# STUDY ON LIMNOLOGY OF THOSNE RIVER LOCATED IN LALITPUR DISTRICT, NEPAL

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## ABSTRACT

*Study on limnology of Thosne River was done to identify the diversity of aquatic insect and fish, and also to determine the water quality parameters for assessing suitability for fish farming. Some water quality parameters were recorded on the spot and others were analyzed in the laboratory. Altogether 14 different limnological parameters (3 physical, 8 chemical, 2 biological and 1 geographical) of Thosne river were studied in winter and spring seasons. During study period, the water temperature at the 1st (downstream) and the 5th (upstream) sampling stations ranged from: 15.75±2.81°C and 12.29±2.61°C: the pH 7.59±0.22 and 6.37±0.23; conductivity 194±10.7 µS/cm and 130±12 µS/cm; turbidity 5.91±2.74 NTU and 2.75±1.89 NTU, dissolved oxygen 9.62±0.87 mg/L and 10.58±0.7 mg/L; hardness 86.70±10.86 mg/L and 60.54±8.9 mg/L; chloride 14.25±25 mg/L and 7.79±1.44 mg/L; and flow rate 22.47±3.5 L/Sec and 13.5±2.4 L/Sec respectively. The ammonia nitrogen at the 1st (downstream), 3rd (midstream) and 5th (upstream) sampling stations ranged from 0.19±0.07; mg/L, 0.031±0.0056 mg/L and 0.013±0.003 mg/L whereas nitrate nitrogen ranged from 2.20±0.84 mg/L, 0.50±0.10 mg/L and 0.17±0.060 mg/L respectively. All the parameters were positively correlated with each other except dissolved oxygen and altitude. Three native fish species and aquatic insects from eight different families were identified. All the water quality parameters were within the recommended limit for rainbow trout fish farming up to midstream.*

**Key words:** Biodiversity, Fisheries, Ichthyologist, , Limnology, Nepal,

## INTRODUCTION

Nepal has tremendous geographic diversity. It rises from as low as 59 meters elevation in the tropical plains to the earth's highest peak 8,848 meters Mount Everest. Nepal lies between India and China, with the latitude of 20°21' to 30°27' north and longitude of 80°4' to 88°12' east. Nepal is rich in water resources. Nepal has 6,000 rivers. Total inland water resource of Nepal is 818,500 ha (3% of Nepal's total land area) of which irrigated paddy field covers the greatest area 398,000 ha (49%), marginal swamp cover 12,500 ha (1.4%), rivers cover 395,000 ha (48%), lakes 5,000 ha (0.60%), reservoirs 1,500 ha (0.20%), village ponds 6,500 ha (0.80%) and marginal/swamps …. ha (1.4%) (CFPCC, 2017). There are 240 species of fin fish including 217 indigenous fish species, 9 species of crabs, 3 species of prawn, 50 species of mollusks, 53 species of frogs, 193 species of water birds and 84 species of aquatic plants found in Nepal (CFPCC, 2017). Fisheries and aquaculture production of Nepal is 91,832 metric ton (mt)/year in which 21,500 mt comes from the captured fisheries from major rivers and lakes (CFPCC, 2017). There are about 462,070 people engaged in capture fisheries among them 60 percent are female (Mishra, 2015). According

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to the UUCN report 2004, 10 ethnic groups are partially engaged in capture fisheries which is about 10 percent of total population of the country.

The aquatic insect diversity in Nepal had been poorly studied relative to other fauna. Fish especially trout farming along the river side is only possible with the continuous monitoring of water quality parameters protecting aquatic ecosystem. Mishra (1975) reported a short list of aquatic insects of Nepal. Malla et al. (1978) carried out the studies on the aquatic insects of Kathmandu valley. He had collected altogether 61 species of insects from various water bodies in Kathmandu valley, of these 37 were new generic and specific records from Nepal. Yadav et al. (1980, 1981, 1982 and 1983) studied macro-invertebrates of Rajdal Pond, Godawari Khola and Godawari fish pond. Yadav and Rajbhandari (1982) studied the benthic fauna of Bansbari Khola and Dhobi Khola. Ojha (2016) reported insects belonging to 5 genera, 5 families and 3 orders from the NA PUKHU pond of Bhaktapur district.

Thosne river is located at the southern part of Lalitpur district which is made up of many small perennial spring-fed torrential streams flowing from east to west.

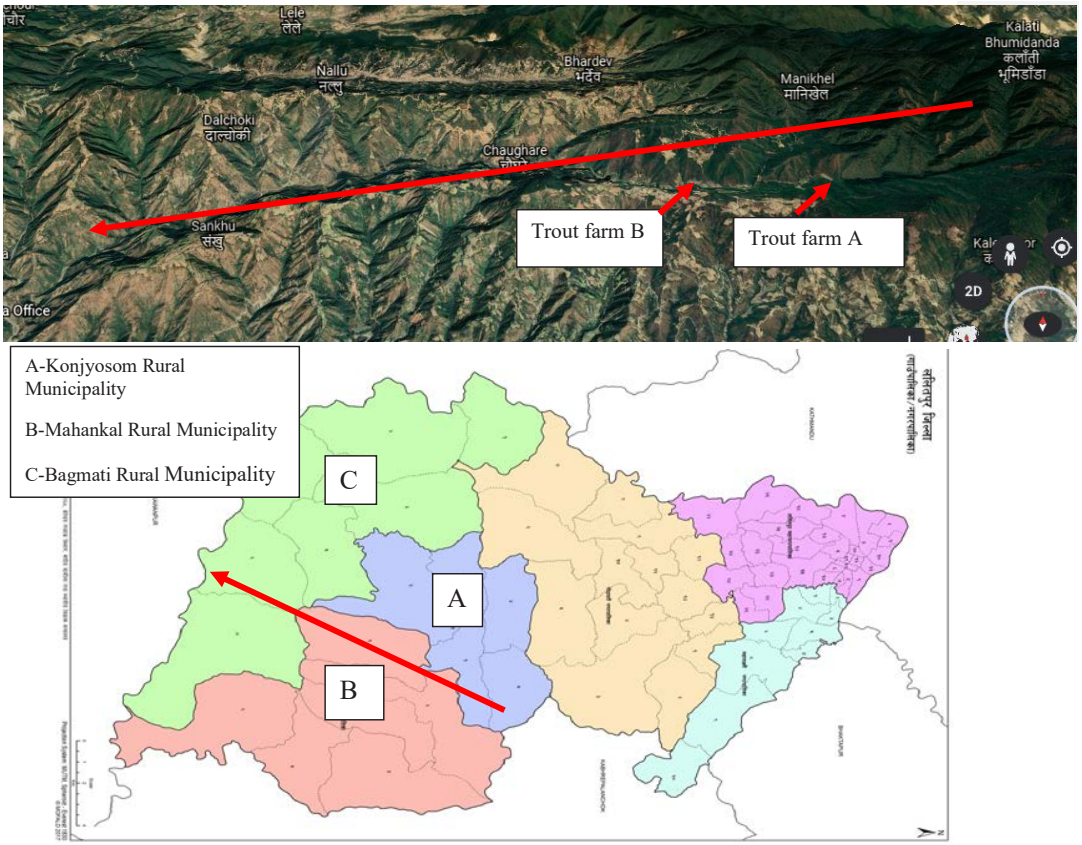

Figure 1: Satellite view of the Thosne river and political map of Lalitpur district

Study on limnology (chemical, physical, biological and geographical characteristics) of Thosne river was done to understand baseline diversity of fish and aquatic insect along with their proper identification. In Nepal, rainbow trout is popular aquaculture fish in the temperate hilly region. Its annual production was 420 mt /year (CFPCC, 2017). This study aims to determine the water quality parameters for assessing suitability and feasibility for fish farming.

## MATERIALS AND METHODS

The study was carried out from 15th December 2017 to 8th June 2018 representing two seasons: winter (December to February) and spring (March to May). Samples were collected in the interval of 20 days for water quality parameters and 45 days for insect and fish. Five different sampling stations were selected for the study which was about 10 km apart from each other. Fifth sampling station was located at the mouth of the river where no villages and trout farms were located. Fourth and third sampling stations were located just behind the trout farm A and trout farm B and second and first sampling stations were located behind the villages viz. Chaughare and Sankhu. Water quality parameters were measured in both field/on the spot and laboratory. Water temperature, pH, conductivity, altitude and flow rate were measured in the field. Determination of dissolved oxygen, hardness, turbidity, chloride, ammonia and nitrate were done in laboratory of Nepal Academy of Science and Technology (NAST), Lalitpur, Nepal. Identification of aquatic insect and fish were done in laboratory of Fisheries Research Division (FRD) under Nepal Agriculture Research Council (NARC).

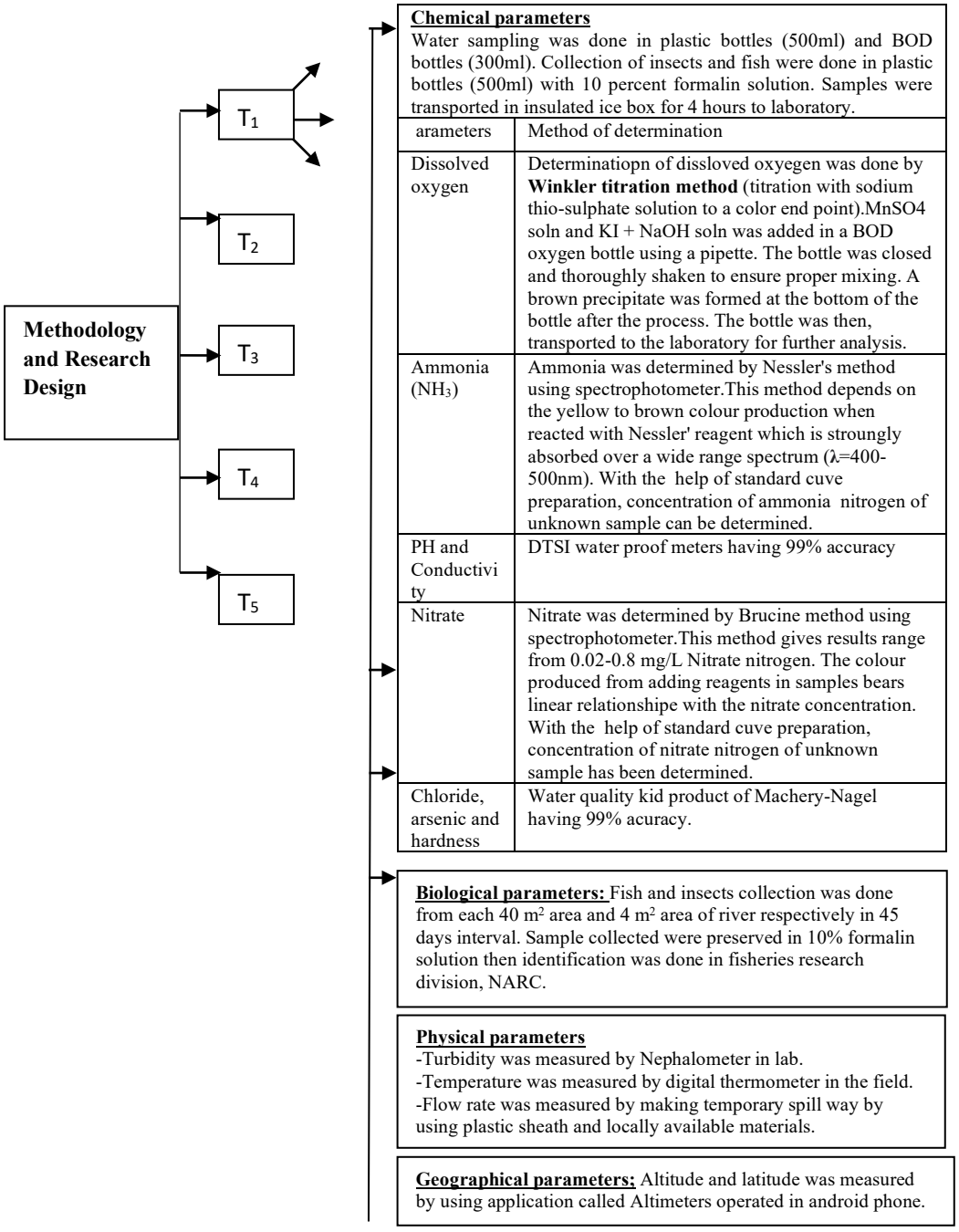


Figure 2: Schematic presentation of measurement of chemical, physical and geographical parameters

## STATISTICAL ANALYSES

Physico-chemical parameters recorded were first tabulated and then analyzed. Data synthesized were average of sampling stations in upstream, midstream and downstream. Following Karl Pearson's method, correlations between different water quality parameters were calculated and the corresponding significance tests were done using SPSS statistical software.

## RESULT AND DISCUSSION

Acherjee and Barat (2014) reported 0.6°C decrease in water temperature per 100 m increase in altitude and they also reported water velocity 0.61-1.5 m/sec with its lowest value in November and highest in July. During the study period flow rate (mean±SD) of Thosne river was 13.53±2.3 L/Sec at upstream in winter and 22.5±4.33L/Sec at downstream in spring. The flow rate of Thosne river was found suitable for 4 to 5 rainbow trout farms operation with the production capacity of 1-2 mt/year from each farm.

Table 1: Season-wise water quality parameters of the Thosne river with mean±SD at upstream, midstream and downstream from 15th December 2017 to 8th June 2018

| Particular | Unit | Winter | | | Spring | | |
|---|---|---|---|---|---|---|---|
| | | Upstream | Midstream | Downstream | Upstream | Midstream | Downstream |
| 1. Water temperature | °c | 10.05±0.8 | 11.9±0.7 | 13.9±1.8 | 14.35±0.89 | 16.13±0.68 | 17.14±1.80 |
| 2. pH | | 6.38±0.25 | 6.55±0.21 | 7.42±0.15 | 6.32±0.25 | 6.87±0.28 | 7.45±0.14 |
| 3. Conductivity | µS/cm | 105.3±6.12 | 143.43±11.1 | 185.83±2.36 | 117.5±6.48 | 148.9±12.15 | 200.7±3.86 |
| 4. Dissolved oxygen | mg/L | 11.04±0.18 | 10.53±0.31 | 10.81±1.1 | 10.04±0.18 | 9.57±0.20 | 9.19±0.73 |
| 5. Hardness | mg/L | 66.47±8.9 | 78.66±11.01 | 93.91±13.22 | 54.66±8.73 | 67.77±11.33 | 82.16±12.78 |
| 6. Turbidity | NTU | 1.72±0.54 | 2.42±1.2 | 3.82±0.92 | 4.1±1.79 | 5.82±1.85 | 7.91±1.73 |
| 7. Chloride | mg/L | 5.01±0.86 | 7.90±1.01 | 10.61±1.2 | 7.05±0.68 | 11.60±1.38 | 16.44±2.99 |
| 8. Ammonia | mg/L | 0.013±0.002 | 0.014±0.006 | 0.12±0.03 | 0.015±0.01 | 0.015±0.03 | 0.19±0.07 |
| 9. Nitrate | mg/L | 0.01±0.06 | 0.03±0.18 | 0.073±0.42 | 0.02±0.003 | 0.046±0.01 | 0.09±0.02 |
| 10. Altitude | M | 1932 | 1741 | 1509 | 1932 | 1741 | 1509 |
| 11. Flow rate | L/sec | 13.53±2.3 | 19.62±5.1 | 21.91±3.2 | 15±2.9 | 20.69±5.3 | 22.5±4.33 |

Bhagat and Barat (2015) reported 8.63±1.21 mg/L dissolved oxygen, electrical conductivity 107.83±55.61 µS/cm and hardness 47.08±24.08 mg/L in the raceway of Kathmandu in the year 2010/11. In Thosne river dissolved oxygen recorded was 10.58±0.7 mg/L at upstream in winter and 9.62±0.87mg/L at downstream in spring. The conductivity was 105.30±6.12 and 200.70±3.89

at the upstream and downstream in the months of winter and spring respectively. The hardness recorded were 82.708±10.86 mg/L and 66.47±8.9 mg/L at the upstream and downstream sampling in winter and spring seasons respectively. All three chemical parameters viz. dissolved oxygen, hardness and electrical conductivity were recorded slightly more in Thosne river than in the raceway of Kathmandu.

The acceptable ammonia ($NH_3$) concentration is less than 0.05 mg/L for cyprinids and 0.0125 mg/L for salmonids (Svobodova *et al.*, 1993) farm fishes. There are two forms of ammonia present in water as ammonium ion ($NH_4^+$) and ammonia ($NH_3$). Ammonia is highly toxic to fish and ammonium ion is nontoxic, because ammonia ($NH_3$) is permeable through the gills to the blood. The concentration of ammonia increases with increase in the alkalinity and temperature while the concentration of ammonium ions increases with the decrease in temperature and pH. In Thosne river, concentration of ammonia nitrogen recorded were 0.013±0.002 mg/L at upstream in winter and0.015±0.006 at midstream and 0.19±0.07 at downstream in spring. So Thosne river is suitable for trout farming up to mid-stream. The appropriate nitrate concentration is <0.5mg/L for trout farming (CFPCC, 2017). The concentration nitrate nitrogen recorded was found suitable for trout farming up to mid-stream of the river.

WHO guideline for chloride concentration in drinking water is 250mg/L. In most of the rivers and lakes chloride content was found to be less than 150 mg/L. The chloride concentrations (mean±SD) recorded were 16.45±2.93 mg/L and 5.01±0.86 mg/L at downstream in spring and at upstream in winter respectively. Chloride recorded at all the sampling stations found within the WHO standard for drinking water. Chloride concentrations were found to be higher in spring months than in winter months. Water temperature, pH and turbidity were higher in midstream and downstream than in upstream.

Table 2: Pearson correlation coefficient along with significance (two-tailed) of physico-chemical parameters of the Thosne river from 15th December 2017 to 8th June 2018

| Parameters | WT | PH | EC | DO | TH | TBD | CL | $NH_4^+$ | $NO_3^-$ | ALTD | FR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Water temperature | 1 | | | | | | | | | | |
| pH | 0.450* | 1 | | | | | | | | | |
| Electrical conductivity | 0.450* | 0.641** | 1 | | | | | | | | |
| Dissolved oxygen | -0.901** | -0.35 | -0.46* | 1 | | | | | | | |
| Total hardness | 0.063 | 0.337 | 0.65** | -0.13 | 1 | | | | | | |
| Turbidity | 0.771** | 0.476* | 0.49* | -0.7** | 0.182 | 1 | | | | | |
| Chloride | 0.736** | 0.667** | 0.76** | -0.7** | 0.244 | 0.735** | 1 | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ammonia | 0.487 * | 0.651 ** | 0.77 ** | -0.5 ** | 0.384 | 0.564 ** | 0.787 ** | 1 | | | |
| Nitrate | 0.526 ** | o.693 ** | 0.83 ** | -0.5 ** | 0.438 * | 0.594 ** | 0.827 ** | 0.912 ** | 1 | | |
| Altitude | -0.42 * | -0.67 ** | -0.90 ** | 0.44 * | -0.67 ** | -0.44 * | -0.74 ** | -0.80 ** | -0.82 ** | 1 | |
| Flow rate | 0.471 * | 0.428 * | 0.412 * | -0.5 ** | -0.01 | 0.540 ** | 0.534 ** | 0.551 ** | 0.488 * | -0.572 ** | 1 |

All the water quality parameters were positively correlated with each other except dissolved oxygen and altitude which were negatively correlated with rest of the other parameters.

During the study period, three species of fish under three orders, three families and three genera were recorded. The most common species distributed in the Roshi khola was *Schizothorax richardsonii* second common species was *Schistura rupecula.*

| **Order/family/genus** | **Description** |
|---|---|
| A. Order: Cypriniformis<br>family: Cyprinid<br>  <br>Fig:*Schizothorax richardsonii(Gray,1832)* | According to wagle et al 2015, this is cold water valuable game fish commonly known as Asala in Nepal. It prefers to live under the rocks and is primarily a phytophagous bottom feeder having special mouth to scrape the algal slime attached on the stone surface. It used to be one of the widely distributed and abundantly available species in the Himalayan foothills of Nepal, India, Bhutan Pakistan, and Afghanistan (Talwar and Jhingran, 1991). Electro fishing, use of acid for harvesting fish and water quality degradation are the main causes of present reduction in abundance in this river than in the past. It feeds on algal slime, detritus, and insects encrusted on the stones. It breeds during April-May before monsoon flood the river. No technology has been developed yet for commercial culture particularly due to not being able to develop appropriate feed for Asala in Nepal. Introduction of exotic fishes like rainbow trout in hill streams of the Himalayan foothills may be threat for this fish. |
| B. Order: Cypriniformes<br>Family: Cobitidae<br>  <br>Fig *Schistura rupecula* (Mc Clelland, 1839) | It is also called stone loach in Nepal which is very popular for its delicious white flesh. It has been used as ornamental fish because of its beautiful appearance with the 14-16 light and dark bands on body. It feeds on small larvae found at the bottom. According to the Gupta and Gupta (2006) stone loach accepts most of the formulated feed. It favors a sandy bottom where there is a possibility of hiding under various stones. The breeding season starts from spring (February) until May and June. It sheds ripe eggs at periodic intervals. It is found at the altitudinal ranges from 1,000 to 1,800 m. This fish is also found in Koshi, Narayani, Gandaki, Trishuli, Bheri and Karnali rivers. Soft water having pH 6-7.5 and temperature (16-25) were recorded at their natural habitat. |

| | |
|---|---|
| C. Order: Siluriformes<br>Family: Sisoridae<br>  <br>Fig: *Glyptosternum maculatum* (Regan) | It is inhabited in shallow, rocky rivers with moderate water current where it feeds on invertebrates. *Glyptosternum maculatum* is important hillstram fish commonly known as torrent catfish in Nepal belonging to family Siluriformes. It is locally known as Til Kabre in Nepal (Bhusal and Chitrakar, 2017). It is found in cold water of foothill of Nepal, India, Tibet and Bhutan. Its body is flattened ventrally, having inferior mouth, four pairs of thick barbells and pointed teeth. It has distinct dark brown body color with depressed head. Mouth has villiform teeth in bands on jaws. Its dorsal fin is longer while the adipose fin is very small. The caudal fin is not forked consisting of black lines. |

Sharma (1996) reported 2 species of Odonata, 3 species of Ephimeptera, 3 species of Diptera, 5 species of Hemiptera, 7 species of Coleopteran, 10 species of Orthoptera and 2 species of Crustacea orders from Koshi river basin belt of Nepal-India (North-Bihar). List of aquatic insects collected in Thosne river were as follows.

Table 4: Insects from different orders and families collected in Thosne river

| **Order/family/genus** | **Description** |
|---|---|
| 1. Order: Ephemeroptera family:Ephemerillidae Fig:*Ephemerella spp.*<br>  <br>2. Order: Ephemeroptera Family: Heptagenidae *Fig: Stenonema spp.*<br>  | Insects belongs to the order Ephemeroptera have elongated, cylindrical or somewhat flattened body that passes through a number of instars molting and increasing in size. Three pairs of legs, operculate gills, thoracic developing wing pads were seen in these insects. Nymphs were found under stones and decaying vegetation. For the hatching of eggs and the larval development they need cold flowing water. They feed on the aquatic micro vegetation including algae. |
| 3. Order: Lepidoptera Family: pyrilidae Fig: Aquatic moth<br>  | The adults were found near the water feeding on nectar which means they also play role in pollinator of semi aquatic plants. Larvae were found at the bottom of the water column. Their portable shelter made by using their silk produced from their special gland and small pieces of leaves were found at clayey bottom of river. |

| | |
|---|---|
| 4. Order: Trichoptera<br>Family : Phryganidae<br>  <br>5. Order:Trichoptera<br>family: Glossosomatidae<br>Fig: Caddisflies<br>  | Adults of most of the Phryganidae are said to be nocturnal and attracted by light. Larvae were found in water. They can build cages of silk produced by them. Pupation takes place in a silicon cocoon inside the cage. Three pairs of legs and two pairs of wings were found in larvae.<br>Insects from Glossomatidae make hard cases of sand particles. Small Sand particles were bonded well by their silk thread produced by special glands to make strong cases. |
| 6. Order: Plecoptera<br>Family: Perlidae<br>  <br>Fig: Stone fly | Most of the adults were grey in color with transparent wings. They dip abdomen on fresh water below the surface of water and laid eggs. Nymphs were seen in water eating aquatic vegetation. When they became ready to be adult they come on the surface of water and break their final nymph skin. Since they produce single generation in a year, they are They are said to be univoltine. |
| 7. Order: Coleptera<br>Family: Gyrinidae<br>  <br>Fig: Water beetle | whirligig beetle are highly carnivorous eating aquatic insects trapped on the water surface and swimming with the help of two pairs of legs as oars. They can swim exceptionally fast in circle. They go complete metamorphosis. |
| 8. Order: Odonata<br>Family: Aeshnidae<br>  <br>Fig: Dragonfly nymph | Dragon flies are the predatory semi-aquatic predatory insects which consume small flying insects like mosquitoes. They have two pairs of long membranous transparent wings. Head possess large compound eyes and three ocelli; and pair of short antennae. They have chewing type mouth part with teeth and strong legs to catch the prey. Their nymph remains in the water feeding aquatic insects. |
| 9. Order: Hemiptera<br>Family: Gerridae<br>  <br>Fig: Water striders | Water skeeters are true bug having piercing and sucking type mouth parts and distinguishing themselves by having the unusual ability to walk and jump on water surface, making them surface living animal. These carnivorous insects' nymphs were similar to adults. They eat aquatic insects and small fish hatchlings. Adults lay eggs under the submerged stone with gelatinous substances. |

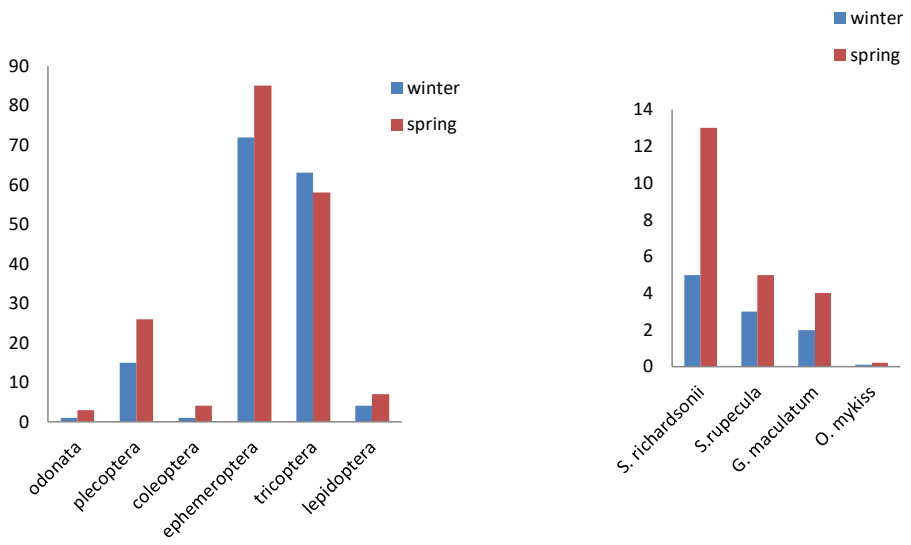


Figure 3: Seasonal abundances of insects and fishes in Thosne river

Insect collection was done in 4 square meters area and fish collection was done in 40 square meters of the river. Similar kind of trend of insect population was reported in Tamakoshi river by Directorate of Fisheries Development, Balaju, Nepal (DoFD, 2014). Snow trout (*Schizothorax richardsonii)* and insects from Family Ephemeridae were most abundant in Thosne river.

## CONCLUSION

Thosne river is one of the most important rivers of the district because it avails its resources to many nearby villages. Biodiversity of this river is in risk due to continuous degradation of aquatic environment. Illegal fishing and bad aquaculture practices, deforestation, construction of roads along the side of the river, soil erosion and growing demand of water for irrigation and other purposes were found the main causes of biodiversity degradation in this river.

All the water quality parameters were found suitable for rainbow trout fish farming up to mid-stream (Thing Tol). Local people were found helpful and supportive in water sampling and fish and insect collection. Collection of water samples and their analysis was done using standard methods in the laboratory of NAST, Lalitpur, Nepal. Identification of fish and insects were done in laboratory of FRD, Godawary, Lalitpur, Nepal. Still there was no considerable effluence pollution seen due to the rainbow trout farming in this river. Continuous monitoring of water quality and aquatic biodiversity along with the effective conservation management practices were highly recommended.

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