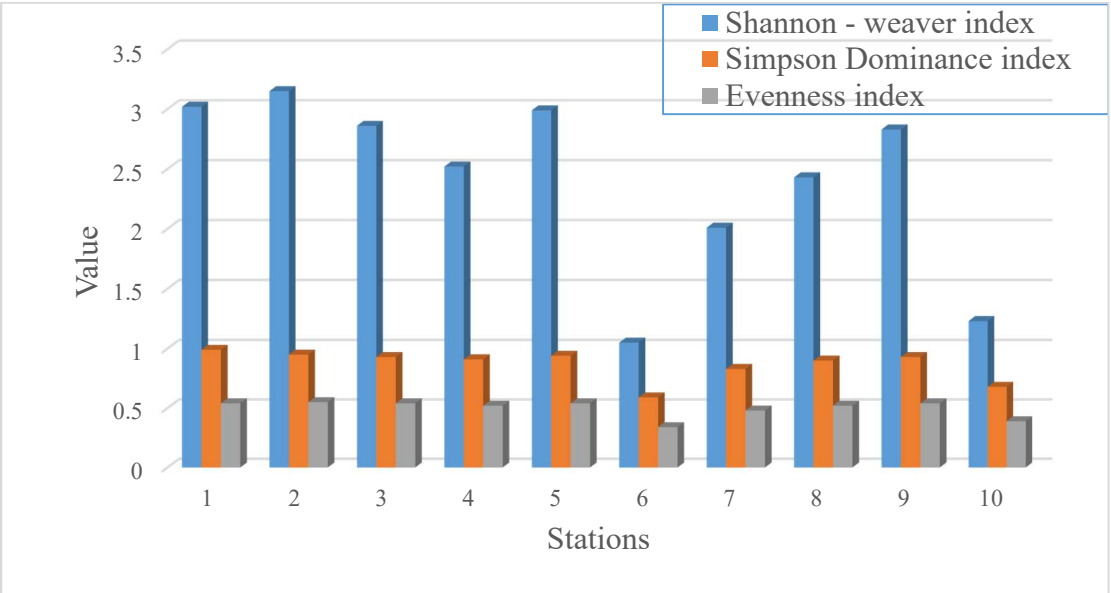


**Figure 10**: Station-wise diversity indices

## 5. DISCUSSION

Nepal is rich in water resources providing shelter for valuable fish stock. The running water system provides a diverse range of habitats for different type of indigenous fishes. The physico-chemical parameters of an aquatic environment exhibit influencing factors for the quantity and quality of the total biota and their life processes directly or indirectly. The relationship between all thsese factors (physico-chemical ) create favorable or unfavorable circumstance for growth and development of any particular biota.

### 5.1 Fish Species Diversity of the study area

Study revealed total 53 species of fishes belonging to 6 orders, 17 families and 31 genera. The most common fish species on the basis of total no. of catch during the study period were *Puntius chola* (113) followed by *Barilius shacra* (94*), Puntius sophore* (85), *Raiamas bola* (69), *Cirrhinus reba* (67), *Mystus vittatus* (66), and *Labeo dyochelius* (66). The result show that order Cypriniformes as the dominant order comprising 60% of species composition that is 29 fish species among 53 recorded species out of 1848 captured fishes. Saund et al., (2012) found 24 fish species belonging to 3 order, 4 families and 13 genera, in Mahakali river where Cypriniformes was the dominant order accounting for 75% of the total fish species followed by Siluriformes and Synbranchiformes which accounted for 21% and 4% fish species respectively.

Cyprinidae is the largest freshwater family of fishes in the world with 210 genera and about 2010 species (Nelson, 2016). Similarly, order Anabantiformes had second highest species composition (17%) that is, 4 families, 4 genera and 9 species followed by order Siluriformes (15% species composition) belonging to 5 families, 6 genera and 8 species and the order Synbranchiformes, Perciformes and Beloniformes had lowest species composition (4%, 2% and 2%) respectively.

Whereas *Wallago attu, Clarius mangur, Sperata seenghala and Tor putitora* were recorded only once and single individual of each of them throughout the study period. This result might be because of smaller number of fish in the river. Two species catagorised in IUCN Red List; *Tor putitora* (EN) and *Seprata seenghala* (UN), were also caught only once which might be due to inefficient performance of fishing gear as well as due to presence of

aquatic vegetation which made it difficult to catch. In case of other fish, many types of fishing gears of different mesh size were used and sufficient time was also taken in capture by covering more than 300 m in every station so higher number of fish species could have been recorded.

Station no. 5 (Swami Taal) had the high number of fish species collected (471 fish). This may be because of the tolerable physico-chemical quality of water as well as this Taal was fed by river water in rainy season as well as water quality parameters were suitable for mostly fish species. Overall ecology of this station was suitable for spawning, breeding, rearing for fish.

*Clarius mangur* was also captured once in Tara taal. According to fishermen, this fish was cultured in different pond so they may have escaped from there and are found in this Taal. It is due to high tolerance capacity of this fish in adverse water quality conditions (Rao, 2017).

According to local fishermen, there are large sized *Anguilla bengalensis*, *Bagarius bagarius, Neolissochilus hexagonolepis, Chitala chitala was found* in the Mahakali River but during study period it was not recorded. It may be due to decline in their number or obstruction in their regular migrating pathways due to constructions of different barriers in the river, habitation destruction or modification, pollution, illegal fishing and fishing gears etc. It might be limited collection time in a study period.

*Bagarius yarellii, Bagarius bagarius, Neolissochilus hexagonolepis* and *Anguilla bengalensis* was caught at 2008 (Poudel). It shows that due to anthropogenic pressure (illegal fishing methods, fishing pressure, habitat destruction for stone mining etc.) pollution and stressor are the reason for reducing of such above mentioned fish species.

Typically, the value of Shannon-Weaver diversity ranges between 1.5-3.5 in this study period in all stations which indicated that highly diverse with the fish species, most ecological studies and the index greater than 4 is very rare so, according to this statement the value of Shannon-weaver diversity obtained from the study shows that the study area is highly diverse. Evenness index range from 0-1 (Pielou, 1966) where near to 1 indicate species are distributes evenly across the season with different stations. The value of evenness

in this study was between 0.34 and 0.55, which shows that only a few fish species are distributed evenly across the seasons in different stations. Simpson dominance index of this study was between 0.59 and 0.99 which indicates that same species was dominant in all stations.

In general, the common status fish according to IUCN Red List were also recorded the most during this study among which, *Puntius chola* had the highest frequency (6.11%) and the least frequently caught species were *Sperata seenghala* (UN), *Clarius mangur* (C), *Wallago attu* (C), and *Tor Putitora* (EN) with least frequency of 0.05% each during the study period.

**5.2 Variation in water quality parameters**

The water temperature of study area ranged from 18–29$^0$C throughout the year. The lowest temperature was 18 $^0$C at station 3 in the months of Sept/Oct (Autumn) and highest was 29 $^0$C at station5 in the months of Mar/Apr (Spring) (21.7$^0$C -27.02$^0$C) as the most suitable water temperature is 24$^0$C to 30$^0$C (Santosh & Singh 2007).

DO of the study area ranged from 3.5 – 13.6 mg/l which means the water of study area is favorable for aquatic biota including fishes (APHA, 1998). Poudel (2008) found DO of the Mahakali River shows positive correlation r = 0.027 with probability error 0.33which meant fish diversity increased with respect to DO. The amount of dissolved oxygen was recorded less during Mar/Apr that is, 3.5-13.6 mg/l whereas amount to DO were obtained highest during Sept/oct 3.7-13.6 mg/l, this is supported by Dutta & Patra (2013). The value of DO increased in winter due to circulation of cold water as well as high solubility of $O_2$ at low temperature (Praveen & Mudasir, 2014).

In the study the range of pH value in between 7.9- 9.8 and is suitable for fish as supported by Swingle (1967). This shows that the water of Swami Taal is slightly alkaline throughout the year. It may be due to presence of limestone rich soil in the bank or presence of vegetations. The value of pH was highest at station 5 (9.8) and the value of pH was lowest at station 4 (7.9) in the months of Sep/ Oct. In case of spring season, the value of pH was in between 8.2- 9.5.

In the study, value of Total dissolved solid was ranged in between 20- 432 ppm. At station 6, TDS ranged in between 20-30 ppm which shows the lowest value of TDS due to presence

of aquatic weed/vegetation but in rest of the other stations, value is more than 177 µm. The total dissolve solid (TDS) is measurement of inorganic salts, minerals, organic matter and other dissolve materials in water.

The analysis of similarity (ANOSIM) showed significant differences in the species with season is (R= - 0.833, P= 0.985) which is similar to findings of Poudel (2008).

## 6. CONCLUSION

The water resources of Shuklaphanta National Park are good habitat for different types of fish like carps, barbs, minnow, eels, catfishes etc. A total number of 53 species of fish fauna belonging to 6 orders, 17 families and 31 genera were collected from different stations of study area. During the study the smallest fish species; *Botia geto*, the biggest sized fish species; *Labeo rohita* and longest*; Sperata seenghala* was reported. The value of Shannon-Wiener diversity ranged between 1.5 and 3.5 which shows that the study area of Shuklaphanta National Park is highly diverse in fish species.

Evenness index denoted that there were only few fish species distributing evenly across the season in different stations. Simpson dominance index of this study was between 0.59 and 0.99 which indicates that same species was dominant in all stations. The common status fish according to IUCN Red List were also recorded the most during this study among which, *Puntius chola* had the highest frequency (6.11%) and the least frequently caught species were *Sperata seenghala* (UN), *Clarius mangur* (C), *Wallago attu* (C), and *Tor Putitora* (EN) with least frequency of 0.05% each during the study period.

An analysis of similarity (ANOSIM) indicated that there is a significant difference between the fish assemblage structure in study seasons ($R= -0.833, P= 0.985$). The result shows that fish species like *Mystus bleekeri*, *Channa striata*, *Monopterus cuchia*, *Nandus nandus*, *Mystus vittaus*, *Clarius mangur Macrognathus pancalus*, and *Trichogaster lalius* are positively related to water temperature but negatively related to dissolve oxygen. Fish species *Puntius* spp. and *Garra* spp. are highly associated with TDS but are negatively related to pH. Similarly, species of *Barilius* spp*, Labeo* spp *Raimas guttatus Devario aequipinnatus* and *Danio devario* showed positive relationship with dissolved oxygen but negative to water temperature. In contrary, species of *Mystus bleekeri, Tor mosal, Botia geto* and *Channa punctata* are highly associated with pH but negatively to TDS. Results from the CCA hinted that water parameters DO and TDS are the influencing factors to determine the fish community structure of Shuklaphanta National Park.

## 7. RECOMMENDATIONS

In the present study, the physico-chemical parameters of water were examined at only the sampling stations, so it is recommended to examine water of tributary rivers before mixing with main river, Taal, Khola etc. so that quality/nature of water among them can be compared.

Construction of dam and changing the lotic system into lentic will certainly create an adverse impact on existing fish fauna especially to long distance migratory fishes and those which are listed in IUCN red list. Therefore, mitigation measures (making effective fish-ladder, establishment of fish hatchery, release of at least 3-5% of river in its original form) is recommended during construction and operation.

The water bodies of the study area are under stress due to environmental degradation and modern development like hydropower, over fishing, electro fishing, plant and animal poisoning, flow modification, hammering were some practices which directly affect the fish diversity. To escape from such bad techniques' proper education and rule, sustainable fishing, close season, suitable mesh size etc. like activities should be recommended.

The main reasons for decline in fish diversity of Nepal are over exploitation, illegal fishing practices, construction of dam and roads along the length of the river, land-slides, soil erosion, unusual flooding, fluctuation of environmental condition, pollution, construction of dam, habitat modification, sand and stone mining, etc. were highlighted in many papers so, regular monitoring and further study on the fish population is recommended.

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**APPENDIX-I**

**PHOTO PLATE-I**

**1**

**2**

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**7**

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**Description of photos in photoplate-I**

Photo 1: Kalakich Taal

Photo 2: Sampling station of Chure

Photo 3: Examine captured fish

Photo 4: Fishermen with his net (Tiyari jal)

Photo 5: Mahakali Nahar

Photo 6: Tara taal

Photo 7: fish capture by using (gill net) elephant at Mahakali River

Photo 8: Fishermen collecting capture fish at Bahune Khola

Photo 9: Physicochemical analysis of water parameter

Photo 10: Examination and identification of fish

**PHOTO PLATE-II**

1. *Lepidocephalus guntea*

**2**. *Wallago attu*

**3**. *Botia geto*


**4**. *Trichogaster fasciatius*

**5**. *Anabas testudineus*

**6**. *Salmostoma acinaces*

**7.** *Labeo bata*

**8**. *Garra annandelei*

**9.** *Labeo gonius*

**10**. *Esomus danricus*

**11.***Rasbora daniconius*

**12.** *Puntius ticto*

**13.** *Channa marulius*

**14**. *Danio devario*

**15.** *Labeo fimbriatus*


**16.** *Mystus cavasius*

**17.** *Barilius shacra*


**18**.*Sperata seenghala*


**19**.*Chagunius chagunio*

**20.** *Barilius vagra*

**21.** *Raiamas guttatus*


**22.** *Monopterus cuchia*

**23.** *Macrognathus pancalus*

**24.** *Puntius sophore*

**25.** *Pseudambassis baculis*

**26.** *Puntius terio*

**27.** *Mystus vittatus*

**28.** *Trichogaster lalius*

**29.** *Channa punctata*

**30.** *Tor mosal*

**31.** *Barilius bendelisis*

**32.** *Mystus bleekeri*

**33.** *Nandus nandus*

**34.** *Channa striata*

**35.** *Cirrinus reba*

**36.** *Heteropneustes fossilis*

**37.** *Glyptothorax pectinopetrus*

**38.** *Garra nasuta*

**39.** *Xenentodon cancila*

**40.** *Mystus tengara*

**41.** *Clarius mangur*

**42.** *Labeo dyocheilus*

**43.***Cabido morar*

**44.***Raiamas bola*

**45.** *Labeo rohita*

**APPENDIX-II**

**Table 4:** The IUCN Status and frequency of captured fishes

| Code | Scientific name | IUCN Status | Total no. of fish | Frequency (%) |
|---|---|---|---|---|
| C1 | *Labeo bata (Hamilton, 1822)* | C | 42 | 2.27 |
| C2 | *Labeo rohita (Hamilton, 1822)* | C | 35 | 1.89 |
| C3 | *Labeo gonius (Hamilton, 1822)* | C | 9 | 0.49 |
| C4 | *Labeo dyocheilus (McClelland, 1839)* | C | 66 | 3.57 |
| C5 | *Labeo fimbriatus (Bloch, 1797)* | C | 20 | 1.08 |
| C6 | *Garra annandelei (Hora, 1921)* | UN | 23 | 1.24 |
| C7 | *Garra nasuta (McClelland, 1838)* | UN | 25 | 1.35 |
| C8 | *Puntius chola (Hamilton, 1822)* | C | 113 | 6.11 |
| C9 | *Puntius terio (Hamilton, 1822)* | UN | 41 | 2.22 |
| C10 | *Puntius ticto (Hamilton, 1822)* | UN | 65 | 3.52 |
| C11 | *Puntius sophore (Hamilton, 1822)* | C | 85 | 4.60 |
| C12 | *Tor mosal (Hamilto, 1822* | VU, CLO, TP | 4 | 0.22 |

| | | | | |
|---|---|---|---|---|
| C13 | *Tor tor (Hamilton, 1822)* | EN, GF, CLO, TP | 3 | 0.16 |
| C14 | *Tor putitora (Hamilton, 1822)* | EN, GF.CLO, TP | 1 | 0.05 |
| C15 | *Cirrhinus reba (Hamilton, 1822)* | UN | 67 | 3.63 |
| C16 | *Chagunius chagunio (Hamilton, 1822)* | VU | 13 | 0.70 |
| C17 | *Barilius vagra (Hamilton, 1822)* | UN | 36 | 1.95 |
| C18 | *Barilius shacra (Hamilton, 1822)* | UN, CL | 94 | 5.09 |
| C19 | *Barilius bendelisis (Hamilton, 1822)* | C | 57 | 3.08 |
| C20 | *Barilus barila (Hamilton, 1822)* | C, CL | 59 | 3.19 |
| C21 | *Barilius modestus (Day, 1869)* | PRO | 27 | 1.46 |
| C22 | *Cabdio morar (Hamilton, 1822* | C | 60 | 3.25 |
| C23 | *Raiamas bola (Hamilton, 1822* | PRO | 69 | 3.73 |
| C24 | *Raimas guttatus (Day, 1869)* | VU, CLO | 23 | 1.24 |
| C25 | *Esomus danricus (Hamilton, 1822)* | C, CL | 14 | 0.76 |
| C26 | *Rasbora daniconius (Hamilton, 1822)* | PRO | 27 | 1.46 |

| | | | | |
|---|---|---|---|---|
| C27 | *Devario aequipinnatus (McClelland, 1839)* | CL, PRO | 40 | 2.16 |
| C28 | *Danio devario (Hamilton, 1822)* | C, CL | 40 | 2.16 |
| C29 | *Salmostoma acinaces (Valencienne, 1842)* | C | 55 | 2.98 |
| C30 | *Paracanthocobitis botia (Hamilton, 1822* | CL, PRO | 26 | 1.41 |
| C31 | *Lepidoceohalicthys guntea (Hamilton, 1822* | CDR, CL | 36 | 1.95 |
| C32 | *Botia geto (Hamilton, 1822)* | CL, PRO | 21 | 1.14 |
| C33 | *Mystus bleekeri (Day, 1878)* | C | 27 | 1.46 |
| C34 | *Mystus vittaus (Bloch, 1797* | C, CL | 66 | 3.57 |
| C35 | *Mystus cavasius (Hamilton, 1822)* | C | 47 | 2.54 |
| C36 | *Sperata seenghala (Sykes,1841)* | UN | 1 | 0.05 |
| C37 | *Wallago attu (Bleeker & Schneider, 1801* | C | 1 | 0.05 |
| C38 | *Glyptothorax pectinopetrus (McClelland, 1842* | UN | 29 | 1.57 |
| C39 | *Clarius mangur (Hamilton, 1822* | C | 1 | 0.05 |
| C40 | *Heteropneustes fossilis (Bloch, 1785* | C | 26 | 1.41 |
| C41 | *Xenentodon cancila (Hamilton, 1822* | C | 47 | 2.54 |

| | | | | |
|---|---|---|---|---|
| C42 | *Monopterus cuchia (Hamilton, 1822* | UN | 3 | 0.16 |
| C43 | *Macrognathus pancalus (Hamilton, 1822* | C, CL | 18 | 0.97 |
| C44 | *Pseudambassis baculis (Hamilton, 1822* | C | 48 | 2.60 |
| C45 | *Anabas testudineus (Bloch, 1795)* | C | 15 | 0.81 |
| C46 | *Trichogaster fasciatus (Bloch &Schneider, 1801)* | C, CL | 5 | 0.27 |
| C47 | *Trichogaster lalius (Hamiltion,1822)* | UN | 34 | 1.84 |
| C48 | *Channa marulius (Hamilton) 1822* | C | 43 | 2.33 |
| C49 | *Channa striata (Bloch, 1785* | C | 26 | 1.41 |
| C50 | *Channa barca (Hamilton, 1822)* | R | 2 | 0.11 |
| C51 | *Channa stewarti (Playfair) 1867* | UN | 24 | 1.30 |
| C52 | *Channa punctata (Bloch, 1793)* | C, EM | 38 | 2.06 |
| C53 | *Nandus nandus (Hamilton, 1822* | C | 51 | 2.76 |

**Table 5:** Total number of fish caught at different stations in different months

| Station/Months | Mar/Apr | Sep/Oct | Total captured fish |
|---|---|---|---|
| Station 1 | 185 | 114 | 299 |
| Station 2 | 167 | 130 | 297 |
| Station 3 | 130 | 101 | 231 |
| Station 4 | 79 | 94 | 173 |
| Station 5 | 171 | 139 | 310 |
| Station 6 | 10 | 3 | 13 |
| Station 7 | 53 | 24 | 77 |
| Station 8 | 92 | 75 | 167 |
| Station 9 | 103 | 120 | 223 |
| Station 10 | 38 | 20 | 58 |
| **Total captured fish** | **1028** | **820** | **1848** |

**Table 6:** Total number of fish species reported at different stations in different months

| Station/Months | Mar/Apr | Sep/Oct | Total species |
|---|---|---|---|
| Station 1 | 29 | 21 | 31 |
| Station 2 | 32 | 22 | 35 |
| Station 3 | 25 | 16 | 27 |
| Station 4 | 14 | 15 | 20 |
| Station 5 | 22 | 23 | 25 |
| Station 6 | 5 | 2 | 5 |
| Station 7 | 12 | 7 | 15 |
| Station 8 | 15 | 12 | 19 |
| Station 9 | 18 | 23 | 29 |
| Station 10 | 5 | 3 | 5 |
| **Total species** | **50** | **49** | **53** |

**Table 7**: Number of fish species recorded from the water bodies of Shuklaphanta National Park according to different authors:

| **Sources** | **Year** | **Number of species** | **Title of study** |
|---|---|---|---|
| Chataut, M. K | 2008 | 21 | Biodiversity of Fish and Fishery resources of Mahakali River. |
| Poudel, L | 2008 | 23 | Study on Fish and Fishery Resources of Mahakali River at Dodhara and Chadani VDC area, Far western, Nepal. |
| Saund, T.B., Thapa, J.B., and Bhatt, H.P. | 2012 | 24 | Fish Diversity at Pancheshwar Multipurpose Project Area in Mahakali River. |

**Table 8:** Water temperature ($^0$C) in different months at different stations

| **Stations** | **Mar/Apr** | **Sep/Oct** |
|---|---|---|
| 1 | 21 | 19 |
| 2 | 25 | 21 |
| 3 | 23 | 18 |
| 4 | 25 | 24 |
| 5 | 29 | 25 |
| 6 | 24 | 23 |
| 7 | 26 | 25 |
| 8 | 27 | 24 |
| 9 | 26 | 19 |
| 10 | 25 | 21 |

**Table 9:** pH at different stations in different months

| Stations | Mar/Apr | Sep/Oct |
|---|---|---|
| 1 | 8.3 | 9.4 |
| 2 | 8.6 | 8.3 |
| 3 | 8.5 | 9.3 |
| 4 | 8.5 | 7.9 |
| 5 | 9 | 9.8 |
| 6 | 8.3 | 8.3 |
| 7 | 8.2 | 8.2 |
| 8 | 8.7 | 8.7 |
| 9 | 9.5 | 9.4 |
| 10 | 8.4 | 9.2 |

**Table 10:** DO (mg/l) at different stations in different months

| Stations | Mar/Apr | Sep/Oct |
|---|---|---|
| 1 | 11 | 12 |
| 2 | 10 | 10 |
| 3 | 8.5 | 8.6 |
| 4 | 11 | 12 |
| 5 | 7.5 | 8 |
| 6 | 3.5 | 3.7 |
| 7 | 7.6 | 8.2 |
| 8 | 10.5 | 10 |
| 9 | 12.2 | 11 |
| 10 | 13 | 13.6 |

**Table 11:** Total dissolved solid (ppm) at different stations in different months

| Stations | Mar/Apr | Sep/Oct |
|---|---|---|
| 1 | 325 | 330 |
| 2 | 220 | 177 |
| 3 | 315 | 315 |
| 4 | 420 | 431 |
| 5 | 265 | 272 |
| 6 | 30 | 20 |
| 7 | 200 | 188 |
| 8 | 291 | 291 |
| 9 | 147 | 345 |
| 10 | 334 | 326 |

**Table 12:** Systematic position of captured fish with identified characterstic

| Classification | Characters for identification and data from field |
|---|---|
| **A. Order: Cypriniformes** | Known as major carps and minnow, have round abdomens, small barbels may be present or absent |
| **Family: Cyprinidae** | Their scales are large distinct, barbells if present; 1 or 2 pairs, a single rayed dorsal fin, head scale less |
| **Sub-family: Cyprininae** | Lower jaw without any symphysial process, dorsal fin originates before or opposite to origin of pelvic fins, generally with a spine, lateral line running along median line of caudal peduncle |
| **Genus: *Chagunius*** | Dorsal fin having eight branched rays, dorsal spine serrated, head is particularly at the snout, deep pits of variable sizes, 2 pairs barbells |
| **1. Species: *chagunio*** | Lateral trunk scales without radii, snout not divided by grooves. It is also found in Bheri River, Bagmati River, Mahakali River and Gandaki, Koshi, Karnali River system. (Appendix II, Photo no.19).<br>D 11 (3/8); P 15; V 9; A 8 (3/5); C 19; $L_1$ 46; L.tr. 11/9 |
| **Genus: *Cirrhinus*** | Body is elongated and cylinder. round abdomen, 2/4 no of barbells, snout is rounded and the lower jaw is beset with small tubercle above the mandibular symphysis. |
| **2. Species: *reba*** | Dark grey colour, 1 pair of short rostral barbel, scales are large hexagonal and have tints of golden colour, eyes are golden, caudle fin deeply forked. It is found in Bagmati, Koshi, Gandaki rivers, Mahakali river system. (Appendix II, photo no. 35).<br>D 11 (2/9); P 16; V 9; A 8 (2/6); C 19; $L_1$ 36-37; L.tr. 7/5 |
| **Genus: *Labeo*** | Elongated body, round abdomen, inferior mouth, fleshy lips and snout, dorsal and anal fins are short in length |

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|---|---|
| **3. Species: *rohita*** | Eyes reddish. It has thick fringed lips. A small pair of maxillary barbles is present. It is found in Bagmati, Koshi, Gandaki rivers, Mahakali river system. (Appendix II, photo no. 45)<br>D 16 (3/13); P 17; V 9; A 7 (2/5); C 19; $L_1$ 40-41; L.tr. $6_{1/2}$-$7_{1/2}$/9 |
| **4. Species: *dyocheilus*** | Lateral lobe distinct, thick, snout with groove in adult. Horney covering on both lips, pores on snout. It was also found in Bheri River, Mahakali River and Gandaki, Koshi, Karnali River system. (Appendix II, photo no.42)<br>D.13 (2/11); P 17; V 9; A 7 (2/5); C 19; l1 43; L.tr. $8_{1/2}$-$7_{1/2}$ |
| **5. Species: *fimbriatus*** | The snout smaller and studded with minute pores, lips thick continuous having inner folds above and below fringed. A distinct dark batch blotch is present at age base of the caudal fin. It was also found in Bheri River, Mahakali River and Gandaki, Koshi, Karnali River system. (Appendix II, photo no. 15).<br>D 19- 22; P 17; V 9; A 7 (2/5); C 19; $L_1$ 44- 47; L.tr. 9-10/8 |
| **6. Species: *bata*** | A pair of minute maxillary barbles present. The pelvic and anal fins are dark. The eyes are larger and lower lip slightly fringed. The dorsal fins are inserted nearer snout tip than base of caudal fin. (Appendix II, photo no. 7).<br>D 11 – 12 (2/3/9-10); P 18; V 9; A 7 (2/5); C 19; $L_1$ 37-40; L.tr.7/6-7 |
| **7. Species: *gonius*** | It is an olive-green fish minute scale. There is honey covering inside the jaws. 2 pair of barbles. Long dark band running through the body. (Appendix II, photo no. 9). |

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| | D 16 (3/13); P 17; V 9; A 7 (2/5); C 19; $L_1$ 74; L.tr. 16/17 |
| **Genus: *Tor*** | Body elongated with thick and continuous lips, scales are large, complete lateral line, two pairs of barbells |
| **8. Species: *putitora*** | Length of head is greater than body depth, yellowish lower fins, snout long and pointed. Mainly, it was recorded from Mahakali, Gandaki, Koshi, Karnali River system and its tributaries.<br>D 12 (3/9); P 16-17; V 9; A 7 (2/5); $L_1$ 25-27; L.tr. 4/4 |
| **9. Species: *tor*** | Body is deep and dorsal side is more convex, abdomen is silvery white with golden color, lower fins reddish yellow, dorsal fins slightly dark, head length is shorter than body depth. It was found in Mahakali, Gandaki, Koshi, Karnali River system and its tributaries.<br>D 12 (3/9); P 17; V 9; A 7 (2/5); $L_1$ 25; L.tr. $4_{1/2}/4_{1/2}$ |
| **10. Species: *mosal*** | Dorsal fins reddish orange, anal fins, pectoral, pelvic fins light orange. 2 pairs of barbles. Scales are larger. (Appendix II, photo no. 30).<br>D 12 (4/8); P 16; V 9; A 8 (3/5); $L_1$ 23-26; L.tr. $4/4/_{1/2}$ |
| **Genus: *Puntius*** | Small sized fishes having short slender, somewhat deeper body and rounded abdomen, jaws closely covered over continuous lips |
| **11.Species: *chola*** | Barbells present, A distinct blotch on caudal peduncle. Its dorsal fins have dark bands This fish was previously found in Gandaki, Koshi, Karnali River and their feeder streams<br>D 11 (3/8); P 14-15; V 9; A 8 (3/5); C 19; $L_1$ 27-28; L.tr. $6_{1/2}/5_{1/2}$ |
| **12. Species: *sophore*** | A distinct black blotch on caudal peduncle and base of dorsal fin, opercula are distinct red, tip of fin reddish, barbel absent. It was found in the Gandaki, Koshi, |

| | |
|---|---|
| | Karnali River and their feeder streams. (Appendix II, photo no. 24).<br>D 11 (3/8); P 15-16; V 9; A 8 (3/5); C 19; $L_1$ 22-26; L.tr. $5\text{-}5_{1/2}\text{-}5_{1/2}$ |
| **13. Species: *terio*** | Clear large round golden-edged black blotch over anal fin, dorsal profile is arched with numerous dark streaks and spots united into a distinct longitudinal band, fins yellowish, their rim marked with black. It was previously found in the Gandaki, Koshi, Karnali River and their feeder streams. (Appendix II, photo no. 26).<br>D 11 (3/8); P 15; V 9; A 7 (2/5); C 19; $L_1$ 22-23; L.tr. 5/5 |
| **14. Species: *ticto*** | With two black blotches one on anterior side of body, another on caudal peduncle, barbells absent, pelvic and anal fins are tinged with red. It was previously found in Gandaki, Koshi, Karnali River and their feeder streams. (Appendix II, photo no. 12).<br>D 11 (3/8); P 13; V 9; A 8 (3/5); C 19; $L_1$ 25; L.tr. $5_{1/2}/6_{1/2}$ |
| **Genus: *Garra*** | Hill stream fish having elongated and sub cylindrical body with inferior mouth, suctorial disc is present on the chin at the ventral side. Upper lip of fish is fringed. |
| **15.Species: *annandalei*** | Dark grey hill stream fish with blackish brown dorsum and pale belly. Slender body with smooth, pointed snout having the groove and tubercles. (Appendix II, photo no. 8).<br>D 11 (3/7-8); P 15; V 8; A 7 (2/5); C 17; $L_1$ 33-34; L.tr. $3_{1/2}/3_{1/2}$ |
| **16. Species: *nasuta*** | Dark brown hill- stream fish having dirty white colour on flanks and belly. It is popular sucker head. 2 pairs of barbles. Caudal fin deeply emarginated. Black spots |

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| | present at the base of dorsal fin ray. (Appendix II, photo no. 38).<br>D 11 (2/8-9); P 15; V 8; A 7 (1-2/5); C 17; $L_1$ 33-34; L.tr. $4_{1/2}/3_{1/2}$ |
| **Sub-family: Danioninae** | Small shiny fishes, body laterally compressed, mouth with 1 or 3 rows of teeth, |
| **Genus: *Cabido*** | Lower lip absent, barbells absent, lower jaw with sharp crescentic edge |
| **17. Species: *morar*** | Snout obtuse. Dorsal, cauda and pectoral fins are splashed with pink colour. It was previously found in the Bagmati, Gandaki, Koshi, Karnali and Mahakali of Nepal. (Appendix II, photo no. 43).<br>D 10 (3/7); P 15; V 8-9; A 12 (2/12); C 19; $L_1$ 38-40; L.tr. $7_{1/2}/3_{1/2}$ |
| **Genus: *Rasbora*** | Elongated body with abdomen rounded, lateral line concave, 3 protuberances in the mouth. |
| **18.Species: *daniconius*** | Silvery grey fish with a deep back band present along the sides, oblong and compressed body, caudal fin forked with yellow colour, barbles are absent. (Appendix II, photo no. 11).<br>D 9 (2/7); P 15; V 9; A 7 (2/5); C 19; $L_1$ 31; L.tr. $5_{1/2}/4_{1/2}$ |
| **Genus: *Raiamos*** | Silvery trout like fish having compressed head and pointed snout, Mouth with large cleft and barbels absent |
| **19. Species: *bola*** | Silvery body with greenish back. Head sharply pointed, caudal fin deeply forked, barbel absent, fin are orange. (Appendix II, photo no. 44).<br>D 10; P 13; V 9; A 3/10; C 19: $L_1$ 84-89; L.tr. 13-14/15 |
| **20. Species: *guttatus*** | Silver fish tinged with purple hues. Lower lobe of caudal fin is orange; the cleft of mouth extends about eyes behind orbit, minute maxillary barbell. (Appendix II, photo no. 21). |

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| | D 9 (2/7); P 15; V 9; A 14; C 17: $L_1$ 44-48; L.tr. 9/5 |
| **Genus: *Esomus*** | Mouth opening is usually small and obliquely directed upwards, 2 pairs of barbels, dorsal fin is short and lies above the anal fin, scales are moderate size |
| **21. Species: *danrica*** | A dark band from behind the eye to the base of caudal fin, maxillary barbells very long reach beyond pelvic base. This type of fish is found in tributaries of Karnali, Koshi, Gandaki river systems. (Appendix II, photo no. 10).<br>D 8-9 (2/6-7); P 11-12; V 8; A 9 (3/6); $L_1$ 20-30; L.tr. 8 |
| **Genus: *Barilius*** | Body is elongated and its abdomen is round, mouth situated at the anterior extremity and is often oblique with deep cleft, compressed jaw, upper jaw has an invagination, anal fin is elongated |
| **22. Species: *modestus*** | Silvery body with brownish back and yellowish fins. A distinct dark band is present on dorsal fin and caudal fin edge is dusky brown. A pair of rostral barbles extends to anterior edge of eyes. It was found in main river system of Nepal Gandaki, Koshi, Karnali and its tributaries or their feeder. (Appendix II, photo no. 3).<br>D 9 (2/7); P 15; V 9; A 13-14 (3/10-11); C 19; $L_1$ 42-43; L.tr. $6/4_{1/2}$ |
| **23. Species: *bendelisis*** | Have black spots at the base of each scale, fine pores on snout, 2 pairs of barbells, lower jaw covered with spiny tubercle, body is crossed with 8-12 lateral band. It was found in main river system of Nepal; Gandaki, Koshi, Karnali and its tributaries or their feeder. (Appendix II, photo no. 31).<br>D 9 (2/7); P 13; V 9; A 9-10 (2-3/7-8); C 18; $L_1$ 40-43; L.tr. 7-8/5 |

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| **24. Species: *barila*** | Silvery white fish well patterned by crossing of 14-15 vertical dark band across the whole body but do not extend below lateral line, barbell one pair, caudal fin deeply forked with lower lobe longer. It was found in the main river system of Nepal Gandaki, Koshi, Karnali and its tributaries or their feeder.<br>D 9 (2/7); P 13; V 9; A 13-14; C 19; $L_1$ 43-46; L.tr. 7/5 |
| **25. Species: *shacra*** | Silvery fish with olive brown back and pinkish and silvery tints on the body, 10-12 vertical bars run from back to lateral line, 2 pairs barbells look like *B. vagra* but have slightly larger scales. It was found in main river system of Nepal; Gandaki, Koshi, Karnali and its tributaries or their feeder. (Appendix II, photo no. 17).<br>D 9 (2/7); P 15; V 8; A 10 (2/8); C 19; $L_1$ 60-70; L.tr. 10-11/9 |
| **26. Species: *vagra*** | Slim and shallow bodied, relatively small head and mouth, about 10-14 bluish vertical bands reach near lateral line scales, 2 pair barbell, mouth cleft extended up to mouth. This fish was found in main river system of Nepal Gandaki, Koshi, Karnali and its tributaries or their feeder. (Appendix II, photo no. 20).<br>D 9 (2/7); P 16; V 9; A 13- 15; C 19; $L_1$ 42-44; L.tr. 7-8/4 |
| **Genus: *Danio*** | They are ornamental fish having coloured stripes, loops and dashes on their body. |
| **27. Species: *devario*** | Ornamental fish with silvery greenish body, head small, snout obtusely pointed, dark band runs from the middle of the caudal above the middle of anal fin. Scales are cycloid. (Appendix II, photo no. 14).<br>D 18 (2/16); P 14; V 8; A 19 (3/16); C 19; $L_1$ 46-48; L.tr. $11_{1/2}/2_{1/2}$ |

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| **Genus: *Devario*** | Vivid colour ornamental fishes with streamlined and compressed body having oblique directed or upturn mouth, barbels 2 pairs. |
| **28. species: *aequipinnatus*** | Beautiful silvery fish having alternate bluish and yellowish bands on body. Orange and reddish yellow colour in fin. Mouth small directed upwards, caudal fin forked.<br>D 12-14 (2/10-12); P 17; V 8; A 14-16(2/12-14); C 19; $L_1$ 32-34; L.tr. 6-7/$3_{1/2}$ |
| **Genus*: Salmostoma*** | Elongated and laterally compressed body with cutting abdominal edge. |
| **29. Species: *acinaces*** | Silver coloured fish with lateral band present, body is elongated and compressed, mouth oblique and slightly upturned. (Appendix II, photo no. 6).<br>D 9-10 (2-3/7-8); P 15; V 8; A 17-19; $L_1$ 43-45; L.tr. $6_{1/2}$-7/3 |
| **Family: Nemacheilidae** | Body depressed and dorsoventrally flattened. Pectoral and pelvic fins not inserted horizontally. |
| **Genus: *Paracanthocobitis*** | Deeper body, head compressed snout blunt. Traces of adipose keel present, lateral line complete. |
| **30. Species: *botia*** | Hill stream fish having 3 pairs of barbles, black ocellus present at caudal peduncle above lateral line. Small oval patches are distributed along lateral line.<br>D 12-14 (2/10-12); P 11; V 8; A 7 (2/5); C 17 |
| **Family: Cobitidae** | Small fish with minute scales occurring in gravel bed habit of brooks and creeks. 3-4 pairs of barbles. |
| **Sub family: cobitinae** | Erectile spine originating from the ethmoid bone, oblong body, Caudal fins usually rounded or slightly emarginated. |

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| **Genus: *Lepidocephalichthys*** | Also called mud loaches, elongated body, dorsal fin short, caudal fin is subtruncate or round, 1 erectile bifid spine bellow eye. |
| **31. Species: *guntea*** | Body colour is black pattern and bright dark band. Dorsal, pectoral and caudal fin have black dots and are crossed with striped, 4 pairs barbles. (Appendix II, photo no. 1).<br>D 8 (2/6); P 14; V 8; A 7 (2/5); C 16 |
| **Family: Botiidae** | Fish are colourful with beautiful patterns, having arched back, robust and fusiform shaped body and pointed snout. |
| **Sub-family: Botinae** | Have short oblong, compressed bodies generally erectile spine originating from ethmoid bone lie hidden in a groove |
| **Genus: *Botia*** | Scales on head absent, snout conical, flattened, eye moderately large |
| **32. Species: *geto*** | Striped yellow brown fish with cloud like marks, a variety of yellow and bluish spots are scattered along the whole body. (Appendix II, photo no. 3).<br>D 12 (3/9); P 14; V 8; A 7 (2/5); C 19 |
| **B.Order: Beloniformes** | Sub cylindrical bodies, jaw prolonged into a beak armed rows of sharp teeth, pectoral fin short and scale cycloid, deciduous. |
| **Family: Belonidae** | Elongated, sub cylindrical body. Both jaws prolonged into beak, armed with rows of sharp opposing teeth. |
| **Genus: *Xenentodon*** | Elongated sub cylindrical body with lateral eye. Jaws from characteristics beak. Caudal fins forked. |
| **33. Species: *cancila*** | Elongated fish with beak like jaw. Body is greenish above and whitish below. Dorsal and anal fins dark-edged and close to tail. Lower jaw slightly longer upper jaw. (Appendix II, photo no. 39). |

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| | D 16-17; P 11; V 6; A 17; C 15 |
| **C. Order: Perciformes** | Small fresh fish having ventral fins are thoracic, dorsal fins usually 2. |
| **Sub order: percoidei** | Small, translucent, brilliant perch like silvery fish with oblong and compressed body. Mouth small protrusible and jaws teeth villiform. |
| **Family: Ambassidae** | Short, oblong, and arched, compressed body. 2 dorsal fins, with spinous and soft parts. Anal fin with spine. |
| **Genus: *Pseudambasis*** | Small transparent elongated and compressed body, mouth small and tongue edentate. Lateral line completer aquarium fish. |
| **34. Species: *baculis*** | Transparent yellow brown fish, with distinct golden spot at occiput. A silvery longitudinal band on flank. Mouth oblique and black spot present along the top of the first/ second dorsal and anal fins. (Appendix II, photo no. 25).<br>D 1+7/1/13-14; P 11-12; V 1/5; A 3/5; C 17; $L_1$ 90 |
| **D.Order: Synbranchiforms** | Cylindrical, eel shaped body, gill openings are confluent as single silt, dorsal, caudal and anal fins are continuous |
| **Family: symbranchidae** | Fish of this family have scales and a pair of accessory respiratory sacs present. |
| **Genes: *monopterus*** | Snake like fish, only dorsal anal fins are present. Body is cylindrical on anteriorly and compressed posteriorly. |
| **35. Species: *cuchila*** | Serpentine amphibious fish having dark brown colour. Numerous round spots on the body above lateral line and all over tail. Barbles are absent, a single gill opening on the ventral surface of the head. (Appendix II, photo no. 22).<br>D very rudimentary, just a fold of skin; p, A, V and C absent |

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| **Family: mastacembelidae** | Have long lower jaw, a single long dorsal fin with anterior free spines, anal are with 3 spines, ventral fin absent |
| **Genus: *Macroganthus*** | Stone eel has transversely striated on ventral sides. Preorbital spine is absent. Cleft of mouth is narrow. |
| **36. Species: *pancalus*** | Body colour is dark brown above and yellow below green, dorsal, anal and caudal fins are yellow colour and shot with many black spots and they are not united. Spiny dorsal fins are long. (Appendix II, photo no. 23).<br>D 24/26- 30/42; P 17-19; A 3/31-46; C 12 |
| **E. Order: Siluriformes** | Have elongated and compressed body devoid of scales or bony plates, usually bears tiny eyes, barbells extending from each sides of upper jaw, spines present in the front of dorsal and pectoral fins, a single in each fin, adipose fin present or absent |
| **Family: Bagridae** | Dorsal fin large and spiny, anal fin short, caudal fin forked |
| **Sub family: Bagrinae** | Gill membrane free from each other and also from isthmus. Anal fin short. |
| **Genus: *Mystus*** | Four pairs barbel, maxillary barbel reach beyond dorsal fin, no pores on ventral surface and sides of head, deeply curved band, separated in the middle |
| **37. Species: *bleekeri*** | Brownish gray fish, three longitudinal bands, a big dark shoulder spot. This fish is found in low land (altitudinal range 70-500 m) at Karnali, Gandaki, Koshi, Kamala and Bagmati Rivers. (Appendix II, photo no. 32).<br>D 1/7/0; P 1/9-10; V 6; A 9-10 (3/6-7); C 17 |
| **38. Species*: cavasius*** | Barbles 8, Caudal fin is forked, upper lobe being longer and pointed. Leaden grey colour fish with obtuse snout. Upper jaw is longer. (Appendix II, photo no. 16).<br>D 1/7/0; P 1/9; V 6; A 11 (3-4/7-8); C 16 |

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| **39. Species: *vittatus*** | Distinct bluish spot shoulder. Barbles 4 pairs, four longitudinal bands on either lateral side. (Appendix II, photo no. 27).<br>D 1/7/0; P 1/8; V 6; A 11 (2/9); C 17 |
| **Genus: *Sperata*** | Snout spatulated or rounded, with wide gap of mouth. Present of long maxillary barbles |
| **40. Species: *seenghala*** | Large size cat fish, Snout spatulated, Maxillary barbles reaching anal fins, pectoral spine strong serrated and dorsal spine week. (Appendix II, photo no. 18).<br>D 1/7/0; P 1/9; V 6; A 11-12 (3/8-9); C 19-21 |
| **Family: Siluridae** | Fish are spineless and very short dorsal fin. Anal fin is long. 2 pairs of barbles cleft is present on mouth. |
| **Geneus : *wallogo*** | Catfish having compressed body and depressed head. Mouth directed obliquely. |
| **41. Species: *attu*** | Large dirty white cat fish having 2 pairs of barbles. Dorsal fins are feathery and has a hard saw edged ray. Small adipose fins are present at end. Head large and fairly depressed. (Appendix II, photo no. 2).<br>D 5; P 1/14; V 10; A 86 (4/82); C 17 |
| **Family: Sisoridae** | Dorsoventrally flattened, elongated, depressed head and body, skin naked, eyes with free orbital margin, paired fins are horizontal, spine in dorsal and pectoral fin, 2 nasal openings on each side separated by nasal barbell, generally 4 pairs of barbells |
| **Sub–family: Glyptosterninae** | Presence of adhesive apparatus on thorax. |
| **Geneus: *Glyptothorax*** | Hill stream character is appearing. Gill opening are wide, 4 pairs of barbles, head and body are flat and depressed or Usually small sized, adhesive apparatus which occurs as longitudinal folds at the chest or in between pectoral fin, head and body flat and depressed |

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| **42.Species: *pectinopterus*** | Brownish colour catfish. Dorsal and caudal fins grayish their tips are light yellow. Well-developed adhesive apparatus, 4 pairs of barbles, paired of fins are splashed with black patches. (Appendix II, photo no. 37).<br>D 1/7/0; P 9-10(1/8-9); V 6; A 9- 11 (1-2/8-9); C 17 |
| **Family: Clariidae** | Long spineless dorsal fin, 4 pairs of barbles, long anal fin |
| **Genus: *Clarius*** | Elongated body and depressed head, mouth transverse, teeth are villiform. |
| **43. Species: *mangur*** | Grayish black catfish with splashes of yellow brown colour with vertical head and laterally compressed tail. Dorsal and anal fins are long. The caudal fins are separated from dorsal and anal.4 pairs of barbles. (Appendix II, photo no. 41).<br>D 65-70; P 1/8-11; V 6; A 47; C 17 |
| **Family: Heteropneustidae** | Dorsal fins are short and spineless, ana fins are long, 4 pairs of barbles. |
| **Genus: *Heteropneustes*** | Elongated and compressed bodies, Dorsal fin originated anterior third of the body, pectoral fin have pungent spine. |
| **44. Species: *fossilis*** | Dirty brown purplish cat fish having anal fin separated from caudal fin by a deep notch, caudal fins rounded. Short dorsal fins. Pectoral fin has spine. (Appendix II, photo no. 36).<br>D 6; P 1/7; V 6; A 62-66; C 19 |
| **F.Order: Anabantiformes** | Fishes have protractile mouth ctenoid and cycloid scales, dorsal and anal fines with spines**.** |
| **Family; Anabantidae** | Fishes are called climbing perches with normal rays in the pelvic fin, small terminal mouth. |

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| **Genus: *Anabas*** | Oblong laterally compressed body, mouth is small. Ventral fins are normal, body is not crossed by oblique vertical bands. |
| **45. Species: *testudineus*** | Ventral anal and caudal fins are orange, edged in blood red. Hard comb like ctenoid scales, fishes are called climbing perch. (Appendix II, photo no. 5).<br>D 16-18/8-10; P 14-15; V 1/5; A 7-11/9-11; $L_1$21-29 |
| **Family: Osphronemidae** | Fishes include a board spectrum of fish having well developed supra occipital crest. |
| **Genus: *Trichogaster*** | Deep and compressed body, oblique vertical band across the body. Dorsal spine is single. |
| **46. Species: *fasciatus*** | Greenish blue stripe is present. Dorsal and anal fin are long. Pelvic fin is modified in to thread statured where the caudal fin is truncated. scales are large. (Appendix II, photo no. 4).<br>D 15-17/9-13; P 10; V 1; A 15-16/14-19; C 15; $L_1$ 29-31; L.tr. $4_{1/2}$-$5_{1/2}$/11-12 |
| **47. Species: *lalius*** | Scarlet bands and light blue spot, mouth small strongly protrusible. Dorsal and anal fin are soft and round. (Appendix II, photo no. 28).<br>D 15-16/7-8; P 10; V 1; A 17-18/13-14; C 15; $L_1$ 26-28; L.tr. $4_{1/2}$-$5_{1/2}$/10 |
| **Family: Nandidea** | Oblong and compressed body with feeble teeth. anal fin is with three spine, ctenoid scales are present. |
| **Genus: *Nandus*** | Oblong and compressed body with protractile mouth having with deep cleft. Opercula are with spine. Villiform teeth on jaws scale are ctenoid and moderate size. |
| **48. Species: *nandus*** | Brownish grey fish having vertical band, rounded blotch present at the caudal peduncle. Large mouth, teeth present on root of tongue. (Appendix II, photo no. 33). |

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| | D 12-14/ 11-13; P 16; V 1/5; A 3/7-9; C 15; $L_1$ 46-57; L.tr. $5_{1/2}$-6 |
| **Family: Channidae** | Large scales, eyes small and lateral, cephalic pits are present in the head and dorsal fin is long single, anal fin shorter, ventral fin is either thoracic or absent |
| **Genus: *Channa*** | Elongated body with serpent like head, long body, depressed head covered with scales, |
| **49. Species: *barca*** | Each scale of the fish is marked with black dots reflecting dotted appearance. It is found in Koshi, Karnali, Gandaki, their tributaries and Bagmati.<br>D 47-52; P 16; V 1/5; A 34-36; C 19; $L_1$ 60-65; L.tr.5-6/13 |
| **50. Species: *marulius*** | Larger in size and dark ocellus in upper half of the base of caudal. Presence of lateral band. (Appendix II, photo no. 13).<br>D 46; P 18; V 6; A 32; C 14; $L_1$ 65–66; L.tr.6/11 |
| **51. Species: *striata*** | Dark brown fish having blackish back and yellowish belly. (Appendix II, photo no. 34).<br>D 37-45; P 17; V 6; A 23-26; C 13; $L_1$ 50-57; L.tr.4 ½-7/9-7 |
| **52. Species: *punctata*** | Small size olive brown fish. Dark and light stripe above and below the lateral line, several bands pass down from back to abdomen. (Appendix II, photo no. 29).<br>D 29-30; P 16-17; V 6; A 20-22; C 12; $L_1$ 37-40; L.tr. 4-5/7 |
| **53. Species: *stewartii*** | Purple black fish having sparse, dark, vertical, oblique bands present on sides above and below the lateral lines.<br>D 39-40; P 17; V 6; A 27; C 14; $L_1$ 47-50; L.tr. 4 ½ -5 ½ /9-7 |

नेपाल सरकार
वन तथा वातावरण मन्त्रालय
राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण विभाग

# शुक्लाफाँटा राष्ट्रिय निकुञ्ज कार्यालय

मझगाँउ, कञ्चनपुर

फोन नं. ०९९-४१४३०९

पत्र संख्या : ०७७/०७८
चलानी नं. ५२४

मिति : २०७७।०६।२२

विषय:अध्ययन अनुसन्धान अनुमति सम्बन्धमा ।

**श्री बिशाल पौड्याल,**
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प्रस्तुत विषयमा राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण विभागको पत्रानुसार यस शुक्लाफाँटा राष्ट्रिय निकुञ्जमा **Fish Diversity of Shuklaphanta National Park, Nepal** " बिषयमा अध्ययन अनुसन्धान गर्न तपाइलाई तपसिलका शर्तहरुको अधिनमा रही मिति **8 October 2020 to 18 October 202)** सम्म जम्मा १० दिनको लागि अनुमति दिईएको व्यहोरा अनुरोध छ ।

तपशिल:

१. अनुसन्धानकर्ताले राष्ट्रिय निकुञ्ज तथा वन्यजन्तु संरक्षण ऐन २०२९ र नियमावली २०३० तथा यस मातहतका सबै नियमावलीहरुको पूर्ण पालना गर्नु पर्ने छ ।
२. अनुसन्धानकर्ताले विभाग र यस कार्यालयसंग समन्वय गरि कार्य गर्नु पर्ने छ ।
३.अनुसन्धानकर्ताले अनुसन्धान समाप्त भएपछि एक प्रति कागजी प्रतिवेदन र एक ईलोक्ट्रोनिक प्रतिवेदन विभाग र यस कार्यालयमा अनिवार्य बुझाउनु पर्ने छ ।
४.अनुसन्धानकर्ताले नतिजाहरु प्रकाशित गर्दा अनुसन्धानमा संलग्न कर्मचारीको योगदानको आधारमा सह लेखकको रुपमा समावेश गराउनु पर्ने छ ।
५. संकलित नमुना विदेश लैजान पाईने छैन ।
६. तोकिएको शर्तहरुको पालना नगरेमा यस कार्यालयले कुनै पनि समयमा अनुमति पत्र रद्द गर्न सक्नेछ ।

(.....)
लक्ष्मण प्रसाद पौड्याल
प्रमुख संरक्षण अधिकृत

**बोधार्थ:**
श्री रा.नि.तथा व.ज.स. विभाग, बबरमहल, काठमाण्डौ ।
श्री देविदल गण, कञ्चनपुर, ब्यारेक, कञ्चनपुर: जानकारीको लागि अनुरोध छ ।