SPECIES DIVERSITY, CONSUMPTION TRENDS AND CONSERVATION STATUS OF FRESHWATER MOLLUSCS IN GHODAGHODI LAKE AREA, KAILALI DISTRICT, NEPAL

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A thesis submitted

In partial fulfilment of the requirements for the award of the degree of Master of Science in Zoology with special paper "Entomology".

Submitted to

Central Department of Zoology

Institute of Science and Technology

Tribhuvan University

Kirtipur, Kathmandu

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October, 2017

DECLARATION

I, Miss Poonam Chaudhary, do hereby declare to the Central Department of Zoology, Tribhuvan University, that this dissertation entitled "**Species Diversity, Consumption Trends and Conservation Status of Freshwater Molluscs in Ghodaghodi Lake Area, Kailali District, Nepal"** has not been submitted elsewhere for the award of any academic degree. Information used from various other sources is duly acknowledged.

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This is to certify that Miss Poonam Chaudhary has completed this dissertation work entitled **"Species Diversity, Consumption Trends and Conservation Status of Freshwater Molluscs in Ghodaghodi Lake Area, Kailali District, Nepal "** has been carried out by Poonam Chaudhary for the partial fulfilment of Master's Degree of Science in Zoology with special paper "Entomology". This is her 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.

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This thesis work submitted by Poonam Chaudhary entitled **"Species Diversity, Consumption Trends and Conservation Status of Freshwater Molluscs in Ghodaghodi Lake Area, Kailali District, Nepal"** has been accepted as a partial fulfilment for the requirements of Master's Degree of Science in Zoology with special paper "Entomology".

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ACKNOWLEDGEMENTS

First of all, I would like to express my sincere thanks and deep gratitude to my respected supervisor Dr. Prem Bahadur Budha for his patient motivation, inspiration, guidance and useful critiques to complete this research work. I'm grateful to him for his lot of suggestions to complete this work.

I am also grateful to Department of Hydrology and Meteorology (DHM), Nepal for providing climatic data of study area.

My special thanks go to the local Tharu Peoples for their co-operation and sharing their knowledge during questionnaire survey. Similarly, thanks goes to Shovaram Tharu, Bipat Tharu for their selfless help during field work. Sincere thanks goes to my friends Govind Rana for his huge support during data analysis. I am very much thankful to Rasmi Kunwar and her family for their lots of love, care and support and also to Sandhya Sharma for her help during field visits.

Lastly but not least, I would like to express my sincere thanks to my parents without whose encourage, supported, help and guidance, I won't be able to complete this task.

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Poonam Chaudhary

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ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
Cor	Correlation
DHM	Department of Hydrology and Meteorology
DO	Dissolved Oxygen
GPS	Geographic Positioning System
IUCN	International Union for Conservation of Nature
TU	Tribhuvan University
VDC	Village Development Committee
WHO	World Health Organization

ABSTRACT

The study deals with diversity, consumption trends and conservation status of freshwater molluscs in Ghodaghodi lake complex and associated lakes, Kailali District, Nepal. Field survey was conducted from March-April 2016. Altogether 17 Molluscan species were revealed from the study area including 13 gastropods and 4 bivalve species. Six Molluscan species viz. *Pila globosa*, *Bellamya bengalensis*, *B. dissimilis*, *Brotia costula*, *Parreysia favidens*, *Lamellidens marginalis* were reported as of food and medicinal value. Most of the people preferred *Bellamya* spp. followed by *Pila* sp. and Bivalve spp. large bivalves *L. marginalis* had restricted distribution and very low population in the study area while *Parreysia favidens* were collected only from permanent stream. DO (Pr= 0.00965), water temperature (Pr= 0.00257), depth (Pr= 0.02081), and elevation (Pr= 0.06898), Spearmans's correlation coefficient were found statistically significant on mollusc species by one-way ANOVA. Species diversity was found by Shannon Wiener Diversity Index. Structured interview showed people collect molluscs either by hand picking or by using local tools (*Heluka*). Consumption trends are increasing by 62 % among Tharu community. People also opined that consumption, poisoning, habitat loss, climate change and pollution as major threats of molluscs.

1. INTRODUCTION

1.1 Background

Molluscs are one of the most successful, the second largest and the most studied invertebrates around world. They are found from the deepest ocean trenches to the intertidal zones, freshwater viz. rivers, lakes, streams, swamps, underground aquifers, springs as well as temporary ponds, drainage ditches, and seasonal water including terrestrial ecosystems (Strong *et al*., 2008). A total number of species of molluscs in the world is estimated to 200,000 (Van Bruggen *et al.*, 1995). The valid species name of terrestrial and freshwater molluscs are 24,000 and 7,000 respectively (Lydeard *et al.*, 2004). All freshwater molluscs belong to the class Gastropoda and Bivalvia (Pelecypoda). The presence of freshwater molluscs and their assemblage vary according to productivity, temperature (Garg *et al*., 2009; Tarr *et al*., 2005), bottom sediments (Lewin and Smolinksi, 2006), Calcium and pH (Briers, 2003), water chemistry and hydroperiod (Heino, 2000; Maltchik *et al*., 2010), availability of food, competition, predators-prey interaction (Harman, 1972; McMohan *et al.*, 1974; Lassen, 1975; Ofoezie, 1999), substrate architecture (Lewin and Smolinksi, 2006; Perez-Qunitero, 2007). Some phenomenon such as waterflow regimes, water chemistry, hydrologic change, damming, water pollution, agriculture intensification, habitat alteration or destruction and direct exploitation as well as climatic changes are contributing for declining and extirpation of freshwater snail and mussel species (Budha *et al*, 2010; Lydeard *et al.*, 2004; Heino, 2000; Maltchik *et al*., 2010; Downing *et al.*, 2010).

The freshwater molluscs are highly affected by human being causing profound declines in the resident freshwater biota (Revenga *et al.*, 2005; Dudgeon *et al*., 2006). They are highly sensitive to climate change which affects survival, growth and reproduction (Subba, 2012). Over exploitation (Budha, 2010) is also considered as threat to edible freshwater molluscs. The climate change, haphazard harvesting, habitat destruction, pollution, poisoning causing shifting species distribution and population declining are common issues about freshwater molluscs of Nepal (Subba, 2012; Budha, 2016a, 2016b). But the sufficient dataset on the freshwater fauna of Nepal is extremely lacking to extrapolate the status of freshwater snails and mussels fauna.

1.1.1 Distribution and Diversity of Molluscs in Nepal

Based on several literatures like Subba Rao (1989), Nesemann *et al.* (2001, 2005 and 2007), Nesemann (2009), Subba and Ghosh (2008), Subba and Pandey (2005), Subba (2003), Surana *et al*. (2004), Pfeiffer and Sharma (2005), Budha (2010, 2016b), Budha *et al.* (2010), Irikov and Bechev (2011), Glöer and Bössneck (2013), there are

around 80 freshwater molluscs containing 30 species of bivalves and 50 species of gastropods from Nepal.

Some of sporadic reports of freshwater molluscs were known from Ghodaghodi Lake with 13 species of freshwater molluscs including one endemic species *Bithynia ghodaghodiensis* (Subba, 2003; Nesemann *et al*., 2007; Glöer and Bössneck, 2013). Budha (2016a) provided lists of 22 gastropods and 12 bivalves species belonging to 20 genera and 12 families from Kailali district.

1.1.2 Importance of Molluscs

Freshwater molluscs are a key component of the ecology of aquatic ecosystems; they forms strong interconnection link in the wetland food-web between the tropic level by recycling and transporting nutrients (Oktener, 2004; Grabarkiewicz and Davis, 2008; Strayer, 2008; Allen and Vaugh, 2011; Chaubisa and Sheikh, 2013). They also play an important role in the rehabilitation of organically polluted water (Erwin, 2009). They are food supplement of nutritional value to terrestrial and aquatic organisms including human being. Flesh of edible molluscs contain low cholesterol e.g. *Bellamya bengalensis* and *Pila globosa* contains saturated fatty acids (48-60%), monoenic (18-30%), polyunsaturated fatty acids (21-33%) (Misra *et al*., 2002). They are also used for traditional treatments such as cardiac diseases, controlling blood pressure, asthma, rickets, calcium metabolism, nervousness, haemorrhoids, night blindness, prevent influenza, restore virility and also providing missing vitamins and minerals (Mahata, 2002). Calcium phosphate extracted from snails in the special form said to be implemented to cure of some kidney diseases and heart circulatory disorder (Abere and Lameed, 2008; Mahata, 2002). Similarly, shell of molluscs are used in industries for manufacturing jewellery, tools and musical instruments as well as poultry feed industries (Williams *et al.*,1993). Bivalves species like *Lamellidens marginalis*, *L. corrianus*, *L. consobrinus* and *Parreysia corrugata* produce pearls (Misra *et al*., 2009). They are mostly found in Nepal (Budha, 2016a).

Some freshwater molluscs are vector of Schistosomiasis caused by Pomatiopsids and Planorbids; liver and lung flukes caused by Pachychilids, Pleurocerids, Thiarids, Bithyniids and lymnaeids (Davis, 1980; Davis *et al*., 1994; Ponder *et al*., 2006). Many animals like water buffaloes, dogs, cats, pigs and rodents are infected by zoophilic strain of *Schistosoma japonicum* (Chen, 2014). Xiphidio have been reported from different freshwater snail species like *B. bengalensis*, *Bithynia* (*Gabbia*) *orcula*, *Gyraulus euphraticus*, *Indoplanorbis exustus*, *Lymnaea luteola* and *Tarebia granifera* from Nepal (Devkota *et al*., 2011).

The sufficient dataset on the freshwater fauna of Nepal is lacking to understand the status of freshwater snails and mussels fauna. The present study aims to provide detail information of freshwater molluscs species in diversity of Ghodaghodi Lake and associated lakes and rivers.

1.2 Objectives

1.2.1 General Objective

To document the mollusc fauna in different freshwater habitats and their consumption trends among Tharu community in Ghodaghodi lake area, Kailali district.

1.2.2 Specific Objectives

Specific objectives are to;

- Explore species diversity of freshwater molluscs in Ghodaghodi and surrounding lakes.
- Find species diversity in relation with water quality and lake size.
- Habitat characteristics of freshwater molluscs.
- Find consumption trends of edible molluscs and conservation threats.

1.2.3 Significane of Study

Molluscs are important component of ecosystems. They serve as food for human being as well as many other fauna such as birds, mammals, amphibian and reptile and play significant key role in the ecosystem services (Chaubisa and Sheikh, 2013), perform as biological monitoring and assessing hazard and risk (Borcherding and Volpers, 1994) but these are one of the most threatened faunal groups globally (Lydeard *et al*., 2004). The climate change, haphazard harvesting, habitat destruction, pollution, poisoning alters species distribution and population declining. Decreasing population of these fauna affect harvesting and consuming practices among Tharu community (Budha, 2016b). About 70% people belonging to ethnic communities in Terai consume nearly 20 species of freshwater molluscs in Terai region (Subba and Ghosh, 2000; Subba, 2012). Very few studies were found in relation of freshwater habitat and molluscs fauna in Nepal. The sufficient datset on the freshwater fauna of Nepal is also extremely lacking to extrapolate the status of freshwater snails and mussels fauna. There are only 13 mollusc species known from the Ghodaghodi lake area even though it is one of the Ramsar site (Subba, 2003; Glöer and Bössneck, 2013). So, unless systematic documentation on species distribution in different freshwater habitats and collecting effort; the diversity and threats are unknown. This study aims to explore molluscan diversity with lake size and water quality including consumption trends and conservation threats in Ghodaghodi and its surrounding lakes in Kailali district. The research finding of this study fulfill baseline data gap, monitoring and future conservation strategies of freshwater molluscs.

1.3 Limitations of the Study

The research survey was conducted within limited period from March-April 2016. The snail population of the some edible molluscs such as *P. globosa* and *B. bengalensis* said to be emerged during rainy season but in large Lakes it is difficult to sample during that season. However only shell of *P. globosa* were observed during the survey period. So, seasonal population variations are excluded in this study. Sampling of molluscs were confined along the shore of the lakes and deeper part of lake was excluded in this survey. Identification of molluscs were based on the shell and anatomical information were not included in this study.

2. LITERATURE REVIEW

Published journal articles, periodicals, books, reports on freshwater molluscs were reviewed. Based on the best available information, literature review is divided into following subheadings:

2.1. Global Freshwater Molluscan Diversity

Global estimation of described species of molluscan fauna ranges from 80,000 to 100,000 with a total number of species as high as 200,000 (Strong *et al*., 2008). Altogether 409 families of gastropods were identified by Bouchet and Rocroi (2005), 26 of them are restricted to freshwater. Global freshwater gastropod fauna is estimated approximately 4000 bivalves belonging to 209 genera, 19 families in all continent except Antarctica (Bogan, 2008).

2.2. Freshwater Molluscs of Indian Sub-continent and China

The history of malacological study in the Indian Sub-continent goes back to 200 years. Several pioneer malacologist such as Annandale, Benson, Blanford, Godwin-Austen, Gude, Hutton, Pilsbry, Prasad and Preston contributed on the molluscsc fauna of the Indian sub-continents 200 years ago. Preston (1915) published book on freshwater molluscs in Indian sub-continent in the fourth volume of Fauna of British India. In the book he compiled all pevious original description of species their distribution, synonyms and classification. This book is very important work but there are tremendous taxonomic changes. Subba Rao (1989) published the book on freshwater molluscs of India. He included species of Myanmar, Sri Lanka but only few species represented from Nepal.

The molluscan study in china began from 1870s while only 3914 molluscs species were reported from china (Zhang *et al*., 2014a. 2014b)

Venkataraman and Wafar (2005) reported 5070 molluscs species containing more than 3370 marine species from India. There are about 1129 of terrestrial molluscs species (Ramakrishna *et al*., 2010) and 285 freshwater molluscs species from India (Subba Rao, 1989).

Amanullah and Hameed (1996) studied molluscan diversity in Kaveri river system and recorded 13 species of molluscs of which eight species were gastropods belonging to Viviparidae, Thiaridae, Pilidae, Lymnaeidae and Planorbidae families and five species of bivalves belonging to two different families Unionidae and Corbiculidae. Thiaridae was the most dominant group representing 50% of the total gastropods population.

Patil and Talmale (2005) published the checklist of the land and freshwater molluscan of Maharashtra state representing 142 species of molluscan belonging to 42 genera including 23 families.

Prabhakar and Roy (2008) reported 30 species of freshwater molluscs by extensive field survey, interview and on the spot inquiries from Koshi region of North- Bihar (India) and found *Bellamya*, *Pila*, *Lymnaea* and *Planorbids* species. *Lamellidens* and *Parreysia* species were abundant species.

Garg *et al.,* (2009) reported total 13 species of molluscs belonging to class Gastropoda and Pelecypoda from four sampling sites of Ramsagar reservoirs Madhya Pradesh, India for two years. *Vivipara dissimilis* was most dominant gastropod species in the reservoir.

Study on Freshwater Molluscan Diversity (Barak river and its tributaries) Assam, India showed 16 molluscan taxa belonging to two classes (Gastropoda and Bivalve), four orders, five families and nine genera. *Brotia costula* and *L. marginalis* were the most common species in the river system. Similarly, study on six reservoirs around Rajkot city, Gujarat, India showed 13 gastropods and six bivalves species. Viviparidae and Tharidae were dominant species to all sites whereas the bivalves were representd by Amblemidae and Corbiculidae families (Roy and Gupta, 2010; Goswami *et al*., 2011).

Freshwater molluscan diversity of Bhim River, Pandharpur, India showed total 15 species of freshwater molluscs and mentioned that the observation drastically decreases the number of molluscan species from summer 2010 onwards because of high pollution in Bhima river. Similarly, 18 sampling stations of Narmada River show, 19 species (13 gastropod and six bivalve species) of molluscan fauna. Among gastropoda *Melanoides tuberculata* and *Tarebia granifera* were most dominant species (Waghmare *et al*., 2012; Kumar and Vyas, 2012).

Amrutsagar and Lohar (2011) studied molluscan diversity of the lake Gondoor and Nakane in northwest Maharashtra, India; used scoop netting in littoral zone, active searching in grass land and rocky shore and reported 17 species of molluscs i.e. 14 species gastropoda and three species bivalves where gastropod were dominant.

Sharma *et al*. (2013) studied the diversity and distribution of molluscs in relation to physiochemical profile of Gho-manhasan stream Jammu, India by bottom sampling for 12 months and revealed 11 taxa of freshwater molluscs representing 54.45% gastropoda and 45.55% bivalvia. Among them, *Pissidium mitchelli* (Bivalvia) was the most abundant taxa followed by *M. tuberculata*, *L. luteola*, *B. bengalensis*, *Physella acuta*, *Gyraulus ladacensis* showed less frequent appearance whereas *Lamellidens corrianus* and *Corbicula cashmeriensis* were recorded as rare taxa.

Waghmare and Kulkarni (2014) studied the molluscan diversity of Lendi River, Nanded district, Maharashtra, India and revealed 15 molluscan species among which nine species of bivalves represented from Unionida and Veneroida and six species of gastropods belong to order Mesogastropoda. (Golwalkar *et al*., 2016) and (Vyas *et al*., 2016) reported 11 molluscs species and 17 molluscan species respectively from Narmada River, Central India and revealed higher dominance of Gastropods than Bivalves. Vyas *et al*. (2013) reported 10 molluscan species from Morand river, India whereas *Tarebia lineata, T. granifera* and *B. bengalensis* among gastropods and *Parreysia corrugata, Corbicula striatella* among bivalves were dominant species.

Magar *et al.* (2016) studied freshwater molluscs in Karanjali river Nasika, India and reported 11 molluscan species belonging to five Gastropoda and six bivalve species. Among gastropods, *M. tuberculata* were rich in number whereas *Parrreysia corrugata* were abundant among bivalves in Karanjali.

Sonowal *et al*. (2016) studied diversity of freshwater molluscs in Assam, India by using random sampling, hand picking and reported total 26 species belonging to nine families while the families Viviparidae followed by Thiaridae and Unionidae were found to be dominant families whereas Pleuroceridae and Ampullariidaie families were rare but most of the recorded species were least concerned category.

Farida (1988) reported 58 species of freshwater molluscs from Lyari river, Pakistan. Shahabuddin *et al*. (2012) reported *M. tuberculatus* from 14 different sites of Balochistan province Pakistan.

Afshan *et al.* (2013) reported 10 freshwater snail species from Pothwar Region, Pakistan and found *Gyraulus convexiusculus, I. exustus, Physa acuta, P. gyrina, B. bengalensis, Lymnaea (P.) acuminata f. rufescens, L. (P.) luteola, L. (P.) acuminata f. chlamys, L. Auricularia* and *M. tuberculata* were identified belonging to five families viz. Planorbidae, Physidae, Viviparidae, Lymnaeidae and Thiaridae.

Mahiuddin *et al.* (2013) recorded six freshwater mussels belonging to two genera of Unionidae that was the first recorded species from Bangladesh. Similarly, Hossian and Abdul (2014) studied freshwater molluscs in three different habitats i.e muddy, sandy and low vegetation in the river Brahmaputra, Mymensingh, Bangladesh and reported 15 freshwater molluscs species (10 gastropods and five species bivalves). Among Gastropoda *M. tuberculata, I. exustus* and *B. bengalensis* were most dominant species and L. *marginalis* was rare Bivalve species.

2.3 Study on Freshwater Molluscs of Nepal

A total 80 species of freshwater molluscs belonging to 30 species of bivalves and 50 species of gastropods are known from Nepal (Subba and Ghosh, 2000; Subba and Pandey, 2005; Subba 2003; Surana *et al*., 2004; Pfeiffer and Sharma, 2005; Budha,

2010; Budha *et al*., 2010; Irikov and Bechev, 2011 and Glöer and Bössneck, 2013). Nesemann and Sharma (2003) reported 45 species of aquatic molluscan (25 gastropods and 20 bivalves) from lowland (Terai) regions of Nepal.

Thapa (2003) reported nine molluscs species (seven freshwater molluscs and two land molluscs) from the rivers, wetlands and paddy field in Koshi Tappu Wildlife Reserve. Among the freshwater molluscs, five were gastropods (*Lymnaea acuminata*, *L. luteola*, *B. costula*, *B. bengalensis f. typica*, *I. exustus*) and two were bivalves (*L. marginalis, Parreysia favidens*). Two species were land gastropods (*Laevicaulis* sp., *Achantina fulica*).

Subba (2003) reported 10 freshwater molluscs and one terrestrial species from Ghodaghodi Tal area, Kailali districts. He found most common species of molluscs in Ghodaghodi Lake area were *B. bengalensis f. typica*, *P. globosa*, *I. exutus*, *L. acuminata f. typica* and *L. acuminata refescens* but *P. caerulea* were rare. Subba and Pandey (2002) studied the Molluscan Diversity of Jhapa District, Eastern Nepal and revealed 17 species of Freshwater molluscs.

Surana *et al*. (2004) reported 10 species of gastropods representing to seven families and four species of bivalves representing two families from Chimdi Lake (Birju Tal), Sunsari district, Eastern Nepal and *P. favidens deltae* and *P.* (*Radiatula*) *lima* were two new species of the report to Nepal. Most of edible genera of molluscs from Nepal are *Bellamya, Brotia, Pila, Lamellidens* and *Parreysia* species.

Yadav and Subba (2008) collected nine molluscs species belonging to six families from local fish ponds of Mudbalwa Village, Rautahat, Nepal. *B.* crassa and *Thiara tuberculata* were common species at that area whereas *B. crassa* was recorded first time in Nepal.

Budha *et al*. (2010) reported 112 species of gastropods and 74 species of bivalves from eastern Himalayan region of which is about one third (i.e 32.6%) of the total population of molluscs. Budha (2010) reported eight species of freshwater snails and mussels from Bahraiya lake, Bardiya, mid-western Nepal among them *B. bengalensis* was most abundant species and other species were *P. globosa*, *I. exustus*, *Gyraulus* sp., and *Segmentina* sp., *L. marginalis, M. tuberculata* and *Lymnaeae acuminata* were reported as rare.

Irikov and Bechev (2011) reported *M. tuberculata* (Muller, 1774), *Filopaludina sumatrensis polygramma* (Martens, 1860), *Viviparus* species, *Pseudosuccinea columella* (say, 1817), *Planorbarius corneus* (Linnaeus, 1758) freshwater snail species from Chitwan National Park.

Thapa Chettri (2011) studied freshwater mollusca of Belbari VDC, Morang, Nepal explore 11 gastropods and four bivalves species among which seven molluscs species

were edible. He reported *B. bengalensis* and *L. acuminata* as dominant and harmful pest of seedling paddy field.

Subba *et al.* (2011) reported 10 species of freshwater molluscs belonging to seven families and eight genera in which nine species were recorded from ponds and five species were recorded from the river. They also revealed that maximum average density was recorded for *B. bengalensis* (30.38/m2) and minimum for *Corbiculata* (0.084/m2).

Budha (2016) studied impacts of anthropogenic climate change of freshwater molluscs in Kailali, western Nepal and reported 14 species (11 gastropods and three bivalves) of freshwater molluscs. *Bellamya* spp., *B. costula*, *P. globosa*, *Lamellidens* spp. and *Parreysia* spp. are valued for food in Nepal.

Budha (2016a) mentioned 34 freshwater molluscs species (22 gastropods species and 12 bivalves species) belonging to 20 genera and 12 families from Kailali district in his book; A field guide to freshwater molluscs of Kailali, Far western, Nepal.

2.4 Molluscs in Relation to Water Qualities

Various aspects of local environment such as productivity, temperature, dissolve oxygen, pH, Calcium, alkalinity, phosphate affect aquatic mollusc habitat structure. Strzelec and Krölczyk (2004) studied the impacts of bottom sediments, water flow and microphyte diversity on gastropod fauna. They found that gastropods presence was determined by bottom sediments type but not affected by vegetation diversity. The highest diversity of gastropods was reported from the bottom sand muddy and sand bottom covered with detritus. WHO (1965) reported that snails need oxygen for their metabolic activities but Cheatum (1934) and Sharma (1986) reported that some molluscs can even survive in very low oxygen condition whereas Garg *et al*. (2009) reported that the fluctuation in dissolved oxygen content does not have any effect on the molluscan population but temperature effects on the freshwater molluscan existence. Appleton (1978) and Sturrock (1993) stated that the temperature affects the abundance, distribution and spread of freshwater snail. Similarly, Michael (1968), Dutta and Malhotra (1986), Malhotra *et al*. (1996), Sharma *et al*. (2013) and Garg *et al*. (2009) found positive correlation of molluscs diversity with temperature. Ricker (1952), Shrivastava (1956), Vasisht and Bhandal (1979) recorded negative correlation between temperature and molluscs. Bath *et al*. (1999) revealed that higher abundance of molluscs can noticed with increased water temperature and decomposed organic matter. Similarly, Michael (1968) suggested that abundance of zoo benthos during summer months are due to high temperature, alkalinity and food.

Bhagde and Mane (2005) studied biodiversity of the edible bivalve shell fishes inhabiting Ratnagiri coast of Maharashtra state and found that topography,

physiography, pollution, over fishing and other human activities in and around the wetland severely affected the distribution of bivalves.

Zeybek *et al.* (2012) assessed composition and distribution of mollusca in relation to water quality in Lake Egirdir, southwestern, Turkey at only 9 sites and they found there is no significant correlation with molluscs species and temperature but positively correlated with DO. Waghmare *et al*. (2012) examined the correlation between freshwater molluscan diversity with Bhima river pollution near Pandharpur, Maharahtra, India and revealed that the molluscan diversity greatly affected by heavily polluted water system i.e. leads the declining of molluscs freshwater species.

2.5 Consumption Trends and Conservation Threats of Molluscs

Surana *et al.* (2004) reported *Bellamya*, *Pila*, *Lamellidens* and *Parreysia* species as the edible molluscan genera from Chimdi Lake (Birju Tal), Sunsari district, Eastern Nepal. Prabhakar and Roy (2009) reported ethno-medical value and mentioned about the food value and medicinal value. Molluscs are also highly used to cure asthma, swelling of joints, burns by aboriginal, cardiac diseases, blood pressure, rheumatism, calcium metabolism, heart diseases, conjunctivitis, giddiness, nervousness, dehydration and various gastro-intestinal disorders. Similarly, Roy and Singh (2007) studied the ethno-medical uses of freshwater molluscs and mentioned that flesh of molluscs and shell are highly used by the tribal people of Santhal Pargana, Jharkhand, India.

Ramakrishna and Dey (2007) provided the food values species of freshwater molluscs in Arunachal Pradesh (one gastropod and two bivalves), Meghalaya (six gastropods and one bivalve), Manipur (six gastropods and six bivalves), Mizoram (14 Molluscs species), West Bengal (*Bellamya* spp. and *Lamellidens* spp.), Jharkhand (*Pila* sp., *Bellamya* spp., *Lamellidens* spp.).

Subba (2012) revealed that more than 20 species of molluscs e.g. *Bellamya* (Three spp.), *Brotia* (One sp.), *Lamellidens* (Four spp.), *Parreysia* (Nine spp.), *Peludomus* (One sp.), *Pila* (Two spp.) are consume in 53 caste of Terai region. Budha (2016b) reported very few individuals of large bivalves in only five lakes viz. Ghodaghodi, Nakrodi, Dhongrahuwa, Ghodtal and Laukabhoka in Kailali district.

3. MATERIALS AND METHODS

3.1 Study Area

3.1.1 Location

The study was conducted in Ghodaghodi Lake complex, one of the Ramsar sites, Kailali, Nepal (Figure 1). It lies at the altitude of 205 m within 28^0 41'03" N latitude and 80^0 56' 43" E longitudes. The maximum depth of Lake has reached around within 3.86 m in rainy season (DHM, 2009). The Lake area covers the area of approximately 150 hectares (Tiwari *et al.,* 2005) and include rivers, flood plains, oxbow lakes, swamps, marshes, reservoirs, ponds and paddy fields (MOFSC, 2003). It lies within three Village Development Committees (VDCs) of Darakh, Sadepani and Ramsikharjhala of Kailali district. Currently Darak, Sadepani and part of Ramshikharjhala belong to Ghodaghodi Municipality.

Soil type of this area varies from alluvial to clay and area is characterised by deposit of soft shale and conglomerates, occurrence of tropical vegetation and influenced of the Western Himalayan floristic province (Ramsar, 2002). The lake area is dominated by Sal forest (*Shorea robusta*) and Black plum (*Syzygium cumini*), Myrobalan (*Terminalia alata*) and other mixed deciduous riverine forest (Ramsar, 2002; Kafle, 2005). There are 45 species of the aquatic vegetation including nine submerged, six free floating, 21 floating leaves and nine emergent species (Lamsal *et al*., 2014). However, the invasive water hyacinth (*Eicchirnia crassipes)* was not found in the Ghodaghodi Lake. Based on Khatri and Baral (2012), there are 34 mammal species, nine reptile species, 140 bird species and 29 fish species. There are 13 species of mollusc recorded (Subba, 2003; Glöer and Bössneck, 2013) from Ghodaghodi Lake.

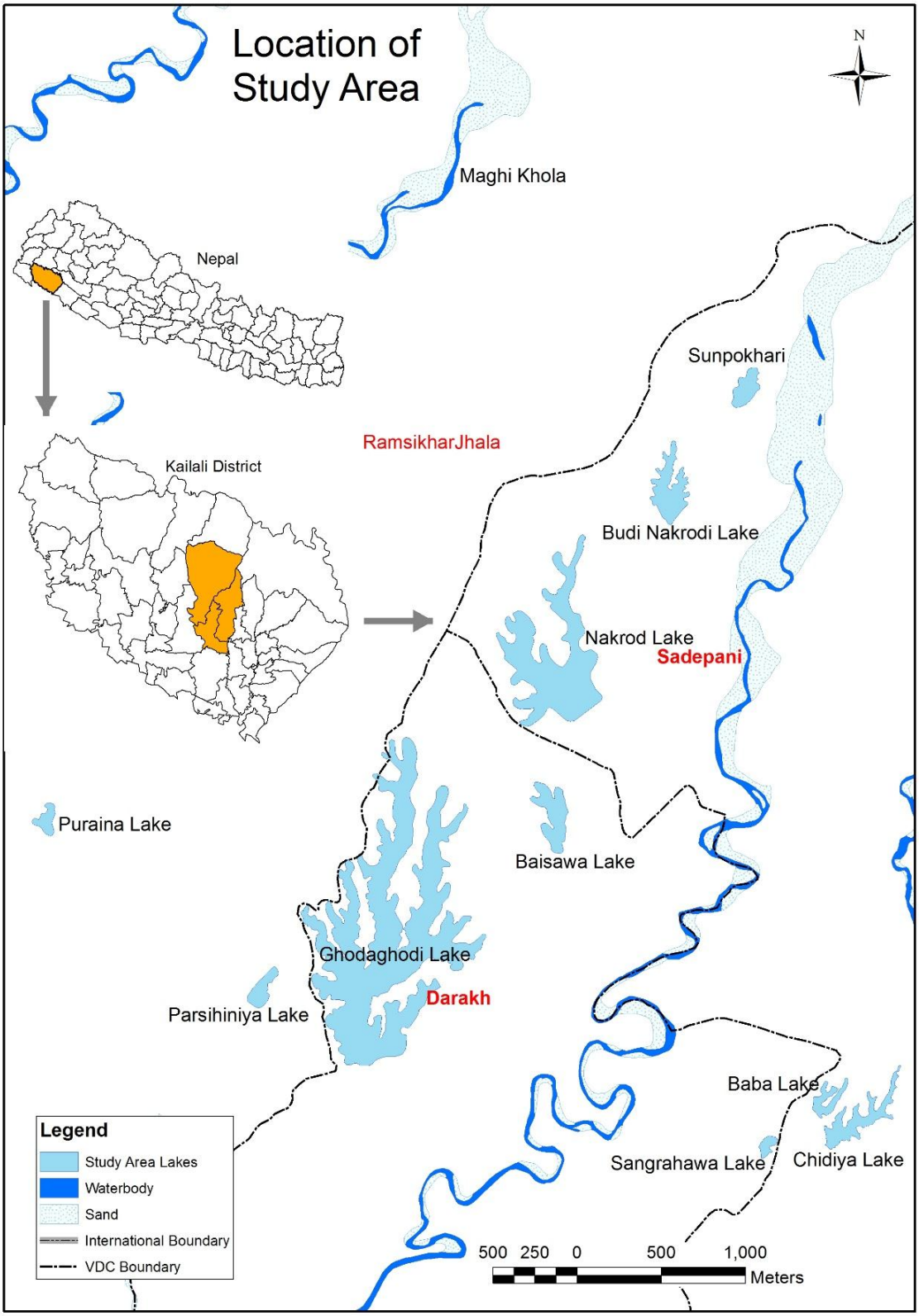

Figure: 1 Map of Study area

3.1.2 Climatic Features

3.1.2.1 Maximum and Minimum Temperature

There is tropical monsoon climatic condition in the study area. Recent data of average maximum temperature has been increased by 0.8°C and the minimum temperature has been decreased by 0.3°C over last 38 years (Figure 2).

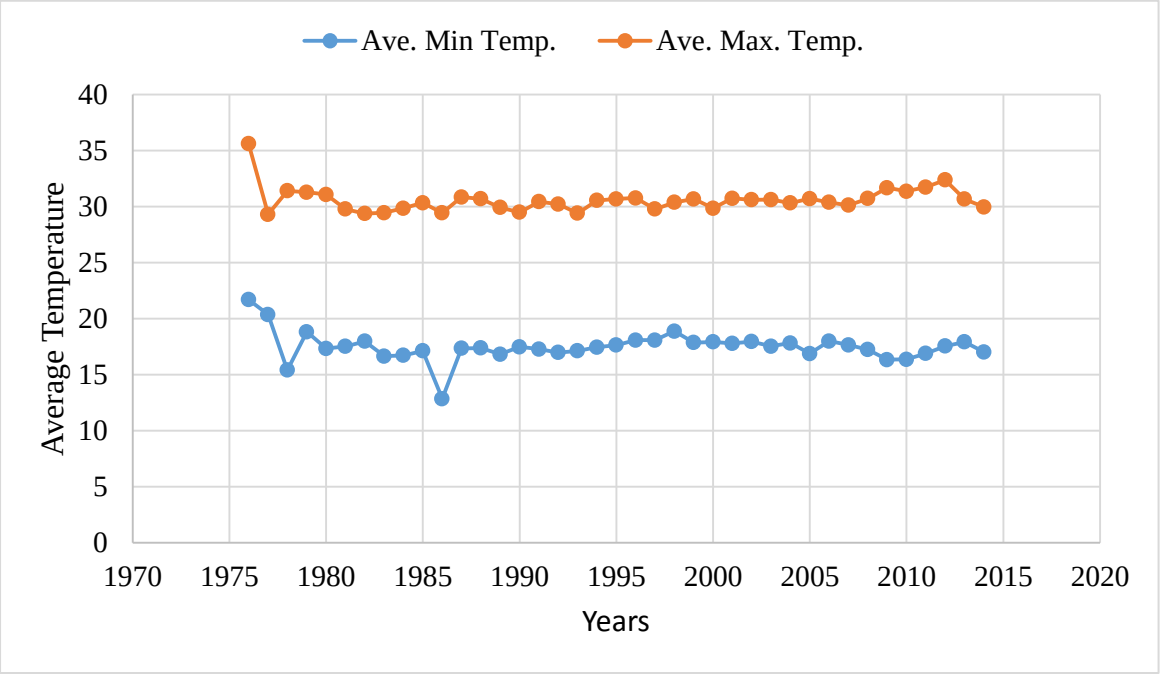

Figure 2: Average maximum and minimum temperature (Tikapur station 1976-2014) (Data source: DHM)

3.1.2.2 Rainfall

The annual rainfall recorded was 1630-1705 mm (Subba, 2003) and drought period remain 5-6 months in a year. The average rainfall pattern of Tikapur over the last 38 years does not show any significant changes in rainfall but heavy rainfall during 1985/86 was seen that was repeated in 2007/2008 and severe drought was noticed during the period (Figure 3).

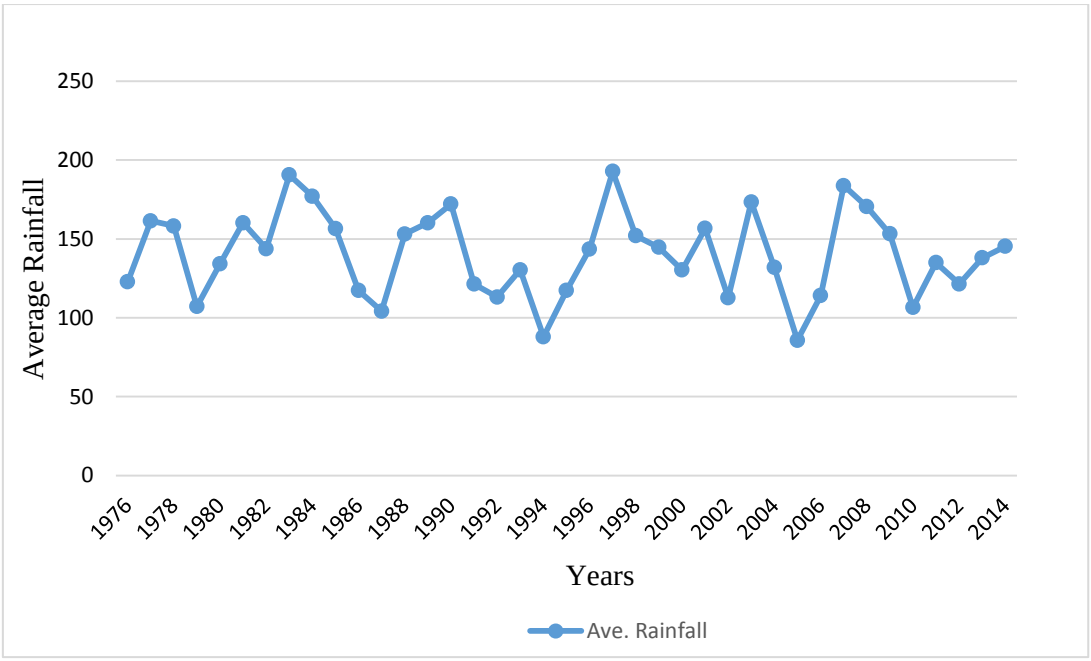

Figure 3. Average rainfall (Tikapur station 1976-2014) (Data source: DHM)

3.1.2.3 Humidity

The relative humidity of Tikapur over the last 38 years (1976- 2014) has been decreased by 7.5 % from 79.5 to 72.0 (Figure 4).

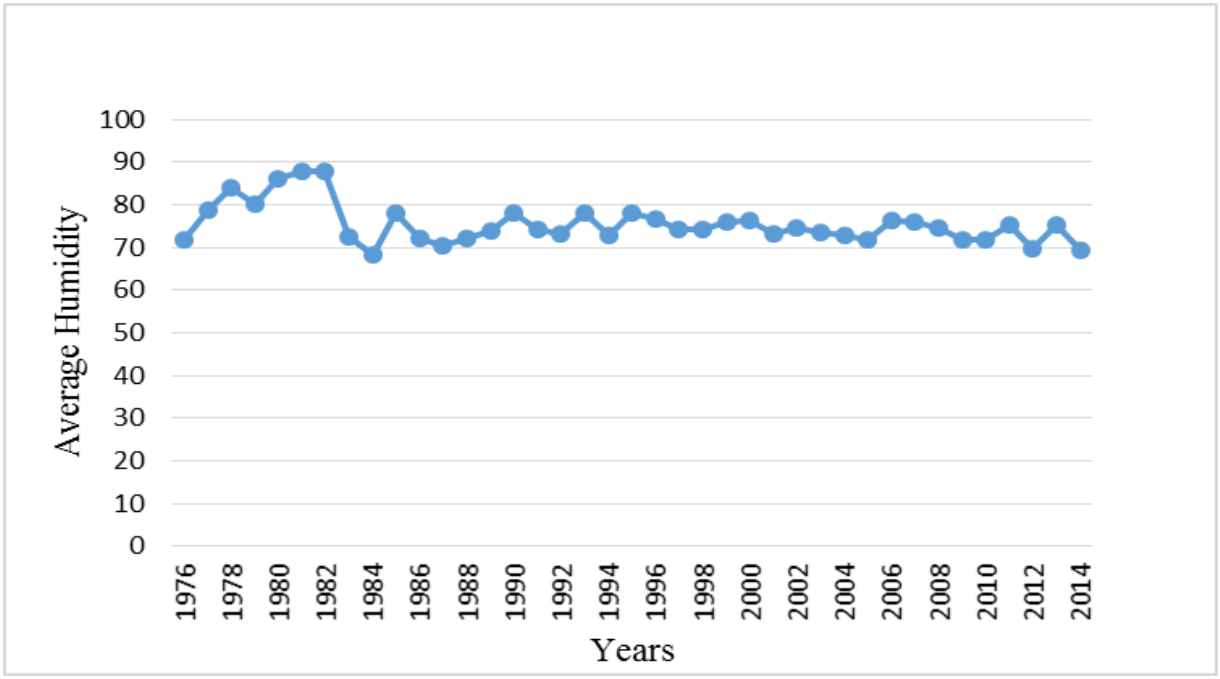

Figure 4. Average humidity (Tikapur station 1976-2014) (Data source: DHM)

3.2 Materials

Following materials were used in research wok

- Collecting nets, seive
- 90 % alcohol as preservative
- Collecting vails
- DO meter (Lutron)
- Rope
- Metal bucket
- GPS (etrex 10)
- Camera(Canon)
- Measuring tape

3.3 Methods

3.3.1 Research Design

Field survey was conducted from March-April, 2016. Ghodaghodi lake complex and associated lakes viz. Nakhrod Lake, Baisahawa Tal, Budi Nakhrodi Tal, Sunpokhari, Parsihiniya Tal, Puraina Tal, Baba Tal, Chidiya Tal, Sangrahawa Tal were assessed. Data were collected by extensive field survey, interview and on the spot inquiries. Climate change data of nearer station (Tikapur station) were bought from the Hydrological and Meterological Department, Kathmandu.

3.3.2 Data Collection

3.3.2.1 Field Survey

Molluscs collection was done in both in undisturbed and disturbed banks. Large sized molluscs were collected by hand picking and small sized molluscs were collected with netting, seiving and dragging substrate by metal bucket. Geographic co-ordinates, DO, water temperature, water depth, vegetation vicinity, and substratum were recorded. Geographic co-ordinates were recorded with hand held GPS device. DO and water temperature were measured with calibrated DO meter. Water depth was marked from substratum and water level in rope then measured by measuring tape. Similarly, substratum was categorized into sand, gravel, mud and litter on the basis of composition. Species checklist was prepared from each site including live animals and dead shells. Unidentified species were preserved in 90% alcohol and dead shells were stored in plastic zipper bag and brought to Central Department of Zoology, Kirtipur for further identification. Species were identified by using Ramakrishna and Dey (2007), Nesemann *et al*.(2007) and Budha (2016a and 2016b).

3.3.2.2 Questionnaire Survey

The Tharu community of Ramsikharjhala, Sadepani and Darak of the study area were purposively chosen. Structured close/open questionnaire were randomly asked to the respondents among Tharu community to get qualitative and quantitative data on the consumption trends of molluscs to minimize missing chance of experienced and wise expertise. The most of the questionnaires were filled in the survey spots from the persons involved in molluscs collection and fishing.

3.3.2.3 Data Analysis

Data were analysed qualitatively and quantitatively. Qualitative data were analysed in Ms-excel. Molluscan diversity data, Hydrological and Meteorological data were analysed in Ms excel 2010. Significance of DO, water temperature, water depth and elevation with molluscan diversity were tested by one-way ANOVA and Spearman's correlation coefficient using R-software (R Core Team, 2016). Molluscan diversity was found with Shannon weiner Index and Menhinick's index for species richness ($D= s/\sqrt{N}$, s equals the number of different species represented in sample and Nequals the total number of individual organisms in the sample). Molluscs measurement were taken by graph paper.

3. RESULTS

4.1 Freshwater Molluscs Reported from Study Area

Altogether 17 molluscan species were reported from the study area including 13 gastropods and four bivalve species. Six molluscan species were reported as food and medicinal value.

Class: Gastropoda
Order: Mesogastropod
Superfamily: Vivipaoidea
Family: Ampullariidae
Genus: *Pila* (Bolten) Roeding, 1798
Pila globosa (Swainson, 1822)

Distribution: India, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Baisahawa Tal, Budi Nakrod Tal and Sunpokhari.

Characteristic features: Shell large, smooth, globose, yellowish olive colour with or without narrow purple brown band on the body whorls, umbilivus narrow, operculum thick and shelly, the margin of aperture is thickened all around, nucleus ecentric. **Adult Shell Size**: Shell length ranges from 55-90 mm and shell width 56.0 mm- 65.5 mm.

Pila globosa

Habitat: Ponds, Lakes (Ghodaghodi and Nakhrod), Paddy fields, small stream. They mostly prefer clear water with adequate vegetation and feed on leaves of plants. Female lay eggs on the moist ground by digging mud above the water margin before rainy season and again buried deep in mud (Budha, 2016a).

Economic importance: Their muscles are eaten as meat. First of all snail are kept for boiling so that their operculum can easily taken out, muscles from shell are taken out with any pointed materials and muscles are cleaned several time and fried. They also have medical importance said to be used as curing jaundice, tuberculosis and also for cooling body temperature. Their eggs are used for curing legs and hands spoiled by mud and water in rainy season. These species carry number of trematods species

Diplodiscus sp. (Anjaneyulu, 1967) *Echinostoma cercatria*, *Cercaria andhraensis* (see Ganapati and Rao, 1969).

Family: Viviparidae

Genus: *Bellamya* Jousseaume, 1886

Bellamya bengalensis (Lamarck, 1822)

Distribution: India, Bangladesh, Myanmar, Sri Lanka, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Baisahawa Tal, Budi Nakrod Tal, Sunpokhari, Parsihiniya Tal, Chidiya Tal and Maghi Khola.

Characteristic features: Shell conical, whorls gradually increasing in size, several spiral greyish bands, umbilicus closed, operculum thin, oval. Shells varied in shape, size and colour, number of bands, forms or races according species (Budha, 2016a). **Adult Shell Size**: Shell height; 30.0-54.0 mm and Shell width 20.0-35.0 mm.

Bellamya bengalensis

Habitat: They are found in Lake (Ghodaghodi, Nakhrod, Baisahawa, Sunpokhari, Puraina, Parsihiniya, Budi Nakhrod, Chidiya), pond, stream, ditches, slow moving river (Maghi Khola) and paddy fields.

Economic importance: This is abundant and highly consumed species by Tharu people. This snail have little different process of cooking than *Pila* sp. The molluscs are collected from their habitat and keep them in the bucket with tap water and fine rice grains and maize flour or wheat flour overnight to clear intestinal mud. Next day, they are cleaned for several time, break its apex to boil. Boiled snails were washed again and prepare according to their preference. These species are eaten gravey rather than fried.

B. bengalensis is primary host of different trematode namely *Amphistome*, *Brevifurcate Apharyngeate distome*, *Clinostomoid*, *Gymnocephalus*, *Longifurcate pharyngeate distome*, and *Xiphidio* (Devkota *et al*., 2011) and also intermediate host of *Cercaria asiatica* Sinha and Prashad, 1964, *Cercaria thaparai* Rai, 1962, *Cercaria kumaunensis* Singh and Malaki, 1963 (see Subba Rao, 1989).

Bellamya dissimilis (Mueller, 1774)

Distribution: India, Bangladesh, Malyasia, Myanmar, Pakistan, Srilanka, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Mohana river, Pathraiya river, Parsihiniya Tal.

Characteristic features: Shell globose, smooth, yellow brown, body whorl with one or two white bands on the body whorl. operculum thick with well developed muscular scars, suture deep with swollen spire, yellowish, brown coluration. Comperatively smaller than *B. bengalensis*. **Adult shell size;** Shell height; 23-36 mm, Shell width; 18-26 mm.

Bellamya dissimilis

Habitat: Stagnant water bodies like Lakes (Ghodaghodi and Parsihiniya), Ponds, Streams and Paddy field. These species are comparatively rare than *B. bengalensis.*

Economic importance: Similar as. *B. bengalensis.*

Superfamily: Rissoidea
Family: Bithyniidae
Genus: *Bithynia* Leach, 1818

Bithynia ghodaghodiensis (Glöer and Bössneck, 2013)

Distribution: Endemic to Ghodaghodi lake area.

Characteristic features: Shell small, globose, whitish, silky and smooth surface, umbilicus closed and aperture narrower, whorls regularly increasing, peristome sharp, slightly thickened columella. **Adult Shell Size:** Shell height 5.1 mm and Shell width 3.2 mm.

Bithynia ghodaghodiensis

Habitat: Ponds, Streams, Ditches, Lakes (Ghodaghodi Nakhrod, Sangrahawa).

Genus: *Bithynia* Leach, 1818.

Bithynia ceremeopoma (Benson, 1830)

Distribution: India, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake and Sangrahawa Tal.

Characteristic features: Shell ovate, whorl gradually increasing, umbilicalis deep closed, suture shallow, operculum calcareous, concave, nucleus subcentral, peristome thick. **Adult shell size:** Shell height 8.0-11.0 mm, Shell width

Bithynia ceremeopoma

Habitat: Ghodaghodi Lake, Nakhrod Lake and Sangrahawa Tal.
Superfamily: Cerithioidea
Family: Pachychilidae
Genus: *Brotia* H. Adams, 1866

*Brotia costula (*Rafinesque, 1833)

Distribution: India, Bangladesh, Bhutan, Nepal: Kailali; Maghi Khola.

Characteristic features: Shell turreted, prominent axial ribs, body whorls comparatively large, aperture ovate, well rounded or angled below, operculum thin and rounded, central nucleus or slightly oval. **Adult shell size:** Shell height: 55.0-74.0 mm, Shell width: 22.0-31.0 mm.

Brotia costula

Habitat: Maghi Khola (gravel or sandy bottom).

Economic importance: Collected molluscs are kept in bucket containing tap water and fine rice grain or maize and wheat flour overnight. Next morning they are cleaned properly, apex are broken and boiled with preferable spices. They are also used for duck feeding.

Family: Thiaridae
Genus *Melanoides* Olivier, 1804

Melanoides tuberculata (Mueller**,** 1774)

Distribution: Cosmopolitan, distributed from southern and eastern shores of Mediterranean through Africa, Asia, China and North Australia, Nepal (Rivers of Terai and midhills but absent in high silt loading flood rivers of Churiya): Kailali; Maghi Khola.

Characteristic features: Shell turreted, increasing regularly, dark red brown patches and flame are regularly distributed or longitudinally arranged, sculpture with vertical ribs and spiral striae, shape and sculpture varied, tubercles on specimens of Southern Asia are less strongly developed than those from Mediterranean (Budha, 2016a). **Adult shell size:** Shell height 55.0-74.0 mm, Shell width: 22.0-31.0 mm.

Habitat: Stream (sandy and gravel bottom covered with silt); Maghi Khola.

Melanoides tuerculata

Economic importance: Based on Pinto and Melo (2011) *M. tuberculatus* were reported as intermediate host of 37 trematodes species from Asia, Africa, America, Oceania. Trematodes like *Acanthostomum burminis, Mesostephanus haliasturis, Echinochasmus bagulai, E. japonicus, E. milvi, Eumegacetes artamii, E. spinosus, Orthetrotrema monostomum, Gastrodiscus aegyptiacus,Centrocestus caninus, C. formosanus, Haplorchis taichui,; H. yokogawai, Haplorchoides cahirinus, H. mehrai, Heterophyes heterophyes, Procerovum cheni, P. varium, Pygidiopsis genata, Stellantchasmus falcatus, Paralecithodendrium pyramidium, Notocotylus mamii, Paramonostomum aegyptiacus, Clonorchis sinensis, Paragonimus westermani, Calicophoron microbothrium, Philophthalmus distomatosa, P. gralli, P. nocturnus, Loxogenoides bicolor, Neopronocephalus triangularis, Grysoma indica, Gigantobilharzia sp., Transversotrema patialense*.

Pulmonata
Order: Basommatophora
Superfamily: Lymnaeoidea
Family: Lymnaeidae
Genus: *Lymnaea* Lamarck, 1799

Lymnaea acuminata (Lamarck, 1822)

Distribution: India, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Baisahawa Tal, Puraina Tal, Parsihiniya Tal, Baba Tal, Sangrahawa Tal.

Characteristic features: Shell shape varies, in general ovate, large and reddish brown in colour. **Adult Shell size:** Shell height 25.0-44.0 mm and shell width 16.0-24.0 mm.

Lymnaea acuminata

Habitat: All over India, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Baisahawa Tal, Puraina Tal, Parsihiniya Tal, Baba Tal, Sangrahawa Tal, Sunpokhari, Chidiya Tal, Kolkatla Tal, Laukabhoka Tal, Bandrahuwa Tal, Bathanchamka Tal, Bakhari Tal.

Economic importance: These animals perform as intermediate host of *Schistosoma spindale, S. nasale, S. indicum* (Liu *et al*., 2010), *Fasciola gigantica, Clinostomum gigantica* (Subba Rao, 1989).

Genus: *Radix* Montfort, 1810

Radix persica (Issel, 1865)

Distribution: Afghanistan, India, Italy, Spain, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Baisahawa Tal, Parsihiniya Tal, Sangrahawa Tal.

Radix persica

Characteristic features: Shell shape is rapidly increasing, body whorl inflatted, suture deep, aperture widley opened, outer lip expanded, columella reflected. **Adult shell size:** Shell height: 18.0-25.0 mm, Shell width: 12-16 mm.

Habitat: Pond, Lake with abundant vegetation (Ghodaghodi Lake, Nakrod Lake, Parsihiniya Tal, Baisahawa Tal, Sangrahawa Tal).

Superfamily: Planorboidea
Family: Planorbidae

Gyraulus convexiusculus (Hutton, 1849)

Distribution: Afghanistan, Iran, India, Pakistan, Myanmar, Thailand, Philippines and Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake and Parsihiniya Tal .

Characteristics Feature: Shell small, discoidal and transparent, umbilicus wide and whorl 4-4.5 gradually increasing, whitish or yellowish brown in colour, aperture moon shaped and peristome sharp. **Adult shell size:** Shell height 1.8-3.0 mm, shell width 6.0-8.0 mm.

Gyraulus convexiusculus

Habitat: Ghodaghodi Lake, Nakhrod Lake and Sangrahawa Tal.

Economic importance: Carry the larval form of *Gastrothylase crumenifer*, *Paramphistomum explanatum*, *Fasciola elongatus*, *Cercaria chugathi*, *C. gyraulusi*, *C. rithorensis*, *C. furgolensis* (see Subba Rao, 1989).

Genus *Hippeutis* Agassiz, 1837

Hippeutis umbilicalis

Hippeutis umbilicalis (Benson, 1836)

Distribution: India, China, Taiwan, Philippines, Sri Lanka, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Sangrahawa Tal.

Characteristics Features: Shell transparent, small, discoidal, whorls rapidly increasing, aperture heart shape, internal lamellae absent and shell periphery bluntly angular. **Adult shell size:** Shell height 1.8 -2.3 mm, Shell width 4.5-8.0 mm.

Habitat: Mostly present in habitat with vegetation (Ghodaghodi Lake, Nakhrod Lake, Sangrahawa Tal).

Economic importance: These serve as intermediate host of *Fasciolopsis buski*, *Cercaria helicorbis* (Kumar and Jain, 1968).

Genus *Segmentina* Fleming, 1817

Segmentina calatha (Benson, 1850)

Segmentina calatha

Characteristics features: Shell small, thin, transparent and whitish in colour, whorls convex above and flattened below, three internal lamellae present, aperture moon shape. **Adult Shell size:** Shell height 1.8-2.1 mm, shell width 4.5-5.0 mm.

Habitat: Cosmopolitan in distribution mainly in North India, SriLanka, Myanmar, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Sangrahawa Tal.

Family: Bulinidae

Genus *Indoplanorbis* Annandale and Prasad, 1921

Indoplanorbis exustus **(**Deshayes, 1834)

Indoplanorbis exustus

Distribution: China, Japan, Malaysia, Sri Lanka, Myanmar, India, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Baisahawa Tal, Baba Tal Sangrahawa Tal.

Characteristics features: Shell discoidal with fine surface and irregular sculpture, rapidly increasing,

yellowish and brownish in colour, peristome sharp. **Adult Shell size:** Shell height 19.0-25.0 mm, Shell width 9.0-13.0 mm.

Habitat: Lake (Ghodaghodi, Nakhrod, Baisahawa, Baba, Sangrahawa), Ponds, ditches and Paddy field. Especially tolerate pollution.

Economic importance: Intermediate host of *Schistosoma indicum* Montgomery (Dutt and Shrivastava, 1961). *Artyfechinostomum* and *Hypoderaeum conoideum* (Hai *et al*., 2009), *Spirorchids, S. nasale, S. spindale*, *Echinostoma* spp. (Liu *et al*., 2010).

Superfamily: Corbiculioideae
Family: Pisidiidae
Genus *Sphaerium* Scopoli, 1777

Sphaerium indicum (Deshayes, 1854)

Distribution: India, Nepal: Kailali; Ghodaghodi Lake, Nakhrod Lake, Chidiya Tal, Ojhuwa Tal, Sangrahawa Tal, Baba Tal.

Characteristic features: Shell thin, transparent, oval bluntly triangular with brownish colour, umbones less prominent, weak concentric striae. **Adult Shell size:** Shell height 3.1-5.2 mm, Shell width 2.0-4.0 mm.

Habitat: Lake (Ghodaghodi, Nakhrod, Sangrahawa), Ponds, Ditches, Stream.

Sphaerium indicum

Genus *Pisidium* Pfeiffer, 1821

Pisidium sp.

Distribution: Cosmopolitan, China, Japan, Myanmar, Thailand, Nepal: Kailali; Sukhi Kauwa, Machhi Khola, Ghaila Khola, Ghodaghodi Lake, Nakhrod Lake, Sangrahawa Tal.

Characteristics features: Shell small, shiny, yellowish or, whitish in colour, delicate and oval or triangular. Adult shell size: Shell height 3.0-5.0 mm, Shell width 2.0-4.0 mm

Habitat: Rivers and Stream (Maghi Khola)

Pisidium species

Superfamily: Unionoidea
Family: Unionidae
Genus *Parreysia* (Mueller, 1774)

Parreysia favidens (Benson, 1862)

Distribution: Throughout the India, Bangladesh, Pakistan, Nepal: kailali; Maghi Khola.

Characteristics features: Shell elongated, thick, cardinal broad and strong teeth, outer surface rough and internal surface is shiny. **Adult shell size:** Shell length 35.0-66.0 mm, shell width 27.0-45.0 mm.

Parreysia favidens

Habitat: Stream (Maghi Khola) (Sandy bottom covered with litter), irrigation canal rich with submerged vegetation (Budha, 2016a).

Economic importance: These Bivalve muscles are used as fried meat (Preparing and cooking process is similar to as *Pila* sp). Their shell are used for decorating handicraft materials called "Dhakiya" in Tharu community, preparation of lime by burning in cow dung, Shell are also used in manufacturing shell Button, shell grit, and source of pearls, dust and residual pieces are used in the poultry food and mosaic tiles preparation (Baneerjee and Satish, 1988), peeling rind of mangoes and potatoes.

Genus *Lamellidens* Simpson, 1900

Genus *Lamellidens marginalis* (Lamarck, 1819)

Distribution: India, Bangladesh, Srilanka, Nepal: Kailali; Maghi Khola.

Characteristics features: Shell slightly inflated, umbones not well elevated, blakish brown, dorsal slope slightly curved and posterior wing narrow. **Adult shell size:** Shell length 95.0-100.0 mm, Shell width: 50.0-52.0 mm.

Lamellidens marginalis

Habitat: Prefer as the habitat *P. Favidens* does.

Economic importace: Preparing and cooking process is similar to *P. favidens*. The shells are used for pilling vegetables, preparing edible lime by local people.

4.2 Habitat Characteristics of Studied Lakes

Altogether ten Lakes and one river was surveyed. The Lakes size ranges from74.17 ha to 0.49 ha. Ghodaghodi Lake is the largest lake (74.17 ha) followed by Nakhrod Lake (70 ha). Other Lake are comperatively small eg. Budhi Nakhrod (5.46 ha), Chidiya Tal (4.93 ha), Baisahawa Lake (4.83 ha), Sangrahawa Tal (3.7 ha), Sunpokhari (2.4 ha), Parsainiya Tal (2.0 ha), Baba Tal (1.96 ha), Puraina Tal (0.46 ha). The most lakes stand at an elevation ranges from 143 m to 204 m. Ghodaghodi and Nakhrod lakes have mostly muddy bottom, submerged and floating vegetation while other lakes have muddy bottom but Chidiya Lake has sandy and gravel bottom in some of its part. Ghodaghodi and Nakhrod Lakes have abundant number of gastropoda and bivalves juviniles while other lakes bear less amount of gastropods and bivalves. Maghi Khola is only stream studied that have sandy bottom mixed with littoral and both bivalves were found in maximum amount in compare to gastropods.

Table 1: Parameters and Characteristics in Relation to Lake Size

Name of lakes	Lake size (ha)	Conservation status	Quadrates	Parameters						Class		Species no. molluscs	Total species
				Elevation (m)	Dissolved Oxygen(mg/l)	Water temperature (^{0}C)	Water depth (m)	Vegetation vicinity	Substratum	Bivalves	Gastropoda		
Ghodaghodi Lake	74.17	Undisturbed	1	204	6.55	31	0.5	Sm	M	+	+	7	
			2	183	4.45	31	1	Sm	M	+	+	5	
			3	191	5.3	30	1.3	Sm	M	+	+	4	
			4	179	5.85	30	1	Sm	M	+	+	5	
			5	186	6.55	26	1.05	Sm	M	+	+	8	
			6	163	5.6	30	0.3	Sm	M	+	+	4	
			7	159	6.3	29	1	Sm	M	+	+	6	
			8	190	4.6	24	0.2	Sm	M	+	+	5	13
Nakhrod Lake	70	Undisturbed	1	180	4.93	31	0.2	F,L	M	+	+	6	
			2	190	4.15	31	0.4	F,L	M	+	+	5	
			3	167	4.7	28	0.3	F,L	M	+	+	3	
			4	174	4.45	31	1	F,L	M	+	+	7	
			5	187	3.5	30	1	F,L	M	+	+	6	12
			6	178	3.6	31	0.67	F,L	M	+	+	3	

Baisahawa Tal	4.83	Disturbed	1	158	3.3	28	0.1	W	M	_	+	2	
			2	148	3.4	27	0.2	W	M	_	+	3	
			3	143	3	28	0.1	W	M	_	+	2	
			4	169	2.4	31	0.1	W	M	_	+	2	5
Sun Pokhari	2.4	Disturbed	1	184	3.35	28	0.3	_	M	_	+	2	
			2	175	3.3	27	0.2	_	M	_	+	1	
			3	191	3.35	31	0.2	_	M	_	+	2	
			4	175	2.95	31	0.2	_	M	_	+	2	2
Budi Nakhrod Lake	5.46	Disturbed	1	185	4.1	32	0.15	_	M	_	+	2	
			2	198	4.9	34	0.2	_	M	_	+	2	
			3	180	5.1	33	0.2	_	M	_	+	2	
			4	180	4.2	32	0.2	_	M	_	+	1	2
Chidiya Tal	4.93	Disturbed	1	166	5.7	30	0.4	_	M, G	_	_		
			2	169	5.4	32	0.4	_	M, G	_	_	0	
			3	165	4.9	32	0.3	_	M, G	_	_		0
Baba Tal	1.96	Disturbed	1	173	3.7	29	0.3	FL	M	_	_		
			2	170	3.5	30	0.2	FL	M	_	_	0	
			3	155	3.1	30	0.3	W	M	_	_		
			4	168	3	30	0.3	W	M	_	_	0	0
Sangrahawa Tal	3.7	Disturbed	1	171	4.2	29	0.1	_	M	+	+	7	
			2	172	3.4	31	0.15	_	M	+	_	5	
			3	172	3.9	32	0.2	_	M	+	_	4	
			4	192	3.1	33	0.2	_	M	+	_	4	9
Puraina Tal	0.49	Distured	1	201	5.5	27.8	0.4	_	M	_	+	2	
			2	187	4.4	27.1	0.4	_	M	_	+	2	3
Parsihiniya Tal	2	Disturbed	1	175	4.4	30.9	0.4	_	M	_	+	3	
			2	174	4.5	31	0.3	_	M	_	+	2	4
Maghi Khola		Disturbed	1	208	7	24.8	0.3	_	S, L	+	+	4	
			2	205	7.1	24.3	0.2	_	S, L	+	+	4	
			3	205	7.4	26.1	0.2	_	S, L	+	+	5	
			4	195	7.2	26.8	0.3	_	S, L	+	+	2	5

[Note: S= Sandy bottom, M= Muddy bottom, L= Littoral bottom, G= Gravel bottom, W= weeds, Sm=Submerged, FL= Floating, '+' indicates presence of molluscs species and – indicatea absence of molluscs species, Undisturbed means protected and disturbed means frequent approach by human being]

4.3 Species Diversity of Freshwater Molluscs

Ghodaghodi Lake and Nakhrod Lake are two undisturbed lake that have highest molluscan diversity (H=2.1704) and (H=2.1241) respectively followed by Sangrahuwa Tal (H=2.066), Parsihiniya Tal (H=1.2035), BudhiNakrod (H=0.5625), Sunpokhari (H=0.50038), Puraina Tal (H=0.3558), Maghi Khola (H=1.261) Baba Tal and Chidiya Tal (H=0). Similarly, highest DO was observed in Maghi Khola i.e 7.2 mg/l followed by Chidiya Tal 5.5 mg/l, Ghodaghodi Lake 5.49 mg/l, Puraina Lake 4.95 mg/l, BudhiNakhrod 4.56 mg/l, Nakhrod Lake 4.23 mg/l, Parsihiniya Tal 4.1 mg/l, Sangrahawa Tal 3.26 mg/l, Sunpokhari 3.24 mg/l, Baba Tal 3.17 mg/l and Baisahawa Lake 3.03 mg/l. The highest temperature was observed in BudiNakhrod i.e 32.5 ^{0}C followed by Baba Tal 31.92 ^{0}C, Chidiya Tal 30.35 ^{0}C, Nakhrod Lake 30.05 ^{0}C, Baisawa Tal 28.73 ^{0}C, Ghodaghodi lake 28.33 ^{0}C, Puraina Tal 27.35 ^{0}C, Maghi Khola 25.4 ^{0}C. Similarly, highest water depth was seen in Ghodaghodi Lake i.e 0.79 m following Puraina Tal 0.38 m, Chidiya Tal 0.33 m, Nakhrod Lake 0.3 m, Maghi Khola 0.24 m, Baba Tal and Sunpokhari 0.23 m, BudiNakhrod 0.19 m, Sangrahawa Tal 0.18 m, Baisahawa Tal 0.13 m. The Largest Lake was Ghodaghodi Lake with lake size 74.17 m followed by BudiNakhrod 5.46 m, Chidiya Tal 4.93 m, Baisahawa Tal 4.83 m, Singrahawa Tal 3.7 m, Sunpokhari 2.4 m, Parsihiniya Tal 2.0 m and Baba Tal 1.96 m (Table 2).

Large bivalve species like *P. favidens* and gastropods *M. tuberculata* are abundant in Maghi Khola at temperature 24.2-26.65 ^{0}C but small gastropods and bivalves were seen abundant in lake where high submerged vegetation are maximum lik Ghodaghodi Lake and Nakhrod Lake. Death molluscs were found in Nakhhrod and Sangrahawa while no molluscs were found in Chidiya and Baba Tal. Except Ghodaghodi Lake, Nakhrod Lake, Maghi Khola all the water bodies are used for fish farming. They use lime, salt regularly while fish farming.

Table 2. Species diversity of freshwater molluscs in different water bodies and their water quality parameters

S. N	Lake's Name	Species diversity	Species richness	Parameters	Mean	SD	Min	Max
	Ghodaghodi Lake	2.1704	0.230	No. Molluscs	4.25	1.83	4	7
				DO(mg/l)	5.49	0.74	4.45	6.55
				Water temp.(0C)	28.33	2.53	24.05	30.65
				Depth(m)	0.79	0.56	0.2	1.05
				Elevation(m)	181.88	14.86	159	204
2	Nakhrod Lake	2.1246	0.282	No. Molluscs	3.5	0.96	2	5
				DO(mg/l)	4.23	0.54	0.3	4.95
				Water temp.(0C)	30.05	0.99	28.1	30.9
				Depth(m)	0.3	0.06	0.2	1
				Elevation(m)	180.33	8.1	167	190

3	Baisahawa Lake	1.1069	0.165	No. Molluscs	2.25	0.5	2	3
				DO(mg/l)	3.0328	0.45	2.5	3.4
				Water temp.(0C)	28.73	1.83	27.4	31.4
				Depth(m)	0.13	0.05	0.1	0.2
				Elevation(m)	154.5	11.5	143	169
4	BudiNakhrod Lake	0.5625	0.9	No. Molluscs	2.25	0.96	1	3
				DO(mg/l)	4.56	0.51	4.1	5.1
				Water temp.(0C)	32.56	0.69	31.9	33.45
				Depth(m)	0.19	0.03	0.15	0.2
				Elevation(m)	185.75	8.5	180	198
5	Sunpokhari	0.50038	0.89	No. Molluscs	1.25	1.26	1	3
				DO(mg/l)	3.24	0.19	2.95	3.35
				Water temp.(0C)	29.1	1.84	26.95	30.8
				Depth(m)	0.23	0.05	0.2	0.3
				Elevation(m)	181.25	7.76	175	191
6	Sangrahawa Tal	2.0661	0.25	No. Molluscs	5	1.41	4	7
				DO(mg/l)	3.64	0.49	3.1	4.2
				Water temp.(0C)	26.99	1.49	25.1	28.6
				Depth(m)	1.18	0.03	0.15	0.2
				Elevation(m)	177	10.03	171	192
7	Baba Tal	0	0	No. Molluscs	0	0	0	0
				DO(mg/l)	3.17	0.36	2.8	3.65
				Water temp.(0C)	31.92	0.59	31.1	32.5
				Depth(m)	0.23	0.06	0.2	0.3
				Elevation(m)	157.33	22.94	131	173
8	Chidiya Tal	0	0	No. Molluscs	0	0	0	0
				DO(mg/l)	5.5	0.43	4.9	5.9
				Water temp.(0C)	30.35	0.64	29.65	31.2
				Depth(m)	0.33	0.05	0.3	0.4
				Elevation(m)	162.67	4.5	159	169
9	Puraina Tal	0.3558	0.268	No. Molluscs	1.5	0.71	1	2
				DO(mg/l)	4.95	0.78	4.4	5.5
				Water temp.(0C)	27.35	0.49	27.5	27
				Depth(m)	0.38	0.11	0.3	0.45
				Elevation(m)	187	19.79	173	201
10	Parsihiniya Tal	1.2035	0.25	No. Molluscs	2.5	0.71	2	3
				DO(mg/l)	4.1	0.14	4	4.2
				Water temp.(0C)	30.65	0.92	30	31.3
				Depth(m)	0.4	0	0.4	0.4
				Elevation(m)	174.5	0.71	174	175
11	Maghi Khola	1.261	0.139	No. Molluscs	3.37	1.26	2	5
				DO(mg/l)	7.2	0.17	7	7.4
				Water temp.(0C)	25.4	1.16	24.2	26.65
				Depth(m)	0.24	0.05	0.2	0.3
				Elevation(m)	201	10.74	185	208

DO, water temperature, depth, and elevation were found statistically significant on mollusc species in study area. Low degree of Spearman's Correlation was revealed between all parameters (DO, water temperature, water depth, elevation) and molluscs species (Table 3). Negative correlation was revealed between water depth and molluscs species while other parameters were positively correlated.

Table 3. Testing significance of different parameters on species of Molluscs by one way ANOVA and calculating Spearman's correlation coefficient.

S.N.	Parameters	F-value	Pr(>F)	Remarks	Cor. Coefficient (r)
1	DO (mg/l)	7.429	0.00965	**	0.351484
2	Water Temperature ^{0}C	5.386	0.02576	*	0.3839809
3	Depth (cm)	5.817	0.02081	*	-0.3970657

Significance codes: 0 '***'= strong significant, 0.001'**'=high significant, 0.01 '*'=significant, and 0.05 '.'=little significant.

4.4 Harvesting Freshwater Molluscs

Mostly people collect edible molluscs while going for fishing in nearby rivers, streams and Lakes and rarely go only for molluscs collection. They use their local tools like Heluka for fishing and collecting molluscs also. Total 73% respondents (N=45) said of using their local tools and 27% respondents goes for hand picking (Figure 5).

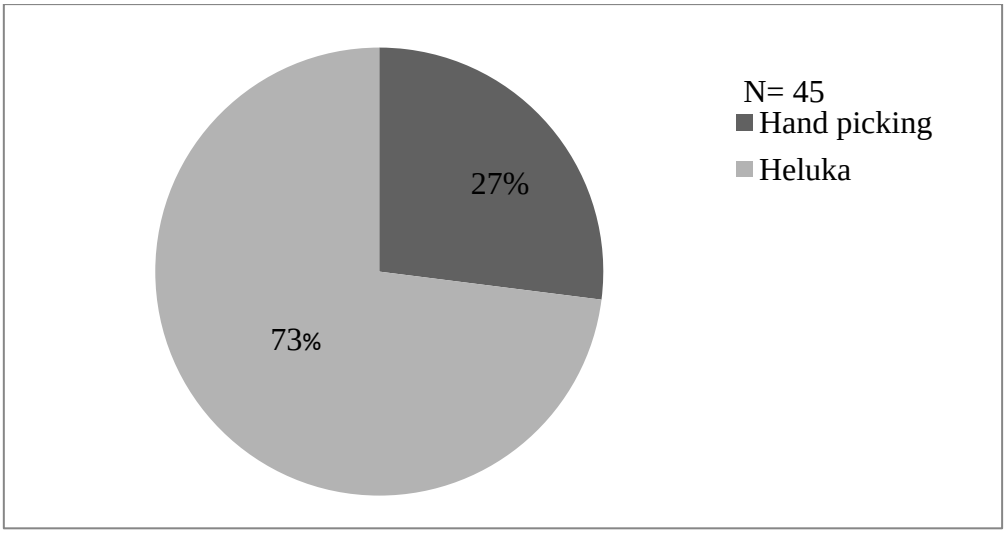

Figure 5. Mollusc's collection methods in Tharu community

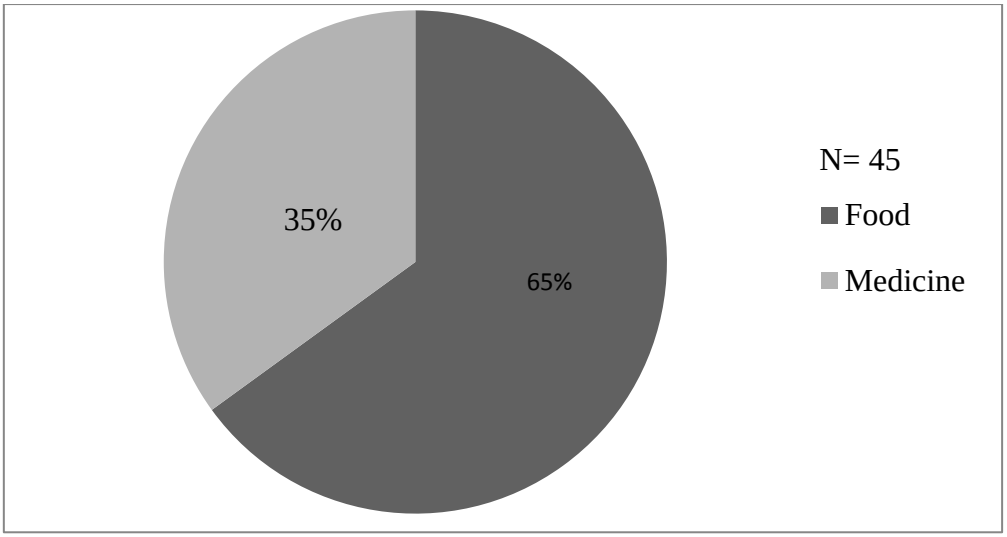

Figure 6. Collection purpose of molluscs

About 65% respondent (N=45) collect molluscs for food and 35% respondent collect molluscs for medicinal value. Molluscs shells used for lime preparation, cleaning utensils and decorating handicraft materials like "Dhakiya" and other local handicraft (Figure 6).

4.4 Preference of Molluscs

Altogether, six species of freshwater gastropods and bivalves were identified as food value, four species belonging to gastropods (*B. bengalensis*, *B. dissimilis*, *Brotia costula* and *P. globosa*) and two of Bivalve (*L. marginalis* and *P. favidens*). Among them *Bellamya* spp. were the most prefered species following *P. globosa* 7%, Bivalves species 4% (Figure 7).

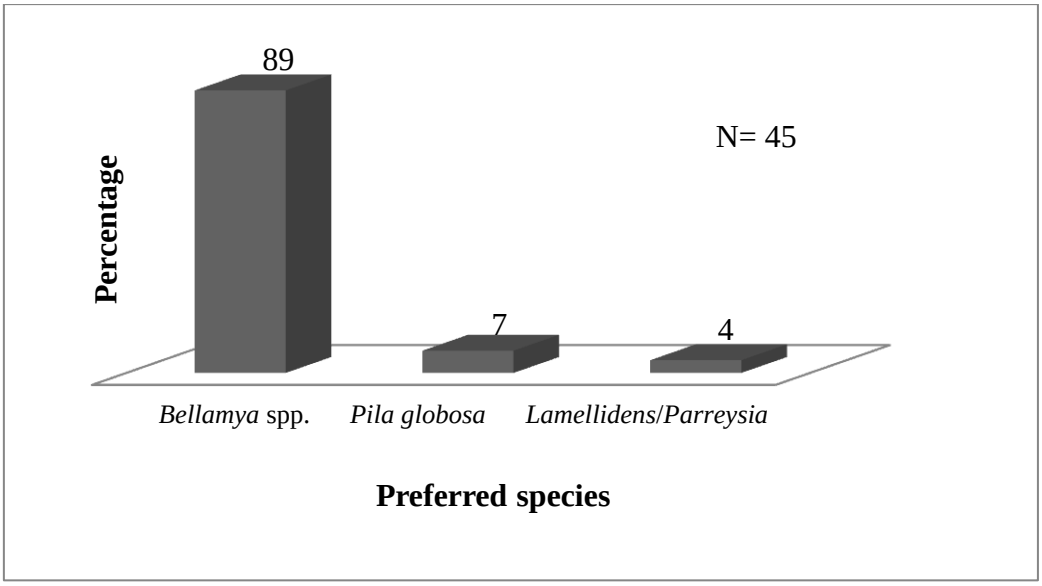

Figure 7. Preferred species by respondents

4.5 Consumption Trends of Edible Molluscs

According to respondents (N=45) 62% said that molluscs consumption has been decreasing in compared to the past 10-20 years because of low availability of molluscs fauna. However 20% respondents said that the consumption trends has been increased due to increased human population but 18% respondents said it was as the past (Figure 8).

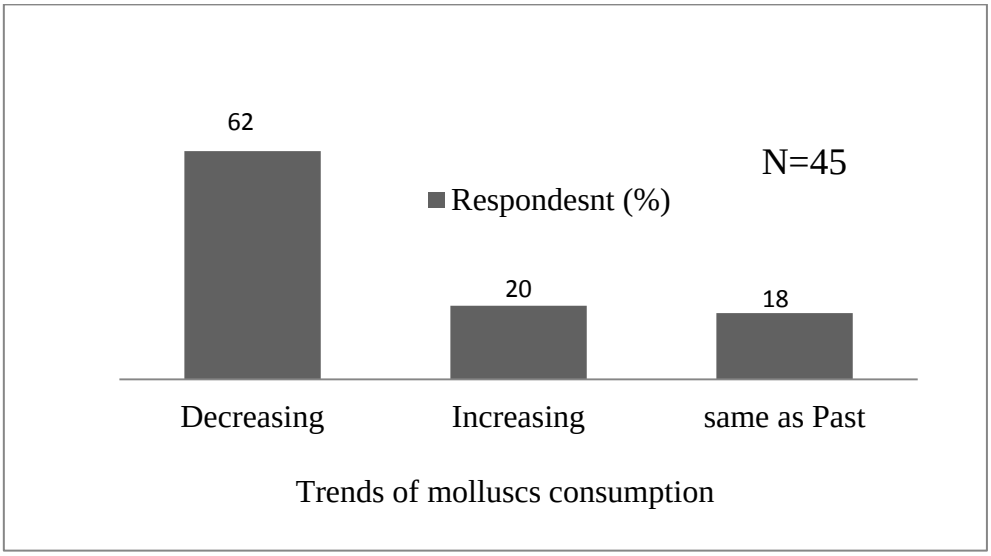

Figure 8. Consumption trends among Tharu community

4.6 Conservation Threats

Among respondents (N= 45) 48% informed high consumption was the main cause of decreasing population due to increased human population, awareness and new taste among the youngstar of edible molluscan species following fish poisoning (26%), habitat loss (20%) and Water pollution (6%) are also reported in the study area responsible for declining molluscs population (Figure 9).

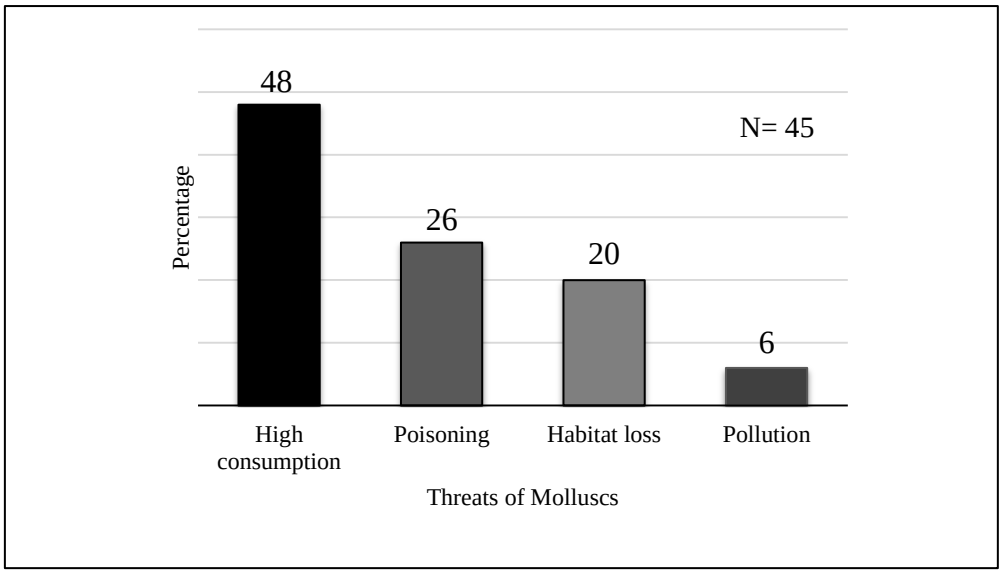

Figure 9. Reason of mollusc destruction

Local respondents were also asked if there was any changes in the climatic condition in the study area. Respondents were experienced with changing in monsoon pattern (62%), drought (25%) and blowing hot air (13%) which is one of the impact responsible in declining population of aquatic fauna in the study area (Figure 10).

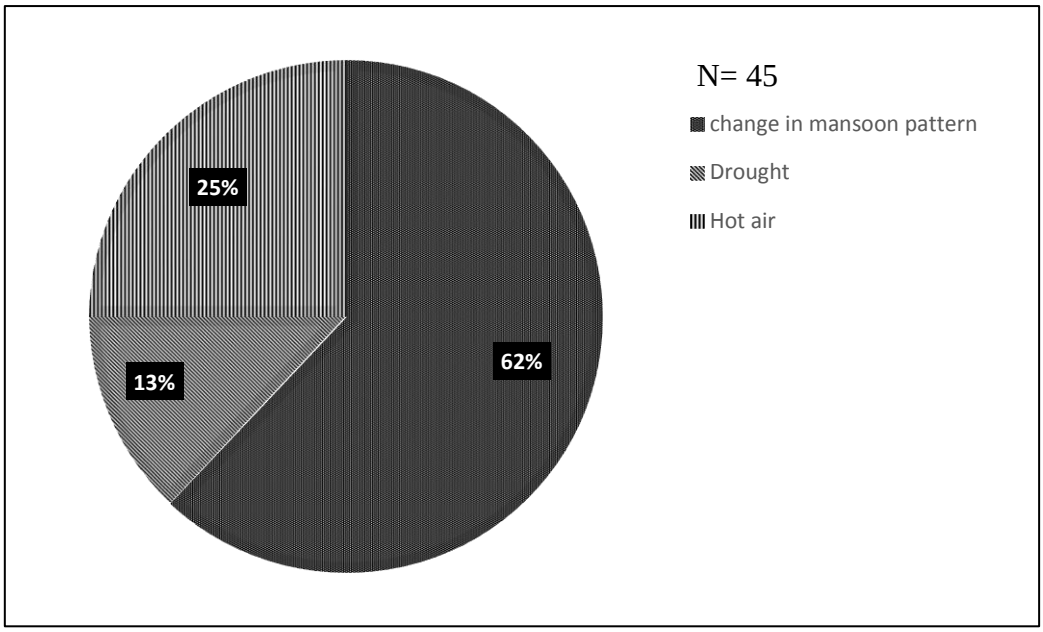

Figure 10. People's perception of climate chang

5. DISCUSSION

5.1 Diversity

The study revealed the diversity in relation to water quality parameters of molluscs in Ghodaghodi Lake complex in Kailali district Nepal. This study reported 17 species of freshwater molluscs among them 13 were gastropods including one endemic species *B. ghodaghodiensis* (Glöer and Bössneck, 2013) and 4 were bivalve species in summer season The study also showed the highest diversity of the mollusc in Ghodaghodi Lake and Nakhrodi Lake and highest species richness in Budhi Nakhrod. Both lakes are undisturbed because exploitation of aquatic resource are restricted due to Ramsar site and larger than other surveyed water bodies while other lakes were used for fish farming which have low molluscan diversity. Subba (2003) reported 10 species of freshwater molluscs from Ghodaghodi Lake. Similarly, Budha (2016) noted 32 species of freshwater molluscs from Kailali district, Nepal including Ghodaghodi Lake.

Small bivalve molluscs like *Sphaerium indicum, Pisidium* species and *I. exustus*, *B. ghodaghodiensis*, *B. ceremeopoma* were found abundant in Ghodaghodi and Nakhrod Lakes. Hence, high abundance of *Radix persica, S. indicum, Pisidium* species and *I. exustus* were highly associated with submerged and floating lotus plants which provides habitat and wide surface to these species. So these species diversity increases with submerged and floating vegetation (Lodge and Kelly, 1985; Zealand and Jeffries, 2009). *I. exustus, Lymnaea acuminata f typica, and L. acuminata refessens* were very common species while *Pila globosa* and *Bellamya* spp. were not common in Ghodaghodi lake area as reported by Subba (2003).

M. tuberculatus and *P. favidens, Brotia castula* were only found in slow moving stream in this study as Oloyede (2016), Duggan (2002), Dudgeon, (1989) and Gutiérrez *et al*. (1997) revealed same type of results in running water in contrast Owojori *et al*., (2006) and Ndifon and Ukoli (1989) who reported that *M. tuberculatus* prefer in reservoirs, ponds and moderately shaded habitat.

5.2 Water Quality Parameter Influencing on Distribution

Water quality parameters are important factors for the distribution of molluscs. Movement of water, temperature, pH, depth and aquatic vegetation are the major factors that influence the snail population (Garg *et al*, 2009). Strzelec and Krölezyk (2004) indicated that many gastropods species tolerate to most physio-chemical parameters and their occurrence is affected by the quality of bottom sediments cover with thin layer of organic silt.

DO was recorded between the range (0.3-6.55 mg/l) Ghodaghodi Lakes. Oloyede *et al*, (2016) also recorded similar DO range from 0.51–7.62 mg/l in shallow eleyele

dam in Ibadan Nigeria. The positive correlation was found between DO and species diversity. Snails need oxygen for their metabolic activities (WHO, 1965) but Cheatum (1934) and Sharma (1986) reported that some molluscs can even survive in very low oxygen condition. Garg *et al*., (2009) also reported the fluctuations in dissolved oxygen contents do not have any effect on the mollusc population. The highest DO was reported in lotic water body i.e. Maghi khola (7.0-7.4 mg/l) than other lentic water bodies. The individual molluscs species e.g *M. tuberculatus, P. favidens* except *B. bengalensis* were higher in the Maghi Khola but their diversity was low.

Appleton (1978) and Sturrock (1993) suggested the temperature affects the abundance, distribution and spread of freshwater snail. The positive correlation (r=+0.3839809) was found between temperature and mollusc species diversity. It means increasing temperature leads increasing molluscan species diversity. Similarly, Michael (1968), Dutta and Malhotra (1986), Malhotra *et al*. (1996) and Garg *et al*. (2009) found the very similar results. Bath *et al*. (1999) revealed that higher abundance of molluscs can noticed with increased water temperature and decomposed organic matter. Similarly Michael (1968) suggested that high temperature, alkalinity and food were probable causes for the high in abundance of zoo-benthos during summer months but Ricker (1952), Shrivastava (1956), Vasisht and Bhandal (1979) recorded negative correlation between temperature and molluscs. Similarly, water depth also found statistically significance on mollusc diversity. A negative correlation (r=-0.397) was reported between water depth and mollusc diversity. Sharma *et al*. (2013) and Hussein *et al*. (2011) also noticed negative correlation between molluscs and depth.

5.3 Consumption Trends and Conservation Threats

The impact of climate change and anthropogenic factors are arising as main problematic factor to all terrestrial as well as aquatic organism but for slow moving organism it seem to be affected more (Subba, 2012). Study found humidity of study area is decreasing by 7.5%, temperature increasing by 0.8 ^{0}C and irregular rainfall as heavily occurred in 1985/86 and 2007/8 but similar average rainfall seen in other years from 1976 to 2014 (DHM, 2016). Questionnaire survey of this study also found that total 62 % respondent were found to be experienced the change in monsoon pattern, 25% hot air and 13% drought. Similarly, Shrestha *et al*. (1999) and Shrestha (2001) reported that recorded temperature of Kathmandu from period of 1921 to 1994 show general warming trends till 1940s and cooling trends during 1940s -1970s and again rapid warming after the mid-1970s in support of their work. Sharma *et al*. (2013) indicates that increasing trends of average temperature during that period was primarily due to increasing trends of gaps between maximum and minimum temperature. Thapa *et al*. (2015) analyzed the trends of average increase of annual temperatures 1.1°C between 1982-1986 of period time and trends of rainfall was decreasing from 1982 to 1997. Subba (2012) speculated similar trends viz climate

change like unexpected rainfall, drought, deforestation, less precipitation, increase Carbon dioxide. These climatic cindition also alter the existance of aquatic fauna.
The study revealed six edible freshwater mollusc species i.e. *Brotia* (One sp.), *Bellamya* (Two spp.), *Pila* (One sp.) and Bivalve (Two sp.) species and *Bellamya* spp. were most preferred species among them. Subba and Ghosh (2000) reported more than 25 species of mollucs are consumed by ethnic people because of delecious and energy giving food items which is directly linked with livelihood. Similarly, Subba (2012) reported twenty edible species i.e. *Pila* (Two sp.), *Bellamya* (Three sp.), *Brotia* (Two sp.), *Lemellidens* (Four sp.), *Parreysia* (Nine Sp.), *Paludomes* (One sp.) in 56 castes from Terai region. Karna and Shrestha (2006) recorded three Mollusc species viz. *B. bengalensis*, *L. marginalis* and *P. globosa* as nutritional species from Sarlahi, Nepal. Ramakrishna and Dey (1986) also reported that *Bellamya* species is mostly preferred as food in Jharkhand, India and *Pila* sp. and *Lamellidens* spp. were eaten by tribal people only. Tharu people use mostly their local tools (Heluka and Diliya) for fishing and mollusc collection while Mollusc were collected by picking, trapping and by fishing net in Jharkhand, India (Ramakrishna and Dey 1986). Study revealed that 65 % Tharu peoples collect molluscs for food and remaining were for medicinal purpose. They use bivalve shell mostly in decorating their traditional instrument "Dhakiya", preparation of lime, Piling the vegetables and *Pila* sp. shell are used for curing of diarrhoea for cattle and remedy for high heating body, healing wound as in favoured of this study Baneerjee and Satish, 1988; Dutta and Chowdhury, 1999 stated that freshwater mussels shell used in manufacture of shell buttons, ornament, preparing poultry feed and mosaic tiles. Roy and Singh (2007) in support of this study investigates that shell of *Pila* sp. and *Lamellidens* spp. are used by local people for rickets curing in children, control blood pressure, curing of cardiac disease and night blindness. Shell of *Pila* sp., *Parreysia* spp. is used for wound healing lime and button preparation, magico- religious purpose.

Study show that consumption trends are decreasing (62% respondents) because of less appearing of molluscs and easily availability of red meat but 20% respondents replied as of increasing trends because of increased human population and good taste of molluscs while 18% said trend was as past. Molluscan population were possessing various threats like high consumption (48%), poisoning (26%), habitat loss (20%), Pollution (6%) due to no any implementation of rules and regulation on killing molluscs haphazardly. Budha (2016) noted that frequent use of fertilizer and pesticide is surrounding agricultural land flushed into lakes and changed the water chemistry of lake causing negative impacts on the aquatic faunal. Subba (2003) reported *P. caerulea* declines due to indiscriminate killing of these species by local people for their delicious meat. Molluscs were found to be sold in different city of India like Meghalaya, Manipur, Mizoram, west Bangal, Jharkhand and Bihar (Ramakrishna and Dey, 2007). The country like China and Japan culture freshwater mussels (Mizumuto, 1976) but in Nepal such practices are not seen yet.

6. CONCLUSION AND RECOMMENDATIONS

Freshwater molluscan diversity in relation to several water quality, threats was observed in Ghodaghodi Lake complex from far western, Kailali, Nepal. Altogether 17 mollusc species were reported out of which six species are edible i.e *P. globosa*, *B. bengalensis*, *B. dissimilis*, *B. costula*, *P. favidens*, *L. marginalis* by the Local people. Ghodaghodi Lake had highest molluscan diversity (H=2.1704) followed by Nakhrod Lake (H=2.1246) and less diversity in Baba and Chidiya Tal (H=0). Maghi Khola is only the stream having molluscan diversity (H=1.261) but have more number of single individual molluscs. Decreasing consumption trends (62%) was observed in the study. Several threats like climatic changes and anthropogenic activities like poisoning, habitat loss, water pollution were also reported in the area. Some of recommendation that will be helpful in management of lakes and preservation of molluscs are as follows;

- Population of freshwater molluscs in the study area has been declining so some rules should be maintained for molluscs habitat conservation and complete drying out of lake water should be avoided and activity fish farmers need to be monitored.

- Some of the large lakes associated with Ghodaghodi Lake Complex should not be given to the fish contractors for maintaining Ghodaghodi lake complex as Ramsar site.

- Ojhawa Lake is the large lake of an area > 3 ha which is only separated by small land barrier. This lake should be linked with Ghodaghodi lake to increase water holding capacity of the Ghodaghodi Lake. This activity enables to enhance irrigation facility to farmers during water scarcity and habitat extinction of aquatic life.

- Advanced irrigation facility in cooperation with Irrigation Department and Conservation Organisation will promote conservation of the Lake Complex and income generating activities to water users group in the area.

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Interviewed Questionnaires

"Species Diversity, Consumption Trends and Conservation Status of Freshwater Molluscs in Ghodaghodi Lake Area, Kailali District, Nepal"

Instruction: Please put tick √ in the box next to the answer of your choice or write in the space provided as the case may be.

1) Personal detail of respondent

Name:.....Sex.....Age.....

Village..... Date.....

Resident Type: a) Local..... b) Migrated.....

Type of House: Cemented/ Tanti/ Thatched roof

Number of family members:.....

Family catagorised on basis of age gap: a) 0-15

b)16-30

c) 31-45

d) 46-60

e) 61 above

Occupation: Service/ Land lord/ Bataiya

Main source of income: selling of crops/Daily wages or seasonal labour/ Poultry, goat or other cattle farms

Education:

Other detail: Had you ever stayed as kamaiya?.....

1) Do you eat molluscs? (Yes/No)

   If yes, how many species? Write their local name.

   Ghonga.....

   Ghongi.....

   Sippi.....

2) Which one is the most preferred species? Write local name.
3) Why do you eat molluscs?

   a)As food.....

   b) As medicine.....

4) What are the uses of molluscs other than eating?.....
5) Which species of edible molluscs are mostly available?.....
6) Name the place from where you collect molluscs.....
7) Which habitat you find abundant edible molluscs?

a)Lake..... b) River..... c) Stream..... d) Paddy field.....

8) What is the frequency of avaibility of molluscs? Write reason also.

a) Increasing.....

b) Decreasing.....

c) Same as past.....

9) What are the trends of molluscs consumption among people? Give the reason also.

a) Increasing.....
b) Decreasing.....
c) Same as Past.....

10) How do you go for molluscs collection?
   a) Along with fishing.....
   b) Only for molluscs collection.....

11) How do you collect molluscs?
   a) Hand picking .....
   b) Using local tools (heluka).....

12) How much you collect molluscs in one time?

a) One bucket.....
b) Two bucket.....
c) More.....

13) Is there any change in cooking/ consuming of molluscs in family? Explain, if yes?

14) Which is the most active group in collecting molluscs?
   a) Male.....
b) Female.....
c) Children.....

15) What are the reason for molluscs destruction?

a) High consumption.....
b) Poisoning.....
c) Habitat loss.....
d) Pollution.....

16) Have you noticed the climate change in your life time?

a) Hot air.....
   b) Changed in winter rain pattern.....
c) Changed in monsoon.....
   d) Flood.....
e) Drought.....