1. INTRODUCTION

1.1 General 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 1,47,181 sq. km. (56,846 sq. mile). 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

a) Himalayan region
b) Sub Himalayan region
c) Terai region

The Himalayan region is always covered with snow and generally lies above the altitude of 16,000 ft. (4,800m.) from the sea level (Amatya, 1967) occupying more than 15 percent (22,077sq.km) of the total area of Nepal. Fish distribution is not reported so far in this region. The sub- Himalayan region is located in between Himalayan and Terai region occupying 68 percent of total area of nation and the region contains massive mountain running from East to West. This region lies between 2,000 ft. (500m.) and 16,000 ft. (4,800 m.).

1.2 Water Resources

Nepal has a total of 8, 17, 100 hectares of inlands water resources comprising 5.5% of Nepal's total area (DOFD 2007). Wetlands are important for their economical, socio-economic, cultural, scientific, aesthetic and recreational values. They provide tremendous socio-economic benefits to mankind.

1.2.1 Natural water resources

The natural water resources of Nepal consist of rivers, lakes, and reservoirs comprising of approximately 49.14 percent of the total existing water area of Nepal (Table 1). The rivers

are of major importance with regard to percentage coverage (48.34%) of the total area. Lake and reservoirs are of less significance; as they comprise only 0.8% of the total water area.

Table1. Estimated water surface area in Nepal

S.N	Resource details	Estimated area (ha)	Coverage (%)	Potential area (ha)
1	Natural water	4,01,500	49.14	
	Rivers	3,95,000	48.34	
	Lakes	5.000	0.61	78,000
	Reservoirs	1,500	0.18	
2	Village ponds	6,500	0.80	14,000
3	Marginal swamps	11.100	1.36	
4	Irrigated paddy field	3,98,000	48.71	
	Total	8,17,100	100	92,000

Source: Directorate of Fishery Development, (2013/2014)

1.3 Fish resources

Various forms of water resources of the country prove to be good shelter area to large number of indigenous fish species of high economic and academic values. A review on the current taxonomic status of indigenous fish species revealed there are 238 fish species identified till now in Nepal (Fish Base 2013). These fish spp. are found in various water bodies at different altitude ranging from a few hundred meter above sea level to as high as 4,000 meters. The total number of species belongs to 98 genera under 35 families and 11 orders. In the upper part of this region, fishes like snow trout *(Schizothorax* spp. and *Schizothoraichthys* spp.), suker headed (*Garra* spp.), stone loaches (*Nemacheilus* spp.) and *Glyptothorax* spp. are found and in the lower part (900- 2000 m) fishes like sahar (*Tor* spp.), bhakur (*Catla catla*), rohu (*Labeo* spp), faketa *(Barilius* spp.), kabre (*Pseudecheneis sulcatus*) are found. The lower plain of Terai is a narrow belt of land situated towards the South of the country at an altitude above 60m. From the sea level to the sub- Himalayan region and constitutes more than 17 percent of the total area of Nepal. The important fishes found in this region are rohu (*Labeo* spp), sidre *(Puntius* spp), catfishes like *Heteropneustes fossilis*, *Wallago attu*, *Clarias batrachus* etc.

In the last few decades, inland water has been subjected to a range of stress caused by direct and indirect human activities such as irrigation, hydroelectric projects,

urbanization, industrialization, modernization of agriculture etc. Particularly river basins in Nepal have undergone extensive changes thus creating adverse effect on the aquatic biodiversity specially the native fish fauna (Swar and Shrestha, 1997). Many anthropogenic problems have been identified as siltation, chemical pollution, introduction of exotic species, over exploitation like irrational fishing (use of small mesh gillnets, use of explosive, electro-fishing and poisoning) and hydraulic engineering (dam and impoundment, leaves, canalization, etc). All these activities posed a danger to many of the indigenous species inhabiting water bodies (Shrestha, 1990/1998).

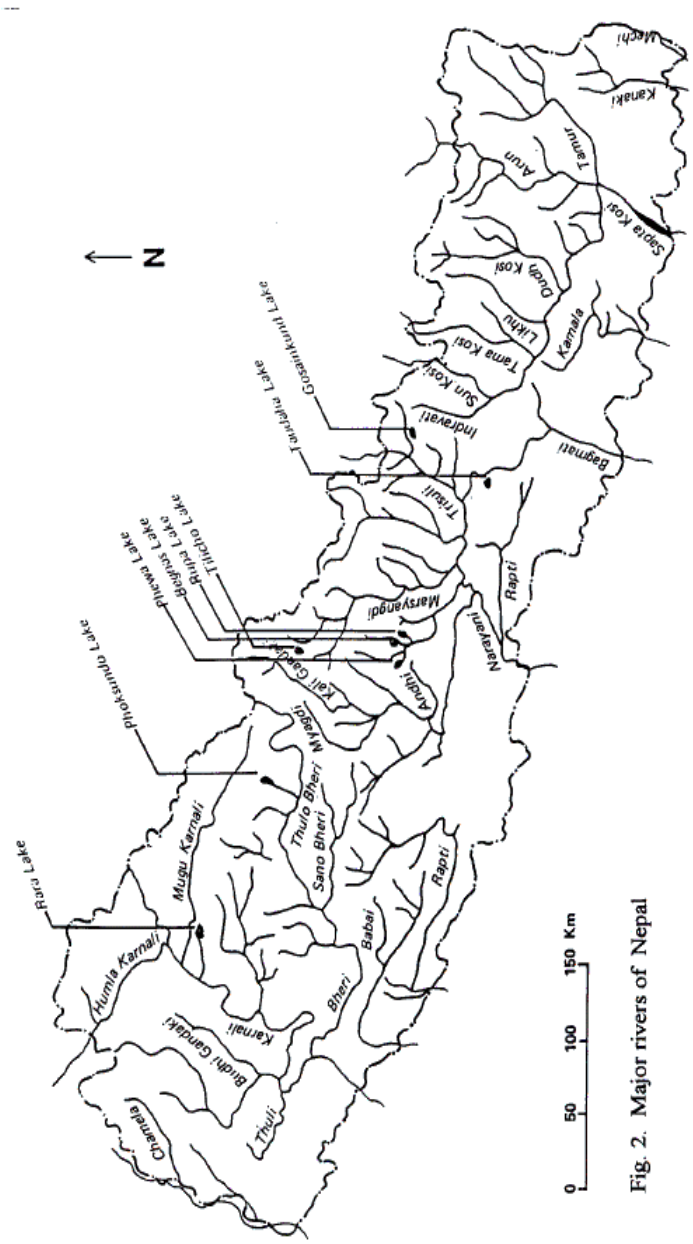


Fig. 2. Major rivers of Nepal

Fig: 1 River system of Nepal.

Several exotic species of commercial value have been introduced in to the country. Out of which brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) are exotic cold water species. The other warm water species are *Cyprinus carpio, Ctenopharyngodon idella, Hypopthalmichthys molitrix, Aristichthys nobilis, Carassius carassius, Carassius auratus, Cyclocheilichthys apogon, Puntius gonionotus, Clarias gariepinus, Oreachromis niloticus, Oreochromis mossambica, Pangasius sutchi*. There are several declining indigenous fish species which were recommended for legal protection. The recommended fish species are *Neolissocheilus hexagonolepis* (V), *Chagunius chagunio* (V), *Tor putitora* (V), *Tor tor* (E), *Schizothorax richardsonii* (V), *Anguilla bengalensis* (V), *Myersglanis blythi* (V) and *Schizothoraichthys progastus* (V) (Shrestha, 2001).

1.4 Sharada river

Sharada river flows along in the small valley of mid-western region of Nepal and the river drains the eastern half of Salyan hilly region through Sitalpati, Luham, Kabra, Kalimati, Kalche and Kabrechour V.D.C. After these areas, the river traverses through the Mahabharat range finally confluence with Babei river. Sharada river flows through the entire districts, Salyan and Dang lying on the latitudes $28^0$15'00"N to $28^0$20'00" N and longitudes $82^0$00'00"E to $82^0$07'30"E.

1.5 Justification of study

The Sharada river is one of the most important river in mid-western region. The water level during winter and summer falls to a considerable amount; however there is considerable aquatic life in this river. Sharada river is degenerating and the population of fish in the river is also experienced to decline due to number of factors such as increasing fishing pressure (legal and illegal), heavy flooding, erosion, construction of road along the river side and construction of bridge across the river.

Almost all of the river of Nepal has been studied including Karnali and Mahakali of western part of Nepal. But unfortunately, the river Sharada is totally ignored for any study. The present study had been undertaken to gather the basic information of indigenous fishes and about fisher communities depend upon on fishing for livelihood in this river.

1.6 Limitation of the study

Paucity of the time, limited financial resources and technical facilities had limited the study work in certain sector of the river.

1.7 Objectives

General objective

The general objectives of this study is to study of fish diversity of Sharada river.

Specific objectives

- To study the physicochemical parameters like transparency, turbidity, water temperature, pH, DO, free Co_2 and water velocity of the Sharada River.
- To study the socio-economic of fishermen.

2 LITERATURE REVIEW

2.1 Historical events

The commencement of the history of ichthyology coincided with that of Zoology which deals back from the time of Aristotle (384-322B.C). Aristotle was regarded to be the father of natural history. He had an accurate knowledge of the general structure of fishes and distinguished various group of aquatic amphibians, mammals and from the various group of aquatic invertebrates. His information on the habits of fisher was surprisingly accurate. His nomenclature of ichthyology was limited to 115 species of fishes, all of which were native of Aegina sea adjacent to Greece. After Aristotle, no proper work on fishes was available for nearly 1800 years. This was considered a period of regression in the science of ichthyology. The contribution of Pierra Belon (1517 - 75AD) was based on his original observation of 110 fishes of Mediterranean sea in Europe. Piso (1611 - 78 AD) was a one of the noteworthy scholars of ichthyology. His notable contributions were arrangement of various species of fishes in proper systematic manner. He also gave fishes independent and proper scientific names. He and his collogues catalogued about 420 fish species including these which were already recorded.

The notable contribution was later made by Linnaeus (1707 - 78AD), McClelland (1839), Bleeker (1853) etc. Gunther published catalogue of the fishes of British Museum, London in eight volumes. The work contained an account of 6847 species together with the description of another 1682 doubtful species.

2.2 Historical studies on fish in Nepal by foreign expert

Little work has been done to explore the fish faun of Nepal in spite of its of huge water resources and great zoo-geographical significance. The earliest record of fish and fishery of Nepal goes back to the eighteenth century. The first historical account had been given by Colonel Kirkpatrick, while he traveled in Kathmandu on a political mission in the year 1793 AD. He described the fishing methods in the Rapti river of Makwanpur district. However, the credit of first scientific report on fish fauna of Nepal goes to Francis Buchanan (later Hamilton) for the work of 1822 “An Account of fish found in the River Ganga and its Branches”. In this work, he had reported 24 fish species from the river Koshi and 2 fish species from the river Rapti of Nepal. But he collected these fish species across the border within the territory of India. From the days of colonel Kirkpatrick

(1793), Hamilton (1802-1803) and Hooker (1848-1851) to the present day, number of ichthyologists had studied the fish fauna of Nepal. Gunther (1861) reported some cold-blooded vertebrates including fishes collected by Hodgson in Nepal and prepared a checklist of 35 fish species. Day (1878) mentioned the distribution of some fresh water fishes of Nepal in historical work "Fish of India Burma and Ceylon". One of the outstanding contributors in this field was Hora (1920-1952) who obtained a collection of fishes from Nepal through Colonel Bailey in 1923 and collection included 159 specimen of 22 species.

Menon (1949) described fishes from the Koshi rivers of Himalayan region. It consisted 11 families comprising 26 genera and 52 species. Taft (1955) conducted a fish survey of Nepal and collected fishes from Kathmandu and adjoining areas. His check list-list included 94 species.

Menon and Datta (1961) described a new *Psilorhynhus pseudecheneis* as endemic fish of Nepal. Menon (1962) contributed a distributional list of fishes of the Himalaya in which he had reported 218 species of fishes. Dibbs (1965) studies the various aspects of development of fisheries of Nepal. His report was based on the work of Zwelling (1963), who undertook the assignment of studying fisheries in Nepal under the Food and Agriculture Organization (FAO) of United Nation. Other important Ichthyologists who had done taxonomic study freshwater fishes of Nepal were Shaw and Shebbeare (1937), and Misra (1959). Shrivastava (1968) published a book entitled "Fishes of Eastern Uttar Pradesh" in which he mentioned a number of Nepalese fishes.

2.3 Fish studies in Nepal by local fishery scientists

Thapa and Rajbanshi (1968) studied the ecology of hill stream fishes of Nepal. Majpuria and Shrestha (1968) published a paper on fresh water fish and fisheries in Nepal. Majupuria (1969) contributed a paper on socio-economic condition of fisherman of Kathmandu valley. Bhatta (1970) had listed about 57 species of fishes in his book "Natural History and Economic Botany of Nepal" Bhatta and Shrestha (1973) had listed 27 species of fishes from Suklaphanta (western Nepal).

The study of biological and limnological condition of lakes and natural waters in Pokhara Velley was done by Ferro and Swar (1978). Shrestha (1978) gave an account of fishing with khukari at night. Shrestha (1979) studied the resource biology and aquatic ecology of

fresh water of Kathmandu valley. Shrestha (1980) studied fishing gear and methods used in Narayani river and reported 103 species of fishes. Mesuda and Karki (1980) had published a check list of fish fauna of Trishuli River - 6 families, 16 genera and 28 species. Shrestha (1981) listed 120 species of fish in the book "Wildlife of Nepal". Shrestha (1981) had written a short account on fishing from bamboo bridge with lift Net.

A milestone work in the field of taxonomic study of fish fauna in Nepal had been done by Shrestha (1970-1986) and published a book entitled "Fishes of Nepal" in 1981. Pokharel (1982) gave an account of the fishery species of Koshi River. Jha (1983) carried study on Karnali River and reported 51 species of fishes. Terashima (1984) had reported three new endemic species of cyprinid of the genus, *Schizothorax* from Lake Rara. McGladdery et.al (1980) and Evenet.al, (1985) noted 58 and 69 fish species respectively from the rivers of Royal Chitwan National Park (RCNP). Jha and Shrestha (1986) had collected 57 species of fishes from Karnali River. Joshi (1988) studied on fish resources of Sunkoshi River. Edds (1986) studied the fishes of Kaligandaki/Narayani River and Chitwan National Park reporting 111 and 107 species respectively.

EIA and socio-economic impact study was done in Arun Hydroelectric Project (New Era 1989). Later, detail study on spawning, ecology, behavior and migration of the fishes was done in upper Arun (New Era,1991). Shrestha (1991) reported 59 cold water fish species from the natural water bodies of Mountains and Himalayan region. Sapkota (1992) studied fishery ecology of swamplands of Koshi River. Shrestha (1992) studied on the fishes in the flood plain of the Koshi river. Sah (1995) studied on the fishery ecology of the Trishuli river.

Very recently, Shrestha (2001) did a taxonomic revision of 186 fish species with their nomenclature and systemic position according to new classification after Jayram (1999). Karki (2000) studied on biodiversity and fishery resources of lower Karnali, Nepal and recorded 50 species of fish belonging to 29 genera under 15 families and 8 orders. Bajaracharya (2001) studied fish and fishery resources of the Bhotekoshi and Sunkoshi snd recorded 16 species of fish under 3 families and 2 orders. Gurung et.al. (2003) had recently reported 186 fish species - 176 indigenous and 10 exotic fish species. Gautam (2003) studied on the fish diversity of aquatic life resource of lake Rupa and recorded 23 species of fish belonging to 5 orders, 6 families and 18 genera. Malla (2004) studied fish diversity and distributional pattern in Daram Khola Baglung and recorded 21 species.

Shah (2005) studies on the fish diversity of Budhiganga river and recorded 18 species of fish belonging to 2 orders, 4 families and 13 genera. Prajoo (2007) studied on fish diversity of Harpan khola and recorded 22 species of fishes belonging to 5 orders, 6 families and 16 genera. Gire (2010) Studied Distribution pattern of fishes and the socio-economic condition of fisher community, recorded 21 species of fish belonging to 5 order, 6 families, 16 genera. Pokheral (2011) studied fish diversity of west Rapti, recorded 24 species belonging to 4 order, 6 families, 16 genera.

Rajbanshi (2005) reviewed on current taxonomic status and diversity of fishes in Nepal" based on the current work of Menon (1999) and recorded a total number of 187 fish species representing 94 genera, 30 families and 10 orders. Shrestha (2008) studied different water bodies of Nepal and reported 75 species of fish from Karnali river, 108 species from Koshi river, 34 species from Trishuli river, 102 species from Narayani river, 69 species from river Mahakali river, 82 species from Bagmati river, 69 species From Kaligandaki river and 29 species from Kulekhani reservoir in his book entitled "Ichthyology of Nepal". Patra and Data (2010) reported only 31 species of the fish belonging to18 Genera and 4 families of cyprnidiformes in karala river, a tributary of teesta river at jalpaiguri district of west Bengal. Patra et. al. (2011) also reported only 55 species of fish belonging to eight orders and twenty families in Karala river.Patra B.C,Sheh M.K (2013) reported only 46 species belonging to 7 order 18 families 26 genera are reported Damodar river, Burdwan district

3. MATERALS AND METHODS

3.1 Study period

The present field studies were conducted from September 2014 to April 2015 for three distinct seasons (rainy, winter and spring); during which the field visits were made for a month in a season. Each sampling station was visited in September, December, and April for sample collections during the study periods.

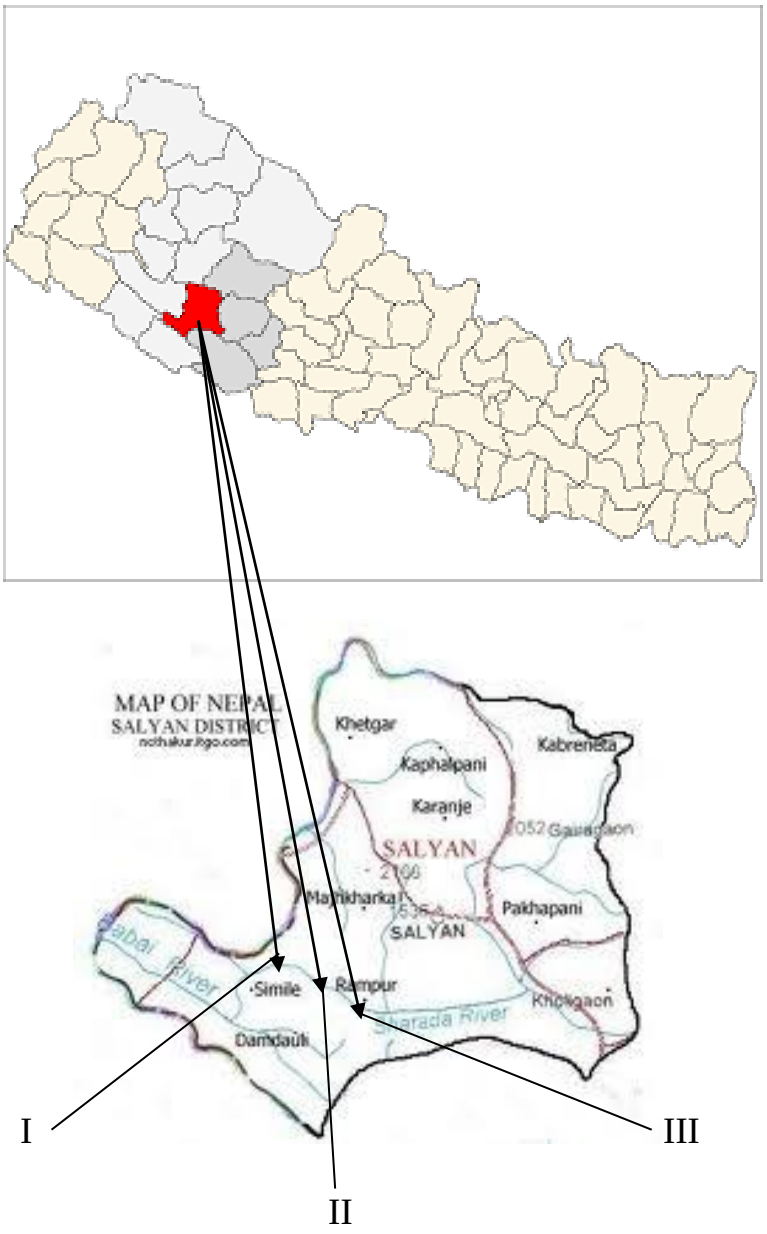
3.2 Study Area

The present study was done in Sharada River. The main tributaries of Sharada river are Kabra khola, Maghe khola, Kaine khola, Joghi khola, Seti khola and Dimure khola. A preliminary survey was done prior to the selection of sampling stations. The present study was confined from Dimure to Maghe rivers only and the area covered about 15 km apart from each other. The criteria for sampling station selection were based on uniform but representative areas like human settlement, altitudinal variations, confluences of tributaries etc. The first station lied on the narrow river but second and third stations lied on the flat wide river.

Station I 'Dimure' : The sampling Station I was selected near Dimure. At this station, large boulders, large amount of pebble, gravel and sand were present in the river bed. Due to the steep river basin, the water was clear and cold with higher velocity of water than stations. There was human settlement on one side of river.

Station II 'Rajhigau' : This sampling station was selected at Rajhigau situated 5 km upstream from the first station at Kalimati. This station was characterized by large gravels, sand and small amount of mud. Velocity of water was lower than first station and the area was surrounded by agricultural land and thick forest of sal (*Shorea rubusta*) at one side.

Station III 'Maghe' : The sampling station was located at Maghe. This station was about 5 km distance upstream of second station. At this station, the river became flat with low water velocity. The river bottom consists of large amount of sand, mud, silt etc. with agricultural land on the sides.



Station I Dimura

Station II Raghigun

Station III Maghe (Source: Google map)

Figure 2: Showing Study area in Nepal

3.3 Source of data collection

Primary data collection was done by direct field observation, photography and information on different aspects of fish biodiversity.

3.4 Physico-chemical parameters

Physico-chemical parameters of water was determined following APHA (1998), Adoni (1985), and Trivedy and Goel (1986).

Water Colour : Simple method was used to determine the colour of water of the Sharada river. A beaker of water from the river was taken out and placed on a white paper and the colour was observed.

Water Temperature: The temperature of water was recorded by using a standard mercury thermometer by dipping directly on the surface water for two minutes.

Depth: The depth was measured using nylon rope with weight and a measuring tape was used to record the depth in centimeters (cm).

Transparency: Transparency of the water was recorded with the help of Secchi disc (APHP, 1979). The Secchi disc was lowered in the water until it becomes invisible and a measuring tape was used to record the depth in centimeters (cm). Then the disc was gradually pulled up and the reading was noted at which it reappeared

The transparency was calculated by applying the following formula,

Transparency (cm) = $\frac{A+B}{2}$ Where, A - Depth at which Secchi Disc disappears

B - Depth at which Secchi Disc reappears

3.5 Bottom Substratum

Bottom substratum was examined carefully in the substratum e.g. boulders, gravels, sand and mud by self judgment method.

3.6 Collection and identification of fishes

The fish were collected from each sampling sites by employing local fisherman and from the local market near each sampling station. The habitat conditions like spawning ground

and shelter and characteristic features of river bed were observed during the field trips. Fishes were collected by using locally prepared fishing gear like cast net, mahajal, rod and hookline, etc. The coloration and morphological characteristics (size, presence and absence of adhesive disc) of collected fishes were noted down. The collected specimens were fixed and preserved in 5 percent formalin. The larger fishes were given longitudinal incision along the abdomen where as the smaller specimen were put in container containing formalin. The specimen of the fishes was kept in container with the tail pointed upwards to avoid any damage to the caudal fin.

The preserved Specimen was brought to the laboratory of Central Department of Zoology (CDZ) for identification. These collected fish samples were identified using standard literatures of fish taxonomy after Shrivastava (1968), Day (1978), Shrestha (1981), Jayram (1981), Talwar and Jhingran (1999), Shrestha (2001) and Shrestha (2008).

3.7 Statistical Analysis

The relation of fish with temperature, depth of water, pH, free CO_2, and water velocity was calculated by using correlation coefficient formula given by Karl Person (Gupta,1988).

$$\text{Correlation Coefficient (r)} = \frac{N.\varepsilon xy - \varepsilon x \varepsilon y}{\sqrt{N.\varepsilon x^2 - (\varepsilon x)^2}\sqrt{N.\varepsilon y^2 - (\varepsilon y)^2}}$$

$$\text{Probability Error (PEr)} = \frac{1-r^2}{\sqrt{N}} \times 0.6745$$

3.8 Fishing appliance and method used in Sharada river.

Generally conventional type fishing appliance used from the direct observation, field visit and traditional method were obtained.

3.9 Socio- Economic condition of fisherman

From the questionnaires and survey, basic information on different indigenous fish species, fish market and demographic status of fisherman were obtained.

4.10 Major hazards of fishery resources of Sharada river

Major hazards of Sharada river are natural and human activities.

4. RESULTS

4.1 Physical Parameters

4.1.1 Water colour

The river is clear, transparent throughout the year except in monsoon; during which water colour became grayish muddy due to heavy flooding.

4.1.2 Water Depth

The depth of river varied during study period and ranged from 52. 3- 90 cm. Highest depth was recorded in rainy season 90 cm in September at Station I and the lowest was recorded 52.3 cm in April at Station III (Table 2).

4.1.3 Water temperature

The surface water temperature ranged from 12.1^0 - 16.5^0C with an average temperature of 14.37^0C during the study period. The highest temperature was 16.5^0C in April at Station II and recorded gradually decreasing to lowest temperature 12.1^0C at Station I in December. Air temperature ranged from 22^0 - 26.3^0C with an average air temperature of 23.85^0C. The highest air temperature 26.3^0C was recorded in the month of April at Station III then it decreased to lowest temperature 22^0C at Station I in December (Table 2).

4.1.4 Transparency

The water was almost clear and transparent throughout the year except in rainy season. The transparency ranged from 69.3 to 98 cm. The highest transparency was 98 cm recorded in December at Station I and the lowest transparency was 69.3 cm recorded in April. The average transparency was 85.56cm (Table 2).

4.1.5 Water Velocity

The water velocity played important role in distribution of fish fauna. The water velocity ranged from 1.13 to 1.69 m/s. The highest water velocity was 1.69 m/s recorded in September at Station I and the lowest 1.13m/s recorded in April at Station II. The average water velocity was 1.49 m/s during study period (Table 2).

4.2 Chemical parameters

4.2.1 *Hydrogen ion concentration (pH)*

The pH ranged from 7.0 to 7.25 with an average pH value of 7.15 during study period. The lowest pH was 7.0 at Station I and II. The pH was recorded highest 7.25 at Station III in September (Table 2).

4.2.2 *Dissolved Oxygen (DO)*

The dissolved oxygen of Sharada river ranged from 5.6 - 6.12 mg/l with an average dissolved oxygen of 6.42 mg/l. The highest dissolved oxygen was 6.12mg/l recorded in September at Station I then it gradually decreased to lowest 5.6 mg/l at Station II in April (Table 2).

4.2.3 *Free Carbon dioxide (CO_2)*

The free carbon dioxide of the Sharada river ranged from 2.25 - 3.7 mg/l with an average value of 2.82 mg/l. The highest CO_2 was 3.7 mg/l recorded in April at Station III. Free CO_2 was decreased to lowest value of 2.25 mg/l at Station III in April (Table 2).

Table 2: Physico-chemical parameter of Sharada River.

SN	Parameter	Unit	Station I			Station II			Station III			Max	Min	Avg
			Dec	Apr	Sep	Dec	Apr	Sep	Dec	Apr	Sep			
1	Water Temperature	0̊C	12.1	16.2	14.6	12.3	16.5	13.9	12.5	16.4	14.9	16.5	12.1	14.37
2	Air Temperature	0̊C	22	25	23.5	22.1	25.4	23.7	22.3	26.3	24.3	26.3	22	23.8
3	Water Depth	cm	79.5	69.1	90	67.6	55.2	80.1	61.3	52.3	70.3	90	52.3	69.5
4	Transparency	cm	98	95	96.5	90	85.1	87.5	76	69.3	72.6	98	69.3	85.5
5	Water velocity	m/s	1.57	1.19	1.69	1.57	1.13	1.65	1.54	1.44	1.68	1.69	1.13	1.49
6	pH Value	-	7	7.1	7.5	7	7.3	7.15	7.1	7.4	7.25	7.25	7	7.15
7	D.O	mg/l	6.8	5.7	6.12	6.9	5.6	7.3	6.7	5.8	6.9	6.12	5.6	6.42
8	Free CO_2	mg/l	2.25	3.01	2.39	2.39	3.06	2.66	2.4	3.7	2.67	3.7	2.25	2.82

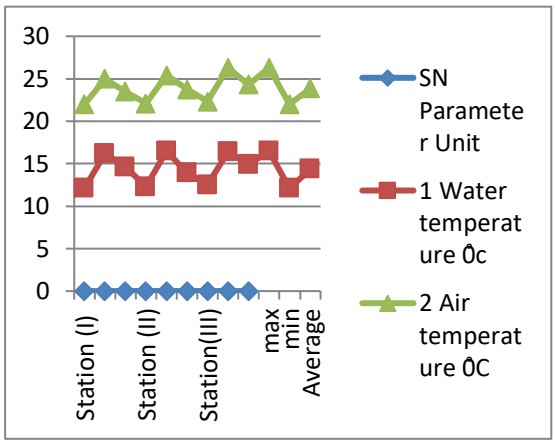


Fig. 1 Water and air temperature

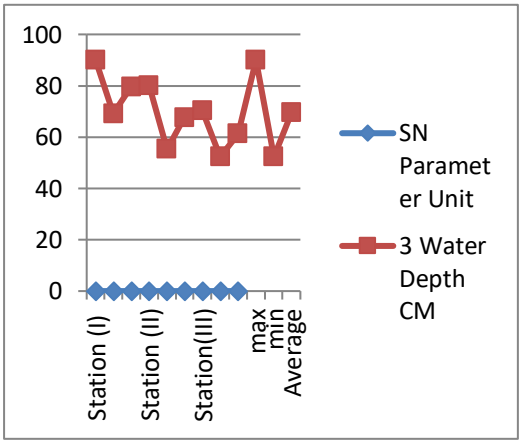


Fig. 2 Water depth

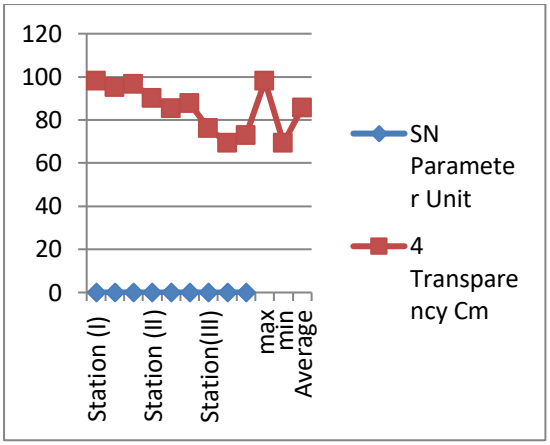


Fig. 3 Transparency

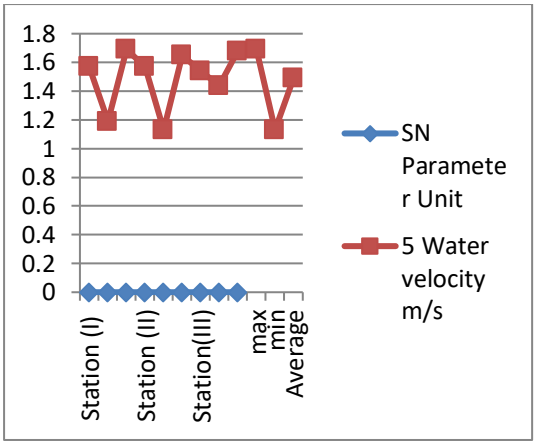


Fig .4 Water Velocity

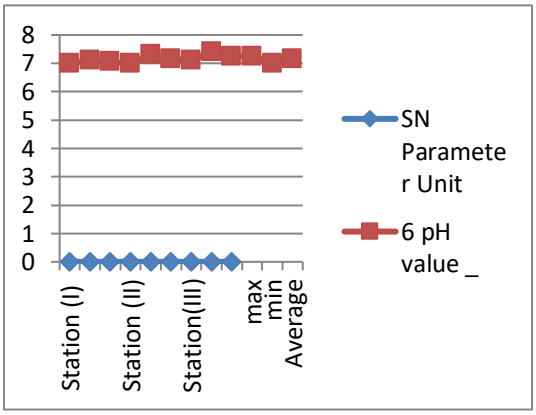


Fig. 5 pH value

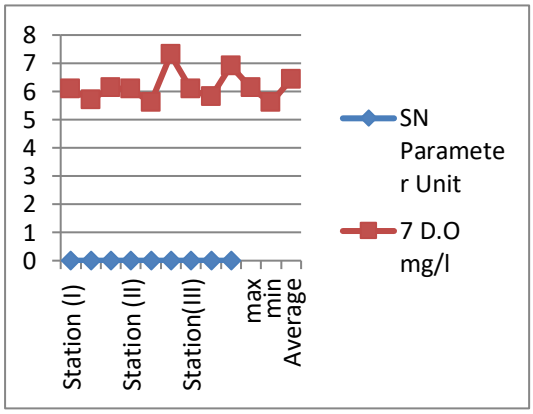


Fig.6 Dissolved Oxygen

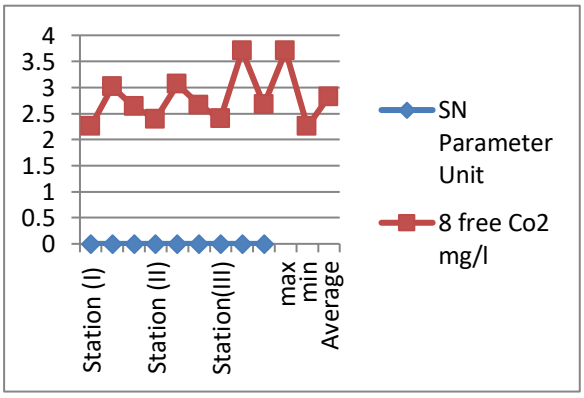


Fig.7 Free Carbon dioxide

4.3 Nature of bottom

The substratum or bottom of Sharada river consisted boulders, pebbles, gravels, cobble, stone, sand and mud (Table 3).

Table 3. Nature of bottom in different sampling stations.

S.N	Station	Substratum	Percentage	Dominant Substratum
1	I	Boulder Pebble Gravel Sand	45 30 20 5	Boulder
2	II	Boulder Pebble Gravel Sand Mud	25 35 20 15 5	Pebble
3	III	Pebble Gravel Sand Mud	15 55 25 5	Gravel

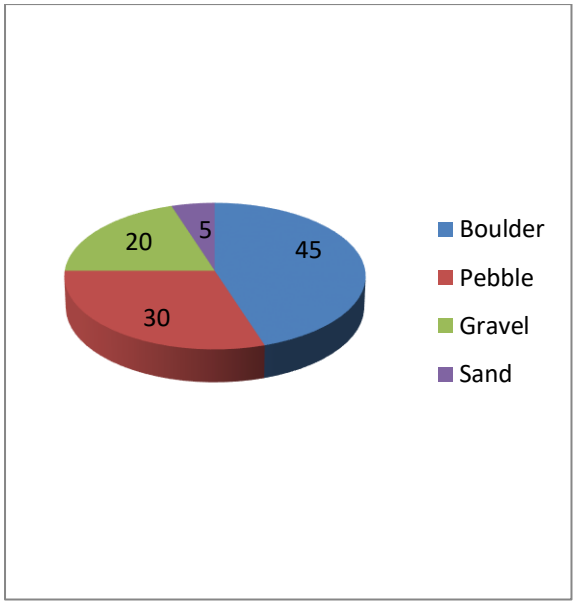


Fig.8. Substratum at Station I

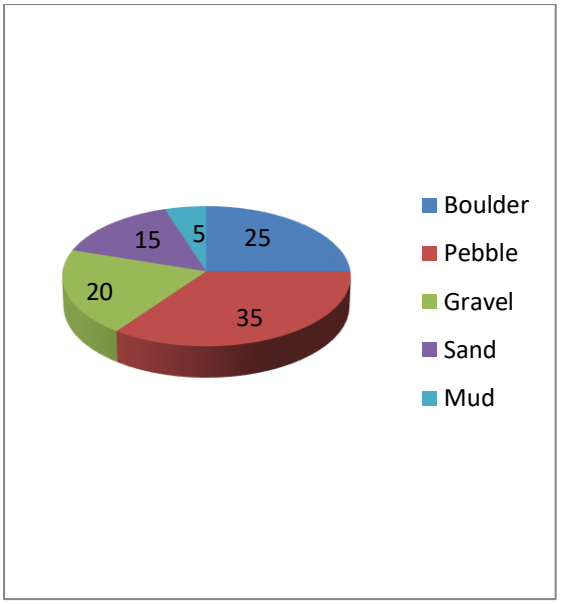


Fig.9.Substratum at Station II

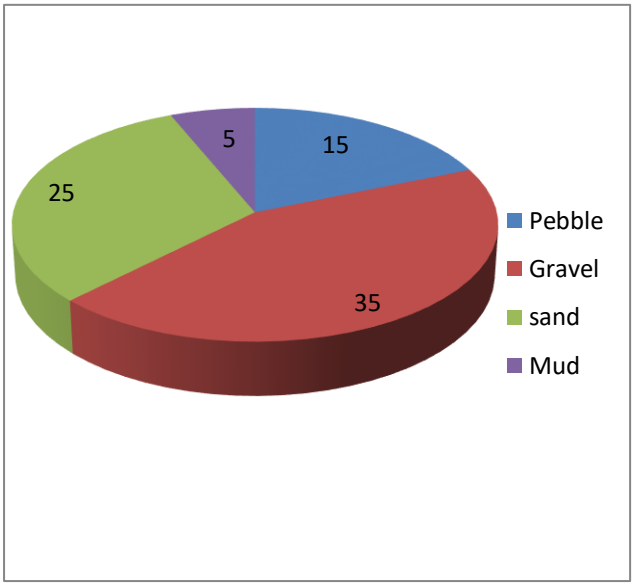


Fig.10.Substratum at Station III

4.4. Fish diversity in Sharada river

15 different fish species were identified belonging to 3 Order, 4 families and 10 genera. The study showed highest diversity of fish species in Station I and lowest in Station III. The dominant fishes in Sharada river were *Barilius bendelensis, Botia lohachata, Tor tor*, followed by *Labeo sp, Glyptothorax sp, Mastacembelius, Puntius* sp (Table 4).

Table 4. Fish species Occurrence and diversity in Sharada River

S.N	Family	Scientific Fish name	Locel name	Status
1	Cyprinidae	*Barilius bendelisis*	Faketa	Common
		Garra gotyla	Buduna	Common
		Garra annandalei	Lohari	Common
		Labeo dyrochelius	Gardi	Common
		Labeo pangusia	Kalacha	Common
		Neolissochilus hexagonolepis	Katle	Common
		Puntius ticto	Sidre	Common
		Puntius sophore	Sidre	Common
		Tor tor	Sahar	Endangered
2	Mastacembelidae	*Mastacembelus armatus*	Bam	Common
3	Cobitidae	*Botia loacheta*	Baghi	Rare
		Schistura horai	Gadela	Rare
		Schistura savona	Gadela	Uncommon
		Schitura parsadi	Gadela	Rare
4	Sisoridae	*Glyptothorax alakandi*	Kapre	Rare

4.4.1 Systematic Position of the Fishes

The classification and systematic position of fish fauna of Sharada River were as follow:

1. Order- Cypriniformes

   Family- Cyprinidae

   Sub-Family- Cypriniformes

   Genus: *Labeo* (Cuvier) 1817

   1) *L. dyocheilus* (Mc clelland) 1839
   2) *L. Pangusia* (Hamilton Buchanan) 1822

   Genus: *Neolissocheilus (*Rainboth) 1985

3) *N. hexagonolepsis* (Mc Clelland) 1839

Genus: *Tor* (Gray) 1833

4) *Tor tor* (Hamiltion Buchanan) 1822

Genus*: Puntius* (Hamiltion Buchanan) 1822

5) *P. ticto* (Hamilton Buchanan) 1822
6) *P. sophore* (Hamilton Buchanan) 1822

Sub-Family Rasboridae

Genus*: Barilius* (Hamilton Buchanan) 18

7) *B. bendelensis* (Hamilton Buchanan) 1822

Sub- family Garrinae

Genus: *Garra* (Hamiltion Buchanan) 1822

8) *G. gotyla* (gray) 1832
9) *G.annandelei* (Hora 1921

Family- Cobtidae

Sub- Family-Nemacheilinae

Genus: *Schistura* (Hamilton Buchanan) 1822

10) *S. savona* (Hamiltion Buchanan) 1822
11) *S. horai (Hamilton Buchanan) 1822*
12) *S. prasadi (Hamilton Buchanan) 1822*

Sub-Family:Botinae

Genus: *Botia*

13*) B. lohachata* (Chaudhari) 1912

Order- Siluriformes

Family-Sisoridae

Genus: *Glyptothorax*

14*) G. alakanandi* (Mc clelland) 1842

Order- Synbranchiformes

Family- Mastacembelidae

Genus: *Mastacembelus*

15*) M. armatus* (Laceped) 1800

Plates I: Fish Diversity

Labeo dyocheilus

Tor tor

Barilius bendelesis

Neolissocheilus hexagonolepis

Plates II: Fish Diversity

Garra annandale

Puntius ticto

Puntius sophore

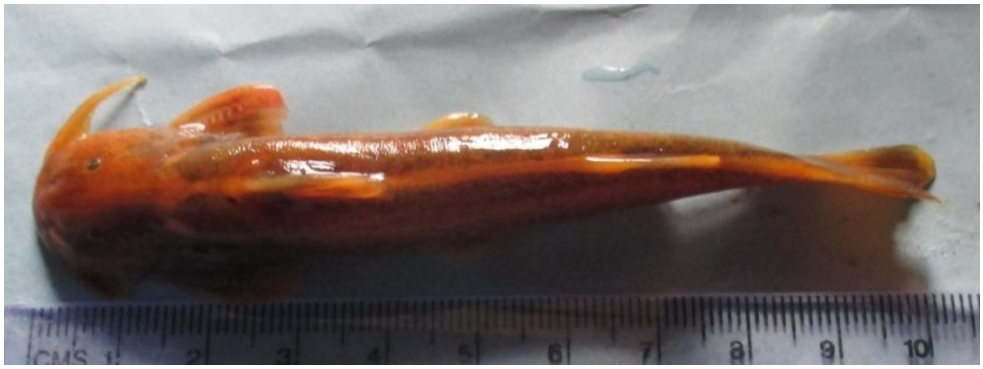
Schitura Savona

Plates III: Fish Diversity

Schistura prasadi

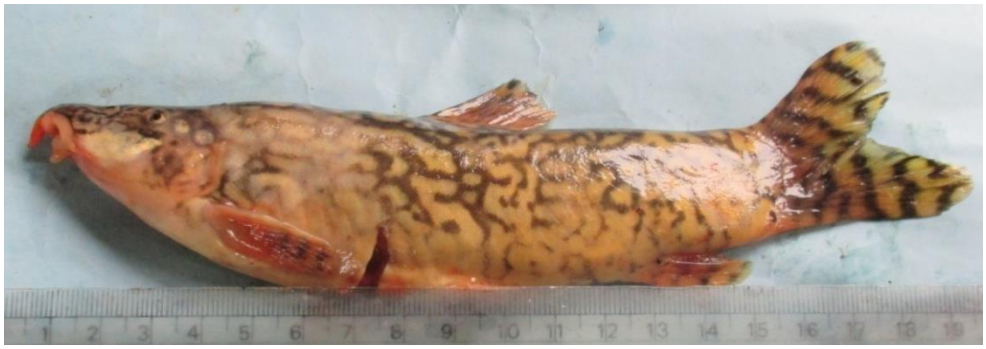
Labeo pangusia

Mastacembelus armatus



Glyptothorax alaknandi

Plates IV: Fish Diversity



Botia lohachata

Garra gotyla

Schistura horai

4.4.2 Ecology and behavior of some important fishes of Sharada river.

Out of 15 fish species recorded from Sharada river, some were (a) game fishes and (b) food fishes. All these species are edible and consumed by local inhabits. The most popular game fishes of Sharada river were *Tor tor, Labeo, Barilius, Botia, Garra* etc.

***Labeo dyocheilus* (Mc Clelland) 1839**

Labeo dyocheilus is commonly known as 'Gardi' A medium sized fish with bluish green color, it has darkish back pale olive belly snout blunt with horny tubercles, rostral fold thick. Pelvic anal fins pink yellows. The ventral surface of head is broad and flat mouth wide and directed downward. The upper jaw has protruded 2 pair of barbels. The altitudinal range of distribution for this fish is 120 to 200m. This fish is good for stocking in pond and capable of wide temperature tolerant and turbidity changes, it is resident fish species of Sharada river and generally inhabits in swift run and riffles. This fish was recorded in Station I in this study.

Fin formula

$D_{13(2/11)}$, P_{17}, V_9, $A_{7(2/5)}$, C_{19}, Ltr $8\frac{1}{2}$-$7\frac{1}{2}$, $TL=_{20\text{-}90cm}$.

***Garra gotyla* (Gray) 1832.**

Garra gotyla is commonly known as 'Buduna'. The body is elongated and sub cylindrical but head is much depressed. General body color is bluish black dot occurs just behind the gill opening. Mouth is inferior and semicircular in shape with upper lip fringed. A characteristics suctorial disc present on the chin. It has large rounded snout covered with the spiny conical tubercles and deep groove is present across it. The fish occurs in all water mass of Nepal ranging from 100 to 1400m. It is a resident fish species of Sharada river and generally inhabits in swift run and riffles. The breeding season occurs from the month of June. During breeding season school of fish migrates in shallow brooks, creeks and spawning is intermittent.

Fin Formula

$D_{11(3\text{-}2/8\text{-}9)}$, P_{15}, V_9, $A_{7(2/5)}$, C_{17}, Ltr $4\frac{1}{4}$, $TL=_{15cm}$.

***Neolissochelius hexagonolepis* (Mc Clelland) 1839**

Neolissochelius hexagonolepsis is commonly known as 'Katle'. It is an important game fish and food fish. The body of fish elongated with round abdomen. Head is short and broad as long as height of the body. Snout obtusely rounded and there is a golden yellow band just above the lateral line. Colour of fins chiefly slate, gray faint towards margin. Barbels is 2 pairs; one pair rostral and other maxillary. It is distributed all torrential river of Nepal from 70-784m. It a medium distance migratory fish for breeding. The female attains maturity in the month of July- August and spawning takes place in August to September. They breed once in a year but release fractional batches of eggs for several times during breeding season. Katle broadcasts ripe eggs in installment in gravel beds.

Fin Formula

$D_{12(3/9)}$, P_{12}, V_9, $A_{7(2/5}$, C_{19}, Ltr $4\frac{1}{4}$-$4\frac{1}{4}$, $TL=_{60cm}$

Tor tor (Hamilton Buchanan) 1822

Tor tor is commonly known as 'Sahar'. It is an important migratory game fish of Nepal. Its body is deep and dorsal side more convex. General body colour is dark grey with greenish tinge along upper half of the body and sides are slightly golden. Generally found gravel, stone it is slowly growing fish. Spawning season extends from June to July/September. When eggs are deposited in small batches along the shallow pool and adhere to varies kind of gravel bed. After spawning downstream migrations occurs, it feed worms, caddish fly larvae. It is found altitudinal range varying from 150-1500m.

Fin Formula

$D_{12\ (3/9)}$, P_{17}, V_9, $A_{7(2/5)}$, Ltr $4\frac{1}{2}$-$4\frac{1}{2}$, $TL=_{90\text{-}200cm}$.

***Mastacembalus armatus* (Lacepede) 1800**

Mastacembalus armatus is commonly known as 'Chuche Bam'. It is long and cylindrical delicious fish. It has elongated body having anal and dorsal fin confluent with caudel. Its snout is pointed. General body colour is brownish becoming lighter on belly. There is a row of distinct round black spots along the base of dorsal fin. Occasionally these spots

are united with other colour patterns. The body of the fish is covered with small scales. This fish breeds in June and July. Its altitudinal range is 80-300m.

Fin formula

$D_{32\text{-}39/74\text{-}90}$, P_{23}, $A_{(3/75\text{-}80)}$, $C_{14\text{-}15}$, $Vert_{38+50}$, $TL=_{67cm}$.

4.4.3 Fish distribution and frequency occurrence in Sharada River

13 spp. of fish were reported from Station I, among which *Garra gotyla* was the most dominant species and other common species were *Barilius bendelensis, Puntius ticto, Puntius sophore, Schistura horai, Tor putitora.* The highest number of fish species were reported from Station I and lowest number from Station II and III. 11 fish species were found in Stations II and III; in which *Barilius bendelensis, Garra gotyla, Garra annandali, Glyptothorax alakandi* were the dominant fish species. But *Puntius ticto, Puntius sophore, Neolissocheilus hexagonolepis* were also common. The most common species distributed in all three sampling stations were *Barilius bendelensis, Garra gotyla, Garra annandali, Puntius titco, Puntius sophore, Neolissocheilus hexagonolepis.* The highest and lowest frequency of fishes was 15.6 and 2.8 percent of *Garra gotyla* and *Botia lohachata* respectively (Table 5).

Table 5. Distribution and frequency occurrence of fishes in Sharada river.

S.N	Name of fish	Stations			Total	Frequency
		I	II	III		
1	*Barilius bendelisis*	+	+	+	12	4.8
2	*Garra gotyla*	+	+	+	39	15.6
3	*Garra annandalei*	+	+	+	23	9.6
4	*Labeo dyocheilus*	+	-	+	15	6
5	*Labeo pangusia*	+	-	-	7	2.8
6	*Neolissochilus hexagonolepis*	+	+	+	21	8.4
7	*Puntius ticto*	+	+	+	23	9.2
8	*Puntius sophore*	+	+	+	17	6.8
9	*Tor tor*	+	-	-	9	3.6
10	*Mastacembelus armatus*	-	+	+	11	4.4
11	*Botia loachata*	+	+	-	7	2.8
12	*Schitura horai*	+	-	-	11	4.4
4	*Schitura savanna*	+	+	+	14	5.6
14	*Schitura prasadi*	-	+	+	12	4.8
15	*Glyptothorax alakandi*	+	+	+	29	11.6
	Total				250	

+ = Present and -- = absent.

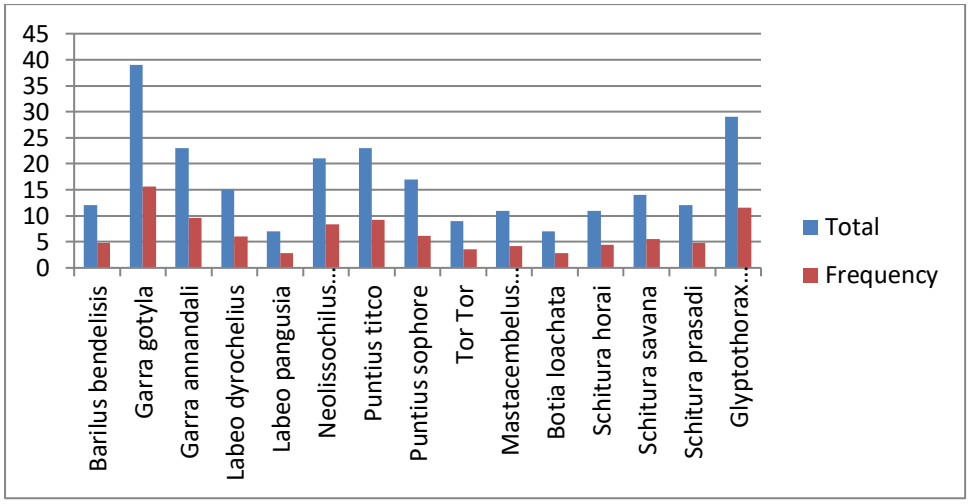


Fig .11 Frequency and distribution of fishes in Sharada river.

4.4.4 Family wise fish composition in Sharada river

The family wise fish species was studied and found 60% of fishes belonging to Cyprinidae, 26.66 % to Cobitidae and 6.66 % to Mastacembelidae and Sisoridae (Table 6).

Table .6 Family wise fish composition in Sharada river.

S.N	Family	No. of fish species	Frequency	No. of Fishes	Frequency
1	Cyprinidae	9	60	166	66.4
2	Cobitidae	4	20.66	44	17.6
3	Mastacebelidae	1	6.66	11	4.4
4	Sisoridae	1	6.66	29	11.6
	Total	15		250	

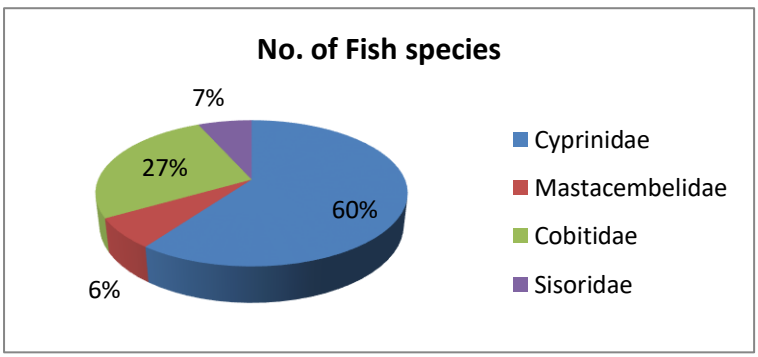


Fig.12. Family wise fish species composition Sharada river.

4.5 Coefficient of correlation between different variables

The coefficient of correlation between different physico-chemical parameters and fish density was calculated by Karl Pearson method (Gutpta,1988) and significance of correlation was tested. The correlation between fish density and temperature, depth, pH, free CO_2 were found positive in all sampling stations. The correlation between fish density and transparency, water velocity was found negative. Similarly, the correlation between the fish density and DO recorded negative except Station II (Table 7).

Table.7. Correlation between physical parameter of water and fish number in Sharada River.

S. N	Coefficent correlation	Station I		Station II		Station III	
		Coefficent of correlation (r)	Probable error (PEr)	Coefficent of correlation (r)	Probable error (PEr)	Coefficent correlation (r)	Probable error (PEr)
1	Temperature and F.D	0.2057	0.0962	0.1306	0.0988	0.2451	0.0945
2	Water depth and F.D	0.2049	0.0963	0.2228	0.0955	0.3005	0.0914
3	Transparency and F.D	-0.2049	0.0963	-0.2228	0.0955	-0.3005	0.0914
4	Water velocity and F.D	-0.1356	0.0987	-0.0665	0.1010	-0.0384	0.1004
5	pH and F.D	0.2049	0.0963	0.2228	0.0955	0.3005	0.0914
6	DO and F.D	-0.15667	0.0980	0.1060	0.0994	-0.0097	0.0995
7	Free CO_2 and F.D	0.1580	0.09804	0.2019	0.0964	0.2935	0.0918

F.D – Fish density

4.6 Fishing appliance and methods used in Sharada river

From the general survey, it was found that there are varied kinds of fishing appliance and method being used in fish catching by local fishermen. All these fishing practice used in this river were mainly grouped in two categories.

A. Conventional fishing methods
B. Non-conventional fishing methods

Conventional fishery method included traditional fishing gears like netting, hook, rod line, trapping devices, fishing with hand etc. Modern fishing implements were non conventional fishing methods.

A. Conventional fishing method

1) Nets

A net is basically a piece of webbing, in which the twins are intersected into regular meshes, given a certain form. Previously nets were prepared by the local fisherman from the fibers form the thistle plant known as 'Allo' but now the nylon threads are used for the net. It has been observed that following types of nets were used in this area.

a. Cast net

It is round in shape and locally known as 'Jal' having mesh size about 15-25 mm. Along the circumference, piece of iron or lead are attached so as to make the sinkable in water. Some pouch or pockets like structure are made at the circumference of cast net where fishes are trapped. A long rope is tied to the center of the net. While throwing the net, the fisherman keeps it in the hand and throws it with a jerk in to water. The cast net is used throughout the year in Sharada River and its feeder streams.

b. Bhureli jal

It is similar to the cast net in shape and texture but it has smaller mesh size from 5-15mm.The practice of this jaal is harmful for the fishes because it wipes out fish juvenile hence destruct fishery resources.

c. Gill net

It is rectangular in shape and commonly known as 'Kande jal'. In the lower border of the net small sinker are tied so as to make the net sinkable. It is operated by two persons. The net flows along with the current of water.

2.Basket Implements

A number of basket implements were used for fishing in the Sharada river. They were different sized and shaped and were made up of bamboo or reed (nigala). The basket implements observed in fishing in the Sharada River were as follows.

a. Dhadiya

It is made up of bamboo stick with wide mouth and tapering body. Mouth is covered with bamboo sticks in one side where there is a small opening. Once the fish goes inside it cannot escape mainly used in Terai region. And it is destructive method because it kills small sized fishes.

2. Hook and line

Fishing with rod and line was locally known as 'Balchhi khelne' which consisted a long and slender rod, nylon thread and hook. Thin nylon thread was tied at the curved tips of rod and hook in the distal end of the thread. Just above the hook there was a sinker made up of lead or stone. The hook was baited with different types of (living and non-living) generally small sized fish, piece of earthworm. Aquatic insects and wet wheat flour were common baits in this area.

4. Fishing with bare hand.

This was the common practice of fishing without gears. This method was very simple and widely used all over the Sharada river area. Young man of village took special delight to fishing with hand. This method was locally known as ' Hatkela Khelne'. To grasp fish by hand a young fisherman dipped arms quietly in water and searched for fish in cervices. When he succeeded to touch fish then grasped the fish with thumb and middle finger to the gill opening and took it out to the bank. Only moderate size of fishes such as katle, buduna were captured with hand

5. Kure thunne (Blocking stone with bushes and grasses)

This was a special type of fishing practice without gear. This was a simple method in which a flat stone, under which a large number of fishes sheltered, was blocked from all sides with the help of bushes and grasses. Then an opening was created from one side and fishes were collected on by one from this opening.

6. Fishing with towels and mosquito Net.

In these fishing practices, small boys and girls used towels, mosquito net to catch the fishes. It was operated by two individuals by dipping the towels under water moving from sometimes here and there and lifting it out, this method was used in shallow water, when water level low in the river.

7. Use poisons

Use of fish poison was a non-conventional fishing practices used in small channels of Sharada river and it feeder streams. Fish poison was extracted from plant derivatives like roots, leaves and barks of plants by crushing, mixing with sand and thrown in stagnant water. Dose was calculated according to their area of water body. The fishes which were paralyzed by poisoning were collected by hand or with the help of scoop net

Following are the plants used mainly to kills the fishes in Sharada river area.

a) Khirro (Sapium insignes)
b) Sihudi (Euphorbis royleana)
c) Ketuke (Agave Americana)
d) Maduwa (Madhuca indica)
e) Churee pina (Bassica butyracea)
f) Lahare bish

8. Diverting water mass.

This was occasionally used method in the small channels of Sharada river and its tributaries and locally known as ‘Duwali Thunne’. In this practice the whole water mass was diverted by construction a rough stone dam so that a semi dry fishing channels was produced at the end of which a fish trap was set to collect the fishes that escaped from

capturing operation. At the middle of the channel, fish were caught by hands but in the pool region and stone, cervices, some poison were also used

4.7 Socio-economic status of fisherman

The socio-economic condition of fishermen of Sharada river was studied through direct observation and questionnaires. According to the present study, most villagers of any communities near the river area had been engaged in fishing activities but they did not take fishing as a full time profession/job. The fishermen of Sharada river were locally known as 'Jalary'. The fishermen of Sharada river could be classified into three categories - a) Full-time fisherman, b) Part-Time fisherman and Occasional fisherman

a) Full time fishermen

Only a few full time fisherman recorded in study area and they belonged to lower caste group such as Damai, Badi, Sarki, Kami, Mager, etc. Fishermen knew about the migratory behaviors of fishes and used different types of fishing appliance in different seasons. Most of the catch sold in the local market if the catch was minimum they consumed themselves also.

b) Part- time fishermen

Most of the fishermen of this area fall under the category of part-time fisherman. The fishermen of Station II had their own small tea shops. During day time, they engaged themselves in the shop while at night or in the early morning, they went to fishing either in group or alone. They sold the catch in their own shop, some time they keep it for themselves. They used all types of fishing implements.

a) Occasional fishermen

The occasional fishermen were active in fishing activities when their agriculture load became low. Most of families from the villages around Sharada river turned to occasional fishermen in summer. At the Stations I and III, most of the village boys and girls were engaged in fishing during flooding with the help of rod and hook line. In small channels of Sharada river, most of occasional fisherman were student also. When they got leave they went to river both at low water level and summer season.

Fishing activities continued throughout the year except the monsoon period during which people were engaged in agriculture. The fishing pressure increased during summer season because people were free from agricultural loads. Economically fishermen inhabiting along the Sharada river like Badi family were poor than others. They did not have their own land for agriculture and worked as labour for livelihood. Majority of fisherman were living in small wooden and thatched roof (Impetrata cylindrica) or zinc sheet (Tin). About 60 percent of fishermen of Sharada river were totally illiterate, 20 percent with education up to below five class, 10 percent have an education up to 8th class. The fishermen of this area had very much interest to educate children. They were aware of facilities of free education in the government school.

4.8 Major hazards of fishery resources of Sharada river

Sharada river supported 15 fish species with predominance of family cyprinidae. The fish conservation and management was posing a serious problem as there was no management activities in Sharada river. Some of the major problems identified for the decline the fish population in Sharada river were:

4.8.1 Environmental problems

Deforestation, landslide, soil erosion, floods, silt deposition and pollution had changed the natural environment of Sharada river dramatically.

a) Destruction of natural habitat by Landslide

In the study area, most of the villagers and fishermen were uneducated and ignorant about the environment. The villagers were converting the forest and steep slopes along the river side into agricultural land because of which a heavy soil erosion occurred during monsoon season thus affecting river ecology and fishes directly by destroying breeding and nursery ground. Road construction along the side of the river was another important factor for land slide and siltation in river. Construction of bridge across the river also destroyed the habitat of fishes.

b) Destruction of Natural habitat by floods.

Flooding of river was another important factor which effected river ecology. The devastating flood of August 2028 B.S.of Sharada river caused massive destruction of large farm land on both sides of river.

C ***Pollution***

At Station II, the human activities was remarkably disturbing the environment. Soap and detergent used in washing clothes in the river might have affected the aquatic life.

4.8.2 Use of destructive fishing Method

In the Sharada river, some of the fishermen were found operating destructive fishing method such as natural plant poisoning, diverting river channels and its tributaries etc for fishing. Such activities affect whole aquatic ecosystem. These types of fishing method killed all types and sizes of fishes, aquatic organism and also destroyed breeding habitat of the fishes.

4.8.3 Lack of Awareness

Lack of awareness and skill knowledge on riverine fishery management in the local inhabitants was the major problem for the destruction of riverine lives. Uneducated local fishermen did not understand the destructive nature of illegal fishing gears and the importance of natural habitat of fishes.

5. DISCUSSION

In the present study, 15 species of fishes were recorded among which 9 species are common, viz, *Barilius* spp, *Garra* spp, *Labeo* spp, *Nelissochilus* spp, *Puntius* spp, *Mastacembules* spp,. One species *Tor tor* was endangered, 4 species rare like *Botia* spp, *Schitura* spp, *Glyptothorax* spp, and 1 species uncommon *Schitura savana* in Sharada River.

In Sharada River, fishes belonged to order Cypriniformes and families Cyprinidae and Cobitidae were dominant. Cyprinidae was common family of two comprising highest frequency of the total catch that was about 66%. Edd (1886) also reported the order Cypriniformes common order of Kaligandaki and Narayani rivers. Shrestha (1996), Karki (2000) and Bajracharya (2001) had also found that Cyprinidae as common family in Tinau, Karnali, Sunkoshi and Bhote Koshi rivers respectively. Family Cobitidae comprised 17% of total percentage followed by families Mastacembelidae and Sisoridae comprising 4.4% and 1.6% respectively. During present study, *Barilius bendelensis, Garra gotyla, Garra annandalei, Puntius ticto, Puntius sophore, Neolissocheilus hexagonolepis, Glyptothorax alakandi* were reported in all three sites (Table 6).

Number fish species was recorded lower in Stations II and III and higher in Station I. The diversity of all aquatic organisms including fish was determined by several factors. Physico-chemical parameters, altitudinal variation, physical factors of the environment appeared to be basic for the distribution of fishes (Hynes, 1970). The richness of fish species in Station I could be correlated with increased transparency and plankton production. On the other hand, lower number fish species at Stations II and III might be related with poor water qualities due to human activities. Physico-chemical factors of water not only affected the distribution patterns and abundances of species; they also played an important part in species richness.

Ecological factors such as velocity, substratum, temperature, transparency, dissolved oxygen of running water systems are interdependent on ecological niche of fishes, invertebrates and other aquatic lives (Whitton, 1975). All metabolic and physiological actives and life processes such as feeding, reproduction, growth rate, movement and distribution of aquatic organism were greatly influenced by water temperature. In the present study, the temperature was recorded to decrease in December Station I and

increase in April Station II. Water temperature showed the positive correlation with fish density - 0.2057, 0.1306, 0.2451, at a Stations I, II and III respectively.

Ansari (1986) reported low transparency with food scarcity due to poor light penetration. According to Jhingram (1975), the turbidity of natural water system may be due to planktons. During present study period the river water remained highly transparent throughout the year except in late summer and rainy season due to rainfall and high flood. The transparency of was 69.3 – 98 cm in present study. The correlation between transparency and fish density was found negative at Stations I, II and III with the value of correlation -0.2049, - 0.2228,-0.3005 respectively.

The depth of water is important physical parameters which directly or indirectly affects the fish species diversity. During the study it was observed that small species like *Barilius, Glyptothorax,* etc were found to be a distributed in shallow habitat and large sized species like *Tor* spp. was recorded in deeper pool. The depth of river was found ranging from 52.3-90 cm. The correlation between water depth and fish density found to be positive during study period at Stations I, II and III with the value of correlation 0.2049, 0.2228 and 0.3005 respectively.

The water velocity plays major role in determining abundance of flora and fauna in a river by grading the river bed and materials and maintenance of high levels of dissolved oxygen (Whitton, 1975). Again the stream velocity is simply the function of slope gradient of the riverbed (Jhingram, 1975). The velocity of water in Sharada river ranged from 1.13 - 1.69 m/s. The correlation between water velocity and fish density was found negative at Stations (I, II, III) with values of - 0.1356, -0.0067, -0.0384 respectively. The fishes were provided with adhesive organs. Shrestha (1990) reported sucker headed fishes as dominant fishes at water velocity 3 - 9 m/s.

The chemical parameters of the water also show great affect on the distribution of fish species in the river. Among the chemical factors, the concentration of dissolved oxygen of water is the most important factors and dissolved oxygen above 5 mg/l is suitable to support diverse biota (APHA, 1976). The dissolved oxygen of Sharada river ranged from 5.6 - 6.12 mg/l with an average of 6.42mg/l. The DO showed the negative correlation with the fish density at Stations I and III but Station II showed positive correlation - 0.1666, 0.0997,-0.098.

Natural water may be neutral acidic or alkaline. It is important environmental factors influencing the metabolism. Generally low pH value is harmful to fishes. Water having pH value below 5.0 mg/l and above 9.5 mg/l are not suitable (APHA, 1976). The pH ranging from 7.0 to 8.5 is considered to support rich biota and fish (Bell, 1971). The pH ranged from 7.0 - 7.25mg/l with an average value of 7.15 mg/l. The pH showed the positive correlation with fish density - 0.2049, 0.2228, 0.3005.

Most of the carbon dioxide in the water is formed by the decomposition of organic matter and from respiration of organism. Carbon dioxide stands at the threshold production (Cole, 1975). The distribution of carbon dioxide in surface water varies both seasonally and vertically. In the present study carbon dioxide varied from the 2.25 - 3.7mg /l with an average value of 2.82mg/l. The coefficient correlation between free carbon dioxide and fish number showed positive correlation at all stations - 0.1580, 0.2019, 0.2935.

The bottom substratum is an important to the fish as well as invertebrates as it serves a habit for them. Although boulder, pebble, and Gravel dominated the bottom substrates of Sharada River; there were minor variations in substrate composition in different stations. Bottom substrate has also considerable significance in the spawning behaviors of fishes (Nikolsely, 1963). Bottom substrates affect the fishes and invertebrates distribution - crabs, stonefly, larvae, caddish fly larvae etc.

About 60 percent of the fishermen were illiterate, live in small houses made up wood and mud having thatched roof. Karna (1993), Sharma (1996), Karki (2000), Malla (2004), Shah (2005), Prajoo (2007), Pokeral (2011) had found poor economic condition of fishermen in Trishuli, Tinnau, Sunkoshi, Bhotekhosi, Dharam Khola, Budhiganga, West Rapti river and Phewa lakes.

6. CONCLUSION

A total number of 15 species fish fauna was collected from the different section of Sharada river belonging to 3 orders 4 families 10 genera. Fish were not uniformly distributed but influenced by the velocity of water, water temperature, depth, altitudinal variation, bottom substratum, dissolved oxygen, free CO_2, pH, etc. Upper reaches of the Sharada river was the habitat of *Glyptothrax alakandi, Puntius ticto, Neolissocheilus hexagnolepis, Barilius bendelensis etc* however *Garra gotyla* was the dominant fish species in the river. Present fish record included endangered species *Tor tor*, common fish species, economically important fishes like *Barilius sp, Labeo dyocheilus, Garra gotyla, Puntius ticto* etc.

The fishermen community in Sharada river was Badi family and they were very poor carrying fishing as full time job. They used both types of conventional and non-conventional fishing appliance. About 60 percent of fishermen were totally illiterate, 30 percent below five class and only 10 percent educated above 8th class.

The study showed riverine environment undergone degradation due to various natural landslide, soil erosion and manmade activities like road construction along side of the river, bridge construction, over fishing, illegal fishing, use of soap and detergent, stone and sand extraction etc.

7. RECOMMENDATIONS

Conservation and management of fishery resources is important for gene pool maintenance and offers a great opportunity for self-employment and income generation among poor people. But no work had been done so far for the conservation of fish fauna in Sharada river; as a result there is decline in density and diversity of riverine fish species. Therefore for successful conservation and management of indigenous fish species in this river, following recommendation are suggested.

- Sand mining and stone mining should be strictly prohibited around Sharada river.
- Many non-conventional method of fishing like poisoning, dynamiting, electro fishing, diverting water masses etc. are being used in this river. Such activities should be controlled immediately.
- Different species of breed in different season, usually female fishes with full of egg in their ovary are caught in a large number during breeding season due to which there occurs loss of large quantity of eggs resources along with death of brood fishes. The banning of fishes activities during breeding season is very much required.
- Regular training and awareness programmed should be conducted at local level for the conservation and management of river and biodiversity through governmental as well as non –governmental organization.
- The aquatic Animals protect act (AAPA) should be implemented effectively through the concerned governmental agencies.
- Rehabilitation of important fishes should be done by the introduction of hatchery reared fry and fingerlings.
- Use of inappropriate mesh sized nets should be strictly avoided.
- In Mid- western region, there is no research activities done on fishery and aquatic resources conservation and management. So, such program should be extended in this area by government and other concerned agencies.

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Plate V: Fishing Appliance and methods

Smoking and dry fish

Collection of Fresh fish

Fishing with mosquito net

Dhadiya for fishing

Cast net

Fishing with hook

Plate VI: Fishing Appliances and Methods

Using Mahala jal for fishing

Bridge of Sharada River

Irrigation cannels of Sharada river

water parameter analysis

Taking interview of Fisherman

Fishing with Cast net

APPENDIX I

A list of questionnaires used in interview with fisherman of Sharada river to Study diversity of fishes Socio-economic condition of fisherman.

Name of fisherman…….

Cast…… Age……..Sex…….

Religion…….

Adress: Zone……. District……

V.D.C: …… Ward no……

Village……

1) How many members are in your family?
   Total……. Male…… Female……
2) Are you literate? …….. Standard…….
3) Are you giving school education to your children?
   a) Yes b) No
4) If no then why? ……
5) Dou you know about family planning? .....
6) Do you have own land? .....
   How……..
7) Is fishing your main profession?
   a) Yes b) No
8) In which category do you fall?
   a) Full time fisherman b) Part-time fisherman
   c) Occasional fisherman.
9) What do you beside fish catching? .....
10) How many members are included in fishing from your family?

    ……..

11) How much time do you spend in fishing within a day?

    …….

12) Which implements do you use mostly in fishing at different fishing season?

    ……

13) How many fishermen come to fishing at this site?

    ……..

14) Persons who engaged in other works are also come to also come to fishing here?

a) Yes b) No

15) What do you do with the captured fisher?

a) Consume b) Sell c) Both

16) What is the selling rat of fish?

……..

17) Is there fish market in this area?

a) Yes b) No

18) If yes, where?

……..

19) If, no where do you sale the fish?

……

20) Which fish species are mostly captured by you?

……

21) How many species are there in the river in your opinion?

……

22) Which fish species are abundance /common/ uncommon in this river?

S. No	Name of fish	Abundant	Common	Uncommon
1.				
2.				
3.				
4.				
5.				

23) Which month is more suitable for fishing?

……..

24) What do you catch the most number of species?

a) Rapid zone b) Pool zone c) Sand bed

d) Large boulder e) at the junction of tributary

25) Do you observed or heard about fish spawning/ breeding?

……

26) In which season/ months you observed more fry/ fingerlings in the river in your catch?

……

28) Do you think fish population has increase or decrease in the recent years?

a) Increased b) decreased c) don't known

29) If decreased, what are the reasons?

…….

30) Is there any fish disappeared from this river?

……

31) Any suggestion would you like to give for the improvement of fishery of Sharada River.

…….

……