SPECIES DIVERSITY AND HABITAT PREFERENCE OF HERPETOFAUNA IN LUMBINI REGION, NEPAL

THESIS SUBMITTED TO

CENTRAL DEPARTMENT OF ZOOLOGY

INSTITUTE OF SCIENCE AND TECHNOLOGY

TRIBHUVAN UNIVERSITY

NEPAL

FOR THE AWARD OF

DOCTOR OF PHILOSOPHY

IN ZOOLOGY

BY

PIT BAHADUR NEPALI

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Institute of Science and Technology
DEAN'S OFFICE
Kirtipur, Kathmandu, Nepal

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The Title of Ph.D. Thesis: "Species Diversity and Habitat Preference of Herpetofauna in Lumbini Region, Nepal "

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Asst. Dean

DECLARATION

Thesis entitled "**Species Diversity and Habitat Preference of Herpetofauna in Lumbini Region, Nepal**" which is being submitted to the Central Department of Zoology, Institute of Science and Technology (IOST), Tribhuvan University, Nepal for the award of the degree of Doctor of Philosophy (Ph.D.), is a research work carried out by me under the supervision of Prof. Dr. Nanda Bahadur Singh of Central Department of Zoology, Tribhuvan University.

This research is original and has not been submitted earlier in part or full in this or any other form to any university or institute, here or elsewhere, for the award of any degree.

Pit Bahadur Nepali

RECOMMENDATION

This is to recommend that **Pit Bahadur Nepali** has carried out research entitled "**Species Diversity and Habitat Preference of Herpetofauna in Lumbini Region, Nepal**" for the award of Doctor of Philosophy (Ph.D.) in **Zoology** under my supervision. To my knowledge, this work has not been submitted for any other degree.

He has fulfilled all the requirements laid down by the Institute of Science and Technology (IOST), Tribhuvan University, Kirtipur for the submission of the thesis for the award of Ph.D. degree.

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LETTER OF APPROVAL

Date: 12/05/2023

On the recommendation of Prof. Dr. Nanda Bahadur Singh, this Ph.D. thesis submitted by Pit Bahadur Nepali, entitled "**Species Diversity and Habitat Preference of Herpetofauna in Lumbini Region Nepal**" is forwarded by Central Department Research Committee (CDRC) to the Dean, IOST, TU

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Pit Bahadur Nepali
January, 2023

ABSTRACT

The herpetofauna (amphibians and reptiles) are diverse and poikilothermic vertebrates that serve as excellent bio-indicators of stressed ecosystems. There is little information on the taxonomy, diversity, abundance, and distribution of herpetofauna in the Lumbini region. The aim of this study is to explore the species diversity and habitat preferences of herpetofauna in this region. The study was conducted from March 2016 to July 2020, in six districts. A total of 36 stations were chosen in these districts. From each station, sampling was done in five different habitats, namely agricultural fields, forests, riparian habitats, wetlands, and human habitats. Five transects, each of 200 m, were fixed in each habitat. In each transect, four quadrats of 20 m x 20 m were used for searching specimens using raking and digging methods. Additionally, pitfall, visual encounters, and opportunistic surveys were used to maximize the collections. The morphometric measurements and the use of specified keys, all species were classified at the species level. The abundance, species richness, diversity, and habitat preference were analyzed in Microsoft Excel, PAST (4.11 version), and R (version 3.6). Arc GIS was used to prepare a distribution map of herpetofauna.

A total of 4,589 and 2,629 individuals of amphibians and reptiles were observed, respectively. There were 58 species of herpetofauna that included 17 species of amphibians and 41 species of reptiles. Amphibians included 12 genera and 6 families: Bufonidae, Megophryidae, Microhylidae, Ranidae, Rhacophoridae, and Ichthyophidae. Reptiles included 30 genera and 12 families: Crocodylidae, Trionychidae, Bataguridae, Agamidae, Gekkonidae, Varanidae, Scincidae, Typhlopidae, Boidae, Colubridae, Elapidae, and Viperidae.

Euphlyctis cyanophlyctis, *Minervarya nepalensis*, *Minervarya teraienesis*, *Duttaphrynus melanostictus*, *Hoplobatrachus tigerinus*, and *Microhyla ornate* were highly observed individuals among amphibians, whereas *Ichthyophis sikkimensis*, *Uperodon taprobanicus*, *Sphaerotheca breviceps*, and *Nanorana liebigii* were least observed individuals among amphibians. The habitat-wise species richness of amphibians was 14, seven, 11, 16, and seven in agricultural fields, forests, human

habitats, riparian areas, and wetland areas, respectively. *D. melanostictus*, *D. stomaticus*, *E. cyanophlyctis*, *Hoplobatrachus*, *Minervarya* species, and *M. ornata* were common species found in every study site. *I. sikkimensis* was a new distributional record among amphibians in the Lumbini region. *Polypedates leucomystax* was distributed in both the Terai and mountainous regions. Simpson's Index, Shannon index (H), and Pilou's evenness (J) of amphibians were found to be the highest in riparian areas, whereas it was found the lowest in wetlands.

Among reptiles, *Calotes versicolor*, *Ptyas mucosa*, and *X. piscator* were the most observed species, whereas *Crocodylus platuris* was the only species observed throughout the survey period. *C. versicolor* is a widely distributed species, *Laudakia tuberculata* was found in the mountains, and turtles were found in the Terai region. Snakes were prevalent in human habitats and forests, while geckos dominated the lowlands, and skinks inhabited the forests only. *C. palustris* is a new distributional record of this region. The Simpson index, Shannon indices (H'), and Pilou's evenness were recorded high in forests while low in wetlands.

Among the 27 identified snakes, eight were venomous, and 19 were non-venomous. Three species of Boiga among non-venomous were semi-venomous. The present study shows that herpetofauna utilized more than two habitats and are also species-specific. Amphibians preferred riparian areas, while reptiles preferred the forest. These habitats were protected for the conservation of amphibians and reptiles. This area has a taxonomically rich herpetofauna, but *C. palustris*, *Varanus flavescens,* Python species, *Oligodon erythrogaster*, *Trachischium tenuiceps,* and *Ophiophagus hannah* were the least observed species and also marked as threatened species in the IUCN Red List of threatened species. The protection of these species is essential.

नेपालको लुम्बिनी क्षेत्रमा पाइने हर्पेटोफौनाका प्रजाति विविधता र वासस्थानका प्राथमिकताहरु

सार

हर्पेटोफौना (Herpetofauna) (Amphibian: उभयचर र Reptiles: सरिसृपहरु) विविध र वातावरण अनुसारको शरिरको तापक्रम वदल्न सक्ने ढाड भएका जनावर हुन जसले तनावग्रस्त पारिस्थितिक प्रणाल्ीको उत्कृष्ट जैविक सुचककोरुपमा काम गर्दछन । लुम्बिनी क्षेत्रमा हर्पेटोफौनाको वर्गीकरण, विविधता, प्रचुरता र भौगोलिक वितरण (Distribution)को वारेमा पर्याप्त मात्रामा जानकारी छैन । यस अध्ययनको उद्देश्य यस क्षेत्रमा उनिहरुको प्रजाति विविधता र वासस्थानका प्राथमिकताहरुको अध्ययन गर्नु हो । यो अध्ययन सन् २०१६ मार्च देखि २०२० जुलाइ सम्म ६ जिल्लामा गरिएको थियो । यी जिल्लाहरुमा ३६ स्टेसनहरु छनोट गरिएको थियो । प्रत्येक स्टेसनबाट कृषि क्षेत्र, वन, मानव वस्ति, नदि क्षेत्र र सिमसार क्षेत्र गरि पाँचबटा फरक वासस्थानमा नमुना संकलन गरिएको थियो । प्रत्येक २०० मिटरका पाँच ट्रान्जेक्टहरु प्रत्येक बासस्थानमा तय गरिएको थियो । प्रत्येक ट्रान्जेक्टहरुमा चारवटा २० वर्ग मिटरको परिधिभित्र खेद्ने, पछ्याउने र खन्ने विधिहरु प्रयोग गरेर नमुनाहरु खोजतलास गरिएको थियो । यसवाहेक संकलनलाई अधिकतम बनाउनको लागि गुप्तखाडल (Pitfall), दृष्य मुठभेड (Visual encounter) र समयानुकुल सर्वेक्षणहरु (Opportunistic survey) गरियो । वाहिरि आकार (Morphometric) मापन र निर्दिष्ट कुञ्जीहरुको (specified keys) प्रयोग गरि सबै प्रजातिहरुलाई प्रजाति स्तरसम्म वर्गीकृत गरियो । माइक्रोसफट् एक्सेल (MS excel), पास्ट (PAST) र आर (R) ३.६ संस्करणको Software प्रयोग गरि प्रशस्तता (Abundance), प्रजाति समृद्धि (Richness), विविधता, र बासस्थान प्राथमिकताहरु विश्लेषण गरिएको थियो । आर्क जिआईएस (Arc GIS) प्रयोग गरी भौगोलिक वितरण (Distribution) नक्सा तयार गरिएको थियो ।

कुल ४५८९ उभयचर र २६२९ सरिसृपहरु अवलोकन गरियो । जम्मा ५८ हर्पेटोफौना प्रजातिहरु मध्ये १७ प्रजातिहरुका उभयचर र ४१ प्रजातिका सरिसृपहरु भेटिएका थिए । उभयचरहरु मध्ये १२ जेनेरा र ६ परिवारहरु समावेश भएकामध्ये बुफोनिडि (Bufonidae), मेगोफ्राइडि (Megophryidae), माइक्रोहाइलिडि (Microhylidae), रानिडि (Ranidae), राकोफोरिडि (Rhacophoridae) र इचथायोपिडि (Ichthyophidae) हुन । सरिसृपहरुमा ३० वंश र १२ परिवारहरु समावेश छन । क्रोकोडाइलिडि (Crocodylidae), टायोनाइसिडि (Trionychidae), वाटागुरिडि (Bataguridae), एगमाडि (Agamidae), गेकोनिडि (Gekkonidae), भारिनिडि (Varanidae), सिन्सिडि ?, टाइफोलिडि (Typhlopidae), वोइडि (Boidae), कोलुव्रिडि (Colubridae), इलापिडि (Elapidae) र भाइपेरिडि (Viperidae) परिवारहरु हुन ।

टिकटिके पाहा (*Euphlyctis cyanophlyctis*), ट्याग ट्याग पाहा (*Minervarya nepalensis*) टिक टिके पाहा (*Minervarya teraienesis*) खस्रे भ्यागुतो (*Duttaphrynus melanostictus*) सिर्के पाहा (*Hoplobatrachus tigerinus*) र भ्यागुतो (*Microhyla ornate*) उभयचर धेरैमात्रामा अवलोकन गरिएका मध्ये पर्दछन् जवकि गन्युले साँप (*Ichthyophis sikkimensis*) भ्यागुतो (*Uperodon taprobanicus*), रानि भ्यागुतो (*Sphaerotheca breviceps*) र मन पाहा (*Nanorana liebigii*)

कम अवलोकन गरिएका मध्ये पर्दछन् । यिनिहरुको वासस्थान अनुसार प्रजातिहरुको समृद्धि क्रमशः १४ कृषि क्षेत्र, वनमा सात, मानव वस्तिमा ११, नदि क्षेत्र १६ र सिमसारमा सात थियो । खस्रे भ्यागुताहरु (*D. melanostictus, D. stomaticus*), टिक टिके पाहा (*E. cyanophlyctis*) सिर्के पाहा (*Hoplobatrachus*) ट्याग ट्याग पाहा (*Minervarya* species) र भ्यागुतो (*Microhyla ornate*) प्रत्येक अध्ययन स्थलमा पाइएका प्रजातिहरु हुन । गन्युले साँप (*Ichthyophis sikkimensis*) यस लुम्बिनी क्षेत्रका उभयचरहरु विच नयाँ भौगोलिक क्षेत्र वितरित दर्ता भएको हो । तराई र पहाडी क्षेत्रमा रुखभ्यागुतो (*Polypedates leucomystax*) भौगोलिक वितरण पाइएको छ । यिनिहरु मध्ये Simpson's सुचकांक, Shannon सुचकांक (H) र Pilou's evenness (J) नदि क्षेत्रमा सबैभन्दा बढि पाईयो जवकि सिमसार क्षेत्रमा सबैभन्दा कम पाइयो।

सरिसृप मध्ये छेपारो (*Calotes versicolor*), धामन (*Ptyas mucosa*) र पानी सर्प (*Xenochrophis piscator*) सवैभन्दा बढि अवलोकन गरिएका प्रजातिहरु थिए जवकि मगर गोहि (*Crocodylus platuris*) एक मात्र प्रजाति सर्वेक्षण अवधिमा अवलोकन गरिएको थियो । छेपारो सर्वव्यापक रुपमा भेटिएको भौगोलिक वितरित प्रजाति हो । पत्थरचटुवा (*Laudakia tuberculata*) पहाडी क्षेत्रमा तथा कछुवा तराई क्षेत्रमा पाइयो । सर्प प्रजातिहरु मानव वस्ति र जङ्गलहरुमा भेटिए जवकि माउसुलीहरु (गेका) तल्लो भूभागहरुमा प्रभुत्व जमाउँछन र भानेमुग्रोहरु (स्कीन्क) जंगलमा मात्र वसेका भेटिए । मगर गोहि (*Crocodylus platuris*) यस क्षेत्रको नयाँ दर्ता भौगोलिक वितरित प्रजाति हो । Simpson's सुचकांक, Shannon सुचकांक (H) र Pilou's evenness (J) जंगल क्षेत्रमा उच्चमात्रामा पाईयो जवकि सिमसार क्षेत्रमा सबैभन्दा कम रेकर्ड गरिएको थियो ।

पहिचान गरिएका २७ सर्पहरु मध्ये ८ वटा विषालु र १९ वटा अविषालु रहेका छन । अविषालु सर्पहरुमध्ये लोहामिन र जिउडे सर्पहरुका (*Boiga* species) तीन प्रजातिहरु अर्धविषालु हुन । यस अध्ययनले हर्पेटोफौनाले दुई भन्दा बढि वासस्थानहरु प्रयोग गर्ने गरेको र वासस्थान प्रजाति विशिष्टिक्रित हुन्छ भन्ने देखायो । उभयचरहरुले नदि क्षेत्र र सरिसृपहरुले जंगल वासस्थानलाई प्राथमिकता दिएको देखियो । यी वासस्थानहरु उभयचर र सरिसृपहरुको संरक्षणको लागि सुरक्षित गर्नु पर्छ । यस क्षेत्रमा वर्गिकरणका हिसावले हर्पेटोफौनाहरुमा प्रचुरता छ । तर मगर गोहि, सुनगोहोरो (*Varanus flavescens*) अजिंगर (Python) प्र्जातिहरु, सर्प (*Oligodon erythrogaster*), चपरे सर्प (*Trachischium tenuiceps*), र राजगोमन (*Ophiophagus hannah*) सबैभन्दा कम अवलोकन गरिएका प्रजातिहरु हुन र आइयुसिएन रेडलिष्टको (IUCN Red list) खतरा सूचीमा सूचीकृत परेका छन । यी प्रजातिहरुको संरक्षण आवश्यक छ ।

LIST OF ACRONYMS AND ABBREVIATIONS

AG	: Agricultural Fields
CITES	: Convention on International Trade in Endangered Species of Wild Fauna and Flora
DCEP	: District Climate and Energy Plan
DNPWC	: Department of National Parks and Wildlife Conservation
FR	: Forest
FL	: Fore-limbs
GAA	: Global Amphibian Assessment
GoN	: Government of Nepal
HH	: Human Habitat
HL	: Hind-limbs
HW	: Head Width
ICIMOD	: International Centre for Integrated Mountain Development
IUCN	: International Union for Conservation of Nature
LTRF	: Labial Teeth Rows Formula
NAST	; National Academy of Science and Technology
RP	: Riparian Area
SVL	: Snout-vent Length
Spp.	: Species
TAL	: Terai Arc Landscape
TiL	: Tibia Length
TU	: Tribhuvan University
WL	: Wetland

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CHAPTER 1

1. INTRODUCTION

1.1 Background

Herpetofauna (Amphibians and Reptiles) of Nepal is more diverse than that of other South Asian countries due to the tropical to alpine climatic zones (Shrestha, 2001). It is a biologically diversified country with a lot of endemism, including herpetofauna (Shrestha, 2001; Shah & Tiwari, 2004). Several herpetofaunal studies have been carried out globally on taxonomy, distribution, diversity, and habitat types. In the context of South Asia, there were 197 amphibian species and 408 reptile species in Bangladesh (IUCN, 2015), 447 species of amphibians and 572 of reptiles in India (Aengals *et al*., 2018; Dinesh *et al.*, 2020), 24 species of amphibians and 195 species of reptiles in Pakistan (Ali *et al*., 2018), 233 species of reptiles in Sri Lanka (Gibson, 2020), and 50 amphibian and 127 species of reptiles in Nepal (Kastle & Rai, 2012). India had more herpetofaunal diversity, whereas Sri Lanka had more endemicity.

1.1.1 Amphibians

They have complex life cycles that include considerable changes (morphological, physiological, and behavioral alterations) throughout their ontogenetic development, which are frequently linked to habitat type transitions (Wilbur, 1980). Amphibians include frogs, toads, salamanders, and caecilians, and are found all over the earth except in the Arctic and Antarctic (Gururaja, 2012). Except for caecilians, all amphibians have paired limbs and bare skin, while caecilians have scales buried beneath the skin. They are a diverse group of vertebrates that require both aquatic and terrestrial habitats to carry out their respective functions (Gibbons *et al.*, 2000; Blaustein *et al.*, 2011; Brum *et al.*, 2013).

Modern amphibians are categorized into three orders: Anura (Frogs and toads), Caudata (Newts and salamanders), whereas caecilians are represented as Gymnophiona or Apoda (Singh & Banyal, 2013). Amphibians are found in a wide range of climatic and biological zones (Hall & Henry, 1992). The majority of amphibian diversity is found in the tropics, primarily in Central and South America. Sub-Saharan Africa, Madagascar, Sri Lanka, Southeast Asia, New Guinea, and

Australia are among the other diversity hotspots. According to Frost (2022), the world's living amphibians include over 8458 species. The order Anura includes 7475 species, Caudata (769 species), and Gymnophiona (214 species). Frogs and toads, salamanders and newts, and caecilians are the most common amphibians (Stuart *et al.*, 2008) facing an extinction crisis. The order Caudata has one family: Salamandridae, Anura has five families: Bufonidae, Dicroglossidae, Megophryidae, Microhylidae, Ranidae, and Rhacophoridae, and Gymnophiona has one family: Ichthyophiidae in Nepal (Schleich & Rai, 2012).

They are influenced by a complex combination of biotic and abiotic variables, resulting in a substantial decrease in species richness and abundance in urban and suburban regions (Andrew & McDonnell, 2008). The species of South Asia are diverse, with some endemic and rare species (Shah & Tiwari 2004). The species richness was equal near wetlands, but pond-breeding anurans were also more abundant than non-pond-breeding anurans (Moura *et al.,* 2015). More importantly, these species typically have a limited population, which can lead to inbreeding and demographic stochasticity, increasing the long-term danger of extinction (O'Grady *et al.,* 2006).

Nowadays, they are found in every possible habitat type, while a few species are distributed widely and abundantly. Damp places, moist soil, and burrowing sites may be necessary to keep their skin moist. They also need habitats with huge forested debris, rock piles, animal burrows, or shelters to provide thermal gradients. Understanding the links between different types of habitats and amphibian assemblages is crucial for the management and conservation of critical areas or species.

They were considered useful biological indicators. The country's indiscriminate exploitation of amphibians and reptiles has put the future of some species at risk (Shah, 1995). Due to habitat loss and overuse, amphibians are becoming more endangered and are declining at a faster rate (Stuart *et al.,* 2004).

1.1.2 Reptiles

They are poikilothermic vertebrates that breathe through their lungs throughout their lives, and their skin has scale-like folds, is tubercular, or produces osseous scutes (Gunther, 1863; Houlenge, 1890). They can bask during the day since their skin is dry and impermeable. They have developed distinct physiological adaptations and have evolved to be able to live a fully terrestrial life as a result of behavioral thermoregulation. They can survive in warm sunny surroundings because of their impermeable scaly skin, which allows them to retain water and avoid evaporation (Savage, 2002).

Globally, reptiles consist of 7,176 lizard species, 3,971 snake species, 356 testudines (turtles), 202 amphisbaena species, 27 crocodile species, and 1 tuatara species (Uetz, 2022). In Nepal, there are three orders: Crocodylia, Testudines, and Squamata. Crocodiles have two species, turtles and tortoises have around 15 species, scaled reptiles have about 40 lizard species, and snakes have about 70 species (Schleich & Rai, 2012). The diverse climate, variable vegetation, and soil composition form a wide range of microhabitats that support a rich variety of reptilian fauna. They need varied habitats for thermal gradients. Lizards, turtles, and snakes prefer more than one habitat type, which is related to species-specific differences in life-history patterns.

Herpetofauna has a wide range of vertical and horizontal distribution in Nepal (Bhattarai *et al.*, 2017). From the past to the present, Nepalese herpetologists have contributed to herpetological research. In the year 1907, Hodgard, Annandale, Boulenger, and Wall described 12 new records of herpetofauna for Nepal (Sawn & Leviton, 1962). Similarly, Shrestha (2001) reported 206 herpetofauna species, Schleich and Kastle (2002) claimed 173 species, Shah and Tiwari (2004) reported the presence of 190 herpetofauna species, and Schleich and Rai (2012a; 2012 c) recorded a total of 177 herpetofauna species around Nepal. Shrestha (2010) reported 195 species of herpetofauna, of which 130 species were found in protected areas. These finding indicated that there was no actual data of herpetofauna in Nepal. According to Bhuju *et al*. (2007), one-third of the total number of herpetofauna is found outside protected areas, and the middle Terai-Siwalik region of Nepal has the highest number (45%) among herpetofauna. Seventeen herpetofauna species are nationally vulnerable, six of which are globally threatened (ICIMOD & MOEST-GON 2007), and about 4% of amphibian species are endemic (Molur, 2008) in Nepal. According to the national biodiversity strategy and action plan (2014), Nepal has 14 endemic species of herpetofauna, 64 species of herpetofauna in the IUCN Red list, and 19 reptiles in CITES. Shah and Gire (1992) had shown the local usage and ethno-herpetological values of amphibians in the study of the Arun River basin in eastern Nepal. The frogs, turtles, and other herps are used for food and medicinal values (Shah, 1997; Aryal *et al.,* 2010; Shrestha & Gurung, 2019).

Herpetofaunal studies are important to show diversity, distribution, and habitat preferences in any ecosystem (Ali *et al.,* 2018). Variation in the climatic, biological, physical environment and altitudinal gradient influenced the distribution, abundance and richness of species (Whittaker *et al.,* 2001). Various criteria have been proposed to describe how species distribution patterns respond to changes in elevation. The most common types of species diversity measures are indices of richness, evenness and abundance, and also distribution models (Ludwig & Reynolds, 1988; Magurran, 1988). Species richness is widely used as a biodiversity metric for a variety of purposes, including monitoring biodiversity and prioritizing management or conservation efforts (Kerr, 1997). Species with a small distribution range are more vulnerable, as hazardous influences can affect their whole range (Whitton, 2012). Although they have been the most diversified in terms of habitat preference and speciation, they are suitable to serve as indicators of habitat quality and disruption (IUCN, 2012).

Snakes are cryptic members of the herpetofauna that are fascinating by nature and play a crucial role in the biota. They prey on worms, insects, as well as frogs, birds, rats, and mice. Venomous snakes can be distinguished from non-venomous ones by their specific tooth structures, such as Sonenoglyphic teeth in Viperidae, proteroglyphic teeth in Elapidae, and opisthoglyphic teeth in Colubridae, while non-venomous snakes lack fangs and presence of maxillary teeth (Pettit, 2019).

The concept about snakes is still conservative among people. Even today, all snakes are thought to be venomous and are often killed on sight. Globally, around 600 snake species are venomous, but only 20% of them are dangerous to humankind (Thornton, 2014). The Indian subcontinent is a habitat for 52 venomous species (Punde, 2008). In the context of Nepal, variable data on venomous snakes has been documented. For example, Sakya and Thapa (1994) reported 8 venomous snakes, while Shrestha (2001) presented 22 species in his work. Likewise, Shah and Tiwari (2004) reported 19 species in their report, Sharma *et al*. (2013) reported 18 species, and Rai (2003) reported 13 venomous snakes from the eastern region of Nepal. The National Guide for Snake Bite Management (2019) reported 18 venomous snake species throughout the country.

Habitats play a vital role in the life activities of herpetofauna, determining their species richness, distribution, abundance, and diversity, and they are highly dependent on their habitat (Gibbons, 2000; Lewis, 2009). A vast diversity of herpetofauna is found in varied climates, vegetation, soil composition, topography, and microhabitats. Additional community or environmental aspects such as period, spatial heterogeneity, constancy, production, antagonism, predation, niche organization, and evolution have also been linked to diversity (Vyas, 2000). Habitat features also influence their population dispersal (Balaji *et al*., 2014). More complex habitats tend to contain more species (Bell *et al*., 2012) and are exposed to all chemicals released into the environment, either directly or indirectly (Vitt & Caldwell, 2014). However, not all species are impacted by habitat changes equally, according to Brook *et al*. (2003).

Reptiles and amphibians prefer terrestrial, semi-aquatic, and aquatic habitats. Numerous studies have demonstrated the close reliance of reptiles and amphibians on terrestrial habitats for essential life-history processes. Amphibians favor a variety of terrestrial habitats, such as foraging areas, refuges, and overwintering places, which often include leaf litter, coarse woody debris, rocks, as well as semi-aquatic and wetland environments. Similarly, reptiles prefer small terrestrial habitats including burrows, rock cracks, spring seeps, and rocky pools for aestivation, basking, hibernation, and nesting (Semlitsch & Bodie, 2003). They have inhabited a variety of habitats spanning from lowland to high mountain regions (Chettri *et al*., 2011). Due to the specific habitat requirements of many, if not all, species, changes to their habitats most often result in population or species extinction.

Herpetofauna are important components of the food web, seed dissemination, forest litter decomposition, and serve as predators and prey for a variety of insect pests and rodent populations. They also act as effective bio-indicators of environmental conditions (Wang & Chan, 2008; Leduc, 2012; Kanaujia *et al*., 2017). As they are considered a beneficial faunal group, research on them will make significant contributions to the functioning ecosystem (Shrestha, 2001; Ahl & Hampton, 2010). Some species are commercially harvested for food or cultural medicines, and those with high monetary value are rapidly being overexploited (Vitt & Caldwell, 2014).

Little information was documented in herpetological research in the Lumbini region. Fleming and Fleming (1974) and Shah and Tiwari (2004) recorded snakes from the Palpa district. Thapa (2016) studied the status and distribution of the herpetofauna of Palpa and reported 49 species. Thapa *et al.* (2019) reported the distribution pattern of the King cobra. Devkota *et al*. (2020) represented the dicephalism of *Bungarus caeruleus* from Nawalparasi district. In the year 2021, Devkota *et al*. also recorded the King cobra and its distribution.

1.2 Rationale

Rather than focusing on long-term ecological data, the majority of herpetofaunal research has been centered on their documentation. Herpetological research, including in Nepal, receives less priority compared to other vertebrate species (CEPF, 2005; Fazey et al., 2005; Bhattarai et al., 2017). However, the previous literature has been ineffective in providing a comprehensive picture of the presence of herpetofauna in Nepal. There is limited information on the occurrence, richness, and abundance of herps in the Lumbini region. While some patchy works have been conducted and reported on the status of herps, research on the taxonomy and diversity of herpetology is largely lacking in this area. Many of the taxonomic studies are based on species that have already been described in neighboring countries such as India, Pakistan, Bangladesh, Tibet, Sri Lanka, China, etc. Despite progress in documentation, taxonomy, systematic distribution, and diversity studies, the literature and scientific activity on amphibians and reptiles in Nepal are relatively limited compared to other species.

Herps play important roles as predators and prey in ecological food webs and contribute to various sectors such as agriculture, recreational activities, insect and rodent control, pharmaceuticals, leather goods, and the pet industry. Amphibians, in particular, are highly sensitive to environmental changes, making them valuable indicators of environmental health. Reptiles, especially snakes, have toxins and venoms that are used as anti-coagulants in the treatment of stroke and heart attack victims.

This study aims to generate a comprehensive database of the herpetofauna in this region, including taxonomy, distribution, richness, and abundance. The findings will serve as a valuable resource for academicians, students, policymakers, and anyone interested in conservation, as well as in developing strategies and plans for the future protection and sustainable use of biological resources in the country.

1.3. Objectives

1.3.1 General objective

The main objective is to study the species diversity and habitat preference of herpetofauna of the Lumbini Region, Nepal.

1.3.2. Specific objectives are

i. To identify and document amphibians and reptiles in Lumbini region, Nepal.

ii. To measure the abundance, distribution, and diversity of amphibians and reptiles in the study area.

iii. To explore the venomous and non-venomous snakes.

iv. To document the habitat preference of herpetofauna in study area

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CHAPTER 2

2. LITERATURE REVIEW

2.1 Herpetological study in Nepal

Herpetological research has been rare in Nepal, and for more than a century, descriptions of the species have appeared irregularly and infrequently (Sawn & Leviton, 1962). The earlier collector of Nepalese amphibians and reptiles was Brian Hodgson during the years 1820 to 1843 and his collection (1500 individuals) was later attributed and monographed by Gunther in Fauna of British India in 1961. Smith (1931) provided the most comprehensive contribution on the herpetofauna of India and adjacent regions, including Nepal, in "Fauna of British India". Swan & Leviton (1962) provided the first zoogeographical analysis of the herpetofauna of the most important Himalayan state, Nepal. Fleming and Fleming (1974) examined the 29 species of snakes collecting from central and eastern part of Nepal. Kramer (1977) made identification keys for snakes of Nepal and described the 40 snakes. In 1968, a large collection of herpetofauna was also compiled by a group of Japanese researchers from the Kathmandu and Pokhara regions (Matsui *et al.,* 1980). Nanhoe and Ouboter (1987) described the distribution and morphometrics of and 21 amphibian species and 32 reptile species herpetofauna in Annapurna conservation area. Shrestha (1989) investigated the behavior and life cycle traits of the Himalayan newt (*Tylototriton verrucosus*) from Eastern Nepal.

The *Bufo microtypanum* was described as new to Nepal by Shah and Gruber (1994). Zug and Mitchell (1995) provided the identification keys and prepared the annotated checklist of 9 frogs and 44 reptiles of the Royal Chitwan National Park, Nepal. A new species of *Rana* (*R. chitwanensis*) was described by Das (1998) from the Terai region of Nepal. Since then, research on reptile taxonomy, distribution, biology, and ecology has grown significantly, forcing the need to update the prior papers. Schleich and Kastle (2002), Rai (2003) and Shah and Tiwari (2004) provided a field guide, on measurements & identifying keys that includes principle characteristics, distribution, behaviours, of herpetofauna on Nepal. Schleich and Rai (2012a, 2012b, and 2012c) described taxonomically the herpetofauna of Nepal. Rai *et al.* (2022) provide a revised checklist of the herpetofauna of Nepal and listed 143 species of reptiles and

57 species of amphibians. A regional studies have been conducted by Aryal *et al.* (2008), Bista (2010), Pokhrel and Thakuri (2010), Thapa Chhetri (2010), Pokhrel *et al.* (2011), CNP (2014), and Bhattarai *et al*. (2018).

Herpetological studies has been concentrated on the diversity, distribution, and abundance at national and regional levels. With an emphasis on the Terai, Chure, Bhabar, and Siwalik forests for their species richness, the distribution of reptiles from the lowland zone (sea level) to the trans-Himalayan zone was documented by Nanhoe, and Ouboter (1987), Shah and Tiwari (2004), Bhuju *et al.* (2007). Khatiwada, and Haugaasen (2015) analysed the richness and abundance and found significantly decresed with increasing elevation. According to Thapa *et al*. (2019) and Devkota *et al.* (2021) the King cobras may also be found in different altitudinal range, varying climatic conditions, and variety of habitats.The species richness and abundance of herpetofauna were influenced by altitudinal gradient. It was decreased as elevation increased as in amphibians because lower elevation areas are larger, and they can also provide suitable habitats for amphibians (Khatiwada *et al.*, 2019; Gautam *et al*., 2020). From the entire Chure Range, 99 (53.3%) herpetofauna species were identified and richness and distribution of the herpetofauna in Chure, Lumbini Province, revealed a high distribution pattern with 73 (16 amphibians and 57 reptiles) species (Bhattarai *et al.*, 2020). Conservation risks of Gharial, critically endangered species was studied by Kaphle *et al.* (2008) and updated the current status and distribution pattern in rivers of Nepal.

Sakya and Thapa (1994), identified venomous and non venomous snakes by using morphometric characters and reported roughly 10% of snakes in Nepal are deadly venomous. Up to 89 snake species, 21 of which are venomous, have been recorded from Nepal by various authors Shrestha (2001), Shah (2003), Shah and Tiwari (2004) Pandey (2012), Kästle and Rai (2012). These are widely dispersed over the lowlands, the tropical mid hills, and the Highlands. 20 different snake species were recorded in Pokhara valley by Shah and Gautam, (2010). Similarly, Shah *et al.* (2011) found that snakes ranges in altitudes from 100 meters (lower Terai zone) to 4,800 meters (high Himalayan zone), with the maximum variety in the Terai and Siwalik zones. Sharma *et al.* (2013) and national field guide for snake bite management (2019) reported the 18 and 19 venomous snakes of Nepal and its bite management.

Many turtles found in the wetlands of Terai. They have the high risk of declimine in population. (Aryal*et al*., 2010). Khatiwada, and Haugaasen (2015) analysed the amphibians on the basis of habitat. The richness and abundance of amphibians were influenced by human disturbance and agricultural fields. The presence of water in rice fields is important because amphibians often aggregate near or at water sources. As a result, they had a positive relationship with agricultural fields but a negative relationship with human habitat. Regarding the herpetofauna of Shuklaphanta National Park, Rawat *et al.* (2020) found important details on a range of habitat types, with identification of 18 species.

2.2 Global review of herpetofauna

Günther (1864), Boulenger (1890) and Smith (1931) contributed the herpetology in India and adjacent region in Fauna of British India, Ceylon, and Burma, encompassing the entire Indo-Chinese sub-region. It provided comprehensive survey reports, books, monographs, and publications on behaviours, habitats, development, and taxonomy. Swan and Leviton (1962), Thomas (1853), Anderson (1879), Hodgson (1894), Annandale (1921), Wall (1926), Smith (1943) had a huge contribution to the herpetology. Minton (1966), Mertens (1966), Mahendra (1983), Dutta (1997), Das and Dutta (1998), Dutta (1999), Daniels (2001), Whitaker and Captain (2004), Inger and Stuebing (2005), Ali Reza (2007), McMahan and Zug (2007), Biju (2008), Das (2008), Lai and Lue (2008), Khan (2012), Khan (2014), Bansode *et al.* (2016), Das *et al.* (2016), Ganesh & Arumugam (2016), Wagner *et al.* (2016), Capinha *et al.* (2017), Subba *et al.* (2017), Ganesh *et al.* (2018) made taxonomic description and exploration of herpetofauna of Indian, Indo- Chinese and other regions.

Many research were carried out on herpetofauna in different region of India, Pakistan, Bangladesh, and Sri Lanka. Khan (2002) prepared the morphometric key to identify herpetofaunal species of and recorded 24 amphibians and 195 reptiles. In India, a total of 61 reptile species and 32 amphibian species was reported in Sikkim by Jha and Thapa, (2002) and 64 species of herpetofauna were identified, comprising 24 species of snakes, 17 species were lizards, and 3 species of turtles of reptiles and 20 species of amphibians in Assam, Northeast India by Das (2008). The herpetofauna found in the Thummalapalle uranium mining regions included 52 species from 17 families. Yanthungbeni *et al.* (2018) reported 3 crocodile species, 34 turtle and tortoise species, 231 lizard species, and 304 snake species and with 9 amphibian and 13 reptile species being endemic to the region (Ali *et al.*, 2018) in Pakistan. In Bangladesh, Khan (2004) were prepared a checklist and identification key for the amphibian. It included taxonomy, specimen information, and identification keys with descriptive data for identification. Hasan and Feeroz (2014) reported a total of 32 amphibian species belonging to six families were recorded in six protected areas of Bangladesh. Erdelen (2012) investigated effect of human activity and climate change for declining herpetofauna in Sri Lanka. The country harbors 178 amphibian species, with 78 being endemic and 50 being vulnerable, and with majority of them distributed in the Eastern Arc Mountains (IUCN, 2012).

Molur (2008) compiled a list of 348 amphibians, as well as new taxonomic data for the eight South Asian countries. He also studied South Asian endemism and reported that India and Sri Lanka had greater endemism, while Nepal had about 4% amphibian endemism. Dubois (1999), Inger (1999), Sukumaran (2002), Stuart and Heatwole (2004) Grismer *et al.* (2004) among others, explored the amphibians of South Asia and its neighboring islands. Gorzula (1998), Baard and de Villiers (2000), Howell (2004) and Channing and Howell (2006), Maritz (2007), Grismer *et al.* (2010), Heath (2012), Frost (2017) worked in herpetofaunal description and documentation and developed a field guide from collected specimens and photographs. Turtles, crocodiles, and tuataras make up only 4% of all living reptiles, but the order Squamata (lizards, snakes, and worm lizards/amphisbaenians) makes up 95% (Hickman *et al.,* 2007).

Elevation range, topography, climatic factors, and food availability are determined amphibian and reptiles species distribution patterns. The herpetofauna of Nepal is hence a mixture of Indo-Malayan, Indo-Chinese, and transitional species (Das, 2010). Khan (2000), Belabut *et al*. (2010), Venkataraman *et al.* (2013) were represented the distribution pattern of herpetofauna with altitudinal gradients.

Diversity, distribution, richness, abundance, and taxonomy, as well as ecology, threats, and conservation status, are the key themes of major herpetofaunal research. There have been analyzed utilizing a variety of diversity indexes also. Begossi (1996), Nagendra(2002), Dash (2003), Khan *et al.* (2007), Johnston and Roberts (2009), Hossain *et al.* (2013), Sha and Pandit (2013), Garcia *et al.*(2015) used diversity indices to mesure species diversity and their interpretation. Hecnar and M'Closkey (1996) analyzed the distribution and species richness of amphibians in relation to pond chemistry in south-western Ontario, Canada. Baard and de Villiers (2000) measured diversity of reptile and found that 63 % lizards, 28 % snakes, 8%, terrestrial tortoises, and 1%, freshwater terrapin species and reported populations of *Ramphotyphlops braminus*. Santori and Benayas *et al.* (2006) studied the sites of herpetofauna diversity on planned infrastructure area, Akani *et al*. (2010) observed aspects of species richness and phenology and Pratihar *et al.* (2014) provides statistics on distribution, threats, and conservation status.Stuart *et al.* (2008) indicated that Tanzania was one of the top 20 nations in the world for higher amphibian diversity.

Snakes were the most abundant, with 20 different species in Andhra Pradesh, India (Reddy *et al.*, 2013). Das (2012), Midathala (2014) and Jadhav *et al.* (2018), Pettit (2019) classified the vanoumous and semi venomous and non venomous snakes. IUCN (2019) listed that *Python* species, *Oligodon erythrogaster, Trachischium tenuiceps*, and *O. hannah* were included in the rare category that is globally threatened species.

Few species are true forest species on a global scale but majority of them occured near the habitat that separates dense forests from open grasslands, while others live in wetlands or open habitats (Harding, 1997; Rakotondravony & Goodman, 2011). They preferred the grassland and forest within small geographical areaof East Africa (Channing & Howell, 2006). Beside these, they exhibit a variety of habitats, from fossorial to arboreal, and can be seen below soil and on tree canopies (Howell, 2004). Crocodiles, snakes, and the majority of amphibians are found in wetland, while others dwell exclusively on rock ridges (Branch, 2005). Lizards were seen in almost every park, garden, agricultural areas, waste land, and open forests due to the variety of food in a prominent microhabitat (Das & de Silva, 2005). Hillers *et al.* (2008) studied at anuran assemblages for habitat features such as fragmentation and degradation. Some reptiles have adapted to exist in extreme conditions like deserts and arid areas. Reptiles can be used in a variety of aquatic and terrestrial habitats since they are adaptable (Hickman *et al.*, 2007).

Reptiles can live in arid environments is assumed to be due to their thick erexo-skeletons. Seasonal temperatures, precipitation, soils, and the slope of the land, all influence herpetofaunal habitat preference and suitability. Santori and McManus (2014) investigated that abiotic factors influenced and damp forest edge has a negative impact on the diversity of reptile and amphibian species in coastal Ecuador. IUCN (2012) showed that coastal barrier island forests had fewer species than swamp forests.

CHAPTER 3

3. MATERIALS AND METHODS

3.1 Study area

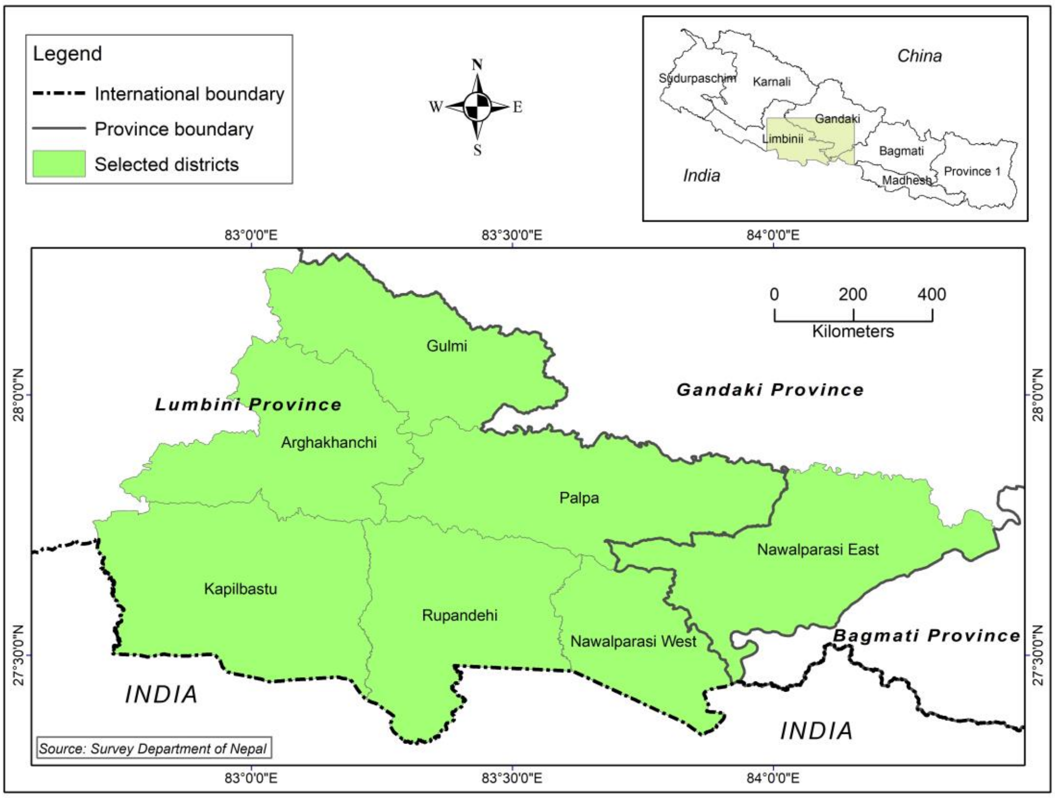


Figure 1: Map of Nepal showing study districts within province

Figure 2: Map of study area showing different stations within different districts

The study was conducted in Lumbini region of Nepal, which is situated in Lumbini province. It is located in southern and central regions of Nepal with 27°44'59.99" N and 83°29'59.99" E. It ranges from lowlands such as the Terai and Churiya hills to Mahabharat mountains. Hilly districts include Arghakhanchi, Gulmi, and Palpa, while Terai districts include Kapilvastu, Rupandehi, and Nawalparasi (east and west Nawalparasi).

It has a diverse range of wetlands, including river, stream, lowland oxbow, lake, swamps, marshes, rice fields, and so on (Lekhak 2003). It has a large Terai, tropical forests, hot and warm climates, marshes, swamps, lakes, rivers, and other natural features. Siwalik hill or Churia range consists of infertile sandy, soft, and porous rock. Mahavarat ranges with temperate climate consists of shrubs area, slight to moderately dense forests, and Midland hill consists of fertile lands, large valleys, temperate climate, slope landscape, caves, and varied microclimatic conditions.

3.1.1 Topography and climate

Physical barriers, temperature, rainfall, wind, humidity, salinity, alkalinity, and other influencing elements are well-adjusted in various ecological niches. The Terai belt (67–300 m), the Siwalik Hills Zone (700–1500 m), the Midlands (an average altitude of 2000 m), and the Mahabharat Lek (1500–2700 m) are all part of the study area. This area is roughly north-south in orientation.It rises from 71 meters above sea level in Krishnanagar station of Kapilvastu to 2515 meters in Gulmi's Resunga. The study locations were chosen because they encompassed and reflected the entire geography, vegetation, and climatic conditions of the district.

The climate is characterized by seasonal rainfall and typically low to high temperatures in this area. Every year, it gets about 1500 mm of rain. Rainfall in the nature reserve has a bimodal distribution in both weekly and monthly rainfall. The average annual temperature is roughly 32°C.

There were three metrological stations (Sandhikharka, Khanchikot and Sitapur) to measures the relative humidity, rainfall, and precipitation in Arghakhanchi district. Tamghas, Dauwa, and Musikot are the metrological stations of Gulmi districts. The metrological stations of Palpa district were Baldengadi, Gandakot, Jalpa, and Tansen. The stations of Nawalparasi were Dumkauli, Bardaghat, and Parasi. Two metrological stations in the Rupandehi area record rainfall, humidity, and temperature near the research site. Butwal and Bhairahawa stations were two stations to measures these parameters. Similarly, the Taulihawa station in Kapilvastu measures maximum and minimum temperatures. Metrological stations recorded the precipitation, temperature, humidiy were detailed in Appendices. These records (2016-2019) were obtained from Department of Metrology, Babarmahal, Kathmandu. The stations are main area which is divided into substations for sampling of station. The stations are main area within each districts which is further divided into substations for sampling. Six stations and 24 sub stations were selected (Appendices XII – XVII).

3.1.2 Arghakhanchi District

Arghakhanchi district lies between 27^o 45" N and 28^o 6" N latitude and 83^o 45" E to 83^o 23" E longitude, cover an area comprising 1193 km^2. The district's elevation ranges from 305 to 2515 meters above sea level.

Sandhikharka station: Chutrabesi, Dharampani, Argha, and Narpani substations were sampled, with elevations ranging from 937 to 1835 metres above sea level. It covers the small town, villages, Bangi Khola, Ghonche Khola, forests, marshy land, mountains, and a small plain area.

Sitapur station: The district's southern portion is located in the midhill areas. It ranges from lowland to midhill land. It has the Seetkhola, streams, small ponds, Thada daha, small villages, and sloping landscapes and rocky areas. The surveyed substations are Bada Chaur, Jhirbas, and Thada Daha, with elevation ranges of 1175 m to 1299 m above sea level.

Gokhunga station: It is the midhill areas lies the northan sites and extends from a ridge to steep slopes on the northern tip of mountain of this district. The surveyed covers the Pasleng, Hamsapur, Neta and Rangamare elevation from 1707 to 1999 m above sea levels. It has slopy and rockymountains, small streams, moist and arid forest and artificial ponds.

Arghatosh station: is also hilly areas lies eastern region of this district. It has mid hill, small Kurdi khola, Milmile khola, small forest, and arid zone. It lies the elavetion of 854 m to 1398 m above sea level. The sampling sites are Milmile khola, Kurdikhola, Chidipani, and Hatiya Arghatosh.

Pokharathok-Khidim station: is eastern and southern part of this district. The sampling substations are Pokhrathok, Panini tapobhumi, Durgaphant, and Simle elevation ranges from 725 to 1967m a.s.l. It roky and slopy area, large forest area, Panini daha, and temporary seasonal streams.

Sidhhara station: It is the sourthern region of the district with Chure and Siwalik hills and join to Terai at base. It has the Baraha daha where the only one species of Crocodile is found. It has less water resource and few streams. Sampling substations are Dansing khola, Barah daha, Lamidamar and their elevation ranging from 342 to 472 m a.s.l.

3.1.3 Gulmi District

(Lat: 27.9167^{o}N to 28.45^o N, Long: 83.1667^{o}E to 83.5834^{o}E) is a mountain district extending 1149 kilometers with altitudes ranging from 465 meters to 2690 meters.

Tamghas-Resunga: It covers towns, villages, forests, woodlands, wetland or swamps, rocks, and leaf litter or vegetation. It has narrow hilly streams and water bodies that frequently become temporary wetland areas. Saampling substations include Tamghas town, Neta, Paralme, and Resunga, whose elevations range from 1453 to 2512 m above sea level.

Kharjeng-Mankot: It is located in Tamghas' western region. Sampling's substations are Kharjeng, Mankot, Gairikhutta, and Angah. They lie 632 m to 893 m above sea level. Bakhrekhola, Kharjeng khola, villages and small markets, a few swampy areas, and riverine forest are the characteristics of these areas.

Aslewa station: It is a mountainous region in the district's east-southeast corner. Dominant vegetation includes Sal, Sissoo, shrubs, cultivated trees, fodder grasses, and plenty of natural water resources. Sampling stations were Temple Side, Badighat, Mochakot, and the forest site, where elevation ranges from 500–999 m above sea level.

Wami station: It lies in the north eastern region, situated in the upper Badighat river basin. It covers small towns, villages, rice fields, crop fields, riverine forests, moist and swampy areas, shrubs, and grasses. Charhari khola, Shera, Badighat khola, Timle chaur high, and Wami taxar are among the sampling stations. It lies at an elevation of 735 m to 817 m above sea level.

Santipur station: It is the rocky and sloping area with the small town and Haruwakhola. It has the wetland of Timure Daha, dry forest, and riparian areas. Sited locations were Harewa khola, Timure daha, Harrah Chaur and Remi, with elevations ranging from 1067 to 1957 m a.s.l.

Purkot- Mahelpokhari station: It is a mountainous region in Tamghas' northernmost region. It has villages, narrow hilly streams, and moist and dry forest, temporary ponds, and areas that are rocky and sloping. Sampling stations were Purkot Daha, Bhanbhane, Doduwa, Bhirkateri, Bahunpani, Gairagaun, and Mahelpokhari, ranging from 1693 to 1883 m above sea level.

3.1.4 Palpa district

Palpa district is located in hilly region of Nepal. It covers the area between 83.25^{o}E and 84.3667^{o}E, and 27.4167^{o}N and 27.95^{o}N. It's a hilly district with a total area of 1,373 km^2.

Tansen: It small urban area. Holangdi, Narayanthan, and Pravas Lake are wetlands. The sampling stations were Tanse, Batase, Madi phant, Parvas; their elevation ranged from 756 to 1318 m above sea level.

Somadi - Sardewa: It is the western part of the district and a hilly region, with a mountain range covering its low-lying hill slopes. The areas surveyed are Chhahara, Somadi, Sardewa, Tansinga, Dammak, and Dhajabanne. It has a Serdewa stream, Dammk marshy area, a forest, and a low human habitat. It lies at an elevation of 731–1670 m a.s.l.

Jhadewa station: It is located in the eastern region of Tansen and covers primarily a stream (Jhadewa River), wet patch, and water-filled depressions, forest, a small stream, and wet land with scrub vegetation. Deugir, Harneta, the Bajar area, and Thanti are the subsampling stations. It lies at an elevation of 983 to 1308 m above sea level.

Dovan station: Chure Hill is located in the southern region of the district. Its Tinahu River floodplain, ponds, and marshes interspersed with riparian forest and gallery forest, small villages, and a town. The substations are Dovan, Jhumsa, Suke Taal, and Satyabati Lake, whose elevation ranges from 275 to 1202 m above sea level.

Rampur station: It is the small plain region located in the upper Kaligandaki river basin, which lies in the eastern region of this district. The Kaligandaki river, Nisdi river, dry deciduous and scrub forests, agricultural land, barren land, and human settlements The elevation of the study site ranges from 358 m to 581 m. Sani Amarai and Khaliban are substations.

Ringneraha station: This site has hilly areas. It is characterised by small towns, villages, sandy plains, wetlands, and moist forests. It has Purbakhola, Thulokhola, and small streams as its water resources. The Campus area, Adhikari Pakhera, Thulakhola, and Phurungdi stations were sampled, with elevations ranging from 827 to 946 m above sea level.

3.1.5 Nawalparasi District

This district covers a total area of 2162 square kilometers and spans elevations of 91 to 1936 meters. The hilly region, the Inner Terai, and the Terai are the three components of this district, which are almost similar in size. Politically it has divided into two districts.

Western Nawalparasi: Dawanne Devi station: It is the Chure Renge. It has a small town, streams, a network of rainwater streams, and a large forest area. The study locations were Dauneedevi Temple, Daunee Bazaar, the western side of Bardaghat, and the eastern side of Bardaghat.

Parasi station: It is in the southern Terai region. It is an area encompassed by dry deciduous and scrub forests, pasture and reserve land, agricultural land, streams, ponds, springs, ditches, and irrigation channels. The study locations are Machharmara Taal, Turia Khola, Dakapani, Bhorahikhola, and Parasi. Its elevation ranged from 71 to 115 metres above sea level.

Eastern Nawalparasi: It is the eastern part of previous Nawalparasi district. Sampling stations of this district were Rajahar, Kawasoti, Rakachuli and Gaidakot. Rajahar:

Kawasoti Station: It is the Terai region, located in the eastern part of this district. The Danda River and human habitation are surrounded by degraded lands, forests, ponds, farmlands, and constructions. The substations include Danda River hight, forest areas, and Vey Good Choke. The elevations of the sites ranged from 165 to 184 metres above sea level.

Rakachuli station: This area is the Chure Renge area. The substation areas are Kudapani, Rakachuli, Midi Danda, and Bhigre Tari, with elevations of 223 to 943 m above sea level. It is characterised by a sal forest, a small hill stream, a village, and less cultivable grazing lands.

Gaidakot station: It is located in the district's east. It is located on the Narayani River's western bank. The study substations are Maula Kalika, Gairi Pitauji, Jaisikhola, Kareth, Bhedabari, Dandadhanch, Narayani Community Forest, etc. Part of this area is dominated by agricultural fields and a pond.

3.1.6 Rupandehi district

The district's diverse geography can be due to the combination of the Terai plain (100 m) and the Chure hills region (1219 m) within a 1360 sq. km area.

Khaireni station: It is located eastern part of district. It is a plain area consisting of agricultural fields, artificial ponds, fast-growing trees, forest roads, deciduous forests, and swampy areas. The localities surveyed under these stations are Chotorampur, Bijoypur Basti, Putichera, and Sanyasitilla, with elevations ranging from 144 to 175 masl.

Belbas station: It is located on Churia Hill, and its base is in the inner Terai. This region has both types of habitat. Belbas, Badelpokhari, Panikhola, Bhutkhola, Jawai, Hawara, and the bank of the Tinau River Pani Pokhari, Bhutkhola, Play Ground, and Tinahu River Bank are the substations, which range in elevation from 135 to 431 metres above sea level.

Gajedi station: It is located near Gajedi Taal. Raniban, Gajedi, Danapur, Kanchan, Bansgadhi, Gajedi taal, Kanchankhola, Shree Samayamai community forest, lakes, marshes, ponds, and human settlements The locations of the substations are Gajedi taal, Kanchan khola, and Raniban, with an elevation of 99 to 114 m above sea level.

Sainamaina station: These stations' studied areas include Bhalukhola danda, Shukli khola, Bolbam temple, Sunagava tole, Sukauj khola, Sarauli, Ranibagiaya, Murgia, and others. The main landscape features are cultivated lands and forests, and human settlements. Sunagava tole, Sukaju khola, and Temple area are the substations, with elevations ranging from 108 to 124 masl.

Chhapiya station: Bandhusari, Amua, Boting Pokari, Chiliya, and Kachkachra are the main sampling sites of this station. The main landscape features include cultivated lands, small water storage reservoirs, permanent or temporary wetlands, and shallow artificial ponds, tropical forests, and underdeveloped urban areas. The elevation of the substations is 85 to 92 m above sea level.

Bhairahawa-Madhulia station: The study areas are lowland, wetland artificial ponds, evergreen forest, human settlement area, and Bhairahawa Sunauli Hiway Crusss. The substations are Budda Chok, Madhaulia, Bhairahawa, and Thutipipa, with an elevation of 102 to 117 m above sea level.

3.1.7 Kapilvastu district

It is 1,738 square kilometers in size. The district is divided geographically in to Terai plains and the low Chure hills. It is located in Terai of Nepal which has lower tropical, upper tropical, and subtropical.

Jeetpur station: It is the complex cropland areas with human habitations that are located in the northern part of this district. This area encompasses dry deciduous forests, ditches, irrigation channels, barren land, a village, and a small town. Badganga, Jeetpur, football ground, and Karmana are among the substations, with elevations ranging from 126 to 144 metres above sea level.

Jagadishpur station: It is also highlighted in the Directory of Asian Wetlands. Banganga River, Bandauli, Jagadispur, Niglihawa, Kushmaghat, Sita Community Forest, Sagrahawa Community Forest, Kohili Nadi, Laxman Ghat, Harnampur. Lokation study sites are Bandauli, Jagdishpur Lake, and Harnampur.

Taulihawa - Khunuwa station: Taulihawa is the urban area in which the Dagawa, Baidauli, Khunuwa, and Mahasuhya rivers are substations at elevations ranging from 71 to 102 masl

Jayanagarr - Pattharkot station: It is the inner Terai joining area for Chure Hill. Gorusinghe, Basantapur, Imelia, Bhelai, Bodgaun, Belagurdua khola, Ranikhola, Kapilbhumi, Haiom community, and government forest are among the sampling areas. It lies 110–191 m above sea level.

Pakadi station: It is located in the district's east-southeast site. The sampling substations are Dubaripur, Pichaki, and Near Border municipalities, with elevations of 78 to 101 m above sea level.

Krishna Nagar station: This station is located in the southern part of the district, near the Terai lowlands and the low Chure hills. Chaipurawa, Patane, Basntapur, Krishnanagar, Surahikhola, Ramnagar, Shemara, and Ghorahikhola are the substation locations of these districts. Sampling substations are Surahikhola, Shemara, and Basantapur, with elevations of 77 to 103 masl.

3.2 MATERIALS

For process of preservation, collection and field procedure the following list of utilized equipment and chemicals were required during research period.

Equipment: Dissecting box, Tool box (with necessary tools), large forceps and scissors, Syringes and needles (different sized), Dissecting tray, Cell torches and headlight, photographic camera (Nicon - Coolpix 900), GPS (Garmin eTrex 10), collecting nets (different sized), Cage, Gumboots, Spring snake catching tongs, U-shaped holding hook, Collecting bags of polythene and cloath (different sized), Small jar (different size), Measuring cylinder and Tape, Scale, Gloves and Masks, Field note book & Labeling tags, Pencils & Markers, Data sheets, Hand lens(large size), Vernier calipers, Sieves, Buckets (15 L), Digging tools etc.

Chemicals required: Formalin, Ethanol, Chloroform, Xylocaine, Detergents, phenols, First aid box, Medicine.

3. 3 METHODS

Herpetofaunal activities, such as living status (in and out of the water, hiding behind foliage, and mobility), nocturnal and diurnal states, all influenced this study. The herpetofauna in the study area were surveyed using systematic survey methods. Observer experience, weather conditions, habitat type, and species behavior are all aspects that can affect the quality of data and determine the type of systematic search that must be used. The survey was primarily conducted during the pre-monsoon and monsoon seasons, and also frequently in other seasons.

3.3.1 Preliminary surveys

The environmental conditions and prior knowledge of the various habitats in the study area would be important to consider before settling on sampling methods, data collection, handling the specimens, and also for lodging (Doan, 2003). For this purpose, crucial logistical contacts were established with local people and trained guides. This was also useful in terms of gaining local knowledge of herpetofaunal species and their behavior that had been seen.

3.3.2 Selection of Habitat

The suitability of a habitat usually based upon a number of factors, like seasonal temperatures, precipitation, soils, and topography. There is a link between species diversity and habitat variety (Araujo, 2004) and habitat structure play vital role in defining species diversity of more physically complex ecosystems (Bell *et al.*, 2012). Herpetofaunal assemblages are influenced by factors such as habitat structure, forest canopy coverage, heterogeneity, and physical characteristics (Urbina-Cardona *et al.*, 2006). The vulnerability of a species to disturbance is determined by a number of taxonomic characteristics (Hooper *et al.*, 2005). It is critical to describe and measure significant habitat characteristics in order to properly evaluate the impacts on forest disturbance on herpetofaunal assemblages. In this study, all habitats are equally capable of being examined, or habitat type is factored into the study. Agriculture fields represented the availability of food between aquatic and terrestrial forms, forests represented the open area including wild species, human habitat represented the human pressure area, riparian area represented the semi-aquatic region, and wetland represented the pure aquatic form. As a result, the habitats described were chosen.

3.3.3 Sampling design

3.3.3.1 Transect and Quadrat methods

A systematic sample procedure was implemented, that included placing sample size at regular intervals and setting their sampling size (Kent & Coker, 1992). Survey was conducted in five different habitats: Agricultural fields, forest, human habitat, riparian and wetland. For the collection of herpetofauna in these habitats, six sampling stations in each six districts were selected for all the stated objectives. A total of 36 stations were selected. In each station four substations (sites) that at least contained one habitat types was selected (Appendix III). In each habitat type five transects each of 200 m were fixed. In each transect, four quadrats of each 20 m × 20 m were used. Hence, 20 quadrats randomly used in each habitat that accounted for 100 in total habitats (Figure 3). In these quadrats, Herpetofauna were detected by three different techniques; trapping, digging, and raking. Besides the quadrat sampling in fixed transects, additional three methods were used for maximum species collection. They were visual encounter method especially for snakes, Pitfall for nocturnal amphibians, and opportunistic survey.

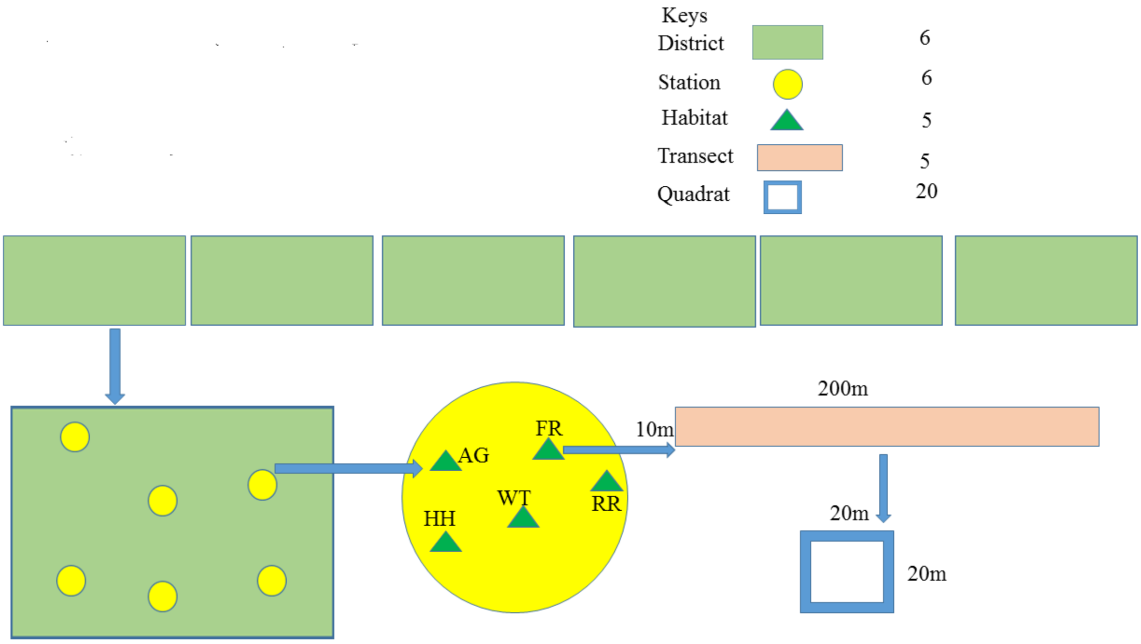


Figure 3: Outline of systematic sampling in six different districts of the study area

3.3.3.2 Herpetofaunal surveys

Fieldwork was conducted in three different period of daytime. It started in evening from 7:00 p.m. to 9:00 p.m., mornings from 6:00 a.m. to 9:00 a.m., and afternoons from 1:00 p.m. to 3:00 p.m. Each habitat was explored for about two hours in each period, so total of 7 hours was spent in each habitat. Frogs were collected inside the studied area during rainy season using a net, paralyzing, or warmed on a pam of hand. Reptiles were more difficult to collect than amphibians. Nets, hooks, and loops were also used to catch lizards. Snakes (both venomous and non venomous) were captured with the help of a snake-catching tongue and a U-shaped hook. Beside this, voucher specimens of snakes with the collected information were also gathered from hospitals and educational institutions. Specimens were paralyzed using a 2% xylocaine solution.

3.3.3.3 Visual Encounter Surveys (VES)

To maximize collection, random visits have been used to perform Visual Encounter Survey. The herpetofaunal surveys were conducted with the help of field guide. They were searched the banks, rocks, logs, pond bottom, and floating plant surface (Crump & Scott, 1994). VES surveys provided more reptiles and amphibians in nocturnal surveys.

3.3.3.4 Pitfall traps

Pitfall trapping used in this study, particularly to catch amphibians. Pitfall trapping used in this study, particularly to catch amphibians.Pit-fall trap system is made of a 15-liter bucket with drift fences (6 ft. x 1ft.) forming a "Y" on the ground (Jones, 1981).The pitfall traps were used in wetland and riparian habitats only. In these habitats, two pitfall traps were led.There were altogether 72 pitfall traps.They were set about 3 or 4 meters away from the water bodies, with the goal of attracting amphibian species during their mating season. Pitfalls had been left in place for two days, and being monitored each morning.

3.3.3.5 Opportunistic survey

Incidental observations and casual walks were performed in each habitat to extend the species list beyond the time frame and transect. This strategy, in addition to other standard protocols, ensures that species found can be included (Durkin *et al.*, 2011). About an hour were spent for this purpose in each habitat during the field survey.

3.3.3.6 Data sheets, record keeping, photography and museum specimens

The geographic coordinates of each survey site were obtained in the field using a Garmin GPS eTrex 10 receivers. During herping, the prepared data sheet was filled up. For morphological studies, live photos in their habitat had been taken by using digital camera (Coolpix 900). The location, date, time, weather condition, habitat, microhabitat, gender (if possible), reproductive condition of each individual (if it can be determined), co-existing species, and behavioral note of individuals captured during field work all were recorded in a field data sheet.

3.3.3.7 External morphology and identification of herps

Field specimens were collected and taken to the laboratory for processing and storage. Ten percent formaldehyde was injected into their thorax, abdomen, forearms, and hind limbs. Amphibian species were fixed in various shapes on a dissection tray after being sprayed with formalin for 24 hours. They were first repaired before being preserved in a 70% alcohol solution. Snakes and lizards were fixed in the same way as amphibians. Turtles and monitor lizards, for instance, were carefully preserved in 10% formalin. Their names, locations, dates, and times were then written on a waterproof tag and attached to the limbs or necks of the specimens.

The collected specimens were observed, and if unidentified, they were paralyzed and identified using a field guide (Shah & Tiwari, 2004). However, unidentified specimens were preserved in formalin for further lab processing. At least two species of each genus or species were measured. The specimens were identified with the help of a field guide book and published literature. For the primary collection of herpetofauna, preservation, and identification, voucher specimens were taken to the Zoology lab at Tribhuvan Multiple Campus in Palpa, Tribhuvan University for identification, and finally, representative specimens will be deposited in CDZ.

3.3.3.7.1 Amphibian

Published sources on regional, national, and international herpetofaunas were used for herpetofauna identification. All species observed were identified to species level using keys provided by Smith (1943), Nanhoe and Ouboter (1987), Dutta and Manamendra-Arachchi (1996), Dixon (2000), Bossuyt and Dubois (2001), Schleich and Kaestle (2002), and Rai (2003). Shah and Tiwari (2004), Schleich and Kaestle and Rai (2012a, 2012b, 2012c), Gururaja (2012), and Khan (2017) and Mitchell *et al.* (2012) were represented by webbing formulas to identify amphibians. For this purpose following morphometrics were used to measures species.

HW (Head width), HL (Head Length), ED (Eye diameter), NS (Distance between nostril and tip of snout), EN (Distance between eye and Nostril), FLL (Fore limb length), HLL (Hind limb length), TiL (Tibia length), AGD (Axilla-groin distance), SVL (Snout vent length)

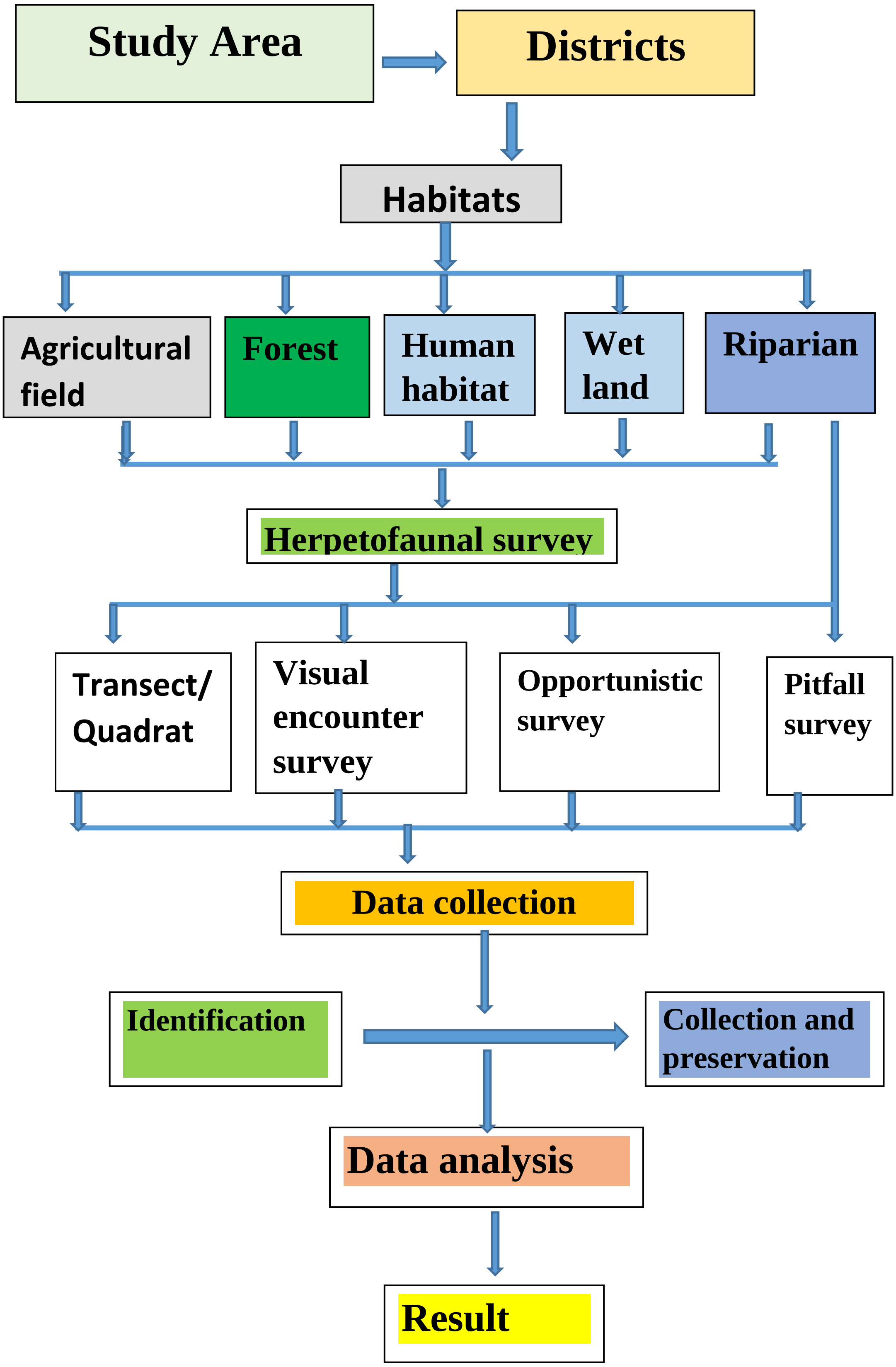
3.3.3.7.2 Reptiles

By using the different keys of herpetologist such as Boulenger (1890), Smith (1931), Fleming, & Fleming, (1974), Kramer (1977), Nanhoe, and Ouboter (1987), Michell, and Zug (1995), Jha, and Thapa (2002), Schleich and Kaestle (2002), and Rai (2003), Shah and Tiwari (2004), Kharel and Thapa Chhetry, (2012), Sharma *et al.* (2013), Khan (2014), Bhattarai *et al.* (2018) morphometric measurement were taken for reptiles. Measurement taken were: Snout-vent length (SVL), and if lizards; axial-groin length (AGD), forelimbs (FL) and hindlimbs (HL), ventral scales, SC (sub caudal scales), Pre Oc: pre ocular, Post Oc: post ocular, Temporal, SL (supra-labials), SL (te) (supra-labial touching eye), IL (infralabials), TL: tail length, TOT: total length (SVL+ TL), HL (head length), HW (head width), HD (head depth), Eye D (eye diameter), RH (rostral height), RW (rostral width), avg: average, max: maximum, min: minimum.

A final list of identification from Lumbini region Nepal was produced and documented taxonomically. The conservation status of listed herpetofauna was given according to IUCN red list of threatened species (2019).

3.3.3.8 Focus group discussion

During field visit, a total of 72 persons, including 36 male and 36 female were used as respondent. Prepared questioners were filled up.



Conceptual framework of research design

3.3.3.9 Data Analysis

The diversity indices were calculated by using software Ms. Excel, R and PAST.

Species richness (S): Total number of species

Shannon diversity index (H'): It determines whether a species is rare or common in a given community. It was used to calculate species diversity in distinct habitats by analyzing the number of species and their evenness.

$$H' = -\Sigma (P\mathrm{i} \ln P\mathrm{i})$$

Where H' is the index of species diversity

S = Species number

pi = The proportion of the whole sample that belongs to the i-th species

ln = Natural logarithm.

Simpson's Index (*λ*): (DS=1) is commonly employed as a diversity indicator, with higher values indicating more diversity. Rare species are less sensitive to the Shannon-Wiener Index.

$$\Lambda\ DS = \sum ni\ (ni-1N(N-1)=1-\sum ni(ni-1N(N-1)$$

Pielou’s evenness index (J'): It compares the reliable diversity rate to the highest realistic diversity value (Hmax= ln S (where S is the total number of species and all species are equally common). The Shannon-Wiener Index employs the Pielou evenness (J). It is calculated as

J' = H'/ln S,

Where ln S = H' max

H'max (maximum Shannon diversity) is what H' would be if every species in the community had the same number of individuals; S is the number of species.

Abundance of species

The number of individual species is used to measure abundance. By dividing the number of each species by the total number of species recorded, the relative abundance of each species was calculated.

Morphometric identification of venomous and non-venomous snakes: For identification of venomous and non-venomous snakes, examine the fangs and morphometric characters of specimens. Solenoglyphous fangs are found in the Viperidae family and are hollow, foldable, accurate, and dangerous. Proteroglyphous fangs were short and specialised fangs found in the Elapidae family. Opisthoglyphous fangs called "rear-fanged" were found in the Colubridae family and were located towards the back of the mouth. There was absence of fangs and maxillary teeth were present on mouth in non venomous snakes. Beside these, morphological features like head scales and shape, loreal pits, hood, dorsal scales, caudal scales ring rounded around body, striped pattern etc. were examined.

Habitat preference of herpetofauna

Specimen individual counts, species richness, and density of amphibians and reptiles were assessed using rank correlation to check for a significant association between annual rainfall, temperature, and humidity (Clarke & Gorley, 2001). Within a class, the microhabitat suitability for one species may differ from that of another. Species correlation was used to examine the habitat preferences of amphibians and reptiles based on the amount of habitat. The species rank abundance curve, diversity index, and correlation between species and habitat were used to measure the habitat preference.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4. 1 RESULTS

4.1.1 To identify and document Amphibians and Reptiles in Lumbini region, Nepal.

4.1.1.1 Amphibians

Families, scientific names, common names, and habitats of Amphibians are included in Table 1. There were six families and 12 genera of amphibians reported. The Ranidae family had ten species and six genera. Microhylidae had two genera, each with two species, and also two species from each of Bufonidae and Rhacophoridae families where as only one species from each of the families Megophryidae and Ichthyophidae.

Table 1: Families, scientific name and common name of Amphibians species in different habitats of Lumbini rigion (Abbriviations of habitat types are given in list of abbreviation)

S. N.	Family	Scientific name	Common name	Habitat type
1	Ichthyophidae	*Ichthyophis sikkimensis* Taylor, 1960	Sikkimese caecilian	AG, RP
2	Bufonidae	*Duttaphrynus melanostictus* (Schneider,1799)	Common Asian Toad	All,
3		*Duttaphrynus stomaticus* Lütken, 1862	Marbled toad	All,
4	Megophryidae	*Megophrys prava* (Boulenger, 1893)	Myanmar pelobatid toad	RP
5	Microhylidae	*Microhyla ornata* (Dumeril & Bibron, 1841)	Ornate narrow moth frog	AG, RP
6		*Uperodon taprobanicus* (Parker, 1934)	Sri Lnka bull frog	AG, RP
7	Ranidae	*Amolops marmoratus* (Blyth, 1855)	Meghalaya stream frog	RP
8		*Euphlyctis cyanophlyctis* (Schneider,1799)	Skittering frog	AG, RP, HH, WL
9		*Hoplobatrachus crassus* (Jerdon, 1853)	Jerdon's bull frog	AG, RP, WL
10		*Hoplobatrachus tigerinus* (Daudin, 1802)	Indian bull frog	AG, RP, WL
11		*Minervarya nepalensis* (Dubois, 1975)	Crikate frog	AG, RP, HH, WL
12		*Minervarya teraienesis* (Dubois, 1975)	Crikate frog	AG, RP, HH, WL
13		*Nanorana liebigii* (Günther, 1860)	Liebig"s paa frog	RP
14		*Sphaerotheca breviceps* (Schneider, 1799)	Indian burrowing frog	AG

15		*Sphaerotheca maskeyei* (Schleich & Anders, 1998)	Maskey's Burrowing Frog	AG, RP
16	Rhacophoridae	*Polypedates leucomystax* (Gravenhorst, 1829)	Java whipping frog	FR
17		*Polypedates maculates* (Gray, 1830)	Common Indian tree frog	FR

4.1.1.2 Reptiles

There were 41 reptiles identified into 30 genera and 12 families in this area. The family Colubridae had 15 species, six species of Elapidae, and three species each of Boidae, Agamidae, Geckonidae, and Scincidae, two species each of Varanidae and Viperidae, and one each of Crocodylidae, Typhlopidae, Bataguridae, and Trionychidae. (Table 2).

Table 2. Families, scientific name and common name of Reptiles species in different habitats of Lumbini rigion

S. N.	Family	Scientific name	Common name	Habitat type
1	Crocodylidae	*Crocodylus palustris* (Lesson, 1831)	Mugger crocodyle	WL
2	Bataguridae	*Pangshura smithii* (Gray, 1863)	Brown/ pale footed roofed turtle	WL, AG
3	Trionychidae	*Lissemys punctata* Webb, 1980	North Indian flap shell turtle	WL, AG
4	Agamidae	*Calotes versicolor* Daudin, 1802	Common garden lizar	AG, FR, HH, Rip
5		*Laudakia tuberculata* Hardwick & Gray. 1827	Himalayan rock lizard	FR
6		*Japalura tricarinata* (Blyth, 1853)	Tree keeled mountain lizard	AG, FR
7	Geckonidae	*Hemidactylus brookii* Gray, 1845	Spotted house gecko	HH
8		*Hemidactylus flaviviridis* Rüppell, 1840	Saffon bellied wall gecko	HH
9		*Hemidactylus frenatus* (Schlegel, 1836)	Common house gecko	HH
10	Scincidae	*Eutropis carinata* (Schneider, 1801)	Bronze grass skink	FR, AG, HH
11		*Mabuya macularia* (Blyth, 1853)	Bronze grass skink	FR, AG, HH
12		*Sphenomorphus maculatus* (Blyth, 1853)	Sikkimese forest skink	FR, AG, HH
13	Varanidae	*Varanus bengalensis* (Daudin, 1802)	Bengal monitor	FR
14		*Varanus flavescens* (Harhwicke & Gray, 1827)	Golden monitor	FR
15	Typhlopidae	*Indotyphlops braminus* (Daudin, 1803)	Brahminy Blindsnake	FR, AG, HH
16	Boidae	*Eryx conica* Schneider, 1801	Common sand boa	FR, AG
17		*Python bivittatus* Kuhl, 1820	Burmese rock python	FR

18		*Python molurus* (Linnaeus,1758)	Asiatic rock python	FR
19	Colubridae	*Amphiesma stolatum* (Linnaeus,1758)	Buff stripped keelback	RP, WL
20		*Boiga forsteni* (Duméril *et al.*,1854)	Forsten's cat snake	AG, FR
21		*Boiga stoliczkia* (Günther,1868)	Common tawny cat snake	AG, FR
22		*Boiga trigonata* (Schneider, 1802)	Common cat snake	AG, FR
23		*Coelognathus helena* (Daubin,1803)	Common trinket snake	AG, FR HH
24		*Coelognathus radiatus* Boie, 1827	Copper head trinket snake	AG, FR, HH
25		*Dendrelaphis tristis* (Daubin,1803)	Common bronzeback tree snake	FR
26		*Lycodon aulicus* (Linnaeus,1758)	Common wolf snake	FR, AG, RP
27		*Oligodon russelius* (Shaw,1802)	Banded kukri snake	FR,AG, HH
28		*Oligodon erythrogaster* Boulenger, 1907	Red bellied kukri snake	FR, AG
29		*Orthriophis hodgsonni* (Günther,1860)	Himalayen trinket snake	FR, AG
30		*Ptyas mucosa* (Linnaeus,1758)	Asiatic rat snake	All
31		*Trachischium tenuiceps* (Blyth, 1854)	Orange billied worm snake	FR
32		*Fowlea piscator* (Schneider, 1799)	Chequered keelbak water snake	RP, WL
33		*Fowlea sanctjohannis* (Boulenger, 1890)	St. John's keelbak water snake	RP, WL
34	Elapidae	*Bungarus caeruleus* (Schneider, 1801)	Common krait	AG, FR, HH
35		*Bungarus fasciatus* (Schneider,1801)	Banded krait	AG, HH
36		*Sinomicrurus macclellandi* (Reinhardt, 1844)	Maclelland's coral snake	AG, FR, HH
37		*Naja kaouthia* Lession, 1831	Monocled cobra	AG, FR, HH
38		*Naja naja* (Linnaeus,1758)	Binoclellate cobra	AG, FR, HH
39		*Ophiophagus hannah* (Cantor, 1836)	King cobra	FR
40	Viperidae	*Trimeresus albolabris* Gray, 1842	White lipped pit viper	AG, FR, HH
41		*Ovophis monticola* (Günther,1864)	Mountain pit viper	AG, FR

4.1.1.3 Morphometric identification of amphibians with distribution

1**. Species Name**: *Ichthyophis sikkimensis* Taylor, 1960

Synonyms: *Ichthyophis glutinosus* (Blanford, 1881)

Common Name: Sikkimese Caecilian; Darjeeling Caecllian.

Nepali Name: Andha sarpa

Location: It was reported from Tansen, Palpa, and it was 1,650 meters above sea level.

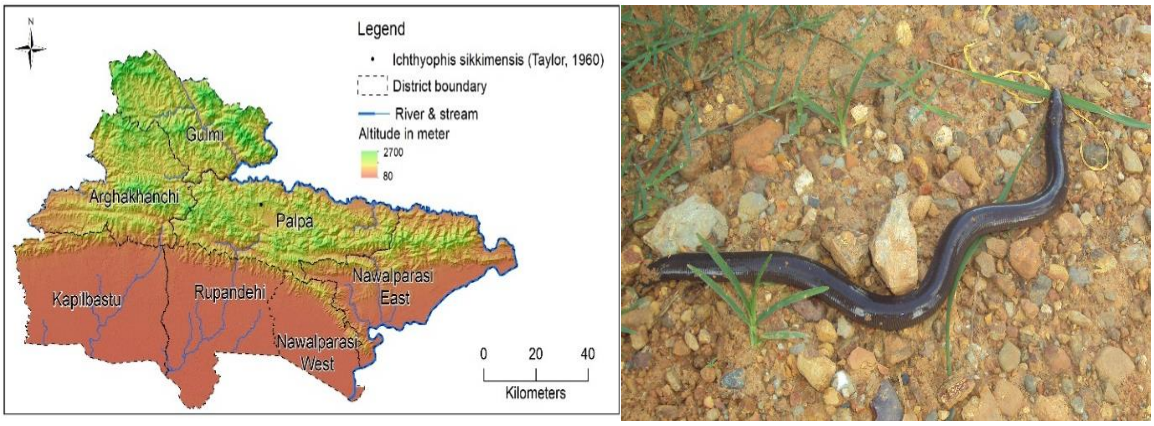


Figure 4: Point location map of the Sikkimese Caecilian *Ichthyophis sikkimensis* Taylor, 1960 at occurrences in the Lumbini region (Tansen Palpa). Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: It's a vermiform medium-sized species having 292 to 307 dorsal annuli, and no lateral yellow stripe. Its tail is short with 5 to 6 folds. The head is slender, thin (9.1-9.3 mm) and long (10.9-11.2 mm). A tentacular aperture is located nearer the eye than a nostril with visible eyes. The snout extends a little beyond the mouth and is situated right below the tip of the snout. Collars are not separated dorsally and are quite inconspicuous.

Measurement: 293-313.0 mm

Body colour: Dark brownish above, pale below.

Habit: During a rainy night, be active outside. During the dry season, it burrows deep into the ground.

Global distribution: Nepal and south Asia, South East Asia, Southern Philippines, western Indo-Australian Archipelago (IUCN, 2019).

Distribution in Nepal: It records from Ilam and Palpa districts of Nepal (Shah & Tiwari, 2004).

Status: Data deficient

2. **Species Name**: *Duttaphrynus melanostictus* (Schneider, 1799)

Synonyms: *Bufo melanostictus* (Schneider, 1799), *Rana melanosticta* (Schneider, 1799), *Bufo chlorogaster* (Daudin, 1802), *Bufo Bengalensis* (Daudin, 1802), *Bufo dubius* (Shaw, 1802), *Bufo carinatus* (Gray, 1830), *Bugo isos* (Lesson, 1834), *Bufo gymnauchen* (Bleeker, 1858).

Common Name: Black spine toad, Common Asian toad

Nepali Name: Kharse bhyaguto, Dhudaribyang Khatkhyarri meghaba

Location: All stations of study areas ranging from 1845 meters in Resunga to 71 meters above sea level in Bhairahawa station.

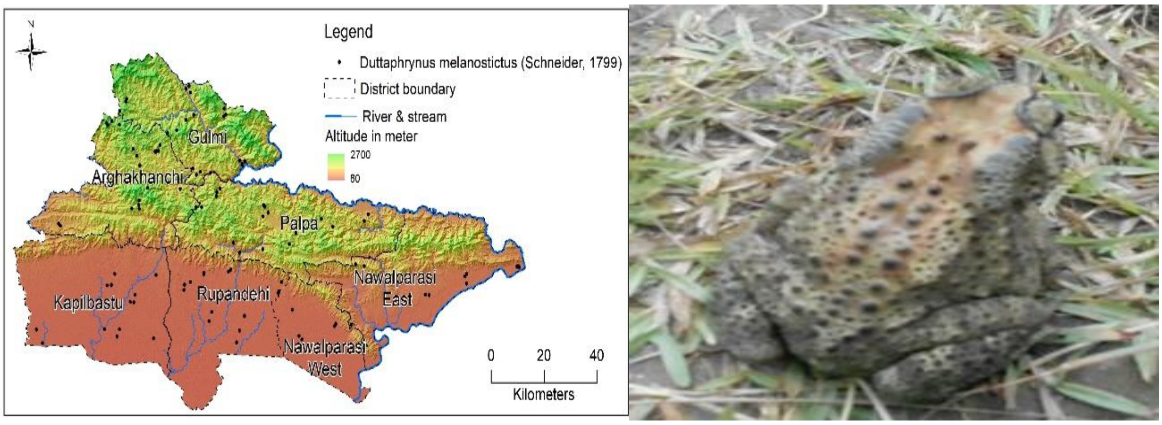


Figure 5: Point location map of the Black spine toad *Duttaphrynus melanostictus* (Schneider, 1799) at occurrences in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: A canthal, pre-orbital, post orbital, and supraorbital ridge are one of the more or less raised cranial ridges on the head. The body's dorsal surface is highly tuberculated, with remarkable warts. Two rows of big warts extend down the center of the back. Its tympanum is a circular or oval structure. Its parotids glands are large, kidney-shaped, or elliptical in shape. The cranial ridges, wart points, and upper jaw rim are all black. The tips of the fingers are swollen and blunt, and the digits are free. Toe tips are blunt, and roughly two-thirds of them are webbed.

Measurement: SVL: 45.0 – 115 mm; HL 17.0–32 mm; HW 26.0–31.0 mm; axilla-groin distance 10.0–19 mm; forelimb length 21.0–31.0 mm; hind limb length 35–50.0 mm; tibio-tarsal articulation reaches between eye and nostril; smooth skin; slightly plain supra-tympanic fold; uniform whitish brown to mild reddish brown dorsally; a prominent black eye steak crosswise post ocular and supra-tympanic regions. Iris is golden above and darker below; with a horizontal black pupil.

Body colour: The coloration of the dorsal area ranges from yellowish to brownish, or beige to greyish. During the reproductive stage, some specimens become brick red. The ventral side is cream-colored; spots occur on the thoracic and gular regions.

Habit: It is a nocturnal and terrestrial toad. It hides beneath logs, stones, brick stacks, moist tree holes and cracks, trunks, and dark corners of houses, among other things.

Global distribution: Nepal and south Asia (IUCN, 2019)

Distribution in Nepal: It is found in Nepal below 2250 meters (Shah & Tiwari, 2004).

Status: Least Concern

3. **Species Name**: *Duttaphrynus stomaticus* Lütken, 1864

Synonyms: *Bufo andersonii* (Boulenger, 1883)

Common Name: Marbled toad, Assam toad

Nepali Name: Kharse bhyaguto, Dhudaribyang Khatkhyarri meghaba

Location: It was observed in all stations in the research area, with altitudes ranging from 75 meters at Taulihawa to 1999 meters at Gokhunga station.

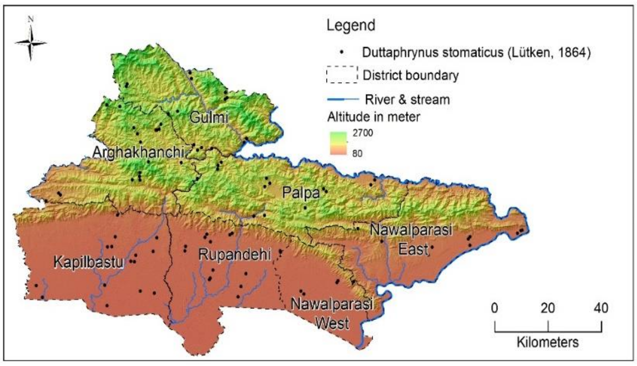


Figure 6: Point location map of the Marbled toad: *Duttaphrynus stomaticus* Lütken, 1864 at occurrences in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: It has broad head without a bony cranial ridge. The inter-orbital gap is somewhat wider than the upper eyelid; the tympanum is distinctive and spherical, its diameter is two-thirds that of the eye. The body's dorsal surface is tuberculated, whereas its ventral surface is roughly granulated. The parotid glands are larger. Short, free fingers with somewhat dilated tips make up the forelimbs; the first and second fingers are subequal. Toes have a single sub-articular tubercle. The hind limbs are medium in size, with two-thirds of the toes webbed.

Measurement: Snout-vent length 38.0 – 95 mm, female is larger than male. Head length is 16.0 – 20mm, head width 16 – 30.0, body width 18 – 25.0 mm, diameter of tympanum 3.0 - 5.0 mm, fore limb length 28.0 – 33.0 mm, hind limb length37 – 50.0 mm. Tibio-tarsal articulation reach in between the shoulder and the eyes. Length of fingers 3 > 1 > 4 > 2. Length of toes 4>3>5>2>1

Body colour: The dorsum has a light grey or olive coloration, black along with dark mottling and grey to darkish reticulation. The front of forelimbs have three dark transverse bands. The throat is spotted with dark dots, and the ventrum has a muddy white colour and tips of digits are a dark brown colour.

Habit: It is nocturnal and hides behind the stones and crevices of tree trunks in moist and shady enclosed locations. It usually appears near human habitation.

Global distribution: Islamic Republic of Iran, Afganistan, Bangladesh, Inida, Nepal, Oman, Pakistan, Bhutan, and China (IUCN, 2019).

Distribution in Nepal: It is common in low lands to hilly area (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

4. **Species Name**: *Megophrys prava* (Boulenger, 1893)

Synonymes: *Xenophrys parva* (Boulenger, 1893), *Leptobrachium parvum* (Boulenger, 1893), *Megalophrys parva* (Boulenger, 1893), *Panophrys parva* (Boulenger, 1893).

Common Name: Brown Horn Frog, Brown Spine-eyed Frog, Tubercular Breasted Frog, Concave-crowned Horned Toad, Small Spade foot Toad, Mountain Horned Toad, Mountain Horned Frog, Lesser Stream Horned Frog

Nepali Name: Jhari bhyaguto

Location: It was reported from Arghakhanchi, Gulmi, and Palpa districts of the study area and altitudinal ranges from 721 m to 1826 m above sea level.

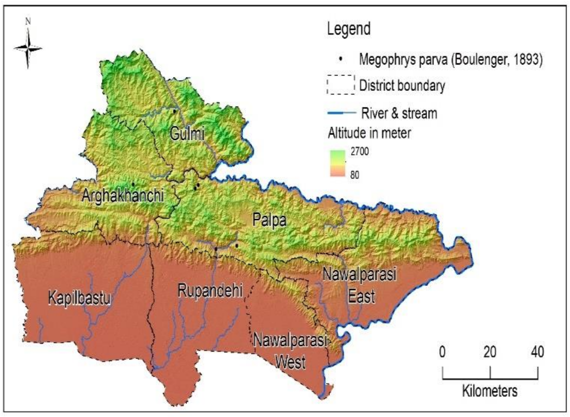


Figure 7: Point location map of the Brown Horn Frog *Megophrys prava* (Boulenger, 1893) existing in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: Head is triangular, broad than long, depressed; pointed snout, supra-orbital ridge originates at the nostril and runs covering the tympanum to the axilla. The eyes are large and distinct tympanum. The supra-tympanal fold is angular and prominent. Between the eyes is a triangle marking, and on the dorsum is a crescent pattern. Fore limbs are moderately long, fingers free and tip feebly swollen. The tibio-tarsal articulation reaches past the mouth with the long hind limbs. Toes have a rounded tip and rudimentary webbing.

Measurement: SVL 33-37 mm, head length: 8.0 – 12mm, head width 12 – 17.0, body width: 15 – 22.0 mm, fore limb 17–22mm hind limb 48 – 55mm. Tibiotarsal articulation reaches close to the nostril. Length of finger 3 > 4 > 1 > 2 and length of toe 4 > 3 > 5 > 2 > 1.

Body colour: Dorsal side is dark brown with triangular black marking on the forehead. Venter is black at the anterior region (more dark to the lower jaw) and posterior past is creamy.

Habit: It's a nocturnal frog that prefers humid biotopes with tree or bush vegetation, streams or small rivers, and bush vegetation near running water.

Global Distribution: Nepal, Bhutan, Bangladesh, Myanmar, Thailand, Yunnan (China), India, Vietnam (IUCN, 2015).

Distribution in Nepal: It is regionally common, but not recorded from all parts of the Midlands (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

5. **Species Name**: *Microhyla ornata* (Dumeril & Bibron, 1841)

Synonyms: *Engystoma ornatum* (Dumeril & Bibron, 1841), *Siphneus ornatum* (Duméril & Bibron, 1841), *Engystoma malabaricum* (Jerdon, 1853), *Diplopelma ornatum* (Duméril & Bibron, 1841), *Diplopelma carnaticum* (Jerdon, 1853), *Microhyla carnatica* (Jerdon, 1853).

Common Name: Ornate narrow mouth frog

Nepali Name: Thutune bhyaguto

Location: It was found in many districts, especially in hilly regions. It ranges in elevation from 192 to 2512 m a.s.l.

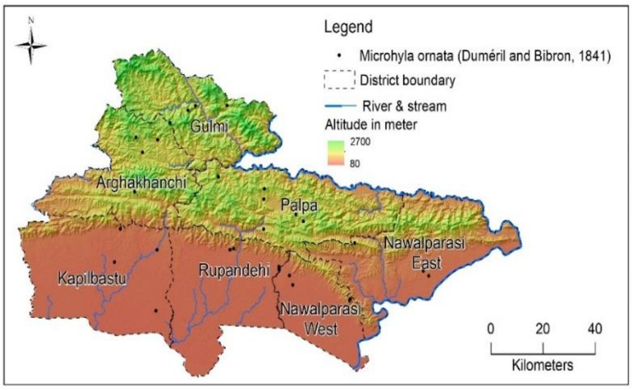


Figure 8: Point location map of the Ornate narrow mouth frog *Microhyla ornata* (Dumeril & Bibron, 1841) existing in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: Body is small and oval with narrow head and broad posteriorly. The pupil is spherical, the nostrils are closer to the snout tip than the eye. Tympanum is hidden, and the snout is broad and obtuse. The dorsal surface has smooth skin. There are tubercles on both the inner and outer metatarsals. Tubercles in the sub-articular space are separate. With free fingers and a swollen tip, the forelimbs are quite short. The posterior limbs are short, muscular, webbed and primitive.

Measurement: SVL 1827 mm, head length: 5.0 – 8mm, head width 6.0 – 8.0, body width 11 – 12.0 mm, fore limb 7.0 – 9.0mm, hind limb 32 – 35mm. Tibio-tarsal articulation extends to the shoulder between the eye or the shoulder. Finger lengths are 3 > 4 > 2 > 1and toes are 4>3>5>2>1.

Body colour: The dorsum is golden to muddy brown in appearance, with darker symmetrical arrow-shaped patterns on the back. A black plate runs from the snout to the belly on each lateral side, with dark cross bars on the limbs. The belly is white, with black dots under the thorax and around the throat.

Habit: It is a nocturnal frog that spends its time in temporary water pools, damp grass, temporary tank water, and leaf litter.

Distribution in Nepal: It is frequent in the Terai and Midlands on the elevation of 140 - 1,980 m in Nepal (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

6. **Species Name**: *Uperodon taprobanicus* (Parker, 1934)

Synonyms: *Kaloula taprobanica* (Parker, 1934), *Kaloula pulchra taprobanicus* (Parker, 1934)

Common Name: Sri Lanka Bulfrog, Indian painted frog

Nepali Name: Pahade panibhyaguto

Location: It was recorded from plain area of Nawalparasi district.

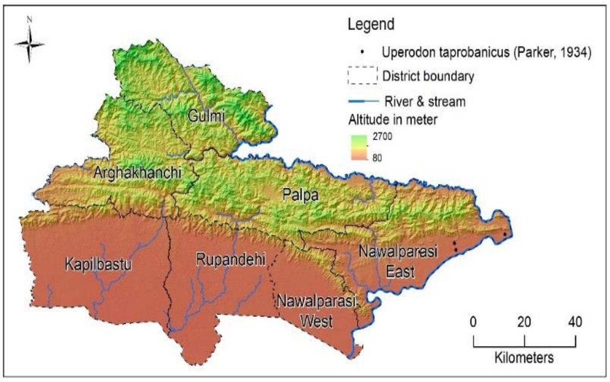


Figure 9: Point location map of the Sri Lanka bullfrog *Uperodon taprobanicus* (Parker, 1934) existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: The body is wide and robust. The snout is oval, the tympanum is indistinct, and the supra-tympanic fold runs from the upper eyelid's posterior corner at the axilla to the forelimb's insertion. The forelimbs are shorter, with truncated discs and no webbing at the tips of all fingers. The hind limbs are short and strong, with rounded, slightly expanded toes that lack discs and webbing.

Measurement: SVL 50.0-61.0 mm, head length: 11.0 – 14.0 mm, head width 12.0–16.0, body width: 25.0 – 35.0 mm, fore limb 24.0 – 33.0 mm hind limb 38.0 – 45.0 mm. Length of finger 3 > 4 > 2 > 1 and length of toes 4 > 3>5 > 2 > 1.

Body colour: Dorsum is greyish-black, reddish-orange bands on head. Adults have a dark or practically undetectable yellow mark on their back.

Habit: It shows crepuscular and nocturnal. During dry period, it lives in tree holes.

Global Distribution: Nepal, Bangladesh, southern and eastern India and Sri Lanka (IUCN, 2015)

Distribution in Nepal: It is common in Terai on the elevation of 100-300m (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

7. **Species Name**: *Amolops monticola (*Anderson, 1871*)*

Synonyms*: Staurois monticola* (Anderson, 1871), *Rana monticola* (Anderson, 1871), *Hylorana monticola* (Anderson, 1871),

Common Name: Mountain cascade frog

Nepali Name: Pangre bhyaguto, Kalo paha, Pirre paha

Location: It was reported from Gulmi district, with an elevation of 1067–1865 m.

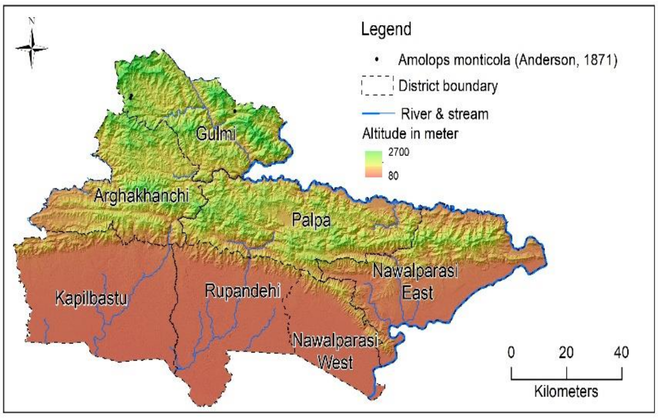


Figure 10: Point location map of the Mountain cascade frog *Amolops monticola* (Anderson, 1871) existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: The head is long and broad with a rounded snout; the tip of the snout and the eyes are separated by the nostrils in an equal distance; the tympanum distinct. The eyes are buldging, and horizontally oval. Two dorsolateral folds that run from the back of the eye to cloaca with smooth dorsal skin. Short forelimbs, third finger is the longest and sub-articular tubercles are noticeable and small. Hind limbs are thin and long, with webbed toes and horizontally grooved discs on the tips of their toes. Inner metatarsal tubercles are present but no outer metatarsal tubercles.

Measurement: SVL 55.0-68.0 mm, head length 22.0 – 25.0 mm, head width 24.0 – 25.0, diameter 3.0 – 5.0, body width, 25.0 – 35.0 mm, fore limb 42.0 – 45.0 mm hind limb 99.0-105 mm. Finger length 3> 4 > 2 >1 Toes length 4 > 5 > 3 > 2 > 1.

Body colour: The dorsum is a darker grey colour with black marbles. The tympanum is a dark brown color. The venter coloration varies from yellowish grey to green to dark brown mottled.

Habit: It is nocturnal, solitary or sedentary, and usually appears in rapidly flowing waters, ponds, and rivers.

Global Distribution: China, India, Nepal, Bhutan, Myanmar (IUCN, 2015).

Distribution in Nepal: It is common on altitude of 1,000-2350 m (Shah & Tiwari, 2004).

Status: Least Concern (Population decreasing)

8. **Species Name**: *Euphlyctis cyanophlyctis* (Schneider, 1799)

Synonym: *Rana cyanophlyetis* (Schneider, 1799), *Bufo cyanophlyctis* (Schneider, 1799), *Rana bengalensis* (Gray, 1830), *Rana leschenaultii* (Duméril & Bibron, 1841), *Dicroglossus adolfi* (Günther, 1860), *Euphlyctis leschenaultii* (Duméril & Bibron, 1841), *Dicroglossus cyanophlyctis* (Schneider, 1799), *Occidozyga cyanophlyctis* (Schneider, 1799), *Rana cyanophlyctis seistanica* (Nikolskii, 1899), *Euphlyctis cyanophlyctis microspinulata* (Khan, 1997).

Common Name: Skittering frog

Nepali Name: Ahale bhyaguto, Dholbaje paha, Chhotki meghi

Location: It was recorded from all sites in the study area, ranging from 71 to 2512 m.

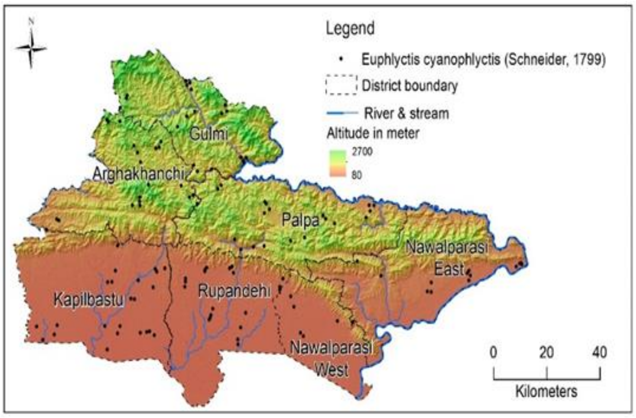


Figure 11: Point location map of the Skittering frog *Euphlyctis cyanophlyctis* (Schneider, 1799) existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: The body is small and oblong; with a broad and depressed head. The snout is rounded in front but pointed in behind. The tympanum is a separate structure and eyes are huge, bulging, and oval in shape horizontally. Dark patches appear on the limbs but do not form complete bands. Short and muscular forelimbs have free and swollen fingers at the tips andshort, muscular hind limbs have fully webbed toes with swollen tips.

Measurement: SVL 48.0 – 67.0 mm; head length 15.0 – 25 mm; head width 14.0 – 21.0; body width 21 – 32.0 mm; fore limb 23.0 – 32.0 mm; hind limb 69 – 85mm. Tibio-tarsal articulation reaching at the eye level. The fingers lengths are 3 > 1 > 2 > 4 and length of toes are 4 >5>3>2 >1.

Body colour: The colour of dorsum varies from brownish to Yellowish, greenish to greyish brown and numerous scattered small smooth tubercles.

Habit: It is an active, diurnal, nocturnal frog that floats on the water surface under the smallest pools of rivers, temporary water pools, village water holes, and wells.

Distribution in Nepal: It is common in Terai to 2,000 m (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

9. **Species Name**: *Hoplobatrachus crassus* (Jerdon, 1853)

Synonyms: *Rana crassa* (Jerdon, 1853), *Hoplobatrachus ceylanicus* (Peters, 1863), *Rana ceylanicus* (Peters, 1863), *Limnonectes crassus* (Jerdon, 1853), *Rana tigerinus ceylanica* (Peters, 1863).

Common Name: Jerdon's bullfrog

Nepali Name: Sadhe bhyaguto, Sirke paha, Meghi

Location: It was reported from Teraian districts and the low altitudes of the mountainous districts.

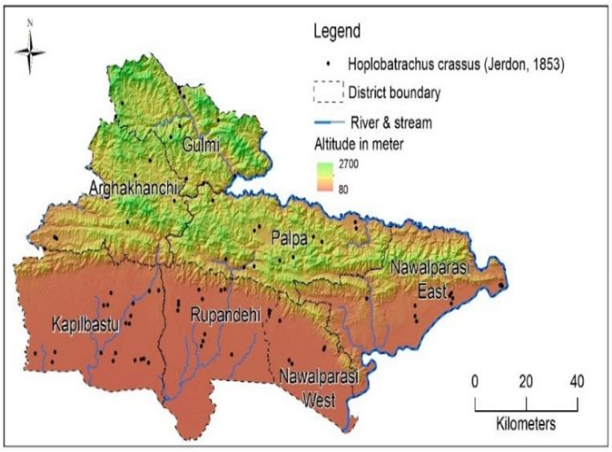


Figure 12: Point location map of the Jerdon's bullfrog *Hoplobatrachus crassus* (Jerdon, 1853) existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: It's a flabby-shaped body, pointed and shorter snout and a prominent tympanum. The head is a little wider than long. The mid dorsal stripe is less prominent, and it's more likely to be absent than present. The forelimbs are smaller, more muscular, and have more free fingers than the hind limbs. The tips of the toes are fully webbed and deeply notched, rather than being pointed.

Measurement: SVL 78.0 – 97.0 mm, head length 22.0 – 27.0 mm, head width 24.0 – 28.0, diameter 4.0 – 5.0, body width: 31 – 48.0 mm, fore limb 43.0 – 52.0mm hind limb 90.0 – 110mm; beyond the tip of the snout, the tibio-tarsal articulation is reached. Length of finger: 3 > 1 > 2 > 4 and toes length: 4>5>3>2>1.

Body colour: Colour of dorsum is yellowish green to greenish brown with black spots. Ventral surface is creamy white.

Habit: It is solitary, sedentary, an active hunter and burrowing frog and exposed along rice fields, ponds, ditches and canals.

Global Distribution: Bhutan, China, Myanmar, Bangladesh, India, Nepal, Sri Lanka (IUCN, 2015).

Distribution in Nepal: It is more common in Terai than hilly region and recorded on the elevation of 145 – 260 m (Shah & Tiwari, 2004).

Status: Least Concern (Population decreasing)

10. Genus: *Hoplobatrachus tigerinus* (Daudin, 1802)

Synonyms: *Rana tigerina* (Daudin, 1802), *Dicroglossus tigerinus* (Daudin, 1802), *Euphlyctis tigerina* (Daudin, 1802), *Limnonectes tigerinus* (Daudin, 1802), *Tigrina tigrina* (Daudin, 1802), *Rana tigerina tigerina* (Daudin, 1802).

Common Name: Indian Bullfrog

Nepali Name: Sigare bhyaguto, Male paha

Location: It was reported from many sites in Terai and the midland in the research area.

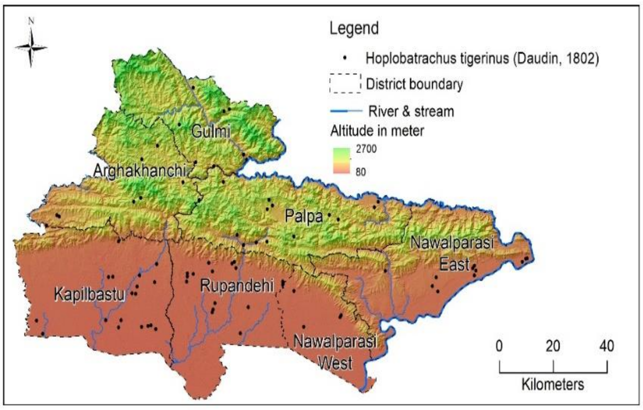


Figure 13: Point location map of the Indian Bullfrog *Hoplobatrachus tigerinus* (Daudin, 1802) at existing in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: It has a cylindrical body. Head is pointed, longer than broad and slightly depressed. Prominent tympanum, as large as eye diameter and supra-tympanal fold are present. From the snout to the vent, a light yellowish or white mid dorsal line runs. It has short and muscular forelimbs with free and swollen fingers at the tips. The hind limbs are long, muscular, and webbed, with the exception of the fourth toe. The tibio-tarsal articular extends beyond the snout's tip.

Measurement:SVL 85.0 – 115.0 mm; head length 29.0 – 37.0 mm; head width 34.0 – 41.0; diameter 4.0-6.0; body width: 33.0 – 45.0 mm; fore limb 48.0 – 55.0mm hind limb 95.0 – 117.0 mm. The length of fingers are 3 > 1 > 4 > 2 and toes 4 > 5 > 3 > 2 > 1.

Body colour: Its dorsum is covered in darker or blackish leopard-like spots. It is grey, brownish green, yellowish grey, or olive green in colour.

Habit: It is nocturnal as well as diurnal, solitary or sedentary and active in searching of food. It is semi aquatic, good swimmer and lives in wet places.

Global Distribution: Afghanistan, Bangladesh, India, Myanmar, Nepal, Pakistan, Madagascar, Maldives (IUCN, 2015).

Distribution in Nepal: It is found in Terai and Midlands up to 1,600m (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

11. **Species Name**: *Minervarya nepalensis* (Dubois, 1975)

Synonym: *Fejervarya nepalensis* (Dubois, 1975), *Rana nepalensis* (Dubois, 1975), *Euphlyctis nepalensis* (Dubois, 1975), *Limnonectes nepalensis* (Dubois, 1975).

Common Name: Nepal Wart frog

Nepali Name: Tyang tyang paha

Location: This species was studied from the all stations of study area ranging from Taulihawa station to Resunga stations.

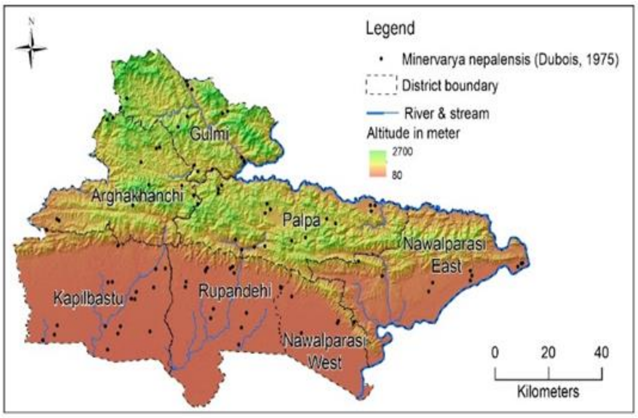


Figure 14: Point location map of the Nepal Wart Frog *Minervarya nepalensis* (Dubois, 1975) existing in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: The body is somewhat oblong oval. Head is pointed dorsally. From the eye's posterior corners to the insertion of the fore limb, the supra-tympanal fold runs. A distinct but thin mid-dorsal line is always present, whether or not there are red patches. Fore limbs are short and finger free and obtusely pointed with rounded tips, Hind limbs are long and moderately webbed toe.

Measurement: SVL 32.0 – 38.0 mm, head length 9.0 – 12.0 mm; head width 9.0 – 10.0; Tympanum diameter 2.0 – 3.0 mm; body width: 15.0 – 19.0 mm; fore limb 22.0 – 27.0 mm hind limb 32.0 – 37.0 mm. Tibio-tarsal articulation reaches between eye and nostril. Finger's length 3>4 > 2 > 1 and toe's length 4 > 3>5 > 2 > 1.

Body colour: The dorsal surface is primarily olive-green with a few scattered black spots fused into crosswise bands. Two red spots appear on the middorsal line. There are two additional red dots on each forelimb. Dark transverse bands run through the fore limbs. Pigmented patches on the thighs and stripes on the lower legs characterize the hind limbs.

Habit: It showed the semi aquatic and aquatic habit.

Global Distribution: India, Bangladesh, Nepal (IUCN, 2015)

Distribution in Nepal: It is most common in low land midlands and mountains, 73-3,360m.a.s.l. (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

12. **Genus**: *Minervarya teraiensis* (Dubois, 1975)

Synonyms: *Limnonectes limnocharis* (DUBOIS, 1974); *Fejervarya teraiensis* (Dubois, 1984); *Rana (Fejervarya) teraiensis (*Dubois, 1984*) Limnonectes (Fejervarya) teraiensis* (Dubois,1987*)*, *Fejervarya teraiensis* (Iskandar,1998*).*

Common Name: Terai Cricket Frog

Nepali Name: Madhese kithre bhyaguto, Tik tik paha

Location: It was found in all districts of study areas, ranging from the plains of Terai to the midland of the mountains.

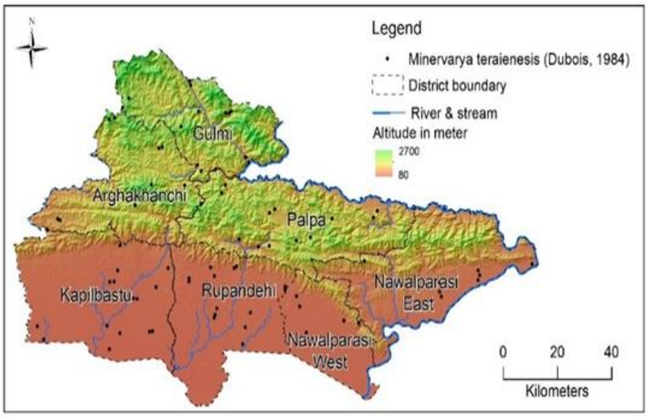


Figure 15: Point location map of the Terai Cricket Frog *Minervarya teraiensis* (Dubois, 1975) at occurrences in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: Head is broader than long. Tympanum is distinct, round with supra tympanic fold. Fingers free, toes half webbed. Mid dorsal lines is highly variable, distinct to indistinct, narrow to broad. Fore and hind limbs are moderate sized. Tips of the fingers and toes are rounded.

Measurement: SVL 42.0 – 52.0 mm; head length 8.0 – 10.0 mm; head width 12.0 – 16.0; Tympanum diameter 3.0 – 4.0 mm; body width 25.0 – 29.0 mm; fore limb 22.0 – 28.0 mm hind limb 52.0 – 63.0 mm. Fingers length: 3 >1 > 4 = 2 and length of toes 4 > 3> 5 > 2 > 1.

Body colour: It is greyish to brownish on the dorsal side, with tiny granules and with or without a narrow mid–dorsal line. Hind limbs has cross-bars. Ventrally smooth, dark grey in colour

Habit: It remains hidden under stones or in cavities in the ground. It is found in leaf litter and near wetlands, far from water, in temporary pools, in large river valleys, and in cultivated regions.

Global Distribution: Bangladesh, India, Nepal, Myanmar (IUCN, 2015).

Distribution in Nepal: Few records from the entire Terai zone (71-400 m) (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

13. **Species Name**: *Nanorana liebigii* (Günther, 1860)

Synonyms: *Megalphrys gigas* (Blyth, 1855), *Rana liebigii* (Günther, 1860), *Chaparana liebigii* (Günther, 1860)

Common Name: Liebig's Paa frog

Nepali Name: Liebig ko Paha, Man Paha, Kalo Paha

Location: It was reported from high altitude of Arghakhanchi and Gulmi districts ranging from 1693 to 1999 m above sea level.

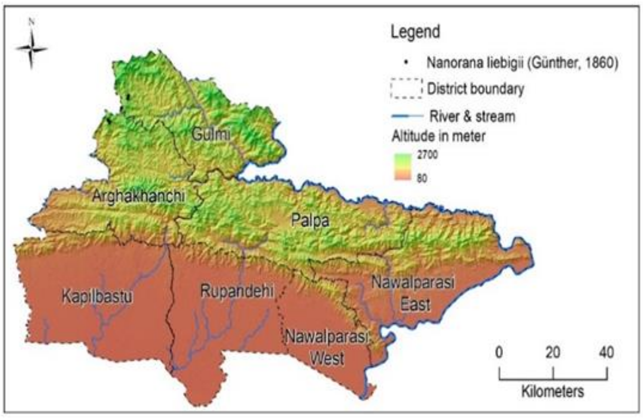


Figure 16: Point location map of the Liebig's Paa frog *Nanorana liebigii* (Günther, 1860) existing in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: Head is broad, long, snout obtuse, strong tubercular fold from the eye to the axilla, another along each side of the back, tympanum small and margin blur. Skin has pustules and granules. Tibio-tarsal articulation extends to the tip of the snout or beyond. The forelimbs are short, powerful, and thickened. The toe and fingers are truncated or ending in small knobs. Hind limbs are rather long and stout. Tips of toes are rounded but not dilated, sub-articular tubercles oval and distinct.

Measurement: SVL 68.0 – 84.0 mm; head length: 22.0 – 24.0 mm; head width 23.0 – 25.0; body width: 55.0 – 59.0 mm; fore limb 32.0 – 37.0mm hind limb 95.0 – 103.0 mm. The tibio-tarsal articulation reaching the nostril. Fingers length: 3 > 4 > 2 > 1and length of toes 4 > 3 > 5 > 2 > 1.

Body colour: Dorsally it is light to dark brown and reddish brown. Belly is white, lateral body, groin and inguinal region are reddish brown.

Habit: They inhabitat to ditches agicultural farms and pools in forest.

Global Distribution: Bhutan, China, India, Nepal (IUCN, 2015)

Distribution in Nepal: It is common in midlands and mountains (1,500 – 3,360m) (Shah & Tiwari, 2004).

Status: Least Concern (Population decreasing)

14. **Species Name**: *Sphaerotheca breviceps* (Schneider, 1799)

Co**mmon Name:** Indian browing frog

Nepali names: Bharati khopilte bhyaguto

Synonyms: *Rana breviceps* (Schneider, 1799), *Pyxicephalus breviceps* (Günther, 1864), S*ystoma breviceps* (Tschudi, 1838), *Tomopterna breviceps* (Deckert, 1938), *Tomopterna (Sphaerotheca) breviceps* (Dubois, 1987).

Common Name: Burrowing frog

Location: It was recorded from Sandhikharka station of Arghakhanchi district.

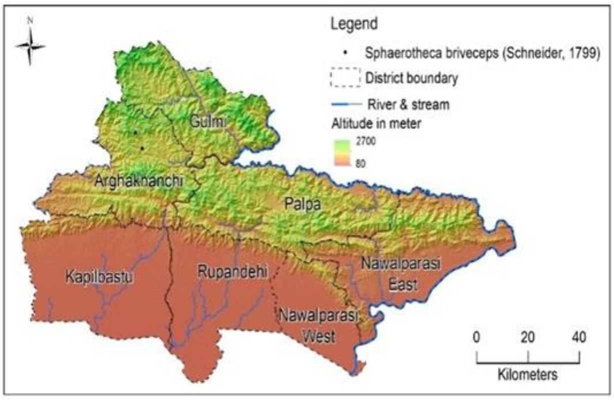


Figure 17: Point location map of the Indian burrowing frog *Sphaerotheca breviceps* (Schneider, 1799) at occurrences in the Lumbini region. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Its head is wide; tongue free and deeply notched behind. The tympanum is noticeable and equal in size to the eye. The fingers are free, tips of the fingers are swollen, and the second finger is shorter than the first. The hind limbs are short, robust, the metatarsals are muscle-bound, and the toes are moderately and sparsely webbed. Inner metatarsal tubercle are shovel-shaped with sharp margins. The axilla has been reached by tibio tarsal articulation. The skin of the upper region is smooth with a few irregular elongated tubercles. On the belly and lower thigh near the anal area, there are glands.

Measurement: SVL 29.21 – 32.53 mm; head length: 11.44 – 14.52 mm; head width 11.92 – 14.76; Tympanum diameter 1.91-2.66 mm; body width: 15.0 – 19.0 mm; fore limb 22.0 – 27.0 mm hind limb 42.5 – 45.2 mm. Tibio-tarsal articulation reaches between eye and nostril. Length of finger 3 >1< 2 < 4 and toes length 4 > 3>5 > 2 > 1.

Colour: It has a dark pattern and is light grey, beige, and green to yellow in color. Olive-gold in color, with a pale yellow middle line. On the limbs and mouth, there are light yellowish bars. Breeding males have a black gular area and a cream ventrum.

Habit: This nocturnal burrowing frog exits from its burrow, which it digs in soft sand with the aid of its large shovel-shaped inner metatarsal tubercle, at dark. These frogs swarm around dusk.

Global Distribution: South and north India, Bangladesh, Myanmar, Pakistan, Sri Lanka, Nepal (IUCN, 2015).

Distribution in Nepal: Considered rare, difficult to discover for its secretive habits, Terai to Midlands (150-2,000 m) (Shah & Tiwari, 2004).

Status: Least concerns

15. **Species Name**: *Sphaerotheca maskeyi* (Schleich & Anders, 1998)

Synonym: *Tomopterna maskeyi* (Schleich & Anders, 1998)

Common Name: Maskey's burrowing frog

Nepali Name: Maskeko khopilte bhyaguto, Ranibhyaguto

Location: It was recorded from Terai, low lands, and mountainous midland in all research districts.

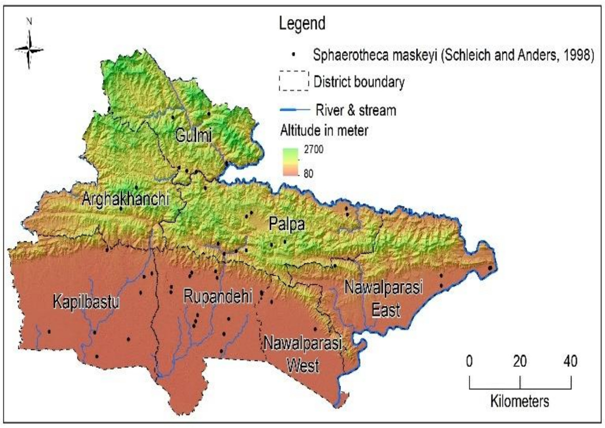


Figure 18: Point location map of the Maskey's burrowing frog *Sphaerotheca maskeyi* (Schleich & Anders, 1998) existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: The nose is closer to the tip of the head and is wider than long. Tympanum is distinctive having a vertically oval shape.

Measurement: SVL 38.0 – 44.0 mm; head length 15.0 – 18.0 mm; head width 17.0 – 19.0; body width 25.0 – 29.0 mm; diameter of tympanum 3.0 – 4.0 mm; fore limb 22.0 – 27.0 mm hind limb 50.0 – 53.0 mm. Tibio-tarsal articulation reaching posterior end of tympanum. Fingers length – 4= 2 > 3= 1 and length of toes- 4 > 3>5 > 2 > 1.

Body colour: Dorsally, it is light to dark brown and reddish brown; the belly is white; the lateral body, goin, and inguinal region are reddish brown.

Habit: It remain hidden, spends most time burrowed into loose substrate.

Global distribution: Bhutan, India, Nepal (IUCN, 2015).

Distribution in Nepal: It is common in Terai and Midlands (200-800 m) (Shah & Tiwari, 2004).

Status: Least Concern (Population)

16. **Species Name**: *Polypedates leucomystax* (Gravenhorst, 1829)

Synonyms: *Hyla wirzzi* (Roux, 1927), *Rhacophorus kampeni* (Ahl, 1927), *Hyla leucomystax* (Gravenhorst, 1829), *Rhacophorus leucomystax* (Gravenhorst, 1829), *Rhacophorus leucomystax leucomystax* (Gravenhorst, 1829), *Rhacophorus maculatus leucomystax* (Gravenhorst, 1829), *Hyla quadrilineata* (Wiegmann, 1834), *Hyla quqerivirgata* (Tschudi, 1838), *Polypedates rugosus* (Duméril and Bibron, 1841), *Polypedates quadrilineatus* (Wiegmann, 1834),*Rhacophorus quadrilineatus* (Wiegmann, 1834), *Hylorana longipes* (Fischer, 1885), *Rhacophorus maculatus quadrilineata* (Wiegmann, 1834), *Polypedates maculatus quadrilineatus* (Wiegmann, 1834).

Common Name: Common tree frog, Golden tree frog

Nepali Name: Chhadi sikre bhyaguta, Rukhbhyaguto, Katmegi

Location: It was recorded in all districts of the study areas that ranged from 84 m to 2512 m above sea level.

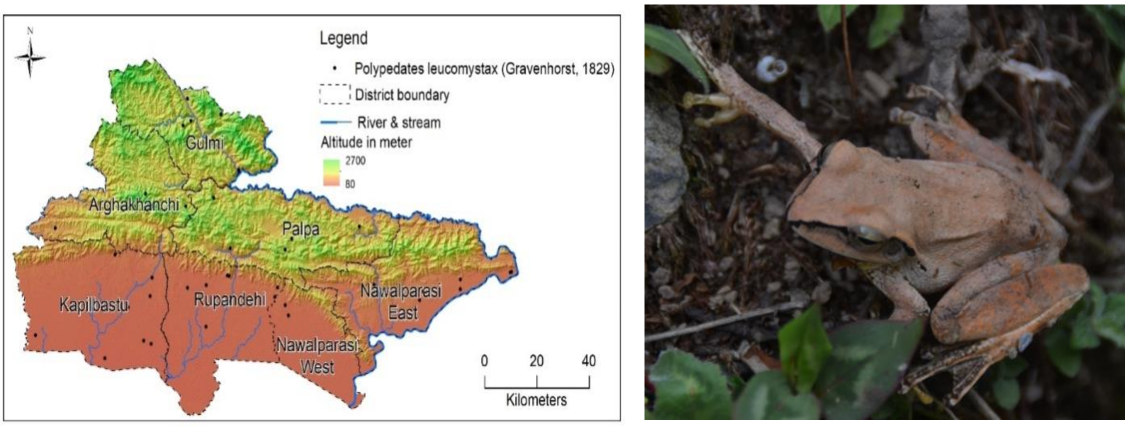


Figure 19: Point location map of the Common tree frog *Polypedates leucomystax* (Gravenhorst, 1829) existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: Head is long, broad, large, and triangular. The nostril is situated nearer to the snout's tip than the eye. The snout is pointed with a rounded tip. Tympanum is distinct. Forelimbs are shorter than hind-limbs and digits are provided with spherical adhesive pads. Fingers have rudimentary webbing and the toes are two-thirds webbed.

Measurement: SVL 46.0 – 65.0 mm, HL 13.0 – 18.0 mm, HW 15.0 – 21.0, body width: 24.0 – 27.0 mm, diameter of tympanum: 4.0 – 5.0 mm fore limb 27.0 – 32.0mm hind limb 70.0 – 83.0 mm. Finger' length is 3 > 4 >2 >1 and the toe's length 4 >5 >3 >2 >1.

Body colour: The colour of body is yellowish-gray on dorsum. Dark longitudinal stripes are distributed from snout to groin region. Venter smooth and uniformly white or yellowish.

Habit: Although it can be found on walls, buried beneath rocks, and under leaves, it is primarily arboreal.

Global Distribution: Philippines, India, Malasia, Myanmar, Nepal, Bangladesh, Brunai, Darussalam, China, Indonesia, Singapore, Thailand, Viet Nam, and Japan (IUCN, 2015).

Distribution in Nepal: The numerous of this species are recorded from Terai and midlands up to 2,400 m (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

17. **Species Name**: *Polypedates maculatus* (Gray, 1830),

Synonym: *Rhacophorus leucomystax maculatus* (Gray, 1830), *Rhacophorus maculatus* (Gray, 1830), *Hyla maculata* (Gray, 1830).

Common Name: Indian tree frog, Chunam frog

Nepali Name: Katkate Paha, Rukh bhyaguto, Katmeghi

Location: It was recorded from the Terai districts of research area.

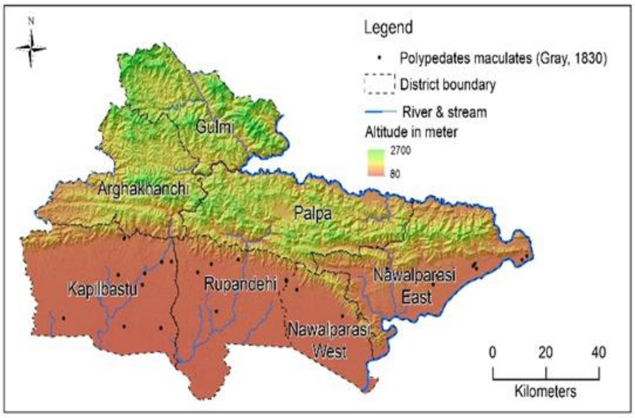


Figure 20: Point location map of the Indian tree frog *Polypedates maculatus* (Gray, 1830), existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characteristics: Head has bony arch in temporal region and slightly wider than length. The nostril is situated nearer to the snout's tip than the eye. The snout has a rounded tip and is pointed. There is a distinct tympanum. It is granular ventrally on the belly and beneath the thigh. The forelimbs are shorter than the hind limbs. The fingers are slightly webbed, and two-thirds of the toes are webbed. The tibio-tarsal joint extends to tip of snout. The tips of the fingers and toes have distinctive discs in the shape of a horseshoe.

Measurement: SVL 60.0-67.0 mm; head length: 19.0 – 22.0 mm; head width 22.0–24.0; body width: 28.0 – 32.0 mm; diameter of tympanum: 4.0 – 5.0 mm fore limb 24.0 – 31.0mm hind limb 88.0 – 95.0 mm. The tibio-tarsal articulation extends from the back corner of the eye to the tip of the snout. Toe length 4 > 3 >5 >2 >1 and finger length is 3 > 4 > 2 >1.

Body colour: The colour of body is yellowish-gray on dorsum and dark longitudinal stripes are distributed from snout to groin region. It is mostly brownish, yellowish, and greyish, with darker spots or markings.

Habit: It is primarily arboreal, though it can occasionally be observed on walls, hiding beneath rocks, and under leaves.

Global Distribution: Bangladesh, Bhutan, India, Nepal, Sri Lanka, China, Myanmar (IUCN, 2015).

Distribution in Nepal: It is common in Terai midland (Shah & Tiwari, 2004).

Status: Least Concern (Population stable)

4.1.1.3 Morphometric identification of reptiles with distribution

1. **Species Name**: *Crocodylus palustris* (Lesson, 1831)

Synonyms: *Crocodylus palustris* (Lesson, 1834), *Crocodylus palustris* (King & Burke, 1989), *Crocodylus palustris* (Ziemann *et al*., 2007).

Common Name: Mugger, Broad-snouted. Crocodile, Marsh Crocodile

Nepali Name: Gohi, Magar Gohi, Seto gohi, Badka gohi.

Location: It was reported from Shiddhara station in Arghakhanchi district at 460 m above sea level.

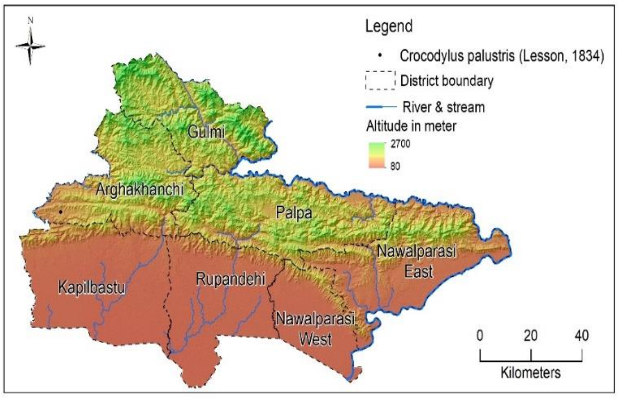


Figure 21: Point location map of the Mugger *Crocodylus palustris* (Lesson, 1831), at presence in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: It is moderately large in length, and broad snouted which is one third to one half times longer than their basal width. There are 15 teeth on either side of the lower jaw, and 17 to 19 sharp teeth on the upper jaw. The body is well guarded and four large nuchal scutes are arranged in a square arrangement. On each angular border of the nuchal area, there is additionally one tiny scute. Two pairs of transverse series of post-occipital scutes. The 16–17 transverse and 4–6 longitudinal series of dorsal scutes are present. There are 33 caudal segments, each with a set of four ridged plates on the dorsal side, and plates with a single high ridge in the distal half of the tail. Webs cover the bases of the fingers. The webbing in the two middle toes are continuous but does not reach the end of the digits, the inner toes are only half webbed, and the outside of the limbs have a serrated edge. The outer two toes are webbed all the way to the tips of the digits.

Measurement: 3 to 5 meters

Colour: Dorsum light brown, with darker mottling to almost uniformly black, juveniles are pale with black spots.

Habit: It swims well in the water and has a tail that serves as a propeller. Additionally, it has good ground mobility, is alert when basking on land, and is carnivorous.

Global distribution: India, Iran, Nepal, Pakistan, and Sri Lanka are known locations for this species (IUCN, 2019).

Distribution in Nepal: It is available in scattered populations over Rapti, Karnali, and Narayani River and recorded from Koshi Tappu wild life reserve, Citwan national parks, Bardiya national park, Suklaphantah wildlife reserve, Ghodaghdi Taal, Nakhroditaal in Nepal (Shah & Tiwari, 2004).

Status: Regionally Extinct

Family*: Bataguridae*

2. **Species Name**: *Pangshura smithii* (Gray, 1868)

Synonyms: *Batagur smithii* (Gray, 1863), *Batagur smithii* (Baig *et al.*, 2008), *Kachuga smithii* (Boulenger, 1889), *Kachuga smithii* (King & Burke, 1989), *Kachuga smithii* (Obst's, 2003), *Kachuga smithii* (Murthy, 2010), *Panshura smithii* (Spink *et al.*, 2004), *Pangshura smithii* (Das *et al.*, 2000), *Pangshura smithii smithii* (Rhodin, 2010**).**

Common Name: Common brown roofed turtle, Brown roofed turtle

Nepali Name: Kachhuwa, Thotari

Location: It was found in the low land of the Terai districts.

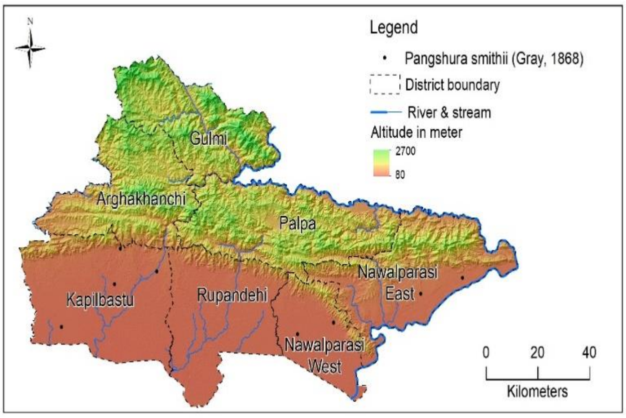


Figure 22: Predicted distribution map of the Brown roofed turtle: *Pangshura smithii* (Gray, 1868), at presence in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The head is small pointed. The posterior edge of the upper shell has a little serration. Shield-like divisions exist in the skin covering the back of the head. It has broadly webbed toes and medium-sized claws on the feet.

Identification: The shell has a very prominent vertebral ridge that runs from the nuchal to the caudal plate and is indistinctly keeled. The sternum is flat, rounded in front and slightly serrated posteriorly. The nuchal plate is narrow and wider in the back than the front. The first vertebral shield is formed like a bell, the second one is quadrangular, and the third one is rectangular and oblong, measuring two-thirds its length in width. The fourth is significantly longer, pear-shaped, and anteriorly tapered. Both the sternum and the thorax are solid, all-bony structures.

Measurement: SVL 10.9-18.3 cm

Colour: With a blackish vertebral keel, the upper shell is yellowish. Each plate has a yellowish edge, and the lower portions are rather blackish. With a yellowish-brown patch behind each eye, the head and neck are olive dorsally. The lateral neck, rump, and hind limbs all have stripes.

Habit: This omnivore eats both semi-aquatic and aquatic vegetation as well as aquatic invertebrates in the wild.

Global distribution: It was reported from Pakistan, Bangladesh, Bhutan, India, and Nepal (IUCN, 2019).

Distribution in Nepal: It is found in low lands of Terai region of Nepal (Shah & Tiwari, 2004).

Status: Near Threatened

Population: Decreasing

Family*:* Trionychidae

3. Genus: *Lissemys punctata* (Lacepede, 1788)

Synonyms: *Testudo puntata* (Lacepede, 1788), *Testudo granulosa* (Suckow, 1798), *Testudo granosa* (Schoepff, 1801), *Trionyx puntata* (Hardwicke & Gray, 1835), *Emyda punctata* (Gray, 1836), *Emyda granosa* (Boulenger, 1889), *Lissemys punctata* (Smith, 1931), *Lissemys punctata* (Schafer, 2006).

Common Name: Spotted flapshell turtle, Indian flap-shelled turtle

Nepali Name: Putali kachhuwa, Matihara kachhuwa, Goraiya

Location: It was observed from different location of Terai districts.

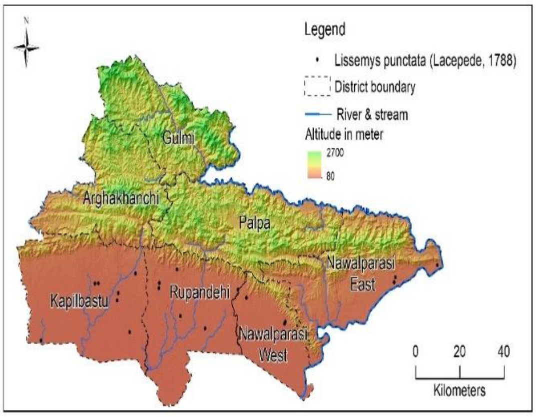


Figure 23: Point location map of the Spotted Flapshell Turtle *Lissemys punctata* (Lacepede, 1788), at presence in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic Characters: It is a soft shelled, moderate and flat turtle. Head is moderately large, conical with long and flexible neck. Femoral flaps and nasal septal ridges are present. Digits are strongly webbed with large claws and very short tail.

Identification: The snout is short and broad.Carapace is oval, dome-shaped, margin smooth and flared posteriorly. Two neural plates present between first pair of pleurals. Eight pair of pleurals and 8th pair meet medially. Plastron contains flaps and seven callouses, which are made up of soft, semicircular flaps roofed by a continuous sheet of soft skin. The lateral and the hind portions are flexible. Soft-shelled with nine partitions of carapace plates faintly seen on the dorsal side of carapace.

Measurement: SVL 18-32 cm. Maximum carapace length = 16.5 cm, width = 13.0 cm. maximum plastron = 14.5.0 cm long, 12.5 cm wide.

Colour: Head is greenish with yellow spots, carapace brownish-black black bordered irregular yellowish spots, with a light yellow marginal border. The ventral surfaces are whitish and unpatterned.

Habit: It consumes a variety of other animals as well as aquatic and semi-aquatic flora, including flowers and seeds. It is an omnivore.

Global distribution: Nepal, India, Pakistan, Bangladesh Sri Lanka, and Myanmar (IUCN, 2019).

Distribution in Nepal: It is found in many region of Terai of Nepal and found in terai district of study area (Shah & Tiwari, 2004).

Population: Decreasing

Status: Least Concern

Family: Agamidae

4. **Species Name**: *Calotes versicolor* Daudin, 1802

Synonym: *Agma versicolor* (Daudin 1802), *Agma tie demanni* (Kuhl, 1820), *Agma vultuosa* (Harlan, 1825), *Calotes versicolor* (Fitzinger, 1826), *Agma indica* (Gray, 1827), *Calotes versicolor* (Dumeril & Bibron, 1837), *Calotes cristatus* (Jaquemont, 1844), *Calotes viridis* (Gray, 1846), *Calotes versicolor versicolor* (Manthey, 2008), *Calotes cf. versicolor* (Mahony *et al.*, 2009), *Calotes versicolor farooqi* (Nguyen *et al.*, 2009), *Calotes versicolor farooqi* (Masroor, 2011), *Calotes versicolor farooqi* (Jamal *et al.*, 2018), *Calotes cf. versicolor* (Karthik *et al.*., 2018).

Common name: Common Garden Lizard, Blood sucker, Oriental Garden Lizard, Indian Garden Lizard.

Nepali Name: Chheparo, Girgit, Kanthutara

Location: It was recorded from all altitudes of the research area.

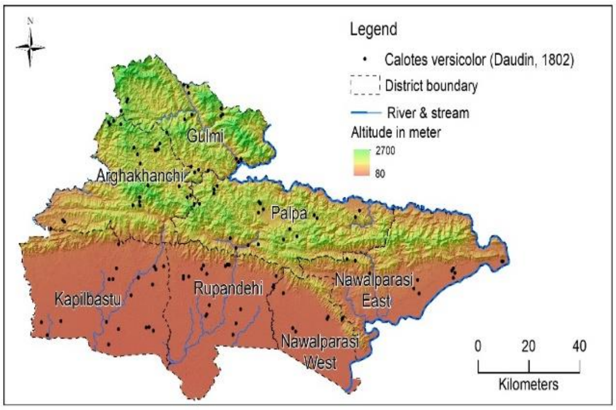


Figure 24: Point location map of the Common Garden Lizard *Calotes versicolor* Daudin, 1802 existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Large head, massive shoulders, laterally flattened bodies, and a crest that extends from the neck almost to the tail are main characteristics. There are two supratympanic spines that areclearly separated from one another, often with paired lighter dorso-lateral stripes and a brick red gular pouch.

Identification: Head (dorsal) is covered with heterogeneous and smooth scales. The average head length 25.8 mm; head width 25.6 mm; distance between nostril and eye 21.8 mm. Supralabials are 9-11; infralabials: 9-13; 39-48 scales around mid body; and keeled scales all pointing backwards. Compared to the forelimbs; the hind limbs are much longer. Scales ranged from small to large. The limbs have heavily keeled scales on the dorsal side. Strongly bicarinate lamellae.

Measurement:

Colour: Body colour is brown, olive or greyish, especially the head which is almost pale yellow. White dorsolateral streak on each side are present and dark streaks radiate from eyes and venter white. There are numerous broken bands of black basal patches along the trunk. Breeding males also get bright orange or crimson patches on their shoulders and head. The colouration changes between light dark according to temperature and humidity.

Habit: The species is diurnal and arboreal.

Global distribution: India, Bhutan, Banladesh, Afganistan, Iran, Indonesia, Maldives, Combodia, South China, Sri Lanka, Myanmar, Thialand (IUCN, 2019).

Distribution in Nepal: It is most widely distributed in Nepal (Shah & Tiwari, 2004).

Status: Least Concern

Population: Stable

*5. **Species Name:** Laudakia tuberculata* (Gray, 1827)

Synonym: *Agama tuberculata* (Gray, 1827), *Agama tuberculata* (Duméril & Bibron, 1837), *Agama tuberculata* (Boulenger, 1885), *Agama tuberculata* (Smith, 1931), *Agama tuberculata* (Minton, 1966), *Stellio indicus* (Blyth, 1853), *Stellio tuberculatus* (Günther, 1864), *Laudakia tuberculata* (Das, 1996), *Laudakia tuberculata* (Baig *et al.*, 2012).

Common name: Tuberculated Agama, Kashmir Rock Agama, Himalayan rock lizard

Nepali name: Patharchatuwa, Pithochor, Bhir chheparo

Location: It was reported in mountainous areas, ranging in elevation from 385 to 2512 meters.

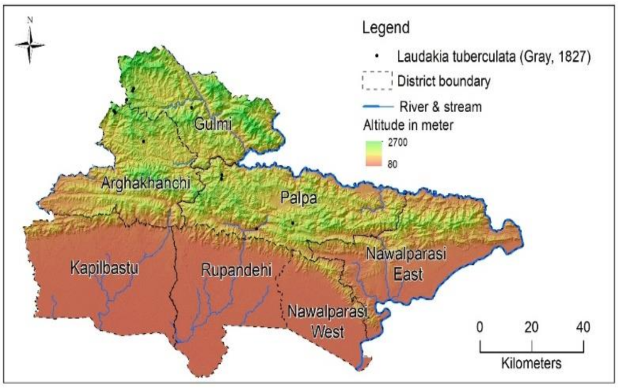


Figure 25: Point location map of the Tuberculated Agama: *Laudakia tuberculata* (Gray, 1827) at occurrences in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Its body is robust with a flat head. Tympanum is large, nacket and distinct, usually no patch of enlarged or spinose scales on flanks, gular and ventral scales smooth, vertebral scales enlarged. Tail depressed, longer than the head and segment of two to four whorls, usually three to four. Limbs are strong with longer toes; the fifth toe extends beyond the first. The male has 6 –7 rows of callose preanal scales and an elongated mid-abdominal patch.

Identification: Head with heterogeneous, smooth, or keeled scales; median dorsals subequal; roundish; keeled; supralabial 10-12; sublaial 9-11; 10-15 across the mid back; ventrals smooth; as large as the dorsals; skin of neck loose; total number of scales around mid -body 134 – 221; finger and toes compressed; 24– 26 lamellae under third finger and 27 – 29 toe under fourth toe.

Measurement: SVL: 127-141 mm, tail 137-152 mm.

Colour: Adults frequently experience the separating of the black patches, which are then replaced by a fusion of dark brown and yellowish flecks. The ventrum is whitish with a light head, and the breast and throat are frequently heavily marbled with dark blue.

Habit: It is predominantly herbivorous, occasionally resorting to insectivorous. Basking occurs during Morning and early afternoon.

Global distribution: Reported from Afghanistan, Pakistan, India, Tibet and Nepal (IUCN, 2019).

Distribution in Nepal: It is relatively common in western to central part of countray especially from mountain above 1500m altitude (Shah & Tiwari, 2004).

Status: Least Concern

6. **Species Name**: *Japalura tricarinata* (Blyth, 1853)

Synonyms: *Calotes tricarinatus* (Blyth, 1853), *Oriotiaris elliotti* (Günther, 1864), *Oreotiaris tricarinata* (Anderson, 1871), *Acanthosaura tricarinata* (Boulenger 1885), *Acanthosaura tricarinata* (Annandale, 1907), *Japalura tricarinata* (Smith, 1935), *Japalura tricarinatus* (Das, 1996), *Oriotiaris tricarinata* (Kästle *et al.*, 2013), *Japalura tricarinata* (Wang *et al.*, 2018).

Common Name: Three keeled mountain lizard, three keeled forest agma

Nepali name: Hariyo chheparo, Chheparo

Location: This species was observed from the low land of mountain to the midland of the mountains in hilly districts of the research area.

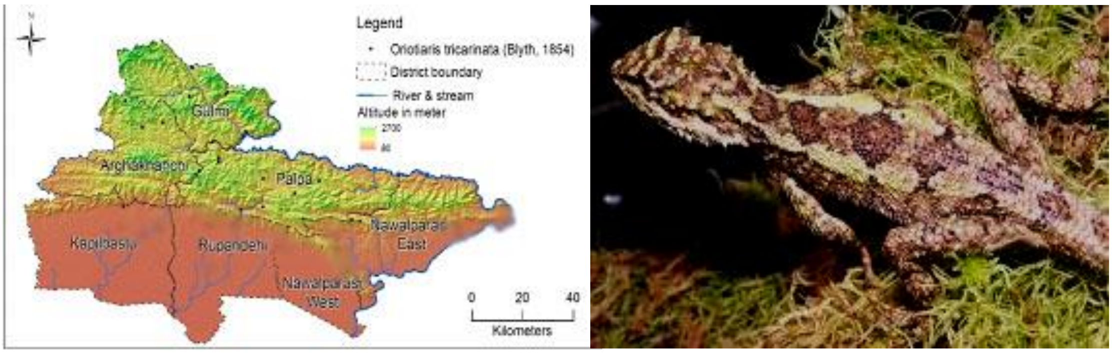


Figure 26: Point location map of the three keeled mountain *Japalura tricarinata* (Blyth, 1853) existing in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: It has cylindrical body and exposed tympanum. There is a visible black stripe from the eye to the angle of the jaws, and the transverse gular fold is lacking. Each side of the vertebral ridge has the dorsolateral ridge, which is distinct and continuous from the neck to the pelvis. Along the body's midline, from the neck to the pelvis, there are V-shaped ridges composed of larger, keeled scales. The limbs are narrow and thin. The tail is longercompare to body and head.

Identification: There is 5 - 7 upperlabial, many lower labial and 11-14 scales between supraocular. Gular scales are small and feebly keeled. On either side of the back of the head, there is a distinctive crest of six conical scales. The mid-body scales vary from 38 to 43. Dorsal scales are very unequal, with the larger ones strongly keeled. Ventral head scales are smooth or feebly keeled in males.

Measurement: SVL = 49-51 mm Tail 118-130 mm.

Colour: The body coloration is mostly uniform grass green in males and light Pratt's rufous in females, Ventral portions are grey to yellowish brown with or without brown spots. A brown to dark brown band connects the eyes to the top of the head. Juveniles resemble the females.

Habit: Being an arboreal species, it is found in the spring mostly by females. It is carnivorous especially it feeds insects.

Global Distribution: India, Nepal, China (Tibet), probably in Bhutan (IUCN, 2019).

Distribution in Nepal: Mostly it is found in mountains. It was recorded from mountainous districts of this area (Shah & Tiwari, 2004).

Status: Least Concern

Status: Not evaluate

7**. Species Name**: *Hemidactylus brookii* Gray, 1845

Synonyms: *Gecko tytlert* (Tytker, 1865), *Hemidactylus guineensis guineensis (*Peters, 1868), *Hemidactylus affinis (*Steindachner, 1870), *Hemidactylus brookii (*Boulenger, 1885), *Hemidactylus luzonensis* (Taylor, 1915), *Hemidactylus neotropicalis (*Shreve, 1936), *Hemidactylus brookii (*Liner, 1994).

Nepali name: Mausuli, Bhitti, Tilktike, Chhipkili

Common Name: Spotted house gecko, Brook's house gecko

Local Name: Tiktiki, Chiti Tiktiki

Location: It was recorded from the Terai region to the midland of the mountains up to an altitude of 1865 m.

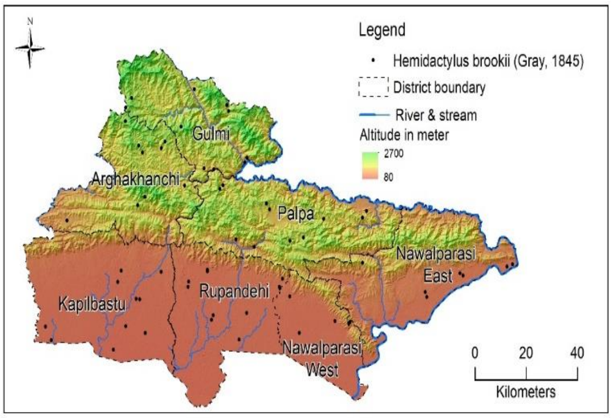


Figure 27: Point location map of the spotted house gecko *Hemidactylus brookii* Gray, 1845 existing in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Body is flattened and no lateral fold. Eyes are black and spherical. The opening of the ear is small, oval, and vertical; roughly one-third the size of the eye. The free distal joint is lengthy, the digits are free, and dilated. The tail has distinct segments and is cylindrical.

Identification: Snout covered with small, convex or keeled scales. Upper labial 8-10; and lower labial 7-9. There are 2 pairs of post-mental and quadrangular rostal scales. Dorsum is granular, interspersed with small subtrihedral tubercles in the form of 16-

18 longitudinal series. Large keeled tubercles, 3-6 lamellae beneath the inner toes, and 6-8 beneath the middle toes are seen on the upper portion of the hind limb. The tail has rows of 8 or 6 spine-like tubercles that are depressed and annulate. Each side of the male has 7–12 preanofemoral pores.

Measurement: Snout-vent length 46-49 mm, tail 49-52 mm.

Colour: The body is faintly greyish or brownish-colored, and dark brown spots. The dark lines run along the side of the head.Ventrum is dirty white.

Habit: The species is nocturnal, active only at night and inactive during the day. It feeds on insects and hides in isolated places.

Global distribution: Southern, Southeast, and Indo-Australian regions are the native habitats of this species (IUCN, 2019).

Distribution in Nepal: It is found below 1730 m (Shah & Tiwari, 2004).

Status: Least Concern

8. **Species Name**: *Hemidactylus flaviviridis* Rüppell, 1835

Synonyms: *Hemidactylus coctaei* (Duméril & Bibron, 1836), *Boltalia sublevis* (Gray, 1842), *Hoplopodion rüppellii* (Fitzinger, 1843), *Hemidactylus bengalensis* (Adorsen, 1871) *Hemidactylus coctaei* (Boulenger, 1887), *Hemidactylus flaviviridis* (Schmidt, 1939)

Common Name: Northern house gecko, House lizard, Yellow-green house lizard

Nepali Name: Mausuli, Bhitti, Chhipkili

Location: This species was observed in the Terai and lowlands of the mountains.

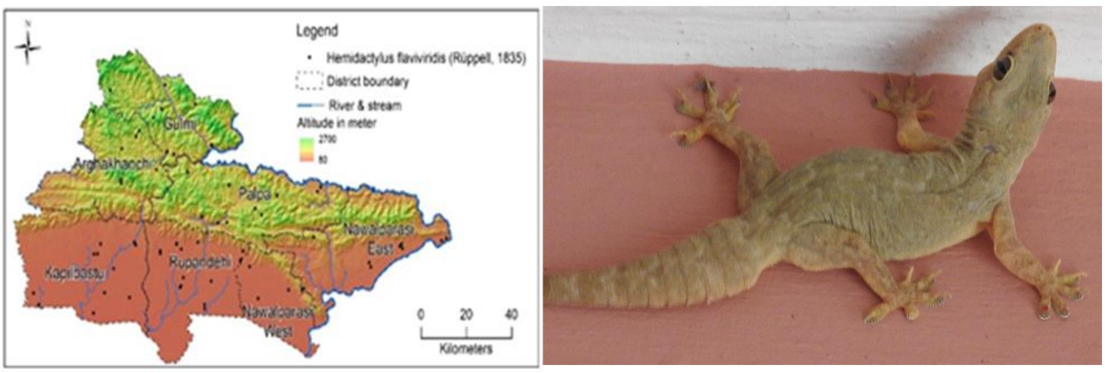


Figure 28: Point location map of the Northern house gecko *Hemidactylus flaviviridis* Rüppell, 1835 present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Tail is without sharp denticulate lateral edge. Outer post mentals are contact with labials and no enlarged dorsal tubercles. Dorsum has granular scales, no distinct tubercles, and digits are free.

Identification: Head is covered with small granules posteriorly. Supralabials are 10 – 13 and infralabials 10 – 12; 39 – 48 scales around midbody; keeled scales all pointing backwards. Lamellae are strongly bicarinate. Under the first and fourth toe; lamellae have 7–10 and 12–14; respectively. The caudal tubercles are tiny and conical; and the tail is not clearly divided. On each side; males have 6-7 femoral pores.

Measurement: Snout-vent length 86-95 mm, tail 89-93 mm.

Colour: Dorsum shows indistinct darker transverse bands, pale band on the side of head, and the ventrum is light yellow.

Habit: During the day, this species hides among garbage, tree bark, brick holes in structures, and cracks and crevices. It is a powerful predator that primarily kills insects, spiders, and other arthropods.

Global distribution: India, Nepal, Iran, Eritrea, Ethiopia, Pakistan, Somalia, Saudi Arebia, Sudan, Afghanistan, Bangladesh, Egypt, Iraq, Kuwait, Nepal, Oman, United Arab Emirates, and Yemen (IUCN, 2019).

Distribution in Nepal: It is found below 960m (Shah & Tiwari, 2004).

Population is stable and expanding

Status: Least Concern

9**. Species Name**: *Hemidactylus frenatus* (Schlegel, 1836)

Synonyms: *Hemidactylus vittatus* (Gray, 1845), *Hemidactylus punctatus* (Jerdon, 1853), *Hemidactylus longiceps* (Cope, 1869), *Hemidactylus hexaspis* (Cope, 1869), *Hemidactylus tristis* (Sauvage, 1879), *Hemidactylus frenatus (*Bouleger, 1885), *Hemidactylus nigriventris* (Lidth de Jeude, 1905), *Hemidactylus fragilis* (Calabresi, 1915)

Common Name: Bridled house gecko, Common House Gecko

Nepali Name: Chhipkili, Mausuli, Puchharkatua

Location: It was observed from low land to the midlands of the research area below 1503masl.

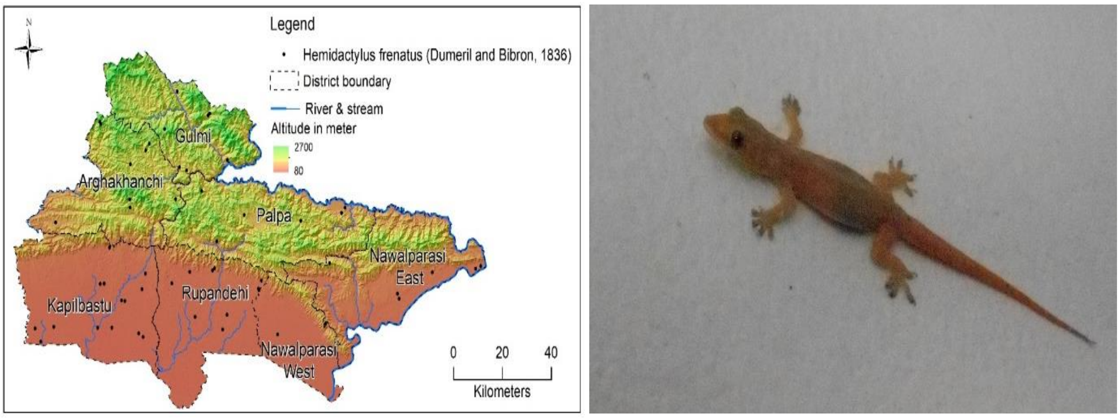


Figure 29: Point location map of the Common House Gecko: *Hemidactylus frenatus* (Schlegel, 1836) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The body is moderately thick and head is somewhat flattened, snout obtusely pointed, with vertical pupil. The limbs are of moderate size with short claws on all digits. The scales on top of the body are small and granular. **Identification:** Snout is obtusely pointed; mental large and subtrangular; 10–12 upper labial; 8–10 lower labial; relatively broad-necked; with small smooth scales and numerous tubercles forming incomplete longitudinal rows. Digits are free; subdigital lamellae under first 4 – 5; and 9 – 10 under fourth toe. There are several expanded subcaudals and a feebly depressed tail. The male has a continuous sequence of 27 – 33 preanofemoral pores. The original tail is weakly dorso-ventrally flattened and is surrounded by small spines.

Measurement: Snout-vent length 59-62 mm, tail 61-64 mm.

Colour: Dorsum grayish or pinkish, sometimes much darker, with indistinct dark spots. The gular region is pink and the ventral side is whitish to yellowish, tail sometimes red.

Habit: The species is nocturnal and comes out to explore in the evenings close to human homes' electrical lights. In the evening, it consumes insects and arthropods.

Global distribution: Southern, Southeast, and the Indo-Australian Archipelago are the native habitats of this species (IUCN, 2019)

Distribution in Nepal: Common species of Nepal and recorded below 1370 m (Shah & Tiwari, 2004).

Population: Stable

Status: Least Concern

10. **Species Name**: *Eutropis carinata* (Schneider, 1801)

Synonyms: *Euprepes merremi* (Dumeril & Bibron, 1839), *Euprepes rufescens* (Günther, 1864), *Mabuya carinata* (Boulenger, 1887), *Mabuya carinata* (Smith, 1935), *Scincus carinatus* (Schneider, 1801), *Tiliqua carinata* (Gray, 1827).

Common Name: Brahminy skink, Keeled grass skink, Common grass skink, Keeled Indian skink

Nepali name: Bhanemungro, Chikani girgit

Location: It was recorded from the mainly forest side of research area.

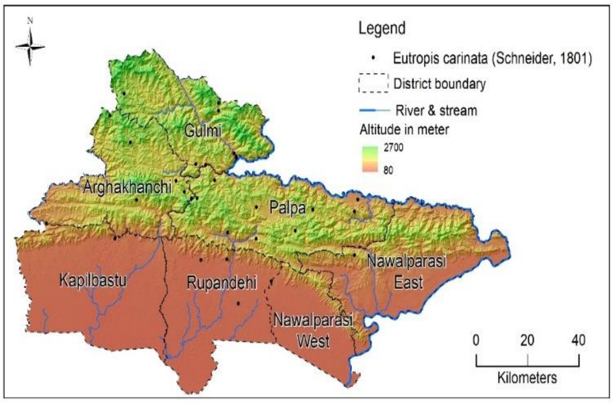


Figure 30: Point location map of the Common skink: *Eutropis carinata* (Schneider, 1801) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: It is a medium sized skink. Body is elongated and dorsoventrally flattened. Snout is moderate, obtuse, lower eyelid scaly, temporal scales keeled, subcircular ear opening. Limbs are well developed. Tail is long and pointed.

Identification: The nostrils are located behind the vertical suture between the rostral. Fronto nasals are wider than long. Lower eyelids are scaly; with enlarged scales on the second and third layers; there is a small ear opening; 7 supralabials that are just touching; and 6 – 8 infralabials. 3 – 5 dorsal and lateral distict keel three medians are strongly marked; and 30 to 34 scales round the middle of the body. The hind limb reaches the wrist. Digits are moderately long; lamellae smooth; 6 – 10 under the first toes; 15 – 16 are on the fourth toe.

Measurement: SVL 118 - 135mm. tail 150 - 155mm

Colour: Glossy brown, yellow-green, or golden are the primary colors. On the supraciliaries and continuing all the way to the tail is a thin dorso-lateral band. There may or may not be a second white line extending from the tips of the eyelids to the sides of the frank. It has a yellowish ventral.

Habit: It is a diurnal, terrestrial species that is commonly observed in open fields either foraging or basking.

Global distribution: Bangladesh, India (with the exception of the Northwest), the Maldives, Nepal, and Sri Lanka have all recorded sighting of the species (IUCN, 2019).

Distribution in Nepal: It is common below 1372m in Nepal (Shah & Tiwari, 2004).

Population: Apparently stable

Status: Least Concern

11. **Species Name**: *Mabuya macularia* (Blyth, 1853)

Synonyms: *Euprepes brevis* (Günther, 1875), *Euprepes macularius* (Blyth, 1853), *Eutropis macularius* (Grismer *et al.*, 2007), *Mabuia macularia* (Boulenger, 1887), *Lygosoma dawsoni* (Annandale, 1909), *Mabuya allapallensis* (Schmidt, 1926), *Mabuya allapallensis* (Smith, 1935), *Mabuya macularius* (Vyas, 2007), *Mabuya macularia macularia* (Bobrov & Semenov 2008), *Tiliqua macularia* (Blyth, 1856).

Common Name: Bronze grass skink

Nepali Name: Bhanemungro, Chikani girgit

Location: This species was reported from lowland and midland areas of all districts of the study area.

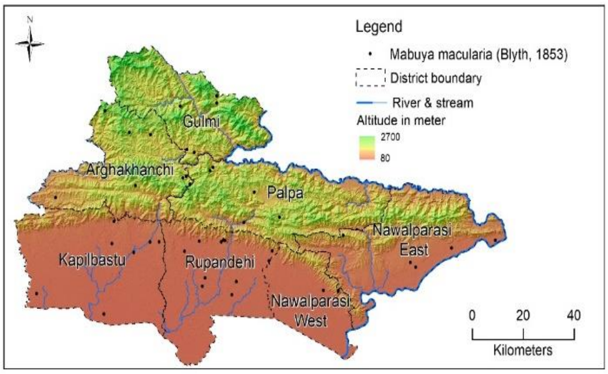


Figure 31: Point location map of the Bronze grass skink *Mabuya macularia* (Blyth, 1853) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Body is cylindrical, head tapered and flat and ear opening semicircular, digits moderately long and long tail. Starting from above the eye and continuing to the base of the tail are two dorso-lateral bands.

Identification: Supra nasal are separated from one another; anterior loreal divided; second loreal short; a postnasal present; lower eyelids not scaly; temporal scale keeled; supralabials: 6 – 7; Infralabials: 7 – 8 and one postmental. The dorsal scales have 5 – 8 keels; where as the ventral scales are smooth and have 27 – 30 scales around the body. Lamellae under the 1st toe are 6 – 9 and the 4th toe is 14 – 18.

Measurement: 6 – 7 cm. tail: 9.5cm

Colour: Black brown or bronze in color. The dorso-lateral bands are pale or yellow, and the flank is a dark brown color with white spots. Ventrally, it is white

Habit: It is diurnal and crepuscular and feeds on beetles and grasshoppers.

Global Distribution: Bangladesh, Bhutan, Cambodia, Lao PDR, India, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand, and Vietnam are among the countries that have it (IUCN, 2019).

Distribution in Nepal: It is found in low land to mountains (Shah & Tiwari, 2004).

Status: Least Concern

12. **Species Name**: *Sphenomorphus maculatus* (Blyth, 1853)

Synonyms: *Lissonota maculata* (Blyth, 1853), *Hinulia maulata* (Theobald, 1868), *Lygosoma maculatum* (Boulenger, 1887), *Sphenomorphus maculatus* (Pope, 1935), *Lygosoma maculatum* (Smith, 1935), *Sphenomorphus maculatus* (Taylor, 1963), *Sphenomorphus maculatus* (Linkem *et al.*, 2010), *Sphenomorphus maculatus* (Grismer & Quah 2019).

Common Name: Sikkimese forest skink, Spotted litter skink

Nepali Name: Bhanemungro

Location: It was recorded in lowlands and mountains with an elevation of less than 2512 meters.

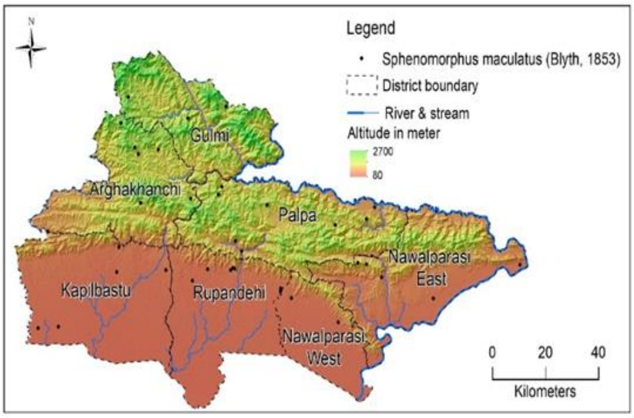


Figure 32: Point location map of the Sikkimese forest skink *Sphenomorphus maculatus* (Blyth, 1853), present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Head is tapered and flat. Tympanum is deeply sunk. Ear opening is quite larger than eye opening. The limbs are moderately long, a pair of large pre-anal scales, tail tapering and two times as long as head and body.

Identification: The head is flat and tapered. The snout is short and pointed with a concave rostal. 7 – 8 supralabials separated by small scales; 9 infralabials; 5 supraoculars; 1st largest; 5 and 6 labials lie below the eye; lorial 2; ear opening quite as large as the eye; 38 – 42 scales around the body.

Measurement: SVL = 50 – 56 mm. Tail 80 – 150 mm

Colour: Its dorsal coloration is bronzy or dark brown, usually with two median rows of small black spots and a few faint, small golden green spots. Belly is white, lower flanks heavily spotted with black and white; laterally brown or black with white markings. Venter is white.

Habit: It consumes a variety of insects, but mostly caterpillars, grasshoppers, and spiders.

Global distribution: From Bangladesh, Bhutan, Cambodia, China, India, Malaysia, Myanmar, Nepal, New Guinea, Thailand, Tibet, and Vietnam, the species has been reported (IUCN, 2019).

Distribution in Nepal: It is normally found at relatively low altitudes and are under anthropogenic pressure (Shah & Tiwari, 2004).

Status: Least Concern

13. **Species Name**: *Varanus bengalensis* (Daudin, 1802)

Synonyms: *Monitor gemmatus* (Guérin-Méneville, 1829), *Monitor inornatus* (Schlegel, 1839), *Tupinambis bengalensis* (Daudin, 1802), *Tupinambis cepedianus* (Daudin, 1802), *Uaranus lunatus* (Gray, 1845), *Varanus bibronii* (Blyth, 1842), *Varanus bengalensis* (Duméril and Bibron, 1836), *Varanus bengalensis* (Cox *et al.*, 1998), *Varanus punctatus*, (Merrem, 1820).

Common Name: Bengal lizard, Bengal monitor lizard, Clouded monitor, Bengal monitor, Indian monitor, Common Indian monitor

Nepali Name: Bhaise gohoro, Nirbud, Kalogohati

Location: It was reported from Terai to high altitude of study area.

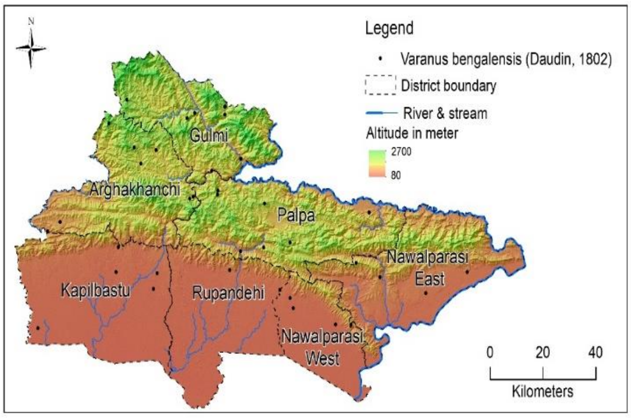


Figure 33: Point location map of the Bengal monitor lizard *Varanus bengalensis* (Daudin, 1802) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The snout is convex. The tongue is protruding, very long, and forked. Its length is almost 2.5 times that of its height.The scales on the crown of the head are rounded and keeled posteriorly, larger than nuchal scales. There is a rounded, depressed tympanum directly below the eye. The tail has strong keel, is compressed laterally, and is long-pointed.

Identification: There is a slit-like nostril nearer to the orbit. Supralabial scales are 34-35; sublabial scales are 35 – 36; 4 rows below the eye; no enlarged supraocular; scales on head between supraocular 19; mid-body scales are 137 – 165; and abdominal scales are 90 – 100 transverse rows. The scales from the eye to the nostril are 11; the scales from the nostril to the snout are 9; the supra-ocular scales are small; the lateral scales are keeled and smaller than the subcaudals. Its skin is rough and has rounded scales found throughout its body.

Measurement: SVL = 70 – 75cm, tail = 85 – 96 cm.

Colour: Body colour is mottled with black and yellowish dotted structure. No of spots on lies on the throat. Ventral side is whitish.

Habit: It is terrestrial, nocturnal, and amphibious species. It is a scavenger and a carnivore. It takes pleasure in running, swimming, and climbing trees. It consumes fish, frogs, lizards, snakes, smaller animals, and lizard eggs.

Global distribution: Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Indonesia (Java, Sumatra), Iran, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Sri Lanka, Thailand, and Vietnam have all confirmed occurrences of the species (IUCN, 2019).

Distribution in Nepal: It is widely distributed in Nepal (Shah & Tiwari, 2004).

Status: Near Threatened

Population: Decreasing.

14. **Species Name**: *Varanus flavescens* (Hardwicke and Gray, 1827)

Synonyms: *Monitor flavescens* (Hardwicke & Gray, 1827), *Varanus russelii* (Heyden, 1830), *Varanus picquotii* (Duméril and Bibron, 1836), *Varanus flavescens* (Cantor, 1847), *Varanus flavescens* (Günther, 1864), *Varanus flavescens* (Boulenger, 1885), *Varanus flavescens* (Taylor, 1963), *Varanus flavescens* (de Lisle, 1996), *Varanus (Empagusia) flavescens* (Visser, 1985).

Common Name: Yellow monitor, Yellow land lizard, Yellow monitor lizard, Golden monitor, Indian oval-grain lizard.

Nepali Name: Suna Gohoro, Rani Gohoro

Location: It was reported from low land and midland of mountain below the 1522 m.

Diagnostic characters: The shape of the body is long, and oblique slit like nostril. Limbs are storng, spotted and tail is triangular, compressed laterally. The short digits have sharp claws for fast digging.

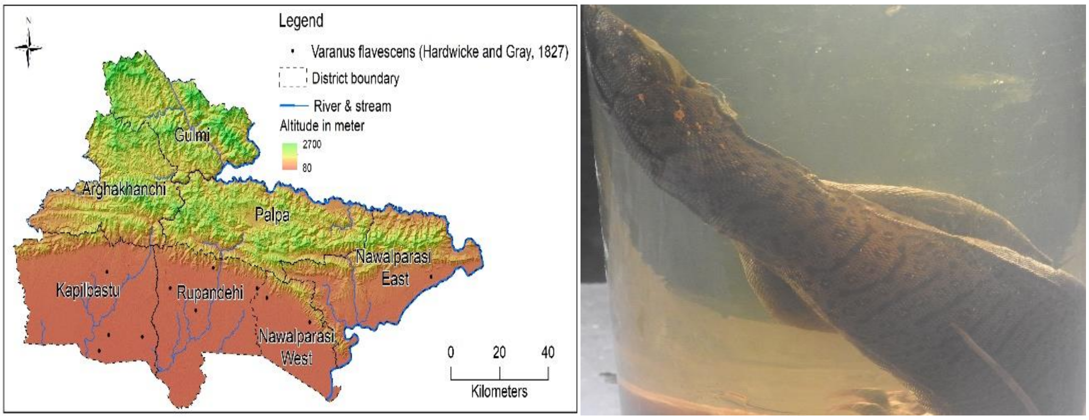


Figure 34: Point location map of the Yellow monitor *Varanus flavescens* (Hardwicke and Gray, 1827) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Identification: Head is flat, black on the upper side. Snout is somewhat pointed, short, convex and bifid blue coloured tongue; nostril nearer to snout tip than orbit. Neck scales are larger than head scales. Teeth are sub-conical and canthus rostralis is distinct. The abdominal scales are smooth; 80 – 92 scales around midbody; 65 – 75 transverse rows.

Measurement: SVL = 30 – 35cm, Tail = 46 – 48cm.

Colour: Its body colour is dark brown in the upper side and yellow in the lower side. A distinct pattern of alternating transverse bars of radish brown on the back and tail.

Habit: It is basically terrestrial, burrow dweller, good swimmer and bad climber. But during monsoon it is more often seen in water than on land. The taxon is carnivorous and scavenger.

Global Distribution: Bangladesh, Bhutan, India, Nepal and Pakistan are the main countries of this species (IUCN, 2019).

Distribution in Nepal: It is found in all sites of Nepal below 1370 m (Shah & Tiwari, 2004).

Population: Decreasing

Status: Near Threatened

15. **Species Name**: *Typhlops braminus* (Boulenger, 1893)

Synonyms: *Argyrophistruncatus* (Gray, 1845), *Eryx braminus* (Daudin, 1803), *Indotyphlops braminus* (Hedges *et al.*, 2014), *Onychocephalus capensis* (Smith, 1946),Indotyphlops *braminus* (Daudin, 1803), *Ophthalmidiumtenue* (Hallowell, 1861), *Ramphotyphlops braminus* (Nussbaum, 1980), *Tortrix russelii* (Merrem, 1820), *Typhlops russeli* (Schlegel, 1839), *Typhlina braminus* (McDowell, 1974), *Typhlops braminus* (Smith, 1943), *Typhlops limbricki* (Annandale, 1906),*Typhlops pseudosaurus* (Dryden and Taylor, 1969).

Common Name: Brahminy blind snake, Common worm snake

Nepali name: Teliya sanp, Matti sanp, Dudha sanp

Location: It was recorded from all districts.

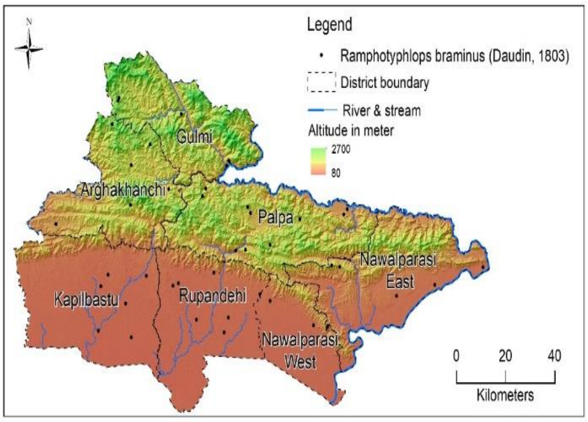


Figure 35: Point location map of the Brahminy blind snake: *Typhlops braminus* (Boulenger, 1893) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Snout is rounded, strongly projecting; nostril lateral; eye small and distinct. Body is small, cylindrical and covered with very small and subequal scales. Tail is very short with ending in a spine. Very fine similar types of scales are distributed throughout the body.

Identification: Head scales include parietals transverse, enlarged and occipitals occasionally enlarged.The nasal shield is completely divided. The rostral is narrow; ocular and pre-ocular are subequal in breath; and the ocular shield's lower edge is wedged between the third and fourth labeal. The pre-frontal is in contact with the rostral; the preocular 1; the supraocular 1; the supralabials 4; the third and fourth touch the eye; the last two are in contact with the ocular scale; the infralabials 5 – 6; the 20 scale rows around the midbody; and the ventral 286 – 301 scales.

Measurement: SVL 13 – 15 cm, tail 1 – 105 cm.

Colour: The ventrum is slightly pale and white near the tail region, and it gets darker and browner above.

Habit: It consumes primarily ants, termites, and small insects, along with their eggs and larvae, and it is fossorial and diurnal.

Global distribution: It is native to Africa and Asia, introduced worldwide (IUCN, 2019).

Distribution in Nepal: It is commonly found in low land to high mountainous regions below 1500 masl (Shah & Tiwari, 2004).

Population: Presumably stable.

Status: Least Concern

16. **Species Name**: *Eryx conicus* (Schneider, 1801)

Synonyms: *Boa conica* (Schneider, 1801), *Erix bengalensis* (Cuvier, 1837), *Gongylophis conicus* (Boulenger, 1892), *Eryx conicus* (Boulenger, 1893), EryIx *conicus* (Smith, 1943), *Gongylophis conicus* (Tokar, 1995), *Eryx conicus* (Bauer, 1998), *Gongylophis conicus* (McDiarmid *et al.*, 1999).

Common Name: Common sand Boa, Russell’s sand boa

Nepali name: Kalo dhusar, Linde sarpa, Dhodesanp

Location: It was reported from Arghakhanchi and Kapilvastu districts.

Diagnostic characters: Body is cylindrical which tapers abruptly; head slightly distinct from neck with small scales except nasals and internasals; rostral wide;

without ridge. Nostril is slit between nasals and internasal, stout; eyes small, with vertically elliptical pupil. Tail very short, blunt, tapering and pointed

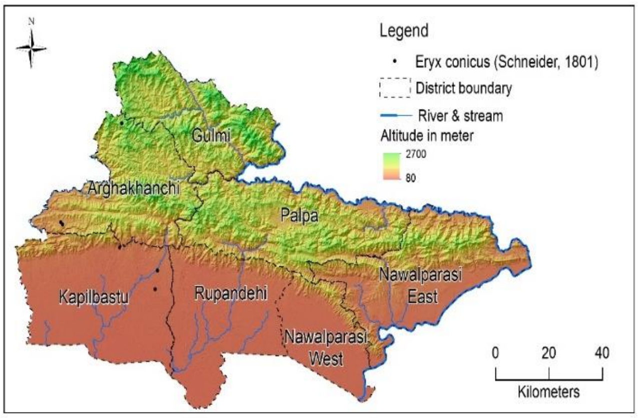


Figure 36: Point location map of the Common sand Boa *Eryx conicus* (Schneider, 1801) present in the Lumbiri region. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Identification: Supralabials 11 – 13; infralabials 13 – 15; dorsal scales at mid body 44 – 52; keeled; keels particularly heavy in posterior half of body and 10 – 14 scales around the eyes. Ventrals 161-178; anal is small undivided; subcaudals 17 – 22.

Measurement: Snout-vent length 75.3 – 81.3 mm, tail 58 – 68 mm.

Colour: Dorsal colour is yellowish, brownish, or grayish with a distinct sequence of dark-brown patches with black edges. A behind-the-eye black stripe and a comparable lateral irregular sequence. Belly is white with irregular spots of gray.

Habit: It hunts both at night and during the day. It eats insects, rodents, small birds, lizards, snakes, frogs, and lizards.

Global distribution: This species occurs in Bangladesh, India, Nepal, Pakistan and Sri Lanka (IUCN, 2019).

Distribution in Nepal: It was found in Terai to mountain below 2628 m (Shah & Tiwari, 2004).

Population: Not known

Status: Data Deficient

17. **Species Name**: *Python molurus* (Linnaeus, 1758)

Synonyms: *Boa ordinata* (Schneider, 1801), *Boa cinerae* (Schneider, 1801), *Coluber molurus* (Linnaeus, 1758), *Python tigriscastaneus* (Daudin, 1803), *Pythonmolurus*

(Gray, 1842), *Python molurus* (Boulenger, 1893), *Pythonmolurus* (Wall, 1921), *Python moluruspimbura* (Deraniyagala, 1945), *Python molurus* (Kluge, 1993), *Python molurus* (Jacobs *et al.*, 2009), *Python molurusmolurus* (Barone, 2004).

Common Name: Asian pock Python, Black-tailed Python, Indian Python, Indian rock Python

Nepali name: Aginger, Ajagar

Location: It was recorded from low land to mid hills below 1623 m altitude.

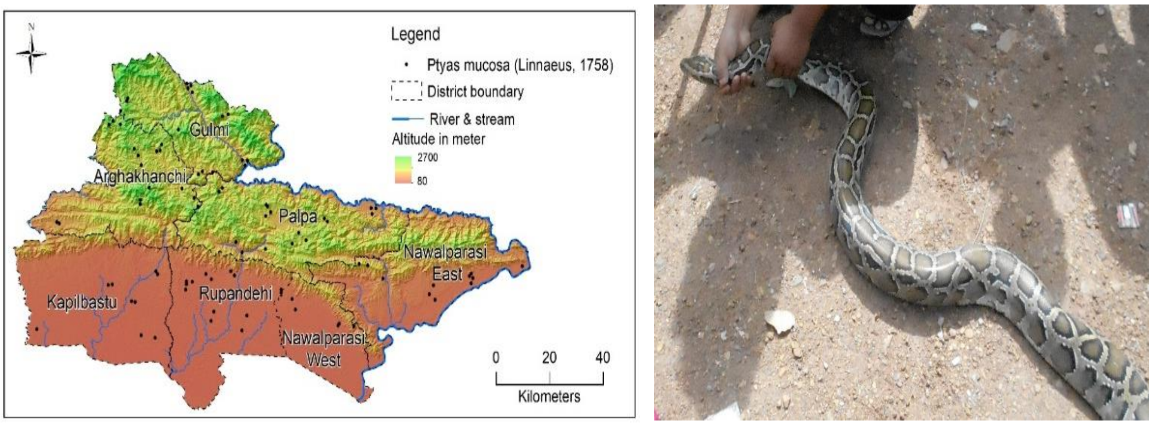


Figure 37: Point location map of the Asian pock Python: *Python molurus* (Linnaeus, 1758) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: It is a large, thick bodied snake, with elongated head. The eyes are small, rounded, and have vertical pupils. Anterior half of head has large scales while posterior half has smaller scales. Body scales are scales very small and smooth.

Identification: Head is distinct from neck and large symmetrical shields. Anterior maxillary and mandibulary teeth are very long. Rostal with deep pit on either side; pre-frontal 2 pairs; pre-ocular 2; post ocular 4; supra labial 11 – 13; 6th and 7th touch the eye; 16 – 18 sub labial; dorsal scales on mid body 68 – 72; 249 – 258 ventrals; anal single; 61 – 70 sub-caudal; paired.

Measurement: SVL 456 – 621cm.

Colour: Dorsum is pale yellow to cream, and above it is gray to brownish. Numerous large, elongated, sub-quadrangular patches of dark gray, brown, or reddish-brown color can be observed on the body. A spear-like mark that runs from the top of the head to the back of the neck. The sub-ocular streak reaches the mouth angle.

Habit: It is a good swimmer and more nocturnal than diurnal. It kills large mammals (rodents, fruit bats, jackals, civets, deer, and wild boar) as well as birds and is an oviparous ambush predator.

Global distribution: Eastern Pakistan, India, Sri Lanka, southern Nepal, Bangladesh, Myanmar, southern China, Vietnam, Lao People's Democratic Republic, Cambodia, Thailand, and Java, Sumbawa, and Sulawesi in Indonesia are among locations where it was observed (IUCN, 2019).

Distribution in Nepal: It was recorded from midland and low land of Nepal (Shah & Tiwari, 2004).

Population: Decreasing

Status: Data Deficient

18. **Species Name**: *Python molurus bivittatus* (Linnaeus, 1758)

Synonyms:

Common Name: Burmese rock Python,

Nepali name: Ajinger, Ajagar, Sonakatar

Location: It was recorded from different stations of all district except Arghakhanchi district.

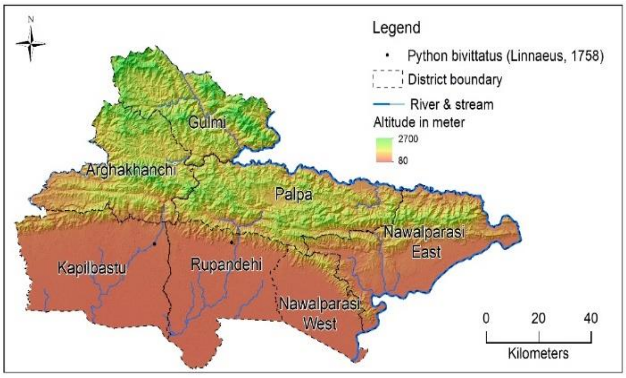


Figure 38: Point location map of the Bromise python *Python molurus bivittatus* (Linnaeus, 1758) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: It is a large, thick bodied snake, with elongated head. The eyes are small with vertical pupils. Anterior half of head has large scales while posterior half has smaller scales. Body scales are scales very small and smooth.

Identification: Head is distinct from neck and has large symmetrical shields. Anterior maxillary and mandibulary teeth are very long. Rostal has deep pit on either side; pre-frontal 2 pairs; pre-ocular 2; post ocular 4; supra labial 11 – 13; subocular is separated from the eye; 16 – 18 sub labial; dorsal scales on mid body 68 –72; 249 – 258 ventrals; anal single; 61 – 70 sub-caudal; paired.

Measurement: SVL 456 – 621cm.

Colour: Dorsum is light yellowish to cream, grayish to brownish above. There are median series of large elongated, sub quadrangular dark gray, brown or reddish-brown spots on the body. A spear shaped mark is seen on top of head, extending on to back of neck. A subocular streak extends past to the angle of mouth.

Habit: It is more nocturnal than diurnal and fond of water and a good swimmer. Diet consists of small to large mammals (rodents, fruit bats, jackal, civets, deer and wild boar) and also birds. It is oviparous.

Global distribution: The species is found in Bangladessh, Bhutan, India, Myanmar, Pakistan, Nepal, Sri Lanka and Vietnam (IUCN, 2019).

Status: Data Deficient

Population: Decreasing

19. **Species Name**: *Amphiesma stolatum* (Linnaeus, 1758)

Synonyms: *Amphiesma stolatum* (Duméril *et al.*, 1854), *Amphiesma stolata* (Das, 1996), *Amphiesma stolatus* (Guo *et al.*, 2014), *Coluber stolatus* (Linnaeus, 1758), *Elaps bilineatus* (Schneider, 1801), *Natrixs tolatus* (Merrem, 1820), *Natrix stolata chinensis* (Mell, 1930), *Natrix stolata* (Smith, 1943), *Rhabdophis stolatus* (Wall, 1921), *Tropidonotus stolatus* (Boie, 1827).

Common Name: Buff striped keelback, Striped keelback

Nepali name: Chankhe sarpa, Rato sanp

Location: It was observed in all districts of the research area at a maximum height of 1967 masl.

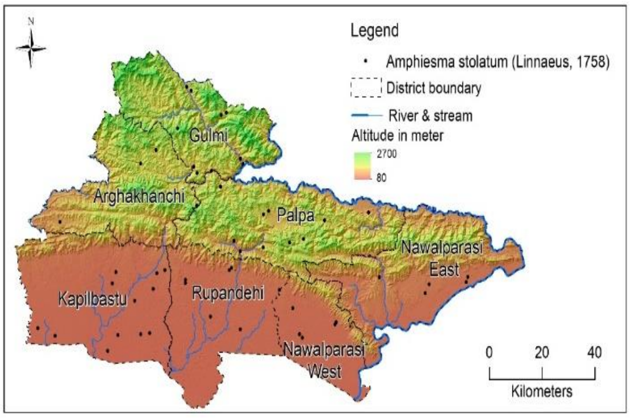


Figure 39: Point location map of the Buff striped keel back *Amphiesma stolatum* (Linnaeus, 1758) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters. Body is cylindrical and tail is long. Head is distinct from neck. Body colour is light olive brown and a pair of dorsolateral has light yellow stripes extending onto the tail.

Identification: The head scales of this snakes are: large head shields; nasal shield; two inter-nasals; 1 pre-ocular; temporal 1+1; supra-labial 7-8; sublabial 10 rarely 9 or 11; 3rd ; 4rh and 5thtouch the eye. The dorsal scales are 19 rows at midbody; 17 rows at vent level; and all scales except the last row are keeled. Subcaudals ranging from 50 to 85 and ventral scales vary from 125 to 157. It has a pointed tail.

Measurement: SVL = 58 – 67 cm, tail = 16 – 18 cm.

Color: With yellowish lips and a light olive brown on the body. The black bands are situated anteriorly, below, and below the eye. Onto the tail, a pair of bright yellow dorsolateral stripes are seen. Interstripe dots that range from dark brown to black and are more apparent anteriorly. The ventrum is white.

Habit: This species is a carnivore that feeds on rodents, tadpoles, small toads, frogs, snails, and other small lizards.

Global distribution: Bangladesh, Bhutan, Cambodia, China, Hong Kong, India, Lao PDR, Myanmar, Nepal, Pakistan, Sri Lanka, Taiwan, Thailand, and Vietnam are places where it is commonly found (IUCN, 2019).

Distribution in Nepal: It is recorded from low land to high mountains (Shah & Tiwari, 2004).

Status: Least Concern

Population: Probably declining

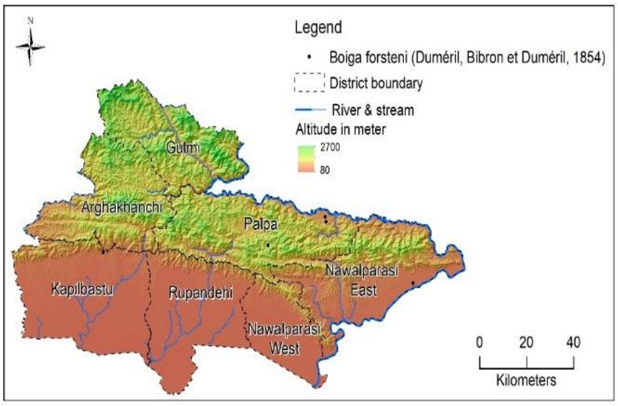
20. **Species Name**: *Boiga forsteni* (Duméril *et al.*, 1854)

Synonyms: *Boiga forsteni* (Smith 1943), *Boiga forsteni haematus*, (Deraniyagala, 1955), *Boiga forsteni* (Wallach *et al.*, 2014), *Dipsas forsteni* (Jan, 1863), *Dipsas tessellata* (Jan, 1863), D*ipsas forsteni* (Günther, 1864), *Dipsas forsteni var. ceylonensis* (Anderson, 1871), *Dipsas cynodon*, variety (Müller, 1878), *Dipsadomorphus forsteni* (Boulenger, 1890), *triglyphodon forsteni*(Duméril, Bibron & Duméril, 1854), *Triglyphodon tessellatum* (Duméril *et al.*, 1854).

Common name: Forsten's cat snakes

Nepali name: Sarpa, Lohagin

Location: It was found in the low land of Palpa, Nawalparasi, and Kapilvastu districts of the study area.



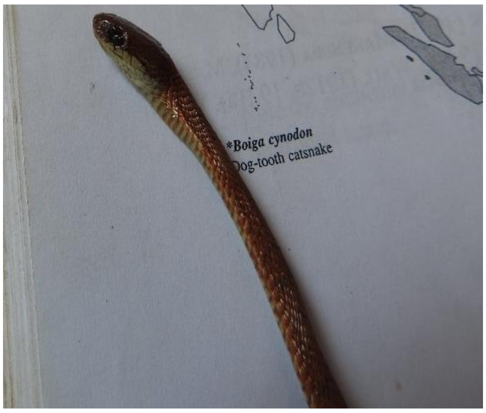


Figure 40: Point location map of the Forsten's cat snakes *Boiga forsteni* (Duméril *et al.* 1854) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The body is laterally compressed and extended. Large, triangular head separate from the neck; dark-black elliptical pupils that resemble slits.Scales are smooth; long shaped and obliquely arranged. Tail is long and thin with pointed tip.

Identification: The following head scales are present on the head: head length 20-60; head width 16-45; supralabials: 8; 9; infralabials: 9-10; preoculars 1; postoculars 2; loreal 1; temporal 3 + 3; 3rd to 5th or 4th to 6th in contact with eyes. Scale rows on body are 25:27:17 in oblique rows and vertebrals feebly or strongly enlarged. Ventral scales are 248 – 255; anal 2; subcaudals 110 –121 pairs.

Measurement: SVL 106 – 135cm. Tail 26 – 31cm

Colour: Dorsal color of body is variable, mostly grayish and brown. Some of the variations include a patternless head and cross bars that are black, white, or yellowish. The ventral scales' outer margins may or may not have blackish patches, while the belly is either white, yellow, or yellowish-brown.

Habit: It remains hidden in tree holes, piles and dense forests in hills, mountain and plains. It is arboreal, nocturnal species but active in dusk and dawn.

Global distribution: Several states of India, including Sikkim, West Bengal, Maharashtra, Uttar Pradesh, Madhya Pradesh, Andhra Pradesh, Tamil Nadu, South Rajasthan, Uttarakhand, and Jharkhand, as well as Nepal and Sri Lanka frequently had it (IUCN, 2019).

Distribution in Nepal: It is common in low lands to high mountains. It occurs in mountainous districts of study sites (Shah & Tiwari, 2004).

Status: Least Concern.

Population: Stable

21. **Species Name**: *Boiga stoliczkia* (Günther, 1868)

Synonyms: *Boiga stoliczkae* (Shaw, 1940), *Boiga ochracea* (Smith, 1943), *Boiga ochraceus* (Das, 1996), *Boiga ochracea* (Whitaker and Captain, 2004), *Dipsas ochraceus* (Günther, 1868), *Dipsas hexogonatus* (Stoliczka, 1871), *Dipsadomorphus stoliczkae* (Wall, 1909),

Common Name: Nicobar cat snake, Tawny cat snake, Wall’s cat snake

Nepali Name: Chudeu, Sarpa

Location: It was recorded from the altitude below 1503 m in the research area.

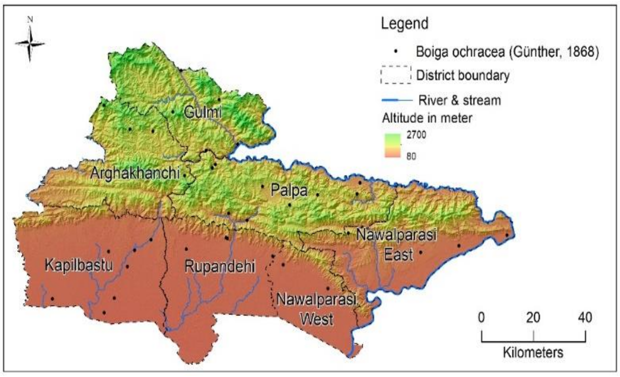


Figure 41: Point location map of the Nicobar cat snake Boiga stoliczkia (Günther, 1868) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The head is triangular, over twice as long as it is wide, and considerably wider than the neck. The body is dorsolaterally compressed. Its tail is pointed.

Identification: Head scales include: inter nasals a little shorter than the pre frontals; internasals somewhat shorter than prefrontals; supralabials 8 – 9; 4, 5, and 6 touch the eye; pre-ocular 1; post-ocular 2. Temporals have 2 + 3, 3-4, or 5; lower labials in contact with the anterior chin-shields; while infralabials have 10 – 12 lower labials.The dorsal scale row is 19/20: 21: 21/19:15/17 scales of the vertebral row are strongly enlarged; disposed obliquely. The ventral scales are 225 – 249; the subcaudals are 99-116; divided, and the anal scales are single.

Measurement: SVL 105 – 130cm, tail 20.2 v 22.5 cm.

Colour: The dorsum is a brownish-yellow in colour. Dusky grey, reddish, or ochraceous above; uniform transverse lines of blackish colour; a more or less prominent brown band extending from the eye to the gape; and whitish lip and chin.

Habit: It is diagnosticly arboreal, carnivorous, and nocturnal in behavior. Additionally, it descends in search of food. It consumes tiny mammals, frogs, lizards, birds, and their eggs.

Global distribution: This species is known to occur in Bangladesh, Bhutan, India, Myanmar, and Nepal (IUCN, 2019).

Distribution in Nepal: It occurs in different region of Nepal. It was recorded low land and mountain of study area (Shah & Tiwari, 2004).

Status: Least concern

Population: Decreasing

22. **Species Name:** *Boiga trigonata* (Schneider, 1802)

Synonyms: *Boiga trigonata* (Smith, 1943), *Boiga trigonata melanocephala* (Leviton, 1959), *Boiga trigonatus* (Das 1996), *Boiga trigonatum* (Szczerbak, 2003), *Boiga trigonata* (Wallach *et al.*, 2014), *Coluber catenularis* (Daudin, 1803), *Coluber trigonatus* (Schneider in Bechstein, 1802), *Dipsas trigonata* (Blyth, 1855), *Dipsadomorphus trigonatus* (Boulenger, 1896), *Dipsadomorphus trigonata var. melanocephalus* (Annandale, 1904), *Sibon catenularis* (Fitzinger, 1826).

Common Name: Common cat snake, Indian gamma gnake

Nepali name: Chudeu sarpa, Tirise sarpa, Bateudesanp

Location: It was reported from low land to mid hill at an altitude of 1503 m.

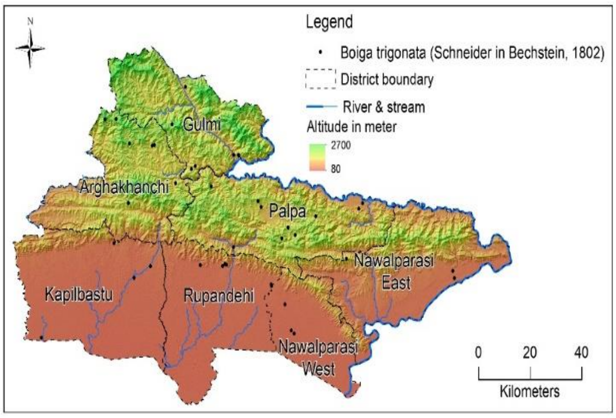


Figure 42: Point location map of the Common cat snake *Boiga trigonata* (Schneider, 1802) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The top of the head has a distinctive marking in the shape of a "Y" or "Gamma." It has a small neck and big eyes. Its eyes are large and protruding, with a vertical elliptic pupil, and it has a triangular head. The body is laterally flattened, and covered in long, smooth scales that have apical pits.The tail is lengthy, prehensile, and pointed at the tip.

Identification: One preocular; two post-ocular; temporals 2+3; 8 supra-labials; of which the third; fourth; and fifth enter the eye; 10 – 11 infralabials; and four or five lower labials in contact with the anterior chin-shields comprise up the head scales.

The inter-nasal scales are shorter than the prefrontal scales.The dorsal scales include oblique rows of 21:21:15; and the vertebrals are larger than the adjacent scales. There are 209 – 243 ventral scales; subcaudal divided into 79 – 95; and a single anal scale.

Measurement: SVL = 70 – 90 cm, tail = 18 – 19 cm.

Colour: The head is brownish with a noticeable bright mark in the shape of a Y. The dorsum is light brown and has a median series of 35–50 irregular, transverse, oblique white bars that are bordered in black and are more noticeable anteriorly. Ventrum is yellow with dark brown or blackish patches along the edges of several scales.

Habit: It exhibits its normal arboreal form and hides in tree crevices and cracks at low to moderate heights. Lizards are the major prey and eats other snakes, small rodents, tiny birds, and frogs.

Global Distribution: Major nations where it was documented include Sri Lanka, India, Pakistan, Nepal, Bangladesh, and Afghanistan, Iran (IUCN, 2019).

Distribution in Nepal: It is common in low lands to mountain below 1400m (Shah & Tiwari, 2004).

Status*:* Least concern

Population: Decreasing

23. **Species Name**: *Coelognathus helena* (Daudin, 1803)

Synonyms: *Coluber helena* (Daudin, 1803), *Coluber helena* (Boulenger, 1894), *Coluber helena* (Wall, 1921),*Cynophis bistrigatus* (Gray, 1849), *Cynophis helena* (Günther, 1858), *Cynophis helena* (Anderson, 1871), *Elaphe helena* (Smith, 1943), *Elaphe helena* (Murthy, 2010), *Herpetodryas helena* (Schlegel, 1837), *Plagiodon helena* (Duméril and Bibron, 1854), *Coelognathus helena* (Helfenberger, 2001).

Common Name: Common trinket tnake

Nepali Name: Singare sarpa, Sarpa

Location: This species was recorded below 1762 m at different stations.

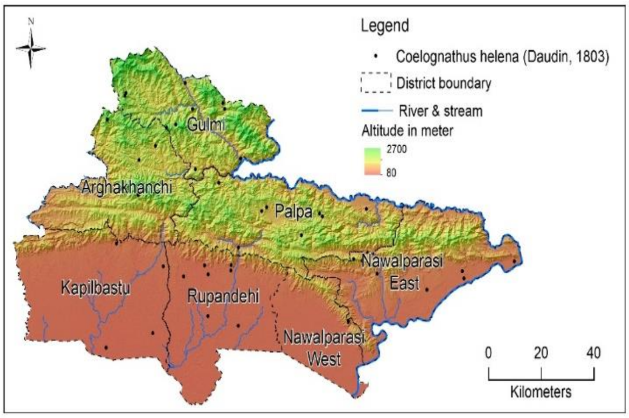


Figure 43: Point location map of the Common trinket snake *Coelognathus helena* (Daudin, 1803) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Dignostic characters: The body is elongate, slightly compressed, scales smooth or keeled, and it has apical pits on the back. Circular, big, black, brown pupils are seen. Below the eye, a vertical black streak can be seen, and an oblique behind the eye. The tail is pointed and long.

Identification: The head measures 23 mm in length and 14 mm in width. Head scales include: rostral is a little broader; visible from above; bell-shaped frontal; shorter than the parietals; loreal longer; large preocular 1; postoculars 2; supralabials; 5th and 6th; or 5th to 7th; touching the eye; the 6th or 7th in contact with the temporals; infralabials 10; 5 or 6 lower labials in contact with the anterior chin-shield. The dorsal surface has 23 or 25:25 rows of scales that are more or less distinctly angulate laterally on the body's posterior region and the tail. The subcaudals are divided; the anals are entire; and there are 215–245 ventral scales.

Measurement: SVL 90 – 121 cm, tail 20 – 27cm.

Colour: Above, the color is light or dark brown with a dark brown crossbar that has white ocelli. In the body's posterior region, this pattern progressively disappears. Below the eye and below it, there is a vertical black streak.

Habit: It primarily eats rodents, birds, frogs, and lizards. It raises its head and coils into S shape when disturbed.

Global distribution: In Bangladesh, India, Nepal, and Sri Lanka, this species can be found (IUCN, 2019).

Distribution in Nepal: It occurs in low and mid hills region (Shah & Tiwari, 2004).

Status: Least Concern

Population: Probably stable

24. **Species Name**: *Coelognathus radiatus* Boie, 1827

Synonyms: *Coluber radiatus* (Boie, 1827), *Coelognathus radiatus* (Cochran, 1930), *Coelognathus radiatus* (Gumprecht, 2000), *Elaphe radiata* (Smith, 1943), *Elaphe radiatus* (Murthy, 2010), *Tropidonotus quinque* (Cantor, 1839).

Common Name: Copper-head trinket snake, Copper headed rat snake, Radiated rat snake

Nepali name: Sarpa, Sigare sarpa

Local Name: Dudhraj Shap.

Location: It was reported from the lowland of Terai to the midland of the mountains.

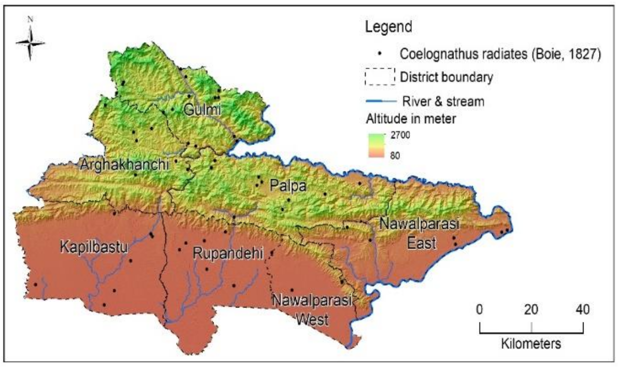


Figure 44: Point location map of the Copper-head trinket snake *Coelognathus radiatus* Boie, 1827 present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The head is wider than the neck, which is bilaterally compressed, elongated, not depressed, and not rounded. A fine black streak on the nape of the neck leads to a similar color streak behind the eyes. The pupils of eyes are spherical. Scales are unequal, smooth, or keeled weakly. The tail is long, thin and pointed.

Identification: The snout is twice the length of the eye; rostral broad; preocular 1; postocular 2; temporal 2+2; supra-labial 8 or 9; 4^{th}, 5^{th}, and 6th touch the eye; infralabial 9-10; 4 or 5 lower labials in contact with the anterior chin-shields. The dorsal scales have 19/21: 19:17 rows and are strongly keeled. Anal single; subcaudals 86 – 103 paired; anal scales 225 – 241; highly angulated.

Measurement: SVL = 165 – 181 cm, tail = 31 – 34 cm.

Colour: Its head is copper in colour. Grayish-brown or reddish brown is the dorsal colour, and the front part of the body has four black stripes as well as chains organized laterally.The black bar across the occiput and the three black streaks extending from under the eye make up the upper vertebral stripes. The belly is typically pale, gray, or yellow in colour.

Habit: It is a diurnal, terrestrial species that is active around mounds and bodies of water. It consumes rodents, lizards, birds, and even frogs as food. When approached closely, it expands a large portion of the forebody, holding it above ground while hissing and opening its mouth.

Global distribution: Bangladesh, Brunei Darussalam, Cambodia, China, Hong Kong, India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Nepal, Singapore, Thailand, and Vietnam are its homelands (IUCN, 2019).

Distribution in Nepal: It occurs in different region of terai and mountain of Nepal (Shah & Tiwari, 2004).

Status: Least Concern

Population: Presumably stable

25. **Species Name**: *Dendrelaphis tristis* (Daudin, 1803)

Synonyms: *Chrysopelea boiei* (Smith, 1836), *Coluber tristis* (Daudin, 1803), *Dendrophis boii* (Cantor, 1839), *Dendrophis helena* (Werner, 1893), *Dendrophis maniar* (Boie, 1827), *Dendrelaphis tristis* (Boulenger, 1894).

Common Name: Common bronzeback tree snake, Daudin’s bronzeback

Nepali name: Sirishe, Laudanga

Location: This is an arboreal species recorded from low land to high altitudes of up to 1600m.

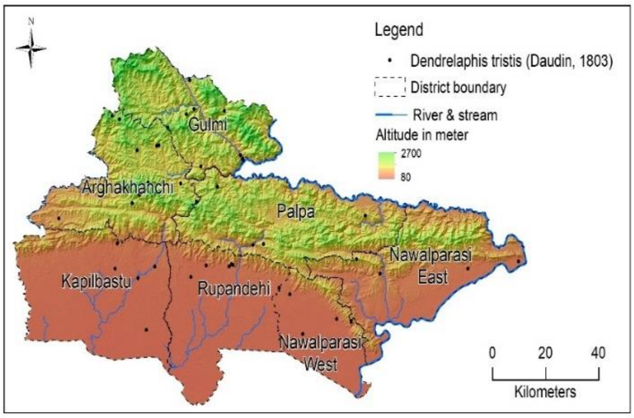


Figure 45: Point location map of the Common bronzeback tree snake *Dendrelaphis tristis* (Daudin, 1803) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The head is a fiat, separate from the neck, and it has broad, round eyes. Body is elongated, thin, long, covered with smooth scales and oblique. Tail is very long, thin and a pointed tip.

Identification: The head scales are broadly rounded at the snout. The prefrontal 1; preocular 1; loreal 2; postocular 2; temporal 2; 9 supralabials; with the 5th and 6th in contact with the eyes; and 9 infralabials are usually a little shorter than the internasals.Vertebral scales are barely larger and smaller than the outer scales; dorsal scales have 9 oblique rows and are arranged 15:15:11. Subcaudals are paired and range from 108 to 131 on the ventrals.

Measurement: SVL = 115 – 161 cm, tail = 33 – 36 cm.

Colour: It is bronze-brown or purplish-brown above, with a buff lateral stripe edged with black. The colour of anterior dorsum is yellow. The colour of the vent is yellowish-white or greenish-white.

Habit: It is an arboreal, and diurnal climber. It consumes insects, tiny birds, rodents, geckos, lizards, frogs, and lizard eggs.

Global distribution: Bangladesh, India, Myanmar, Nepal, Pakistan, and Sri Lanka are all native to the taxon (IUCN, 2019).

Distribution in Nepal: It is common snakes found below the1600 m (Shah & Tiwari, 2004).

Population: Presumably decreasing

Status: Least Concern

26. **Species Name**: *Lycodon aulicus* (Linnaeus, 1758)

Synonyms: *Boaedon unicolor* (Duméril *et al.*, 1854), *Coluber aulicus* (Linnaeus, 1758), *Lycodon unicolor* (Boie, 1827), *Lycodon subfuscus* (Cantor, 1839), *Lycodon aulicum* (Duméril *et al.*, 1854), *Lycodon aulicus* (Günther, 1864), *Lycodon atropurpureus* (Bulenger, 1891), *Natrix aulica (*Laurenti 1768).

Common Name: Common Wolf Snake, Indain Wolf Snake

Nepali name: Chichinde sarpa, Buwase sarpa

Location: It was reported from all station of study area.

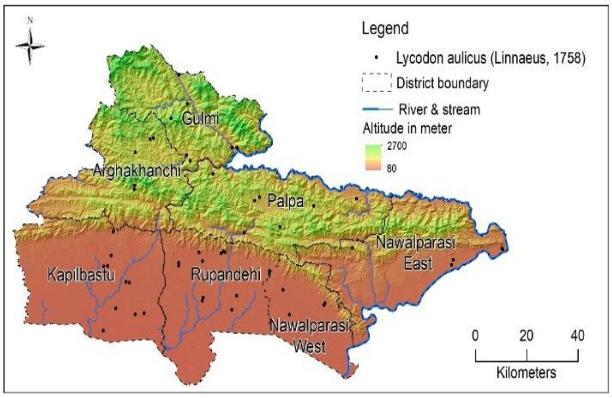


Figure 46: Point location map of the Common Wolf Snake *Lycodon aulicus* (Linnaeus, 1758) at existences in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: It is medium sized snakes which has elongated body and flat head. Snout is spatulate projecting beyond lower jaw, with smooth & shiny dorsal scales. Tail is normal and has pointed tip.

Identification: Head scales include 1 preocular contact to the frontal; postocular 2; 1 loreal; in good contact with internasals and supralabials: 9, 3rd, 4th and 5th touches to the eye.

Measurement: SVL 55 – 70cm. Tail 12 – 14cm.

Colour: The dorsal portion of the animal is a dark brown to grayish brown with a light sheen. On the whole dorsal body, starting at the neck and decreasing in the tail region, there are 10–20 yellow or yellowish-white bands. The ventrum and top lip are both glossy white and patternless.

Habitat: It lives at night and is both arboreal and terrestrial. It has the ability to climb vertical walls and pipes. It is a carnivore that eats lizards, skinks, and frogs.

Global distribution: Bangladesh, Bhutan, China, Hong Kong, India, Indonesia, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Seychelles, Sri Lanka, Thailand, and Timor, as well as Maldives and Mauritius, have it (IUCN, 2019).

Distribution in Nepal: It is commonly found in low to high altitudes of Nepal (Shah & Tiwari, 2004).

Population: Decreasing

Status: Least Concern

27. **Species Name**: *Oligodon russelius* (Shaw, 1802)

Synonyms: *Coluber arnensis* (Shaw, 1802), *Coluber russelius (*Daudin, 1803), *Coronell arusselii* (Schlegel, 1837), *Oligodon arnensis* (Smith, 1943), *Oligodon arnensis* (Wallach *et al.*, 2014), *Simotes russelii* (Duméril *et al.*, 1854), *Simotesa lbiventer* (Günther, 1864), *Simotes arnensis* (Boulenger, 1890), *Simotes arnensis* (Wall, 1908).

Common Name: Banded Kukri, Common Kukri shap, Yellow-speckled wolf snake,

Nepali name: Sankhad sanp

Location: It was recorded from different stations in the study area at a height of 1693 m.

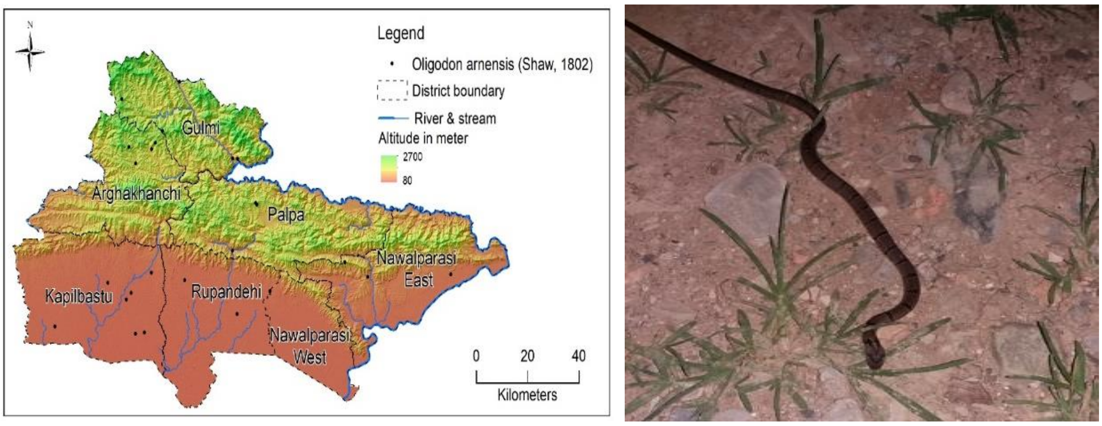


Figure 47: Point location map of the Banded Kukri *Oligodon russelius* (Shaw, 1802) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The head is indistinct, the snout is blunt, and there are two V-shaped marks on the head and two on the neck, starting from the frontal and progressing through parietal scales to 1– 5 ventral scales.

Identification: Rostral scales are large and almost separating internasals; loreal scales are frequently united with the prefrontal; 1 preocular; 2 – 3 postoculars; supralabials 7; third and fourth touching eye; and 7 or 8 lower labials. Body scales smooth glossy; 17:17:15 at midbody. Ventral scales are 179 – 198; subcaudals 45 – 56; paired; anal divided.

Measurement: Snout-vent length 64-67cm, tail 9-10 cm.

Colour: The dorsum is reddish to dark brown, with 19–32 black crossbars that are closely bordered with white, and two V-shaped markings that extend backward.Ventrum is white.

Habit: Despite the species' nocturnal and crepuscular habits, daytime is when the majority of activity take place.

Global distribution: Bangladesh, Bhutan, India, Nepal, Pakistan, and Sri Lanka have all documented occurrences of this species (IUCN, 2019).

Distribution in Nepal: It is commonly found in the altitude below the 2130m in Nepal (Shah & Tiwari, 2004).

Population: Not known

Status: Data Deficient

28. **Species Name**: *Oligodon erythrogaster* Boulenger, 1907

Synonyms: *Oligodon erythrogaster* (Smith, 1943), *Oligodon erythrogaster* (Kramer, 1977), *Oligodon erythrogaster* (Das 1996), *Oligodon erythrogaster* (Wallach *et al.*, 2014).

Common Name: Nagarkot kukri snake, Red bellied kukri snakes

Nepali name: Sarpa

Location: It was recorded in the mountainous district of the study area.

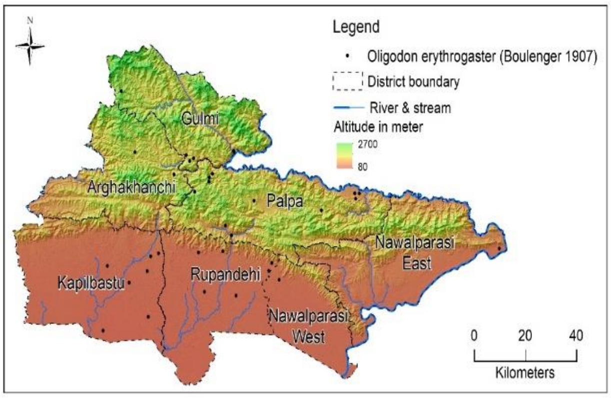


Figure 48: Point location map of the Nagarkot kukri snake *Oligodon erythrogaster* Boulenger, 1907 present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Body is cylindrical, head slightly triangular, faintly distinct from neck, snout narrowed, triangle with blunt tip, eye slightly small, pupil rounded. Body scales are smooth tail relatively long and pointed tip.

Identification: An undivided nasal, a frontal that is somewhat shorter than the parietals and much longer than its distance from the end of the snout make up the head scalation.There is no loreal; prefrontal in contact with the second upper labial; 1 pre-ocular 2; postoculars 2; temporals 2 + 2; supralabials 6 or 7, third and fourth contact with the eye; four infralabials in contact with the anterior chin shields.Ventral scales range in size from 179 – 185; are anal divided, subcaudals 45 – 54; and are paired while17 rows make up the dorsal scales.

Measurement: SVL 45 – 46cm, tail 7.5 – 8cm

Colour: The dorsal colour is purplish-grey with two dark brown streaks enclosing a yellowish vertebral streak, meeting on the tail with a dark streak and three narrow black lines on each side. There is a V-shaped dark brown band across the snout and a broad dark brown oblique band on each side of the head. The ventrum is red in the middle, white on the sides, and subcaudal with black spots.

Habit: It is active in day and feed lizard, their eggs and rodents

Global distribution: It occurs in Nepal, Sikkim, and India (IUCN, 2019).

Distribution in Nepal: It is commonly occurred in tropical to temperate region below 2560 m (Shah & Tiwari, 2004).

Population: Not known

Status: Data Deficient

29**. Species Name:** *Orthriophis hodgsoni* (Günther, 1860)

Synonyms: *Coluber hodgsoni* (Boulenger, 1890), *Compsosoma hodgsonii* (Günther, 1864), *Compsosoma hodgsoni* (Stoliczka, 1870), *Coluber hodgsonii* (Boulenger, 1894), *Elaphe hodgsoni* (Smith, 1943), *Elaphe hodgsoni*, (Das, 1996),*Elaphe hodgsoni* (Chen *et al.*, 2017),*Orthriophis hodgsonii* (Utiger *et al.*, 2002), *Ortriophis hodgsoni* (Kästle *et al.*, 2013), *Orthriophis hodgsonii* (Wallach *et al.*, 2014), *Spilotes hodgsonii* (Günther, 1860).

Common Name: Himalayan trinket snake, Hodgson's racer

Nepali Name: Wayana, Pila matia

Location: It occurs in the mountains ranges of study sites.

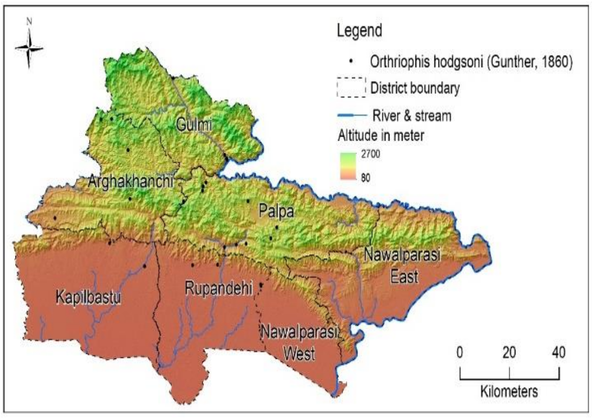


Figure 49: Point location map of the Himalayan trinket snake *Orthriophis hodgsoni* (Günther, 1860) (Boulenger, 1907) at presence in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic Characters: The body is cylindrical, slightly compressed, and elongated. Dorsal scales are smooth or feebly keeled on the back of the body, and the head and neck are different from one another. The end of tail is long and pointed.

Identification: The prefrontal shields are almost two times longer than the internasal shields; the frontal is as long as its distance from the end of the snout; the loreal is longer than the deep; 1 large preocular; 2 postoculars; temporals 2+2 or 2+3. Supralabial 8 or 9; 3th, 4th, 5,th or 6 in contact with the eyes; and 5 lower labials in touch with the anterior chin shields. The 23:17 rows of dorsal scales. With a prominent lateral keel; angulated laterally; anal split; and subcaudals 79 – 90; the ventral scales measure 227 – 246.

Measurement: SVL 123 – 151 cm, tail 25 – 30 cm.

Colour: Olive-brown coloration covers the dorsal portion, and many scales have black edges. The ventrum is yellowish, and the ventral shields' outer margins are edged in black.

Habit: It is diurnal and catches tiny birds, mammals, frogs, and lizards.

Global distribution: Nepal, India (Sikkim, Assam, Kashmir, Himachal Pradesh, Jammu and Kashmir), and China are the main localities for this species (IUCN, 2019).

Distribution in Nepal: It occurs in high altitudinal area (Shah & Tiwari, 2004).

Population: Not known

Status: Not Assessed

30. **Species Name**: *Ptyas mucosa* (Linnaeus, 1758)

Synonyms: *Coluber mucosus* (Linnaeus, 1758), *Coluber dhumna* (Cantor, 1839), *Coryphodon blumenbachii* (Duméril and Bibron, 1854), *Leptophis trifrenatus* (Hallowell, 1860), *Natrix mucosa* (Laurenti, 1768), *Ptyas blumenbachii* (Fitzinger, 1843), *Ptyas mucosus* (Cope, 1861), *Ptyas mucosus* (David & Das, 2004), *Ptyas mucosa* (Wallach *et al.*, 2014), *Zamensis mucosus* (Boulenger, 1890).

Common Name: Asiatic rat snake, Indian rat snake, Oriental rat snake.

Nepali name: Dhaman, Lambaiya, Dhamala, Dhodyan sanp

Location: It was found in all stations of the study area, ranging from low land to a height of 1958 m.

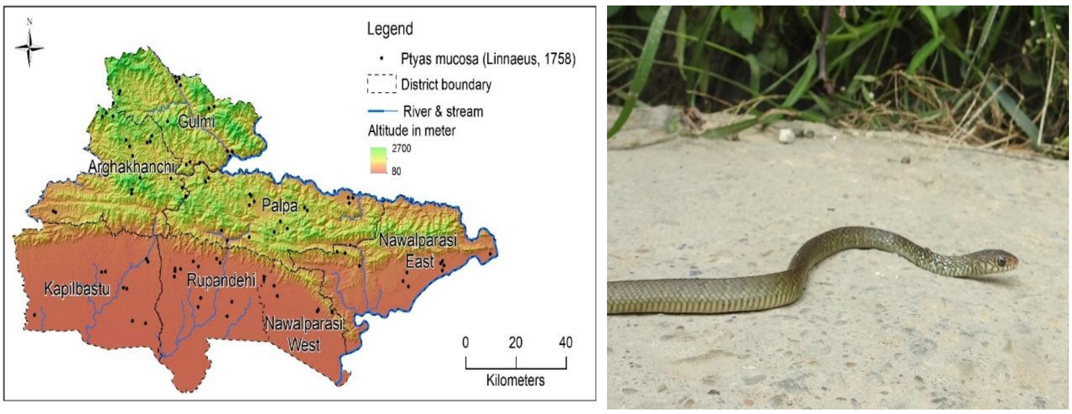


Figure 50: Point location map of the Asiatic rat snake *Ptyas mucosa* (Linnaeus, 1758) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: This species has elongated head; distinct from the neck; a blunt snout; large eyes; a solid, rigid body; and a long prehensile tail. A blackish-colored border is present on the upper lip and underside scales.

Identification: Nostrils are located between the nasals and the first supralabial; internasals are shorter than prefrontals; loreal concave and 2 – 4; 2 preocular, 3 – 4 postocular; 8 supralabials; 4th and 5th touches eye; 8-10 infralabials; 2 + 2 temporals. Dorsal scale comprise 17/18/19: 16/17: 14/16 rows; smooth or median rows slightly keeled. Ventral scales are 190 – 209; anal divided; subcaudals are 107–127; paired.

Measurement: SVL 189 – 215cm, tail 51 – 56 cm.

Colour: Dorsum is wheatish, olive, brown, greyish black. Black mark present over body often prominent at posterior part.Most of the body's scales have light and dark edges.

Habit: The majority of it is an excellent climber and an opportunistic semi-arboreal species. It consumes a variety of animals, primarily toads and rodents.

Global distribution: Afghanistan, Bangladesh, Cambodia, China, India, Indonesia, Iran, Lao PDR, Myanmar, Sri Lanka, West Malaysia, Nepal, Pakistan, Taiwan, Thailand, Turkmenistan, and Vietnam are among the countries that have reported it (IUCN, 2019).

Distribution in Nepal: It is common in the altitude below the 1750m (Shah & Tiwari, 2004).

Population: Presumably decreasing

Status: Least Concern

31. **Species Name**: *Trachischium tenuiceps* (Blyth, 1854*)*

Synonyms: *Ablabes tenuiceps* (Theobald, 1868), *Calamaria tenuiceps* (Blyth, 1854), *Trachischium tenuiceps* (Boulenger, 1893), *Trachischium tenuiceps* (Smith, 1943), *Trachischium tenuiceps* (Das, 1996), *Trachischium tenuiceps* (Schleich & Kästle 2000), *Trachischium tenuiceps* (Wang *et al.*, 2019).

Common Name: Orange bellied slender snake, Yellow belly worm-eating snake

Nepali Name: Chapere sarpa, Mate sarpa, Kumale sarpa

Location: It was reported from mid hills of Arghakhanchi, Gulmi and Palpa districts.

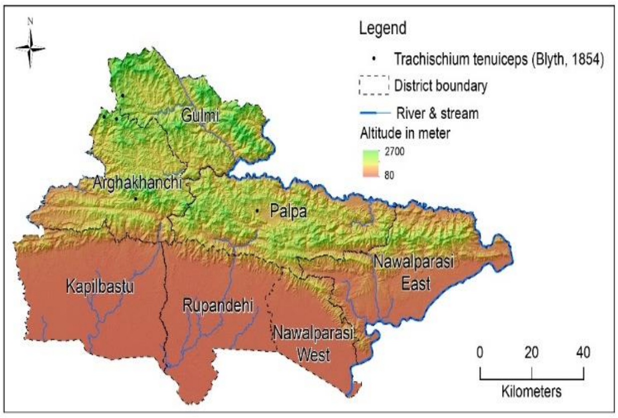


Figure 51: Point location map of the Orange bellied slender snake *Trachischium tenuiceps* (Blyth, 1854) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The snake is a little one. Its body is cylindrical; its head not distinct into its neck. Its small eye has a vertically sub-elliptic pupil; and its tail is short.

Identification: Rostral is as broad as hight. Internasals are much shorter than prefrontals; loreal 1 is as long as hight; 2 prefrontals; 1 preocular; 2 postoculars; rarely united; temporals 1+1 or 1+2. Upperlabials are 6; the 3rd and 4th touching the eye. Dorsal scales comprise 13 rows; keeled in the male on the sides of the vent. Ventrals are 125 to 140; and anal divided; subcaudals 28 to 42.

Measurement SVL 34 – 37cm, tail 45 – 48cm.

Colour: Dark brown to blackish is the predominant colour on the dorsum, with yellow or orange below. The tail is brown with a brown mesial line.

Habit: It is carnivorous and feeds on worms and insects.

Global distribution: It is widely distributed in Nepal, Bangladesh, India, Bhutan China (IUCN, 2019).

Distribution in Nepal: It is commonly found in high altitude above 2440m of Nepal (Shah & Tiwari, 2004).

Population: Presumably decreasing

Status: Not Evaluate

32. **Species Name**: *Fowlea piscator* (Schneider, 1799)

Synonyms: *Hydrus piscator* (Schneider, 1799), *Natrix piscator* (Merrem, 1820), *Natrix piscator* (Stejneger, 1907), *Natrix piscator* (Smith, 1943), *Tropidonotus piscator* (Boulenger, 1893), *Tropidonotus piscator* (Wall, 1908), *Xenochrophis piscator* (Malnate and Minton, 1965), *Xenochrophis piscator* (Cox *et al.*, 1998).

Common Name: Asiatic water snake, checkered keelback

Nepali name: Pani Sarpa, Pani Sanp, Dhodiya sanp

Location: It was reported from low land and midlands of research station.

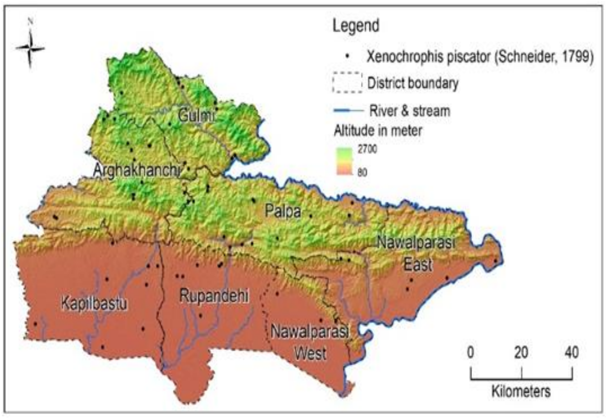


Figure 52: Point location map of the checkered keel back *Fowlea piscator* (Schneider, 1799) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Dignostic characters: The long snout and flattened head are separate from the neck. The eyes have spherical pupils, a single nasal, and dorsolateral nostrils. It is strongly keeled dorsal scales.

Identification: The loreal is nearly as long as it is deep. One preocular; three post-ocular; and temporals 2+2 or 2+3.There are 9 upper labials; of which the 4th and 5th reach the eye. There are also 9 to 10 infralabial labials; and five lower labials that come into touch with the anterior chin shields. The dorsal has 19 rows of scales. Ventral scales are at 132 – 151; anal divided; with subcaudals at 67–78; paired.

Measurement: SVL 93 – 120 cm, tail 175 –180 cm.

Colour: Coloration of dorsum is light green-gray or light reddish brown, containing of dark spots arranged quincuncially and often separated by a whitish network, with or without whitish spots. Two black stripes run from eyes to angle of jaws. Ventral side is white or cream with transverse scales up to cloaca region.

Habit: It is both diurnal and nocturnal. It consumes frog eggs, tadpoles, small frogs, insects, and rodents and birds as an adult. Tadpoles consume fish.

Global distribution: The species is known to occur in Afghanistan, Bangladesh, Bhutan, China, Indonesia, India, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Singapore, Sri Lanka, Taiwan and Thailand (IUCN, 2019).

Population: Presumably stable

Status: Least Concern

33. **Species Name**: *Fowlea sanctijohannis* **(**Boulenger, 1890)

Synonyms: *Fowlea sanctijohannis* (Purkayastha *et al.*, 2019); *Nerodia piscator sancti*-johannis (Bourret, 1935), *Natrix piscator sancti-johannis* (Bourret, 1936), *Tropidonotus sancti-johannis* (Boulenger, 1890), *Tropidonotus sancti-johannis* (Boulenger, 1893), *Tropidonotus piscator unicolor*, (Wall, 1907), *Tropidonotus piscator obscurus*, (Wall, 1907), *Fowlea piscator sanctijohannis* (Kramer, 1977).

Common name: St. John's keelback

Nepali name: Pani Sarpa, Pani Sanp, Dhodiya sanp

Location: This species was recorded from the mountainous districts of study area.

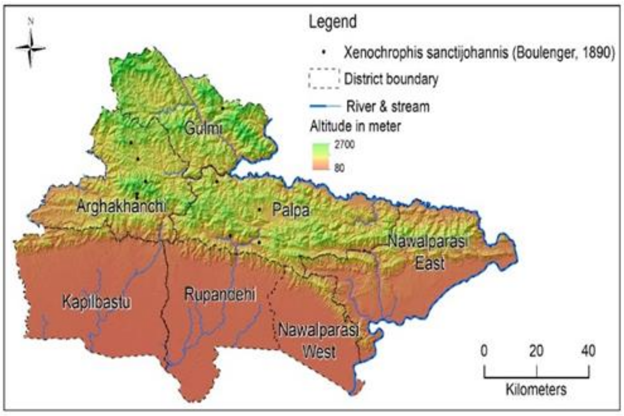


Figure 53: Point location map of the St. John's keel back *Fowlea sanctijohannis* (Boulenger, 1890) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnistict characters: The diameter of the eye is lesser than its distance from the nostril. From above, the rostral is seeming. Dorsal scales are weakly keeled.The four outer rows of dorsal scales are smooth, and there is a short tail.

Identification: The frontal is longer than it is from the tip of the snout; almost as long as the parietals; loreal; 1 preocular; 3 postocular; temporals 2+2; supralabial 9; fourth entering the eye; fifth very small; triangular; and 5 infralabial contact with the anterior chin-shields. There are 19 rows of feebly keeled dorsal scales. Scales on the ventral surface range from 139 – 142; anal pairs; and have paired subcaudals from 85 – 92.

Measurement: SVL 76 – 83 cm, tail 27 – 29 cm.

Colour: With no pattern or even an indication of spots on the front half of the body, the dorsum has a yellowish-green colour. Ventum has a yellowish colour.

Habit: It is capable of swimming in irrigation channels and fast streams. It preys on lizards, frogs, and fish.

Global distribution: The major countries of location are Myanmar, Bhutan, Pakistan, India (Himachal Pradesh, Kashmir, and Uttarakhand), and Nepal (IUCN, 2019).

Distribution in Nepal: It is commonly found in mid hilly areas above 1000 m height to22000 m (Shah & Tiwari, 2004).

Population: Presumably stable

Status: Not Evaluate

34. **Species Name**: *Bungarus caeruleus* (Schneider, 1801)

Synonyms: *Boa lineata* (Shaw, 1802), *Bungarus arcuatus* (Duméril and Bibron, 1854), *Bungarus caeruleus* (Duméril and Bibron, 1854), *Bungarus sidanus* (Boulenger, 1897), *Bungarus candidus* (Wall, 1907), *Bungarus caeruleus* (Smith, 1943), *Bungarus caeruleus* (Welch, 1994), *Bungarus caeruleus* (Janzen *et al.*, 2007), *Pseudoboa caerulea (*Schneider, 1801).

Common Name: Blue Krait, Common Krait, Common Indian Krait

Nepali name: Karet sarpa, Gadainch, Bairi karet.

Location: It was mostly found in lowlands, but it was also found in the midhills up to 1503 m altitude. The voucher specimens were observed from Rampur hospital, Palpa, United Mission hospital, Palpa, Gorusinghe smakebite centre, and Kapilvastu.

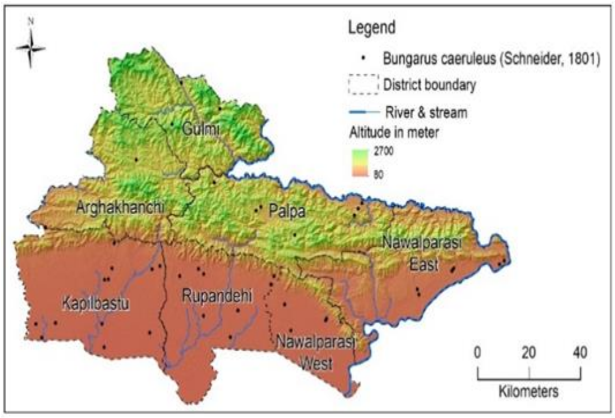


Figure 54: Point location map of the common Krait *Bungarus caeruleus* (Schneider, 1801) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Head is depressed with rounded snout, barely distinguishable from neck, small dark eyes, round pupil. Body is slender with shiny smooth scales. Tail is prehensile, shorter and ends with pointed tip. The white crossbars arrange more or less distinctly in pairs with white spots.

Identification: Head scalation comprise rostal broader than height; internasal shorter than prefrontal; loreal absent; 1 preocular contact posterior nasal; 2 postocular; temporals 1+2; 7 supralabials; 3rd & 4th in contact with eyes and 6th usually largest; 8 infralabials. Dorsal scales are in the rows of 15 – 17; the vertebral row is distinctly enlarged and hexagonal. Ventral scales comprise 194 – 217; anal entire; subcaudal 38 – 51; undivided.

Measurement: SVL 173 – 117 cm, tail 13 – 15 cm.

Colour: It is generally black or bluish black, with about 32 – 40 thin, Upper lip brownish or yellowish. A series of white spots lie on the vertebral region. Belly is yellowish-white in adults.

Habit: It hides out in silent, dark, or nudist places like rat burrows, termite mounds, various caves, old tree mounds, beneath rocks, etc. and climbs easily on rough surfaces when hunting prey during the day.

Global distribution: Afghanistan, Bangladesh, India, Pakistan, Nepal, and Sri Lanka are main places to this species (IUCN, 2019).

Distribution in Nepal: It was commonly found in low altitude of Nepal (Shah & Tiwari, 2004).

Population: Presumably stable

Status: Least Concern

35. **Species Name**: *Bungarus fasciatus* (Schneider, 1801)

Synonyms: *Pseudoboa fasciata* (Schneider, 1801), *Boa fasciata* (Shaw, 1802), *Bungarus annularis* (Daudin, 1803), *Aspidoclonion annulare* (Wagler, 1830), *Bungarus fasciatus* (Cantor, 1847), *Bungarus annularis* (Duméril and Bibron, 1854), *Bungarus fasciatus bifasciatus* (Mell, 1929), *Bungarus fasciatus insularis* (Mell, 1930), *Bungarus fasciatus fasciatus* (Mell, 1931), *Bungarus fasciatus* (Smith, 1943).

Common Name: Banded Krait

Nepali name: Laxmi sanp, Raja sanp, Maher, Kanthamala

Location: It was found in Terai districts of research area.

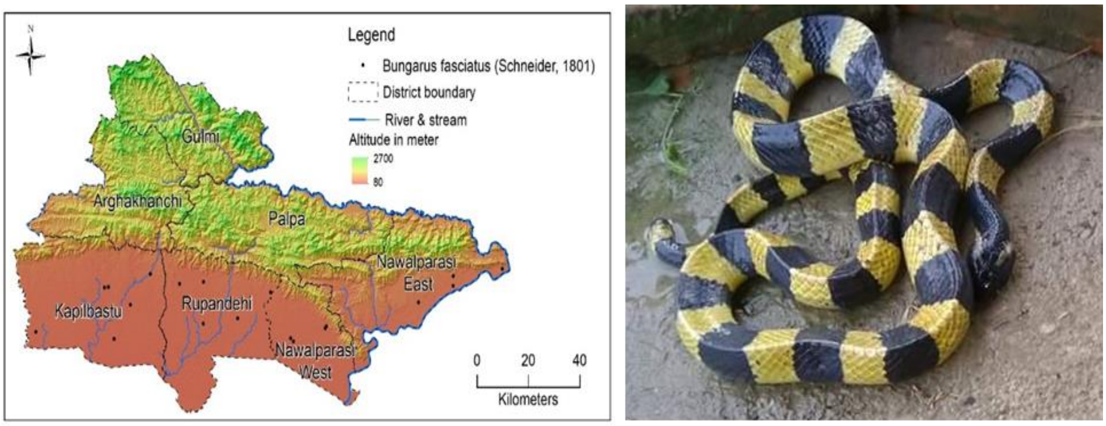


Figure 55: Point location map of the Banded Krait *Bungarus fasciatus* (Schneider, 1801) present in the study area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Head is triangular and broad with rounded edges; depressed; snout short; eyes black; pupil very faintly outlined in yellow and neck distinct. Tail shorter than a typical snake with blunt end. Body is marked with alternating yellow and black bands; dorsally a vertebral ridge up to tail.

Identification: Head scales include: rostal is broader than height; Internasal shorter than prefrontal; 1 preocular; loreal absent; 2 postocular; temporals 1+2; 7 upperlabials; 3rd & 4th in contact with eyes and 6th usually largest; lowerlabials 7. There are 15 rows of dorsal scales; with a distinctly expanded and hexagonal vertebral row. The numbers on the ventral scale 200 – 232 and subcaudals 23 – 39; anal single undivided.

Measurement: SVL 89 – 112cm, tail 9 – 11.5 cm.

Colour: Colour of body is shiny black and yellow alternatively broad bands of almost the same breadth. The snout is brown and the head is black; it has an inverted "V"-shaped yellow mark and narrow, oblique yellow streaks on the back that reached the neck.

Habit: This species is nocturnal and is frequently observed during rain in regions with rodent burrows, running water, riparian areas, and human settlement.

Global distribution: Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China (including Hong Kong), Hong Kong, India, Indonesia (Borneo, Java, Kalimantan, Slak, and Sumatra), Lao PDR, Macau, Malaysia, Myanmar, Nepal, Singapore, Sri Lanka, Thailand, and Vietnam are among the countries where it is widespread (IUCN, 2019).

Distribution in Nepal: It is common in terai region below 250 m (Shah & Tiwari, 2004).

Population: Presumably stable

Status: Least Concern

36. **Species Name**: *Sinomicrurus macclellandi* (Reinhardt, 1844)

Synonyms: *Elaps macclellandii* (Reinhadrt, 1844), *Elaps personatus* (Blyth, 1855), *Callophisannularis* (Günther, 1864), *Calliophis macclellandii* (Stejneger, 1907), *Micrurus macclellandi* (Welch, 1994), *Calliophis macclellandi* (Cox *et al.*, 1998), *Sinomicrurus macclellandi* (Slowinski *et al.*, 2001), *Hemibungarus macclellandii* (Orlov *et al.*, 2003), *Sinomicrurus macclellandi* (Ziegler *et al.*, 2007).

Common Name: Macclelland's coral snake

Nepali name: Rato sarpa, Nag, Karkat nag

Location: It was observed from the lowlands of mountainous districts and some stations in the Terai regions. The vauchar specimens were observed from Rampur hospital, Paplpa, United mission hospital, Palpa, Butwal multiple campus, Butwal and Gorusinghe snakebite centre, Kapilvastu.

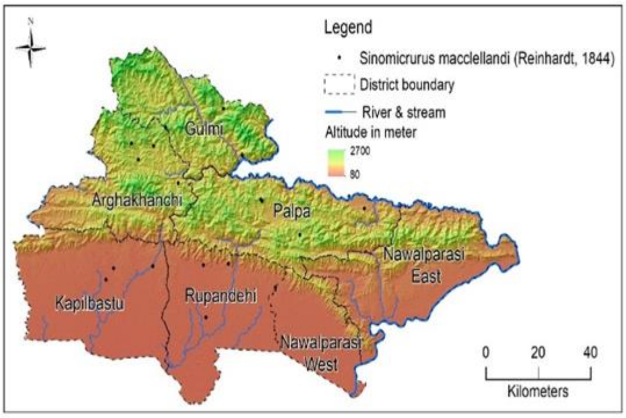


Figure 56: Point location map of the Macclelland's coral snake *Sinomicrurus macclellandi* (Reinhardt, 1844) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The head is very little or equally as wide as the neck. The circular pupil and small eye are almost entirely black. Snout is blunt and rounded. The tail's tip is sharply pointed and short. There is no enlargement of the vertebral series of scales, and white a headband.

Identification: The head scales include:the diameter of the eye less than its distance from the mouth; 1 pre-ocular in contact with the posterior nasal; 2 post-oculars; temporals 1 + 1; 7 upper labials; 3rd and 4th touching the eye; 5th and 6th touching the anterior temporal; 3 or 4 lowerlabials touching the anterior pair. The body scales are smooth in 13:13:13 parallel longitudinal rows. The ventral scales are 182 – 221; the caudal scales are 25 – 31 paired; and the anal scales are divided.

Measurement: SVL 44 – 58 cm, tail 4 – 7 cm

Colour: Its dorsal side is reddish-brown in color. Transverse vertebral spots and a black head are present. After a broad white band that extends anteriorly to the level of the eyes, a black nuchal band covers the entire region on the back. It has a creamy white belly.

Habit: It lives in hilly and forested regions and prefers the night. It consumes small lizards and snakes for food.

Global distribution: Bangladesh, China, India, Japan, Myanmar, Nepal, Taiwan, Thailand, and Vietnam are the countries where the species is found (IUCN, 2019).

Distribution of Nepal: It was found below 2200 m (Shah & Tiwari, 2004).

Population: Not known

Status: Data Deficient

37. **Species Name**: *Naja kaouthia* (Lesson, 1831)

Synonyms: *Naja kaouthia* (Lesson, 1831), *Naja tripudians var. fasciata* (Hardwicke and Gray, 1835), *Naja tripudians var. fasciata* (Boulenger, 1896), *Naja naja sputatrix* (Bourret, 1937), *Naja naja kaouthia* (Smith, 1943), *Naja kaouthia kaouthia* (Deraniyagala, 1960), *Naja naja kaouthia* (Harding and Welch, 1980).

Common Name: Monocled Cobra

Nepali Name: Goman, Tilakdom, Dumini

Location: It was located in the hilly regions of Terai and the mid hills of the mountainous districts of the research area. The vauchar specimens were observed from Rampur hospital, Paplpa, United mission hospital, Palpa, Butwal multiple campus, Butwal and Gorusinghe snakebite centre, Kapilvastu.

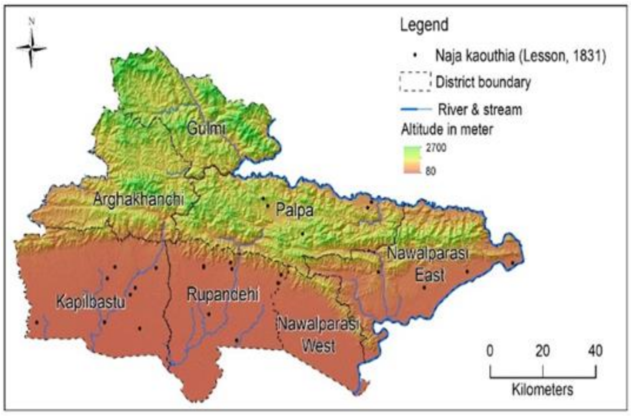


Figure 57: Point location map of the Monocled Cobra *Naja kaouthia* (Lesson, 1831) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: The scales are smooth and oval-shaped. The head has smooth, shiny scales and a slightly triangular shape. Unstretched, the hood has a thick appearance with a rounded, O-shaped, or monocellate mark on the hood. Between the anterior and posterior nasal is the nostril. The tail is shorter than the typical range and ends in a point.

Identification: Head shield is normal except loreal which is absent; preocular 1; postocular 2-3; temporal 2+3; supralabials 6-7; 3rd and 4th touches eye; Infralabials 8 and 2 cuneate scale exist on each side.They have 25 to 31 scales on the neck; 19 to 21 on the body; and 17 or 15 on the front of the vent. They have 166 to 191 ventral scales; anal undivided; and 43 – 58 subcaudal scales; usually paired.

Measurement: SVL 113 – 135 cm, tail 17 – 22 cm.

Colour: The diversity of body colors is evident. The dorsal surface is yellow, brown, gray, or blackish, with or without ragged or distinct cross bars. Behind the hood, a large black crossbar is visible on the belly. Almost all of the specimens have bands.

Habit: It is active in the daytime and preys on small fishes, frogs, toads, lizards, small snakes, birds, and rats.

Global Distribution: Major countries include Cambodia, China, India, Lao PDR, Malaysia (Peninsular Malaysia), Myanmar, Nepal, Thailand, and Vietnam (IUCN, 2019)

Distribution in Nepal: It is commonly distributed in midland of Nepal below 3200 m (Shah & Tiwari, 2004).

Status: Occasional

Status: Least concern

38. **Species Name**: *Naja naja* (Linnaeus, 1758)

Synonyms: *Coluber naja* (Linnaeus, 1758), *Naja brasiliensis* (Laurenti, 1768), *Coluber caecus* (Gmelin, 1788), *Coluber rufus* (Gmelin, 1788), *Coluber naja* (Shaw and Nodder, 1791), *Naja tripudians* (Merrem, 1820), *Naja nigra* (Gray, 1830), *Naja tripudians var. caeca* (Boulenger, 1896), *Naja naja* (Stejneger, 1907) *Naja naja* (Smith, 1943)

Common Name: Asian cobra, Binocellate cobra, Indian cobra, Spectacled cobra

Nepali name: Goman sarpa, Phetara, Supaile sarpa

Location: It was observed from lowland of midhills and abundantly found in Terai belt. The voucher specimence were examined from Rampur hospital, Paplpa, United mission hospital, Palpa, Butwal multiple campus, Butwal and Gorusinghe snakebite centre, Kapilvastu.

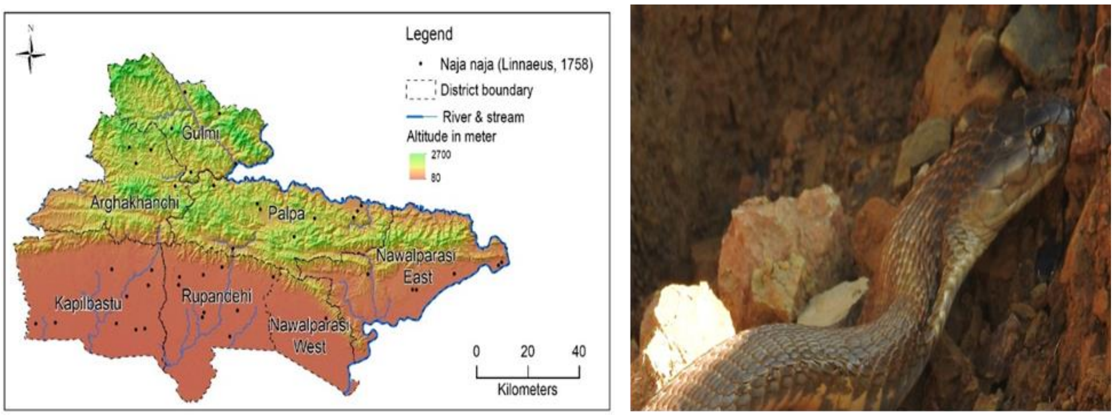


Figure 58: Point location map of the spectacled cobra *Naja naja* (Linnaeus, 1758) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnonstic characters: The head is flat and less distinct from the neck; the neck is dilatable into an expanded hood; the snout is rounded and short; nostrils are large; eyes are moderate with round pupils. Dorsal scales are oblique and have a smooth surface. On the dorsal side of the hood, there is a spectacle mark. The tail is tapering at end.

Identification: Head shields are normal except for the lorial; the absence of the lorieal.There is 1 preocular in contact with the internasals; 3 posterior oculars; 2+3 or 2+4 temporals; 7 – 9 supra-labials; the third the largest and in contact with the nasal anteriorly; and the third and fourth in contact with the eye. The anterior and posterior chin shields are nearly equal.There are 21 – 25 rows of scales on the midbody; 25 – 35 scales on the neck; and 17 – 15 scales in front of the ventral. The anal scales are solitary; the subcaudal scales are divided; and the ventral scales range from 176 – 197.

Measurement: SVL 121 – 129 cm, tail 19.5 – 24 cm.

Colour: Dark olive, jet black, and dark brown dorsum are its colours. Four to six irregular, dark, transverse stripes are draped from across ventral side of the hood. It is uniformly dark. The colours of ventrum range from butter yellow to light gray.

Habit: It is typically silent but alert, quick, nimble, and good at swimming. It may extend between one-third and half of the body when exited, with the hood expanded. **Globaldistribution**: Afghanistan, Bangladesh, Bhutan, India, Myanmar, Nepal, Pakistan, and Sri Lanka (IUCN, 2019)

Distribution in Nepal: It was found in low lands upto 1600m height (Shah & Tiwari, 2004).

Population: Decreasing

Status: Near Threatened

39. **Species Name**: *Ophiophagus hannah* (Cantor, 1836)

Synonyms:*Hamadryas Hannah* (Cantor, 1836),*Naja bungarus* (Schlegel, 1837), *Hamadryas ophiophagus* (Cantor, 1838), *Naja vittata*(Elliott, 1840),*Dendraspis bungarus* (Fitzinger, 1843), *Hamadryas elaps* (Günther, 1858),*Ophiophagus elaps* (Günther, 1864),*Naja ingens* (Van Hasselt, 1882),*Naia bungarus* (Wall, 1908),*Naja Hannah* (Taylor, 1922),*Ophiophagus Hannah* (Bogert, 1945).

Common Name: King Cobra

Nepali Name: Rajgoman, Nagraja, Kalinag

Local Name: Raj Gokra, Sangkhachur, Hala Jamuro (Chakma)

Location: It was reported from the Tamghas, Aslewa, Chorkate, Jalpa, Argheli, Dovan, Khaireni of study area.It was found specially found in Kaligandaki Corridor.

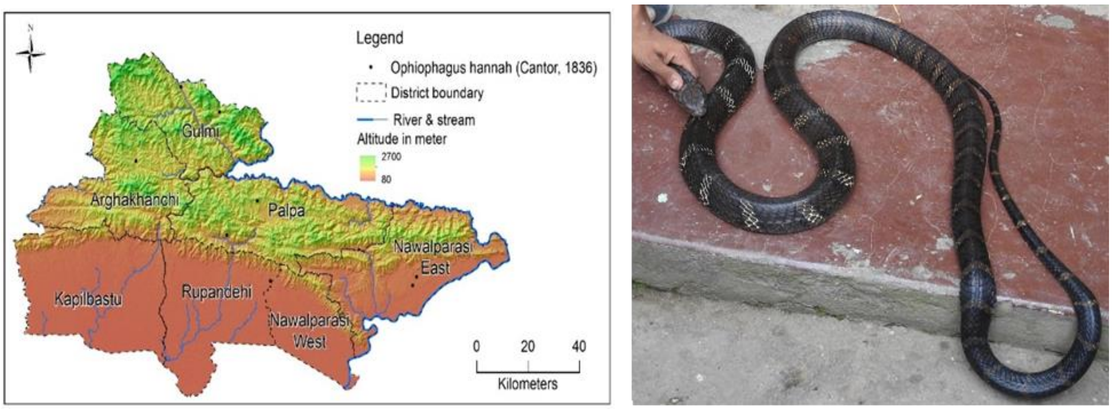


Figure 59: Point location map of the King Cobra *Ophiophagus hannah* (Cantor, 1836) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: Neck can be expanded into a hood. Head is large with rounded snout, eyes moderately large, with a round pupil. The body is incredibly long, slender, and coated in broad, smooth scales. The tip of the tail is pointed. The dorsal body has bands it last all the way to the end. The hood region's bands have an inverted V shape.

Identification: The head scalation includes a rounded snout; the nostril is located between the anterior and posterior nasal; and the loreal scale is absent. Preocular not in contact with the internasal; a pair of large occipital shields in contact with each other behind the parietals. Preoculars 1-2; postoculars 3; 2 typical large occipital shields present;temporals 2+3; supralabials 7; 3rd and 4th touches eye; 5th, 6th, and 7th touches lower anterior temporal; infralabials 8. Dorsal scales are 17/19:15:15; arranged obliquely; 3 vertebral series are comparatively larger than the others. The ventral scales are 240-254; the anal shield is single; the subcoudal is 87-94; the anterior 2-4 is undivided; and the remaining caudal scale is divided.

Measurement: SVL 312-417 cm, tail 31-33 cm.

Colour: Dorsal coloration ranges from yellow to olive-brown to entirely black, species. Along the body axis, there is a yellow or white chevron mark, which fades toward the back. The throat of the ventrum is light yellow or it is a uniform colour with dark bands.

Habit: The only snake species known to construct a type of nest for reproduction is this one. It is nocturnal and mostly eats other snakes.

Global distribution: These countries: Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, Hong Kong, India, Indonesia, Lao PDR, Malaysia, Myanmar, Nepal, Philippines, Singapore, Thailand, and Vietnam (IUCN, 2019).

Distribution in Nepal: It occurs in low lands to high altitude (Shah & Tiwari, 2004).

Population: Decreasing

Status: Vulnerable

40. **Species Name**: *Trimeresurus albolabris (*Gray, 1842)

Synonyms: *Trimesurus albolabris (*Gray, 1842), *Trimesurus albolabris* (Gray, 1849), *Lachesisgramineus albolabris* (Mell, 1922), *Trimeresurus albolabris* (Pope & Pope, 1933), *Trimeresurus albolabris* albolabris (Kramer, 1977), *Trimeresurus gramineus* albolabris (Mell, 1929), *Trimeresurus albolabrisalbolabris* (Welch, 1994), *Trimeresurus albolabris* (Manthey &Grossmann, 1997), *Cryptelytrops albolabris* (Malhotra and Thorpe, 2004), *Trimeresurus Trimeresurus albolabris* (David *et al.*, 2011)

Common Name: Bamboo pit viper, Green pit viper, White lipped viper

Nepali name: Haryousanp, Pattar

Location: It was found in all districts especially in hilly area of research area.

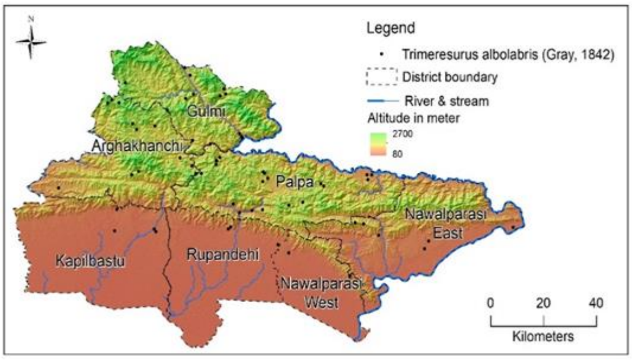


Figure 60: Point location map of the White lipped viper *Trimeresurus albolabris* (Gray, 1842) present in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic characters: It has triangular head, distinct from the neck, Eyes orange-yellow with vertical, slit-like pupil. Pit organs are presented in front of the eyes, back and sides grass-green. Tail is short prehensile and reddish-brown dorsally.

Identification: Small, subequal, feebly imbricate, and smooth characterize the upper head scales. Supraoculars have a line of 8 – 12 scales running between them and are small and entire. The internasals are 2 – 4 times larger than the adjacent scales; temporal scales are small; smooth or feebly keeled; 10-11 (12) upper labials; the first partially or completely fused to the nasal; 1 – 2 rows of scales between the labials and the elongate subocular; infralabial 10 – 12. The midbody has 21 (19): 15 (17) longitudinal dorsal scale rows; distinctly keeled. The ventral scales are 165 –183; anal, single; and subcaudals, 62 – 72, paired.

Measurement: SVL 49 – 64 cm, tail = 9 – 12 cm.

Colour: This species has a green upper body and a yellow, white, or pale green lower side of the head. Below, the belly is white, green, or yellowish. The ventral scales are a pale yellow colour without any patterns.The dorsal of its tail is a reddish-brown colour.

Habitat: It is nocturnal and arboreal. It consumes rodents, lizards, frogs, and other small animals.

Global distribution: Bangladesh, Cambodia, China, Hong Kong, Lao PDR, Macao, Malaysia, Myanmar, Taiwan, Thailand, and Vietnam are located (IUCN, 2019).

Distribution in Nepal: It is found in the forests of lowland areas and at higher altitudes of the country below 3050 m.

Population: Decreasing

Status: Least Concern

41. **Species Name**: *Ovophis monticola* (Günther, 1864)

Common Name: Mountain Pit Viper

Nepali name: Gurube sarpa, Chirbire sarpa

Synonyms: *Trimeresurus monticola* (Günther, 1864), *Trimeresurus monticola* (Anderson, 1871), *Lachesis monticola* (Venning, 1910), *Lachesis monticola* (De rooij, 1917), *Trimeresurus monticola monticola* (Mell, 1929), *Trimeresurus monticola meridionalis* (Bourret, 1935), *Trimeresurus monticola* (Smith 1943), *Ovophis monticola meridionalis* (Hoge & Romano-hoge 1981), *Ovophis monticola monticola*

(Welch,1994), *Ovophis monticola* (Mcdiarmid *et al.*, 1999), *Trimeresurus monticola* (Sharma, 2004), *Ovophis monticola monticola* (Gumprecht *et al.*, 2004), *Ovophis monticola monticola* (Zhao, 2006: 132), *Ovophis monticola* (Wallach *et al.*, 2014).

Location: It was recorded from the hilly regions of the mountainous districts of the study area.

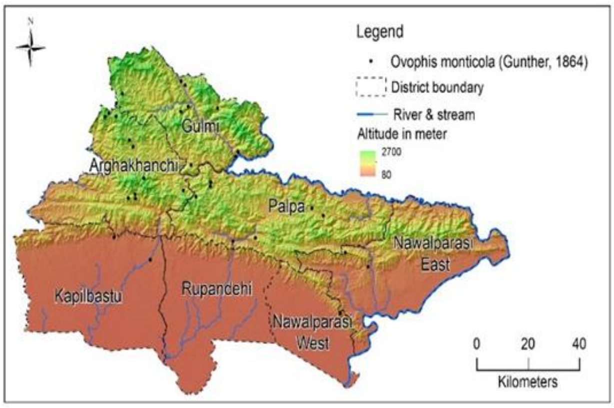


Figure 61: Point location map of the Mountain Pit Viper *Ovophis monticola* (Günther, 1864) at existences in the research area. Appropriate locations based on altitudinal range are shown on a scale bar. Dark brown-low altitude and dark green-high altitude.

Diagnostic Characters: The snout is short, and the body is massive. The triangular-shaped head is distinct from the short neck and is covered in small scales rather than substantial shields on above. Small eyes with a vertical pupil are present. The tail is half reddish and half short and tapering.

Identification: Head scales include rostral as deep as broad internasals; usually separated by one or two scales; subocular small; supraoculars large; not much longer than wide and split into small scales; 6 – 9 scales in a line between them. The first is completely separated from the nasal; the second is usually fused to the scale bordering the facial sensory pit anteriorly (rarely separated); the third supralabial is the largest; the fourth and fifth are beneath the eye but separated from the orbit by 2 – 4 series of small scales. There are 2 – 3 preocular; 2 – 3 postocular; and 8 – 10 upper labials. Infralabial are 10 – 12. The midbody has 23:25 longitudinal dorsal scale rows and is weakly keeled. Ventral scales are 107–163; anal single; subcaudals 22 – 49; divided.

Measurement: SVL 35– 57 cm, tail 8 – 11.5 cm.

Colour: A greyish brown color with dark brown patches is found on the dorsal side. Overhead, a dark brown colour can be seen. Behind the eyes, to the angle of the jaw, is a light brown streak. Venter is black and white marbled.

Habit: This species is terrestrial and nocturnal. It remains under rock in hilly cultivation areas.

Global Distribution: Main nations include Bangladesh, India, Myanmar, Nepal, Bhutan, China, Indonesia, Cambodia, Laos, West Malaysia, Thailand, Vietnam, and Hong Kong (IUCN, 2019)

Distribution in Nepal: It occurs in low land to high elevation of hilly area above 1350 m (Shah & Tiwari, 2004).

Population: Unknown

Status: Least Concern

4.1.1.5 District wise documentation of herpetofauna in study area

According to the data that has been compiled, Palpa district has more families, Gulmi district has more genera, and Arghakhanchi and Gulmi districts have more species. Rupandehi and Kapilvastu districts were smaller than the rest in number of families and species. Family ranidae had more species (9), the Bufonidae, the Microhylidae, and Rhacophoridae has two species, Megophryidae and Ichthyophidae has single species.

Districts in Palpa has higher density of reptile species (34). Few reptiles (31) were found in Gulmi district. Only *Crocodylus palustris* was detected in Arghakhanchi district during the field visit. In the mountainous regions, *Laudakia tuberculata* was observed. *Pungshura smithii* and *Lissemys punctate* were reported from the Terai districts. Geckos, skinks, and the majority of snakes were widespread in the study area. Except for the King Cobra, venomous snakes could be found in every district. There were fewer species of *Python bivittatus, Python molurus, Boiga forsteni, Oligodon erythrogaster, Trachischium tenuiceps,* and *Fowlea sanctjohannis* in this region.

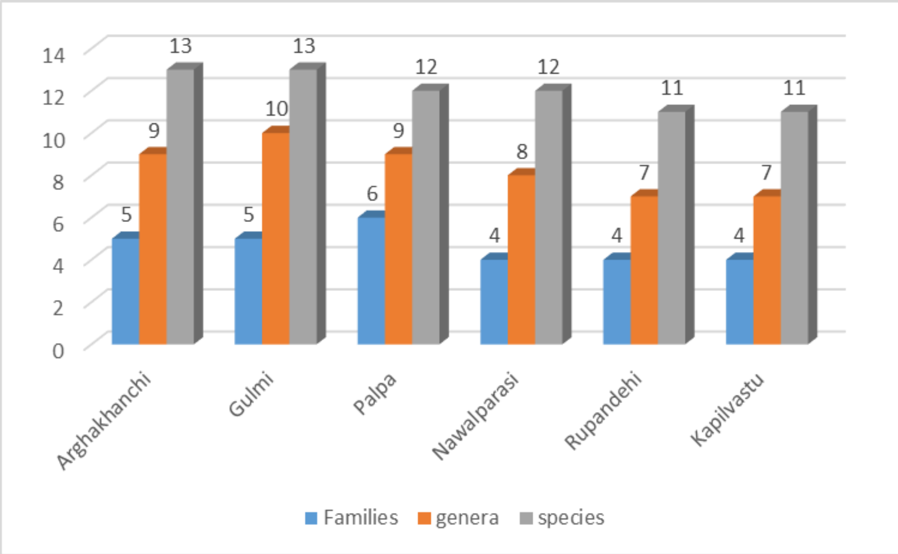


Figure 62: Families, genera and species of total amphibians in different districts of study area

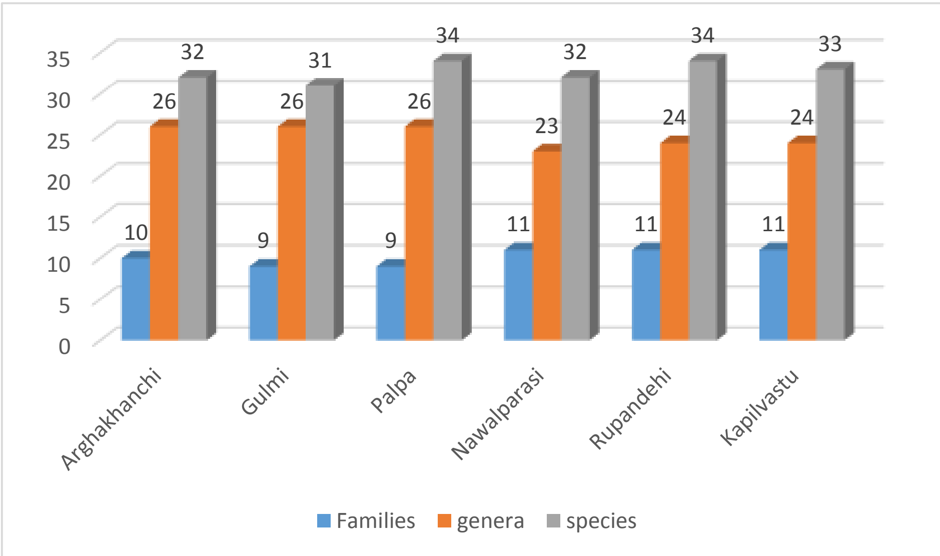


Figure 63: Families, genera and species of total reptiles in different districts of study area

4.1.2 Measurement of individual abundance, distribution and diversity in the study areas

4.1.2.1 Individual species abundance of herpetofauna

A total of 4589 amphibian individuals were recorded during the field study. Table 3 shows that the majority of amphibians were observed in Rupandehi district (943). It comprises 20.55% of the area under study's amphibian species. However, only 677 (14.75%) of all the least amphibians were found in Gulmi district. In other districts, amphibian species were found in Arghakhanchi (706, 15.39%), Palpa (707, 15.41%), Nawalparasi (830, 18.09%), and Kapilvastu (726, 15.82%). Ranidae had 3583 (78.07%) individual species than other families. The number of individuals was found in the Bufonidae with 784 (17.11%), followed by the Microhylidae with 112 (2.44%), Rhacophoridae with 79 (1.72%), Magophryidae with 26 (0.57%), and Ichthyophidae with 5 (0.11%). According to this finding, out of six families, the Ranidae family had the greatest individual population and the Ichthophidae family had the lowest. Similar to this, the number of individual species was greater in riparian regions (1526) and lower in forests (224).

On a species level, *Sphaerotheca breviceps* (3; 0.7%) was the least abundant species recorded from Arghakhanchi district whereas *Euphlyctis cyanophlyctis* (1616, 35.21 %.) was the most abundant species, and most frequent species in Rupandehi district (Table 3). Rank abundance curve showed that *E. cyanophlyctis, Minervarya* species *Hoplobatrachus* species, and *Duttaphrynus* species were at higher rank and *Nanorana*, *Sphrotheca* and *Polypedatus* species had low species rank (Appendix IV-VI).

In the study area, 2629 individual reptiles were observed. The number of species were 406, 381, 554, 452, 435, and 401 in the districts of Arghakhanchi, Gulmi, Palpa, Nawalparasi, Rupandehi, and Kapilvastu, respectively. The most reptile species were found in Palpa district, which makes up 21.07% of the total area, while the fewest were found in Gulmi district 14.49 %. Arghakhanchi, Nawalparasi, Rupandehi, and Kapilvastu obtained 15.44%, 17.19%, 16.55%, and 15.25% of the total, respectively (Table 4). Among 12 families, Colubridae represented for 34%, Elapidae 14%, Agmatidae and Scinidae 10%, Viperidae 7%, Boidae 7%, and Crocodylidae, Bataguridae, Trionychidae, Geckonidae, Typhlopidae, and Varanidae 3% of each family. The most frequent species, *Calotes versicolor* (25.33 %), was found in every site in the study area. In the Arghakhanchi district's Siddhara station, there was only one species to be found *Crocodylus palustris* (0.04 %) (Table 4). According to the rank abundance curve, the most abundance species such as *C. versicolor, Hemidactylus brookii, Hemidactylus flaviviridis, Eutrophis carinata, Coelognathus helena, Lycodon aulicus, Ptyas mucosa, Fowlea piscator,* and *Naja naja* were shown to have greater species rank. But *Crocodylus palustris, Pungshura smithii, Fowlea sanctjohannis, Sinomicrurus macclellandi,* and *Ophiophagus hannah* were the lower rank reptile species, whereas other reptile species were moderately abundant (Appendix VII-XII).

Table. 3 Abundance of amphibians in different habitats of study area

S.N.	Family	Scientific name	Agricultural field	Forest	Human habitat	Riparian	Wet land	Total	%
1	Ichthyophidae	*Ichthyophis sikkimensis* Taylor, 1960	2	0	0	3	0	5	0.11
2	Bufonidae	*Duttaphrynus melanostictus* (Schneider, 1799)	117	53	152	68	11	401	8.74
3		*Duttaphrynus stomaticus* (Lütken, 1864)	106	64	130	72	11	383	8.35
4	Megophryidae	*Megophrys parva* (Boulenger, 1893)	0	15	0	11	0	26	0.57
5	Microhylidae	*Microhyla ornata* (Duméril and Bibron, 1841)	8	0	0	8	0	16	0.35
6		*Uperodon taprobanicus* (Parker, 1934)	43	24	4	25	0	96	2.09
7	Ranidae	*Amolops monticola* (Anderson, 1871)	0	0	0	10	0	10	0.22
8		*Euphlyctis cyanophlyctis* (Schneider, 1799)	426	0	150	585	455	1616	35.21
9		*Hoplobatrachus crassus* (Jerdon, 1853)	93	0	20	130	95	338	7.37
10		*Hoplobatrachus tigerinus* (Daudin, 1802)	109	0	27	131	99	366	7.98
11		*Minervarya nepalensis* (Dubois, 1975)	183	0	54	212	138	587	12.79
12		*Minervarya teraienesis* (Dubois, 1984)	174	0	56	213	119	562	12.25
13		*Nanorana liebigii* (Günther, 1860)	0	0	0	9	0	9	0.20
14		*Sphaerotheca breviceps* (Schneider, 1799)	2	0	0	1	0	3	0.07
15		*Sphaerotheca maskeyi* (Schleich and Anders, 1998)	42	3	0	47	0	92	2.00
16	Rhacophoridae	*Polypedates leucomystax* (Gravenhorst, 1829)	3	45	2	1	0	51	1.11
17		*Polypedates maculatus* (Gray, 1830)	5	20	2	1	0	28	0.61
	Total		**1313**	**224**	**598**	**1526**	**928**	**4589**	
	%		**28.61**	**4.88**	**13.03**	**33.25**	**20.22**		

Table. 4 Abundance of reptiles in different habitats of study area

S. N.	Family	Scientific name	Agriculture	Forest	Human habitat	Riparian	Wet land	Total	%
1	Crocodylidae	*Crocodylus palustris* (Lesson, 1831)	0	0	0	0	1	1	0.04
2	Bataguridae	*Pangshura smithii* (Gray, 1863)	3	0	0	2	2	7	0.27
3	Trionychidae	*Lissemys punctata* Webb, 1980	10	0	0	9	18	37	1.41
4	Agamidae	*Calotes versicolor* Daudin, 1802	215	171	253	21	6	666	25.33
5		*Laudakia tuberculata* Hardwick & Gray. 1827	3	36	0	0	0	39	1.48
6		*Japalura tricarinata* (Blyth, 1853)	14	21	9	0	0	44	1.67
7	Gekkonidae	*Hemidactylus brookii* Gray, 1845	0	0	125	0	0	125	4.75
8		*Hemidactylus flaviviridis* Rüppell, 1840	0	0	158	0	0	158	6.01
9		*Hemidactylus frenatus* (Schlegel, 1836)	0	0	141	0	0	141	5.36
10	Scincidae	*Eutropis carinata* (Schneider, 1801)	3	16	8	0	0	27	1.03
11		*Mabuya macularia (Blyth, 1853)*	12	38	10	0	0	60	2.28
12		*Sphenomorphus maculatus* (Blyth, 1853)	10	32	11	0	0	53	2.02
13	Varanidae	*Varanus bengalensis* (Daudin, 1802)	9	27	0	0	0	36	1.37
14		*Varanus flavescens* (Harhwicke & Gray, 1827)	5	8	0	0	0	13	0.49
15	Typhlopidae	*Indotyphlops braminus* (Daudin, 1803)	26	36	15	0	0	77	2.93

16	Boidae	*Eryx conica* Schneider, 1801	3	5	2	0	0	10	0.38
17		*Python bivittatus* Kuhl, 1820	0	2	0	0	0	2	0.08
18		*Python molurus* (Linnaeus,1758)	1	7	0	0	0	8	0.30
19	Colubridae	*Amphiesma stolatum* (Linnaeus,1758)	25	2	5	30	17	79	3.00
20		*Boiga forsteni* (Duméril *et al.*.,1854)	1	3	1	0	0	5	0.19
21		Boiga stoliczkia (Günther,1868)	12	14	16	0	0	42	1.60
22		*Boiga trigonata* (Schneider, 1802)	22	18	19	0	0	59	2.24
23		*Coelognathus helena* (Daubin,1803)	19	26	13	0	0	58	2.21
24		*Coelognathus radiatus* Boie, 1827	23	19	21	1	0	64	2.43
25		*Dendrelaphis tristis* (Daubin,1803)	9	36	4	0	0	49	1.86
26		*Lycodon aulicus* (Linnaeus,1758)	19	4	10	22	9	64	2.43
27		*Oligodon russelius* (Shaw,1802)	15	2	13	0	0	30	1.14
28		*Oligodon erythrogaster* Boulenger, 1907	20	2	21	0	0	43	1.64
29		*Orthriophis hodgsonni* (Günther,1860)	7	16	6	0	0	29	1.10
30		*Ptyas mucosa* (Linnaeus,1758)	32	42	37	26	29	166	6.31
31		*Trachischium tenuiceps* (Blyth, 1854)	2	5	0	0	0	7	0.27
32		*Fowlea piscator* (Schneider, 1799)	9	0	5	45	36	95	3.61

33		*Fowlea sanctjohannis* (Boulenger, 1890)	0	0	0	10	8	18	0.68
34	Elapidae	*Bungarus caeruleus* (Schneider, 1801)	15	7	31	0	0	53	2.02
35		*Bungarus fasciatus* (Schneider,1801)	3	2	14	1	0	20	0.76
36		*Sinomicrurus macclellandi* (Reinhardt, 1844)	6	5	13	0	0	24	0.91
37		*Naja kaouthia* Lession, 1831	9	9	10	0	0	28	1.07
38		*Naja naja* (Linnaeus,1758)	15	15	32	0	0	62	2.36
39		*Ophiophagus hannah* (Cantor, 1836)	0	8	1	0	0	9	0.34
40	Viperidae	*Trimeresus albolabris* Gray, 1842	25	49	13	0	0	87	3.31
41		*Ovophis monticola* (Günther,1864)	14	19	1	0	0	34	1.29
			616	**702**	**1018**	**167**	**126**	**2629**	
			23.43096	**26.70217**	**38.72195**	**6.352225**	**4.792697**	**100**	

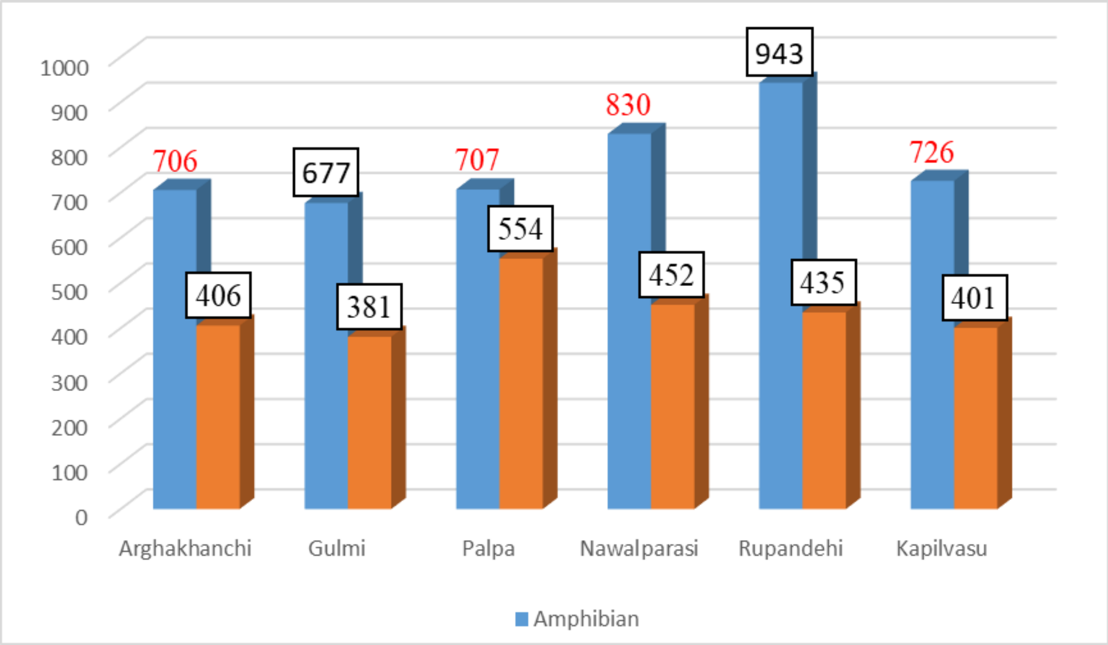


Figure 64: Abundance of herpetofauna in different districts of study area

4.1.2.2 Station wise species abundance of Herpetofauna

In Arghakhanchi, station 2 had the most individuals captured (188), followed by station 1 (153), station 4 (135), station 5 (109), station 6, (88), and station 3 had the least number of individuals taken (33). *E. cyanophlyctis* (33.99%) was the most common species exposed in all stations, while *Sphaerotheca breviceps* (0.42%) was a less common species found only in station 1. Similarly, station 1 had a higher abundance of reptile species, with 96 individuals while 47 individual species were identified at station 6. The other stations 2, 3, 4, and 5, had 70, 81, 57, and 55 individual respectively. *Calotes versicolor* was the most abundant species, accounting for 27.09% of the total and being detected at all stations. *C. palustris* was the least common species, with only one species (0.25%) found in Arghakhanchi district's Sidhhara station. *Ptyas mucosa* was the most common snake species.

Amphibian abundance is the highest in station 5, Santipur (159) and the lowest in station 6, which includes 87 individual reptile species in Gulmi district. At the other stations, there were 90 individuals captured in station 1, 105 in station 2, 107 in station 3, and 99 in station 4. *E. cyanophlyctis* (36.63%) was detected in all stations with a higher abundance than others, but *Polypedates leucomystax* (1.33%) was less abundant. For reptiles, at stations 1, 2, 3, 4, 5 and 6, the other number of individuals comprised 79, 73, 68, 56, 61, and 44 in this district. *C. versicolor* (29.13 %) was the most common individual found in this district, and *Trachischium tenuiceps* (0.26 %) was the least common. Similarly, *Ptyas mucosa* was the most common snake, representing for 8.40 % of total.

The station with the highest number of amphibians individuals recorded (149) is station 4 (Dovan), followed by station 3 (143), station1 (123), station2 (109), station5 (102), and station6 (81). Station 4 has a higher concentration of *E. cyanophlyctis* (52) than the other stations. Despite *Polypedates leucomystax* being a less dominant species, *Ichthyophis sikkimensis* was only found in station 1. Similarly the most abundant species was *C. versicolor* (21.66%), while *Trachischium tenuiceps* was the least common. *Ptyas mucosa* snakes were also the most common. The maximum number of reptile individuals (114) were recorded at station 1, while the lowest number of individuals (73) were measured at station 3. Station 2 has 104 individuals, station 6 has 74, station 4 has 91, and station 5 has 98.

At station 1 of Nawalparasi district, fewer individuals (60) were captured, while at station 2, more individuals (202) were listed. Station 3 had 189 individuals, station 4 had 187 individuals, station 5 had 58 individuals, and station 6 had 134 individuals. *Sphaerotheca maskeyei* and *P. leucomystax* (1.45%) were less common than other species in this district, whereas *E. cyanophlyctis* (32.77%) was the most common. A larger number of reptile individuals from station 3 were examined (105) while station 6 had a minor number of individuals (71) in Nawalparasi distict. The most common species in this area was *Calotes versicolor* (26.11%). The least abundant species in this district were *Python molurus, Ophiophagus hannah, Oligodon russelius,* and *Sinomicrurus macclellandi* (0.22%)

In Rupendehi district, station 3 (224) contained more number of individual species than in station 5 (196), station 1 (168), station 4 (132), station 6 (110), and station 2 (113). The most abundant species in this district was *E. cyanophlyctis* (33.72%), whereas *Polypedates maculates* (0.64%) was the least common. The most common species of reptile was *C. versicolor* (26.67 %), while the least abundant were *Pungshura smithii, Python bivittatus,* and *O. hannah* (0.23 %) in this district. Higher individuals were recorded at station 1 (94), while fewer individuals were observed at station 6 (58). Other species found in stations 2, 3, 4, and 5 were 87, 65, 73, and 69, respectively.

In Kapilvastu district, the amphibian species *E. cyanophlyctis* had the highest percentage (37.91%), while *Sphaerotheca maskeyei* had the lowest percentage (0.57%). More individuals were at station 5, with 147, followed by station 6, with 129, station 2, with 118, station 3, with 109, station 1, with 101, and station 4, with 103. Similarly, station 4 (96) had the highest number of reptile individuals in this district. Station 6 (47) had the lowest number. Station 1 had more individuals (82). This is followed by station 5 (64), station 2 (60), and station 3 (51). *C. versicolor* (22.68%) was the more abundant species in this district, whereas *Python* species and *Orthriophis hodgsonni* were the least common (0.25%).

According to this finding, *Sphaerotheca breviceps* and *P. maculates* were amphibian species that were least to be encountered. They were observed in a few of the stations while *E. cyanophlyctis* was more abundant across all stations.

4.1.2.3 Distribution of herpetofauna

The species distribution map was plotted which is placed on taxonomic description of species. The amphibians and reptiles were represented in species distribution maps.

The commonly distributed amphibians were *Duttaphrynus melanostictus*, *Duttaphrynus stomaticus*, *Microhyla ornate*, *E. cyanophlyctis*, *Hoplobatrachus crassus*, *Hoplobatrachus tigerinus*, *Sphaerotheca maskeyei*, *Minervarya nepalensis*, and *Minervarya teraienesis* in this area.They were found in all of the study area and in five different habitats at each station, indicating that they are widely distributed throughout the district.

Species such as *Uperodon taprobanicus*, *Megophrys prava*, *Amolops marmoratus* *Nanorana liebigii*, and *S. breviceps,* observed mostly in riparian areas and *P. leucomystax*, *P. maculates*, and *I. sikkimensis* were patchy in distribution. *Hoplobatrachus* spp. was found mostly in agricultural areas and wastelands. Arboreal species include *P. leucomystax* and *P. maculates.*

The majority of reptiles are found in human settlements, followed by forests, and are less common in riparian and wetland areas. The most widely distributed reptiles were *C. versicolor* and *Ptyas mucosa*, which were found in all research locations. *Eryx conica, Oligodon erythrogaster, Trachischium tenuiceps,* and *Fowlea sanctjohannis* were found at some of the locations.The gecko was the most notable species observed in the studied human habitat in which *Hemidactylus frenatus* was common.

All districts have venomous species like *Naja* species, and *Bungarus caeruleus*. *O. hanah* was the most venomous species found in the Kaligandaki corridor and landscape region.

4.1.2.4 Diversity of herpetofauna

A wide variety of environments and microhabitats, including deserts, grasslands, forests, oceans, hills, and even our own homes, are habitat to reptiles and amphibians (Nath, 2012).The relative value of the species in a community is measured by richness. The sample size has no effect on the richness index. Diversity, according to Pielou, is the simple statics of no species being confounded in evenness.

4.1.2.4.1 Species richness of herpetofauna

The species richness of amphibians were calculate both species wise and district wise and found that a total of 58 species of herpetofauna in the study area.

4.1.2.4.1.1 District wise species richness of amphibian

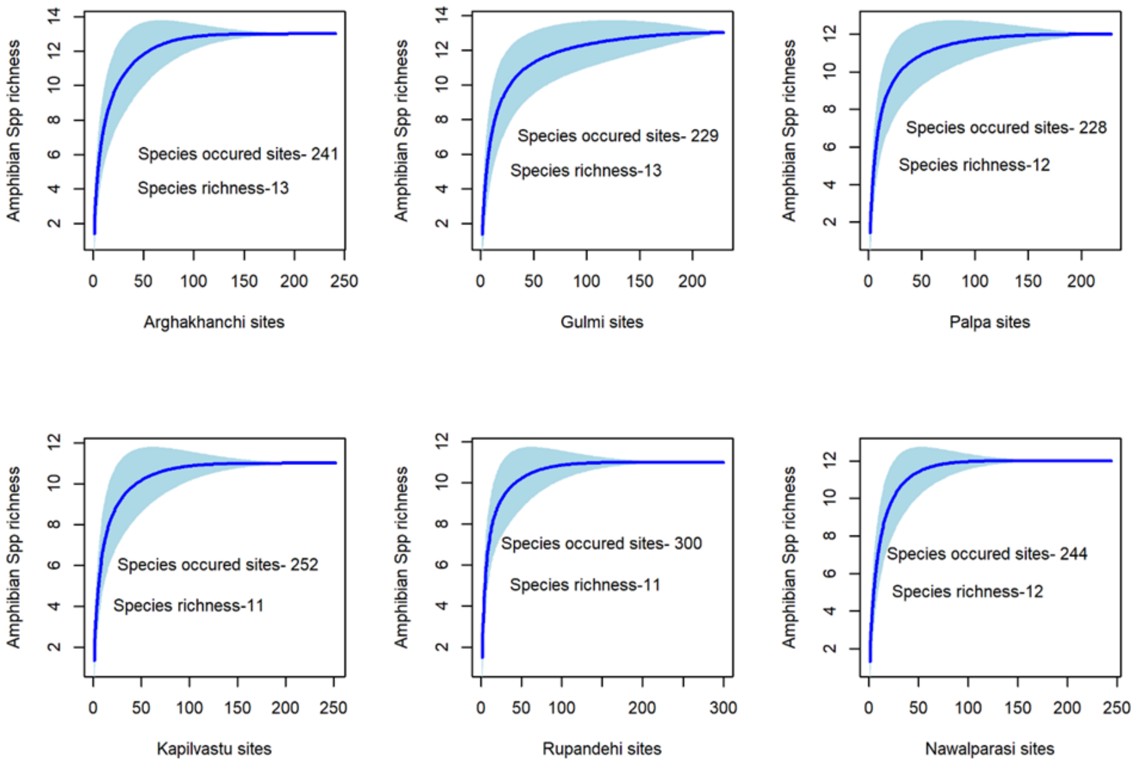


Figure 65: Species accumulation curve of Amphibians in different sites of study area

There were 13 amphibian species documented in Arghakhanchi district, with 13 species recorded at station 1, and the lowest species (S = 6) found at station 2. Gulmi district had 13 amphibian species, with 11 species at stations, 5 higher species richness, but lower species richness (S = 8) at stations 2. In Palpa district, there were 12 amphibian species, with the highest species richness (S = 10) in stations 2 and 4 and the lowest richness (S = 7) in station 6. The district of Nawalparasi had a total of 12 amphibian species richness, with station 4 having the most (S = 11) and station 1 having the lowest (S = 9). There were 11 amphibians in Rupandehi district, with stations 1 and 2 having more species richness (S = 10) than the other stations, but stations 5 and 6 had lower richness (S = 8). Eleven amphibian species were captured in Kapilvastu district, with higher species richness in stations 1 and 4 (S = 11) and lower richness in stations 6 (S = 8) (Figure 65).

4.1.2.4.1.2 District wise species richness of reptiles

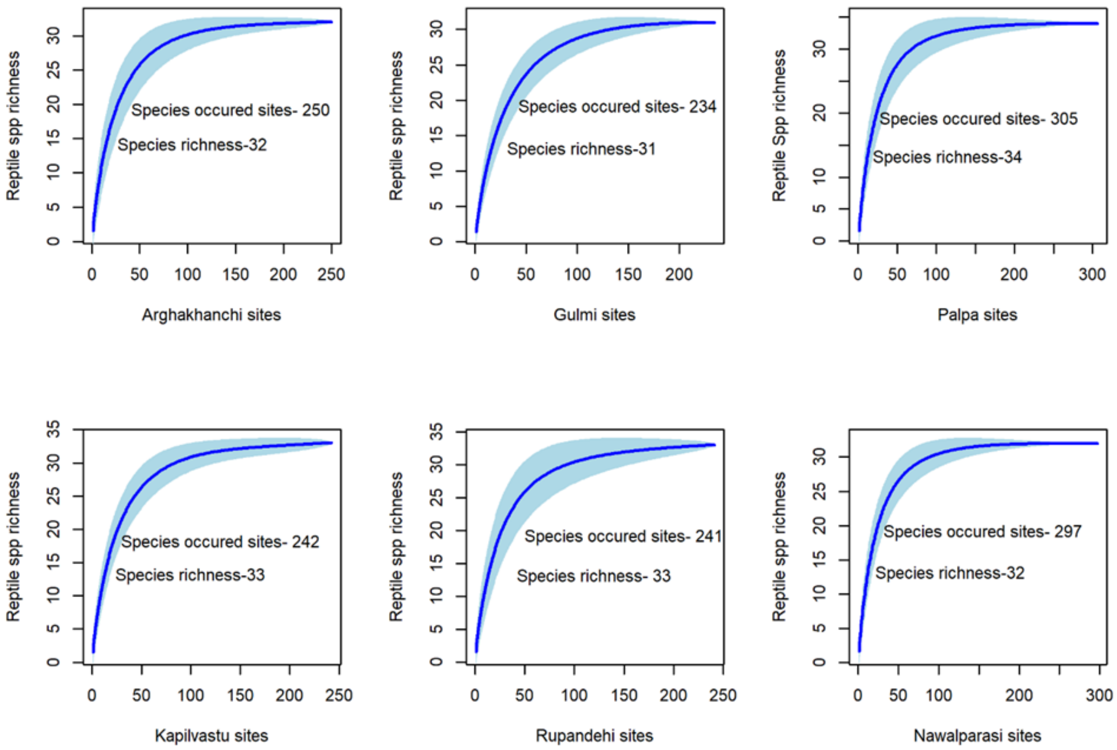


Figure 66: Species accumulation curve of Reptiles in different sites of study area

In Arghakhanchi district, 32 reptile species were observed. At station 1, 28 species were found, while at station 6 (S = 17), there were fewer. Station 3 (S = 26) in Gulmi district documented 31 reptile species, whereas station 6 (S = 19) reported fewer species. The reptile species richness was 34, while station 1 had a higher richness (S = 31) and station 6 had a lower richness (S = 23) in Palpa district. There were 32 species in Nawalparasi district, with stations 2 and 3 having the highest reptile species richness (S = 27) and station 6 having the lowest (S = 23). Similarly, there were 33 species in Rupandehi district, with station 1 having the highest species richness (S = 31) and station 5 and 6 having the lowest species richness (S = 18).The reptile species richness was 33, with higher richness in stations 4 and 4 (S = 31) and lower richness in station 5and 6 (S = 17) in Kapilvastu district (Figure 66).

4.1.2.4.2 Diversity indices of herpetofauna in study areas

Table 5: Diversity indices of amphibians in different habitats of Lumbini region

Amphibians	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Richness	14	7	11	16	7
Abundance	1313	224	598	1526	928
Shannon-Wiener Index (H')	2.02	1.72	1.80	1.94	1.47
Simpson's Index (λ)	0.83	0.80	0.81	0.79	0.70
Pielou evenness (*J*)	0.31	0.41	0.34	0.29	0.36
Equitability J	0.77	0.88	0.75	0.70	0.76

In the Lumbini region, different amphibian diversity indices were calculated habitat by habitat. According to the amphibian diversity indices, richness was higher in riparian areas and agricultural fields but was lower in wetland and forest areas (Table 4). According to Simpson's index, the amphibian diversity was the highest (0.83) in agricultural field followed by human habitat (0.81), forest (0.80), riparian (0.79), and wetland (0.70). The Simpson's index value of 0.83 of all the habitat put together indicates the rich diversity of amphibian species of the region. Shannon's index shows more species richness and evenness of the amphibian in agricultural fields (2.03), followed by riparian (1.94), human habitat (1.80), and the least species richness and evenness in forest (1.72), and wetland (1.47). Similarly, Pielou evenness of the amphibian is higher in forest (0.41) followed by wetland (0.36), human habitat (0.34), agricultural field (0.31), and riparian (0.29). The species evenness is more in riparian and less in forest. Shannon-Wiener, Simpson's, and Pielou evenness values indicated that amphibian diversity was higher in agricultural fields and lower in forests. Agricultural fields and riparian habitat were shown to be more diversified than other types of habitat.

Table 6: Diversity indices of Reptiles in different habitats of Lumbini region

Reptile	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Richness	34	35	31	10	9
Abundance	616	702	1018	167	126
Shannon-Wiener Index (H')	2.76	2.92	2.55	1.92	1.86
Simpson's Index (λ)	0.86	0.91	0.87	0.83	0.82
Pielou evenness (*J*)	0.24	0.26	0.25	0.36	0.37
Equitability J	0.78	0.84	0.74	0.83	0.85

According to various diversity indices examined, this region had a high reptile diversity. The habitats with the highest Shannon-Wiener Index (H') are forests, followed by wetlands, riparian area, agricultural lands, and human habitats. Similarly, Simpson's Index in agricultural areas was 0.86, 0.91 for forest, 0.87 for human habitat, 0.83 for riparian, and 0.82 for wetland. Pilou evenness (J) was 0.24, 0.26, 0.25, 0.36, and 0.37 in agricultural fields, forests, riparian areas, and wetlands. These indices indicated that diversity of reptiles were higher in forest and agricultural fields were lower in wetland and riparian habitats.

4.2.4.4.2.1 District wise diversity indices

To assess the variation in species richness, abundance, and diversity, three mountainous and three terrain districts were selected. Diversity indices were calculated to assess the species diversity of these districts.

In amphibians, the Simpson indexes appeared to be the same in each of these districts. Naawalparasi district had high Shannon-Wiener Index (H) (2.06) while Kapilvastu district had lower values (1.87). Pilou evenness was the highest in Nawalparasi district (0.66), then in Rupandehi (0.63), Kapilvastu (0.59), Arghakhanchi (0.58), and Gulmi district (0.56). Equitability (J) values were 0.79, 0.78, 0.81, 0.83, 0.81, and 0.78 in the districts of Arghakhanchi, Gulmi, Palpa, Nawalparasi, and Rupandehi, respectively. This result showed amphibian diversity and richness are higher in mountainous regions than in the Terai region (Table 7).

A variety of indices of reptiles, including Simpson's index, Shannon's index and evenness, were measured (Table 6). The Simpson's index was nearly the same across all districts. Palpa districts had high Shannon's indices while Gulmi districts had low indices. Similarly, the district with the highest evenness was Palpa (0.64), followed by Kapilvastu (0.62), Nawalparasi (0.58), Arghakhanchi (0.57), Gulmi (0.56), and Rupandehi (54). According to this finding, the diversity of reptiles was higher in Palpa than in the Gulmi district. All of the districts' equitability index values were over 0.79, indicating the good equitability of reptile species throughout six districts of the research area ((Table 8).

Table 7: Diversity indices of amphibian in different districts

Diversity indices	Arghakhanchi	Gulmi	Palpa	Nawalparasi	Rupandehi	Kapilvastu
Richness	13	13	12	12	11	11
Abundance	706	677	707	830	943	726
Simpson_1-D	0.82	0.81	0.82	0.83	0.82	0.79
Shannon_H	2.02	1.99	2.01	2.06	1.93	1.87
Evenness_e^H/S	0.58	0.56	0.62	0.66	0.63	0.59
Equitability_J	0.79	0.78	0.81	0.83	0.81	0.78

Table 8: Diversity indices of reptiles in different districts

Diversity indices	Arghakhanchi	Gulmi	Palpa	Nawalparasi	Rupandehi	Kapilvastu
Richness	32	31	34	32	34	33
Abundance	406	381	554	452	435	401
Simpson_1-D	0.90	0.89	0.93	0.91	0.90	0.92
Shannon_H	2.91	2.85	3.09	2.92	2.92	3.01
Evenness_e^H/S	0.57	0.56	0.64	0.58	0.54	0.62
Equitability_J	0.84	0.83	0.88	0.84	0.83	0.88

In this area, various habitats were evaluated for species richness, abundance, and diversity because the richness of species depends greatly on habitat. In Nawalparasi's human habitat, the Shannon-Wiener indices were higher in agricultural fields (2.08 and 1.99) and lower in forests (1.32 and 1.19) respectively. Simpson's Index was high in the Kapilvastu agricultural fields at 0.84 and low in the Gulmi district forest (0.61).

Pilou evenness was higher in the Gulmi forest (0.56) and in human habitat, but less so in the riparian area of Arghakhanchi (0.31). Equitability in the riparian zone and the forest of the Arghakhanchi district, respectively, were both above 0.72 to 0.99. According to this statistic, forest habitats were less diversified than agricultural fields of all habitat (Appendix XVII, XX, XXII, XXIV, and XXVI)

In the study area, reptile habitat-wise diversity indices were calculated. The Simpson index was 0.90 in Kapilvastu district's agricultural fields, 0.93 in Palpa district's forests, 0.87 in Gulmi district's human habitat, and 0.83 in Kapilvastu district's wetland, according to the results. In the Arghakhanchi district's agricultural lands, this index was low. In a similar manner, the Shannon index was highest in Palpa's forest (2.95 and 273) and lowest in Gulmi's wetland (1.04 and 0.75). The Arghakhanchi district's agricultural fields had less evenness (0.22), while the wetland in the Nawalparasi and Rupandehi districts had higher evenness (0.46). This indicated that the diversity of reptiles was higher in forests and lower in wetlands. (Appendix XIX, XXI, XXIII, XXIV, XXVIII, and XXIX).

4.1.3 Exploration of the venomous and non-venomous snakes

The majority of snakes are classified as venomous or non-venomous based on physical characters. However, these traits are simply used to support identification. The venomous snakes of Nepal include the Elapidae and Viperidae families, while the other snake families are not venomous. Some characteristics of snake morphology can be categorized as venomous or non-venomous.

There were 27 different species of snakes identified in the study sites. Among the eight venomous species were six species from the family Elapidae and two species from the family Viperidae. There were venomus species reported, including *Bungarus caeruleus, Bungarus fasciatus, Sinomicrurus macclellandi, Naja kaouthia, Naja naja, O. hannah, Trimeresus albolabris,* and *Ovophis monticola*. A total of 19 non-venomous species were identified from three families, one Typhlopidae species, three Boidae species, and fifteen Colubridae species. Three species of snakes, the *Boiga forsteni, Boiga stoliczkia,* and *Boiga trigonata*, were considered to be mildly venomous out of the 19 nonvenomous snakes (Table 9).

Elapidae species except coral snakes were found on low land, whereas viperidae was found at higher altitudes as in Chure and mountain locations. *Bungarus caeruleus* can be found throughout the district. The single species found in Terai was *Bungarus fasciatus*.

Most non-venomous species were observed in all study areas, such as *Typhlopsbraminus*, *Coelognathus radiatus*, *Lycodon aulicus*, *P. mucosa*, and *X. piscator*. *Eryx conica*, *Python molurus*, *Python bivittatus*, *Boiga forsteni*, *Trachischium tenuiceps*, and *Fowlea sanctjohannis* were the less frequent non-venomous species. Threatened species that were less common in the study area included the *python* and the *O. hannah.*

Table 9: Status of venomous and non-venomous snakes in different habitats of study sites

Family	Scientific name	Habitat					Total	%
		Agricultural field	Forest	Human habitat	Riparian	Wet land		
Typhlopidae	*Typhlops braminus*	48	59	22	0	0	129	9.02
Boidae	*Eryx conica*	8	10	2	0	0	20	1.40
	Python bivittatus	0	2	0	0	0	2	0.14
	Python molurus	1	5	0	0	0	6	0.42
Colubridae	*Amphiesma solatum*	31	2	7	41	25	106	7.41
	Boiga forsteni	1	5	1	0	0	7	0.49
	Boiga stoliczkia	14	12	16	0	0	42	2.94
	Boiga trigonata	25	18	19	0	0	62	4.34
	Coelognathus helena	20	25	9	0	0	54	3.78
	Coelognathus radiatus	17	30	27	1	1	76	5.31
	Dendrelaphis trisis	17	31	11	0	0	59	4.13
	Lycodon aulicus	30	4	17	25	10	86	6.01
	Oligodon russelius	17	2	13	0	0	32	2.24
	oligodon erythrogaster	24	2	21	0	0	47	3.29
	Orthriophis hodgsonni	9	16	6	0	0	31	2.17
	Ptyas mucosa	67	51	73	29	31	251	17.55
	Trachischium	0	5	0	8	0	13	0.91

	tenuiceps							
	Fowlea piscator	14	0	3	49	50	116	8.11
	Fowlea sanctjohannis	0	0	0	10	8	18	1.26
Elapidae	*Bungarus caeruleus*	19	7	31	0	0	57	3.99
	Bungarus fasciatus	3	2	19	0	0	24	1.68
	Hemibunarus macclellandii	8	5	18	0	0	31	2.17
	Naja kaouthia	13	14	18	1	0	46	3.22
	Naja naja	24	18	42	0	0	84	5.87
	Ophiophagus hannah	0	8	0	0	0	8	0.56
Viveridae	*Trimeresus albolabris*	43	61	13	0	0	117	8.18
	Ovophis monticola	15	19	1	0	0	35	2.45
Total		**420**	**354**	**367**	**164**	**125**	**1430**	**100**

According to Table 9, the majority of people were unfamiliar with snakes. They believed that every snake is venomous and that anyone who is bitten by one will die. They were unable to distinguish venomous snakes from nonvenomous snakes. Thus, a snake's contact or bite caused them to die. They had no idea how important snake conservation is. They were terrified because they thought every snake was venomous. As a result, they killed snakes whenever and wherever they found.

4.1.4 Habitat preference of herpetofauna

In both watery and arid habitats, there are numerous species of the vastly varied herpetofauna. Five different habitat types were sampled in the Lumbini region. Mostly, richness and abundance of species determine the habitat preference. The richness of amphibian species was higher in riparian habitat (S = 16) and in fields of agriculture (S = 14), while it was lower in wetland (S = 7) (Fig. 68). With 1526 (33%) individuals, riparian landscapes had the greatest abundance when compared to other habitat categories. 1313 (29%) of the individual species were abundant in agricultural areas, compared to 928 (20%) in wetland habitats, 598 (13%) in human habitats, and 224 (5%), respectively (Table 3).

Based on the amphibian species richness and abundance, riparian areas and agricultural fields served as the species' major habitats. Furthermore, the habitat varied according on the species. According to rank abundance curve showed that riparian habitat used most of amphibian where as forest used least (Fig. 67).

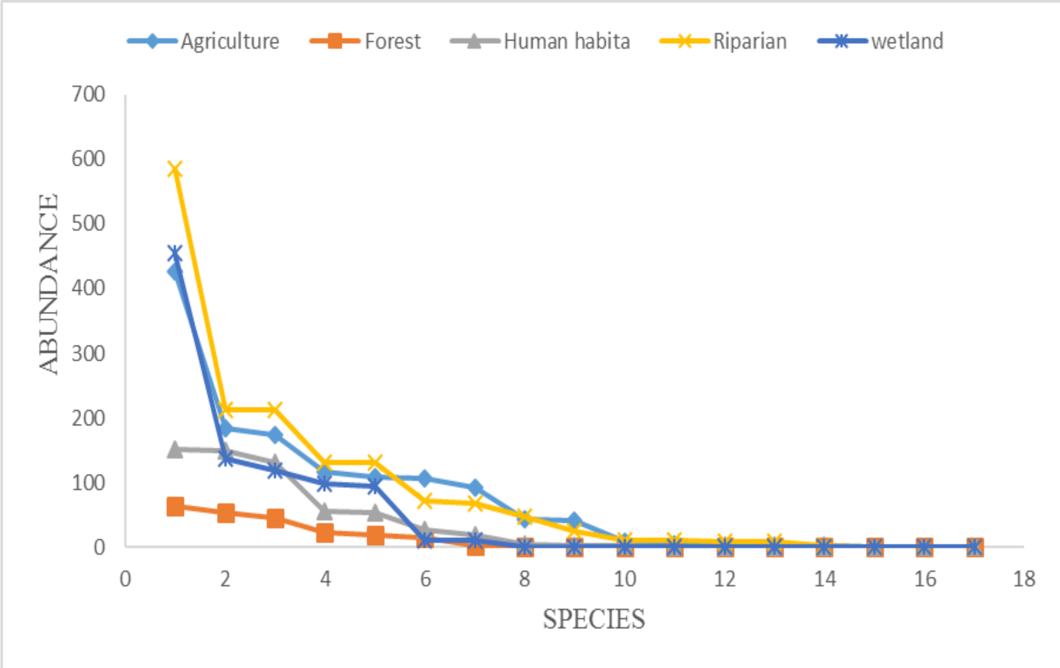


Figure 67: Species rank abundance curve of amphibians in different habitats of study area

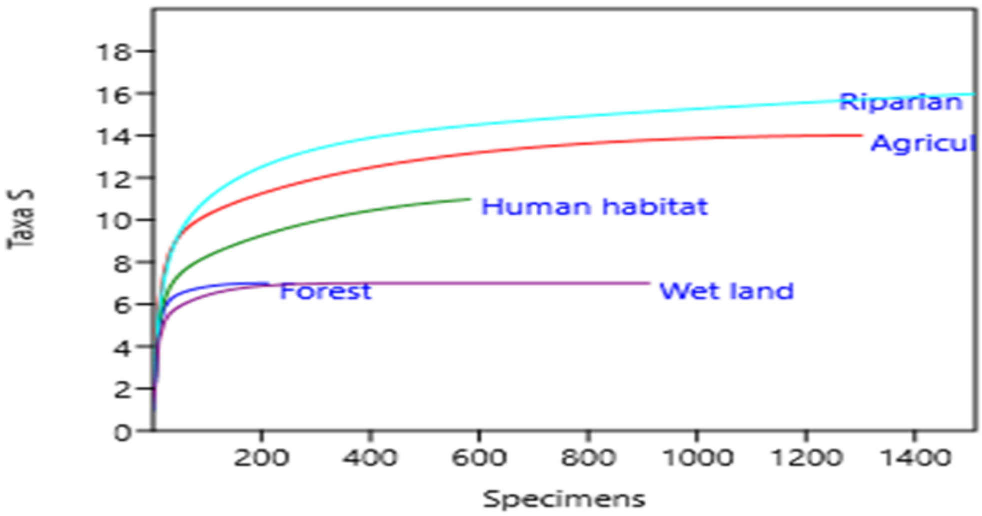


Figure 68: Richness of amphibians in different habitats of study area

The correlation between habitat and amphibian species was analyzed. P values between 0.13 and 0.38 were substantially associated. Values between 0.13 and 0.61 were noticeably linked of amphibian with different habitat. *M. nepalensis (0.15), Sphaerotheca maskeyei* (0.17), *Microhyla ornate* (0.18) favor agricultural field. *P.*

leucomystax (0.49) and *P. maculates* (059) had excellent links with the forest and a negative correlation with *E. cyanophlyctis*, *Hoplobatrachus cracus*, *H. tigerinus*, *M. nepalensis*, and *M. teraienesisin* in this habitat.

D. melanostictus and *D. stomaticus* showed a positive value (0.22 and 0.16), indicating a positive relationship with human habitats but *M. nepalensis* (-0.15) and *M. teraienesis* (-0.16) exhibited a negative relationship with human habitat. *Megophrys prava*, *Amolops*, *M. teraienesis*, *H. tigerinus*, and *Nanorana liebigii* exhibited a link to riparian (0.13, 0.23 and 0.17) environment. *E. cyanophlyctis (0.47)*, *Hoplobatrachus cracus* (0.17), *M. nepalensis* (0.16), and *M. teraienesis* (0.13) exhibited a good association, while *D. melanostictus* (-0.21) and *D. stomaticus* (-0.20) had negative relationship with wetland.

According to Appendix XXXII, there were more species of reptiles in agriculturalfields (S = 34), followed by forests (33), humans' habitats (S = 31), riparian areas (S = 10) and wetland (S = 9). Compared to other habitat types, human habitat was the most abundant. Of the individual species, 1018 (38.32%) were found in the human habitat. There were 616 (23.43%) agricultural fields, 702 (26.70%) forests, 167 (6.35%) riparian areas, and 126 (4.79%) wetland habitats (Table 4). According to the rank abundance curve and richness, reptile species prefer human habitat and forests (Fig 69).

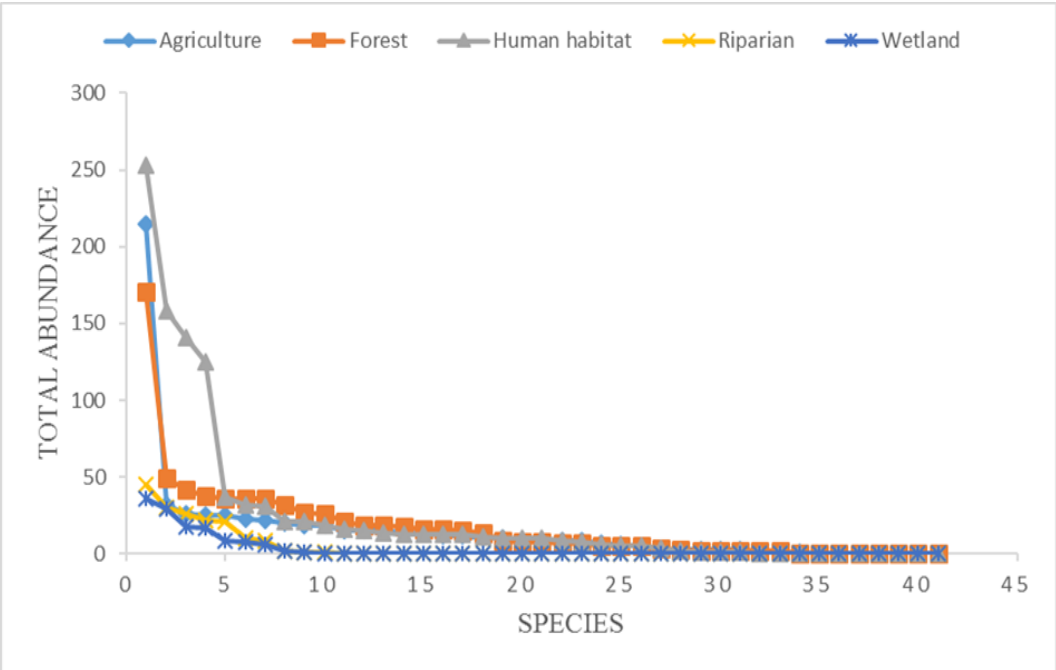


Figure 69: Species rank abundance curve of reptiles in different habitats of study area

Overall, reptiles used natural habitats more frequently. Even after the data were taxonomically categorized, the general trends remained the same (for example, lizards, geckos, and snakes). In a wetland, a single species of *Crocodylus palustris* was observed. Multiple habitats were used by many reptiles.

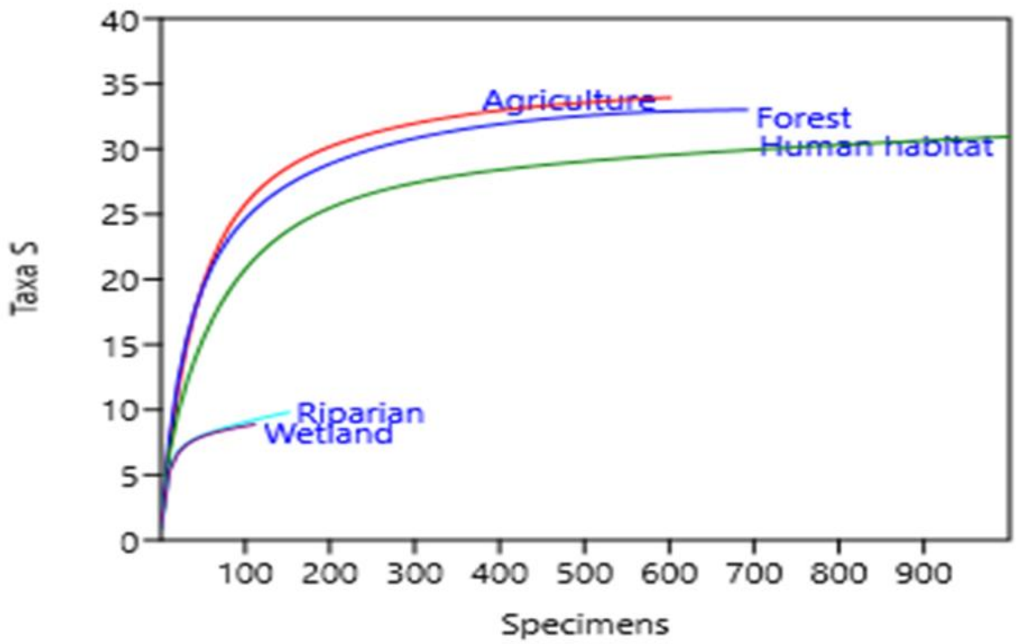


Figure 70: Richness of reptiles in different habitats of study area

In the aquatic habitat of wetlands, riparian zones, and agricultural fields, two kinds of turtle were found. The Geckonidae family was found in a human habitat, but the Agmatidae family was reported from the forest. A total of 1362 lizards were found from 5 different families. They were recorded from agricultural fields (271, 19.9%), 349 (25.62%) in forests, 715 (52.50%) in human habitat, 21 (1.54%) in riparian areas, and 6 (0.44%) in wetland habitats. The Geckonidae family was found in a human habitat during field observations, whereas *Laudakia tuberculata* was found in a rocky forest. This showed that lizard preferred human habitat and forests therefore these habitat supportes lizard species. *C. versicolor* occasanaly found in wetlands.

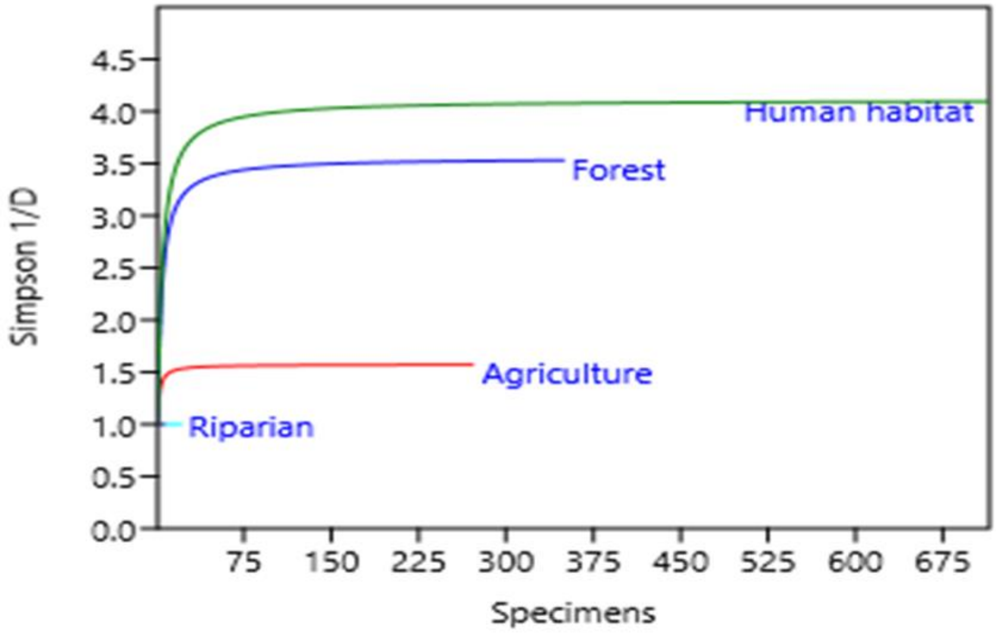


Figure 71: Diversity of Lizard in research area in different habitats of study area

In total, 1222 distinct snakes were documented in the different habitat of the study. The wetland had reported 99 (8.10%), while the forest had 353 (28.89%) snakes. The number of snake species richness was highest in forests (25) followed by agricultural fields (24), human habitat (23), riparian regions (7), and wetland habitats (5). Many snakes preferred forests to other habitats.

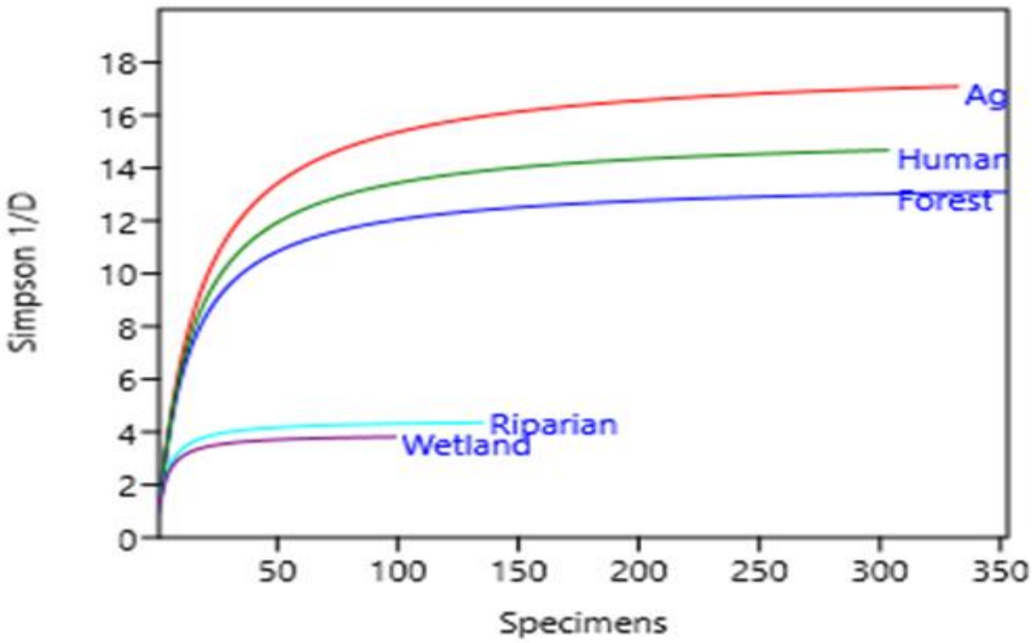


Figure 72: Diversity of snakes in different habitats of study area

The correlation between habitat and species were measured. *Varanus bengalensis* (0.2), *Eryx conica* (0.16), Boiga stoliczkia (0.15), *Bungarus fasciatus* (0.13), *Boiga trigonata* (0.17), *Coelognathus radiatus* (0.14), *Oligodon russelius* (0.17), *Oligodon erythrogaster* (0.14), *Orthriophis hodgsonni,* and *Indotyphlops braminus* (0.17), *Amphiesma stolatum* (0.23), *Sinomicrurus macclellandi* (0.19) had shown a positive correlation in agricultural field but *H. brookii* (-0.18), *Hemidactylus frenatus* (-0.18), *and X. piscator* (-0.15) had a negative association with agricultural fields. *Laudakia tuberculata* (0.2), *Oriotiaris tricarinata* (0.16), *Mabuya macularia* (0.17), *Sphenomorphos maculatus* (0.21), *Python, Coelognathus radiatus* (0.14), *Dendrelaphis trisis* (0.28), *Python molurus* (0.15), *O. hannah* (0.14), *Trimeresus albolabris* (0.24), and *Ovophis monticola* (0.25) preferred the forest but *H. brookii* (-0.19), *Hemidactylus flaviviridis* (-0.14) *Hemidactylus frenatus* (-019), *Coelognathus radiatus* (-0.15), *X. piscator* (-0.15) showed negative correlation to forest. Similarly, *C. versicolor* (0.2), *Hemidactylus flaviviridis* (0.35*), Hemidactylus frenatus* (0.49), *Bungarus caeruleus (0.18), and N. naja (0.14)* was ideal for human habitat, but *Mabuya macularia* (-0.12), *Amphiesma stolatum* (-0.17), *P. mucosa* (-0.18), *X. piscator* (-0.15), *Fowlea sanctjohannis* (-0.12), *Trimeresus albolabris* (-0.15), *and Ovophis monticola* (-0.13) were not. *Amphiesma stolatum* (0.17), *Lycodon aulicus* (0.32), *Trachischium tenuiceps* (0.14), *P. mucosa* (0.23), *X. piscator* (0.36), and *Fowlea sanctjohannis* (0.22) had a positive correlation with riparian but *C. versicolor* (-0.16) had an adverse correlation with riparian habitat. Similarly, *C. palustris* (0.21), *Pungshura smithii* (0.18), *Lissemys punctate, P. mucosa* (0.14), *X. piscator* (0.36), and *Fowlea sanctjohannis* (0.34) favored wetlands, whereas *C. versicolor* (-0.17) had a lower preference for this habitat (Appendix XXXII-XXXIII).

4.2 DISCUSSION

This study was conducted in three districts of the mountain and Terai regions of the Lumbini region in Nepal. The area ranges from low areas of 72 meters to high areas of 2512 meters and comprises various microhabitats, such as the plain Terai, Chure Hills, mid-hills to high mountains, rivers, substantial forests, and human settlement areas. Herpetofaunal richness increases under these circumstances (Shrestha, 2001; Schleich & Kästle 2002; Shah & Tiwari 2004). However, information on this fauna is limited and was done in very early days by researchers like Boulenger (1882), Smith (1981), and Leviton *et al*. (1962). Other studies conducted by different researchers in later days show unclear data on herpetofauna. For example, Shrestha (2001) documented 206 species of amphibians and reptiles, including one salamander, one caecilian, 59 species of toads and frogs, 39 species of lizards, 81 species of snakes, two species of crocodiles, and 16 species of tortoises and turtles. Shah and Tiwari (2004), on the other hand, reported 173 species of herpetofauna, including 50 amphibians and 123 reptiles. This indicates that there were no actual records of the country's herpetofauna. Therefore, this research could be a useful addition to the knowledgebase.

4.2.1 Identification and documentation of herpetofauna

The herpetofauna with morphometric measurement, colouring, locality records, geographic distribution and global distribution, habit, and IUCN category are documented in present work. The currently known fauna of herpetology from fieldwork resulted 58 species including 17 (6 families and 12 genera) amphibians and 41 (12 families and 30 genera) reptiles. This result shows amphibian and reptile comprise 33% (17/52) and reptiles 30% (41/138) of total herpetofauna of Nepal (Schleich & Rai, 2012a; 2012c) resulting a high taxonomic rank from the study area. The amphibians were collected more than reptiles. This finding is concurrent with several other studies within and beyond the country. Many regional studies show fewer amphibian compared to reptiles. Rai (2003) reported 36 species of amphibians belong to 7 families and 66 species of reptiles belong to 10 families from eastern Nepal. Pokhrel and Thakuri (2010) found 16 species of herpetofauna (7 amphibians and 9 reptiles) in the Manaslu conservation area. They observed 12 amphibian species and 39 reptile species in Parsa National Park of Nepal. Bhattrai *et al*. (2018) documented 47 species of herpetofauna in Chitwan National Park, comprising 13 amphibian species and 34 reptile species. Rawat *et al*. (2020), also collected 71 species of herpetofauna (15) amphibians species including 8 genera, 4 families and 56 species of reptiles including 37 genera in 17 families) in Shuklaphanta National Park. Ali (2007) found less amphibian than reptiles from Bangladesh (202 amphibians and 484 reptiles). Likewise, Das *et al*. (2009) work in the low to mid-elevation sections of the Barail Hill range in Assam, Northeast India reported 66 species of herpetofauna were recorded, comprising 45 reptile species and 23 amphibian species. The geographical condition of this area are similar as study area so that more similarity in species of herpetofauna. There were 73 herpetofauna reported from the Chure range of Lumbini province (Bhattarai *et al.*, 2020). Except for the Gulmi districts, some study locations included the Chure Range. Therefore, the finding was similar to the research area. Low amphibian populations individual may have been a result of the relatively dry conditions, according to Supsup *et al*. (2016).

4.2.1.1 Amphibians

In Nepal, there are three different orders of amphibians, however, two orders namely, Anura and Gymnophiona have been identified from the study area. Different families included in Anura, are Bufonidae, Megophryidae, Microhylidae, Ranidae, and Rhacophoridae and one family that is Ichthyopidae from Gymnophiona, were explored. Ranidae comprises 9 species, each Bufonidae, Microhylidae and Rhacophoridae comprise two species while Megophryidae and Ichthyopidae comprise only one species. The most frequent order was Anura which included 16 species and five families. *I. sikkimensis* was the first record from the study area. The overall taxonomy 17 species of amphibians in the Lumbini region follow recognized taxonomically. Bhattarai *et al.* (2020) reported the sixteen species of amphibians reported from the Chure range from the Lumbini province so that similar type of observation found in this region also. Most amphibian species were classified into orders, families, genera, and species in various parts of South Asia and Asia, as well as Nepal, using morphometric data.

For amphibians, majority of the sampling takes place during the early rainy season and rainy season, making them both temporary and permanent breeding ponds. Many of them go under substratum during rain. They feel uncomfort from moisture. Several amphibians have been appeared on surface after short periods of rain. Their breeding and blooming season occurred during this time. Toft (1980), Omogbai *et al*. (2002), Channing and Howell (2006), and Spawls *et al*. (2006) suggested that these species' mating season occurred during short rainfalls in shallow temporary ponds. Most amphibians migrate from wetland habitats to bogs, open ponds, and forests for breeding, feeding, and hibernation, according to Brotherton *et al*. (2004). *E. cyanophlyctis* (35.21%) was the species with the highest frequency, and *S. breviceps* (0.07%) was the species with the lowest frequency. The species of *D. melanostictus, Duttaphrynus stomaticus, E. cyanophlyctis, H. tigerinus, Minervarya nepalensis,* and

Minervarya teraiensis all have different colour patterns, strips and sizes. *D. melanostictus* was found in forests and lowlands and differed noticeably in colour, size, and dorsal spines. Forest and Teraian species was recorded in black colour and large size. Due to species adaptability, it happened. Wetland areas of *E. cyanophlyctis* exhibited a darker pattern than riparian regions. At higher altitudes, particularly at Timure Daha and Gulmi, the body size and pattern were different. E. cyanophlyctis was the most tolerable species, which was found in all conditions of water as well as in all seasons in the research area. *E. cyanophlyctis* was the most tolerable species, which was found in all conditions of water as well as in all seasons. Similarly, *M. nepalensis* had varieties in size and colour pattern so that it is said to be *M.* complex. In Sikkim, 23 species of amphibians from Teesta Valley and Maenam Wildlife Sanctuary constituted about 46% of the species (Chettri *et al*, 2011). This area has similar habitat like to study area.

4.2.1.2 Reptiles

Herpetologists described the characteristics of reptiles and provided the identification key to their proper identification. The main order of reptiles in Nepal are Crocodylia, Testudines and Squamata (Schleich, & Rai, 2012). According to the study, two families; Trionychidae and Batatguridae comprised a single genus and one species. Similarly, Agamidae with three genera and three species, Gekkonidae comprised one genus and three species, Scincidae contained three genera and three species, one genus, and two species were documented in Varanidae. Furthermore, there are two genera and three species of snakes in the Boidae family, ten genera and 15 species in the Colubridae family, four genera and six species in the Elapidae family, one genus and one species in the Typhlopidae family, and two genera and two species in the Viperidae family. In contrast, the Crocodylidae family had a one genus and one species. This shows all orders and the major family of reptiles were found throughout this small geographic area.

Over 11733 different species of reptiles have been identified, including 7,176 lizards, 3971 snakes, 356 turtles, and 27 crocodiles (Uetz, 2022). Ortega-Andrade *et al*. (2010) reported the taxonomy and distribution of reptiles and also documented the 72 species of reptiles that were recorded in Bilsa Biological Station, Ecuador. Jha and Thapa (2002) conducted scientific research and provided basic information on 78 species, 39 genera, 10 families, and four orders of reptiles found in the Sikkim Himalaya. Snakes are represented as 24 species, lizards by 17 species, and turtles by three species in a variety of habitats including tropical evergreen forest, secondary forest, mixed forest, roadside vegetation, agricultural land, and fringe village areas (Das *et al*., 2009). There are two species of crocodiles (Order Crocodylia), roughly 15 species of turtles and tortoises (Order Testudines), 40 species of lizards (Order Squamata), and about 70 species of snakes (Schleich & Rai, 2012) and 143 species (Rai *et al.*, 2022) in Nepal . In the research region, there are also 27 different species of snakes, 11 different species of lizards, two species of turtles, and one species of crocodile. No.s of gecko species were observed on their Lamillae, but I was fail to capture *Hemidactylus garnotii* was not recorded from this area. Major turtle species, *Asymblepharus* species, *Daboia russelii*, and other non-venomous snakes were all previously recorded in this region but were not found during the field survey. The IUCN Red List now includes species of turtles so locals are unable to provide information on these threatened species. The findings of this study were comparable to that published by Bhattarai et al. (2020) in regards to 57 retiles from Chure, Lumbini Province.

The topographical and climatic characteristics of South Asia were very similar. As a result, there are similarities among numerous herpetofauna in Bhutan, Bangladesh, Sri Lanka, Pakistan, India etc. So that these species are similar in morphology and taxonomy.

4.2. 2 Measurement of individual abundance, distribution and diversity in the study areas

4.2.2.1 Species abundance of herpetofauna

4.2.2.1.1 Individual Abundance of amphibians

There were 4,546 amphibian recorded during the study period, which is relatively high. These collections represent a wide range of species with a wide range of morphological, physiological, and ecological characteristics. Climate, habitat, and food supply all have an influence on the total number of species and high population levels. According to Henderson (1977), anuran activity is higher and more abundant during the rainy season. With the exception of one caecilian, every amphibian found in the research locations was anura mainly rainy seasons.

Six species of amphibians such as *E. cyanophlyctis, Minervarya nepalensis, Minervarya teraienesis D. melanostictus, H. tigerinus,* and *Microhyla ornata,* were consistently observed throughout the study. These species individual species had high in rank compared to others (Appendix XVIII-XXVI). In Nepal, frog are the most abundant, according to Schleich & Kästle (2002). Crane *et al*. (2018) in Thailand represented similar type of result. They were observed in a wide range of habitats throughout the study area, with the highest altitude range (78–1850 m). This could be because they are exceedingly adaptable and are considered as habitat generalized. It is also believed that they can tolerate pollution (Khaiwada, 2015) and ocasionally reported species like *H. crassus, Uperodon taprobanicus, Amolops marmoratus,* and *Polypedates maculatus.* (Das 2008) were also infrequently found. However, during the field visit, *I. sikkimensis* and *S. breviceps* had the lowest abundance values at the research sites. Although the frogs were found in most of the study locations, they were more common at lower elevations. It is a result of low elevations having ideal climatic conditions like precipitation, temperature, and humidity.

D. melanostictus is anthropegenic species occurring below 1800 meters in elevation. Anthropogenic activities in and around the human habitat provided the prayer foods that lured these animals. Therefore, these species might had higher abundance. However, it was most common near forest boundaries, along stream banks, and in water pools between forest and agriculture edges (Madhava *et al*., 2012). Pakistan had an abundance of these species as well (Khan, 2004). Four amphibian species (*I. sikkimensis, Uperodon taprobbanica, S. breviceps,* and *Nanorana liebigii*.) were identified as being less numerous.

A. marmortus, P. maculates and *S. breviceps* had the lowest rank abundance. *A. marmortus* and *N. liebigii,* on the other hand, was found near fast-flowing streams with dense vegetation above 1100 m, according to Shah and Tiwari (2004) and Khatiwada and Haugaasen (2015). These species had the lowest rank abundance in this analysis and was found in high altitude of sample sites. *D. melanostictus, P. leucomystax, H. tigerinus, M. ornana,* and *Minervarya* species are all adapted to specific habitats, greater abundance and are found on the Indo-Gangetic plains. They are the most abundant frogs in agricultural lands and marshy wastelands, but not in forests (Dutta & Manamendra-Arachchi, 1996; Khan, 2000; Manamendra-Arachchj & Pethiyagoda, 2006). Similar results were seen in the present study, where this species was found in significant numbers in and around water resources but not in the forests. The observed trend is most likely due to monsoonal rainfall providing amphibians with suitable breeding sites.

4.3.1.2 Abundance of Reptiles

As they look for food and basking during the rainy season, reptile activity increases. According to Msuya (2003), early rains increased the abundance and movement of reptiles since there is more food available. They were commonly seen during this study period as well. *C. versicobor* is the most abundant and widespread agamid of Nepal. It showed a diverse range of terrestrial habitats (Shah & Tiwari 2004), from untouched forest to highly disturbed agricultural lands and human dwellings. This can be seen in almost every park, garden, agricultural areas, waste land, and open forests due to the variety of food in a prominent microhabitat (Das & de Silva, 2005). It was recorded in all types of habitats so that the abundance of it was high in these sites. Lizards were observed basking under the sun throughout the winter on a sunny day. The geckos were frequently seen at dusk, when they predated the insets in the walls of houses. In the rainy season, the majority of the snakes were sighted on a field trip. During the rainy season, snakes and frogs interacted as prey and predators, resulting in a high abundance of individual snakes (Henderson, 1977). There was a lesser abundance of snakes during the dry season due to a lack of humidity, which forces snakes to hide in humid regions like burrows or trunks to reduce evaporation. Snakes are more common in agricultural fields and human habitation because there is more food and fewer natural predators. The rank abundance curve showed that lizards and snakes were the most predominant species among reptiles. Crane *et al*. (2018) showed the similar abundance. *C. versicolor*, *Ptyas mucosa* and *X. piscator* were the most predominant species. *C. palustris* was the least common reptile species found in the Arghakhanchi district of wetland habitat. *C. palustris, O. hannah*, and *Python bivittatus* have all been listed as vulnerable species by the IUCN. The Asiatic Rock Python (*Python molurus*) and Golden Monitor Lizard (*Varanus flavescens*), two of the three protected species of reptiles, were also less common species in this region

4.3.2 Distribution of herpetofauna in study area

Species detection probability varies hugely across geographical and time scales. Understanding species distributions and range limitations is crucial for both ecology and conservation biology, since it provides the foundation for developing effective conservation strategies (Brown *et al*., 1996; Guisan & Thuiller, 2005; Gaston, 2009). However, various parameters such as elevation, topography, geographical, climatic factors, and food availability are associated to amphibian and reptiles species distribution patterns, indicating that more diversity might be expected in warmer areas (Saxton *et al*., 2009; Funk *et al*., 2012). They are distributed between 80–5,490 m and include Palearctic, Oriental, Indo-Chinese, and Himalayan features, which is appropriate place for a number of herpetofauna in Nepal (Shah and Tiwari, 2004).

The distribution pattern of the herpetofauna in the Lumbini region includes species from different genera, including the Indian genera *Euphlyctis, Sphaerotheca, Calotes, Hemidactylus,* and *Bungarus*, the Indo-Malayan genera *Varanus, Amphiesma, Crocodylus, Indotyphlops, Naja, Ptyas, Python,* and *Fowlea*, the Indo-Chinese genera (*Uperodon, Microhyla, Polypedates*), and transitional species (*Boiga, Dendrelaphis, Lycodon, Oligodon,* and *Trimeresurus*) (O'Shea 1998; Schleich & Kastle 2002). The fauna of this area reveals a significant degree of association with the fauna of South Asia. This implies that this region and Southeast Asia exhibit the greatest biological affinities. The herpetofauna of Nepal is hence combination of Indo-Malayan, Indo-Chinese, and transitional species (Das, 2010). Along altitudinal gradients, Gautam *et al*. (2018) represented herpetofaunal distribution and influential factors (particularly habitat). Similarly Nanhoe and Ouboter (1987) explored the zoogeography and altitudinal distribution of herpetofauna in Annapurna-Dhaulagiri region of Nepal. BCDP (1994) also reported the herpetofaunal distribution on the Annapurna conservation area.

The distribution pattern of herpetofauna was plotted on the basis of its occurrence in those areas demonstrates the general distribution of each species. Bhuju *et al*. (2007) and Bhattarai *et al.* (2020) classified species distribution based on confinement and richness, suggesting that the middle Terai Siwalik region has the most herpetofauna. In this region also there was similar observation. The biologically and climatologically representative Terai, Siwalik, and mid-hill to mountainous terrain in the study sites resulted in similar findings.

4.3.2.1 Distribution of Amphibians

Since the study area included lowland, midland, and highland areas, a wide variety of amphibian species can be encountered there. During the rainy season, the majority of frog juveniles were found near their breeding ponds. It's most probably because they come from their natal ponds or because they have better protection from their adversaries. *D. melanostictus* and *D. stomaticus*, members of the Bufonidae family, had previously been recognized as well-adapted species, reported from all stations and especially in disturbed locations (Belabut *et al*., 2010*). D. melanostictus, D. stomaticus, E. cyanophlyctis, Hoplobatrachus, Minervarya* species, and *M. ornata* species were all located in the research area. From Bangladesh to the Ganges Plain, peninsular India, Balochistan, Afghanistan, and Iran, they are widespread species in Southeast Asian nations (Khan, 2000). These species can survive in a variety of habitats and areas with numerous streams thanks to their adaptability. Daniel (2002), illustrated a similar distribution. Most of them were reported from locations at low altitudes. *E. cynophlyctis*, however, was also seen at high altitudes at the study sites. The distribution of amphibian species over an altitudinal gradient was described by Swan and Leviton in 1962 and Khatiwada (2011). High- and middle-elevation species included *S. maskeyi, S. brevicep, N. liebigii, A. marmortus*, and *Meophrys parva* (Sparrows *et al*., 2006; Khatiwada, 2011; Schleich & Rai, 2012a). Similar to that, several species were found in research locations with mountainous topography. In Nepal, these species appeared to have a similar relationship, according to Shah and Tiwari (2004). While *P. maculates* is only found in low heights, *P. leucomystax* can be found in both mountainous and low elevations. Similar type of observation reported by Iangrai (2008). The single species observed at Sandhikharka station was *S. brevicep*.

4.3.2.2 Distribution of Reptiles

Crocodile, turtles, lizards and snakes were well distributed in research area. Reptiles have limited movement for basking and hunting ground prey and need specialised habitats (Branch, 2005). *C. palustris* (Crocodylidae) was also seen in different stations of Nawalparasi district near the bank of the Narayeni River. But a single species was recorded in a small pond and temporary hill stream at Siddhara station. It was passive and mostly lived inside the depths of the pond. It is a new distribution record for this research area, and how can it survive in this small pond? This species' appearance in the small pond reveals that it has most probably occurred there for a long time and possibly migrated there from the Rapti River, where it is known to occur. There were four individuals, but only one-possibly a male-lived alone, according to locals. Khadka *et al*. (2008), reported the distribution of (*Gavialis gangeticus*). Distribution of this species was recorded by Venkataraman *et al*. (2013) in low land. Bataguridae and Trionychidae, were located in these study locations. The turtles found in the Terai region were *Pungshura smithii* and *Lissemys punctate*. The similar kind of distribution of turtle was presented by Kharel and Thapa Chhetry (2013), Aryal *et al.* (2010), Rai (2003), and Schleich and Kästle (2002) from Nepal. There were 16 species of tortole found in Terai region but only two species were recorded. Local people captured different species illigly so they could not share the information. A widely spread species with in Indian subregion is fresh water turtle, *Lissemys puncta*, which can be located from Pakistan's Indus basin to northeast India, Nepal, and Bangladesh to extreme western Myanmar (Rhodin *et al*., 2014).

According to recent studies, mid-elevation herpetofaunal groups are the most diversified and broadly spread (Naniwadekar & Vasudevan 2007; Chhetri *et al*., 2010; Khatiwada & Haugaasen, 2015). The Agamidae that is the most common garden lizard, *C. versicolor*, was a widely dispersed species of reptile. This species was widely widespread throughout Nepal, according to Shah and Tiwari (2004), Schleich and Catstle (2002), and Nanhoe and Ouboter (1987). It was recorded from a height of 2512 m at Resunga Gulmi. Nanhoe and Ouboter (1987), Shah (2001), Shah and Tiwari (2004), Pokhrel and Thakuri (2010), all reported on the altitudinal distribution of *Laudakia tuberculata*. This species is rock dweller species. In the research area, this species was also a high-altitudinal species, documented at 2512 m.

In the region of human settlement, three species of geckos were found. They are nocturnal species and prey the insects around electric bulbs. They were found in the houses, on the ground and feed insects (Murthy, 1990). *Hemidactylus frenatus* was the most predominant in the lowlands. Three species of the Scincidae family were found in forests of this region. They were evenly dispersed across this Lumbini area because of either decent forest or stony boulders.

Varanus bengalensis and *Varanus flavescens* are two species reported from study area. *V. flavescens* was a protected species reported from Jagadishpur Reservoir in Kapilvastu District by Baral and Thapa (2008), in Chitwan District by Khatiwada and Ghimire (2009), and in Kanchanpur by Ghimire and Shah (2014). This species was found throughout Nepal's lowlands, according to Shah and Tiwari (2004).

Snakes can be found from under 100 metres in the Terai to the Himalayan zone, however the Terai and Siwalik region have a greater diversity, according to Shah, Kharel, and Thapa (2011). In the Terai and Siwalik regions, snakes live in warmer, lower-elevation places that provide favorable climatic conditions. As a result, there was a wider dispersion of snakes in the research region. Throughout the course of the investigation, the following species were widespread in the study area: *Amphiesma stolatum, Coelognathus radiates, Lycodon aulicus, P. mucosa, X. piscator, Bungarus caeruleus, Naja naja,* and *Trimeresus albolabris*. Less commonly observed snakes were the *python* species, *Trachischium tenuiceps*, *Fowlea sanctjohannis*, and *O. hannah* in this area. With the exception of Arghakhanchi, the distribution of *Python* species has been reported in all of the study area's districts. There have been reports of *P. bivittatus* in Chitwan National Park in Nepal (Bhattarai *et al*., 2017). At research locations, *O. hannah*, a protected species, is widely distributed. Some researcher such as Thapa, Rana, and Shah (2019), Pandey (2012), Rai (2003), Schleich and Kästle (2002), Shretha (2001), Das (1994), Kramer (1977), and Fleming and Fleming (1974) reported on the distribution of this species in various parts of Nepal. With the exception of uncommon species, all of the local snake fauna is more or less evenly dispersed. The minor change in snake distribution between urban, rural, and forest areas may be a sign that alterations to the original habitat structure have not affected the habitat for the species (Rojas-Morales, 2012). Nanhoe and Ouboter (1987) found Himalayen trinket snake up to 2740 m. Similar type of distribution occurs in this study.

4.2.3 Diversity of herpetofauna in the study areas

4.2.3.1 Richness of herpetofauna

Herpetofaunal species richness were significantly influenced by the temperature, range from water and different habitat. Because the characteristics of this transition zone, as well as the availability of more predatory species, the moist forest edge has a negative impact on species richness of herpetofauna. The habitat provided the availability of food, a good environment for settlement and protection from their predators. According to James and M'Closkey (2003) and Hinde *et al*. (2001), habitat structure can be a key factor of terrestrial herpetofauna. The Terai and surrounding mountain ranges were the site of the current study, where sampling was conducted in wetlands, riparian zones, agricultural fields, forests, and human habitat. The region's geographical location, altitudinal variety, and changing climatic conditions are all factors that contribute richness and diversity. As a result, the herpetofaunal diversity in this area is quite significant.

According to Schleich and Rai (2012), Nepal is inhabited to about 190 herpetofaunal species. The study area had 58 species, which represents for 30.5% of a total national herpetofauna. The Chure Range contained 99 species of herpetofauna, which represents for 55.3% of the herpetofauna reported in Nepal (Bhattarai *et al*., 2020). The Central Terai-Siwalik region has the highest percentage (45%) of herpetofauna, according to Bhuju *et al*. (2007).

4.2.3.1.1 Richness of amphibians

The research region contained 17 different amphibian species, which represents about 33% of all amphibian species in Nepal. Mountainous districts were richer than terrain districts, although there was no statistically significant difference. Higher amphibian species richness was promoted by the availability of a variety of microhabitats, including open regions, marshes, ephemeral pools, ponds, and tiny perennial and seasonal streams. Amphibian richness was highest in the riparian zone (16) and lowest in the wetland and forest (7). The riparian area provided habitat for aquatic and semi-aquatic species. It attracted more amphibians, which made it appear to have a high diversity index. Due to the amphibian mating season, (the pre-monsoon and monsoon seasons) are also thought to have a high species richness. Channing and Howell (2006) and Spawls *et al*. (2006) stated that these species spawn in shallow temporary ponds after short rains. Santos and Conte (2014) also reported that wider range of site types in puddles, lakes, and streams produced a higher number of species. The species richness pattern was considerably affected by the altitudinal component. In locations with a high human habitation, the richness of these taxa was minimal. In dry zone forests and unforgiving environments, amphibians are less common (Abayarathna, 2009). *D. melanostictus,* and *D. stomaticus* were rich in human habitat. Because of the anthropogenic disturbance cause significant effect on the richness of amphibian species. With rising elevation, there was a decline in the species richness (Khatiwada, 2017). Due to more favorable environmental circumstances for amphibian species, there are more species richness at lower altitudes. Most amphibians migrate from wetland environments to bogs, open ponds, road sides, grassland, and forests for breeding, feeding, and hibernation, according to Brotherton *et al*. (2004). The lack of water ponds most play an integral role for food supply, feeding, and nesting places, resulting in a low species richness for most amphibians which rely on water (Msindai, 2014). Farmers using tractors while cultivating agricultural items during the pre-monsoon and monsoon seasons killed many frogs. It showed that the vast number of amphibians might be reduced by modern technologies in study area.

4.2.3.1.2 Richness of reptiles

There were 27 snakes, 11 lizards, 2 turtles, and 1 crocodile were recorded. There is no any significant difference in reptile species richness in this sites. Forests, agricultural fields, and human habitats were all occupied to a greater extent in Palpa. The climate varies from tropical to temperate. As a result, Palpa is one of the richer district in terms of reptile species (34) composition when compared to other districts in the region. The Gulmi, however, is located in the north and has a high altitude, therefore the richness (31) may be reduced. It was observed that the high elevation has the fewest species richness of reptiles. (Toledo-Bruno *et al*., 2017). Basking, temperature, humidiy and other climatics parameters were low in high elevation alter the species richness in higher altitudinal range.

The majority of reptiles have been found in a variety of habitats. Habitat wise richness of reptiles suggests that agricultural fields (34) and forests (33) have higher reptile richness than wetlands (9), which have lower richness. Many reptile species are reliant on forests (Abayarathna, 2009). Similar observation were found in this study. These habitats are home to a wide range of animal species as well as a large number of little insects. This may provide the availability of food so that result become significant. The minimum species richness of these stations was related to the lack of suitable microhabitats, such as ponds, wetland, and a few paddy fields, composed of rock ridges, altitude, sloppy areas, Chure range, high temperature, and little moisture. Because of the flood, low forest coverage and agricultural fields, the species richness at these stations were decreased. Malonza *et al*. (2011) also noted the effect of flooding on species richness. Reptiles were rich in monsoon period in this area. Since the most reptiles breed during the monsoon, the rainy season is when they are the most frequent and the winter is when they are minimal in richness (Joshi & Tantarpale, 2016).

4.2.3.2 Measurement of diversity indices of herpetofauna

Measurements of species diversity in areas are critical in determining a region's natural richness, ecological value, and rarity. In studies of environmental factors that affect animal community dynamics, species diversity indices have been commonly applied (Werner & Glennemeier, 1999). Shannon (1948) and Simpson (1949) are two of the most common used diversity indices in ecology (Gorelick, 2006). Diverseness, on the other hand, can't be quantified by a single metric (Hayek & Buzas, 1997; Purvis & Hector, 2000). As a result, ecological studies have emphasized different sampling matrices (Patil & Taillie, 1982). The number of species, evenness, and more complex variations that account for taxonomic, phylogenetic, and/or functional differences across species can all be quantified using different diversity indices (Meynard *et al.*, 2011). Das and Dijk (2013) studied the diversity of herpetofauna in Southern and Southeast Asia, indicating that the altitudinal gradient in species diversity of herpetofauna below 3,000 m.

Diversity indices were calculated in different habitat for this study. A number of simple indices have been derived using some combination of S (total number of species) and N (total number of individuals). The number of species and individuals are fundamentally bonded to each other (Morris *et al*., 2014).

Predation, breeding locations, thermal maintenance, and other environmental factors all contribute to the species' richness. Many rivers, rice fields, dense human settlements, climatic zones ranging from tropical to temperate, and other habitat features all contribute to the higher amphibian richness in this region. Amphibian richness was higher in riparian areas than in wetland, according to these indices.

According to Garcia *et al*. (2015) showed that the Simpson Index (1-D) is the best for determining which regions have more diverse ecosystems than others. The Simpson's Index of agricultural fields (0.83) was greater than that of other ecosystems and wetland (0.70). This result showed that agricultural fields and riparian habitat were more diversified than other types of habitat. Increased richness is mostly determined by seasonal events, breeding behaviour, and food availability. Forest diversity was low resulting in a smaller number of species and ecological degradation caused by anthropogenic pressures and other biotic factors (Ravera, 2001).

The Shannon index (H') in agricultural fields were higher than that of other habitats. However, the calculated diversity values in this present study which ranged from 1.47 to 2.02 are found to be low when compared to the Shannon-Weiner diversity scale developed by Fernando (1998) i.e. 2.00 to 2.49. A higher diversity of amphibians are attracted to agricultural fields as they provide an aquatic habitat for reproduction and transformation for aquatic and semi-aquatic species.

Pielou evenness and Shannon-Weiner diversity had a similar effect on diversity as the simpler metric of species richness (Johnston & Roberts, 2009). In this study, Pilou evenness (J) was no more significantly different between in riparian, agricultural field, and in wetlands. It was 0.31 in agricultural field, 0.41 in forests, 0.34 in human habitat, 0.29 in riparian, and 0.36 in wetlands. According to Shah and Pandit (2013), when the Simpson diversity index rises in value, the evenness index rises in the opposite manner. This current research shows that there is an inverse association between Simson diversity index and evenness. As a result, they appear to be in antagonism to one another.

For reptiles, the Simpson index varies between 0.82 in wet lands to 0.91 in forests. In communities that are established and stable, this index varies from 0.6 to 0.9. (Whittaker, 1965; Nagendra, 2002; Dash, 2003). Because of this, it could be seen that it was higher in forests and lower in wetlands.

Forests and agricultural fields had Shannon indices (H') of 2.92 and 2.76, respectively, greater than wetland habitats (1.82) reported. However, the calculated diversity values in this study, which ranged from 1.82 to 2.92 when compared to the Shannon-Weiner diversity scale created by Fernando (1998), showed that human habitat, agricultural fields, and forests had medium diversity while riparian and wetland environment had low diversity. A greater variety of reptiles were drawn to forests and agricultural areas because they provided an environment that was conducive to adaptation. In their study of the Keystone reservoir in the United States, Ransom and Dorris (1972) made a similar observation. A comparable finding was made in Hossain *et al*. (2013) and Khan *et al*. (2007). Shannon-Weiner and Simpson diversities, according to Shah and Pandit (2013), rise as richness increases for a given pattern of evenness and increase when evenness increases for a given richness.

In the current study, Pilou evenness (J) was 0.24 in agricultural fields and 0.26 in forests, but 0.36 in riparian areas and 0.37 in wet land. It showed that evenness was lower in forests but higher in wet lands. These metrics demonstrated that forests have greater diversity than wetland regions. The diversity and distribution of species are influenced by temperature, humidity, altitude, closeness to water, or habitat type (Santori & McManus, 2014). A low evenness means a high dominance in the use (or presence) of a few species (Begossi, 1996). It might be caused by the interaction of various factors, like the elevation and the surroundings (2,400 m).

Comparison of relative abundance and equitability index (J) of individuals among the species showed that species diversity of agricultural field and riparian habitats were more abundant and numerically more equal than other areas.

4.2.3.2.1 District wise diversity indices

The district-based diversity indices were estimated. It was observed that Arghakhanchi and Gulmi had a higher taxon richness of amphibians while Rupandeni and Kapilvastu had a lesser taxon richness. Although there were more species altogether in the Arghakhanchi and Gulmi districts, the Rupandehi districts had more individuals total. Morris *et al*. (2014) revealed that many species and individuals share a crucial link with one another.

These characteristics reflected the greater diversity of this area. Pielou evenness was higher in Palpa (0.66) and lower in Gulmi (0.56) (Table 7). As a result, amphibians were regarded with evenly distribution in Gulmi and neighbouring districts. The majority of the sampling was done during the rainy season because it supplied ideal reproductive conditions, adequate food supply, and favourable environmental conditions for adaption.

Palpa and Rupandehi (34) have more species of reptiles than Gulmi, which has less (31). The high Simpson index, above 0.90, indicated that the region's reptile species was highly diverse. The Shannon (H) indices also fell between 2.76 to 3.09, indicating moderate to high diversity (Fernandez, 1998). Rupandehi and Palpa had low and high Pielou evenness, respectively. Geographically, Gulmi district is mountainous slopy area and low climatic parameters that reduce the species where as Rupandehi district is large and low elevation area harvour more species. According to Begossi (2006) when evenness is low, it is a result of a small number of dominant species.

4.2.4 Exploration of the venomous and non-venomous snakes.

Twenty seven snakes were identified in study locations. Among them, eight of them are venomous species: two Kraits, three cobras, one coral, and two pit vipers and 16 species were non-venomous species. Three semi-venomous species, including the 3 *Boiga* species. One species of each coral snake, six species of Karait, three species of Cobra, including the King Cobra, seven species of green pit vipers, viper, and one species of Colubridae are among the venomous snakes in Nepal, according to Sharma *et al.* (2013). Similar result were found by Midathala (2014) and Jadhav, *et al*. (2018) in the snake examined from lowland Terai habitats to intermediate elevations in the Siwalik Hills and into the Mahabharat Range. These species can be seen because the study location is within this elevation range.

According to the findings, 34% of snake species were venomous. According to Shah and Gautam (2010) and Shakya and Thapa (1994), 10% of the snakes in Nepal are poisonous but Sharma (1999) argued that 12.5% snakes were venomous. According to Sharma *et al.* (2013), there were about 18 (20.22%) venomous snakes in Nepal, 10 (32.56%) in the Chure range of Lumbini province (Bhattarai *et al.*, 2020), and 8 (29.63%) in the research area. This indicated that venomous snakes were widely spread. The diversity of venomous snakes was significant in this region because it included low land in the Terai and Chure and high mountains. The non-venomous group of snakes in Nepal are represent in three families; Typhlopidae, Boidae, and Colubridae. Elapidae and Viperidae (Shah, 2003) represent the venomous group. In this location, non-venomous species were minimum recorded. Especially, the snakes could not encounter within qadrats, but can encounter in Visual encounter and Oppertunistic survey that limit the species.

On research sites, people seem to believe that all snakes are hazardous and venomous, and they are unaware of the significance of snakes, which can kill whenever they are seen. Due to habitat degradation, killing, unfavourable environmental conditions, illegal collection, misinformation, and lack of conservation awareness, the population of snakes is declining. The *Python* species, *Oligodon erythrogaster*, *Trachischium tenuiceps,* and *O. hannah* were found during this study. The conservation of these snake species is crucial. Just a small number are included in the rare category that is globally threatened according to the International Union for Conservation of Nature (IUCN) classification. Therefore, methods to protect these unique and threatened snakes are urgently needed (Jadhav *et al.*, 2018).

4.2.5 Habitat preference of herpetofauna

Characterizing the herpetofaunal assemblage of a particular habitat is challenging. However, some habitats have distinct boundaries due to major changes in soil moisture and fertility, fire, and climatic conditions, which makes it simpler to recognize herpetofaunal accumulations. Numerous studies have revealed that the habitat types in which herpetofauna species live are the primary factor of their survival (Gibbons, 2000; Lewis, 2009). These habitat types have a wide range of distinct microhabitat traits. Use of microhabitats may affect survival because they provide better or higher quality food or greater predator protection (Martin & Lopez, 1998) and thus microhabitat use may influence survival (Civantos, 2000).

Herpetofauna species richness and abundance were not affected by habitat type or humidity, but temperature and distance from water may be more influential than habitat type. The habitat type cover different variances in biotic factors (Ortiz-Yusty *et al*. 2013). According to Do *et al*. (2022), numerous earlier research on the herpetofauna suggested that forests and agricultural land were the herpetofauna's primary habitats. Therefore, paddy wetlands for amphibians and forest for reptiles were the most significant habitats.

At the study locations, five different types of habitat were used for sampling. The principal habitats of amphibians were around and in water sources. They need water sources for complete their life cycle. They are not dependent on a single type of environment because many of them utilised more than two different habitats. The microhabitat of agricultural fields, such as paddy fields and other terrestrial croplands, as well as cultivated areas for vegetables and grains, is included by agricultural fields. This research found 14 species and 1313 amphibian individuals (28.612%) in a field of crops. Paddy fields make up the majority of the region's agricultural areas. The majority of the population are farmers who take care of their paddy fields, which offer amphibians a healthy aquatic environment. Similar to semi-terrestrial environments, riparian areas contain things like rivers, streams, marshy areas, etc. There are 16 species and 1526 (33.25%) individuals in this habitat. These habitats had comparable microhabitats and favourable environmental factors that may have supported a large number of species and individuals. They preferred riverine habitats because they are more constant in terms of temperature and humidity than the surrounding forest

4.2.5.1 Habitat preference of amphibian

The amphibian less favoured forests and human habitat. The area where people live, which includes smaller towns and cities as well as structures like homes and the streets that connect them, is referred to as the "human habitat." Of the 11 species, 528 (13.33%) are supported by human habitat. The forest area contains bushes, trees, climbers, and wild species. Seven species were represented by 224 (4.88%) individuals in this habitat. Forest and human habitats also had fewer water resources than riparian, agricultural, and wetland regions. According to Srinivasulu and Das (2008), amphibians used fossorial, terrestrial, aquatic, semi aquatic, arboreal and human dwelling mode of habitat. Fourteen species of amphibians used human commensals, while six species were forest users. In this study, reported species coexisted in the same habitat. According to Veith *et al*. (2004), the forest site did not provide breeding places due to a lack of open water that were not found in forest for most amphibian species. However, some species (*Polypedates* species) could survived in such habitat. This species abundance curves indicated that forest area were not favorable for amphibians.

Wetlands include small ponds, wells, fish ponds, lakes, and reservoirs. There were 8 species and 928 (90.22%) individuals. The richness and abundance of the amphibian species was much higher in the locality of water resources but species richness in wetland was low indicating that these habitats were not preferred by many amphibian species. Toledo-Bruno *et al*. (2017), Mouria *et al*. (2015), reported similar results.

In riparian and agricultural fields, the Shannon (H) and Simpson indices were high, whereas they were low in forests and wetlands. They favoured riparian areas and agricultural fields over forests and wetlands as a result. Khatiwada (2011) found that anthropogenic disturbance and near on agricultural fields negatively affected species richness. Similar observations were reported in both human and agricultural environments.

The most abundant species in Sri Lanka, South Asia, including Nepal is *E. cyanophlyciis*. It is a species that has adapted well and is frequently observed on the sides of ponds or streams. More disturbed agricultural areas than forest habitats were where it had been found (Dutta & Manamendra-Arachchi, 1996). Amphibians preferred similar habitats due to ecological conditions, adaptability, agronomic activities such as plowing the fields, applying herbicides, fertilizers, and fungicides, and regularly regulating the water level and migration (Bambaradeniya *et al*., 2004; Fox *et al*., 2004). This type of finding was also shown in study sites. The findings for this species are similar to previous investigations which showed their presence in disturbed agricultural areas like rice fields (Abayarathna, 2009). *N. liebigii* is a single species recorded from the riparian area.

During a field survey, just one caecilian *(I. sikkimensis)* was observed in a riparian area in Palpa which also reported by Rai (2003) from Ilam district. Krishnamurthy (2003) reported that caecilians were confined to undisturbed habitats. *S. breviceps* in Arghakhanchi in agricultural fields. *Duttaphrynus* species were mostly found in human areas, but they were also found in agricultural land, as indicated by Pokhrel and Thakuri's observations (2010). In this study, *Polypedates, Uperodon taprobanica* and *Sphaerotheca* observed in forest. *P. maculates* utilised two habitats. *Sphaerotheca maskeyei* and *P. leucomystax* were restricted to a single habitat. Pokhrel and Thakuri (2016) observed similar findings. *Nanorana* and *Amolops* species were recorded from small streams of the areas. Similar type of habitat observed by

Khatiwada (2011), Pokhrel and Thakuri (2010), and Schleich and Kästle (2002). During field visit, many amphibian species were recorded after brief periods of rain in study site. Before rain, they search safe lands for protection. Many species visited riparian areas and wetlands at that a period. *P. leucomystax* inhabited in the forests of study sites, regardless of the topography, which ranges from Terai to high mountains, showing that it has a variety of adaptations to survive at both low and high altitudes. Dutta and Manamendra-Arachchi (1996) reported the similar observation.

Indeed, it appears that the majority of amphibian species use riparian and agricultural field habitats as transitory homes, either for reproduction, feeding, or as migration corridors connecting adjoining natural wetlands, such as permanent ponds and surrounding streams. The presence of water in agricultural fields during the monsoon season and the breeding season of amphibians means that they often aggregate near or at water sources, so that some species showed a positive correlation with this habitat (Khatiwada & Haugaasen, 2015). For protection, the amphibians prefer shade and leaf litter. It showed that water containing agricultural fields, riparian zones, and wetland areas appear to be key habitats for amphibians. Clearly, the majority of the species found in this survey were found across a wide range of habitats and were not exclusively dependent on one. As a result, in order to maintain amphibian diversity, the range of habitats available in this area must be preserved.

4.2.5.2 Habitat preference of reptiles

The documentation of habitat preference were measured by individual abundance, richness and correlation of species with different habitat. In the study region, 2629 distinct reptiles were observed, of which 1018 (38.32%) are found in human habitat, 702 (26.70%) in forests, 616 (23.43%) in agricultural fields, 167 (6.35%) in riparian areas, and 126 (4.79%) in wetland habitats. Based on the total number of individuals, the majority of them favoured the human habitat, followed by the forest; riparian and wetland habitats were less preferred. Similarly, richness were high in agricultural fields, followed by forests, human habitats, riparian areas, and wetland areas. Some reptile species are more likely to be present than others in this habitat, according to high dominance values in both human habitat and forest. Wetland and riparian habitats exhibited lower species richness than other habitat types, which suggested that many reptile species did not prefer these types of habitats (Abayarathna, 2009), as in the current study.

The majority of reptiles utilized multiple habitats.But most of them recorded from dry agricultural area, home sites and forest. However, some of them only inhabited a specific habitat, such as two species of reptiles that could only be found in forests, three species in human areas, and one species in wetlands. Due to the decrease of open habitats, greater thermoregulation habitat became a major limitation for reptiles. Snakes can regulate their body temperature by basking in the sun or finding shelter, both of which are possible in open terrestrial habitats. Snakes may have lost significant sites for thermoregulation as a result of loss of open terrestrial habitats (Markle *et al*., 2018).

Mainly reptiles utilised cultivated regions, uncultivated areas, human settlements, rocky areas, and certain water bodies, according to Ali *et al*. (2017). Such habitat types were likewise utilized by the species that were identified locally. Geckos have been observed in building walls, but they avoid dense forests (Vignoli *et al*., 2017). They are the insect predators that were observed around the electric lights in the evening in this study. However, snakes were observed in a variety of microhabitats such as fossorial species (*Ramphotyphlops braminus*), arboreal species (*Boiga forsteni, B. trigonata, Dendrelaphis tristis, and Lycodon aulicus*), and wetlands (*Python molurus, C. palustris, P. mucosa, X. piscator,* and *Amphiesma stolatum*). These habitats give adequate food and refuge, allowing them to continue their life cycle.

Bhattarai *et al*. (2018) studied *V. flavescens* in agricultural land, *C. versicolor, Eutropis carinata Eutropis macularia, Sphenomorphus maculatus, Coelognathus helena, Dendrelaphis tristis* in forest. *H. brooki, H. flavidiris,* and *H. frenatus*. *Bungarus caeruleus, X. piscator* were found in human habitat. The overall number of reptiles found in the four habitats did not differ considerably. However, the human habitat had the highest percentage of reptile individuals captured. The habitats of different *V. flavescens* studied in Terai region by Ghimire and Shah (2014), Khatiwada and Ghimire (2009), Baral and Thapa (2008), and Shah and Tiwari (2004) documented that *V. flavescens* was usually found in riparian areas, while *V.*

bengalensis was mostly found in forests and agricultural fields. Similar type of habitat used by these species in present study.

These findings indicate a correlation between the presence of reptiles and various reptile species' habitats. In this study, more than two habitats were utilised by the species that were studied in. Wetlands are often habitat to turtles and crocodiles. But lizards and snakes lived in habitats that changed with the seasons and were common in forests. However, the richest and most numerous snake species were to be found in forest, agricultural areas, and human habitat. Importantly, this study also showed an association between habitat, reptile abundance and diversity. According to categories of natural land cover influences on patterns of species distribution, species richness rises with increased habitat complexity and heterogeneity increased (Vignoli *et al*., 2017). This might have occurred as a result of the higher number of reptile observations in this region.

Correlation between lizards and Skinks showed the positive correlation with forest and negative relation between riparian and wetland. It indicated that Agamidae (Lizards) and Scincidae (Skinks) species were found irrespective of the distance from water bodies (Aryal *et al.*, 2010).

CHAPTER 5

5. CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Taxonomical identification was carried out based on identification keys, morphometric, and meristic data previously published in the literature. The identified amphibians included 16 frogs and toads and 1 Caecilian. Among the six families, Ranidae dominated over the others. For reptiles, 41 species were identified, including 27 snakes, 11 lizards, 2 turtles, and 1 Crocodile. The Colubridae family had the most species. These species were documented with taxonomic descriptions, common names, localities, habitats used, distributions, and statuses. Amphibians represent all families except salamendridae, and similar species were found in the Chure of Lumbini Province. In reptiles families Gavialidae, Anguidae, and Testunidae were absent, and there were also fewer species as compared to this province.

Individual amphibians were most abundant in the Rupandehi district and riparian habitat, while they were least abundant in the Gulmi districts and forests. Similarly, Palpa district and human habitat had the highest abundance, whereas Gulmi district and wetland habitat had the lowest individual of reptiles. Some species like *D. melanostictus*, *E. cyanophlyctis*, *H. tigerinus*, *M. nepalensis*, *C. versicolor*, *H. flaviviridis*, *P. mucosa*, and *N. naja* were frequently observed, *C. palustris*, *P. smithii*, *F. sanctjohannis*, and *O. hannah* were the least abundant species, while other species were moderately observed during herping.

D. melanostictus, *D. stomaticus*, Gecko species, *P. mucosa* were inhabitant on anthropogenic pressure. *E. cyanophlyctis* can adapted in unfavorable condition of water and *C. versicolar* and *P. mucosa* use multiple habitats so widly distributed. Species such as *U. taprobbanica*, *M. prava*, *A. marmoratus*, *N. liebigii*, *S. breviceps*, and *P. maculates* were patchy in distribution. *E. conica*, *O. erythrogaster*, *T. tenuiceps*, and *F. sanctjohannis* were less distributed species. *I. sikkimensis* and *C. palustris* were the first distribution recorded in the Palpa and Arghakhanchi district respectively.

The mountainous districts were richer compared to the Terai districts in terms of amphibian species. The richness of reptiles was higher in Palpa district and lower in Gulmi.

Simpson's Index, Shannon-Wiener index, and Pielou evenness indicated that riparian areas and agricultural fields had high values, indicating higher amphibian diversity, but low values in wetlands. Similarly, these indices were higher in forests and agricultural fields for reptiles, but lower in wetlands. Therefore, diversity was higher in forests for reptiles.

Eight species (0.45%) comprise 2 Kraits, 3 cobras, 1 coral, and 2 pit vipers were venomous snakes belongs to families Elapidae and Viperidae. The families Typhlopidae, Boidae, and Colubridae which belons to 19 non venomous snakes, including 3 semivenomous snakes. In comparison to national data, the number of venomous and non-poisonous species reported was very low, although venomous snakes were comparable to the Chure of Lumbini Province. It represents all families of non-venomous snakes as well as the Krait, coral, and viper among venomous snakes.Visual encounter survey and opportunistic survey used to encounter snakes therefore their richness was reduce.

Diversity indices, richness and species individual rank showed that riparian and agricultural fields were preferred by amphibians but less favour the wetland. The reptiles preferred forest and agricultural land but less preferred the wetlands.

5.2 RECOMMENDATIONS

The following are recommendations for enriching the checklist and information on the herpetofauna of the study area:

For accurate species identification, molecular studies of species complexes such as *Duttaphrynus melanostictus, Euphlyctis cyanophlyctis, Minervarya* spp., and *Calotes versicolor* should be conducted. As *E. cyanophlyctis* can adapted in all season during study further research is essential to know how they can adapt in winter season.

Determine whether the *C. palusris* was a male or a female, then mate and reproduce there or clone it to increase its population. Additionally, give food, treat diseases, and away from anthropogenic pressure.

Future research should concentrate on seasonal, altitudinal, and environmental variables in order to obtain a complete and comprehensive picture of the diversity, richness, and distribution of herpetofauna.

This study was unable to report on *Bungarus bungaroides*, *B. niger*, *B. lividus*, Russell's viper, or any other viper species and other non venomous snakes. Therefore, additional research using other appropriate approaches will be required.

Various herpetofauna prefer distinct habitat like forests, agricultural lands, human habitats, riparian and wetland so all need to be conserved as each of these habitat supports a different species.

Herpetofaunal species are at risk due to anthropogenic pressure, road traffic, the use of pesticides in agricultural lands, and modern agricultural technology. Therefore, these activities should be minimized and closely monitored to protect the herpetofauna.

SUMMARY

The herpetofauna, poikilothermic vertebrates, are effective bioindicators of stressed ecosystems. The main objective of this study is to explore the species diversity and habitat preferences of herpetofauna in the Lumbini Region, within Lumbini Province of Nepal. This study aims to identify local herpetofauna, measure abundance, distribution, and diversity, as well as determine habitat preferences. The study was conducted from 2016 to 2022.

The research was carried out in Arghakhanchi, Gulmi, Palpa, Kapilvastu, Rupendehi, and Nawalparasi (east and west regions). From these districts, 36 sampling stations were selected based on geography and vegetation covers. Systematic surveys were conducted in 5 different habitat types. The riparian habitat represented the semi-aquatic habitat, the agricultural fields represented the aquatic and terrestrial habitats, the forest covered the open area, and the human habitat represented the anthropogenic area while wetland represented an entirely aquatic habitat. The standard 5 transects of 200 m were fixed, and in each transect, 5 quadrats of 20 m x 20 m were taken, resulting in 100 quadrats randomly selected for each station sampling. A visual encounter survey was conducted specifically for snakes, and the Pitfall method was used for nocturnal amphibians, as well as an opportunistic survey for more species encounters. Morphometric measurements and GIS records were taken for each species. All recorded species were categorized at the species level using the keys from Schleich and Kaestle (2002), and Shah and Tiwari (2004). The abundance, richness, diversity, and habitat types were analyzed using Microsoft Excel, PAST (version 4.11), and R (version 3.6.1).

A total of 58 herpetofauna; six families of amphibians including 16 frogs and one caecilian while 41 reptiles including three orders and twelve families of reptiles were identified. *E. cyanophlyctis, M. nepalensis, M. teraienesis, D. melanostictus, H. tigerinus,* and *M. ornata* were found to have high rank abundance among 4546 amphibian individuals. *I. sikkimensis* and *S. breviceps* had the lowest rank abundance at the study sites. There were 2629 different species of reptiles, with Palpa district having the greatest individuals and Gulmi district having the least. The most prevalent species are *X. piscator, P. mucosa,* and *C. versicolor* and *Crocodylus, Python* spp. *T.*

tenuiceps, F. sanctjohannis, and *O. hannah* were least observed throughout the investigation period.

The distribution pattern of the herpetofauna in the Lumbini region includes the Indian genera *E. cyanophlyctis, Calotes, Hemidactylus,* and *Bungarus* the Indo-Malayan genera *Varanus, Amphiesma, Crocodylus, Indotyphlops, Naja, Ptyas, Python,* and *Fowlea*; the Indo-Chinese genera (*Uperodon, Microhyla, and Polypedates*); and transitional species (*Boiga, Dendrelaphis, Lycodon, Oligodon, and Trimeresurus*). *D. melanostictus, D. stomaticus, E. cyanophlyctis, Hoplobatrachus, Minervarya* spp., and *M. ornata* species were found in all sites. High and middle-elevation species included *S. maskeyi, S. brevicep, N. liebigii, A. marmortus,* and *M. parva. P. leucomystax* can be found in both mountainous and low elevations. *C. palustris, V. flavescens, Python* species, *O. erythrogaster, T. guentheri,* and *O. hannah* were protected species according to IUCN red data of threatened species.

In the Terai wetlands, *P. smithii* and *L. punctate* were found. In rocky areas, *L. tuberculata*, was found at high altitude. Geckos dominated the lowlands, while the Scincidae family inhabited forests. *Hemidactylus* were typically encountered in anthropogenic habitats. Snakes and skins were most common in the agricultural fields and forests. *I. sikkimensis*, an amphibian and *C. palustris*, a reptile, had new distribution report for Palpa and Arghakhachi district respectively.

The mountainous districts had more species than Terai districts. The riparian habitat favours most species. Palpa districts had highest diversity of reptiles in compare to other districts while Gulmi had lowest reptilian diversity. The highest species richness was found in forests and agricultural fields, while the lowest was found in wetlands.

Wetlands had the lowest Simpson's Index and Shannon Index (H), while agricultural fields and riparian areas had the highest. Pilou's evenness (J) was lower in riparian regions but higher in wetlands and human habitat. These indicators show that agricultural lands have a greater diversity of amphibians than wetlands. In wet lands, the Simpson index and Shannon indices (H') were lowest, but highest in forests. Pilou evenness (J) in agricultural fields and forests but was low riparian habitat. This indicates that reptile diversity was higher in agricultural fields and forests and lower in riparian areas. Wetland and riparian habitats have lower species richness than other habitat categories, which may be because many reptile species find it challenging to exist there.

There were five snake families, two of which were venomous (Elapidae and Viperidae), and the others (Typhlopidae, Boidae, and Colubridae) were non-venomous. Among 27 species, 8 were venomous, 3 Boiga species were mildly venomous, and 16 species were non-venomous. Visual encounters and opportunistic surveying contributed to the limited number of snake species encountered. The protected snakes included the *O. erythrogaster, Trachischium,* and *Ophiophagus,* as well as the *Python* species. The conservation of these snake species is essential.

Habitat suitability was analyzed using the abundance, richness, and diversity indexes. According to species richness, rank abundance, and diversity, amphibians preferred agricultural fields and less preferred the wetland. D. melanostictus can live under anthropogenic pressure, while E. cyanophlyctis is the most adaptive species found in all water situations. A. marmortus and N. liebigii were found near fast-flowing streams with dense vegetation. Reptiles also favored human habitats and forests but less favored wetlands. They need to bask in the sun in open areas. Many gecko species prefer human habitation. Except for a few species, many of them prefer diverse habitats, so habitats were made species-specific.

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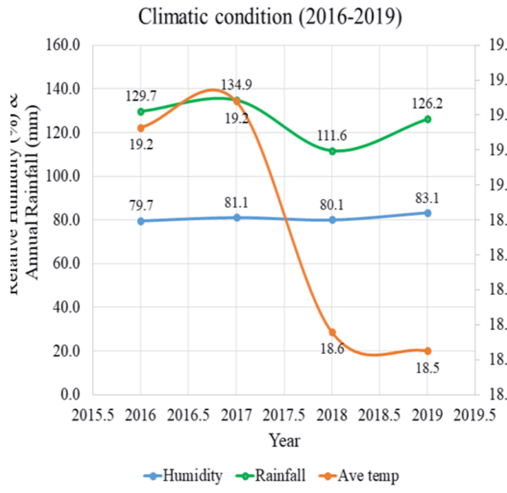
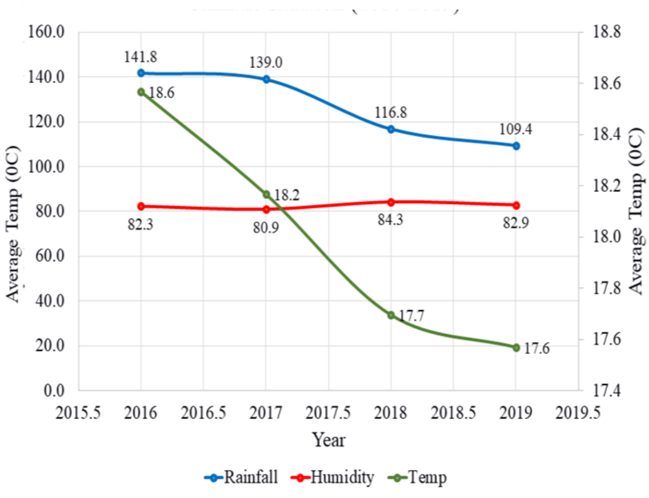
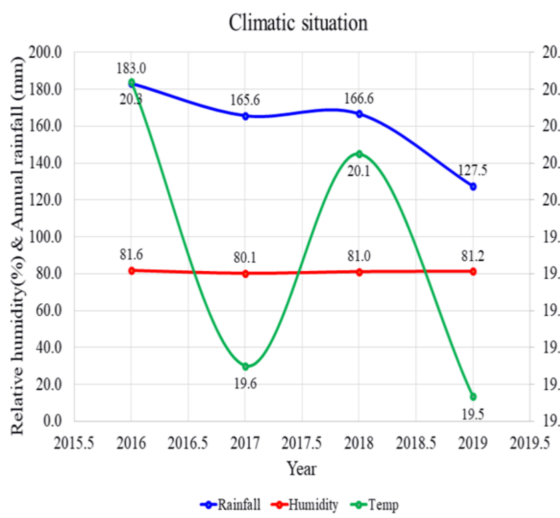
APPENDICES

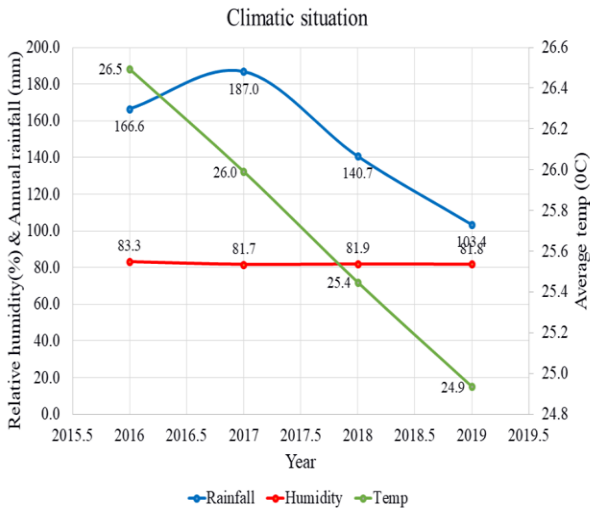
Appendix I: Mean Precipitation, Humidity and Temperature of Arghakhanchi and Gulmi districts from 2016 to 2019.



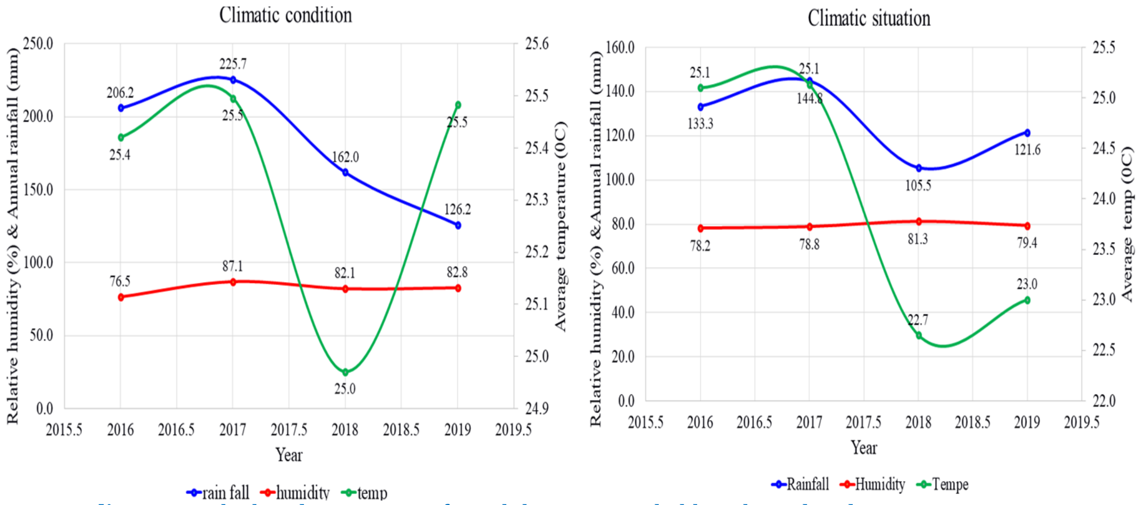


Appendix II: Mean Precipitation, Humidity and Temperature of Palpa and Nawalparasi districts from 2016 to 2019

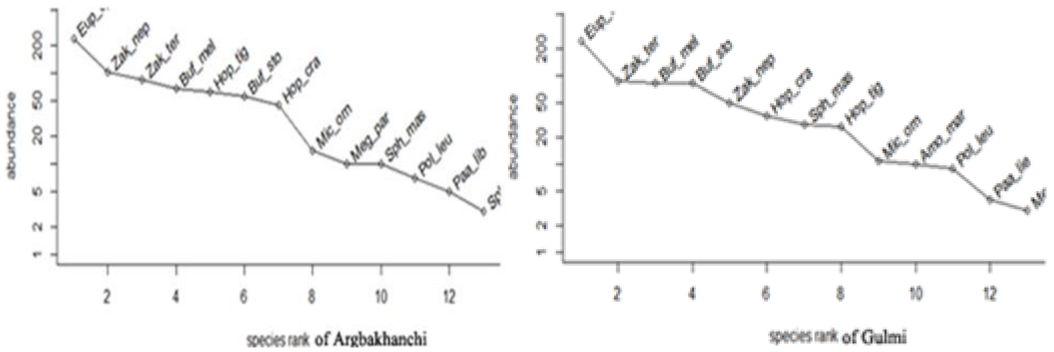




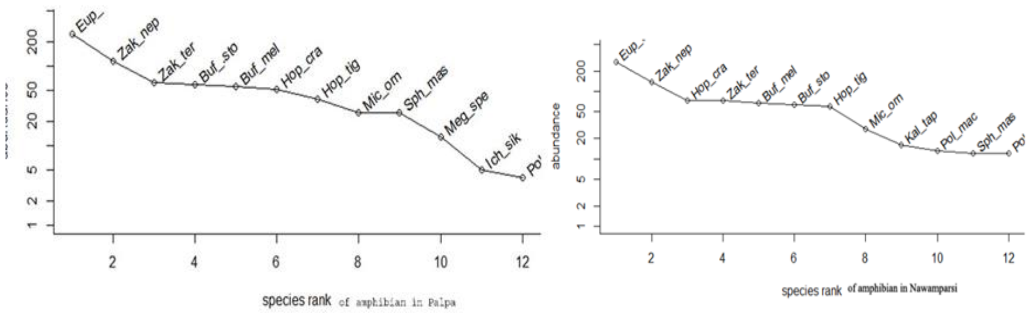
Appendix III: Mean Precipitation, Humidity and Temperature of Rupandehi and Kapilvastu districts from 2016 to 2019

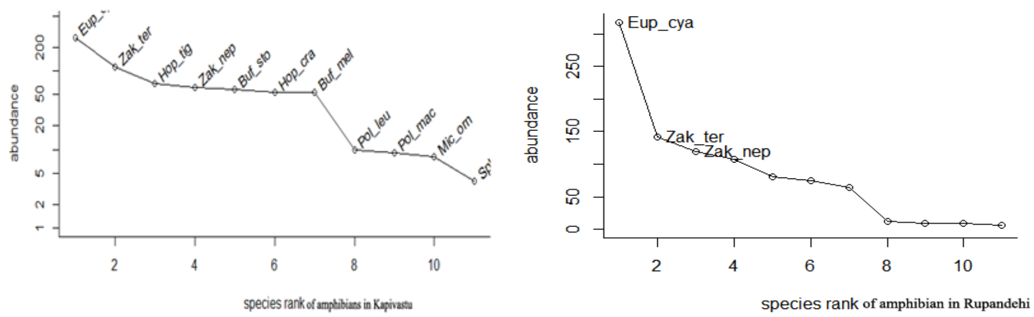


Appendix IV: Rank abundance curve of amphibians in Arghakhanchi and Gulmi

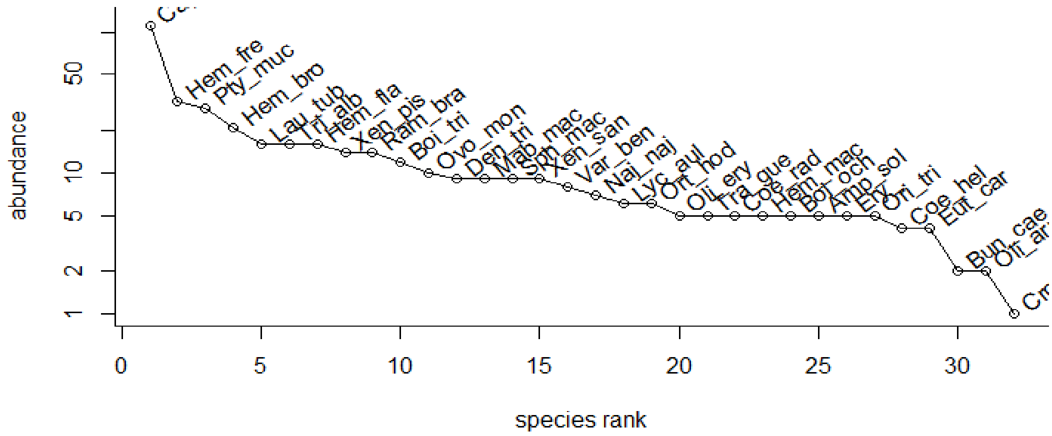


Appendix V: Rank abundance curve of amphibians in Palpa and Nawalparasi districts

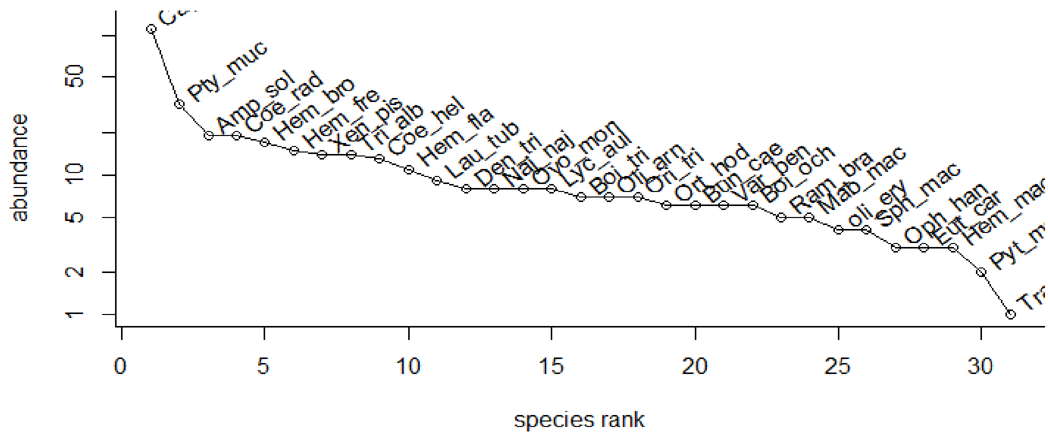




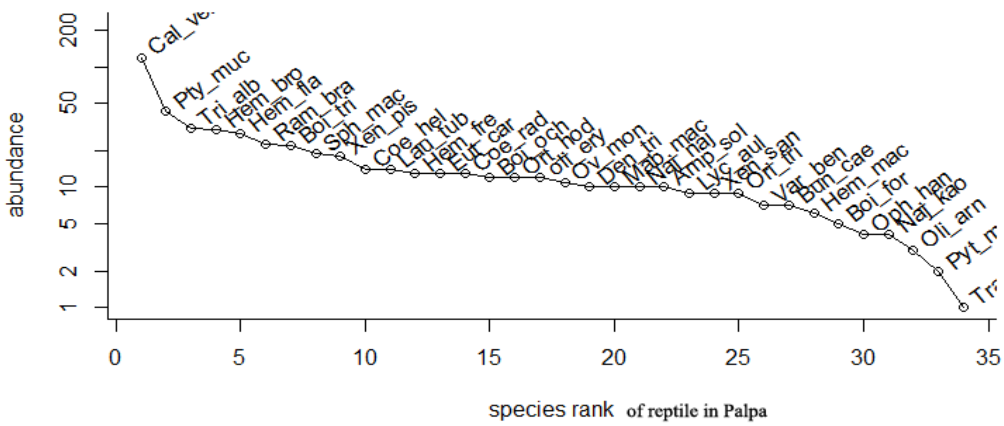
Appendix VI: Rank abundance curve of amphibian in Rupandehi and Kapilvastu districts.



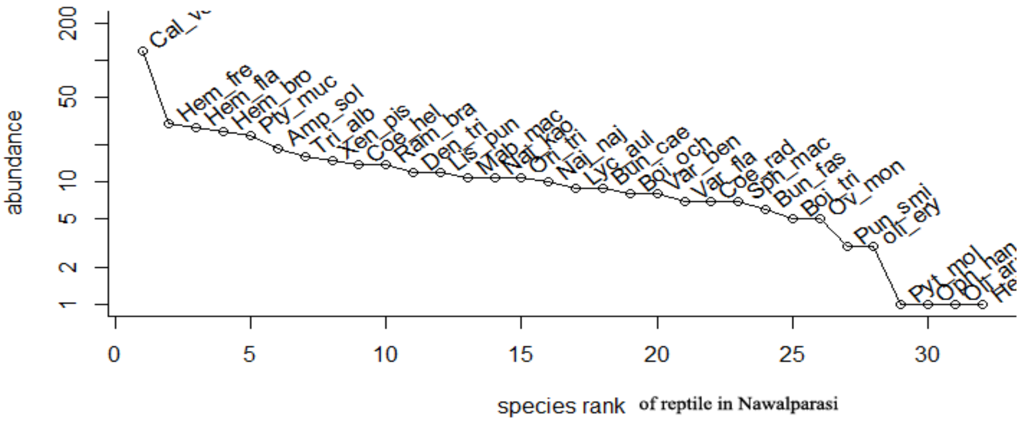
Appendix VII: Rank abundance curve of reptiles in Arghakhanchi district



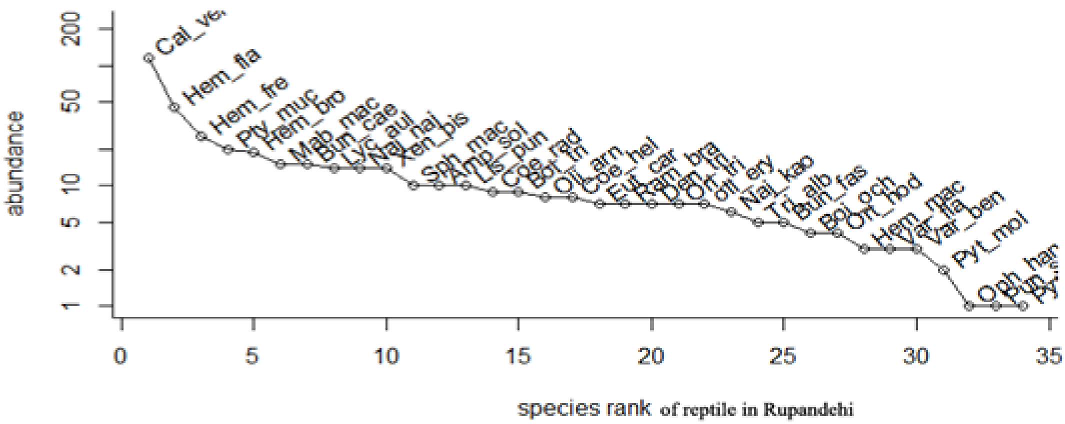
Appendix VIII: Rank abundance curve of reptiles in Gulmi district



Appendix IX: Rank abundance curve of reptiles in Palpa district



Appendix X: Rank abundance curve of reptiles in Nawalparasi district



Appendix XI: Rank abundance curve of reptiles in Rupandehi district

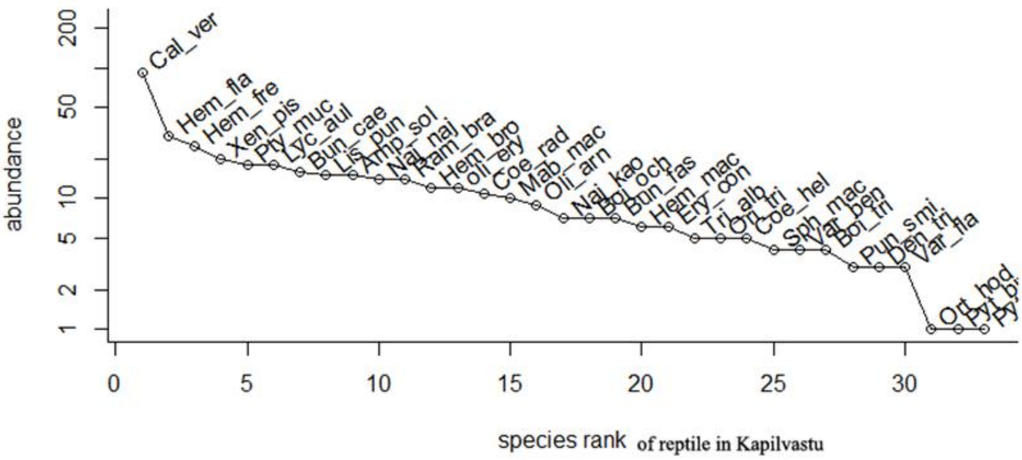


Figure 11: Rank abundance curve of reptiles in Kapilvasu district

Appendix XII. Description of Arghakhanchi district on the basis of stations, sampling station elevation, coverage area and habitat types

Ser. No	Stations	Sampling stations	Coordinate	Elevation/m	Coverage area	Habitat types
1	Sandhikharka	Chutrabesi Argha Dharampani Narpani	27.9755 ºN 83.1254ºE 28.0007 ºN 83.1150 ºE 28.0187 ºN 83.1024 ºE 27.9162ºN 83.1526 ºE	937 1720 1226 1825	Sandhikharka area, Kura, , Dharampani area, Argha areas, Narpani	Forest, paddy field, Bangi khola, Gordanikhola, Dahakhola,cultivated area, well, mushy area, steep hill, flood plains
	Sitapur	Badachaur Thada Jhirbas Bhuwan pata	27.8722 ºN 83.1220 ºE 27.8621 ºN 83.0984 ºE 27.8613 ºN 83.1235 ºE 27.8831 ºN 83.1231 ºE	1095 1295 1299 1075	Bhuwanpata, Badachaur, Thada Daha, Jhirvas area, mid hills	Paddy field, riverine forest, bushes, crop land, village and small town, hilly area, flood plains
	Gokhunga	Hanmsapur Pasleng Rangamare Neeta	28.0826 ºN 83.0560 ºE 28.0919 ºN 83.0303 ºE 28.0820 ºN 83.0167 ºE 28.0876 ºN 83.0124 ºE	1792 1707 1762 1999	Ratanmanre, Kabra, Rangamare, Gokhunga, Patle, Neta, Pasleng area, steep hills	Small town and village, community forest, crop land, small stream, moist vegetation, artificial small pond, slopy and rokey areas

	Arghatosh	Chidipani Kurdikhola Milmilekhola Haittae	28.0123 ºN 83.1814 ºE 28.0140 ºN 83.1890 ºE 28.0118 ºN 83.1772 ºE 28.0296 ºN 83.1943 ºE	1109 893 854 1398	Ratamata, Ghatakhola, Chanp gaira, Bhiramuni, Haite area	Community and personal forest sesonal and off seasonal stream, household area, small paddy field, crop field.
	Pokharathok-Khidim	Panini Tapovumi Simle Durgaphant Pokhrathok	27.8657 ºN 83.3165 ºE 27.888 ºN 83.3028 ºE 27.9137 ºN 83.2626 ºE 27.8835 ºN 83.2912 ºE	1967 1405 725 1321	Nigali, , Paninin daha, Durvasa gufa, Khidim area, Danda kateri,	Village, moist and dry forest, Durgakhola, daha, paddy field, crop land, agrofarm, steep hills, seasonal streams
	Siddhara	Baraha daha Lamidamar Rangsing	27.8160 ºN 82.8562 ºE 27.8218 ºN 82.8501 ºE 27.7978 ºN 82.8077 ºE	460 476 342	Lamidamar, Lauri, Kali daha, Baraha daha, Rangsing khola,	Sal forest, stream, ponds, croplands, Chure hills

Appendix XIII: Station, substation, coordinates, and elevation, coverage and habitat types of Gulmi district

Ser. No	Stations	Substation	Coordinate	Elevation/m	Coverage	Habitat types
1	Tamghs-Resunga	Tamghas bazar Neeta Resunga Paralme	28.0650ºN 83.2464 ºN 28.0605 ºE 83.2195 ºE 28.0957 ºN 83.2821 ºE 28.1090 ºN 83.3081 ºE	1503 1453 2512 1623	Town, Resunga, Paralme, Gausala, Temple area	Community and cultural forest, crop field, households area, well, mushy area, small streams, steep high mountain
	Kharjeng-Mankot	Kharjeng Mankot Aangaha Gairikhutta	27.9673 ºN 83.3055 ºE 27.9589 ºN 83.3316 ºE 27.9566 ºN 83.3657 ºE 27.9508 ºN 83.3174 ºE	711 906 632 893	Tallachaur, Aampokhari, Dhairani, Jabundanda, Chhapa, Bhalukhola, Kharjeng khola, Bakhrekhola	Paddy field, riverine forest, bushes, crop land, village and small town, small, reservoir, arid mid hills
	Aslewa	Temple site Mochakot Jungle site	27.9885 ºN 83.4655 ºE 27.9871 ºN 83.4818 ºE 27.9794 ºN 83.4725 ºE	500 858 995	Rani ban, Rudrabini, Budadi ban, Mochakot, Badighat river, Aalewa, Sapaudi khola, Dhawadi khola	Small village, community forest, crop land, small stream, moist forest, riverine forest, small pond, slopy and rokey areas
	Wami	Wami Taxar Charhari khola Shera Timlechaur	28.1811 ºN 83.2853 ºE 28.1897 ºN 83.2789 ºE 28.1674 ºN 83.2972 ºE 28.1853 ºN 83.2927 ºE	778 735 749 813	Nwara, Sodi Jangle,Tar-Paruwa, Badighat, Daramkhola, Bodini khola, Chisa khola	Small town, Community forest river, village, paddy field, crop field, slope, rocky area, small stream, artificieal ponds

	Santipur	Timure daha Shantipur bazar Remi Harachaur	28.1006 ºN 83.3792 ºE 28.1095 ºN 83.4172 ºE 28.1047 ºN 83.4105 ºE 28.1256 ºN 83.4112 ºE	1958 1067 1368 1522	Uppalo Remi, Danda ban, dwar khola, Harewa khola, Timure daha area	Village, moist forest, daha, moist forest, paddy field, crop land, small town, mersy areas, hilly area, flood plain, stream, pond
	Purkot-Mahelpokhari	Purkot daha Daduwa Mahelpokhari	28.1442 ºN 83.0773 ºE 28.1510 ºN 83.0807 ºE 28.1188 ºN 83.0567 ºE	1693 1865 1717	Bhirkateri, Bhanbhane, Doduwa area, Bahunpani, Gwadikhola, Gairagaun	Community forest, slopy and rocky area, stream, croplands, moist area, rough and sloppy terrain.

Appendix XIV: Station, substation, coordinates, elevation, coverage and habitat types of Palpa district

Ser. No	Stations	Substations	Coordinate	Elevation/m	Coverage	Habitat types
1	Tansen	Madi Pravas Tansen Batase	27.8511ºN 83.5609ºE 27.8416ºN 83.5436ºE 27.8666ºN 83.5499ºE 27.8710ºN83.5454ºE	75 876 1059 1318	Tansen Bazar, shreenagar, Damkada, Argheli, Bartung, Tinau river, pond	Town, village, Madi plain, Community and cultural forest, paddy field, crop field, hilly area, stream well, mushy area
	Somadi - Sardewa	Sardewa Diga Somadi Kaphal butta	27.9148ºN 83.3974ºE 27.8940ºN 83.3856ºE 27.9053ºN 83.3870ºE 27.8660ºN 83.3351ºE	731 1123 1196 1670	Dammk, Sardewa stream, Tansingal, Somadi, Maheldhap	Paddy field, riverine forest, bushes, crop land, villages and small towns, small streams, ponds
	Jhadewa	Harneta Bajar area	27.7708ºN 83.6691ºE 27.7682ºN	984 1022	Marmara, Naumule, Mulabari,	Small village, community forest, riverine

		Thanti Deugir	83.6328ºE 27.7770ºN 83.6797ºE 27.7972ºN 83.6546ºE	1062 1308	Aagridanda, Jukeni, jhdewa khola, Rahabas khola, Marmara khola,	forest, crop land, small streams, moist forest, small pond, slopy and rokey areas, paddy fields,
	Dovan	Dobhan Jhumsa Suke tal Satyabati lake	27.7453ºN 83.4644ºE 27.7524ºN83. 5072ºE 27.7724ºN83. 4431ºE 27.7549ºN 83.5429ºE	275 385 648 1202	Tinau river, Bhutt khola, Jhumsa khola, suke taal area, Danda, Temple area	Community forestt riverine forest, villages, small town, paddy fields, crop fields, slope, rocky area, Chure area
	Rampur	Bangepasal Sani amarai Ramcheban Khaliban	27.8614ºN 83.9014ºE 27.8469ºN 83.9011ºE 27.8558ºN 83.885 ºE 27.8295ºN 83.8871ºE	398 402 437 569	Rampur, Kisanbari, Tilakpur, Bahakhola, Muralikhola, Gaudan, Kaligandaki side	Rampur plain area, dry forest, artificial ponds, moist forest, paddy field, crop land, small town, villages
	Ringneraha	Campus area Thulakhola Adhikari pokhera	27.8265ºN 83.7511ºE 27.8125ºN 83.7761ºE 27.8347ºN 83.7414ºE	827 848 946	Mandir danda, Murdakhola, Purbakhola, Garang khola, Phurungdi, Nimtung, Karne danda, Udbuddha campus,	Community forest, seasonal and off seasonal streams, croplands, rice fields, moist area, villages, peddy fields,

Appendix XV: Station, substation, coordinates, elevation, coverage and habitat types of Nawalparasi district

Ser. No	Stations	Substation	Coordinate	Elevation/ m	Coverage	Habitat type
1	Dawanne Devi	Bardaghat east side Bardaghat west side Dawanne bazar Temple site	27.5576ºN 83.7905ºE 27.5525ºN83. 7868ºE27.55 54ºN83.8428º E 27.5511ºN 83.8393ºE	101 123 505 631	Temple side, small town of Bardaghat and daunee, high way, western and estern side of Bardaghat, Triveni road side	Small town, Community and religious forest, paddy field, human sattelment area
	Parasi	Parasi Dakpani Turia khola Macchar tal	27.5264ºN83. 6656ºE 27.5175ºN 83.6756ºE 27.5947ºN 83.6386ºE 27.6219ºN 83.6324ºE	89 91 104 115	Sunawal and parasi suurban area, Machharmara taal area, school area, Bhorahikhola	Paddy field, forest, bushes, crop land, village and urban areas, seasonal reservoir and stream, ponds, irrigation channels
	Rajahar	Riversite Kalikamandir area Bhokatghari Rajhar bazar	27.6639ºN 84.2340ºE 27.6900ºN 84.2344ºE 27.6773ºN84. 2394ºE 27.6830ºN 84.2287ºE	165 169 172 184	Urban and village area, bank of Narayani river, temple area	Small village, small forest, crop land, small stream, seasonal reservoir and stream, ponds, irrigation channels
	Kawasoti	Verygood chok Danda river River hight	27.6208ºN 84.1125ºE 27.6585ºN 84.1073ºE 27.6351ºN	161 162 182	Urban areas, Danda river sites, Sinh niwas community forest, Very	Community forestt river, village, urban areas, paddy field, riverine

			84.0938ºE		good chock area	forest, seasonal ponds, irrigation channels
	Rakachuli	Birgetari Danda gau Rakachuli	27.6763ºN 83.9375ºE 27.7108ºN 83.8868ºE 27.7150ºN 83.8574ºE	223 881 943	Midi danda, Kudapani, road sites, Rakachuli area, Birgetari area	Village, moist forest, daha, moist forest, paddy field, crop land, small town, mersy areas, Chure forest
	Gaidakot	Gairi Pitauji Jaishikhola Gaidakot	27.7096ºN 84.4100ºE 27.7002ºN 84.3052ºE 27.7090ºN 84.4057ºE 27.7086ºN 84.3886ºE	172 173 185 189	Bhedabari, Dandadhanch, Thumsi, Pitauji area, Gairikhola	Community dense forest, slopy and chure area, stream, paddy field, moist area, small villages and urban areas

Appendix XVI: Station, substation, coordinates, elevation, coverage and habitat types of Rupandehi district

Ser. No	Stations	Substations	Coordinate	Elevation/ m	Coverage	Habitat type
1	Khaireni	Highway east Bazar Highway west Kerbani	27.6434ºN83. 5972ºE 27.6691ºN 83.6063ºE 27.6390ºN 83.5954ºE 27.6617ºN 83.6033ºE	144 147 161 175	Jyoti nagar, Kerwani, Bhulbhule khola, Devdaha	Town, village, Community forest, paddy field, crop field, small ponds, mushy area, seasonal streams, irrigation channels
	Belbas	Play ground River site Bhutkhola Panipokhari hight	27.7010ºN 83.4342ºE 27.6886ºN 83.4491ºE 27.6958ºN 83.4267ºE27. 6992ºN 83.4397ºE	135 155 160 431	Belbas, Badelpokhari, Panikhola, Bhutkhola, Jawai, Hawara, bank of Tinau river,	Paddy field, village and urban areas, Salpari wetland, river, small streams, small reservoir, Chure forest
	Gajedi	Taal area Raniban Kanchan khola	27.6614ºN 83.2773ºE 27.6694ºN 83.2773ºE27. 6676ºN83.297 2ºE	99 102 114	Danapur, Kanchan, Bansgadhi, Gajedi tal area, Kanchankhola,	Small village, community forest, moist forest, crop land, small stream, small pond, irrigation channel
	Sainamaina	Sunagava tole Sukauj khola Temple area	27.6885ºN 83.3426ºE 27.6979ºN 83.3491ºE 27.6745ºN 83.3608ºE	108 110 124	Bolbam, Murgia, Sarauli, Shukla khola, Hamaha khola, Bolbam temple	Community forest village, small town, paddy field, villages, seasonal streams,

						swampy area, irrigation channels
	Chhapiya	Chock area Amua Boting pokari Bandhusari	27.5603ºN 83.3570ºE27. 5648ºN 83.3601ºE 27.5791ºN83. 3586ºE 27.5891ºN 83.3696ºE	85 90 90 92	Pond area, chhapiya town, Chiliya, Kachkachra, fish farms	Village, forest, fish ponds, moist forest, paddy field, crop land, small town, mersy areas, temporary reservoirs
	Bhairahawa-Madhulia	Bhairahawa Near budda chok Thuttipipal Madhauliya	27.5086ºN 83.4536ºE 27.5155ºN83. 4611ºE 27.5397ºN 83.4638ºE 27.5786ºN 83.4802ºE	102 107 114 117	Hospital area, Bhairahawa campus area, Buddha chok area, Fish farm, Behuli	Small forest, plain area, seasonal stream, peddy field, moist area, reservoir, city area

Appendix XVII: Station, substation, coordinates, elevation, coverage and habitat types of Kapilvastu district

Ser. No	Stations	Substation	Coordinate	Elevation/ m	Coverage	Habitat type
1	Jeetpur	Bandganga Karmana Jeetpur Football ground	27.6948ºN 83.1754ºE 27.6461ºN 83.1683ºE 27.6872ºN 83.1803ºE 27.6886ºN 83.1755ºE	126 142 140 144	4 no. area, river sides, Karmana area, ground sides	Urban and rural areas, community and cultural forest, paddy field, well, mushy area, ditches, irrigation canals, barren land
	Jagadishpur	Bandauli Harnapur	27.6165ºN 83.0929ºE 27.6957ºN	92 96	Niglihawa, Kushmaghat, Kohili nadi,	Paddy field, riverine forest,

		Laxmanghat Jagdishpur Lake	83.2078ºE 27.6644ºN 83.1179ºE 27.6886ºN 83.1755ºE	97 104	Laxman ghat sides, lake sides,	bushes, crop land, village and small town, paddy field, Taal, murshy areas, chennel
	Taulihawa-Khunuwa	Mahasuhya river Dagawa Baidauli Piparhawa	27.5247ºN 83.0479ºE 27.4405ºN 83.0216ºE 27.4822ºN 83.0129ºE 27.5439ºN 83.0052ºE	71 73 75 102	Taulihawa urban area, Khunuwa, Mahasuhya river, Haat bazar area	Urban area, small village, community forest, paddy field, small stream, irrigation channel small pond,
	Jayanagar – Pattharkot	Immeliya Badahara Pachakaiya Patharkot	27.6597ºN 83.0144ºE 27.6605ºN 83.0286ºE 27.6900ºN 83.0405ºE 27.7557ºN 83.0483ºE	110 112 115 192	Gorusinghe, Basantapur, Imelia, Bhelai, Bodgaun, Belagurdua khola, Ranikhola,	Community forestt river, village, small town, paddy field, crop field, irrigation channel, seasonal streams, ponds
	Pakadi	Dubaripur Boundry of municipality Pakadi Pichaki	27.5263ºN 83.125ºE 27.5200ºN 83.1719ºE 27.5284ºN 83.1462ºE 27.5300ºN 83.1561ºE	78 99 101 102	Yasodha municipality boundry,Pakadi chock, Dubaripur area, Pichaki, Sisai river	Small town, villages, stream, fish ponds, paddy fields, small forest, seasonal streams, irrigation channels
	Krishna Nagar	Shemara	27.5072ºN 82.7953ºE	77	Chaipurawa, Patane,	community forest,

		Basantapur Bahadurgunj	27.5428ºN 82.7747ºE 27.5462ºN 82.8437ºE	84 103	KrishnanagarSurahikhola, Ramnagar, Ghorahikhola	seasonal streams, paddy fields, urban and rural areas, ponds, moist area

Appendix XVIII: District wise abundance of amphibians

S.N.	Family	Scientific name	Arghakhanchi	Gulmi	Palpa	Nawalparasi	Rupandehi	Kapilvastu	Total	%
1	Ichthyophidae	*Ichthyophis sikkimensis* Taylor, 1960	0	0	5	0	0	0	5	0.11
2	Bufonidae	*Duttaphrynus melanostictus* (Schneider,1799)	68	83	55	67	75	53	401	8.74
3		*Duttaphrynus stomaticus* Lütken, 1862	56	82	59	64	64	58	383	8.35
4	Megophryidae	*Megophrys prava* (Boulenger, 1893)	10	3	13	0	0	0	26	0.57
5	Microhylidae	*Microhyla ornata* (Dumeril & Bibron, 1841)	14	11	26	28	9	8	96	2.09
6		*Uperodon taprobanicus* (Parker, 1934)	0	0	0	16	0	0	16	0.35
7	Ranidae	*Amolops marmoratus* (Blyth, 1855)	0	10	0	0	0	0	10	0.22
8		*Euphlyctis cyanophlyctis* (Schneider,1799)	240	248	251	272	318	287	1616	35.21
9		*Hoplobatrachus crassus* (Jerdon, 1853)	44	35	51	74	81	53	338	7.37
10		*Hoplobatrachus tigerinus* (Daudin, 1802)	62	27	39	60	108	70	366	7.98
11		*Minervarya nepalensis* (Dubois, 1975)	102	49	116	139	119	62	587	12.79
12		*Minervarya teraienesis* (Dubois, 1975*)*	85	88	62	73	142	112	562	12.25
13		*Nanorana liebigii* (Günther, 1860)	5	4	0	0	0	0	9	0.20
14		*Sphaerotheca breviceps* (Schneider, 1799)	3	0	0	0	0	0	3	0.07
15		*Sphaerotheca maskeyei* (Schleich & Anders, 1998)	10	28	26	12	12	4	92	2.00
16	Rhacophoridae	*Polypedates leucomystax* (Gravenhorst, 1829)	7	9	4	12	9	10	51	1.11
17		*Polypedates maculates* (Gray, 1830)	0	0	0	13	6	9	28	0.61
	Total		706	677	707	830	943	726	4589	100.00
	%		15.38	14.75	15.41	18.09	20.55	15.82		

Appendix XIX. Total district wise wise reptiles

S.N.	Family	Scientific name	Arghakhanchi	Gulmi	Palpa	Nawalparasi	Rupandehi	Kapilvastu	Total	%
1	Crocodylidae	*Crocodylus palustris (Lesson, 1831)*	1	0	0	0	0	0	1	0.04
2	Bataguridae	*Pangshura smithii (Gray, 1863)*	0	0	0	3	1	3	7	0.27
3	Trionychidae	*Lissemys punctata Webb, 1980*	0	0	0	12	10	15	37	1.41
4	Agamidae	*Calotes versicolor Daudin, 1802*	110	111	120	118	116	91	666	25.33
5		*Laudakia tuberculata Hardwick & Gray. 1827*	16	9	14	0	0	0	39	1.48
6		*Japalura tricarinata (Blyth, 1853)*	5	7	9	11	7	5	44	1.67
7	Gekkonidae	*Hemidactylus brookii Gray, 1845*	21	17	30	26	19	12	125	4.75
8		*Hemidactylus flaviviridis Rüppell, 1840*	16	11	28	28	45	30	158	6.01
9		*Hemidactylus frenatus (Schlegel, 1836)*	32	15	13	30	26	25	141	5.36
10	Scincidae	*Eutropis carinata (Schneider, 1801)*	4	3	13	0	7	0	27	1.03
11		*Mabuya macularia (Blyth, 1853)*	9	5	10	11	15	10	60	2.28
12		*Sphenomorphus maculatus (Blyth, 1853)*	9	4	19	7	10	4	53	2.02
13	Varanidae	*Varanus bengalensis (Daudin, 1802)*	8	6	7	8	3	4	36	1.37
14		*Varanus flavescens (Harhwicke & Gray, 1827)*	0	0	0	7	3	3	13	0.49
15	Typhlopidae	*Indotyphlops braminus (Daudin, 1803)*	14	5	23	14	7	14	77	2.93
16	Boidae	*Eryx conica Schneider, 1801*	5	0	0	0	0	5	10	0.38
17		*Python bivittatus Kuhl, 1820*	0	0	0	0	1	1	2	0.08
18		*Python molurus (Linnaeus,1758)*	0	2	2	1	2	1	8	0.30
19	Colubridae	*Amphiesma stolatum (Linnaeus,1758)*	5	20	10	19	10	15	79	3.00
20		*Boiga forsteni (Duméril et al..,1854)*	0	0	12	0	0	0	12	0.46
21		Boiga stoliczkia *(Günther,1868)*	5	6	5	8	4	7	35	1.33

22		*Boiga trigonata (Schneider, 1802)*	12	7	22	5	9	4	59	2.24
23		*Coelognathus helena (Daubin,1803)*	4	8	14	14	8	5	53	2.02
24		*Coelognathus radiatus Boie, 1827*	5	13	13	7	9	11	58	2.21
25		*Dendrelaphis tristis (Daubin,1803)*	9	19	10	12	7	3	60	2.28
26		*Lycodon aulicus (Linnaeus,1758)*	6	8	9	9	14	18	64	2.43
27		*Oligodon russelius (Shaw,1802)*	2	7	3	1	8	9	30	1.14
28		*Oligodon erythrogaster Boulenger, 1907*	5	4	12	3	7	12	43	1.64
29		*Orthriophis hodgsonni (Günther,1860)*	6	6	12	0	4	1	29	1.10
30		*Ptyas mucosa (Linnaeus,1758)*	29	32	43	24	20	18	166	6.31
31		*Trachischium tenuiceps (Blyth, 1854)*	5	1	1	0	0	0	7	0.27
32		*Fowlea piscator (Schneider, 1799)*	14	14	18	15	14	20	95	3.61
33		*Fowlea sanctjohannis (Boulenger, 1890)*	9	0	9	0	0	0	18	0.68
34	Elapidae	*Bungarus caeruleus (Schneider, 1801)*	2	6	7	9	15	14	53	2.02
35		*Bungarus fasciatus (Schneider,1801)*	0	0	0	6	5	9	20	0.76
36		*Sinomicrurus macclellandi (Reinhardt, 1844)*	5	3	6	1	3	6	24	0.91
37		*Naja kaouthia Lession, 1831*	0	0	4	11	6	7	28	1.07
38		*Naja naja (Linnaeus,1758)*	7	7	10	10	14	0	48	1.83
39		*Ophiophagus hannah (Cantor, 1836)*	0	3	4	1	1	14	23	0.87
40	Viperidae	*Trimeresus albolabris Gray, 1842*	16	14	31	16	5	5	87	3.31
41		*Ovophis monticola (Günther,1864)*	10	8	11	5	0	0	34	1.29
	Total		**406**	**381**	**554**	**452**	**435**	**401**	**2629**	**100.00**
	%		**15.44**	**14.49**	**21.07**	**17.19**	**16.55**	**15.25**		

Appendix XX. Diversity indices of amphibians in different habitats of Arghakhanchi

Amphibians	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	0.83	0.83	0.77	0.69	0.52
Margalef's	1.94	1.12	1.50	1.80	1.03
Abundance	175.00	36.00	107.00	257.00	131.00
Shannon-Wiener Index (H')	1.98	1.60	1.73	1.72	1.51
Brillouin Index	1.88	1.41	1.61	1.65	1.43
Simpson's Index (λ)	0.83	0.80	0.80	0.74	0.74
Pielou evenness (*J*)	0.35	0.50	0.39	0.31	0.41
Equitability	0.83	0.99	0.83	0.72	0.84

Appendix XXI. Diversity indices of reptiles in different habitats of Arghakhanchi

Reptile	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	2.38	1.79	1.54	1.10	1.31
Margalef's	4.33	4.06	3.58	1.47	1.64
Abundance	64	138	153	30	21
Shannon-Wiener Index (H')	1.83	2.76	2.16	1.58	1.57
Brillouin Index	1.51	2.52	1.99	1.34	1.27
Simpson's Index (λ)	0.64	0.92	0.83	0.76	0.77
Pielou evenness (*J*)	0.22	0.30	0.28	0.42	0.43
Equitability	0.62	0.91	0.73	0.88	0.88

Appendix XXII. Diversity indices of amphibian in different habitats of Gulmi

Amphibians	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	0.63	0.65	0.46	0.71	0.75
Margalef's	1.51	0.66	0.69	1.94	1.34
Abundance	203	21	76	289	88
Shannon-Wiener Index (H')	1.84	1.00	1.13	2.05	1.42
Brillouin Index	1.76	0.86	1.06	1.97	1.30
Simpson's Index (λ)	0.79	0.61	0.66	0.82	0.63
Pielou evenness (*J*)	0.36	0.56	0.47	0.33	0.33
Equitability	0.84	0.91	0.81	0.82	0.73

Appendix XXIII. Diversity indices of reptiles in different habitats of Gulmi

Reptiles	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	1.85	1.96	1.50	1.02	1.06
Margalef's	3.99	4.09	3.30	1.26	0.96
Abundance	117	187	193	35	22
Shannon-Wiener Index (H')	2.48	2.48	2.26	1.40	1.04
Brillouin Index	2.24	2.22	2.06	1.17	0.75
Simpson's Index (λ)	0.86	0.87	0.90	0.72	0.63
Pielou evenness (J)	0.27	0.29	0.28	0.42	0.42
Equitability	0.83	0.83	0.80	0.87	0.95

Appendix XXIV. Diversity indices of amphibian in different habitats of Palpa

Amphibians	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	0.71	0.79	0.64	0.65	0.52
Margalef's	1.70	1.08	1.12	1.77	0.88
Abundance	201	40	88	284	94
Shannon-Wiener Index (H')	1.99	1.54	1.51	1.85	1.19
Brillouin Index	1.89	1.37	1.40	1.49	1.11
Simpson's Index (λ)	0.82	0.77	0.75	0.78	0.61
Pielou evenness (J)	0.36	0.48	0.42	0.33	0.38
Equitability	0.86	0.96	0.84	0.77	0.74

Appendix XXV. Diversity indices of reptile in different habitats of Palpa

Reptiles	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	2.22	1.83	1.87	1.18	1.28
Margalef's	4.83	4.59	4.75	1.69	1.62
Abundance	117.00	187.00	193.00	35.00	22.00
Shannon-Wiener Index (H')	2.56	2.95	2.67	1.79	1.55
Brillouin Index	2.28	2.73	2.46	1.54	1.27
Simpson's Index (λ)	0.85	0.93	0.90	0.82	0.76
Pielou evenness (J)	0.27	0.29	0.28	0.42	0.42
Equitability	0.80	0.92	0.82	0.92	0.87

Appenddix XVI. Diversity indices of amphibian in different habitats of Nawalparasi

Amphibians	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	0.75	0.62	0.98	0.71	0.51
Margalef's	1.99	0.81	1.66	1.95	1.15
Abundance	253	41	67	284	185
Shannon-Wiener Index (H')	2.08	1.32	1.70	1.99	1.54
Brillouin Index	1.99	1.19	1.53	1.90	1.15
Simpson's Index (λ)	0.83	0.72	0.78	0.82	0.75
Pielou evenness (J)	0.34	0.52	0.38	0.33	0.38
Equitability	0.84	0.95	0.82	0.80	0.79

Appendix XXVII. Diversity indices of reptile in different habitats of Nawalparasi

Reptile	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	2.14	1.65	1.70	1.41	1.15
Margalef's	4.76	3.43	4.22	1.73	1.36
Abundance	126	106	183	18	19
Shannon-Wiener Index (H')	2.68	2.41	2.42	1.72	1.45
Brillouin Index	2.41	2.17	2.23	1.36	1.17
Simpson's Index (λ)	0.88	0.86	0.87	0.81	0.74
Pielou evenness (J)	0.28	0.30	0.28	0.45	0.46
Equitability	0.84	0.85	0.77	0.96	0.90

Appendix XXVIII. Diversity indices of amphibian in different habitats of Rupandehi

Amphibians	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	0.58	0.71	0.57	0.50	0.51
Margalef's	1.58	1.03	1.19	1.26	1.15
Abundance	299	49	153	254	188
Shannon-Wiener Index (H')	1.93	1.45	1.86	1.66	1.59
Brillouin Index	1.86	1.31	1.77	1.60	1.52
Simpson's Index (λ)	0.82	0.74	0.83	0.76	0.75
Pielou evenness (J)	0.36	0.46	0.43	0.37	0.38
Equitability	0.84	0.90	0.96	0.80	0.84

Appendix XXIX. Diversity indices of reptile in different habitats of Rupandehi

Reptile	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	2.18	2.26	1.70	1.30	1.15
Margalef's	4.41	4.74	4.23	1.78	1.52
Abundance	93	104	182	29	27
Shannon-Wiener Index (H')	2.49	2.67	2.31	1.74	1.78
Brillouin Index	2.18	2.37	2.13	1.46	1.50
Simpson's Index (λ)	0.85	0.88	0.85	0.80	0.83
Pielou evenness (J)	0.28	0.28	0.27	0.41	0.46
Equitability	0.82	0.85	0.74	0.90	0.99

Appendix XXX: Diversity index of amphibian in different habitats of Kapilvastu

Amphibians	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	0.67	0.82	0.68	0.56	0.33
Margalef's	1.54	1.11	1.29	1.19	0.74
Abundance	183	37	106	158	223
Shannon-Wiener Index (H')	1.99	1.52	1.69	1.67	1.29
Brillouin Index	1.99	1.34	1.58	1.58	1.24
Simpson's Index (λ)	0.84	0.77	0.79	0.76	0.64
Pielou evenness (J)	0.38	0.48	0.41	0.41	0.39
Equitability	0.81	0.94	0.87	0.86	0.80

Appendix XXXI: Diversity indices of reptile in different habitats of Kapilvastu

Reptile	Agricultural fields	Forest	Human habitat	Riparian	Wetland
Menhinick	2.45	2.82	1.80	1.46	1.30
Margalef's	5.17	5.11	4.44	2.06	1.78
Abundance	104	61	178	30	29
Shannon-Wiener Index (H')	2.79	2.66	2.57	1.92	1.64
Brillouin Index	2.47	2.23	2.37	1.60	1.36
Simpson's Index (λ)	0.90	0.88	0.88	0.84	0.76
Pielou evenness (J)	0.28	0.29	0.28	0.40	0.39
Equitability	0.87	0.86	0.81	0.92	0.84

Appendix XXXII: People perception on snakes in study sites

S.no	Questioners survey	Male		Female	
		Yes	No	Yes	No
1	Can identification of venomous snakes	11	25	3	33
2	Can identification of non-venomous snakes	8	28	3	31
3	Fairs from snakes	36	0	36	0
4	Snake bites on self	2	34	14	26
5	Killing the snakes after seen or bites	23	13	7	29
6	Release or chasing after seen	1	35	2	34
7	Knowledge on importance of snakes for people	2	34	0	36
8	Conservation status on snakes	8	28	3	33

Appendix XXXIII: Habitat wise correlation of species of amphibians in study area

	Amol_ marm	Dut_ mela	Dut_ Stom	Euph_ cyan	Hopl_ cras	Hopl_ tige	Icht_ sikk	Upe_ tapr	Mego_ parv	Micr_ orna	Nan_ libe	Poly_ leuc	Poly_ macu	Spha_ Brev	Spha_ mask	Min_ nepa	Min_ tera
Agri	-0.09	0.32	0.28	0.21	0.22	0.26	0.4	-0.09	-0.2	0.44	-0.13	-0.2	-0.19	0.16	0.44	0.33	0.34
Forest	-0.09	-0.24	-0.12	-0.67	-0.59	-0.53	-0.14	-0.09	0.4	0.09	-0.13	0.95	0.64	-0.15	-0.16	-0.58	-0.62
Human	-0.09	0.62	0.52	-0.36	-0.41	-0.34	-0.14	-0.09	-0.2	-0.28	-0.13	-0.22	-0.11	-0.11	-0.32	-0.32	-0.31
Riparian	0.37	-0.11	-0.04	0.54	0.54	0.42	0.02	0.37	0.21	0.11	0.53	-0.25	-0.15	0.25	0.36	0.47	0.55
Wetland	-0.09	-0.6	-0.63	0.27	0.24	0.19	-0.14	-0.09	-0.2	-0.36	-0.13	-0.28	-0.19	-0.15	-0.32	0.1	0.04

Appendix XXXIV: Habitat wise correlation of species of reptiles in study area

	Agri	Forest	Human	Riparian	Wet
Amphi_sola	0.25	-0.33	-0.27	0.37	-0.02
Boiga_fors	0	0.29	0	-0.14	-0.14
Boiga_ochr	0.19	0.28	0.42	-0.45	-0.45
Boiga_trig	0.41	0.13	0.17	-0.35	-0.35
Bunga_caer	0.16	-0.14	0.75	-0.38	-0.38
Bunga_fasc	-0.06	-0.11	0.56	-0.17	-0.22
Calot_vers	0.3	0.24	0.44	-0.46	-0.52
Coelo_hele	0.19	0.58	0.08	-0.42	-0.42
Coelo_radi	0.3	0.3	0.16	-0.37	-0.4
Croco_palu	0.12	0	0.19	-0.14	-0.16
Dendr_tris	-0.05	0.81	-0.16	-0.28	-0.32
Eryx_sp	0	0	0	0	0
Eutro_cari	-0.11	0.57	0.12	-0.29	-0.29
Hemib_macc	0.12	0.05	0.52	-0.34	-0.34
Hemid_broo	-0.24	-0.24	0.95	-0.24	-0.24
Hemid_flav	-0.23	-0.23	0.93	-0.23	-0.23
Hemid_fren	-0.22	-0.19	0.85	-0.22	-0.22
Lauda_tube	-0.05	0.59	-0.18	-0.18	-0.18
Lisse_punc	0.1	-0.3	-0.3	0.06	0.43
Lycod_auli	0.32	-0.4	-0.08	0.32	-0.16
Mabuy_macu	-0.03	0.85	-0.06	-0.38	-0.38
Naja_kaou	0.2	0.2	0.26	-0.33	-0.33
Naja_naja	0.01	0.33	0.48	-0.4	-0.4
Oligo_arne	0.43	-0.24	0.48	-0.34	-0.34
Oligo_eryt	0.51	-0.2	0.42	-0.36	-0.36
Ophio_hann	-0.07	0.48	-0.07	-0.17	-0.17
Oriot_tric	0.02	0.11	0.38	-0.25	-0.25
Orthr_hodg	-0.16	0.35	-0.07	0.02	-0.13
Ovoph_mont	-0.02	0.14	0.16	-0.12	-0.14
Ptyas_muco	0.14	0.22	0.12	-0.34	-0.14
Pungs_smit	0.27	-0.24	-0.24	0.1	0.1
Pytho_bivi	-0.13	0.53	-0.13	-0.13	-0.13
Pytho_molu	-0.13	0.5	0.08	-0.23	-0.23
Ramph_bram	0.26	0.53	-0.06	-0.36	-0.36
Sphen_macu	0.02	0.7	-0.05	-0.34	-0.34
Trach_guen	-0.15	-0.06	-0.15	0.23	0.13
Trime_albo	0.17	0.61	-0.07	-0.36	-0.36
Varan_beng	0.15	0.71	-0.29	-0.29	-0.29
Varan_flav	0.19	0.43	-0.21	-0.21	-0.21
Xenoc_pisc	-0.22	-0.44	-0.32	0.56	0.41
Xenoc_sanc	-0.15	-0.15	-0.01	0.26	0.05

Appendix XXXV : Identification keys of herpetofauna

Key to Orders of Class Amphibia

1a. Tentacular organ is present in adults; without limbs; eyes presents or absent. Annulated skin on body and sub-dermal scales..................... Gymnophiona

b. Tentacular organs are absent; limbs present........ 2

2. Body skin is usually if not invariably showing segmentation; without tympanum; presence of four limbs and tail... .... Caudata.

3. The body consists of shorten but absence of tail……………………….Anura.

Key to the families of the order Anura

1a. Large parotoid glands are present; jaws toothless; skin warty, rough and dry; tongue oval and pupil horizontal ……… …………Family **Bufonidae**

1b. Large parotoid glands are absent …………………………………………………2

2b. Body structure is not toad-like, and skin smooth or has a few warts and moist. The upper eyelid has no sharp edge, and the tip of the snout does not extend far over the mouth 3

3a. Head is very small and pointed; without or with tympanum; mouth narrow and pointed, toothless jaws; tongue oval; pupil vertical and circular; body roundish and solid; skin smooth and SVL below 35 mm …… Family **Microhylidae**

3b. Head is not relatively small; tympanum is mostly present; jaws toothed; body is not roundish and stocky; SVL mostly over 35 mm ……......… 4

4a. Fingers and toes have adhesive pads; toes two-thirds to fully webbed; maxillary teeth on upper jaw; the presence of a short extra cartilaginous part between the ultimate and penultimate toe segment; arboreal forms...Family **Rhacophoridae**

4b. Fingers and toes have with or without adhesive disks; if disks on finger without webbed; upper jaw with maxillary teeth; without claw-shaped on fingers and toes; aquatic and terrestrial forms ………………………… Family **Ranidae**

Key to the genus of Bufonidae

Key to species of Genus *Bufo / Duttaphrynus*

1. Top of head has got bony supraorbital ridges; postorbital and orbito-tympanic crests; parotoid glands are bean shaped; warts on body with black tips; distinct tympanum …………………………………… *Duttaphrynus melanostictus*

2. Bony ridges are absence on head; parotoid glands are flat and elliptical; tarsal fold indicated by a weak spinulated line …………..…*Duttaphrynus stomaticus*

Key to the genera of Microhylidae

Presence of two small, normal (not shovel-shaped) and distinct inner pedal tubercles with elliptical tongue. ------------------***Microhyla***

Key to the species of *Microhyla*

1. Shovel-like inner and outer metatarsal tubercles where the inner tubercle is larger, SVL > 45 mm in adults …………………………………… 2

2 a. Body is slender, bullet shape; tongue elliptical; a dermal ridge between internal naris; 2 normal metatarsal tubercles; inner metatarsal tubercle present; outer metatarsal tubercle absent; SVL > 25 mm in adults. Tibio-tarsal articulation reaches slightly in front of shoulder; toes has rudiment of web. *Microhyla ornate*

2b. Finger tips are enlarge; triangular; anteriorly truncated adhesive disks; broad reddish-orange or red inter-orbital and lateral bands *Uperodon taprobanicus*

Key to the genera and species of Ranidae

1a. Toes and fingers have distinct large digital pads; groove separated the upper and lower surface of discs; mountain brooks ……. *Amolops*

Dorso-lateral fold present, dorsal side is smooth, grey-brown with few irregular darker spots ... *Amolops monticola.*

1b. Fingers and toes are not enlarged adhesive pads …2

2a. Inner metatarsal tubercles are very large, sharp-edged; larger than the inner toe; habitus stocky; almost globular; tibio-tarsal joint reaches between axilla and tympanum ….. … ……… *Sphaerotheca* (*Tomopterna)*

2b. The habitus is toad-like; the first finger extends far beyond the second; and the tympanum is about half the size of the eye. Toes are short; tibio-tarsal tubercles are flattened; metatarsal tubercles are flattened; distal tubercle on first toe present; inner metatarsal tubercle shovel-shaped …*Sphaerotheca breviceps*

2c. Head is distinctly wider than long; dorsum with homogenous granulation; larger warts or tubercles are absent; tibio-tarsal joint reaches posterior border of tympanum, throat and pectoral region smooth but granular skin between axilla and groin. Dorsum is reddish brown; with a more or less distinct triangular mark on the shoulder region …….. .. *Sphaerotheca maskeyii*

2d. Inner metatarsal tubercle shorter than 1st toe, rather blunt; tibio-tarsal joint reaches the eye or farther ……………………………………………... 3

3a.Males have spinose; they usually keratinize during the reproductive period; nuptial fields on fingers; metacarpal tubercles, arms and the pectoral or anal regions; tympanum usually indistinct and covered by the supra-tympanal fold; mountain brooks ……………………………………………………………..… 4

3b. Males never have spinose at nuptial time; tympanum large and distinct; supra-tympanal fold extends above the tympanum without covering it; standing or slowly running water ……………………………… . 5

4. The tympanum is small about half the size of the eye and is generally partially hidden by the supra-tympanic fold. Nuptial fields of males lie on fingers; metacarpal tubercles on arms and pectoral regional thickened …………………………… … *Nanorana*

Pustules and granules on skin; a glandular dorso-lateral fold that is frequently interrupted; a moderate tibia; males with horny spines on the first three fingers duringreproduction; metacarpal tubercle; thickened forelimbs; tibio-tarsal articulation reach to tip of snout, or beyond; SVL 53 to 117 mm ………. *Nanorana liebigii*

5a. Adults has got persistent lateral line system; eyes positioned conspicuously dorsal; tympanum usually smaller than eye; posterior sides of thighs with characteristically dark/pale stripes; skin of back with tubercles and warts. The lower surface is smooth with a single row of porous warts on each flank; tip of toes swollen …….. *Euphlyctis cyanophlyctis*.

5b. Adults have not got lateral line system; eyes usually positioned laterally; without stripes on posterior sides of the thigh; no dorso-lateral folds; longitudinal folds or elongated tubercles on dorsum………………………………… ... 6

6a. SVL is between 61.0 – 135.0 mm in adult; large inner metatarsal tubercle as long as 1st toe (either semicircular and shovel-shaped or flattened and narrow); absence of outer metatarsal tubercle; except for the fourth toe, the toes are webbed to the tips; predominantly dull brown; vivid green with dark spots or blotches .. *Hoplobatrachus*

Large irregular black spots can be seen in the gular and pectoral areas, and a large shovel-shaped inner pedal and inner meta-tarsal tubercle; habitus stocky; legs relatively short.The toes' tips are not pointed; instead. They are completely webbed and sharply notched ……………. .. *Hoplobatrachus crassus*

The gular and pectoral regions have dots; the inner metatarsal tubercle is flat, oblong, and blunt. The habitus is not stocky; the legs are not relatively short; the skin of the back has longitudinal folds; the dorsum has longitudinal folds; and supra-tympanal folds are present. The toes are nearly entirely webbed. A white or pale yellowish middorsal line goes from the snout to the vent….. *Hoplobatrachus tigerinus*

6b. SVL of adults has 27.0-56.0 mm; inner metatarsal tubercle oval and significantly shorter than 1st toe; small roundish outer metatarsal tubercle; no web on toes to tips; tibio-tarsal joint reaching to anterior border of eye or a point between eye and tip of snout. The colour is predominantly greyish olive or greyish brown with dark spots and often with red; orange or green spots on the dorsum …... *Minervarya/Zakerana / Fejervarya* / *Limnonectes*

Key to the species of *Minervarya*

1 Always mid-dorsal line or band is present and head as long broad. The adult males' throats are very pale medially, fingers free; hind limbs distinctly striped, with moderately webbed toes. … *Minervarya nepalensis*

2 Frequently with mid-dorsal line; dorsal side with long longitudinal folds; head relatively long and pointed; hind limbs weakly barred; Tips of the fingers and toes are rounded ……………………………………*Minervarya teraiensis*

Key to the genera of Rhachophoridae

1. Presence of vomerine teeth; finger webbed or rudimentary or lacking; SVL 30 mm or more in adults …………………………… ……………..…2

2a. Skin on dorsum of head is ossified to the cranial bones …… 3

2b. Skin on dorsum of head is not ossified to the cranial bones. Head is only a little wider than longer, fingers slightly webbed; tibio-tarsal joint reaches snout tip; disk of 3rd finger not more than half diameter of eye; an intercalary ossification present between the distal and penultimate phalanges; dorsum usually uniform colored or in some specimens spotted with dark; rarely with an hour-glass shaped mark; arboreal ….... *Polypedates maculatus*

3 Head is distinctly wider than long, rugose, with skin adhering to fronto-parietal bones; digits are provided with spherical adhesive pads. Fingers has rudimentary webbing and the toes are two-thirds webbed. Dorsum is uniform or with pattern of dark spots; usually with an hour-glass shaped mark; tongue bifid; SVL in adults 50 – 75 mm ……… *Polypedates leucomystax*

Tadpoles

Field identification of tadpoles is notoriously difficult and often not exact. Furthermore, some identification cannot be reliably made past the genus-level in the field. The structure of the mouth parts are used in laboratory identification. The oral disk and head shape, examining the location of the anal opening, structure of the tail, dorsal patterning and pigmentation, color of the venter, and eye placement are necessary to make an identification.

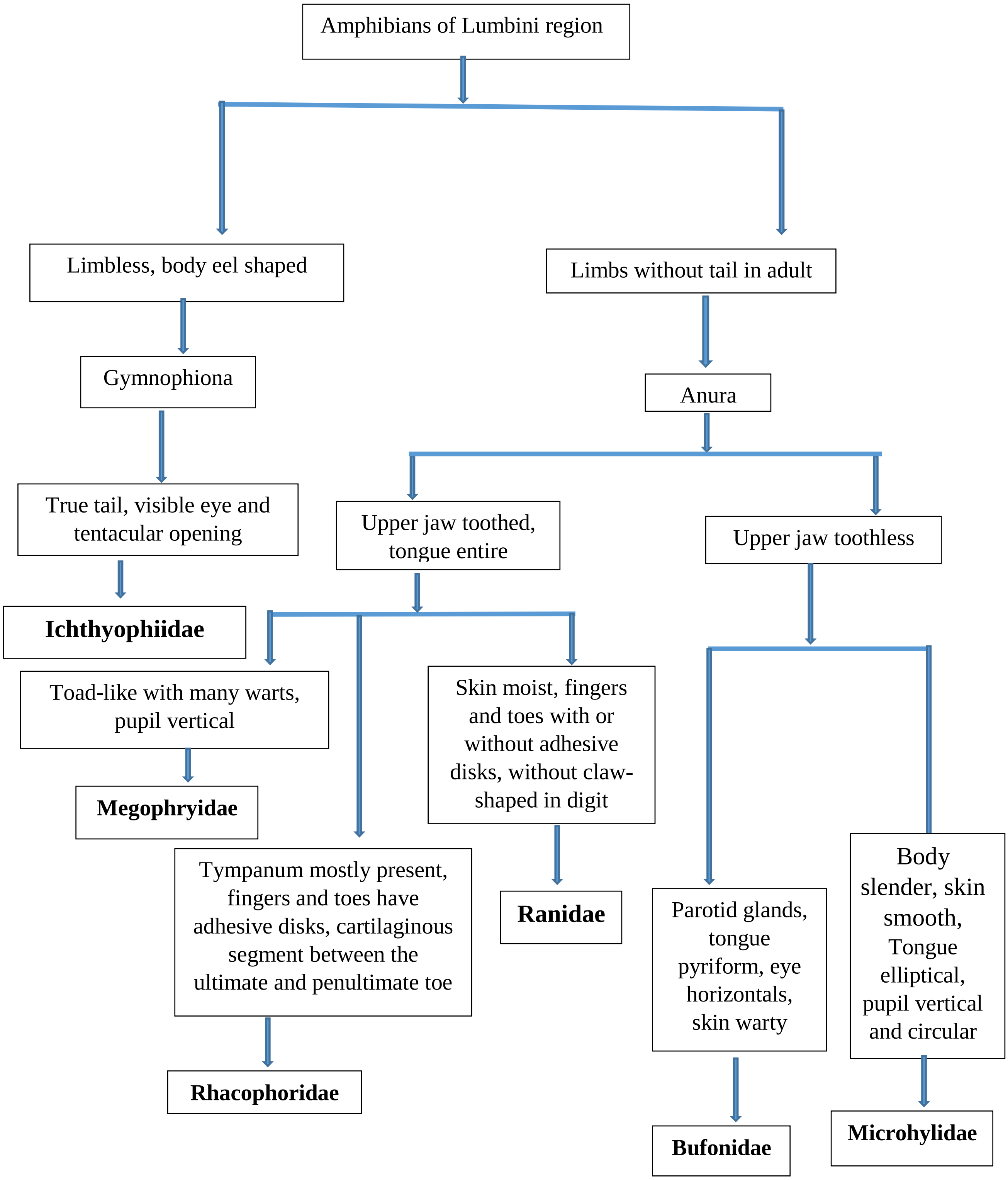


Figure 8.1: Flow chart of identification of Amphibians of Lumbini region up to families

Keys for Identification of reptiles

Order and suborders of Reptiles

4a. Body with shell ……………………… order Chelonia

4b. without shell ………………………. Suborder Sauria

Key to the families of the order Sauria

1. Four limbs are present ...2

2a. Eyes with movable eyelids . 3

2b. Eyes without movable lids; pupil vertical covered with a transparent membrane; head broad, covered with small granules; digits dilated Family **Gekkonidae**

3a. Head covered with large symmetrical plates; scales not or only slightly keeled; tongue with imbricate; scale-like papillae no femoral or pre-anal pores

Family **Scincidae**

3b Head covered with small scales .. 4

4a. Nostrils are obliquely slit; very large forms with a long bifid tongue, sheathed at base throat with a transverse fold …………………………Family **Varanidae**

4b. Head with symmetrical shields above; numerous very small scales; eyes withouttransparent

Key to the genusand species of Gekkonidae

Digit dilated at the base, the distal joint compressed; dilated part of digits with a double series of lamellae below, distal end of digits narrow; without flap-like skin folds on the body and tail sides; dorsal scales granular; smaller or lacking toe webbing: …………………………… *Hemidactylus*

1. Dorsal conical tubercles are large and numerous, with a rough appearance, and are placed in a rather regular longitudinal series; 7 to 10 lamellae, strongly keeled below the fourth toe; brown patches in a row. … *Hemidactylus brookii*

2. Tail round or oval in cross section with or without a denticulate lateral edge, distinctly segmented 3

3a.Tail not strikingly enlarged in adults; dorsal granules uniform or with scattered small, round, convex tubercles; size moderate, SVL up to 80 mm, free distal phalanx of inner digit scarcely exceeding the dilated portion; inner toe not half the length of the second, male has a continuous series of pre-anal-femoral pores … *Hemidactylus frenatus*

3b. Tail is more or less swollen at the base, without denticulate on lateral edge. Back has a pattern of undulating light and dark transverse lines, enlarged tubercles above, SVL up to 91 mm, free distal phalanx of inner digit markedly exceeding the dilated portion, inner toe well developed, more than half the length of the second, males have femoral pores only which are separated by a gap of at least 6 scales in the anal region … *Hemidactylus flaviviridis*

Key to the genus and species of Scincidae

1a. Supra-nasal present …2

1b. No supra-nasal ...3

2. Limbs well developed, dorsal scales have several keels …..… *Mabuya*

The tympanum, if present, is more or less depressed; movable eyelids, but the claws cannot retract. The palatal notch extends anteriorly to an imaginary line linking the centers of the eyes, and the pterygoid bones are separated along the median line of the palate.

2a. Lower eyelid scaly, dorsal scales with 3, 5, 7, or 9 keels … 2c

2b. Dorsal scales mostly have 3 or 5 keels, 30 to 84 scales round body; no post nasal, fronto-nasal wider than long, with a striking light dorso-lateral band ... … M*abuya carinata /* (*Eutropis carinata*).

2c. Dorsal scales mostly have 5 or 7 keels, no light dorso-lateral band flanks often have white dots, anterior loreal deeper than second M*abuya macularia*

3. Lower eyelid scaly; no enlarged nuchals .... *Sphenomorphus*

There are 38 or more scales around the body; 5 supra-oculars, 1st largest; 5th smallest; rostral above flat or concave. Usually found along rivers; …………… *Sphenomorphus maculatus*

Key to the genera and species of Agamidae

1a. Tail scales are verticillate. Body depressed andusually found on rock *Laudakia tuberculata*

1b. Tail scales are not verticillate …2

2a. Dorsal scalesare heterogenous; often a dorsal pattern of stripes … 3

2b. Dorsal scales are uniform in size and placed in a regular pattern. There is no or a very tiny fold across the throat; the tympanum is clearly defined *Calotes versicolor*

3. Tympanum normally exposed and dorsal crest of low cones. A prominent crest of 6-8 conical scales on each side of the back of the head; not interrupted behind the neck; nuchal and dorsal crest scales much wider than high; with a broad base; throat of males has no dark patch …..*Oriotiaris tricarinata*

Key to the genus and species of Varanidae

1. Nostril closer to orbit than to tip of snout; neck scales no larger than pileus scales; smooth ventral scales; supra oculars equal …… *Varanus bengalensis*

2. Nostril nearer to the snout tip than to the orbit; neck scales distinctly larger than pileus scales ...... *Varanus flavescens*

Key to the families Serpentes

1a. More than 40 scales are around the body; pre-frontals forming a suture with nasals; supra-temporal large, suspending the quadrate; quite distinct narrow ventrals; vestiges of hind limbs at both sides of the cloaca … Family **Boidae**

1b. Less than 40 scales are a round the body, ventrals almost as large as the body no vestiges of hind limbs ……. 3

2a. The maxillary bone has poison fangs in the front of the mouth . ……….4

2b. No poison fangs or premaxillary teeth on the front maxillary bone; one or more loreals; ventral scales nearly as wide as the body; cylindrical and pointed tail ……….. **Colubridae**

3a. The maxillary bone has teeth behind the fangs, but the loreal bone is lacking. The pupil is circular; no pit between the eyes and the nostrils; the neck is significantly wider, and the scales are usually smooth. Ventral scales are nearly as wide as the body; with a cylindrical tail …… ……..………**Elapidae**

3b. A pit organ located between the nostrils and the eye; a very short, vertically erectile maxillary bone with no teeth other than the poison fangs; a head covered in many little scales; and an oval or vertical pupil ……….**Viperidae**

Key to the genera and species of Boidae

1. Pre-maxillary teeth and supraorbital bone are present; the head has broad symmetrical shields; labial scales are pitted; and the subcaudals are in two rows. .... *Python*

1a. Two supralabials and the rostral shield are pitted, and there are large scales on the upper head; the eyes are large, the pupil vertically elliptical, and the sixth and seventh scales touch the eye; 62–69 scales across the body; ventral 252-265; caudal 61–67 . ... *Python molurus*

1b. Rostral, anterior supralabials and infralabials are pitted; eyes are large, pupil vertically elliptical; 6^{th} and 7^{th} supra labial are separated by sub-ocular from the eye; 67 scales across the body; ventral 257; caudal 62 scales ..*Python bivittatus.*

2. Supraorbital bone is absence, no pre-maxillary teeth; small scales on head and labials not pitted; a mental groove....... *Eryx*

The tail is pointed and short, without a mental groove .... *Eryx conicus*

Key to the genera of Colubridae

1a. All the teeth are solid, without grooves ………..2

1b. All the teeth are not solid, the last 2 or 3 maxillary teeth are grooved ………10

2a. The posterior maxillary teeth are the longest; with rounded pupil;, and there are no hypapophyses in the posterior dorsal vertebrae …..3

2b. Rounded pupils; the maxillary teeth are subequal ………4

2c. The front maxillary teeth (some of the front most teeth) are larger and fang-like; the pupil is vertical and indistinct; 15-19 rows of scales are present ……*5*

3a. There are 20–28 teeth, which gradually enlarge; 2–3 loreals are present; scales are arranged in 15–18 rows (17, 16, 18 or 15 rows) .... *Ptyas*

3b. The rostal is clearly visible and extends well on the upper side of the snout; the head and neck are slightly distinguishable, while the body scales are smooth and organized into 13–21 rows .... *Oligodon*

4a. 19-27 rows of scales are in mid body and presence of apical pits on scales ..... *Elaphe/ Coelognathus*

4b. Head is indistinct from neck; 13-15 rows of oblique scales; vertebral scales are enlarged .... *Dendrelaphis*

5a. The pupil of the eye is dark, and the sub-caudal scales are divided. There are 15-17 rows of smooth or feebly keeled scales .... *Lycodon*

6a. The post-maxillary teeth are the longest; rounded pupil; there are two inter-nasal shields; the anterior post-mental is shorter than the posterior post-mental; the hypophysis on the post-dorsal vertebrae is well developed. …………… ……. 7

6b. Pupil is round; one inter-nasal shield is present. Nostril is directed forwards and outwards …………….. ..…… 8

7. The body is slender, with 17–19 scale rows and 19–30 maxillary teeth...*Amphiesma*

8a. The body is covered in 19 rows of sharply keeled scales, with the nostril positioned within the nasal shield............ *Xenochrophis / Fowlea*

8b. 13–15 rows of scales cover the body, and a regular or single prefrontal shield with 18–20 teeth covers the skull. .... *Trachischium*

9. Posterior dorsal vertebrae mayor may not have hypapophyses.

9a. Vertically elliptic pupil; 19–29 rows of more or less oblique scales on the body; expanded vertebral scales; maxillary solid teeth; 10–14 are sub-equal in number .... *Boiga*

Key to the species of *Ptyas*

1. Supralabials are eight or fewer; two or three loreal; regular dark border scales; 17 or 16 rows at mid-body; with 190–213 vertebral scales.............. *Ptyas mucosus*

Key to the species of *Oligodon*

1. Head has 3 inverted V-shapes dark mark stripe, lorial one; separate from one another; supralaial 7; scales in 17 rows at mid-body; ventral 164- 202................ *Oligodon russelius*

2. The mid-body bears 17 rows of scales; three distinctive marks on the head; including an extended dark spot between the anterior crescent and the nuchal chevron; lorial absent; ventral 169–186 ....*Oligodon erythrogaster*

Key to the species of *Elaphe / Coelognathus*

1. The black stripe along the side of the head is absent; the lorial is present; the last labial below the eye touches the temporal; mid-body has 23–29 rows of scales; the ischiadic region is strongly keeled; the ventral are well marked, and the laterals are keeled .... *Elaphe helena/ Coelognathus helena*

2. The rostral is as wide as it is high; usually 8 supra-labials; the 4th and 5th touch the eye; no black stripes projecting from the eye; 23 rows of scales on the mid-body; anal 2 and ventral; 233-247. .... *Elaphe hodgsoni / Coelognathus hodgsoni*;

3. The occiput bears a black line; a black streak lies below and two behind the eye; dark collar extending from neck to mid body; last labial below the eye touch the temporal; 19 rows of scales at mid-body; strongly keeled on hinder part of back; scales of the ischiadic region strongly keeled .... *Elaphe radiate / Coelognathus radiate*

Key to the *Dendrelaphis*

1. The distance between the nostril and the eye is the same length as the distance between the nostril and the eye. A light lateral band and a more or less distinct temporal stripe are visible on the body. The 5th and 6th supra-labials touch to the eye, and the posterior maxillary teeth are usually shorter than the others. .... *Dendrelaphis tristis*

Key to *Lycodon* species

1. Loreal is broad contact with the internasals; snout projecting beyond the lower jaw; posterior and anterior nasal scales are equal in size; 9 supra-labials, 3rd, 4th, 5th touching the eyes. Scales are smooth; 17 rows at mid body; ventral angulate laterally; anal 1 or 2 ……………………… .... *Lycodon. aulicus*

Key to *Amphiesma*s

1. No nuchal groove, intemasals much narrowed anteriorly; a single anterior temporal, 3 labials entering eye, two light stripes down the back; scales in 19 rows; less than 160 ventral scales .... *Amphiesma stolata*,

Key to *Fowlea*

1. Scales are in 19 rows in mid body, keeled, two oblique black stripes from the eye on head; one below and the other behind the eye; with pattern of dark spots; 2 anterior temporal; and 2 labials entering eye are present. Ventral includes 122-168; sub-caudal 60-97 ………………....... *Xenochrophis/ Fowlea piscator*

2. Orbito-labial stripes are indistinct; a single labial entering eye; 2 anterior temporal, dorsum yellowish green, unicolor ... . *Fowlea sanctijohannis*

Key to the species of *Trachischium*

Dorsal scales are in 13 rows over whole body. Head scales include 1; prefrontal; 2 post-oculars, and 6 supra-labials …….. …*Trachischium tenuiceps*

Key to *Boiga*

1. Scales are arranged in 19 rows in the midbody; the body is uniform brown above; the back of the neck has three longitudinal stripes, the middle of which projects forwards on the top of the head to the fornial shields; Ventral scales are 223-252 and caudal 100-119 … …. *Boiga stoliczkia*

2. There are no spherical, oval, or irregular patches on the body, and the scales are arranged in 25–29 or (19) rows, and the anterior palatine bone and mandibular teeth are much larger than the others. Ventral scales vary from 248 to 255, whereas caudal scales range from 102-121. …... *Boiga forsteni*

3. There is vertical pupil, 8 upper-labials, huge nostrils in a pair of nasal scales; 3 labials touching the eye, and 1 pre-ocular; distinct the head and neck. The dorsal scales are under 23 (21) rows; the vertebral are feebly extended; with rounded or obtusely pointed posterior margins; and there is a dorsal series of branching dots …………………………… *Boiga tricarinata*

Key to the Genus Elapidae

1a. Scales arranged obliquely; especially on the neck; form a hood; the third upper labial meets the eye; and the posterior nasal ……………………… …2

1b. Scales aren't arranged obliquely, and same number of rows across the body 3

2a. Scales arrange on the body in 15–25 rows; placed obliquely; with more on the neck and no occipital shields .... *Naja*

2b. 15 rows of scales present on middle of the body, and 2 large occipital shields are present .... *Ophiophagus*

3a. The sub-caudal are usually single, the vertebral rows are larger; and the third upper labial does not touch the back of the nasa............................ *Bungarus*

3b. The scales are arranged in 13–15 rows across the body; the sub-caudal are paired; but the vertebral scales are not enlarged; The 3rd supra-labial contact at the posterior of the nasal and eye .... *Callophis /Hemibungarus*

Key to *Bungarus*

1. There is no ridge down the back, and the tail is pointed. The frontal is significantly longer than it is wide, and the second supralabial is almost as wide as the third. The midbody bears 15 or 17 rows of scales, with rare exceptions of 17: 19: 17 rows; the back has short white corss-bars organized in pairs, most prominently posteriorly. *Bungarus caeruleus*

2. Back with black and yellow alternate stripes; sub-caudal single, blunt tail with obtusely finger-like tip; dorsal vertebrae forms a ridge down the back ……. *Bungarus fasciatus*

Key to Genus *Callophis*

1. Prefrontal not in contact with any supra-labial; pre-ocular separated from nasal; one pre-ocular, 2 post ocular, temporal 1+ 1; supra-labials 7, anterior chinshields in contact with 3 labials; and anal 2. Body dorsally red or brownish with dark vertebral line, upper head contrasting black and white …… *Callophis macclellandi/ Hemibugarus macclellandi / Sinomacrurus*

Key to the species of *Naja*

1. Hood mark consists of monocellate or mask-shaped; throat pattern is usually distinct; two cuneate scales, usually less than 29 scale rows at the level of 10th ventral ... *Naja kaouthia*

2. Hood mark comprises spectacle-shaped or absent, throat pattern is often indistinct; lateral spots usually encroach on second dorsal scale row; one cuneate scale lies on anterior to the fifth infra-labial; more than 29 scale rows at the level of 10th ventral ……. *Naja naja*

3. With large occipital shields, dorsal in 15 rows; Yellow or white chevron mark occurs along the body axis …… …….. O*phiophagus hannah*

Key to the subfamilies of Family Viperidae

Each side of the snout has a loreal pit, which is generated by hollowing out the maxillary bone. .... Subfamily Crotalinae (Pit-vipers)

Without a pit organ (Absent in study area) *Vipera russelii*

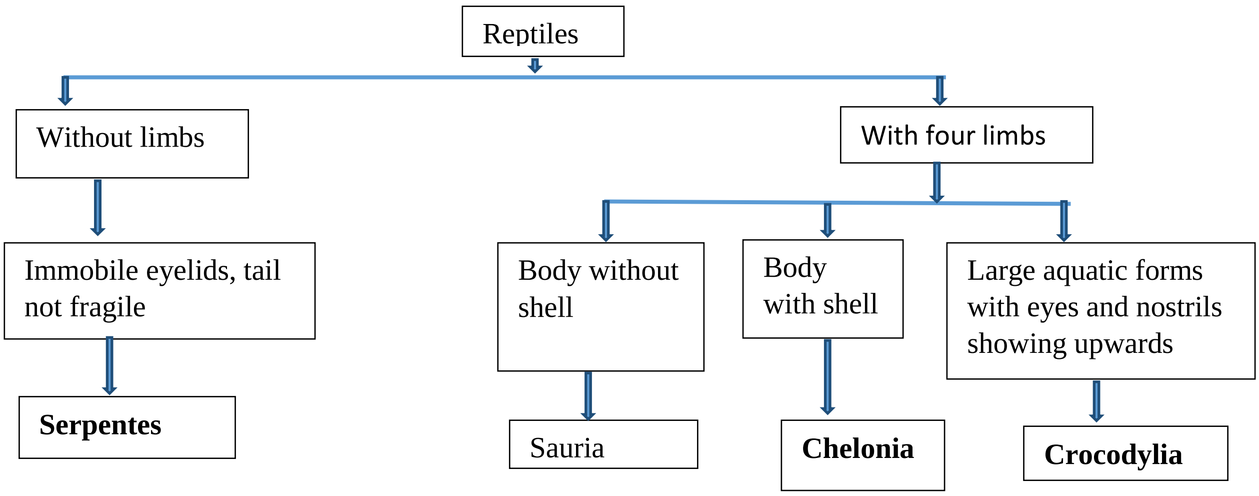
Key to the Genera of the Subfamily Crotalinae

1. Small scales covered head; and small scales completely replace the frontal which is led and followed by the many scales ………. *Trimeresurus*

Key to the species of the Genus *Trimeresurus*

1. Upper head scale are flat, supra-labials 10- 12; temporal smooth or feebly keeled; body scales are distinctly keeled; in 21 or 23:21 (10):15(17) rows; ventral 152-176 ..…………………………………. …. *Trimeresurus albolabris*

2. Supra-oculars are broad, with 5 to 8 series of scales separating them; the upper region of the second supralabial includes a furrow that leads into the loreal pit. The scales are feebly keeled; 127–176 ventral …*Ovophis monticola monticola*



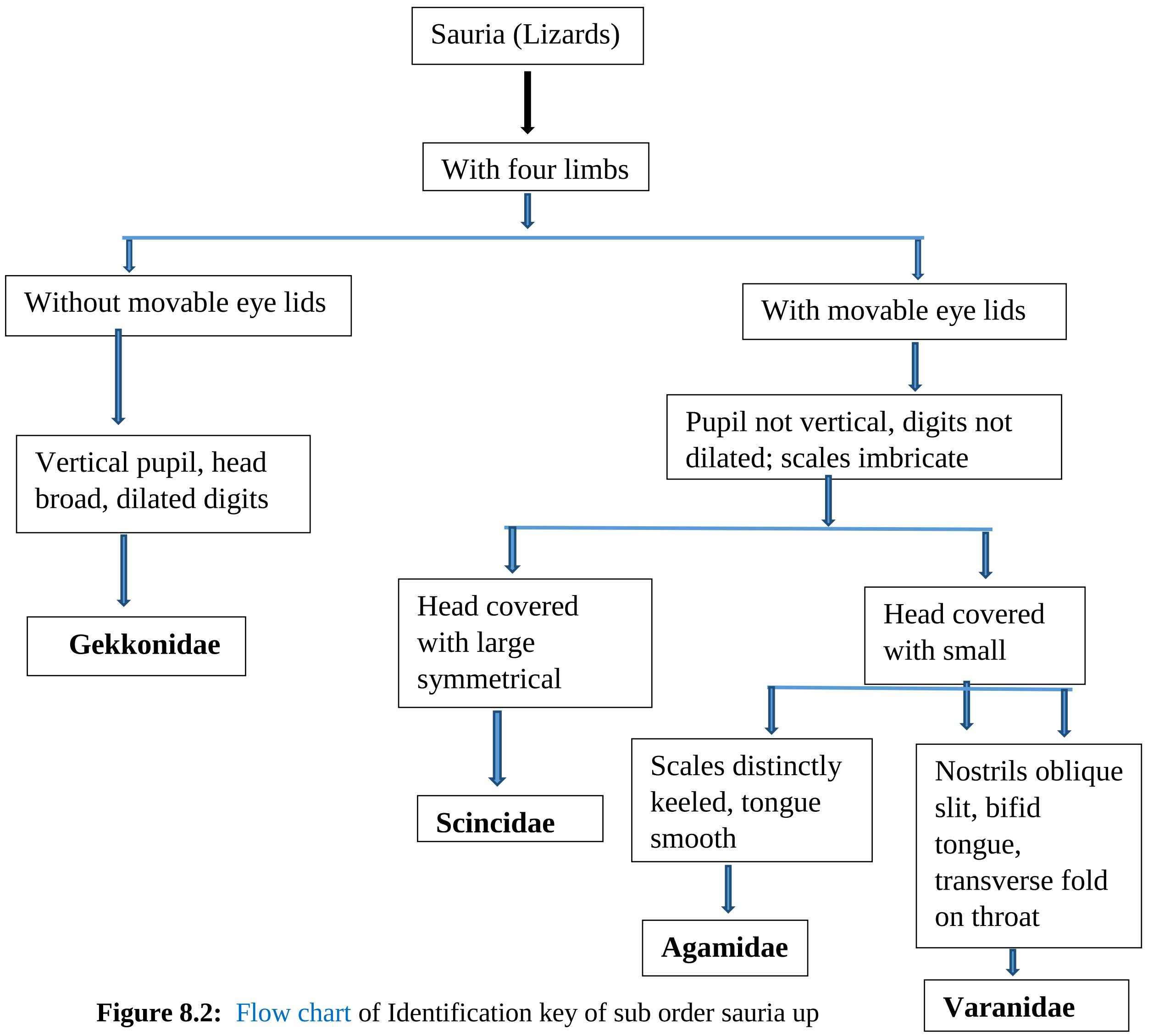


Figure 8.2: Flow chart of Identification key of sub order sauria up

Sub-order Serpentes

- Eyes rudimentary, head not distinct, short tail with spine
  - **Typhlopidae**
- Eyes exposed, head distinct, medium sized tail, ventral scales large teeth in jaws
  - More than 40 scales round the body; ventral narrow, with spur-like rudimentary hind limbs (giant snakes)
    - **Boidae**
  - Poison fangs on the maxillary bone, Less than 40 scales round the body
    - Pupil round; no pit between the eyes and the nostrils, lorial absent, scales usually smooth
      - **Elapidae**
    - Head triangular, pupil vertical; a pit between the eyes and the nostrils, scales keeled
      - **Viperidae**
  - No poison fangs on the maxillary bone, rounded pupil, mental groove is present.
    - **Colubridae**

Questioners

Can identify of venomous snakes?

Can identify of non-venomous snakes?

Can you feel fairs from snakes?

Do you have snake bites on self?

Do you kill the snakes after seen or bites?

Do you release or chasing after seen?

You have knowledge on importance of snakes for people?

Do you know the conservation status on snakes?

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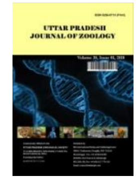

DOCUMENTATION OF HERPETOFAUNAL DIVERSITY IN NAWALPARASI DISTRICT, NEPAL

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author PBN had searched different related literatures, designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author NBS managed sample analyses and did grammatical correction. Both authors read and approved the final manuscript.

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ABSTRACT

The study aimed to (i) prepare a checklist of the amphibians and reptiles of the low to mid-elevation and (ii) measure the abundance, distribution, and diversity of the herpetofauna of Nawalparasi district, Nepal. The samples were collected at six different sites in the habitat of agricultural field, human habitat, forest, riparian, and wetland of Nawalparasi, Nepal from May 2016 to April 2019. In each habitat type, 20 cell quadrates were sampled and altogether 100 quadrates in each site. Besides this, visual encounter surveys, opportunistic surveys, and pitfall were conducted seasonally. Altogether 44 species of herpetofauna belonging to 12 species of amphibians 32 species of reptiles were recorded. The richness of amphibians is greater in agricultural fields (S=12) and lower in the forest (S=4) and reptile's richness was greater in the forest (S= 24) and lowest in the wetland (S=6). The abundance of amphibians in agricultural fields was more than in other habitats. Shannon diversity index (H') of amphibians in agricultural fields was higher (2.07) and lowest in the wetland (1.54) and reptile 2.68 and 1.45 respectively. Similarly Simpson index of amphibians were 0.83, 0.72, 0.78, 0.82, 0.75 and 0.88, 0.86, 0.87, 0.81, and 0.74 in reptiles in such habitat respectively. Pielou evenness index ranges from 0.33 to 0.52 in amphibians and 0.28 to 0.46 in reptiles. The values indicate that amphibians in agricultural fields are more diverse compared to the forest and agricultural fields are more diverse compared to the wetlands in the reptile. Information on herpetofaunal abundance and diversity helps to control insect pests, detect environmental pollution, maintain healthy ecosystems, and aid future research.

Keywords: Agricultural field; diversity indices; forest; habitat; human habitat; riparian; wetland.

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1. INTRODUCTION

Herpetofauna is cold-blooded vertebrates including amphibians and reptiles. They are diverse and cryptic vertebrates and serve as excellent bio-indicators of stressed ecosystems [1]. They are dependent on terrestrial and wetlands or aquatic habitats. They can spend their life span in almost all habitat types for nesting, hibernating, aestivating, dispersal, biological functions, etc. There is an interrelationship between terrestrial and neighboring wetlands for spending life activities of them [2]. The amphibian shows bimodal life and has three orders (Anura, Caudata, and Gymnophiona). The order Caudata includes limbs with tail animal (e.g. salamanders and newts), Anura includes limbs without tail (e.g. toads and frogs), and Gymnophiona caecilians are limbless amphibians like *Ichthyophis*. Reptiles have their three representative orders of Crocodylia (crocodiles), Testudines (turtles and tortoises), and Squamata (lizards and snakes). Reptiles occupy and live in a great variety of aquatic and terrestrial habitats [3]. According to Frost [4], there are currently 8106 species of amphibians, Order: Anura (7149 sp.), Order: Caudata (743 sp.), and Order: Gymnophiona (214 sp.) and 11,050 reptile species reported worldwide [5].

A review of available literature revealed that limited study of Nepalese herpetofauna was made by some herpetologist such as Swan and Leviton [6], Fleming and Fleming [7], Kramer ([8], Joshi [9], Nanhoe and Ouboter [10], Shah and Giri (1991), Schleich [11], Shah [12], Shresths [13] Schleich and Kastle [14], Shah and Tiwari [15]. There have been some attempts at listing the herpetofaunal species of Nepal. Shrestha (2001) documented 59 amphibian species and 147 reptiles, Schleich and Kastle [14] reported 50 amphibian species and 123 reptiles, Shah and Tiwari [15] 190 species and 127 species of reptiles and 50 amphibian species from Nepal [16,17]. Likewise, Bhuju et al. [18] claimed that the highest number (45%) of herpetofauna harbor Central Terai-Siwaliks region. Seventeen species of herpetofauna are nationally threatened in Nepal, of which six species are globally threatened [19].

Few researchers studied herpetofauna regionally, according to which, 16 species of herpetofauna were found in Manasolu conservation area [20], 11 amphibian species in Mustang (resource mapping report–2014), 12 species in Parsa national park [21], 11 species in Nagarjun forest (Pokhrel et al., 2010), 29 species in eastern Nepal Himalaya [22], 45 species in Arghakhanchi and Rupandehi district [23], etc.

Several herpetofaunal studies have been conducted in South Asia. Grismer et al. [24] listed a total of 107 species of herpetofauna from Banjaran Bintang in Perak, Malaysia. A total of 64 species of herpetofauna comprising of 43 species of reptiles and 23 species of amphibians were recorded. Among reptiles, 24 species were snakes, 17 species are lizards; and 3 species were turtles [25]. Soorae et al. (2012) reported the 72 native and 8 alien species of herpetofauna from the United Arab Emirates (UAE). Hasan and Feeroz [26] reported species diversity and habitat preferences in Bangladesh.

Habitat plays a vital role in spending life activities. Habitat preference and resource distributions, herpetofauna, being the most diverse and influential in movement and aggregation of individuals Marsh et al. [27]; Relox et al. [28], have more physically complex habitats containing more species [29]. A complex arrangement of interacting biotic and abiotic factors affect amphibians that significantly reduce species richness and the abundance of individual species towards the center of cities and towns, urban and suburban landscapes Andrew &. McDonnell [30]. The species richness was similar near wetlands but the greater abundance of pond-breeding compared to non-pond breeding anurans [31]. Amphibians are more threatened and declining more rapidly due to habitat loss and overutilization [32].

This study has carried out the differences in herpetofaunal community composition among five different habitat types within the agricultural fields, forest, riparian, human habitats, and wetlands. The main purpose of this study was to (i) prepare a checklist of the amphibians and reptiles of the low to mid-elevation, (ii) measure the abundance, distribution, and diversity of the herpetofauna of Nawalparasi district. Although previous studies provided little information on the associated habitats of these sympatric and distribution amphibians and reptiles, their report lacks data on diversity distribution and taxonomy in this region. This study provided the quantitative diversity of herpetofauna and helps to aid in further research and monitoring for conservation. They are significant predators and also play a crucial role in ecosystem function (Kanaujia, et al., 2017).

2. MATERIALS AND METHODS

2.1 Study Area

Nawalparasi district (Lat. 27°21’-27°47’ N and long. 83°36’-84°25’ E) before federalism lies in the middle of Terai region and Lumbini region of Nepal. Now, this district is divided into eastern Nawalparasi and Western Nawalparasi district due to federalism. It includes the Mahabharat range, Churia, Terai, and Inner Terai (DCEP, 2014). The region harbors a mosaic of habitats for various species of wildlife.

There were 6 sampling stations chosen that covered and represented the whole district's geography, vegetation, and climatic condition. These stations were divided into five classes of habitats, namely agricultural land (AG), forest (FT), riparian (RP), human habitat (HH) and wetlands (WL).

These sampling stations were Dawanne Devi (27° 33'.055" N & 83°50' .155" E 101 m to 631 m), Parasi (27°38'.802" N & 83°35.35" E 89 m to 115 m) are western regions of Nawalparasi district, while Rajahar (27°40' 968" N, 84° 13' 782" E 161 m to 179 m), Kawasoti (27°37'.425" N & 84°07.165" E 161 m to 183 m), Rakachuli (27°42' 45.54 N 83°53' 02.16 E 315 m to 948 m) and Gaidakot (27°42' 39.09 N 84°22' 35.64 E, 175 m to 195 m) lie in eastern part of Nawalparasi.

2.2 Data Collection

Samplings conducted from May 2016 to April 2019 were sampled on quadrats located throughout the study area randomly. Each sampling site was split into five sub-habitat sites in which 20 cell quadrates were sampled in each sub-habitat and altogether 100 quadrates in each site. The other sampling methods were opportunistic surveys conducted in other parts based on [33] and pitfall in riparian and side of wetland habitats seasonally. Each sampling effort was carried out by field helpers for about two hours in the evening from 7.00 pm to 9:00 pm, morning from 6.00 am to 9.00 am and afternoon from 12.00 to 2.00 pm. Trapping, digging, and raking was used to detect species. While looking for basking or active reptiles, we visually recorded the habitat to be surveyed in the afternoon.

The prepared data sheet was filled during herping. The possible individuals were caught then euthanized for morphological study, measured for future reference, taking the photograph in a natural condition, and released back. The sample specimens were fixed in 10% formalin and preserved in 70% alcohol.

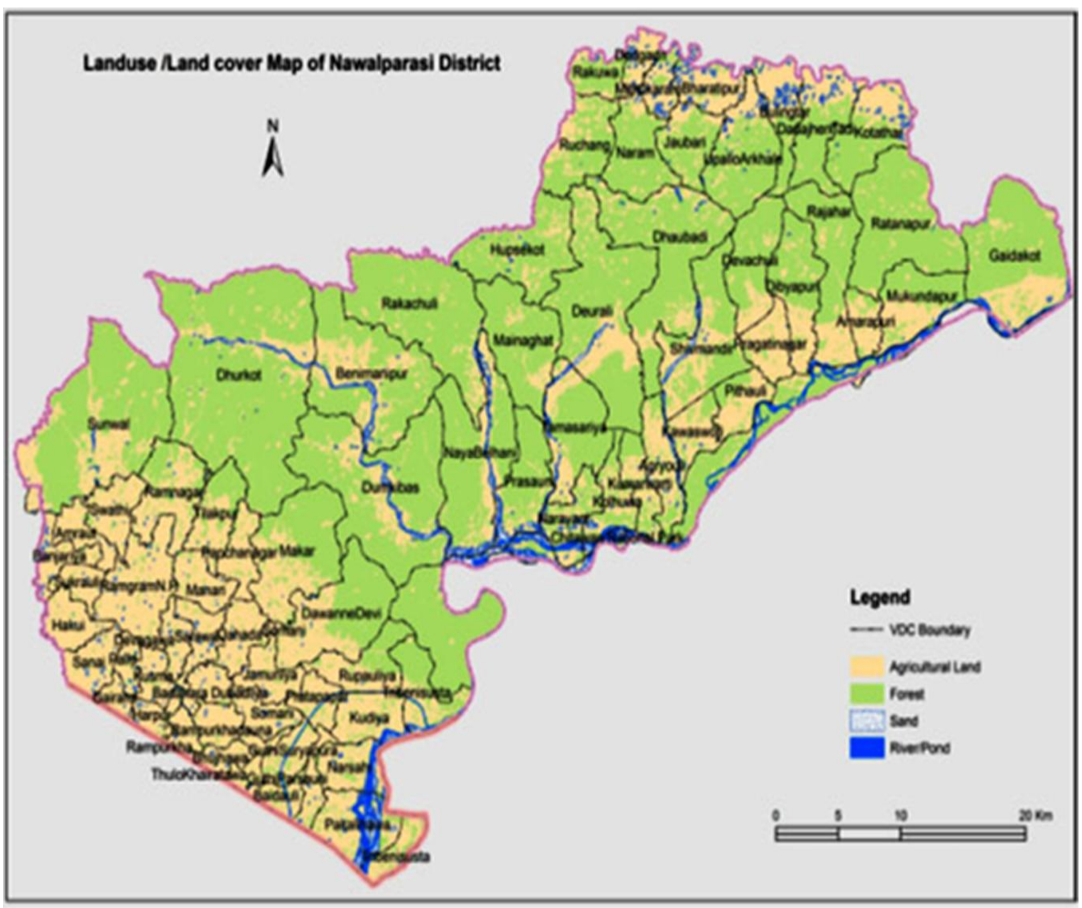

Fig. 1. Map of study site in Nawalparasi district

2.3 Data Analysis

The observed data on five general habitat types were tested by using software R package 3.6.1 in R Studio v.3.1.0 (R Development Core Team 2013) and Microsoft Excel 2013. The diversity indices such as species richness, the abundance of each taxon, Simpson's index, Shannon-Wiener index, Pilou evenness (*J*) were estimated by using software R package 3.6.1. The Shannon-Wiener Index [H' = -∑ (pi ln pi)] the diversity of species heterogeneity (where, H' = species diversity, and pi = proportional frequency of the species), Simpson's index (λ)λ $DS=\sum ni(ni-1N(N-1)=1-\sum ni(ni-1N(N-1)$ and Pilou evenness (*J*) *(J=H'Hmax=H'ln S)* were tested in R package. All the figures were made by using the Microsoft Excel 2013 and SPSS software IBM 23 version.

2.4 Nomenclature and Taxonomy

For identification of herpetofauna, published sources on the regional, national, and international herpetofauna level were consulted. All species encountered were identified up to species level using keys given by various books and works of literature of Smith [34], Sharma [35], Dixon [36], Schleich and Kaestle [14], and Rai [37]. Amphibian specimens were identified with the help of the literature; Bossuyt and Dubois [38], Gururaja [39], Khan [40], and Dutta and Manamendra-Arachchi [41]. The encountered species were identified by using field guides and color photographs [15].

3. RESULTS

3.1 Documentation of Herpetofauna

The present study explored the presence of an authentic, explained, and illustrated checklist of the herpetofauna of Nawalparsi district. A total of 840 individuals of amphibians belonging to 12 species, 8 genera, and 4 families, and 471 reptiles represented by 32 species, 24 genera, and 10 families were recorded (Tables 1 and 2). The amphibians belong to four families; the family Ranidae was the largest family with 6 species, the other families were Microhylidae (2 species.), Bufonidae (2 species) and Rhacophoridae (2 species). In the 32 species of reported reptiles, more species were recorded from the snake's family Colubridae (11 species), Elapidae (6 species), Viperidae (2 species), Pythonidae (1 species), and typhoid (1 species). The other families of reptiles were Bataguridae (1 species), Trionychidae (1 species), Agamidae (2 species), Gekkonidae (3species.), Scincidae (2 species.), and Varanidae (2 species).

3.2 Richness, Abundance, and Diversity

Species richness and abundance were calculated for each habitat. Diversity was calculated using the Shannon-Weiner diversity index, evenness, and Simpson index (Table 3). The richness of amphibians in greater in agricultural fields (S=12) and lower in the forest(S=4) and the reptile's richness was greater in the forest(S=23) and lowest in the wetland(S=6).

The most abundant amphibians species was *Euphlyctis cyanophlyctis* (32.77%) followed by *Zakerana nepalensis* (16.75%) and *Zakerana teraienesis*(8.79%).The less abundant amphibian species were *Sphaerotheca maskeyei* and *Polypedates leucomystax* (1.45%). The most abundant reptile species was *Calotes versicolar* (27.39%) followed by *Ptyas mucosa* (5.09%). *Python molurus, Hemibunarus macclellandii,* and *Ophiophagus hannah* (0.21%) were rarely recorded in this district (Tables 1 and 2). In this study, amphibians species preferred riparian (34%), followed by agricultural field (31%), wetland (22%), forest (8%), and 5% human habitat (Table 1; Fig. 2). Similarly reptile species preferred agricultural fields (27%), forest (22%), human habitat (39%), riparian (8%), and Wetland (4%) (Table 2, Fig. 3).

The result showed that many species of amphibians frequently used temporary wetland and riparian areas. Among them, *Euphlyctis cyanophlyctis* was the most commonly encountered species in and around the wetland, riparian, and some agricultural fields. *Polypedates leucomystax* was less captured species during the field survey. *Bufo stomatictus* and *Bufo melanostictus* were found in arid habitats; *Polypedates leucomystax* and *Polypedates maculatus* is an arboreal species, *Euphlyctis* spp. and *Hoplobatrachus* spp. preferred aquatic habitat, while the remaining species of amphibians were found in moist and shady habitats. *Fejevarya species, Polypedates leucomystax and Polypedates maculates* were seen around the bushes along the forest and near shallow water resources. Most amphibian species observed after short periods of rain.

Table 1. Checklist of amphibians at different habitat in Nawalparasi district

Family	Scientific name	Agriculture field	Human habitat	Forest	Riparian	Wetland	total	
Bufonidae	*Bufo melanostictus* (Schneider,1799)	14	17	11	24	1	67	8.07
	Bufo stomaticus (Lutken, 1862)	15	13	16	18	2	64	7.71
Microhylidae	*Kaloula taprobbanica* (Parker, 1934)	8	0	0	8	0	16	1.93
	Microhyla ornate (Boulenger, 1893)	18	2	0	8	0	28	3.37
Ranidae	*Euphlyctis cyanophlyctis* (Schneider,1799)	82	21	0	94	75	272	32.77
	Hoplobatrachus crassus (Jerdon, 1853)	23	8	0	25	18	74	8.92
	*Hoplobatrachus tigerinus (*Daudin, 1802)	18	0	0	13	29	60	7.23
	Sphaerotheca maskeyei (Schleich & Anders, 1998)	3	0	0	9	0	12	1.45
	Zakerana nepalensis (Schneider,1799)	39	3	0	60	37	139	16.75
	Zakerana teraienesis (Dubois, 1975*)*	27	0	0	23	23	73	8.79
Rhacophoridae	*Polypedates leucomystax* (Gravenhorst, 1829)	1	2	8	1	0	12	1.45
	Polypedates maculates (Gray, 1834)	5	1	6	1	0	13	1.57
		253	67	41	284	185	830	100.

Table 2. Checklist of reptiles in Nawalparasi district

Family	scientific name	Agriculture field	Forest	Human habitat	Riparian	Wetland	Total	%
Bataguridae	*Pungshura smithii* (Gray, 1863)	2	0	0	0	1	3	0.66
Trionychidae	*Lissemys punctata* (webb, 1980)	4	0	0	2	6	12	2.66
Agamidae	*Calotes versicolor* (Daudin, 1802)	38	35	43	2	0	118	26.11
	Oriotiaris tricarinata (Blyth, 1854)	4	3	4	0	0	11	2.43
Gekonidae	*Hemidactylus brooki* (Gray, 1845)	0	0	26	0	0	26	5.75
	Hemidactylus flaviviridis (Ruppell, 1830)	0	0	28	0	0	28	6.19
	Hemidactylus frenatus (Schlegel in: Dumeril & Bibron 1836)	0	0	30	0	0	30	6.64
Scinidae	*Mabuya macularia* (Blyth, 1853)	2	9	0	0	0	11	2.43
	Sphenomorphos maculatus (Blyth, 1853)	0	7	0	0	0	7	1.55
Varinidae	*Varanus bengalensis* (Daudin, 1802)	3	5	0	0	0	8	1.77
	Varanus flavescenes (Harhwicke & Gray, 1827)	3	4	0	0	0	7	1.55
Boidae	*Python molurus* (Linnaeus,1758)	1	0	0	0	0	1	0.22

Family	scientific name	Agriculture field	Forest	Human habitat	Riparian	Wetland	Total	%
Colubridae	*Amphiesma stolatum* (Linnaeus,1758)	8	0	4	5	2	19	4.20
	Boiga trigonata (Schneider in: Bechstein, 1802)	4	0	1	0	0	5	1.11
	Boiga ochracea (Gunther, 1868)	2	3	3	0	0	8	1.77
	Coelognathus helena (Daubin,1803)	7	3	4	0	0	14	3.09
	Coelognathus radiatus (Boie, 1827)	0	5	2	0	0	7	1.55
	Dendrelaphis trisis (Daubin,1803)	4	6	2	0	0	12	2.66
	Lycodon aulicus (Linnaeus,1758)	2	2	1	4	0	9	1.99
	Oligodon arnensis (Shaw,1802)	0	0	1	0	0	1	0.22
	oligodon erythrogaster (Boulenger, 1907)	0	0	3	0	0	3	0.66
	Ptyas mucosa (Linnaeus,1758)	9	2	5	2	6	24	5.31
	Xenochrophis piscator (Schneider, 1799)	6	0	2	3	4	15	3.32
Elapidae	*Bungarus caeruleus* (Schneider, 1801)	5	0	4	0	0	9	1.99
	Bungarus fasciatus (Gunther, 1858)	1	0	5	0	0	6	1.33
	Hemibunarus macclellandii (Lession, 1831)	0	0	1	0	0	1	0.22
	Naja kaouthia (Lession, 1831)	4	5	2	0	0	11	2.43
	Naja naja (Linnaeus,1758)	2	1	7	0	0	10	2.21
	*Ophiophagus hannah (*Cantor, 1836)	1	0	0	0	0	1	0.22
Typhlopidae	*Ramphotyphlops braminus* (Daubin,1803)	7	5	2	0	0	14	3.09
Viperidae	*Trimeresus albolabris* (Gray, 1842)	5	8	3	0	0	16	3.54
	Ovophis monticola (Gunther, 1864)	2	3	0	0	0	5	1.11
Total		126	106	183	18	19	452	100
%		27.88	23.45	40.49	3.98	4.20		

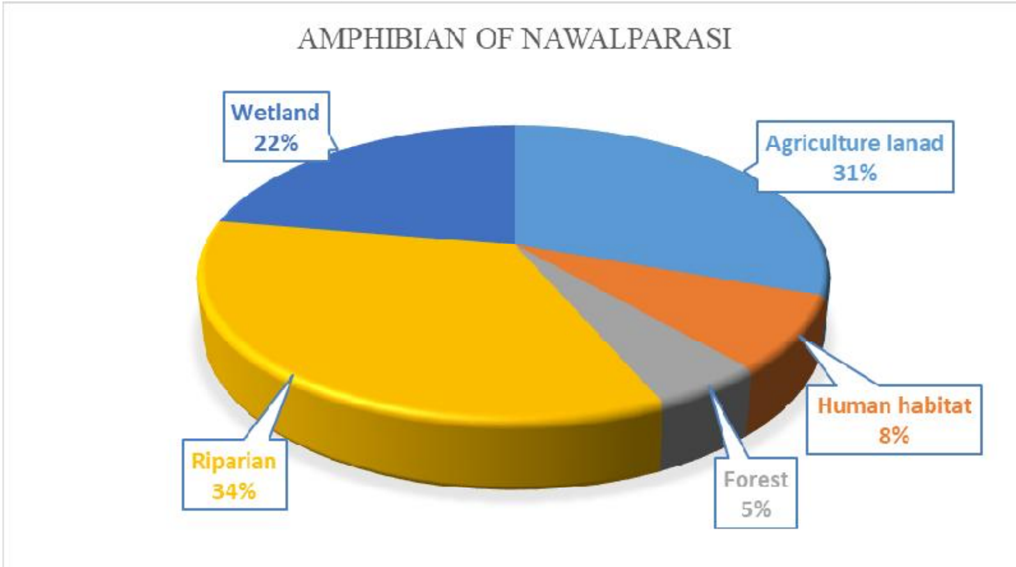

Fig. 2. Habitat used by amphibians

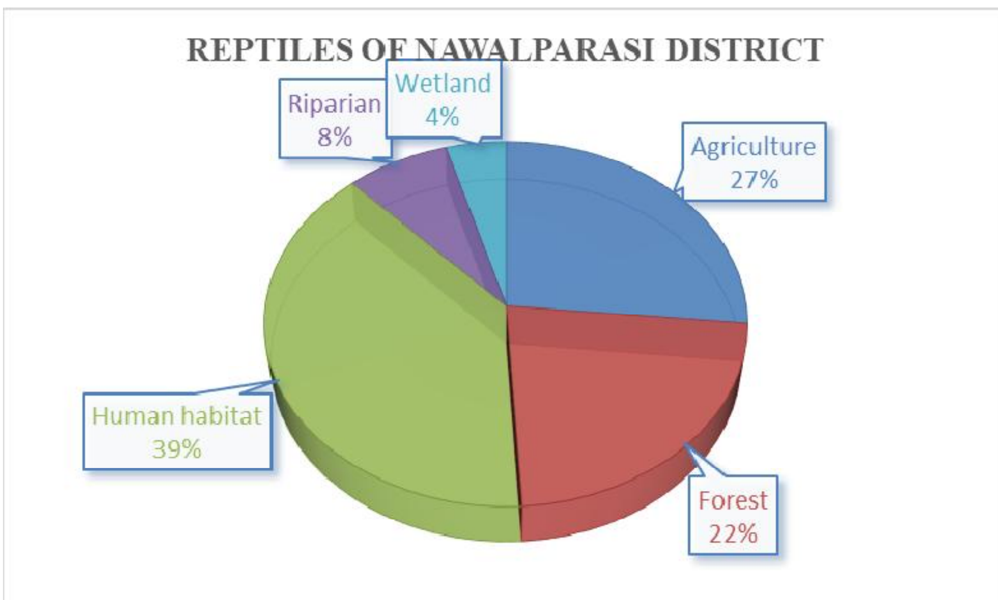

Fig. 3. Habitat used by reptiles

There were two families of turtles found on permanent sources of water as riparian and agricultural fields. The lizards are members of four families that have been recorded in the study area. Most of the species of lizards occupied the undisturbed forest areas. They crawled on the sides of trees and rock surfaces. The gecko species crept on the ceiling and walls of buildings. *Calotes versicolar*, *Hemidactylus* spp .and *Mabuya macularia* were remarkable appeared. Some snakes such as *Amphiesma stolatum, Coelognathus helena, Coelognathus radiates, Lycodon aulicus, Ptyas mucosa, Xenochrophis piscator, Naja kaouthia, Naja naja, Ramphotyphlops braminus* and *Trimeresus albolabris* were notable records during the study period. Most of the reptile species were observed at human habitation followed by undisturbed forest area. Altogether 23 species of snakes were recorded in which eight species were venomous snakes. Local people often kill both venomous and non-venomous snakes in this area for preventive measures against snakebites.

Diversity indices used in this study were the Shannon-Wiener index (1949), Simpson index (1949), and Evenness to find out the interrelationship between them. Richness and Evenness are the components of diversity [42,43]. In the present study, Shannon Wiener's index of amphibians varied from 1.32 to 2.07 at forest and agricultural fields and reptiles at 1.62 to 2.66 at wetland and agricultural fields (Table 3). Simpson index varied from 0.72 to 0.83 in amphibians at forest and agricultural field and reptiles 0.74 to 0.88 at wetland and agricultural field. Similarly, the evenness of amphibians varied from a minimum of 0.33 to a maximum of 0.52 at the forest and riparian whereas in reptiles it varied from 0.28 to 0.46 at agricultural fields and wetland (Fig. 4, Fig. 5, and Table 3).

The rank abundance curve represents both species richness and species evenness in biodiversity. These data comprise information on the abundance, richness, and the relative proportion of each species within the sampled assemblage (evenness). These charts showed that 12 species of amphibians and 32 species of reptiles were visualized (Fig. 6, Fig. 7).

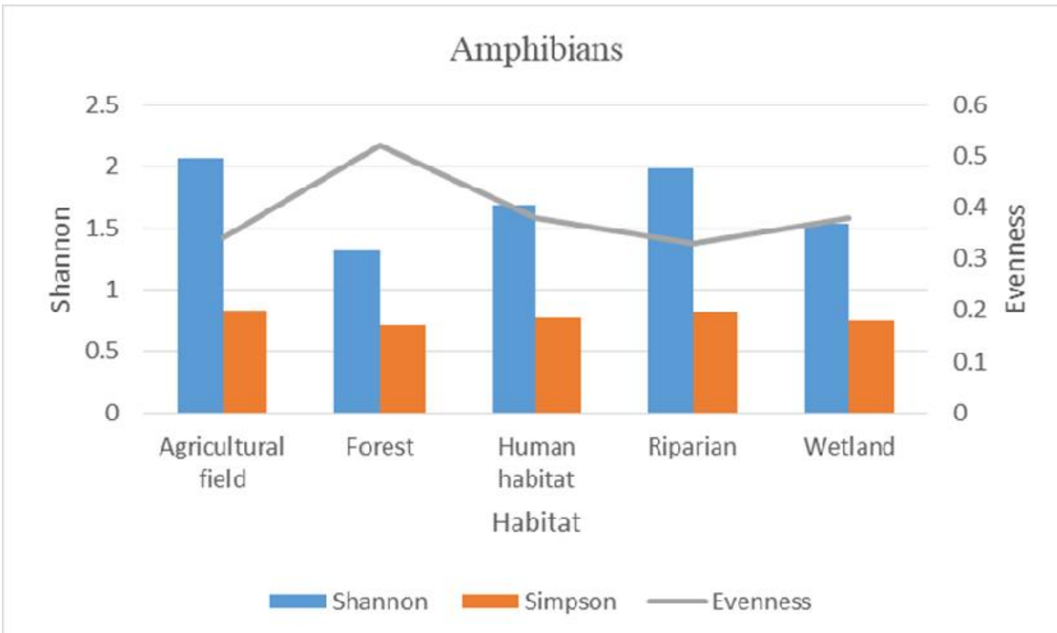

Fig. 4. Diversity indices of amphibians

Table 3. Amphibian and reptile diversity Nawalparasi

	Diversity indices						
	Habitat	**Richness**	**Abundance**	**Rarefy**	**Shannon**	**Simpson**	**Evenness**
Amphibians	Agricultural field	12	253	5.68	2.07	0.83	0.34
	Forest	4	41	3.72	1.32	0.72	0.52
	Human habitat	8	67	4.69	1.69	0.78	0.38
	Riparian	12	284	5.39	1.99	0.82	0.33
	Wetland	7	185	4.28	1.54	0.75	0.38
Reptiles							
	Agricultural field	23	125	6.97	2.66	0.88	0.28
	Forest	17	106	6.53	2.41	0.86	0.30
	Human habitat	23	183	6.24	2.42	0.88	0.28
	Riparian	10	36	5.90	1.99	0.81	0.35
	Wetland	6	21	4.88	1.62	0.78	0.44

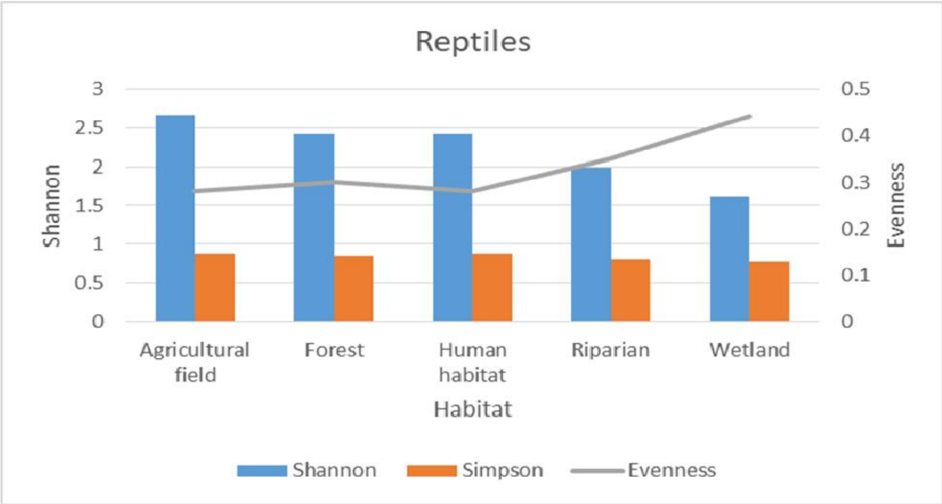

Fig. 5. The diversity index of Reptiles

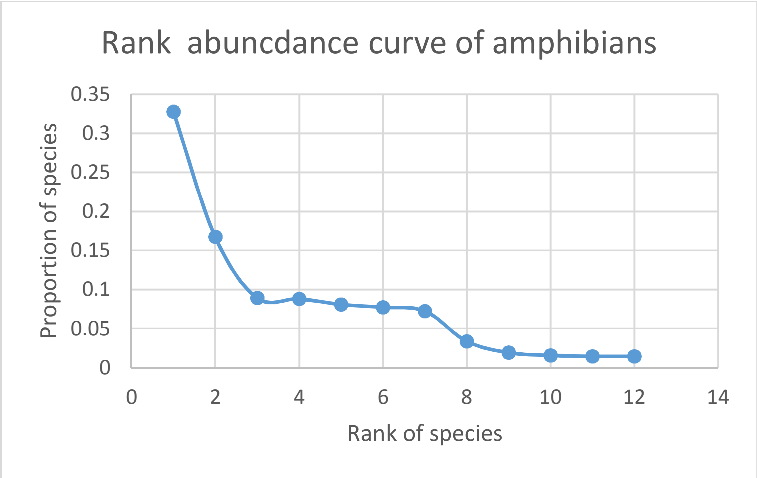

Fig. 6. Rank abundance curve of amphibians in study sites

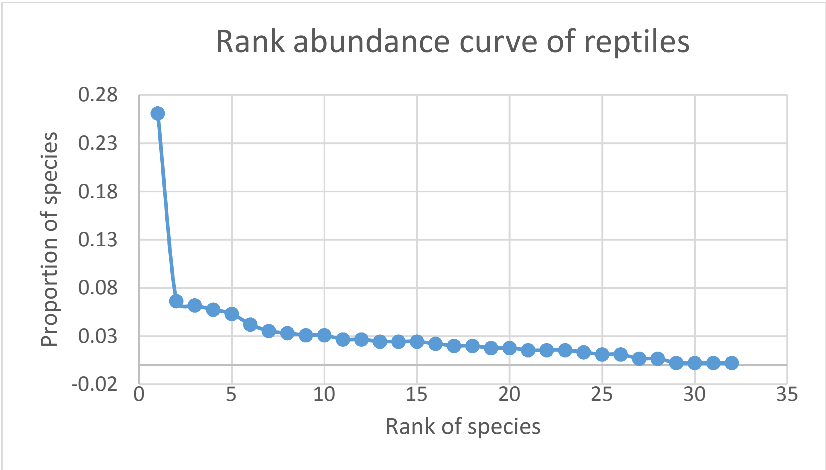

Fig. 7. Rank abundance curve of reptiles in study sites

4. DISCUSSION

Our observation showed that herpetofauna diversity was high in the Nawalparasi district. There were 44 herpetofauna species listed in this survey represents about 24.85% of the 177 known herpetofauna species listed for Nepal [16,17]. The family Ranidae was the largest in amphibians whereas snake families were more than other families in reptiles. The most abundant amphibian species was *Euphlyctis cyanophlyctis.* They are found in all habitats except forest and most adapted amphibians. It was most abundant in forest edge, along stream banks and water pools between edges of forest and cultivations [44]. Similarly Manamendra-Arachchi and Pethiyagod (2006) reported that *H. crassus* and *Zakerana* species were preferred the wetland, paddy fields and ponds. In this study, amphibian species preferred riparian followed by the agricultural field.

The behavior and reproduction of herpetofauna vary with fluctuations in precipitation and temperature [45]. The present study revealed that the species richness and abundance was greater during rainy seasons due to mating activity of amphibian and basking of reptiles. To compete for all life activities of species, which may not even come close to serving as a suitable habitat for others. Pradhan et al. [46] reported that most of the amphibian species require agriculture-based ecosystems for survival. *Zakerana* species occurred near water bodies. According to Dutta and Manamendra-Arachchi [41] they are widely distributed both in the dry and wet zones. Indeed, past studies have noticed amphibians to be a very sensitive group to extreme climates compared to, for instance, mammals [47].

The species of reptiles preferred the human habitat. *Calotes versicolar*, *Hemidactylus* spp were the most abundant species. Colubridae were the dominant families in terms of richness [48] and also highly encountered during herping by Bawaskar and Bawaskar [49]. A similar observation occurred during the field visit. All snakes are considered to be poisonous and killed at sight [15] and also kill them due to fear and ignorance as a precautionary measure against snakebites [50]. Similar observations were recorded in the field visit. Different habitat types and abiotic factors influenced species richness and abundance of herpetofauna [51].

Shannon-Wiener index is expected to determine the evenness and richness [52]. Generally, the Simpson index ranges from 0 to 1 [53]. Simpson diversity index is higher in the community dominated by less number of species [54], and in mature and stable communities, high diversity values lied between 0.6 to 0.9 [55]. The Shannon index suggests that the amphibian diversity in the agricultural field is more diverse than in forests and also reptile diversity in the wetland is less diverse than in the agricultural field. This result showed that herpetofaunal diversity is more in the agricultural field. According to Shah and Pandit [56] whenever the Simpson diversity index increases towards a higher value, the evenness index goes in antagonistic directions. The present study also indicates that there is an inverse relationship between the Simson diversity index and evenness (Table 3). The level of scattering species varies between species and this affects the pattern of dispersion in the corresponding rank abundance curve. It is difficult to conclude anything about the effect of this heterogeneity by inspecting the rank distribution curves alone [57]. Species evenness is reflected in the slope of the line that fits the graph. A steep gradient indicates low evenness as the high-ranking species have much higher abundances than the low-ranking species. A shallow gradient indicates high evenness as the abundances of different species is similar to the present study.

5. CONCLUSION

The present study showed that the study area harbors a total of 44 herpetofauna species in which 12 species of amphibian and 32 species of reptiles. The richness of amphibians was higher in agricultural fields there as the higher richness of reptiles in human habitat and agricultural field. Only one species of *Python molurus, Oligodon arnensis,* and *Ophiophagus hannah* were recorded during the herping. The herpetofauna abundance varied seasonally and more abundant during the rainy season. The data support that more amphibian species preferred the agricultural field but the forest had a negative effect on species richness. Reptiles use the agricultural field but less preferred the wetland habitats. Shannon Wiener index of herpetofauna is higher in agricultural fields. Shannon and Simpson diversities increases as richness increase for a given pattern of evenness, and increase as evenness increases for a given richness. Maintenance of both habitats (forest and agricultural field) are needed to protect the herpetofaunal diversity of this region.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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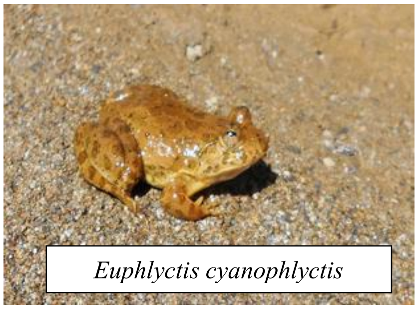
APPENDIX

Representative Photos of herpetofauna in Nawalparasi district



Euphlyctis cyanophlyctis

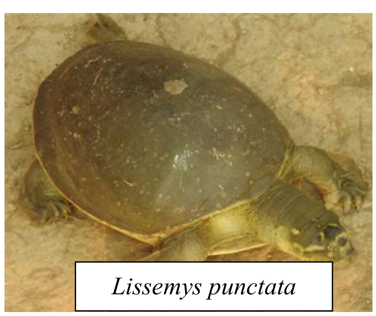
Sphaerotheca maskeyei

Kaloula taprobbanica

Zakerana teraienesis

Bufo stomaticus

Bufo melanostictus



Lissemys punctata

Calotes versicolar

Oligodon arnensis

Coelognathus radiatus

Naja kaouthia

Hemibunarus macclellandii

Trimeresus albolabris

Ovophis monticola

REPTILES & AMPHIBIANS

New Records of the Sikkimese Caecilian, *Ichthyophis sikkimensis* Taylor 1960 (Amphibia: Gymnophiona: Ichthyophiidae), in Nepal

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The Sikkimese Caecilian (*Ichthyophis sikkimensis*) (Nepali name: Andha Sarpa) is known to occur in the Sikkim and Darjeeling regions of West Bengal in northern India and Ilam District in eastern Nepal, and likely occurs in western Bhutan (Taylor 1960; Sarkar et al. 1992; Dutta 1997; Pillai and Ravichandran 1999; Anders et al. 2002; Chanda 2002; Shah and Tiwari 2004; Kamei et al. 2009; Wangyal 2014; Kamei 2017; Frost et al. 2021). The species was classified as Data Deficient (DD) in the IUCN Red List of Threatened Species (Ohler et al. 2004).

From 2016 to 2019, we conducted field surveys at six closely grouped sites in Tansen Municipality, Palpa District, Nepal (Fig. 1): Holangdi, Narayansthan, Setipokhari, and Parvas (27°86.683'N, 83°54.865'E; 27°50.283'N, 83°33.865'E; elev. 1,278 m asl), riparian and marshy areas of Dammak (27°91.595'N, 83°39.785'E; 27°53.595'N, 8°22.285'E), and marshy areas of Rampur (27°51.215'N, 83º03.060'E; elev. 437 m asl; 27°52.050'N, 83o53.040'E; elev. 402 m asl). We

Fig. 1. Map of Nepal. Ilam District, site of the previously documented record of the Sikkimese Caecilian (*Ichthyophis sikkimensis*) is indicated in blue; Palpa District, site of the new records is marked in red.

Fig. 2. A Sikkimese Caecilian (*Ichthyophis sikkimensis*) from the bank of a small stream in Holangdi (top) and preserved specimen (TMC-0017) from under a decaying log in Narayansthan. Photographs by Pit Bahadur Nepali.

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searched for caeclians during daylight hours by digging to depths of approximately 40 cm in moist, dark, porous soil, particularly along the banks of permanent streams, and by raking through leaf litter and lifting decaying logs.

With local help, we collected five adult Sikkimese Caecilians (Fig. 2), three in an agricultural field and riparian habitats at Holangdi and two from a small stream and adjacent riparian habitat at Narayansthan. Based on these sites and conversations with local residents, these caecilians are most frequently encountered in the soil of agricultural fields, under decaying leaves in low marshy areas, or along the banks of streams (Fig. 3).

Fig. 3. Habitat at Holangdi (left) and Narayansthan (right) near Tansen Municipality, Palpa, where Sikkimese Caecilians (*Ichthyophis sikkimensis*) were found. Photographs by Pit Bahadur Nepali.

Table 1. Morphometric and meristic data for five Sikkimese Caecilians (*Ichthyophis sikkimensis*) from Tansen Municipality, Palpa District, Nepal. Measurements to the nearest 0.1 mm.

	Specimen					
Measurement	**1**	**2**	**3**	**4**	**5**	**Mean ± SD**
Total length	299	293	301	313	295	300.2 ± 7.82
Total annuli (counted ventrally)	292	287	297	307	291	294.8 ± 7.69
Total annuli (counted dorsally)	296	301	291	305	295	297.6 ± 5.46
Tail annuli	5	5	6	6	6	5.6 ± 0.55
Dorsal transverse grooves on second collar	2.1	2.0	2.0	2.0	2.1	2.04 ± 0.05
Distance between eyes	4.9	4.9	5.7	5.8	5.6	5.38 ± 0.44
Distance between eye and tentacle	1.1	2.0	2.0	2.1	2.0	1.84 ± 0.42
Distance between eye and naris	4.9	4.7	5.1	5.4	5.1	5.04 ± 0.26
Distance between eye and tip of snout	6.2	6.3	6.1	7.0	6.3	6.38 ± 0.36
Distance between eye and angle of jaw	4.2	4.1	4.8	5.1	5.0	4.64 ± 0.46
Distance between naris and tentacle	2.3	2.1	2.5	2.7	2.4	2.4 ± 0.22
Distance between tentacles	8.3	8.1	8.1	8.3	8.2	8.2 ± 0.10
Head width at angle of jaw	11.8	11.8	12.0	12.1	11.7	11.88 ± 0.16
Head length	10.9	11.1	11.1	11.2	10.9	11.04 ± 0.13
Head width at occiput (lateral edge of the first nuchal groove)	9.3	9.1	9.3	9.1	9.3	9.22 ± 0.11
Distance between tip of the snout and first nuchal groove	13.8	13.9	14.1	14.9	14.1	14.16 ± 0.43
Length of first collar (measured laterally)	3.2	3.2	3.9	3.9	3.7	3.58 ± 0.36
Length of second collar (measured laterally)	4.2	4.1	4.8	5.0	4.1	4.44 ± 0.43
Circumference at midbody	41.3	41.0	41.6	43.2	43.0	42.02 ± 1.01
Length of the tail from anterior end of the vent	4.1	4.1	4.1	4.2	4.0	4.1 ± 0.07

Specimens (Table 1) were deposited in the Department of Zoology, Tribhuvan Multiple Campus, Palpa, Tribhuvan University, Nepal (TMC-0017). Using descriptions and keys in Taylor (1960), Sarkar et al. (1992), Dutta (1997), Bhatta (1998), Pillai and Ravichandran (1999), Anders et al. (2002), Chanda (2002), Rai (2003), Kupfer and Müller (2004), Shah and Tiwari (2004), Kamei et al. (2009), Wangyal (2014), Kamei and Biju (2016), and Kamei (2017), we identified them as *Ichthyophis* by being limbless and wormlike in general appearance and by having a short tentacle between the eye and nostril on each side of the head, small scales usually embedded in the skin, body with a series of annulations, and a short tail; and as *I. sikkimensis* by lacking a lateral stripe and having about 293–313 annuli, ten or fewer caudal folds, and 18–21 teeth on each dentary and 1–10 on each splenial with teeth not conspicuously sunken in pits. The identity of the species was confirmed by Prof. Karan Bahadur Shah.

The presence of this species in Tansen Municipality, Palpa District, Nepal, suggests that it also is likely to occur in similar habitats elsewhere in southern Nepal and adjacent northcentral India.

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Status of herpetofauna in Rupandehi and Arghakhanchi districts, Nepal

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ABSTRACT

Herpetofauna are unique creature which comprise both amphibians and reptiles. The present study was carried out on herpetofaunal diversity in Rupandehi and Arghakhanchi districts. Each of six sampling stations was conducted in the study areas. Ten standardized 10 x 200 m strip transects and 20-25 standard Quadrat sizes of 20 m x 20 m were set in each station. Observed museum specimens and questionnaire survey were also conducted during data collection. A total of 45 spe cies of herpetofauna was recorded with 9 species of amphibians) and 36 species of reptiles. Six species were from the family Ranidae, two species from Bufonidae and one species from Rhacophoridae. Lizards were represented by 11 species belonging to four different families. Each of Gekkonidae, Agamidae and Scincidae family was represented by 3 species and the Varanidae by two species. The family Crocodylidae was represented by one species. The order Testudines (turtles) was represented by 2 species from family trionychidae and bataguridae. Twenty two species of snakes were recorded from 6 different families. The amphibian species, namely; *Euphlyctis cyanophlyctis, Zakerana nepalensis, Bufo melanostictus* and *B. stomaticus* and reptile species *Calotes versicolor* were relatively abundant. Seven species of amphibians and 18 species of reptiles were common in both districts. The study areas were diverse microhabitats due to the elevation from 71 m to 2004 m with plain, Churia and mountain range.

Keywords: Amphibian, diversity, richness, reptile

INTRODUCTION

Herpetofauna are poikilothermic tetrapods. Amphibians were represented by frogs, toads, caecilians and salamanders, whereas reptiles include crocodiles, turtles, tortoises, snakes and lizards. Many of them were dependent on terrestrial cum aquatic habitats and wetlands for some parts of their life cycles. Different habitats were needed for many life activities like nesting, hibernating, aestivating, dispersal, biological functions etc. Their microhabitats include lotic and lentic water, swamps, rocks and different vegetations.

Amphibians were known to be extremely variable as so many different morphs of the same species exist in all geographical variations (Barlett & Barlett, 2003). Reptiles occupy and live in a great variety of aquatic and terrestrial habitats (Mc Diarmid *et al.,* 2012) and there is interrelationship between terrestrial and neighboring wetlands (Gibbons, 2003).

The habitat modifications determine the quantitative and qualitative data of herpetofaunal biodiversity in particular areas. Many activities indispensable for human subsistence lead to biodiversity loss (Aerts *et al.,* 2006; Diaz *et al.,* 2006). Land-use change results in the decline of diversity (Lajmanovich *et al.,* 2003; Storfer, 2003). Altitudinal gradients and the physical environment were prime factors that determine spatial and temporal distribution, abundance and richness patterns of organisms (Korner, 2000). Gibbons *et al.* (2000) reflects that decline of herpetofauna species diversity and population size can be attributed in part to causes including anthropogenic factors like habitat loss, and presence of invasive and introduced species, pollution, and disease.

Sri Lanka is very rich in herpetofauna and was included in the revised hot spots of the world with 55 species of herpetofauna belonging to 39 genera and 15 families (Mittermeier *et al.,* 1998; Majumder *et al.,* 2012). Grismer *et al.* (2010) as well as Das & Norsham (2007) listed a total of 107 species of herpetofauna from Banjaran Bintang in Perak and that 600 herpetofauna species including 203 species of amphibians and 397 species of reptiles were from Peninsular Malaysia. Hasan & Feeroz (2014) reported species diversity and habitat preferences in Bangladesh. A total of 32 amphibian species under 6 families had been reported from six protected areas of Bangladesh. The herpetofauna in Thummalapalle uranium mining areas resulted in a collection of 52 species belonging to 17 families. Snakes were the dominant group with 20 species (Reddy *et al.,* 2013).

Nepal has variety of habitats due to presence of altitudinal variation with macro and micro habitats which are suitable for rich diversity of herpetofauna. Schleich and Kastle (2002) reported an account of 50 amphibians and 123 reptiles. At the same time, Shrestha (2001) reported that 206 species of herpetofauna including one species of salamander, one species of caecilians, 59 species of toad and frogs, 39 species of lizards, 81 species of snakes, two species of crocodiles, and 16 species of tortoise and turtles in Nepal. There was a total number of 138 species of reptiles from Nepal including 17 species of turtles, 2 species of crocodiles, 39 species of lizards and 80 species of snakes (Shah & Tiwari, 2004). Bista (2010) carried out a survey in a Ramsar site of Nepal reporting 43 species of herpetofauna including 8 species of amphibians belonging to 3 families and 7 genera and 35 species of reptiles belonging to 13 families and 25 genera. Similarly the herpetofaual studies were carried out in different National parks of Nepal as well.

Very few species have been described from disturbed habitats, indicating a diminished species composition when compared with the original habitat (Molur, 2008). From a conservation point of view also, herpetofauna conservation efforts have been limited (Shah &Tiwari, 2004). Despite these facts, the herpetofauna are poorly studied and determination of distribution, population status and habitat suitability for populations has not been carried out in these study areas so far. Therefore, the aim of this study is to identify and document the status as well as explore the venomous and non-venomous snakes of Rupandehi and Arghakhanchi districts of Nepal which helps to generate the current status of herpetofaunal species to current list, habitat situation, sensitization of the conservation efforts along with specie.s association analyses.

MATERIALS AND METHODS

Study areas

This study was undertaken in hilly Arghakhanchi and plain Rupandehi districts of Nepal. Twelve sampling stations were selected covering different habitats of these two districts (fig.1)

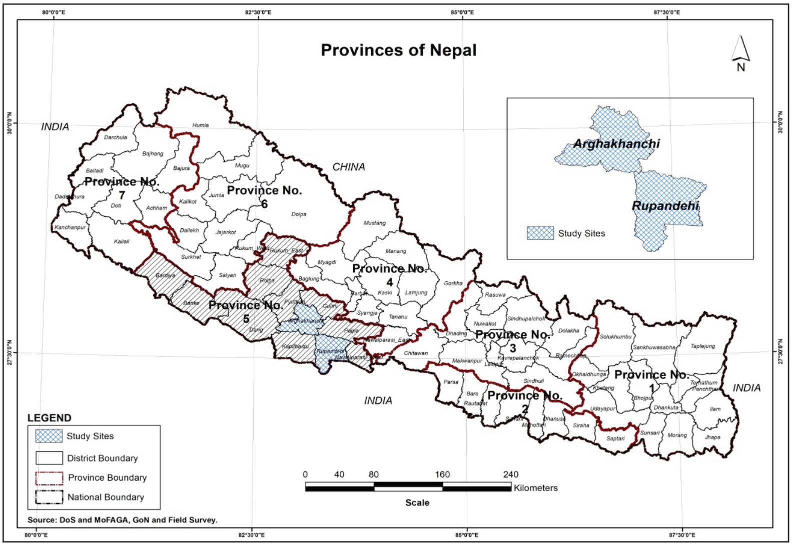

FIG. 1. Map of Nepal showing Arghakhanchi and Rupandehi districts in Province No. 5.

TABLE 1. Districts, stations, locations, elevations and habitat types in study areas.

District	Stations	Locations	Elevations	Habitat types
Arghakhanchi	Sandhikharka	27^{0}58’.626’N &.83^{0}07’.385’E	935 m	Agricultural fields, wetlands, town areas and community forest
	Sitapur	28^{0}00’.256’N & 83^{0}10.281’E	906 m	Subtropical forest, few agricultural land, village areas, riparian vegetation, hilly areas
	Gokhunga	28^{0}06’.125’N & 83^{0}0.595’E	2004 m	Agricultural lands, village areas and community forest, sloppy lands.
	Arghatosh	28^{0}0’.25’N & 83^{0}10’195’ E	890 m	Riparian, community and government forests, agricultural lands and small villages
	Pokharathok-Khidimand	27^{0}51’.055’N & 83^{0}18.465’E	915 m.	Wetlands, community and government forests, agricultural lands and small villages, hilly areas
	Siddhara	27^{0}49’21.11’N & 82^{0}50’58.1’E	460 m	Riparian, Churia range, tropical forest, agricultural lands

Rupendehi	Khaireni	27^{0}37’.855’N & 83^{0}34.279’E	127 m.	Agricultural fields, small urban areas, tropical forest, plain
	Belbas	27^{0}41’525’N & 83^{0}26’436’E	147 m	Plain to Churia range, few agricultural lands and small urban areas ,tropical forest
	Gajedi	27^{0}40’.295’N & 83^{0}21.385’E.	107 m.	Agricultural fields, wetland, small town, small tropical forest, plain
	Sainamaina	27^{0}39’.255’N & 83^{0}21.383’E	106 m	Agricultural lands, village areas, small forest and plain
	Bhairahawa-Madhulia:	27^{0}30’.655’N & 83^{0}24’.595’E	71 m.	Agricultural fields, riparian, urban areas, plain
	Chhapiya	27^{0}30’.377’N & 83^{0}12’599’E	79 m	Agricultural fields, wetlands, town areas, plain

Data collections: In each station (table 1), the data collection was carried out by applying the different methods like transects, quadrats, visual encounter, spot light, catching etc. Samplings were carried out in the study sites, beginning from February 2016 till to the end of January 2017. The active search was carried out during the day time in selected sites. The samplings were taken in the mornings (approximately 9:00 a.m. to 12:00 p.m., depending on weather) and at nights (7:00 p.m. to 10:00 p.m.).

Surveys on herpetofauna were conducted in 10 standardized 10 × 200 m strip transects, the number of which varied depending on patch size. Standard quadrat sizes of 20 m × 20 m were set in different stations. Twenty quadrats were taken in mid hills and Chure regions and 25 quadrats were set randomly according to the type of locality in Terai region. Observation of museum specimens and questionnaire survey were also developed for data collection. The data were collected for each individuals of a species encountered during field work. The locality, date, time, weather condition, habitat, microhabitat and behavioral note were recorded in a field data sheet.

Specimens were captured for identification. Information recorded for each individual included species, snout-vent-length (SVL), tail length maximum, head width (HW), axilla-groin distance (AGD), fore-limbs (FL: axilla to tip of longest finger) and hind-limbs (HL: groin to tip of longest toe), and webbing formula etc. followed Anders & Schleich (2002) and Rai (2003). Photographs were taken of representatives of each species and habitats. Geographic coordinates for each survey site were determined in the field with a Garmin GPS (etrex 10) receiver. Coordinates were recorded as latitude and longitude in decimal degrees.

Identification of the species was carried out by using the identification keys developed by field guide of Smith (1981), Dixon (2000), Schleich & Kaestle (2002), and Rai (2003). Amphibian specimens were also identified with the aid of Bossuyt & Dubois (2001), Dutta & Manamendra-Arachchi (1996), Das (2008), Kabir *et al.* (2009) etc. The species encountered were identified using field guides and color photographs (Shah & Tiwari, 2004).

RESULTS AND DISCUSSION

In this study, a total of 9 species of amphibians and 36 species of reptiles were recorded in study areas. In amphibians, 6 species were from the family Ranidae, two species from Bufonidae and one species from Rhacophoridae (table 2). Lizards were represented by 11 species belonging to four different families. In each family of Gekkonidae, Agamidae and Scincidae was represented by 3 species and Varanidae with two species. Order Testudines (turtles) was represented by 2 species from family trionychidae and bataguridae. Family Crocodylidae had species of *Crocodylus palustris.* Twenty two species of snake were recorded with five different families (table 3).

In Arghakhanchi district, there were 115 individuals of 8 amphibian species (two families and five genera) and 163 individuals of 26 reptile species (9 families and 22 genera). The amphibian species; *Limnonectes teraiensis* and reptile species *Laudakia tuberculata, oligodon erythrogaster, Trachischium guentheri, Ramphotyphlops braminus, Oligodon arnensis, Hemibungarus macclellandii, Xenochrophis sanctjohannis, and Ovophis monticola* were recorded in this district. *Crocodylus palustris* species recorded in small pond of Chure hill of this district.

A total of 88 individuals of 8 amphibian species under 3 families and 146 individual of 28 reptile species under 12 families and 21 genera were recorded from six stations of Rupandehi district. During the study, *Pungshura smithii*, *Lissemys punctata*, *Varanus flavescens*, *Python molurus*, *Python bivittatus*, *Bungarus fasciatus*, *Naja kaouthia*, and *Naja naja* were fairly recorded in this district.

The pond frog (*Euphlyctis cyanophlyctis*) and Cricket frog (*Zakerana nepalensis*) were relatively abundant in the study sites. The common Indian toad (*Bufo melanostictus*) and *Bufo stomaticus* (Marbled balloon frog) were commonly occurred. The tree frog (*Polypedates leucomystax*) was found in the forest and rocky areas. The snake belonged to five families, more number of snakes recorded from the family Colubridae (11 species) followed by Elapidae (5 species), Viperidae (2 species), Boidae (2 species), and Typhlopidae (1 species).

The lizard (*Calotes versicolor*), Rat snake (*Ptyas mucosus*) and Chichred keelback (*Xenochrophis piscator*) and Common wolf snake (*Lycodon aulicus*) were relatively common. Very rearly recorded species were *Varanus flavescens*, *Python molurus*, *P. bivittatus*, *Pungshura smithii*, *Lissemys punctata*, *Dendrelaphis tristis*, *Oligodon erythrogaster*, *O. arnensis*, *Trachischium guentheri*, and *Xenochrophis sanctjohannis*.

In the reported 22 species of snakes, seven species (2 families of Elapidae and Viperidae) were venomous. The common venomous snakes recorded were *Bungarus caeruleus*, *B. fasciatus*, *Hemibunarus macclellandii*, *Naja kaouthia*, *Naja naja*, *Trimeresus albolabris*, and *Ovophis monticola*. Fifteen non-venomous species recorded in the present study were *Python* *molurus*, *P. bivittatus*, *Ramphotyphlops braminus*, *Amphiesma stolatum*, *Boiga trigonata*, *Coelognathus helena*, *C. radiates*, *Dendrelaphis trisis*, *Lycodon aulicus*, *Oligodon arnensis*, *Oligodon erythrogaster*, *Ptyas mucosa*, *Trachischium guentheri*, *Xenochrophis piscator*, and *Xenochrophis sanctjohannis*.

The *Bufo stomatictus* and *B. melanostictus* were found in arid habitats and *Polypedates leucomystax* was an arboreal species recorded during the study. Ocock, *et al.* (2016) reported similar habitat of tree frog which had specialized toe-discs for climbing and a relatively high resistance to water-loss. The *Euphlyctis* spp. and *Hoplobatrachus* spp. preferred aquatic habitat, while the remaining species of amphibians were found in semi-aquatic and shady habitats. A similar biology was explained by Andreone (1993, 1994) taking into account the scarcity of still water bodies at the analysed sites, and therefore to a local rarity of this species, elsewhere almost abundant. According to Omogbai *et al.* (2002), populations of amphibians were excess during the rainy season. Amphibians presented their highest diversity where they had spent most of their evolutionary history (Alexandra & Troumbis, 1997). Aryal *et al.* (2010) reported Turtle trade surveys conducted in the markets mainly in Kailali, Kapilbastu, Rupandehi, Nawalparasi, Sunsari and Saptari districts and 16 species were reported the status of species distributions and incorporating the turtles in conservation issues. In the present study *Pungshura smithii* and *Lissemys punctata* were recorded from study sites.

Abundantly encounter species found to be were *Calotes versicolor*, *Hemidactylus brookii*, *H. flaviviridis*, *Eutrophis carinata*, *Coelognathus helena*, *C. radiates*, *Lycodon aulicus*, *Ptyas mucosa*, *Xenochrophis piscator*,*Trimeresurus albolabris*, *Bufo melanostictus*, *B. stomaticus*, *Euphlyctis cyanophlyctis* and *Hoplobatrachus tigerinus*. Shah (1998) prepared a checklist of herpetofauna of Nepal in which he recorded 64 snake species. Similarly, Shah & Tiwari (2004) reported abundantly available species *Euphlyctis cyanophlyctis* and *Calotes versicolor* in Nepal. The diversity of herpetofauna in the study area was reflected in species richness due to wide range of temperature, diverse topography, land use and diverse microhabitat. Diversity of herpetofuna is high due to land of topographic contrast climate and water condition etc. A total of 45 species of herpetofauna were recorded in which 9 species of amphibians (6 genera, and 3 families) and 36 species of reptiles (27 genera, 12 families, and 3 suborders).In Arghakhanchi district, there were 115 individuals of 8 amphibian species including 2 families with 5 genera and 162 individuals of 25 reptile species (22 genera and 10 families). In Rupandehi district, a total of 88 individual of amphibian under 8 species (5 genera and 3 families) and 146 individual of reptile under 28 species (21 genera and 10 families) were recorded. Out of 9 amphibian species, 7 species were common in both district but *Limnonectes teraiensis* was only found in Arghakhanchi and *Polypedates leucomystax* was only found in Rupandehi district. A total of 36 reptile species, 18 species were common in both sites but 8 species were only recorded in Arghakhanchi and other 10 species were only found in Rupandehi district.

The *Euphlyctis cyanophlyctis*, *Zakerana nepalensis*, *Bufo melanostictus* and *B. stomaticus* were relatively abundant in study sites. The most common reptile species was *Calotes versicolor*. The species richness of reptiles was found to be more in Rupandehi than in Arghkhanchi district. Habitat type may be a main contributing factor on major effect on species richness, diversity, distribution and abundance of amphibians and reptiles of study sites. Amphibian species were recorded in aquatic, semi-aquatic and shady habitats and found active in rainy season. On the other hand, the main habitats of reptiles were forests, grasslands, trees, tunnels, cliffs, rocks, different aquatic bodies, agricultural lands and human dwellings.There were 22 species of snakes in which 7 species were venomous species under 2 families (Elapidae and Viperidae) and 15 non-venomous species under 3 families (Boidae, Colubridae and Typhlopidae). Out of 7 venomous species, 2 species were common in both districts but 2 species were recorded in Arghakhanchi and 3 species were recorded in Rupandehi district. A total of 15 non-venomous species, 7 species were common in both districts while 5 species in Arghakhanchi and 3 species in Rupandehi districts were recorded.

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TABLE 2. Amphibian of order Anura in different stations of Arghakhanchi and Rupandehi districts.

S. N.	Scientific name	Family	Arghakhanchi							Rupandehi						
			TI	Sandhikharka	Sitapur	Pokhrathok	Arghatosh	Gokhunga	Siddhara	TI	Khaireni	Belbas	Sainamaina	Gajedi	Bhairahawa	Chhapia
1.	*Bufo melanostictus*	Bufonidae	14	+	+	+	+	+	+	12	+	+	+	-	+	+
2.	*Bufo stomaticus*	Bufonidae	4	+	+	+	+	-	+	9	+	-	-	+	+	-
3.	*Euphlyctis cyanophlyctis*	Ranidae	65	+	+	+	+	+	+	35	+	+	+	+	+	+
4.	*Hoplobatrachus crassus*	Ranidae	5	+	−	−	+	−	-	7	-	-	-	+	+	-
5.	*Hoplobatrachus tigerinus*	Ranidae	4	+	-	-	-	-	+	9	+	-	-	+	+	-
6.	*Limnonectes teraiensis*	Ranidae	5	−	-	−	+	−	-	-	--	-	-	-	-	-
7.	*Zakerana nepalensis*	Ranidae	15	+	+	+	+	-	+	8	-	-	+	-	+	+
8.	*Zakerana teraienesis*	Ranidae	3	-	+	-	-	-	+	5	-	-	-	+	-	+
9.	*Polypedates leucomystax*	Rhacophoridae	--	--	-	-	-	-	-	3	-	+	-	-	+	-
	Total		115							88						

(TI= Total individuals)

TABLE 3. Distribution of reptiles species in Arghakhanchi and Rupandehi districts of Nepal.

S. N.	Scientific name	Family	Arghakhanchi							Rupandehi						
			TI	Sandhikharka	Sitapur	pokhrathok	Arghatosh	Gokhunga	Siddhara	TI	Khaireni	Belbas	Sainamaina	Gajedi	Bhairahawa	Chhapia
1.	*Pungshura smithii*	Bataguridae	-	-	-	-	-	-	-	2	-	-	-	-	+	+
2.	*Lissemys punctata*	Trionychidae	-	-	-	-	-	-	-	2	-	-	-	+	-	+
3.	*Calotes versicolor*	Agamidae	39	+	+	+	+	+	+	31	+	+	+	+	+	+
4.	*Laudakia tuberculata*	Agamidae	15	-	-	-	-	+	-	-	-	-	-	-	-	
5.	*Oriotiaris tricarinata*	Agamidae	3	+	-	-	+	-	-	2	-	+	-	-	-	-
6.	*Hemidactylus brookii*	Gekkonidae	13	+	-	-	+	-	-	21	+	-	+	-	+	-
7.	*Hemidactylus flaviviridis*	Gekkonidae	11	+	-	-	-	-	+	9	+	+	-	+	+	-
8.	*Hemidactylus frenatus*	Gekkonidae	-	-	-	-	-	-	-	8	-	+	+	-	+	-
9.	*Eutropis carinata*	Scincidae	5	-	-	-	+	-	-	1	--	-	-	-	-	-
10.	*Mabuya macularia*	Scincidae	8	+	+	+	-	-	-	5	-	-	+	-	+	+
11.	*Sphenomorphos maculatus*	Scincidae	4	-	+	-	-	-	+	6	-	-	-	+	-	+
12.	*Varanus bengalensis*	Scincidae	7	+	-	+	+	-	+	2	-	+	-	-	+	-
13.	*Varanus flavescens*	Scincidae	-	-	-	-	-	-	-	1	+	-	-	-	-	-
14.	*Crocodylus palustris*	Crocodylidae	1	-	-	-	-	-	+	-	-	-	-	-	-	-
15.	*Python bivittatus*	Boidae	-	-	-	-	-	-	-	2	-	+	-	-	-	-
16.	*Python molurus*	Boidae	-	-	-	-	-	-	-	2	+	+	-	-	-	-

17.	*Amphiesma stolatum*	Colubridae	3	+	-	-	+	-	-	4	+	-	-	+	+	-
18.	*Boiga trigonata*	Colubridae	3	+	-	-	+	-	-	3	-	-	+	-	+	+
19.	*Coelognathus helena*	Colubridae	6	+	+	-	-	+	+	4	-	+	-	-	+	-
20.	*Coelognathus radiatus*	Colubridae	5	-	+	+	-	-	+	3	+	-	-	+	-	-
21.	*Dendrelaphis trisis*	Colubridae	-	-	-	-	-	-	-	1	+	-	-	-	-	-
22.	*Lycodon aulicus*	Colubridae	5	+	+	+	-	-	-	4	+	+	-	-	+	+
23.	*Oligodon arnensis*	Colubridae	1	+	-	-	-	-	-	-	-	-	-	-	-	-
24.	*Oligodon erythrogaster*	Colubridae	1	-	-	+	-	-	-	-	-	-	-	-	-	-
25.	*Ptyas mucosa*	Colubridae	11	+	+	+	+	+	+	9	+	+	+	+	+	+
26.	*Trachischium guentheri*	Colubridae	1	-	-	-	-	+	-	-	-	-	-	-	-	-
27.	*Xenochrophis piscator*	Colubridae	4	+	+	+	+	-	-	5	+	-	-	+	+	+
28.	*Xenochrophis sanctjohannis*	Colubridae	1	-	+	-	-	-	-	1	-	-	-	+	-	-
29.	*Ramphotyphlops braminus*	Typhlopidae	2	+	-	-	-	-	-	-	-	-	-	-	-	-
30.	*Bungarus caeruleus*	Elapidae	2	+	-	-	-	-	+	5	+	-	+	+	+	-
31.	*Bungarus fasciatus*	Elapidae	-	-	-	-	-	-	-	1	-	-	-	-	+	-
32.	*Hemibungarus macclellandii*	Elapidae	2	-	-	-	-	+	-	-	-	-	-	-	-	-
33.	*Naja kaouthia*	Elapidae	-	-	-	-	-	-	-	2	-	-	-	-	+	+
34.	*Naja naja*	Elapidae	-							4	+	-	+	-	+	-
35.	*Trimeresus albolabris*	Viperidae	8	+	+	+	+	-	-	6	+	+	-	+	+	+
36.	*Ovophis monticola*	Viperidae	2	-	-	-	-	+		-	-	-	-	-	-	-
	Total		163							146						

TABLE 4. Distribution of venomous and non venomous snakes in Arghakhanchi and Rupendehi districts, Nepal.

S.N.	Scientific name	Family	Venomous		Non venomous	
			Arghakhanchi	Rupandehi	Arghakhanchi	Rupandehi
1.	*Amphiesma stolatum*	Colubridae	-	-	+	+
2.	*Boiga trigonata*	Colubridae	-	-	+	+
3.	*Coelognathus Helena*	Colubridae	-	-	+	+
4.	*Coelognathus radiatus*	Colubridae	-	-	+	+
5.	*Dendrelaphis trisis*	Colubridae	-	-	+	+
6.	*Ptyas mucosa*	Colubridae	-	-	+	+
7.	*Xenochrophis piscator*	Colubridae	-	-	+	+
8.	*Oligodon arnensis*	Colubridae	-	-	+	-
9.	*Oligodon erythrogaster*	Colubridae	-	-	+	-
10.	*Trachischium guentheri*	Colubridae	-	-	+	-
11.	*Xenochrophis sanctjohannis*	Colubridae	-	-	+	-
12.	*Ramphotyphlops braminus*	Typhlopidae	-	-	+	-
13.	*Python bivittatus*	Boidae	-	-	-	+
14.	*Python molurus*	Boidae	-	-	-	+
15.	*Lycodon aulicus*	Colubridae	-	-	-	+
16.	*Bungarus caeruleus*	Elapidae	+	+	-	-
17.	*Trimeresus albolabris*	Viperidae	+	+	-	-
18.	*Hemibungarus macclellandii*	Elapidae	+	-	-	-
19.	*Ovophis monticola*	Viperidae	+	-	-	-
20.	*Naja kaouthia*	Elapidae	-	+	-	--
21.	*Naja naja*	Elapidae	-	+	-	-
22.	*Bungarus fasciatus*	Elapidae	-	+	-	
	Total		4	5	12	10

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Research Article

Species diversity of reptiles in Palpa District, Nepal

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Abstract

Gastrointestinal (GI) This study was conducted in agricultural field, forests, riparian and wetland habitats, and human habitats of six sampling sites in Palpa, Nepal, from May 2016 and April 2020. The purpose of the study was to document and measure the richness, abundance, and diversity of the reptile in this district. Data was collected randomly in these habitats of this district using quadrat, visual encounter, and opportunistic survey methods. For 100 quadrates for each site seasonally, 20 quadrats were placed in each habitat along 5 transects. In total, 554 individual species belonging to 9 families, 26 genera, and 34 species were recorded. The richness of reptiles was high in the human habitat and forest (S = 25) but lower in wetland (S = 6). The abundance was more in human habitat than in other habitats. Shannon diversity index (H') of reptile was 2.51 and 0.99 in forest and wetland respectively. Similarly, the Simpson index in reptiles (λ) was high in forest (0.87) and low in wetland (0.57). Pielou evenness (J) of individuals among the species was 0.29 in forest and 0.54 in a wetland. The values indicate that the diversity of reptiles were more diverse in forest as compared to the wetland. This study aids the resources for additional research.

Keywords: Agricultural fields; Diversity indices; Forests; Human habitats; Riparian; Wetland

1 | Introduction

Since The diversity and distribution of reptile species are influenced by factors such as geography, humidity, disturbance, and habitat type. There are 11,690 reptile species reported in which lizards (7,144 species), snakes (3956 species), turtles (360 species), amphisbaenians (202 species), crocodiles (27 species), and tuataras (1 species) (Uetz 2021). In Nepal, there are 142 species of scaled reptiles, including crocodiles (2 species), turtles and tortoises (15 species), 40 lizard species, and 70 snake species (Schleich & Rai 2012).

South Asia has a rich diversity of herpetofauna including several unique and endemic species (Shah & Tiwari 2004). The identification and distribution of the herpetofauna in Nepal was aided by the research of Swan and Leviton (1962), Fleming and Fleming (1974), Kramer (1977), Nanhoe and Ouboter (1989), Schleich and Kastle (2002), Anders (2002), and others. Other Nepalese researchers have taken an interest in herpetology following T. K. Shrestha (1989), including Shah and Gire (1992), Shrestha (2001), and Shah and Tiwari (2004). Reptiles have diverse forms, are widely distributed, except polar ice and the Tundra regions. They are among the most successful vertebrates in terms of diversity, distribution, and abundance as they occupy and live in a great variety of aquatic and terrestrial habitats (Hickman et al. 2007; McDiarmid et al. 2012). Some species of reptiles have adapted to live in very harsh climates such as desert and arid areas. The occurrence of these species in the dry climate is attributed to their thickened skin.

Indexes of richness, evenness, diversity, and abundance, as well as distribution models, are the most used types of species diversity metrics (Magurran 1988; Ludwig & Reynolds 1988). Species richness is commonly used as a measure of biodiversity for many purposes, including monitoring of biodiversity and determining where to prioritize conservation efforts (Magurran 2004; Kerr 1997).

Although they are extensively distributed in Nepal and the around the world, research on reptiles has been less focused as that on other vertebrates. Less research has been carried out on the population, distribution, and status of reptiles in Nepal than other vertebrate species (CEPF 2005; Bhattarai et al. 2017). There is still a shortage of information on these species from western Nepal (Lumbini region). This study assesses the diversity, abundance, and richness of the reptiles in the Palpa district of Nepal and includes comprehensive data.

2 | Materials and methods

2.1 | Study area

This study was conducted from May 2016 and April 2020 in Palpa district. It extends from 83°15′ to 84°22′ east and 27°24′ to 27°57′ north. The six sampling stations were Tansen, Sardewa, Deugir- jhadewa, Dobhan, Rampur and Ringneraha. It is hilly district and covers an area of 1,373 km². It has several terrestrial macro-habitat type. It covers Siwalik hill or Churia range and Mahavarat range. It consists of tropical to temperate climates and consists of shrubs area, slight to moderately dense forests, fertile lands, slope landscape, caves, and varied microclimatic conditions.

Figure 1. Map of Palpa District showing study area

Table 1. Station, coordinate and elevation of study area

SN	Station	Coordinate	Elevation (m)
1	Tansen	27.8666 °N, 83.5499 °E	1059
2	Somadi – Sardewa	27.9148 °N; 83.3974 °E	731
3	Jhadewa	27.7770 °N, 83.6797 °E	1062
4	Dovan	27.7453 °N, 83.4644 °E	271
5	Rampur	27.8469 °N, 83.9011 °E	402
6	Ringneraha	27.8265 °N, 83.7511 °E	827

2.2 | Data collection

Samplings were conducted from May 2016 to April 2020 six sampling stations of this district. Each sampling site was split into five sub-habitat sites (Agricultural fields, forest, human habitat, riparian and wetlands) in which 5 transects at which 20 cell quadrates were sampled in each sub-habitat and altogether 100 quadrates in each site. The other sampling methods were opportunistic surveys conducted in other parts based on (Gardner 2007) and visual encounter method on each habitat. Each sampling effort was carried out by field helpers for about three hours in morning from 6.00 am to 9.00 am, afternoon from 12.00 to 3.00 pm and evening from 7.00 pm to 9:00 pm. Trapping, digging, and raking was used to detect species. While looking for basking or active reptiles, visually recorded the habitat to be surveyed in the afternoon.

The possible individuals were caught then euthanized for morphological study, measured for future reference, taken of representatives of each species and habitats in a natural condition, and released back. Geographic coordinates for each survey site were determined in the field with a Garmin GPS (etrex 10) receiver. The sample specimens were fixed in 10% formalin and preserved in 70% alcohol. The specimens were identified using the identification keys developed by field guide of Gunther 1863), Smith (1981), Dixon (2000), Schleich & Kaestle (2002), and Rai (2003) and Shah & Tiwari 2004).

2.3 | Data analysis

Table and figure were prepared from Microsoft Excel 2013 and species diversity were calculated by software R package 3.6.1 in R Studio v.3.1.0 (R Development Core Team 2013). Species richness (the number of species) and abundance (number of individuals) of each taxon was estimated. Diversity indices used in this study were the Shannon Wiener index (1949), Simpson index (1949), and Evenness to find out the interrelationship between them. Richness and Evenness are the components of diversity (Pielou 1969; Liu et al. 2008). Biodiversity indices were calculated to investigate the differences in reptile diversity and abundance among different habitats (Table 2). Data was tested by using Menhinick's index (D=nN—√N), Margalef's index (D=n−1lnN). The Shannon-Wiener Index [H′ = -Σ (pi ln pi)] was used to determine the diversity of species heterogeneity (where, H′ = species diversity, and pi = proportional frequency of the ith species). Simpson's Index (λ) λ DS=Σni (ni−1N(N−1)=1−Σni(ni−1N(N−1) and Pilou evenness (J) were tested.

$$J = \frac{H'}{H_{max}} = \frac{H'}{ln.S} =$$

3 | Results

Throughout this study, 34 species of reptiles exposed in the studied locations (Table 2). Ten species of lizards from four distinct families were present (Gekkonidae, Agamidae, Scincidae, and Varanidae). Five distinct snake families and 24 species of snake have identified. Among them family Colubridae has 15 species followed by Elapidae (5 species), Viperidae (2 species), Boidae (1 species), and Typhlopidae (1 species). There were 39 species of lizards, 81 species of snakes, 2 species of crocodiles, and 16 species of tortoise and turtles (Shrestha, 2001), Shah and Tiwari (2004), on the other hand, reported 123 reptiles in Nepal. In addition to

Table 2. Families, species and habitat of Reptiles in Palpa district

Families	Scientific name	Agricultural field	Forest	Human habitat	Riparian	Wet land	Total	%	IUCN status
Agamidae	*Calotes versicolor*	41	34	39	5	1	120	21.66	LC
	Laudakia tuberculata	3	11	0	0	0	14	2.53	LC
	Oriotiaris tricarinata	1	7	1	0	0	9	1.62	LC
Gekkonidae	*Hemidactylus brooki*	0	0	30	0	0	30	5.42	NA
	Hemidactylus flaviviridis	0	0	28	0	0	28	5.05	LC
	Hemidactylus frentatus	0	0	13	0	0	13	2.35	LC
Scincidae	*Eutropis carinata*	2	7	4	0	0	13	2.35	LC
	Mabuya macularia	2	7	1	0	0	10	1.81	NA
	Sphenomorphos maculates	5	9	5	0	0	19	3.43	NA
Varanidae	*Varanus bengalensis*	0	7	0	0	0	7	1.26	LC
Typhlopidae	*Indotyphlops braminus*	5	12	6	0	0	23	4.15	LC
Boidae	*Python molurus*	0	2	0	0	0	2	0.36	NT
Colubridae	*Amphiesma solatum*	0	0	0	7	3	10	1.81	LC
	Boiga forsteni	1	3	1	0	0	5	0.90	LC
	Boiga ochracea	5	5	2	0	0	12	2.17	LC
	Boiga trigonata	5	10	7	0	0	22	3.97	LC
	Coelognathus helena	3	8	3	0	0	14	2.53	LC
	Coelognathus radiatus	3	5	4	1	0	13	2.35	LC
	Dendrelaphis trisis	2	6	2	0	0	10	1.81	NA
	Lycodon aulicus	2	0	4	2	1	9	1.62	LC
	Oligodon arnensis	1	0	2	0	0	3	0.54	LC
	Oligodon erythrogaster	6	0	6	0	0	12	2.17	NT
	Orthriophis hodgsonni	3	5	4	0	0	12	2.17	NA
	Ptyas mucosa	7	13	11	5	7	43	7.76	LC
	Trachischium guentheri	0	1	0	0	0	1	0.18	VU
	Xenochrophis piscator	2	0	0	9	7	18	3.25	LC
	Xenochrophis sanctjohannis	0	0	0	6	3	9	1.62	LC
Elapidae	*Bungarus caeruleus*	1	2	4	0	0	7	1.26	LC
	Sinomicrurus macclellandi	0	3	3	0	0	6	1.08	LC
	Naja kaouthia	1	2	1	0	0	4	0.72	LC
	Naja naja	2	6	2	0	0	10	1.81	LC
	Ophiophagus hannah	0	4	0	0	0	4	0.72	VU
Viperidae	*Trimeresus albolabris*	9	13	9	0	0	31	5.60	NA
	Ovophis monticola	5	5	1	0	0	11	1.99	LC
		117	187	193	35	22	554	100.00	

Table 3. Diversity index of reptile in different habitat in Palpa District

S. N	Diversity index	Agriculture field	Forest	Human habitat	Riparian	Wetland
1	Species richness (S)	23	25	26	7	6
2	Menhinick's index	1.86	2.05	1.51	1.00	0.80
3	Margalef's index	4.00	4.30	3.30	1.24	0.76
4	Shannon-Wiener Index (H')	2.47	2.51	2.25	1.41	0.96
5	Simpson's Index (λ)	0.86	0.87	0.84	0.73	0.57
6	Pilou evenness (J)	0.29	0.29	0.30	0.45	0.52

these, regional reptiles have been described taxonomically, geographically, genetically, and moreover by a variety of researchers. For example, Pokhrel and Thakuri (2010) observed 9 reptiles in the Manaslu conservation area, 34 species of reptiles (Bhattrai et al. 2018; 2010) in Chitwan National Park, and 56 species of reptiles (including 37 genera in 17 families) in Shuklaphanta National Park (Rawat et al. 2020). Das et al. (2009) found 45reptile species in the Barail Wildlife Sanctuary.

3.1 | Species richness and abundance

Species richness of reptile was 34 in Palpa district. During field visits, 554 individual reptiles were recorded. The most abundant reptile species was *Calotes versicolar* (21.66%) followed by *Ptyas mucosa* (7.76%) and *Python molurus* (0.36%) was rarely recorded in this district but least species recorded in *Trachischium guentheri* (0.18%). In this study, reptile preferred Human habitat (S=26), followed by forest (25), agricultural field (23), riparian (7), and 6 in Wetland (Table 3; Fig.2). There were four families of lizards, which were found in forest. Among them gecko was observed on ceiling and wall of building so preferred the human habitat.

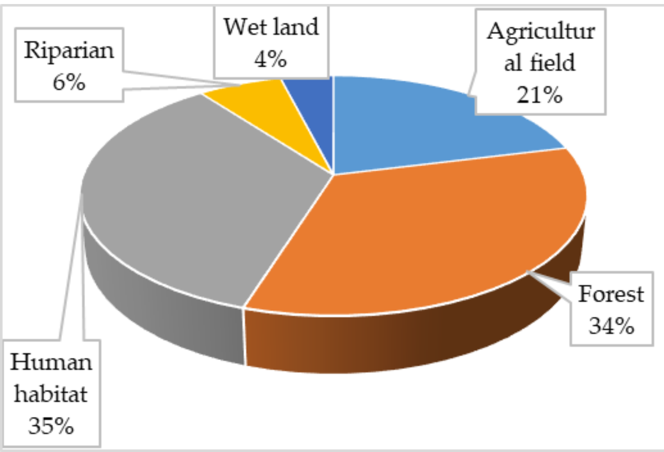

Figure 2. Habitat wise abundance of reptiles in Palpa

3.2 | Species diversity of reptiles

Menhinick's index and Margalef's index both have more value in forest and agricultural field. The Simpson diversity index was 0.86, 0.87, 0.84, 0.73, and 0.57 in different habitats of agricultural field, forest, human habitat, riparian, and wetland; respectively. A higher Simpson's index as well as a higher Shannon-Wiener's index also indicated great species evenness in the riparian and agricultural areas. The index value (H) was 2.51 in forest, 2.47 agricultural field and 2.25 in human habitat, which were more than 1.50. This indicates the higher diversity, but values of diversity index of riparian and wetlands were 1.41 and 0.96 respectively less than 1.50. Therefore, these habitats showed less diversity (Table 3).

4 | Discussion

There were 10 species of lizard and 24 species of snakes observed. Lizards were most diversified and well-adapted species for walking, running, climbing, and burrowing (Hickman et al. 2007). *Calotes versicobor* is most abundant and widespread agamid of Nepal (Shah and Tiwari 2004). *Calotes versicolor*, *Hemidactylus* spp .and *Mabuya macularia* remarkable appeared species. Snakes such as *Amphiesma stolatum*, *Coelognathus radiates*, *Lycodon aulicus*, *Ptyas mucosa*, *Xenochrophis piscator*, *Naja kaouthia*, *Naja naja*, *Indotyphlops braminus* and *Trimeresus albolabris* were notable records during the study period. Altogether 24 species of snakes were recorded in which eight species were venomous snakes. Local people often kill both venomous and non-venomous snakes in this area for preventive measures against snakebites. Reptile abundance and movement rise with early rains, according to Msuya (2003), because of increased food availability.

Simpson index ranges from 0 to 1. Mature and stable communities have high diversity value (0.6 to 0.9), while the communities under stress conditions, exhibiting low diversity, usually show close to zero value (Dash 2003). Shannon-Weiner and Simpson diversities increase as richness increase for a given pattern of evenness, and increase as evenness increases for a given richness (Shah & Pandit 2013). Habitats have higher Margalef index values (> 1.50), indicating more reptile species diversity. Margalef index value was 4.0 in agricultural field, 4.3 in forest, and 3.3 in human habitat which was more than 1.50, showed the higher species diversity, but in other habitats, values were less than 1.50, thus, the lesser diversity. Pielou evenness (J) constrained between 0 and 1.0 and the more variation in abundances between different taxa within the community, the lower the J. It depended on sample size and was also highly sensitive to rare taxa. Pielou evenness was 0.29, 0.29, 0.30, 0.45, and 0.52in the habitats of agricultural field, forest, human habitat, riparian, and wetland; respectively. The exponential of the Shannon's diversity index was computed to get the effective diversity of species. The diversity indices as Simpson index (1-D > 0.80), and Shannon-Weiner (H >2.20) found the areas with high diversity. Shannon-Wiener index is expected to determine the evenness and richness (Melo 2008). In the present study, Shannon index (H') were more in forest than other habitats. The relative abundance, equitability index (J > 0.80) and evenness (e^H/S) > 0.70) of individuals among the species show that species diversity was more abundant (Gixhari et al. 2016).

5 | Conclusions

Current study found that there was a total of 9 families, 34 species, and 554 reptiles in the study region. There were 24 different kinds of snakes, and 8 of them were venomous. The richness of reptile was higher in habitat and forest. Only one species of *Trachischium guentheri* was recorded during the survey. Many diversity indices had high diversity values for stable communities, while unstable ones had low values due to environmental degradation. Species diversity was higher in forest and agricultural fields. They preferred the human habitat, forest and agricultural field but not riparian and wetland. The majority of diversity indices' information was used to determine habitat characteristics and conduct quantitative analysis (species richness, evenness). This demonstrates the importance of maintaining both habitats (forests and agricultural areas) in order to preserve the diversity of reptiles in this area.

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Conflicts of interest

Authors declare no conflict of interest.

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