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ASSESSMENT AND CONSERVATION STATUS OF AQUATIC BIODIVERSITY IN LOWER KARNALI AND MAHAKALI RIVER BASIN

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Cover photo: School of juvinielle fish in Babai River in Lower Karnali Watershed

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EXECUTIVE SUMMARY

The Karnali and Mahakali River Basins offers a striking example of the ecological and socioeconomic complexities that make conservation of lotic ecosystems in western Nepal is challenging. Aquatic biodiversity, sensitive to human induced actions, are overlooked in research and conservation planning. In Nepal, information on the diversity of lower faunal and floral groups in aquatic system is limited. Hence, this project inventoried the diversity, threats and management implications for wetland associated fauna and flora in selected wetlands of lower Karnali and Mahakali River Basins. Birds, mammals and herpetofauna were sampled using a transect survey method whereas fishing net casting samplings was performed along shore. Molluscas were surveyed using a time constrained survey technique. The diet of the amphibians was collected using stomach flusing technique and assessed the role as crop pest and disease vectors controller. Aquatic vegetation was sampled using the belt transect method. Key informant interviews, community interactions and questionnaires were used to collect data on use of herpetofauna and aquatic biodiversity and wetland management.

The lakes of Mahakali (Rani and Jhilmila) and Karnali (Satti Karnali and Ramaroshan lake complex) River Basins have high ecological, cultural and economic importance. The local people directly or indirectly depended on aquatic ecosystem goods and services such as snails, fish, edible plants etc. These lakes play vital roles especially in providing breeding, feeding and shelter to many fauna and flora. Satti Karnali Lake is a new lake formed when Karnali River changed its course whose main feeder is Rani canal (*Kulo*). A total of 116 species of bird including 4 species of globally vulnerable and 4 nearly threated birds, 11 species of mammal including endangered mammal- Ganges river dolphin (*Platanista gangetica gangetica*), three vulnerable (Smooth-coated otter, Leopard and Fishing cat), seven species of amphibian, eight species of reptile including Indian rock python, 29 species of fish, five species of aquatic insects, 14 species of fresh water mollusk, 61 species of terrestrial plant and 37 species of macrophytes were recorded. The ethnic and marginalized groups such as *Badi* and *Tharu* depend upon the lake for collecting fish, mollusks and edible plants. Out of 14 freshwater mollusks reported from the lake, six species were used as food by *Tharu* and *Badi* communities. Moreover, the community forest (Satti Karnali) collected annual revenue which exceeded nine million Nepalese rupees (USD 95,000) by Rattan cane (*Bet*) alone. Livestock grazing, buffalo wallowing and over exploitation of fish and snails were major threats to aquatic ecosystems in Satti Karnali.

Rani lake, which is located inside the Shuklaphanta National Park (ShNP), has played a vital role in maintaining the wetland ecosystem inside the park. The field study found that the lake supports 131 species of birds, 10 species of mammals including Royal Bengal tiger, One horned rhinoceros, Hog deer and 10 species of amphibian, 10 species of reptiles, six species of fish, more than ten species of macro invertebrates, 77 species of flowering plants and 22 species of aquatic plants. Livestock grazing and collection of natural resources are stickily prohibited in this lake area. Due to natural succession and eutrophication, this lake is shrinking.

Jhilmila lake is considered to be a holy lake located in the Churiya hill of the Western Nepal. Thousands of pilgrims from India and Nepal visit this lake annually. Bathing and collecting natural products from the lake is fully prohibited. The lake supports more than 104 species of bird, seven species of mammal, six species of amphibian, six species of reptile, three species of fish, more than seven species of macro invertebrate, 105 species of flowering plants and 15 species of wetland dependent plants. Livestock grazing and siltation are the major threats in the lake.

Ramaroshan lake complex is composed of a cluster of 12 lakes (two of them have dried up). The lake complex is the main feeder of the Kailash River which is a tributary of the Karnali River. This lake complex is economically, culturally and ecologically important for people living around and the downstream. A total of 11 species of mammal including Leopard (*Panthera pardus*), Red panda (*Ailurus fulgens*), Asiatic black bear (*Ursus thibetanus*), Clouded leopard (*Neofelis nebulosa*), Himalayan goral (*Naemorhedus goral*); 79 species of birds including one globally Endangered bird (Egyptian Vulture *Neophron percnopterus),* three globally vulnerable birds (Asian woolly-necked *Ciconia episcopus* and Cheer pheasant *Catreus wallichii*) and one globally near threatened bird Northern lapwing (*Vanellus vanellus*); five species of reptiles, seven species of amphibians, three species of fish including Budhe Asala (*Schizothorax nepalensis*) and Tikhe Asala (*Schizothorax richardsonii*), 14 species of macro invertebrates, 169 species of plants including 30 species of macrophytes were recorded.

The dietary analysis of the frog revealed that they consumed several insects species including crop pest and harmful insects. Our result showed that frog consumed some of the notorious crop pest like grasshoppers, caterpillars, crickets, insect larvae, leaf hoppers, aphids, and mole crickets. Their diet also composed of mosquitoes, sand flies and house flies, which are considered as vectors of many diseases and potentially harmful to human. Frogs are consumed as food and considered to have its medicinal value in traditional healing practices.

Despite their vital ecological, social and economic importance, the lakes that were assessed in western Nepal are degrading, shrinking and drying up due anthropogenic disturbances including improper management. A concerted management effort by stakeholders at all levels is necessary to ensure sustained ecosystem services from the wetlands. Wetland policies and management plans should address the spatial and temporal dynamics of wetland degradation and appreciate rich biodiversity and complex ecological system while treating water bodies and wetlands as a resource unit.

1. INTRODUCTION

1.1 PROJECT BACKGROUND

The Paani Program—also known in Nepali as the "USAID Water Project", *युएसएड पानी परियोजना*—is a 5-year USAID-funded project in Nepal. Water is the single most important natural resource underpinning Nepal's economy and livelihoods. The sustainable management of water resources in Nepal depends on addressing climate change and protecting biodiversity and ecosystems. Paani aims to enhance Nepal's ability to manage water resources for multiple uses and users through climate change adaptation and the conservation of freshwater biodiversity.

The Karnali and Mahakali River Basins offer striking examples of the ecological and socioeconomic complexities that make managing ecosystems in western Nepal challenging. Theses river basins are biologically significant areas for freshwater biodiversity especially fish, amphibians, reptiles, birds, and mammals with high endemism. In addition, there are unique habitats – grassland and forests, oxbow lakes, clear and white-water streams – which enrich the biological diversity and endemism. In the Karnali River Basin, the landscape has been transformed over a long period due to human activities such as hydroelectric projects, cultivation, grazing, and extraction of natural resources. These ever-increasing human activities sometimes serve as threat factor for viability, ecosystem integrity, and the over exploitation of ecosystem services by ever growing human populations. At the same time, the basin lacks systematic information about the distribution patterns of freshwater species, an information gap that hinders adequate conservation and management initiatives.

Aquatic biodiversity, sensitive to human induced actions, are often overlooked in diversity studies and conservation planning. Ideally, an accurate estimation of freshwater diversity patterns should include both vertebrate and invertebrate taxa because they may have different diversity patterns and differential response to the environmental characteristics. However, typically, adequate data on the diversity of vertebrate and invertebrate groups in Nepal does not exist. In this context, this project aims to explore the diversity patterns, threats and management options for both wetlands associated vertebrate and invertebrate groups in lower Karnali and Mahakali River Basins. Given the complexity of wetland and associated biodiversity, we evaluated four lakes in western Nepal for this study. We assessed fish, birds, macroinvertebrates, macrophytes, flora and mammals with special focus on herpetofaunas for specific wetlands. Herpetofaunas are very sensitive to environmental changes and are threatened taxa due to anthropogenic activities but are largely ignored in conservation policies and programs. Along with biodiversity profiling, we assessed management practices and threats to suggest actions for different stakeholders. Outputs of the result will form a knowledge base on wetland biodiversity conservation in western Nepal.

1.2 OBJECTIVES

1. Assess status of aquatic diversity especially vertebrate and major invertebrate and their relationship in ecosystem functioning.
2. Study to identify indicator species that proximate the health of the wetlands in especially Lower Mahakali [Rani Lake, Jhilmila Lake], Lower Karnali [Satighaat], Middle Karnali [Ramaroshan in Achham].
3. Determine major threats to the conservation of vertebrate and invertebrate species including the human and climate induced hazards on herpetofauna.

4. Evaluate the role of herpetofauna as a biological control agent for crop pest and disease vectors through investigation of dietary habits.
5. Assess the provisional and cultural ecosystem services of the herpetofauna in Karnali and Mahakali River Basins.

2. MATERIALS AND METHODS

2.1 STUDY AREA

This study was carried out in four wetlands of Mahakali and Karnali River basins. As shown in Figure 1 these wetlands are Rani lake and Jhilmilain Kanchanpur District, Satti Karnali lake in Kailali and Ramaroshan in Accham district. These lakes were selected based on our review of wetland literatures on western Nepal (for e. g, DOF 2017), anecdotal experiences of Forest Action Nepals research team. We identified lakes that are underexplored yet threatened due to diverse anthropogenic and natural drivers. We also targeted lakes with biodiversity data gap and tried to capture geographic and climatic variation in the sites. Based on these we picked above four lakes.

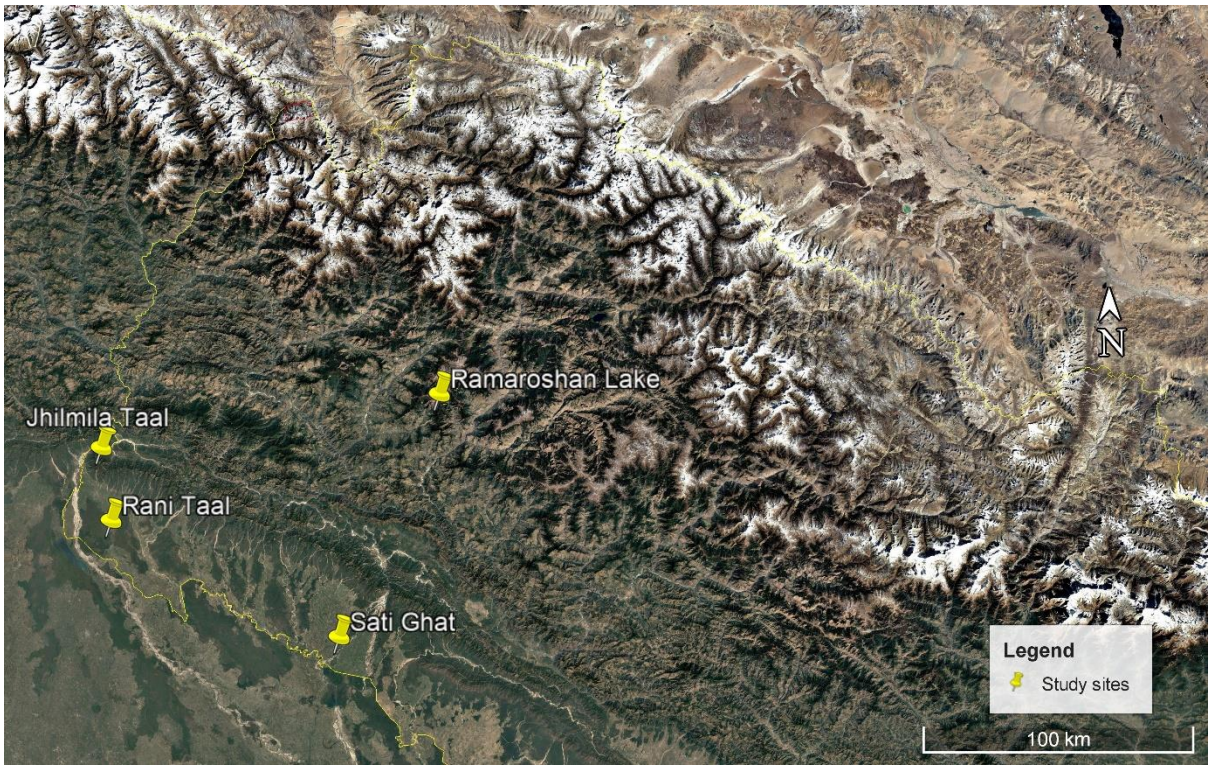


Figure 1. Map of Western Nepal showing the study area locations.

2.2 DATA COLLECTION

In this study, we surveyed major vertebrate and invertebrate fauna from the four different wetlands.

2.2.1 Herpetofaunal survey and frog diet collection

Both amphibians and reptiles were surveyed using diurnal and nocturnal transect by time constrained visual encounter survey (Khatiwada 2012, Khatiwada et al. 2016, Khatiwada et al. 2019). Transects were searched by four people for one hour using torches, walking at a slow pace at night/days. The number of species and individuals encountered in each transect were recorded with all habitat and environmental variables. Apart from nocturnal and diurnal transects, opportunistic random surveys were also carried out to list the available species in the area. All individuals encountered were captured and stored in 15-liter plastic bucket with small holes on the lid. Some uncaptured individuals will also be counted. All captured individuals were taken to nearby dry place where

animals were sexed, measured, diet collection and identified at species level performed based on guide books: Schleich and Kästle (2002) and Shah and Tiwari (2004), and then released back into the original habitats. Male frogs were identified based on secondary sexual characteristics in the presence of black pigment on the throat (vocal sac) and nuptial pads, and females by the enlargement of the coelomic cavity in gravid individuals. Identifying sex of frogs would give idea on population status. It also can help predict future scenarios. Specimens cannot be identified based on morphological traits and were euthanized in a chlorobutanol solution, fix in natural formalin for 24 hours and then specimens were preserved in 75% ethanol. Voucher specimens deposited at the Central Department of Zoology, Tribuvan University, Kathmandu, Nepal. The species nomenclature herein follows standard taxomic literature of Frost (2019).

Frog diets were collected using a non-lethal stomach flushing technique described by Khatiwada et al. (2016). A tube attached to a syringe was introduced through the oesophagus into the stomach. Once the tube is inserted, a small amount of water was squeezed from the attached syringe into the stomach and any content that is forced were collected. The stomach-flushing procedures were repeated until no further stomach content is produced. The stomach contents were preserved in 70% ethanol for further identification and measurements in the laboratory. Stomach contents of individual frogs were dried on filter paper and weighed to the nearest 0.01g using a digital scale. Prey items were subsequently placed in a petri dish and observed under a stereoscopic microscope, and reference slides were also prepared from wings, antenna and legs. All prey items were identified to the lowest possible taxonomic level at the Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal.

2.2.2 DIET IDENTIFICATION AND CLASSIFICATION

Collected stomach contents were dried on filter paper and observed under a stereoscopic microscope, and reference slides prepared from wings, antenna and legs. All stomach contents were then identified to the lowest possible taxonomic level at the Central Department of Zoology, Tribhuvan University, Kathmandu, Nepal. Only insect prey were classified as crop pests and non-pests as described by Neupane (2010). Insect prey that are harmful to plants and may affect crop yield for example: grasshoppers, caterpillars, crickets, insect larvae, leaf hoppers, aphids, and mole crickets were classified as crop pest (Neupane 2010). Moreover, some other insects for example mosquitoes, sand flies and house flies are considered as vectors of many diseases and potentially harmful to human health (Mullen and Durden 2002) and were classed as harmful insects. In contrast, rice thrips, ladybird beetles, spiders and dragonflies are predatory insects preying upon insect pests, and these are grouped as beneficial insects (Kartohardjono and Heinrichs 1984, Barrion and Litsinger 1994, Dale 1994).

2.2.3 BIRD SURVEY

Bird sampling were conducted using the open width point count method along transects near the bank of lake/wetland detailed by (Bibby et al. 2000). The length of transects were from 1.5 km to 3.5 km. In each transect, a minimum of 5 vantage points at each 500m distance were established and scanned with binoculars (Nikon 20×50) to count the birds. At each point, bird species were counted for five minutes. All the observed species were recorded with abundance by visual and auditory aids with habitat and environmental variables. The birds were observed by two observers in one transect, and then the lists of birds counted in vantage points were pooled together for each transect. The bird species were identified using the field guide book for birds of Nepal (Grimmett et

al. 2016). Besides that, we also carried out questionnaire survey and literature review to record migratory and other rare bird species presence in the area.

2.2.4 FISH SURVEY

Fish were sampled using the fishing nets (used by local fisher folks) to take representative samples individual wetlands were divided into three parts: left bank, center and right bank. At each site, 5 castings per fishing net was performed at the interval of 30 minutes. All captured individuals were taken to nearby dry place and photographed, measured and identified at species level referring to guide book by Shrestha (2008), and hence specimens were released back into the original habitats. Specimens that could not be identified based on morphological traits and guide book were euthanized in a chlorobutanol solution, fix in natural formalin for 24 hours and then specimens were preserved in 75% ethanol. Voucher specimens were deposited at the Central Department of Zoology, Tribuvan University, Kathmandu, Nepal. We did not carry out fish sampling and collection in Jhilmila lake and Rani lake, due to cultural norms and prohibition of collection activities in Shuklaphanta National Park, respectively.

2.2.5 MAMMAL SURVEY

2.2.5.1. TRANSECT SURVEY

Five systematic transects (varying between 0.42 to 1.5 km, Transects are trails or line established from one point to another) were laid in the riparian areas. Transect line was searched by 2-3 people and all the animal sighted and signs of animals like scats, pellets, droppings, feces, dungs, pugmarks, scrapings, carcasses, feathers, quills and burrows were recorded. Apart from these, anthropogenic threats like signs of poaching and snaring, logging, grazing intensity, firewood and fodder collection were also recorded in the transect.

2.2.5.2. CAMERA TRAPPING

Five pairs of camera traps were deployed for three consecutive nights at each wetland. Camera stations were selected based on frequency of animal sightings and signs recorded during transect walk. Camera traps were kept in active mode for 24 hrs. a day to maximize photo capture rate (Fig. 2).

Figure 2. Heat sensitive camera trap: used to capture the nocturnal and illusive mammals (Trapping station: southern part of Satti Karnali Lake)

2.2.6 MACROINVERTEBRATE SURVEY

Macroinvertebrate samples were collected from a total of 15 sampling locations (Sati Ghat), 10 locations (Rani lake), 25 locations in Ramaroshan lake once during the month of May. The sampling locations were selected based on the level of human disturbance and depth of the water. Equal sampling effort was ensured in all sites by allocating proportional time. A circular frame net (0.5 m diameter) with a mesh size of 300 µm with 10 m long stick attached with the net was used to sample the macroinvertebrate for 5 minutes (Fig 3A and 3B). The samples were collected kicking up the substrate and then sweeping above the disturbed area to capture dislodged or escaping macroinvertebrates as detailed by Stenert et al. (2008). All collected macroinvertebrates were sorted into collection bottles and stored into 70% ethanol for later identification. In the laboratory, all the samples were washed through a 250-µm sieve and leaves, stems, and other debris will be removed. The resulting material were preserved with 80% ethanol. Afterwards, all macroinvertebrates were examined using a stereomicroscope (10 × magnification). Identification was conducted to family level using the identification keys according to Sharma et al. (2005), Sharma and Rawat (2009), Korte et al. (2010), Budha et al. (2015), Budha et al. (2017).

Terrestrial molluscans in the riparian habitat were searched using time constrained survey technique. The length of the transect was 50m and were searched by four people for 30 minutes. The number of species including buried, or dead shells and individuals encountered in each transect were collected, photographed and measured. Fresh water and terrestrial mollusca were identified as described by Budha et al. (2015), Budha et al. (2017). Unidentified specimens were preserved in 70%

ethanol and were transported to the Central Department of Zoology, Tribuvan University, Kathmandu, Nepal for the identifications.

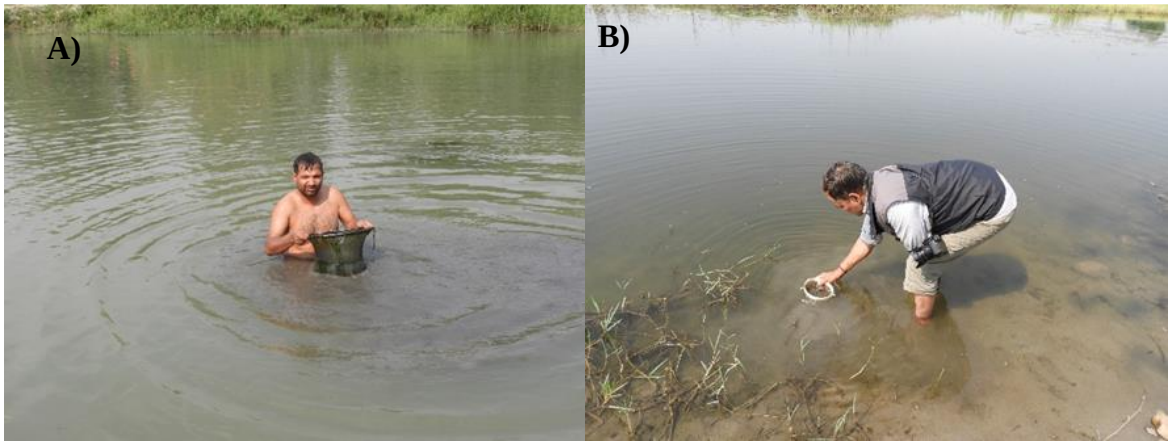


Figure 3. Sampling of A) macro invertebrates B) mollusca.

2.2.7 SAMPLING OF MACROPHYTES

Transects were established from shore to the lake center. Along the transect plot of 0.5 m radius was sampled. Macrophytes along the water column of 0.5 m radius were sampled. First plot sampling was done at the shore, second plot at 5 m and third and fourth plot at 10 m and 20 m away from the shore. Rest of plots along the transect was placed at the interval of 25 m. In each plot, all the species collected were recorded and their fresh biomass was measured.

2.2.8 EXTRACTION OF ENVIRONMENTAL SAMPLINGS

Various biophysical and disturbance related variables were collected based on their potential importance in shaping species diversity and composition of aquatic biodiversity.

Following are the major variables

i. Water quality related: water conductivity, turbidity, suspended particles, water depth, pH, water temperature, nitrate, nitrite, iron.
ii. Habitat: substrate type, habitat type, vegetation types, vegetation cover, tree diversity, canopy cover.
iii. Disturbance: Collection (fish, frog, snail, crocodile, otter, Ghariyal) activities, biomass outtake, mining and excavation, water pumping and irrigation channels, grazing and poaching
iv. Land use: Land cover and land use in the catchment of the wetland sites, siltation, agricultural practices (Use of chemical fertilizer) and intensity

2.2.9. SOCIO-ECONOMIC DATA COLLECTION

Community surveys were conducted using semi structured questionnaires related to the wetland, its utilization, dependency of local livelihood and local participation on development and management of wetlands. Similarly, sufficiency of the dietary supplements provided by the lake, change in the intensity of fishing practice and fishing cycles, consequences of lake deterioration to local livelihood, women participation on decision making meetings of the lake, mythological beliefs and religious importance of the wetlands were asked to local people. Two focal group discussions were

performed in each lake except Rani lake with the local stakeholders, local governances, representative of Division forest office about the name, drainage and management strategies and future planning for the development and management of the lakes and their long-term sustainability (Fig 4A and 4B). To obtain detailed information and management strategies of the lakes, key person interviews were performed with Chairman of respective ward, Chairman of Community forest, Division Forest officers, Rangers, Warden of National Park.

Figure 4. Interaction with local people A) Focal group discussion B) Questionnaire survey

2.2.10 ETHNO-BIOLOGICAL DATA COLLECTION

The ethnobiological data (mainly ethno medicinal) about the use of the different types of animals and plants collected by using Participatory Rural Appraisal (PRA) method (Long et al. 2009, Lohani 2012, Mootoosamy and Mahomoodally 2014). This study aimed to show the ethno-medicine and ethno-cultural knowledge with regards to conservation perspectives of plants and animals. Most of the traditional healers used body parts wild animals and plants for traditional medicines. An oral consent was taken from the respondent prior to have formal interviews with them. The focus group discussion, informal interview, key informant interview (local healers, Jhakri-wizard doctors, community leaders, teachers) performed during the field study. For the detailed information, semi-structured questionnaires were prepared and asked with the local people. The respondents were chosen randomly about their ethnicity, age, sex, profession including education level. The detailed information including local name of the animals, parts used, methods of preparation and mode of administration also recorded. The vernacular names collected from local people.

2.2.11 STATISTICAL ANALYSES

Descriptive statistics was used to illustrate the results. The results were presented in tables and bar-graphs as appropriate.

The diversity of the recorded animals was analyzed by using different diversity and dominance indexes such as Shannon's index, Simpson index. A diversity index is a mathematical measure of species diversity in a community.

Shannon's index: The Shannon diversity index (*H*) is commonly used to characterize species diversity in a community (Shannon 1948).

$$\text{Shannon Index (H)} = -\sum_{i=1}^{s} p_i \ln p_i,$$

Where, p_i is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N),

Where, ln is the natural log,

Σ is the sum of the calculations, and s is the number of species.

Simpson index: The Simpson index is a dominance index because it gives more weight to common or dominant species. In this case, a few rare species with only a few representatives will not affect the diversity (Simpson 1949).

Simpson Index (D) = $\frac{1}{\sum_{i=1}^{S} p_i^2}$

Where, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is still the sum of the calculations, and s is the number of species.

Evenness (e): Evenness is a statistical tool that compares actual diversity value to the maximum possible diversity by using evenness. The evenness of the sample is obtained from the formula:

Evenness = H'/Hmax

By definition, E is constrained between 0 and 1.0. As with H', evenness assumes that all species are represented within the sample.

Jacob's Equitability (J): The equitability is calculated by dividing the Shannon index of diversity by the logarithm of number of taxa. This measures the evenness with which individuals are divided among the taxa present.

Equitability (J)= H'/lnS

Where, H'= Shannon's index of diversity, S= number of taxa

Fisher's index describes mathematically the relation between the number of species and the number of individuals in those species (Fisher & Yates 1943). Fisher diversity index, defined implicitly by the formula.

$$S = a \times \ln\left(1 + \frac{n}{a}\right)$$

Where, *S* is number of taxa, *n* is number of individuals and *a* is the Fisher's alpha.

3. FINDINGS

3.1 SATTI KARNALI LAKE

3.1.1 PHYSIOGRAPHY

Satti Karnali is an ox-bow lake located at Sati Karnali Community Forest (SKCF), Kailali district (28°27' N 81°05' E) extended over 298.5 ha of natural forest, 47% of which (170 ha) is covered with rattan cane (Calamus tenuis) (Paudel and Chowdhary 2005) (Fig. 5 and 6A). The main feeder of this lake is outlet of Rani canal (Kulo) (Fig 6B) which is the main irrigation channel originated from Karnali river at Chisapani. The lake covers an area of 25 ha and located at ward no 8 of Tikapur Municipality. The community forest includes the user groups of Tikapur Municipality Ward no 6, 7 and 8. Total user groups of this community forest are 993 households (Total population-6366; Male-3211 and Female 3155) (source: Register of Satti Karnali Community forest, 2019). People from different ethnic and caste group use the community forest and the wetland; Tharu (312), Magar (135), Newar (69), Baadi and Dalits (109), Brahmin (64), Chhetri (300) and others (4).

3.1.2 HYDROLOGICAL FEATURES

The lake was formed due to overflow/seepage of water coming from the one of the channels of Karnali river. The present form of lake was formed after the construction of the dam to block the water seepage.

The climate is subtropical and the temperature ranges from 15°C to 43°C with an annual average of 23.7°C (Paudel and Chowdhary 2005).

3.1.3 WATER QUALITY

Physio-chemical properties of Satti Karnali were described based on analysis of samples collected at six strategic sites. The kits provided by the field office of USAID Paani program were used to analyze water quality of the Lake. Average temperature and dissolved oxygen (DO) were 22 ^{0}C and 7.2 ppm. Average pH was 6.4, ranged from 6.4 to 6.5. Average Nitrate was 0.70 mg/l, ranged from 0.5 to 1.7. The amount of ammonium was 3.20mg/l in the lake, as the overflow of the cropland also mix into the water of Rani Kulo, the main feeder of the lake. The farmers use urea or nitrogen containing fertilizer that makes the ammonium contents relatively higher in this Lake (Table 1).

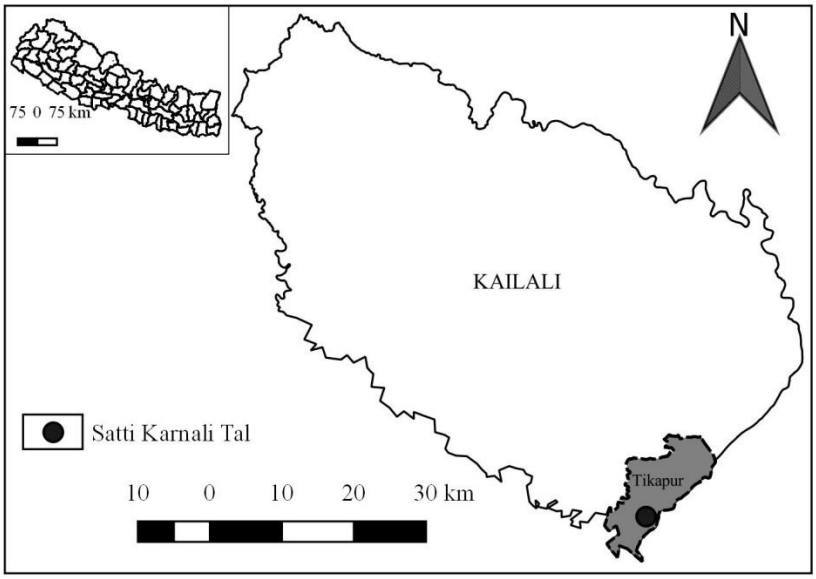


Figure 5. Map showing the location of Satti Karnali Lake

Figure 6. A) A section of Satti Karnali Lake B) Outlet of Rani Kulo which is the main source of Satti Karnali Lake

TABLE 1. WATER QUALITY PARAMETERS OF SATTI KARNALI LAKE

WATER QUALITY PARAMETER	MEASUREMENTS
Conductivity	71.68 S/m
Temperature	22^{0}C
Total Iron	0mg/l
pH	6.44
Nitrate	0.70mg/l
Nitrite	0mg/l
Dissolved oxygen	7.28ppm

TABLE 1. WATER QUALITY PARAMETERS OF SATTI KARNALI LAKE	
WATER QUALITY PARAMETER	MEASUREMENTS
Ammonium	3.20mg/l

3.1.4 WETLAND STATUS

Permanent lake

3.1.5 BIODIVERSITY

3.1.5.1 BIRDS

Status of birds

A total of 1697 individuals from both season (summer N =902, winter N = 795) belonging to 116 species from 16 orders and 43 families were recorded. 86 species were recorded in both seasons, while 15 species were recorded in winter season only and 16 species in summer only (Fig. 7 and 8). The most abundant species were from order Passeriformes (winter = 49% and summer = 53%), followed by Coraciiformes (winter = 9% and summer = 11%) and Psittaciformes (winter = 6% and summer = 5%) (Fig. 8). Anseriformes was only recorded in winter season. Among them, cattle egret (N = 78, 4.6%), house sparrow (N = 72, 4.2%), blue-tailed bee-eater (N = 62, 3.6%) and lesser whistling-duck (N = 55, 3.2%) were must abundant species (Appendix Table S1). With respect to feeding guilds, this study recorded the largest number of insectivorous species (51.5%), followed by omnivores (20.8%) and Piscivores (14.9%) (Fig. 9).

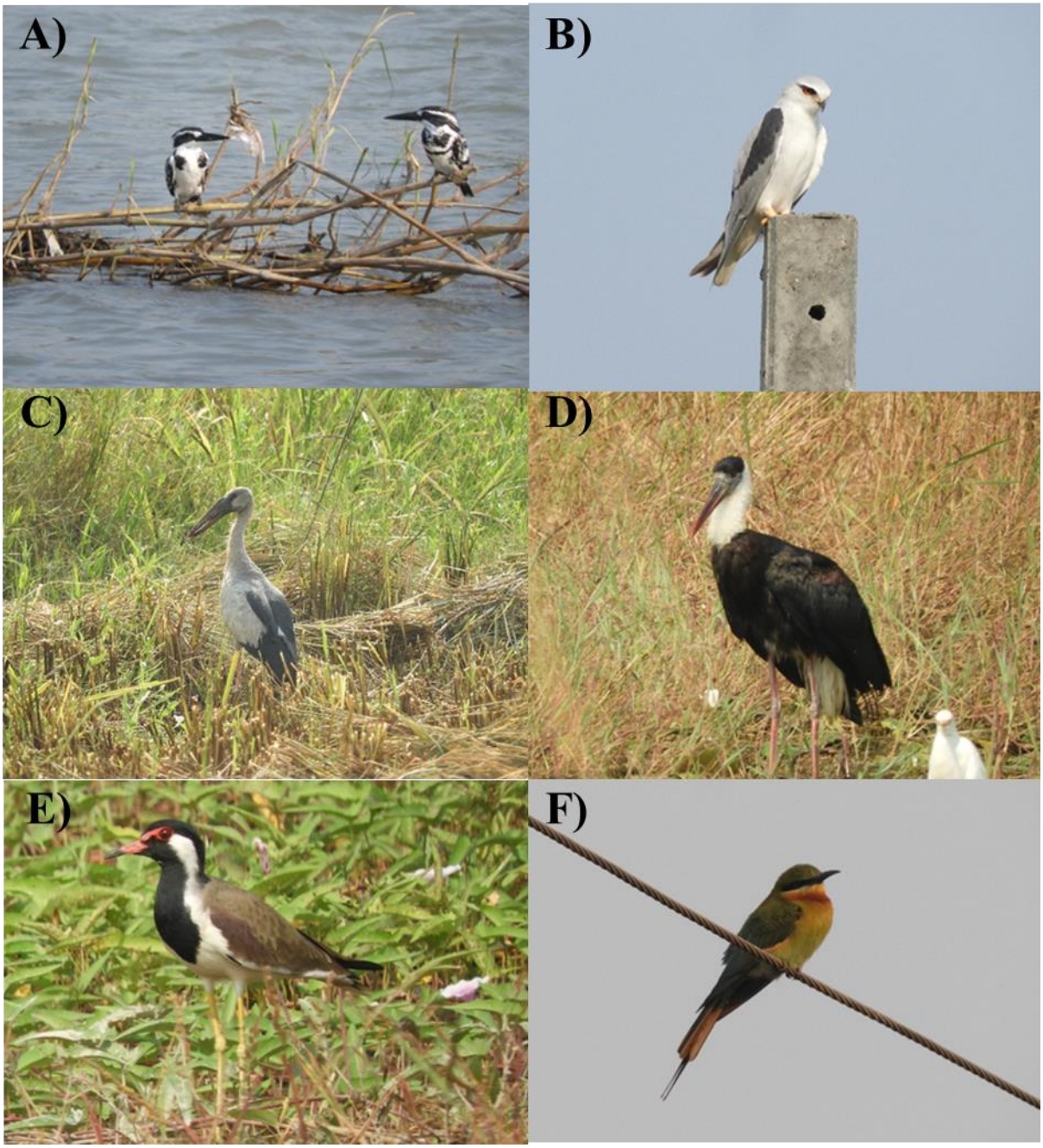


Figure 7. Birds recorded in Satti Karnali Lake- A) Pied Kingfisher, B) Black shouldered Kite, C) Asian Openbill, D) Asian Wollynecked, E) Red watelled Lapwing and F) Chestnut headed Bee-eater.

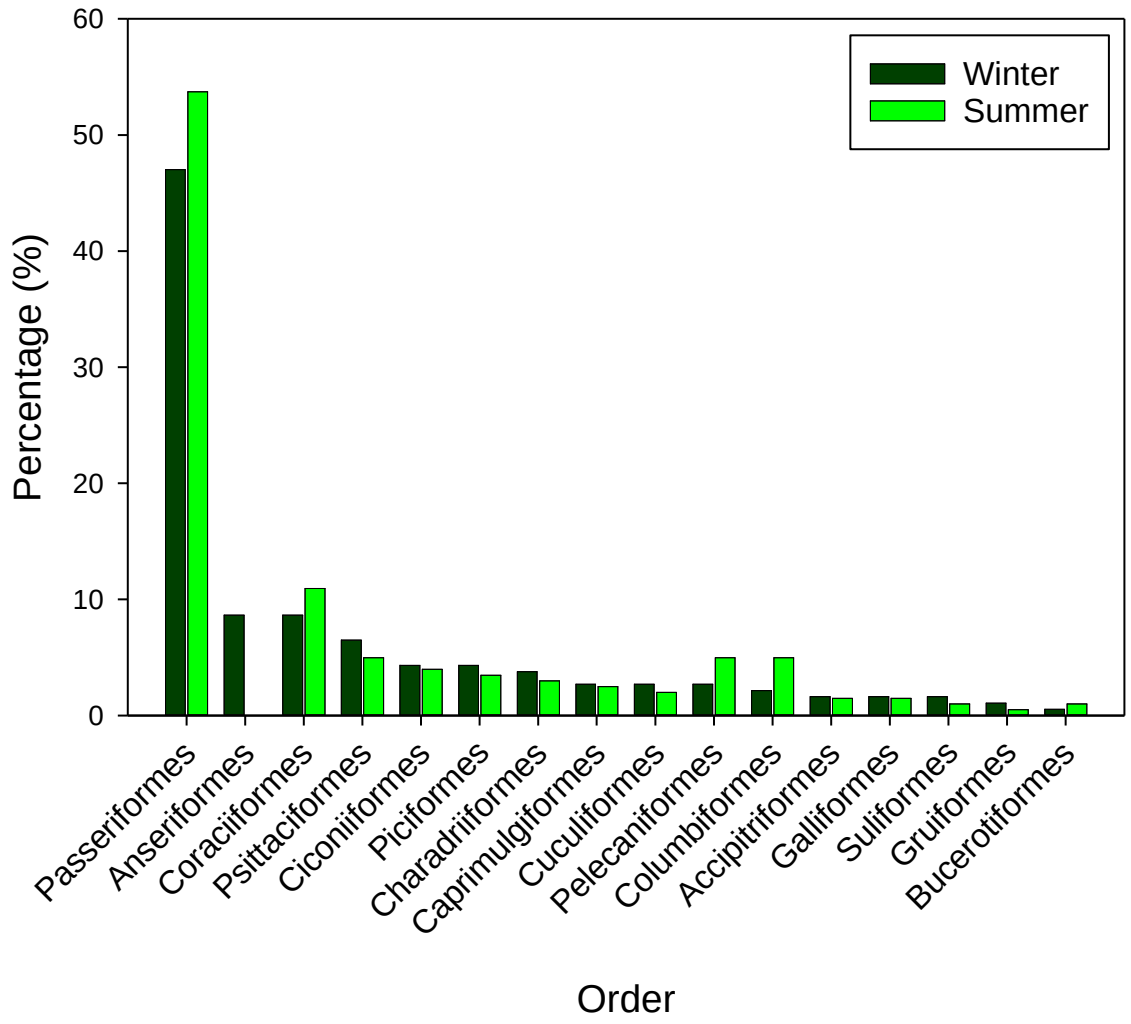


Figure 8. Percentage of bird species recorded according to their taxonomic order in Satighat.

Species diversity and seasonal variations of the birds

The species diversity of birds in two seasons revealed a significant seasonal variation ($t = 1.4353$, $p = 0.053$). The species diversity was significantly more in winter season (Shannon index H= 4.23, ranges from 4.145 to 4.258, Fisher alpha= 30.67) than winter (H= 4.208, ranges from 4.12 to 4.23, Fisher alpha= 28.76). There was no significant variation in species dominace index and Simpson index of diversity during winter and summer seasons (Dominace index D= 0.202, Simpson index of diversity (1-D) = 0.979 in winter and D=0.021, 1-D=0.9784 in summer season) (Table 2).

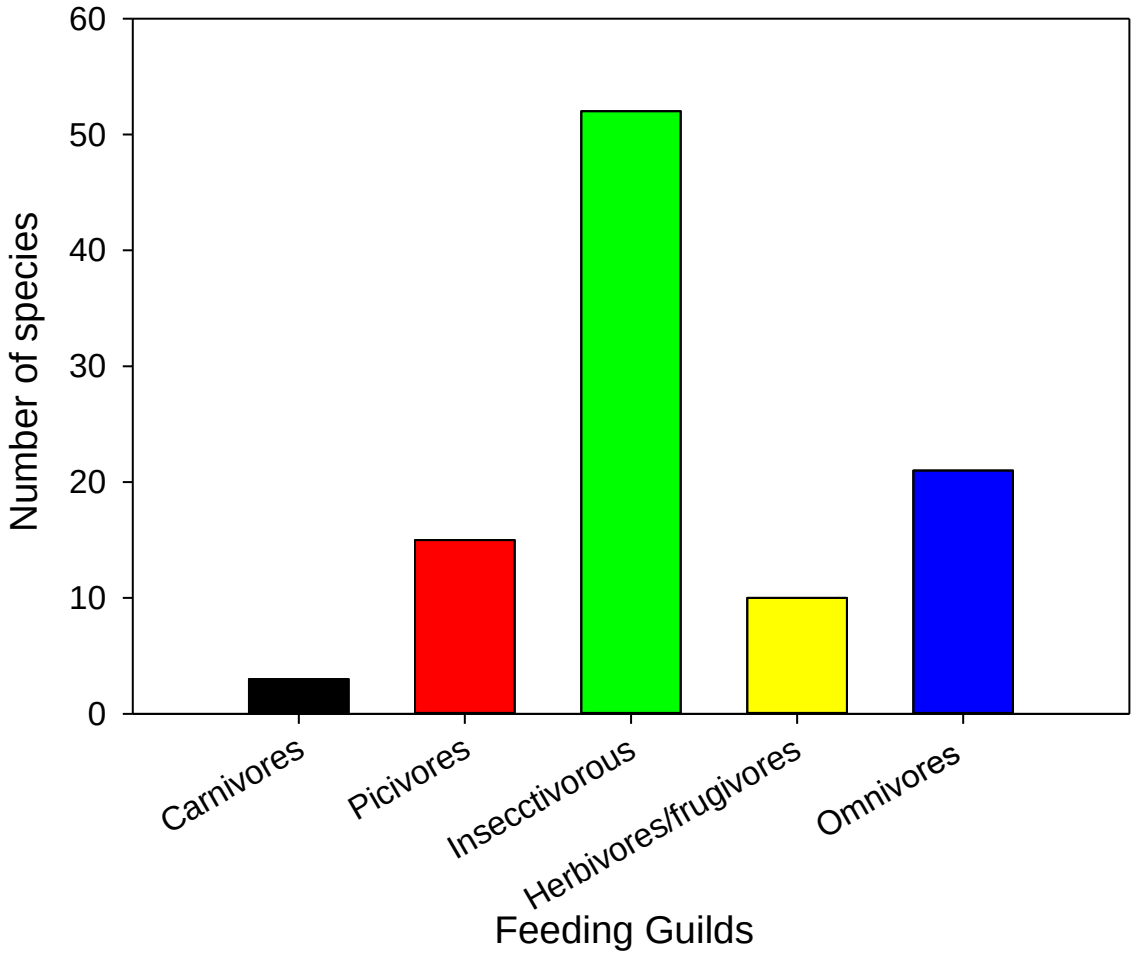


Figure 9. Number of bird species recorded for the different feeding guilds.

Human disturbance (number of people collecting plants, snails and fishes) was observed relatively higher in winter season compared to summer and rainy seasons (community interaction). This area lies on the edge of human settlement and highway and maximum human impacts such as fishing, collection of snails, collection of edible plants from lake were commonly observed in all seasons.

The species evenness and Jacob's coefficient of equality was evidently higher in winter than in summer (Table 2).

TABLE 2. BIRD'S DIVERSITY AND DOMINANCE INDICES IN SATTI KARNALI LAKE

	WINTER			SUMMER		
	Average	**Lower**	**Upper**	**Average**	**Lower**	**Upper**
Taxa_S	101	101	101	100	100	100
Individuals	795	795	795	902	902	902
Dominance_D	0.02023	0.01889	0.02358	0.02156	0.0199	0.02483
Simpson_1-D	0.9798	0.9764	0.9811	0.9784	0.9752	0.9801
Shannon_H	4.238	4.145	4.258	4.208	4.12	4.23

TABLE 2. BIRD'S DIVERSITY AND DOMINANCE INDICES IN SATTI KARNALI LAKE						
	WINTER			SUMMER		
Evenness_e^H/S	0.6861	0.625	0.6994	0.6719	0.6156	0.6872
Equitability_J	0.9184	0.8982	0.9225	0.9137	0.8946	0.9185
Fisher_alpha	30.67	30.67	30.67	28.76	28.76	28.76

Distribution of birds as their preferred habitat types

Satti Karnali lake and adjoining area includes many small patches of forest and open areas which is suitable habitat for diverse birds. Habitat preference of the birds indicate their feeding and adaptational habit. The Satti Karnali lake is located at the edge of Satti Karnali Community Forest near to the Karnali river. Hence, the species richness of wetland and wetland dependent birds recorded more in this lake (n=41). Asian open billed, Asian Wolly necked, Bar-headed Goose, Common coot, Oriental Darter are the notable bird species recorded in Satti Karnali lake (Fig. 10, Appendix Table S5).

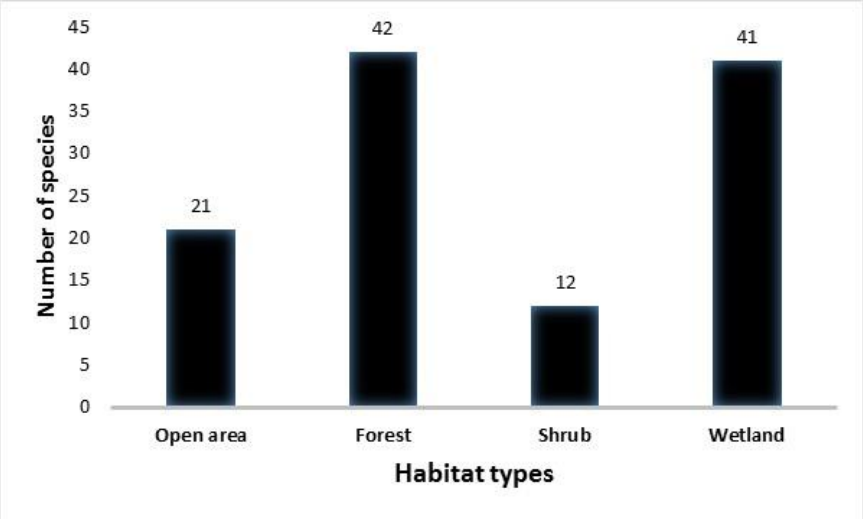


Figure 10. Distribution of birds as their preferred habitats in Satti Karnali Lake

Conservation value of Satti Karnali Lake for Birds

Satti Karnali lake supports 13.09% (N=104) of total birds recorded from Nepal (N=886). This study recorded four globally vulnerable wetland birds (Lesser Adjutant *Leptoptilos javanicus,* Great Slaty Woodpecker *Mulleripicus pulverulentus*, Asian Woolly-necked *Ciconia episcopus,* Red watelled Lapwing *Vanellus indicus)* and four globally near threatened birds *(*Grey-headed Fish-eagle *Icthyophaga ichthyaetus,* River Lapwing *Vanellus duvaucelii*, Oriental Darter *Anhinga melanogaster,* Painted Stork *Mycteria leucocephala)* (Table 3).

TABLE 3. THREATENED BIRDS RECORDED FROM SATTI KARNALI LAKE			
S.N.	COMMON NAME	SCIENTIFIC NAME	IUCN STATUS
1	Lesser Adjutant strok	*Leptoptilos javanicus*	VU

TABLE 3. THREATENED BIRDS RECORDED FROM SATTI KARNALI LAKE			
S.N.	COMMON NAME	SCIENTIFIC NAME	IUCN STATUS
2	Great Slaty Woodpecker	*Mulleripicus pulverulentus*	VU
3	Asian Wollynecked	*Ciconia episcopus*	VU
4	Red watelled Lapwing	*Vanellus indicus*	VU
5	Grey-headed Fish-eagle	*Icthyophaga ichthyaetus*	NT
6	River Lapwing	*Vanellus duvaucelii*	NT
7	Orienlake Darter	*Anhinga melanogaster*	NT
8	Painted Stork	*Mycteria leucocephala*	NT

3.1.5.2 MAMMALS

This lake supports 149 individuals of 11 species of mammals belonging to 9 families and 5 orders (Fig. 11, 12 A-D). The sighting and their signs were more in summer season (species= 10) than winter season (species=5) ($t=6.258$, $p=0.007$), but in terms of numbers, the sighting frequency was more in winter (N=94) than summer (N=55). According to local people, Royal Bangal Tiger and Leopard are occasional visitor in the forest (Fig. 13). During summer season, we recorded a scat and pugmark of Leopard, but the signs of tiger were not observed. Based on the signs, Smooth-coated otter (track) and fishing cat (pugmark) were also recorded (Appendix Table S17).

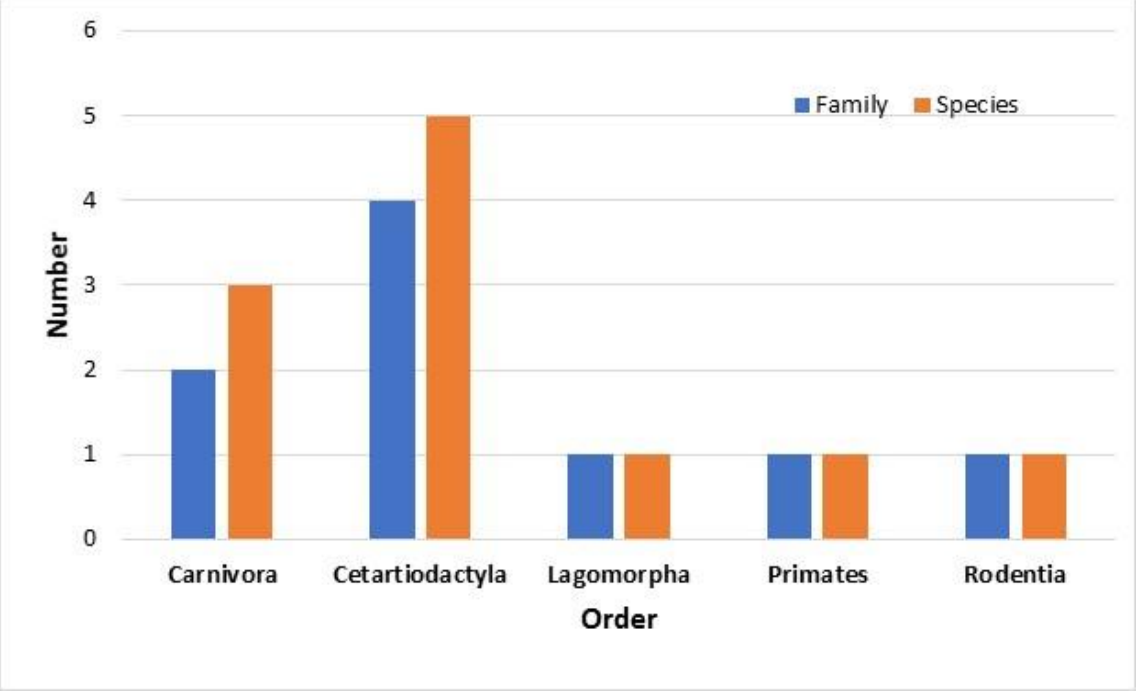


Figure 11. Order and family wise distribution of mammals recorded

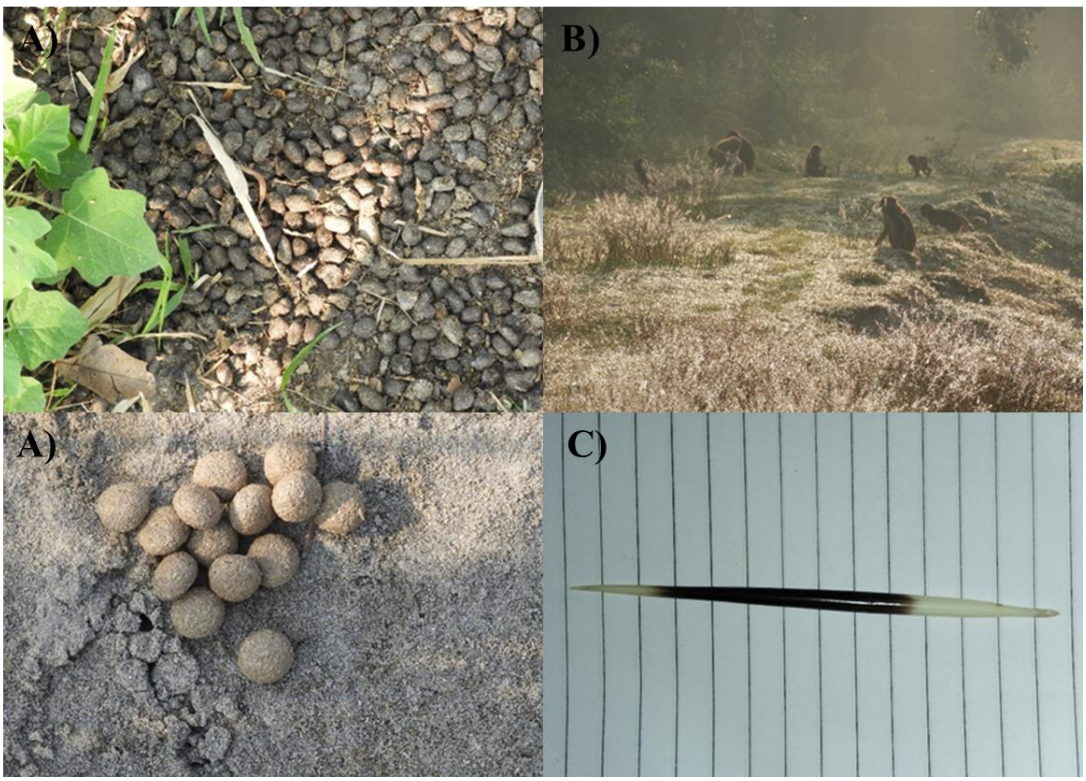


Figure 12. A) Dropping of Chital B) Rhesus monkeys on the bank of Satti Karnali lake C) Dropping of Indian hare D) Quails of Malayan Porcupine

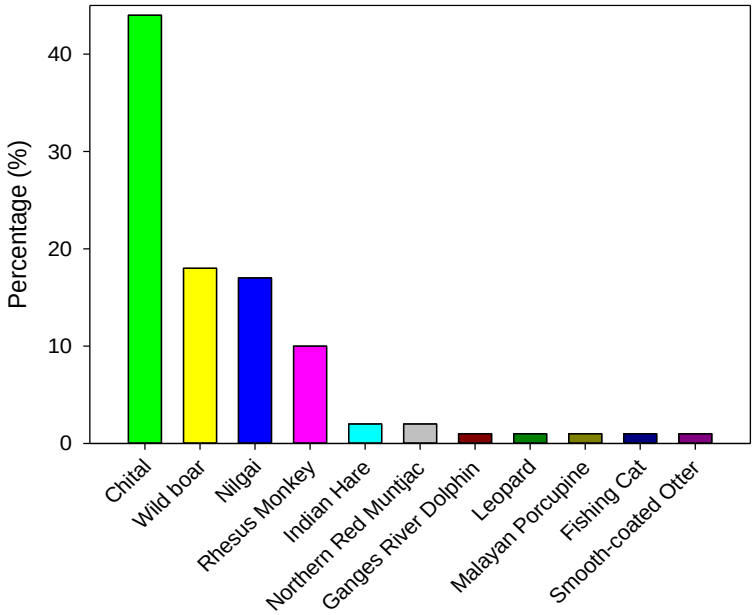


Figure 13. Percentage of mammalian species recorded in Satti Karnali areas

Conservation status of mammals

Among the 11 species of recorded mammals, one species- Ganges River Dolphin (*Platanista gangetica gangetica*) is listed in endangered category in IUCN redlist. Similarly, three species of mammals (Smooth-coated Otter, Leopard and Fishing cat) were listed in vulnerable category. Remaining 7

species were listed in least concerned category. Hence, the Satti Karnali lake is the good habitat for globally threatened mammals (Fig. 14).

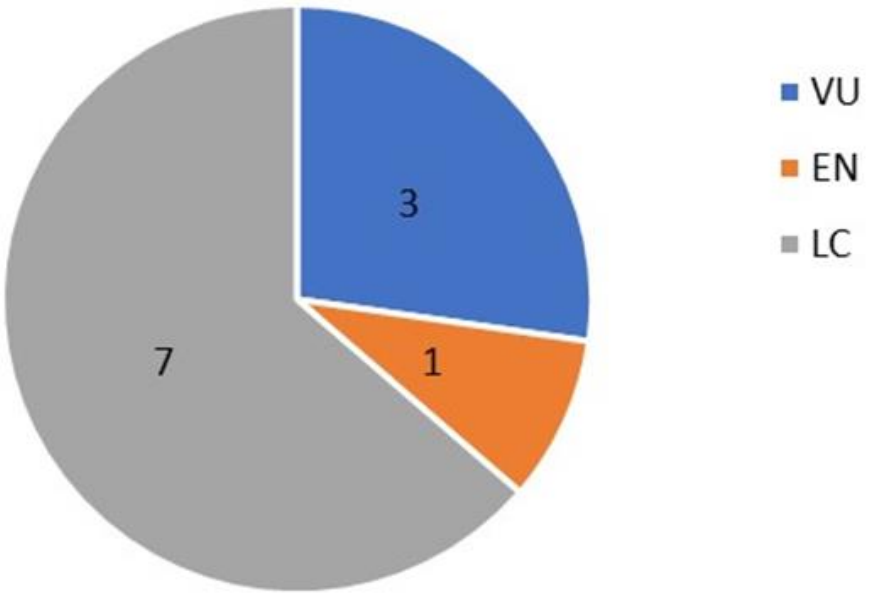


Figure 14. The conservation status of mammals in Satti Karnali Lake

Species with conservation significance

Smooth-coated otter (*Lutrogale perspicillata*)

We observed fecal matters and hunting ground of Smooth-coated otter. The Smooth-coated otter prefers the bank of lakes, rivers, streams, and canals, and even uses paddy fields as foraging ground (Shrestha 1997). It usually uses the burrows near the water edge for resting sites. Fish comprise over 70% of its diet, but also feed on reptiles, frogs, insects, crustaceans, and other small mammals (Baral and Shah 2008). It is listed under IUCN redlist as vulnerable species.

Ganges River Dolphin (*Platanista gangetica gangetica*)

The outlet of lake opens into Karnali River. Karnali river is good habitat for Ganges River Dolphin, and the species is listed as an Endangered category IUCN redlist. There exists ambiguity about dolphin population in Nepal; its considered to be less than 100. A study mentions it to be less than 28 (Paudel and Koporowski 2018). According to local people, the number of dolphins in the area has been declining in the recent years.

3.1.5.3 AMPHIBIANS

A total of 225 individuals of amphibians from seven species belonging to two families were recorded. *Euphlyctus cyanophlyctis* was the most abundant species, comprising 55.6% of the total number of species recorded followed by *Hoplobatrachus tigerinus* (12.0%), *Minervarya teraiensis* (11.1%) and *Hoplobatrachus crassus* (10.7%) respectively (Fig. 15, Appendix Table S9).

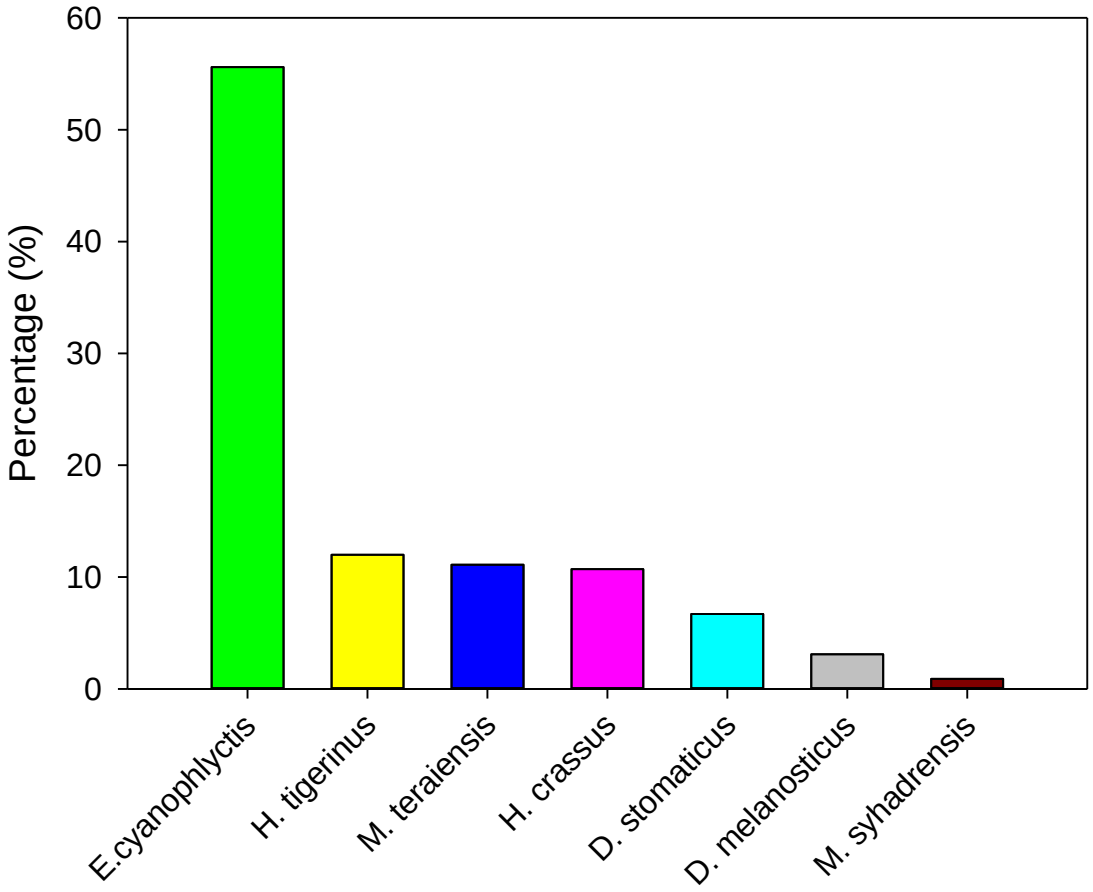


Figure 15. Percentage of amphibian species recorded during the survey period

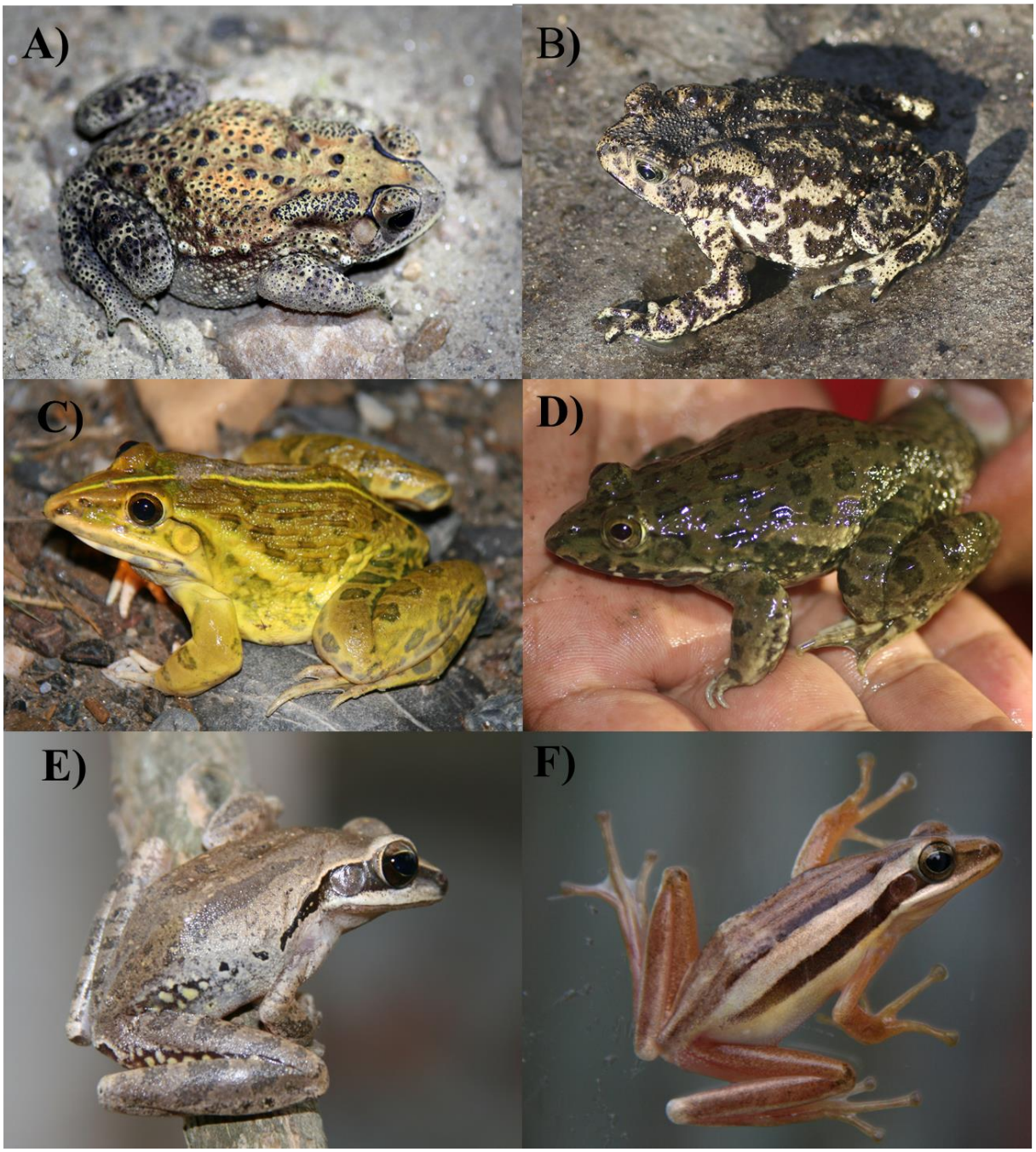


Figure 16. A) *Duttaphrynus melanostictus* B) *Duttaphrynus stomaticus* C) *Hoplobatrachus tigerinus* D) *Hoplobatrachus carsus* E) *Polypedates maculatus* F) *Polypedates taniatus*

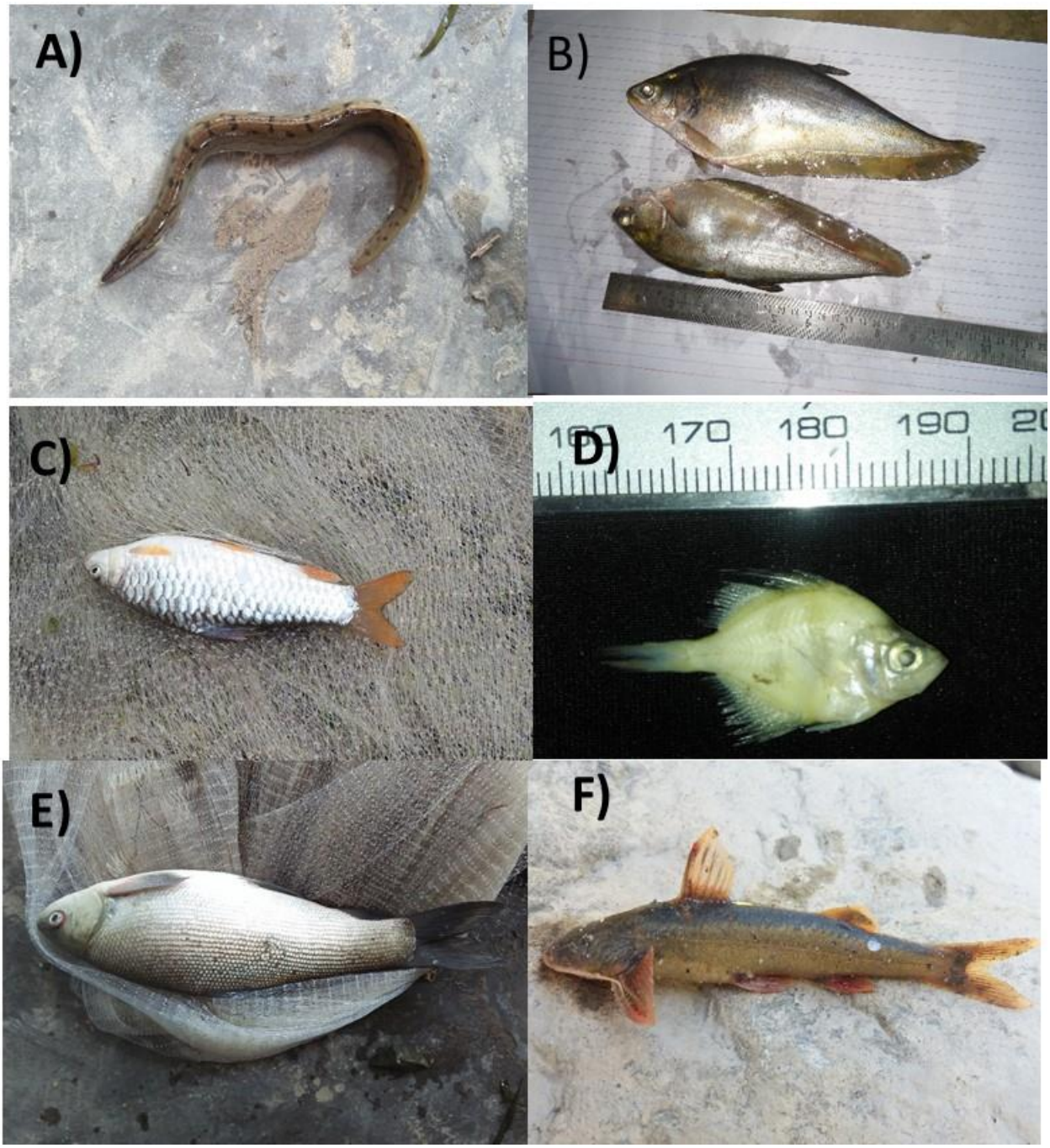
3.1.5.4 REPTILES

A total of eight species of reptiles were recorded (one -lizard, four - skink, one – snake and two – monitor lizards) during the survey period. Among them, Golden monitor lizard *Varanus flavescens* is one of the indicator species suffering from the human disturbance and encroachment. This species is heavily exploited for the meat and skin. Local people reported that Gohoro (*Varanus*) meat can be used to cure different type of diseases such as Rheumatism and Respiratory Tract lifectrion (RTI). Therefore, the population of this species has been declining in its range and has been categorized as vulnerable by IUCN (Appendix Table S13).

Figure 17. Indina Rock Python recorded inside the Satti Karnali CF

3.1.5.5 FISHES

A total of 29 species of fishes belonging four orders and 12 families were recorded in our study. The most abundant species were from order Cypriniformes (N = 17, 59%), followed by Siluriformes (N=7, 24%), Perciformes (N=2, 7%) and Synbranchiformes (N=2, 7%) respectively. Among them, Sidhre (*Punticus chola*) (N=29, 10%) were must abundant species in the Satti Karnali followed by Sidhre (*Puntius sophore*) (N=27, 9.3%), *Pseudambassis baculis* (N=25, 8.6%) and *Monopterus cuchia* (N=22, 7.6%) respectively (Fig. 18 A –J, Appendix Table S5).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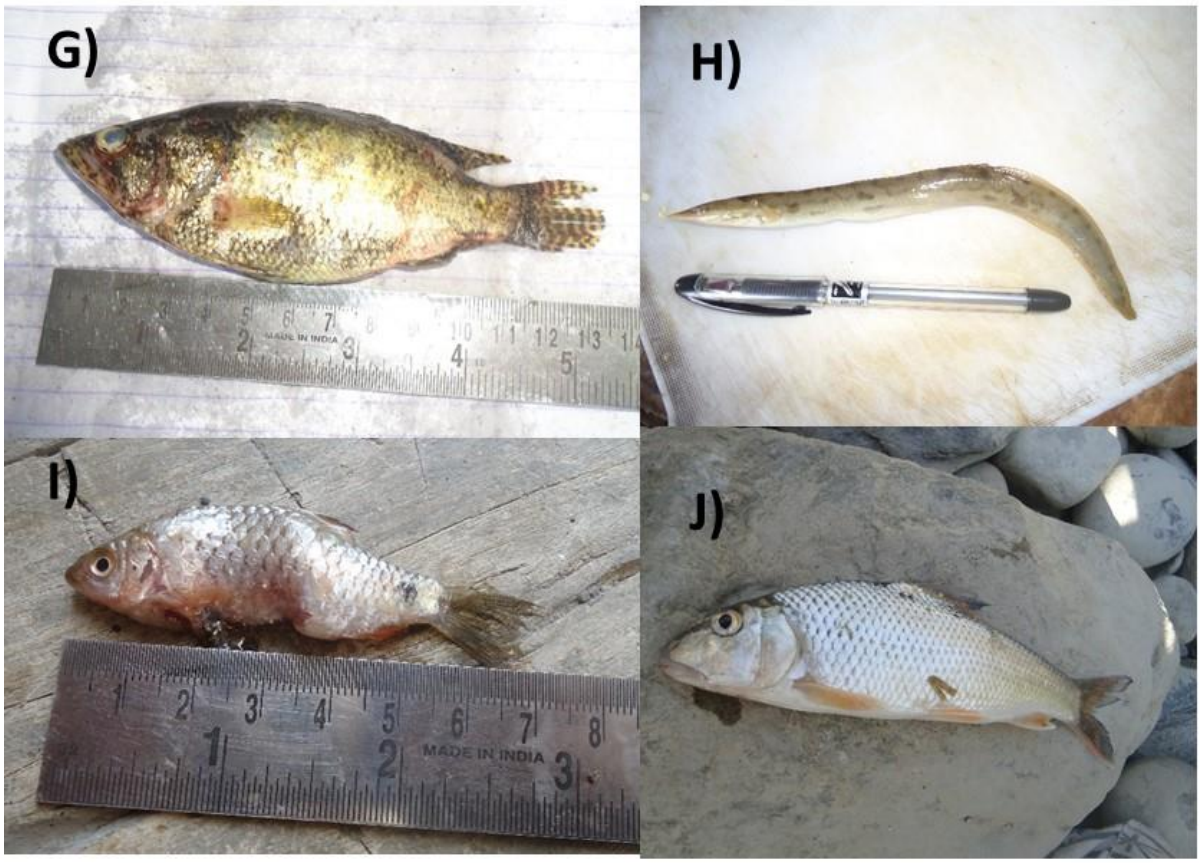

Figure 18. Fish recorded in Satti Karnali Lake A) *Monopterus cuchia* B) *Notopterus notopterus* C) *Tor tor* D) *Pseudambassis baculis* E) *Labeo frimbiatus* F) *Glyptothorax telchitta* G) *Nundus nundus* H) *Macrognathus pancalus* I) *Puntius sophore* J) *Cirrhinus mrigala*

3.1.5.6. MACRO INVERTEBRATES

Aquatic insects not only play an important role in maintaining trophic order but also known an indicator of quality of aquatic habitat. Globally, three percent of total insects area aquatic in nature (which require water to complete at least a part of their life cycle).

A total of ten common macro invertebrates were recorded from Satti Karnali Lake during our field study. The abundance of driving beetles and water bugs was more in Satti Karnali which is food of fishes and frogs (Table 4)

Dragonflies, an important indicator of good health of aquatic ecosystem. They lay eggs in near freshwater. Different ecological factors like acidity, temperature, pH, amount of aquatic vegetation and nature of water (like lotic and lentic) affects the distribution of nymphs of dragonflies. Damselflies are more sensitive than dragonflies because of their smaller body size and small home range.

TABLE 4. MACROINVERTEBRATES OF SATTI KARNALI LAKE

SN	COMMON NAME	FAMILY	PHYLUM
1	Nymph of Dragonfly	Aeschnidae- Odonata	Arthropoda
2	Dragon fly	Libellulidae- Odonata	Arthopoda

TABLE 4. MACROINVERTEBRATES OF SATTI KARNALI LAKE			
SN	COMMON NAME	FAMILY	PHYLUM
2	Nymph of Damselfly	Calopterygidae-Odonata	Arthropoda
3	Water bug	Saldidae-Hemiptera	Arthropoda
4	Diving beetle	Dytiscidae- Coleoptera	Arthropoda
5	Freshwater prawn	Palaemonidae- Decopoda	Arthropoda

Study of Mollusca in Satti Karnali Lake

Molluscs are second largest group of animal in the animal kingdom and are among the well investigated animals in the world due to their socio-cultural value. However, the freshwater mollusks studies in Nepal is one of the neglected field which has been started very recently only after 2000s. Few publications have been found on freshwater mollusks of Nepal such as Subba and Ghosh, 2000, Subba, 2003; Subba and Pandey, 2005; Nesemann et al. (2001, 2005, 2007), Nesemann and Sharma 2005a, 2005b), Gloer and Bossneck, 2013 and Budha 2016. Subba (2003) published few species of freshwater snails from Ghodaghodi lake of Kailali district. Budha (2016) documented 34 species of freshwater mollusks of Kailali district comprising 22 gastropods and 12 bivalve species.

Molluscs are found in marine, brackish and freshwater including terrestrial ecosystems. Freshwater mollusks are crucial components of freshwater ecosystem due to their various roles such as plant grazers, filter feeders and detritus habits. Many species are consumed by many ethnic groups in Nepal. They are also intermediate hosts of trematode parasites (Subba Rao, 1989; Devkota et al. 2011; Budha, 2016).

Field survey of freshwater mollusks in wetlands of Satti Karnali was conducted from 2nd -13th October 2019 at Rani Kulo from Sattighat-Simraun village. In addition, wetlands along the road sides were also explored. Small snails were sampled by sieving mud and submerged vegetation. Molluscs were explored in the western branch of Karnali River. All samples were sorted into shells and live individuals and then kept separately into different vials. Live individuals were preserved in 70 % alcohol for further identification.

Species Diversity of freshwater mollusks

Altogether, 14 species of freshwater mollusks including gastropods (12 species) and two bivalve species were found in the Satti Karnali lake (Table 5, Fig. 19).

TABLE 5. LIST OF FRESHWATER MOLLUSKS RECORDED DURING THE FIELD SURVEY		
MOLLUSCS	HABITAT	POPULATION STATUS
Class: Gastropoda		
Order: Mesogastropoda		
Superfamily: Vivipaoidea		
Family: Viviparidae		

TABLE 5. LIST OF FRESHWATER MOLLUSKS RECORDED DURING THE FIELD SURVEY		
MOLLUSCS	HABITAT	POPULATION STATUS
1. *Bellamya bengalensis*	Common in Satti Karnali	Common in Satti Karnali Lake
2. *Idiopoa disimilis*	Only reported from Ketland and along roadside wetlands	Only reported from Khetland
Family: Ampullariidae		
3. Pila globose	Reported from Satti Karnali lake, along Tikapur-Khakraula road sides near Khakraula	Common
Superfamily: Rissoidea **Famiy: Bithyniidae**		
4. *Gabbia* cf. *stenothyroides*	Satti Karnali lake, Suryapur	Common
Superfamily: Cerithioidea **Family: Thiaridae**		
5. *Thiara scabra*	Satti Karnali lake	
6. *Melanoides tuberculatus*	Satti Karnali lake	Common
7. *Tarebia lineate*	Satti Karnali lake	Rare
Sub-Class: Pulmonata **Order: Bassomatophora** **Superfamily: Lymnaeoidea** **Family: Lymnaeidae**		
8. *Lymanea acuminata*	Outlet area with submerged vegetation	Common
9. *Radix* sp.	Suryapur	
Superfamily: Planorbidae **Family: Planorbidae**		
10. *Gyraulus convexiusculus*	Khakraula along roadside, Suryapur	Common
11. *Segmentina calatha*	Khetland, Suryapur	Uncommon
Family: Bulinidae		
12. *Indoplanorbis exustus*	Satti Karnali lake, Khetland, along roadside	Common
Class: Bivalvia **Superfamily: Unionoidea** **Family: Unionidae**		
13. *Lamellidens* cf. *jenkinsianus*	Only found in Suryapur	Rare
14. *Radiatula* sp.	Satti Karnali lake	Rare

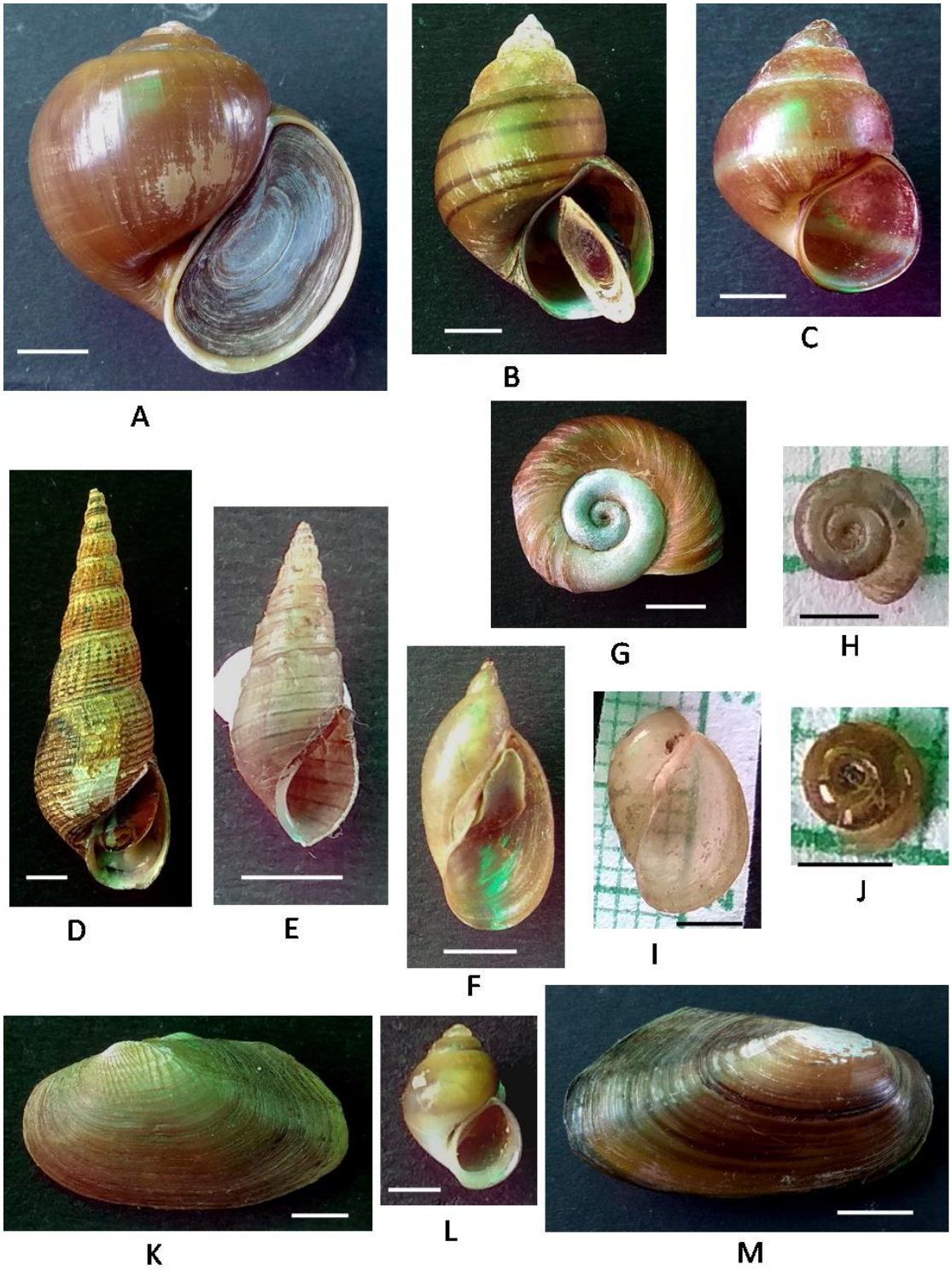

Figure 19. Freshwater mollusks of Wetlands around Satti Kailali. A- *Pila globosa*, B. *Bellamy bengalensis*, C. *Idiopoma dissimils*, D. *Melanoides tuberculatus*, E. *Tarebia lineate* F. *Lymnaea acuminata*, G. *Indoplanorbis exustus*, H. *Gyraulus convesxiusculus*, I. *Radix*

3.1.5.7 VEGETATION

Satti Karnali lake is sandwiched between agricultural field and a riverine forest, which creates environmental heterogeneity around the lake. This heterogeneity makes Sattighat a biodiversity rich area. Forest around Satti Karnali lake is riverine type and dominated by Sisoo *Dalbergia sisso*o, Simal

Bombax ceiba, Vellar *Trewia nudiflora* and Khayer *Acacia catechu*. Sindhure *Mallotus phillieɒnsis* and Shirish *Albizia chinensis* are commonly associated in this forest type. Asare *Murraya keonighii* is a common shrub species in sub canopy layer. Bhati *Clerodendrum viscosum* is common shrub in the forest understory. This area is well known for rattan cane (*Calamus tenuis)*. In our transect survey, we have reported 61 species of terrestrial plants around the lakes (Appendix Table S21). *Bombax ceiba* trees are good nesting sites of birds including endangered vultures.

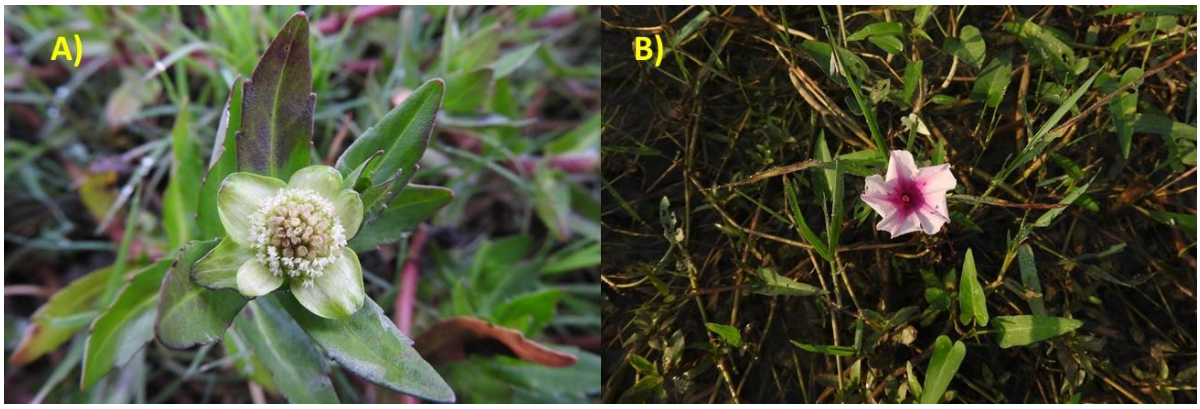

Figure 20. Aquatic plants recorded in Satti Karnali Lake A- *Enhydra fluctuans*: A new species report to Nepal (Not reported till the date) B- Ipomoea aquatic: An edible aquatic plant in Satti Karnali Lake

Macrophytes

Satti Karnali lake harbors diverse aquatic and wetland plants. We have reported a total of 37 wetland plants during our fieldwork. There is free floating, submerged and emergent plant species. Majority of the plants are emergent (Appendix Table S22). Floating plants include Nelumbo nucifera, Azolla pinnata and Spirodela polyrhiza. Similarly, Hydrilla verticillata and Potamogeton natans are dominant submerged plants. Among the recorded plant, Enhydra fluctuans was new for Nepal (Fig. 20A).

3.1.6 ECOSYSTEM SERVICES OF WETLANDS

Forest products: Presence of diverse ecosystem makes Satti Karnali wetland and surrounding area a rich in terms of ecosystem services and goods. Local people extract timber, firewood and fodder from the area. Rattans provide the major source of income for SKCF (Paudel and Chowdhary 2005). In the 2018-2019 (till September), the annual revenue collected exceeded more than nine million Nepalese rupees (USD 95,000) by rattan alone (personal communication with Prakash Timilsina and Deepak Acharya).

Satti Karnali lake provide important livelihood resources to local people. Local fisherfolk collect catch fishes from the lake. We reported that more than 29 species of native fishes are being harvested from the lake.

Local people collect Dhode saag *Ipomea aquatica* from the lake is consumed as vegetable. An edible species of Fern *Diplzium esculentum* is also collected by local people to consume as vegetable. Pater *Typha angustifolia* is also an important wetland plant collected and used by local people.

Harvesting of Freshwater mollusks of food value

Out of 14 freshwater molluscs reported, six species found in the area are used as food value by Tharu communities. The food value molluscs are *Pila globosa, Bellamya bengalensis, Idiopoma dissimilis, Lamellidens* spp., *Radiatula* spp. and *Melanoides tuberculatus.* Large sized freshwater snails and mussels were the most preferred species such as *P. globosa* and *Lamellidens* spp. (Fig. 21). The most abundant

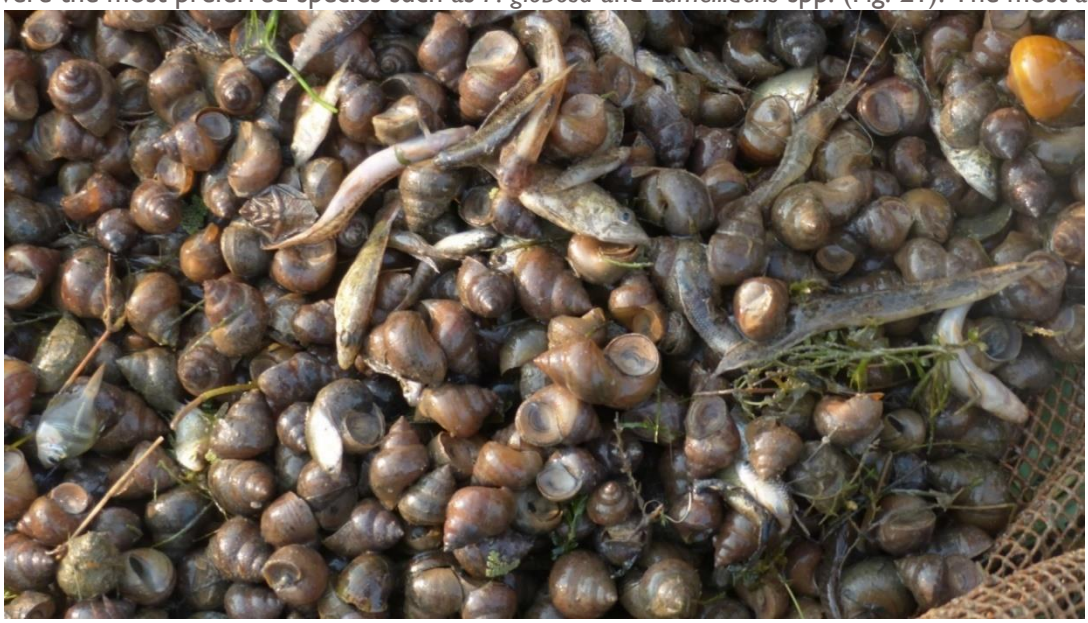

Figure 21. Snails, fish and prawn harvested by local people for food from Satti Karnali Taal

species of edible mollusks were *Bellamya bengalensis. Idiopoma dissimilis* was reported only from the khetlands and wetlands along the Khakraula-Tikapur road. This species was not reported from the Satti Karnali wetland. Single shell of *Radiatula* sp. was collected from the outlet of Satti Karnali area but not found during the sampling. It shows that this species was flooded from the upstream. This species including other bivalves were found in low siltation water bodies. *M. tuberculatus* is generally not used as food but people were found collecting and consuming this species. This indicates that lower abundance of main preferred species inclined people to collect less fleshy snails as well. Interestingly, most of the snail collectors were the locals from Bardia district. With exception of participation of young boys, most of the snail collectors were females throughout the survey period. They usually do not miss the opportunity of fishing and collecting snails whenever they become free just before harvesting paddy crops. During Dashain festival period, groups of people from Kailali and Bardia were found fishing and collecting edible mollusks species indicates that mollusks were overharvested during this period. Tharu women used local fish collecting device *Helka* however Tharu males use cast nest for fishing (Fig. 22).

Figure 22. Shell Fishing by Tharu Women at Satti Karnali Lake

Ethnozoology of herpetofauna and fish

There is no mass harvesting of frogs and reptiles in Satti Karnali areas. Some people use frogs and reptiles for medicinal purposes. The locally called "Sun Gohoro" *Varanus flavescence* is mainly harvested for meat and also used for different local medicine. The skin of the Varanus is used make musical instrument called Khaijadi (holy instrument). The gall bladder of Sahar (*Tor sp*.) is used as traditional medicine for the patients suffering from cough, fever and tuberculosis.

3.2 JHIMMILA LAKE

3.2.1 PHYSIOGRAPHY

Jhilmila lake is located at Churia hill of Kachanpur district (29°4'02"N; 80°11'28"E, elevation 985m, area 8.5ha and max. depth 11m (Neupane et al. 2010) (Fig. 23 and 24).

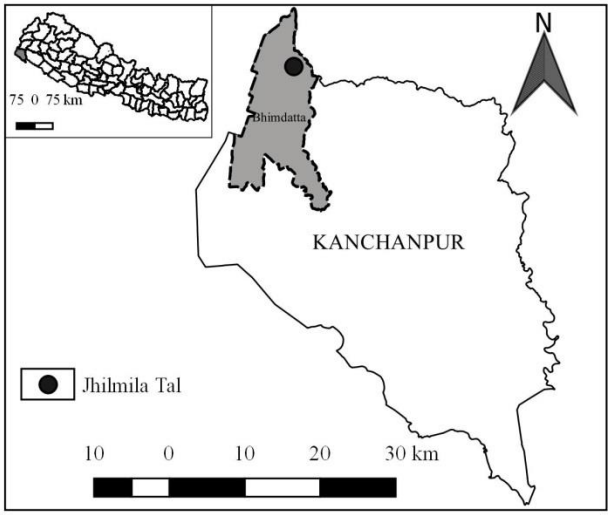

Figure 23. Map showing the location of Jhilmila Lake

Figure 24. Jhilmila lake: A holey lake of Midhill that provide the shelter and breeding ground many wetland dependent fauna, Kanchanpur, Nepal

3.2.2 WATER QUALITY

Physio-chemical characteristics of Jhilmila lake were described based on samplings at four sampling sites. Average temperature and dissolved were 26 ^{0}C and 8.2 ppm respectively. Average pH, Nitrate and Nitrite was 5.2, 3 and 0.33 respectively (Table 6).

TABLE 6. WATER QUALITY PARAMETERS OF JHILMILA LAKE	
WATER QUALITY PARAMETER	MEASUREMENTS
Conductivity	25.2 S/m
Temperature	19.6^{0}C
Total Iron	0mg/l
pH	5.23
Nitrate	3.0mg/l
Nitrite	0.33mg/l
Dissolved oxygen	8.20ppm
Ammonium	1.0mg/l

3.2.3 WETLAND STATUS

Permanent

3.2.4 BIODIVERSITY

3.2.4.1 BIRDS

A total of 936 individuals (winter N = 585 and summer N = 347) belonging to 104 species from 14 orders and 43 families were recorded in our study. The most abundant species in winter season belonged to Passeriformes (58%), followed by Piciformes (9%), Psittaciformes (7%), and Galliformes (6%). In summer season Passeriforme (45%) were most abundant followed by Coraciiformes (12%), Pelecaniformes (10%), Columbiformes (6%) and Psittaciformes (6%) respectively (Fig. 21). Among them, Jungle Babbler (3.6%) were most abundant species in the Jhilmila Lake followed by Common Peafowl (3.4%), Dusky Warbler (3.3%), House swift (3.0%) and Northern House Martin (2.7%) (Appendix Table S2).

With respect to feeding guilds, this study recorded the largest number of insectivorous avian species (53.5%), followed by herbivores/frugivores (21.2%) and omnivores (19.2%) (Fig. 26).

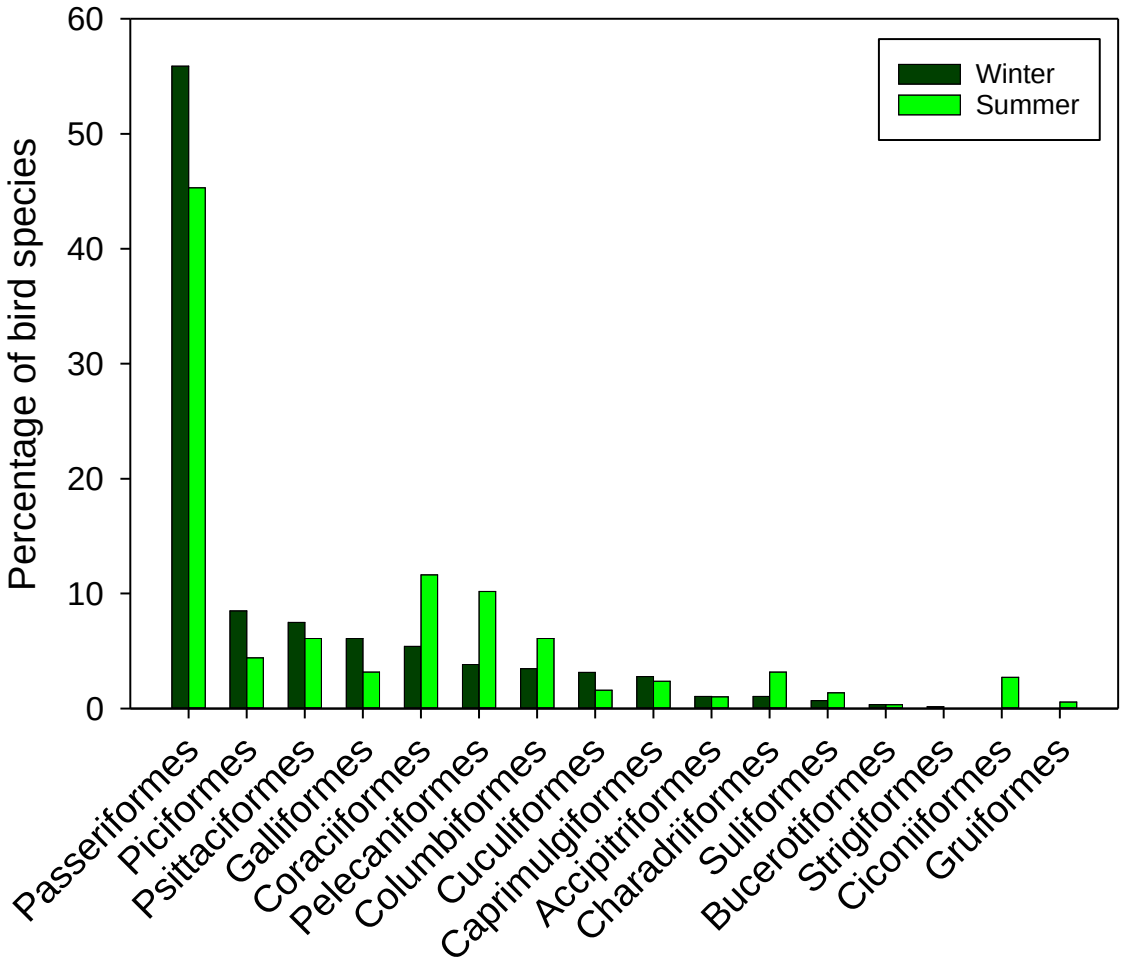

Figure 25. Number of bird species recorded according to their taxonomic order in Jhilmila lake

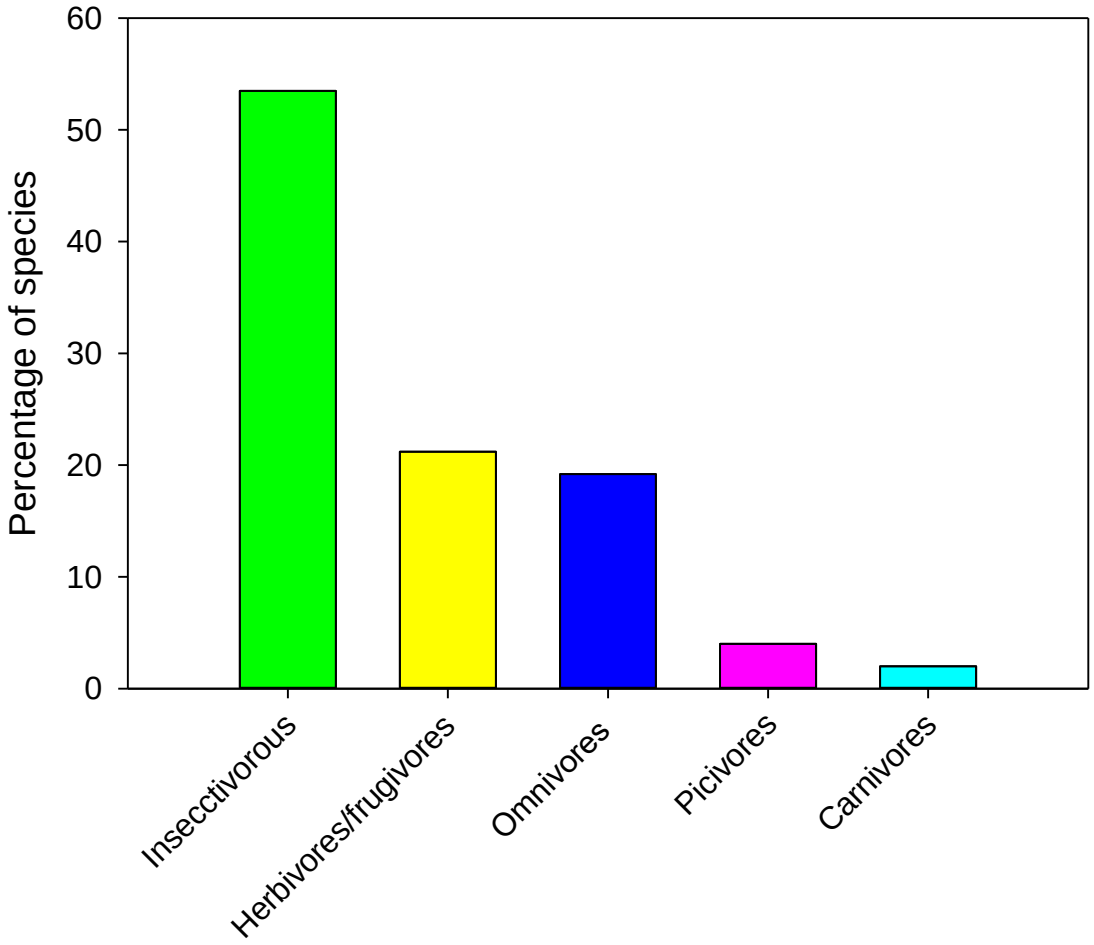

Figure 26. Percentage of bird species recorded for the different feeding guilds

Species diversity and seasonal variations of the birds

The species diversity of birds in two seasons were significantly different (t = 4.167, p= 0.0004). The species diversity was higher in winter (Shannon index H = 4.38, ranges from 4.27 to 4.37, Fisher alpha = 30.67) than summer (H = 4.208, ranges from 4.12 to 4.23, Fisher alpha = 34.69). There was no difference in species dominace index and Simpson index of diversity during winter and summer seasons (Dominace index D= 0.015, Simpson index of diversity (1-D) = 0.984 in winter and D = 0.0201, 1-D = 0.979 in summer season) (Table 7).

TABLE 7. BIRD'S DIVERSITY AND DOMINANCE INDICES IN JHILMILA LAKE

	WINTER			SUMMER		
	AVERAGE	LOWER	UPPER	AVERAGE	LOWER	UPPER
Taxa_S	100	99	100	74	74	74
Individuals	585	585	585	347	347	347
Dominance_D	0.01535	0.01512	0.01837	0.02014	0.01984	0.02497
Simpson_1-D	0.9847	0.9816	0.9849	0.9799	0.975	0.9802

TABLE 7. BIRD'S DIVERSITY AND DOMINANCE INDICES IN JHILMILA LAKE						
	WINTER			SUMMER		
	AVERAGE	LOWER	UPPER	AVERAGE	LOWER	UPPER
Shannon_H	4.385	4.274	4.376	4.091	3.965	4.089
Evenness_e^H/S	0.8023	0.7184	0.7958	0.8083	0.7124	0.8065
Equitability_J	0.9522	0.9282	0.9504	0.9506	0.9212	0.95
Fisher_alpha	34.69	34.17	34.69	28.81	28.81	28.81

Jhilmila lake is an important religious place, hence many pilgrims from Nepal and India visit this lake every season. The fishing and collection of natural products from the lake is fully prohibited. But the grazing pressure is comparatively more in winter season. The species evenness of birds (0.8023) and Jacob's coefficient of equality (0.9522) was more in winter than in summer (evenness = 0.8083, Jacob's coefficient of equality = 0.9506) (Table 7). This area is surrounded by old growth forest which is an important habitat for many forest, grassland and wetland birds.

Distribution of birds as their preferred habitat types

Jhilmila lake is located inside the dense Sal dominated forest. Fifty ones species of forest birds were recorded around the forest of Jhilmila lake. Wetland and wetland dependent birds recorded were very low (n=15) in Jhilmila lake comparing with other habitat types and it may be attributed to high grazing pressure and pressure of the pilgrims, (Fig. 27, Appendix Table S5).

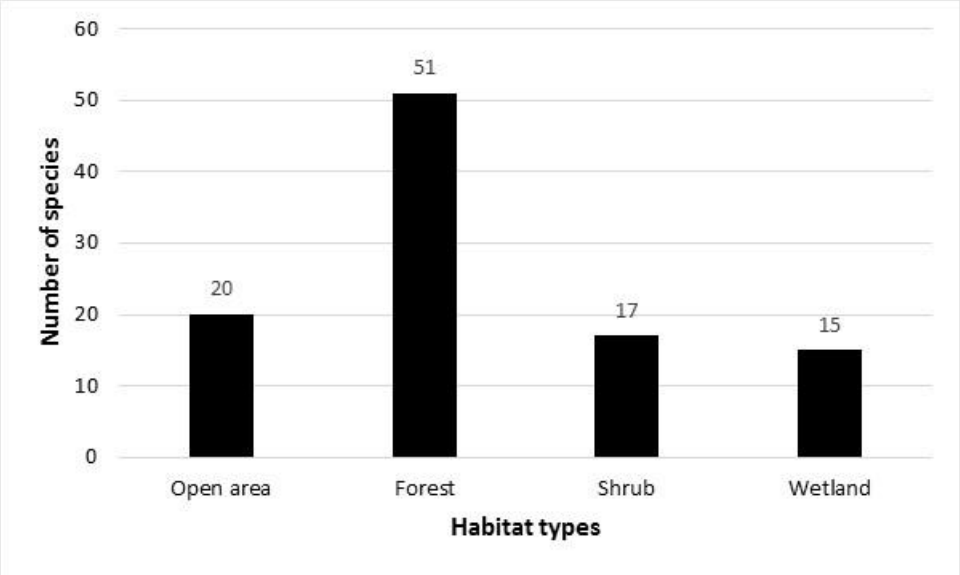

Figure 27. Distribution of birds according to their habitat types in Jhilmila Lake area

Conservation value of Jhilmila Lake for Birds

Jhilmila lake is the habitat site for 11.73 % of total birds species recorded from Nepal (N=886). This study recorded two globally vulnerable wetland birds (Great hornbill *Buceros bicornis* and Great Slaty

Woodpecker *Mulleripicus pulverulentus)* and one globally near threatened birds *(*Dark-throated Oriole *Oriolus xanthonotus (*Table 8)

TABLE 8. THREATENED BIRDS RECORDED FROM JHILMILA LAKE

SN	COMMON NAME	SCIENTIFIC NAME	IUCN STATUS
1	Great hornbill	*Buceros bicornis*	VU
2	Great Slaty Woodpecker	*Mulleripicus pulverulentus*	VU
3	Dark-throated Oriole	*Oriolus xanthonotus*	NT

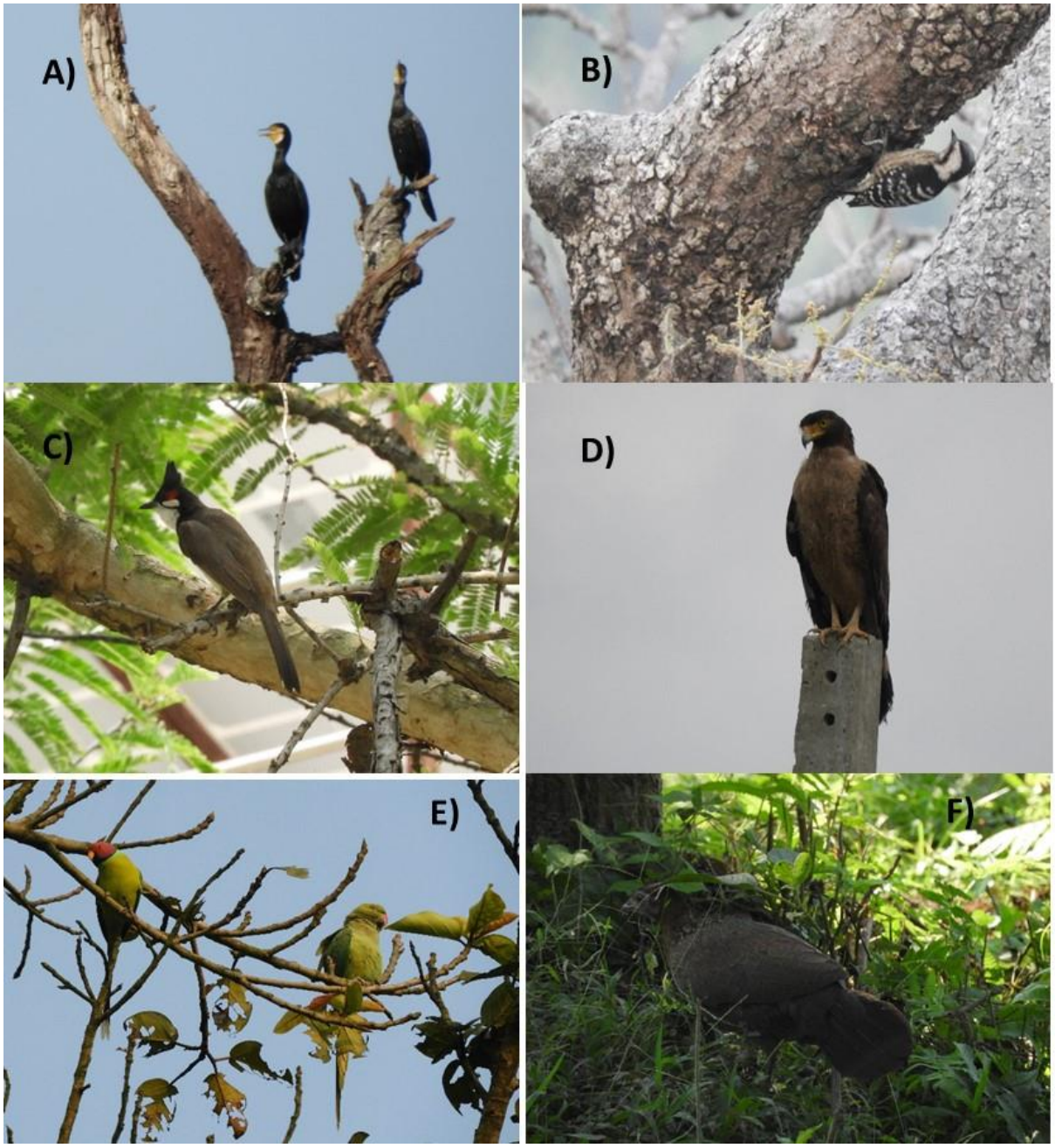

Figure 28. Birds recorded from Jhilmila Lake A) Little Cormorant B) Grey capped Pygmy Woodpecker C) Red whickered Bulbul D) Crested serpent Eagle E) Plum-headed parakeet (Red headed male) F) Red Jungle Fowl (Female)

3.2.4.2 MAMMALS

In Jhilmila lake, seven species of mammals were recorded using both visual aids and sign survey. Rhesus macaque was the most abundant species (Fig. 29, 30). According to local people, leopard is occasional visitor in the forest. Based on the signs, Northern Red Muntjac, Indian hare, Jungle cat and Himalayan Goral were recorded. Among them, two species namely Himalayan Goral and Terai Grey Langur are listed in near threatened category in IUCN redlist (Appendix Table S18).

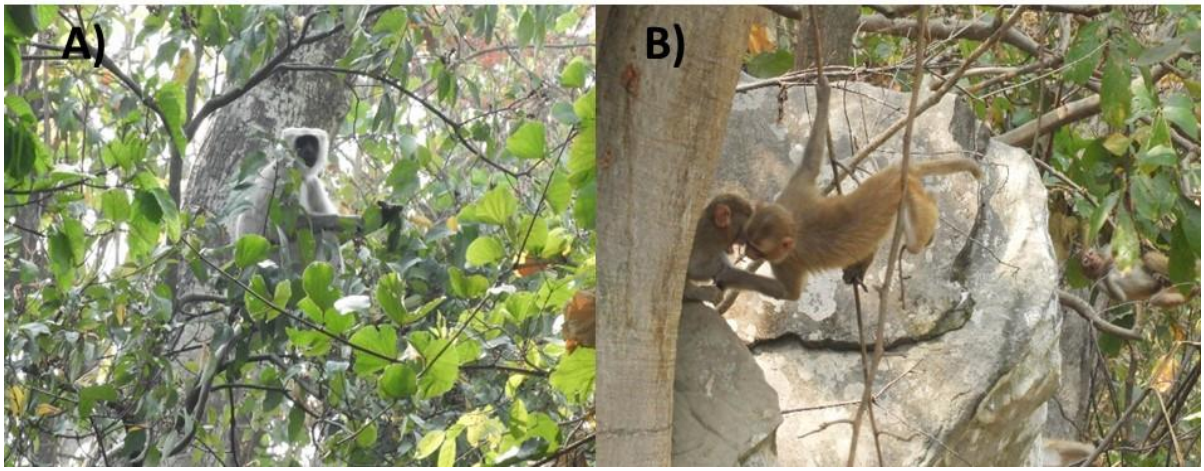

Figure 29. Mammals of Jhilmila: A) Terai Grey Langur B) Rhesus macaque

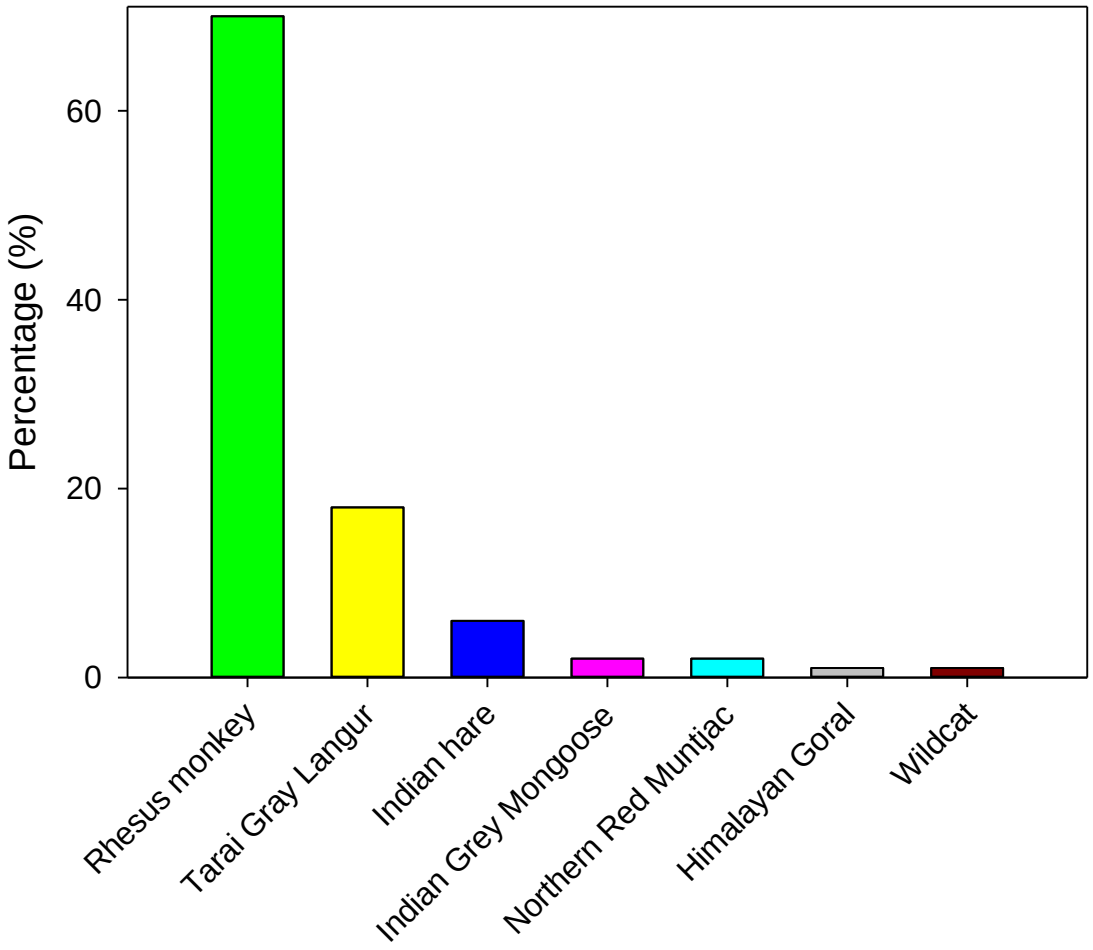

Figure 30. Percentage of mammalian species recorded in Jhilmila lake areas

3.2.4.3 AMPHIBIANS

A total of 50 individuals of amphibians belonging to six species were recorded from Jhilmila lake. The most abundant species in this area were *E. cynophlyctis* (64%) followed by *H. tigerinus* (10%), *D. melanostictus* (8%) and *M. teraiensis* (8%) respectively (Fig. 31, Appendix Table S10).

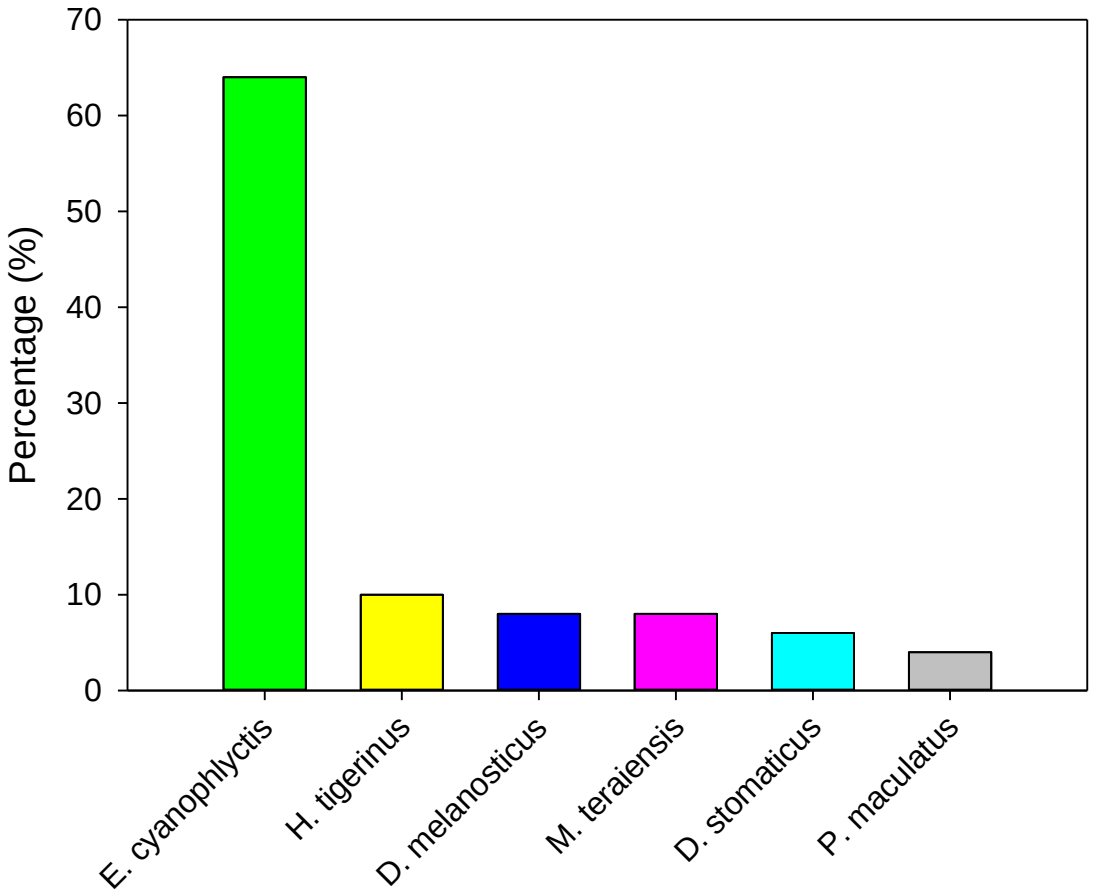

Figure 31. Percentage of amphibian species recorded in Jhilmila lake areas

3.2.4.4 REPTILES

A total of six species of reptiles were recorded from the Jhilmila area. They were common garden lizard *Calotes versicolor*, Bengal monitor lizard *Varanus bengalensis*, Common Indian Skink *Mabuya carinata*, Himalayan Rock Lizard *Laudakia tuberculata*, Nepalese Bent-toad Gecko *Cyrtopodion nepalensis* and Common House Gecko *Hemidactylus fenatus* (Appendix Table S14).

3.2.4.5 FISHES

Three species of fishes: Mangur *Clarias batrachus* (Fig. 32), Sidhre *Punticus chola* and Garai *Channa punctatus* were observed in Jhilmila lake. *Clarias batrachus* was the most abundant species in the area with more than 350 individuals have been observed (Appendix Table S6).

Figure 32. Mangur (*Clarias batrachus*): highly abundant fish in Jhilmila lake

3.2.4.6. MACRO INVERTEBRATES

Water bug and driving beetles were most abundant macro invertebrates in Jhilmila lake. Along with these, nymph of dragonfly and damselflies were also found. These macro and others micro invertebrates were the food of fish and frogs found in Jhilmila lake (Table 9).

TABLE 9. MACROINVERTEBRATES OF JHILMILA LAKE

SN	COMMON NAME	FAMILY- ORDER	PHYLUM
1	Nymph of Dragonfly	Aeschnidae- Odonata	Arthropoda
2	Nymph oy Damselfly	Libellulidae- Odonata	Arthropoda
3	Water bug	Saldidae-Hemiptera	Arthropoda
4	Scavenger beetle	Hydrophilidae- Coleoptera	Arthropoda
5	Water strider	Gerridae- Hemiptera	Arthropoda
6	Water scorpions	Nepidae- Hemiptera	Arthropoda

3.2.4.7 VEGETATION

There is a relatively protected Sal forest around the Jhilmila lake. Sal *Shorea robusta* is the most dominant and canopy forming tree species. Other associated species include Sindure *Mallotus philipensis*, Kadam *Adina cordifolia*, Saaj *Terminalia alata*, Jamun *Syzygium cumini*, Bot Dhaiyanro *Largerstroemia parviflora* and Kusum *Schleichera oleosa*. Common shrub species include Rudilo

Pogostemon bengalensis and Damai fal *Ardisia solanacea*. Bijay Sal *Pterocarpus marsupium,* a protected species listed in near threatened category in IUCN redlist was also reported in the forest around Jhilmila lake.The forest around the lake is richer in biodiversity and we recorded a total of 105 species of flowering plants and ferns (Appendix Table S21).

Macrophytes

Contrary to forest diversity surrounding the lake, Jhilmila lake is relatively less diverse in terms of macrophytes. Only 15 species of wetland plants were recorded during the sampling. Only one free floating species namely *Azola pinnata* was reported. Spirogyra species was only a submerged species in the lake. Common emergent plants included *Persicaria barbata*, *Polygonum hydropiper* and *Cynodon arcautus* (Appendix Table S22).

3.2.5 ECOSYSTEM SERVICES OF WETLANDS

Forest products: Local people in the nearby settlement surrounding the lake were found dependent on the forage and fodder, firewood, timber and medicinal herbs. The collection of the fish from the lake is fully prohibited in the lake. There was no any evidence of use of herpeto-fauna for food and medicine.

Cultural and aesthetic services: Jhilmila lake has great socio-cultural and religious values. This area is important for deities Baijanath and Siddhanath. Each year people from various parts of western Nepal and even from India visit this area during Magh Shukla Dashami, Maghe Sakranti, Shiva Ratri, New Year and Dashain. The local people believe that the color of the lake changes three times a day therefore local people named as *Jhilmila*.

3.3 RANI LAKE

2.3.1 PHYSIOGRAPHY

Rani lake is one of the largest ox-bow lake, located inside the Suklaphanta National Park (Fig. 33 and 34). This park is important due to its extensive grasslands or phantas. The main grassland, Sukla Phanta proper, is the largest protected patch of continuous grassland in Nepal.

3.3.2 WATER QUALITY

Physio-chemical characteristics of Rani lake were described based on samplings at five sites. Average temperature and dissolved oxyen were 26 ^{0}C and 6.9 ppm respectively. Average pH was 6.9 ranged from 6.7 to 7.2. The dissolved ammonium was 4.0mg/l due to more eutrophication of the lake (Table 10).

TABLE 10. WATER QUALITY PARAMETERS OF RANI LAKE

WATER QUALITY PARAMETER	VALUE
Conductivity	12.1 S/m
Temperature	26.01^{0}C
Total Iron	0mg/l

Ph	6.97
Nitrate	0mg/l
Nitrite	0mg/l
Dissolved oxygen	6.97ppm
Ammonium	4.0mg/l

Figure 33. Rani lake, inside the Suklaphanta National Park, plays a vital role to save the wildlife, but its status is venerable due to eutrophication, siltation and natural succession

3.3.3 WETLAND STATUS

Permanent

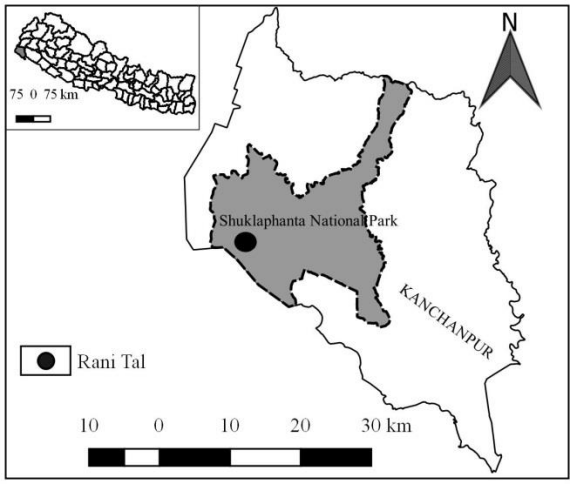

Figure 34. Map showing the location of Rani lake

3.3.4.1 BIRDS

Status of birds

Rani lake is important for birds. More than 450 species birds were recorded from Suklaphanta National Park (Paudhyal and Chaudhary, 2019), some of the important birds are: Bengal floricans, Swamp francolin, Jerdon's bushchat, Rufous-rumped grassbird, Chestnut-capped babbler, Jerdon's babbler, Yellow-eyed babbler, Finn's weaver, Hodgson's bushchat, Spot-bellied eagle owl, Dusky eagle owl, Rufous-bellied eagle, Oriental pied hornbill, Great slaty woodpecker, White-naped woodpecker, White-rumped vulture, Slender-billed vulture, Lesser adjutant, Grey-headed fish eagle, Darter, Rufous-rumped grassbird, Sarus crane, Painted stork, Bristled grassbird, Greater racquet-tailed drongo, White-capped water redstart, Rusty-tailed flycatcher and Rufous-gorgeted flycatcher (Baral and Inskipp 2009).

A total of 1780 (winter = 968 and summer =753) individuals belonging to 131 species from 18 orders and 49 families were recorded in our study. The most abundant species were from order Passeriformes (36%) followed by Coraciiformes (9%), Psittaciformes (8%) and Galliformes (7%) in the winter season (Fig. 35). In summer season, Passeriformes (41%) were most abundant followed by Coraciiformes (11%), Psittaciformes (6%) and Galliformes (6%) in Rani lake area.

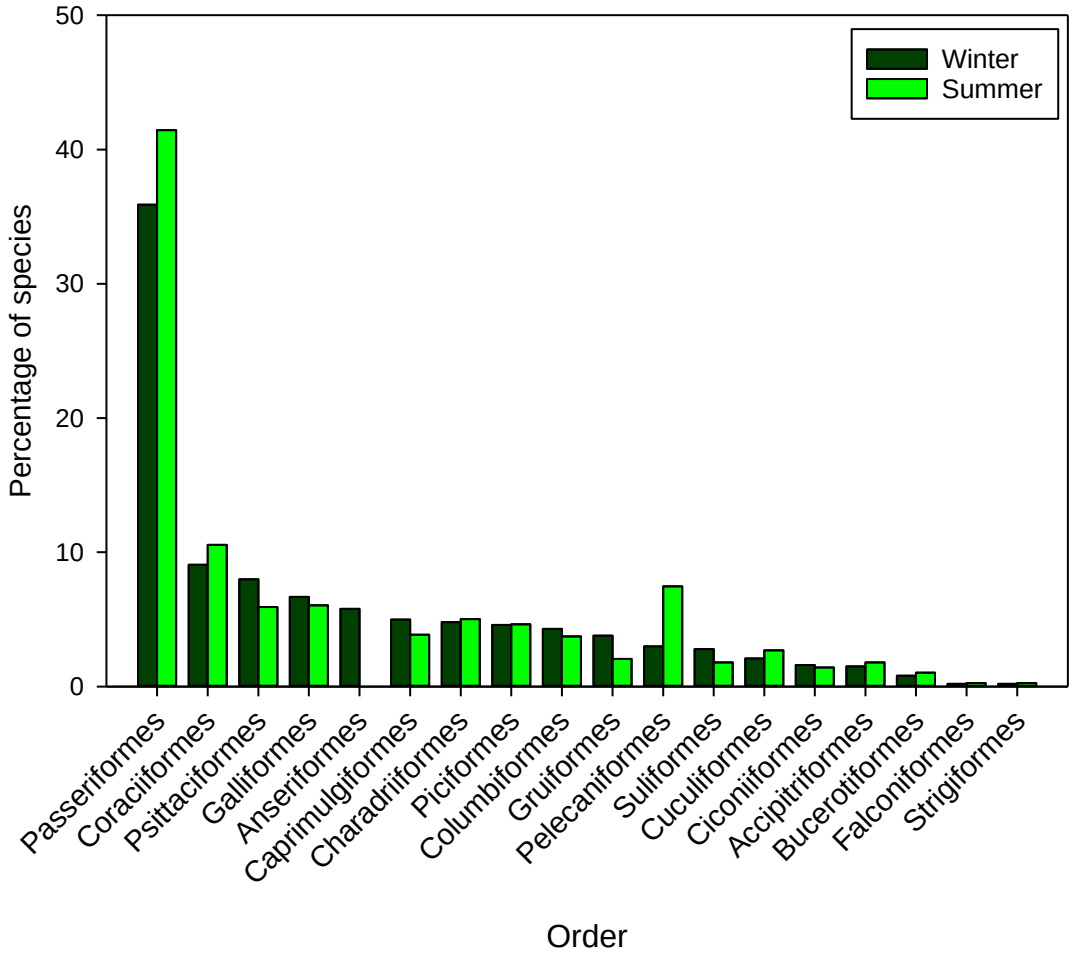

Figure 35. Percentage of bird species recorded according to their taxonomic order in Rani lake

Among them, Common Peafowl (N=86, 4.8%) were must abundant species in the Rani lake followed by House swift (N=80, 4.4%), Blue-tailed bee-eater (N=73, 4.1%), and House sparrow (N=54, 3.03%) (Appendix Table S3).

With respect to feeding guilds, this study recorded the largest number of insectivorous species (45.2%), followed by Omnivores (25.0%), Picivores (12.9%) and Herbivores/Frugivores (10.5%) (Fig. 36).

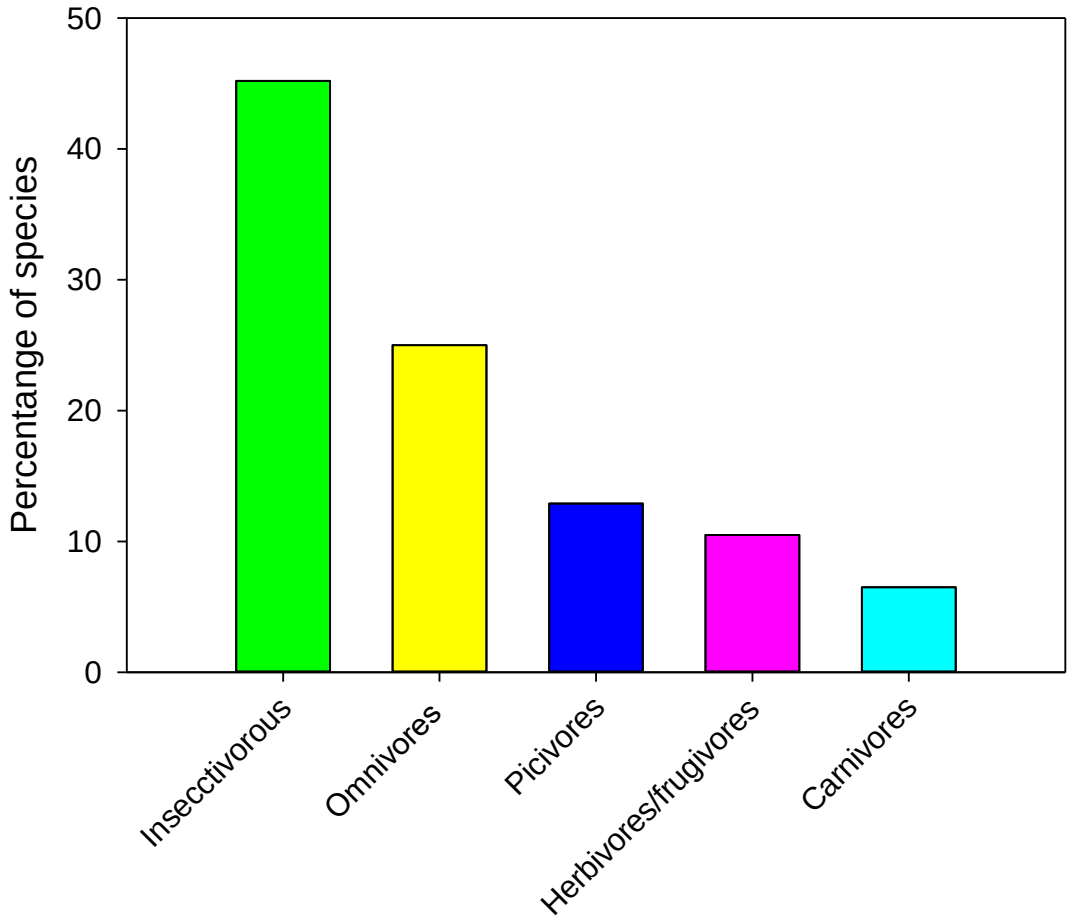

Figure 36. Number of bird species recorded for the different feeding guilds

Species diversity and seasonal variations of the birds

The species diversity of birds in two seasons was significantly difference (t =1.531, p= 0.015). The species diversity was significantly higher in winter (Shannon index H= 4.38, ranges from 4.27 to 4.37, Fisher alpha= 38.22) than summer (H= 4.337, ranges from 4.252 to 4.363, Fisher alpha= 36.6). There was no significant difference in species dominace index and Simpson index of diversity during winter and summer seasons (Dominace index D= 0.017, Simpson index of diversity (1-D) = 0.982 in winter and D=0.017, 1-D=0.982 in summer) (Table 11).

TABLE 11. BIRD'S DIVERSITY AND DOMINANCE INDICES IN RANI LAKE.

	WINTER			SUMMER		
	AVERAGE	LOWER	UPPER	AVERAGE	LOWER	UPPER
Dominance_D	0.01722	0.01605	0.01966	0.01795	0.01676	0.02048

TABLE 11. BIRD'S DIVERSITY AND DOMINANCE INDICES IN RANI LAKE.						
	WINTER			SUMMER		
	AVERAGE	LOWER	UPPER	AVERAGE	LOWER	UPPER
Simpson_1-D	0.9828	0.9803	0.9839	0.982	0.9795	0.9832
Shannon_H	4.424	4.338	4.444	4.337	4.252	4.363
Evenness_e^H/S	0.6671	0.6123	0.6807	0.6826	0.6271	0.7006
Equitability_J	0.9162	0.8984	0.9203	0.9191	0.9011	0.9246
Fisher_alpha	38.22	38.22	38.22	36.4	36.4	36.4

The fishing and collection of natural products, livestock grazing in the Rani lake is fully prohibited as it is located inside Suklaphanta National Park. But this lake is highly degradation condition due to eutrophication and natural succession. The species evenness of birds (0.667) and Jacob's coefficient of equality (0.9162) was less in winter than summer (evenness=0. 682, Jacob's coefficient of equality= 0.9191) in Rani lake (Table 11).

Status of birds in Rani lake according to habitat types

Rani lake is located inside the Suklaphanta National Park. A total of 50 species of forest birds followed by 49 species of wetland and wetland dependent birds, 19 species of birds in open grounds and grass lands and 13 species of shrub habitat dependent birds were recorded during field study (Fig. 37, Appendix Table S5).

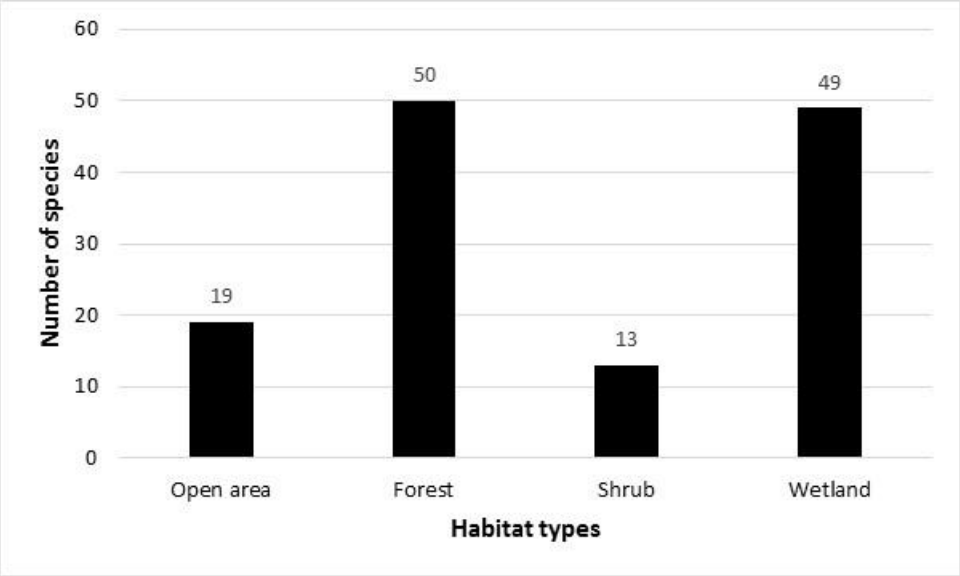

Figure 37. Status of birds as their preferred habitat types in Rani lake area

Conservation value of Rani Lake for Birds

Rani lake harbors 14.78% of total bird species recorded from Nepal (N=886). This study recorded one globally endangered bird (Steppe eagle *Aquila nipalensis),* three globally vulnerable birds (Red-wattled lapwing *Vanellus indicus*, Asian woolly necked *Ciconia episcopus* and Great slaty woodpecker Mulleripicus pulverulentus) and five globally near threatened birds (Table 12).

TABLE 12. THREATENED BIRDS RECORDED FROM RANI LAKE

SN	COMMON NAME	SCIENTIFIC NAME	IUCN STATUS
1	Steppe Eagle	*Aquila nipalensis Hodgson, 1833*	EN
2	Red-wattled Lapwing	*Vanellus indicus (Boddaert, 1783)*	VU
3	Asian Woolly necked	*Ciconia episcopus (Boddaert, 1783)*	VU
4	Great Slaty Woodpecker	*Mulleripicus pulverulentus (Temminck, 1826)*	VU
5	Grey-headed Fish-eagle	*Icthyophaga ichthyaetus (Horsfield, 1821)*	NT
6	Lesser Fish-eagle	*Icthyophaga humilis (Müller & Schlegel, 1841)*	NT
7	River Lapwing	*Vanellus duvaucelii (Lesson, 1826)*	NT
8	Painted Stork	*Mycteria leucocephala (Pennant, 1769)*	NT
9	Oriental Darter	*Anhinga melanogaster Pennant, 1769*	NT

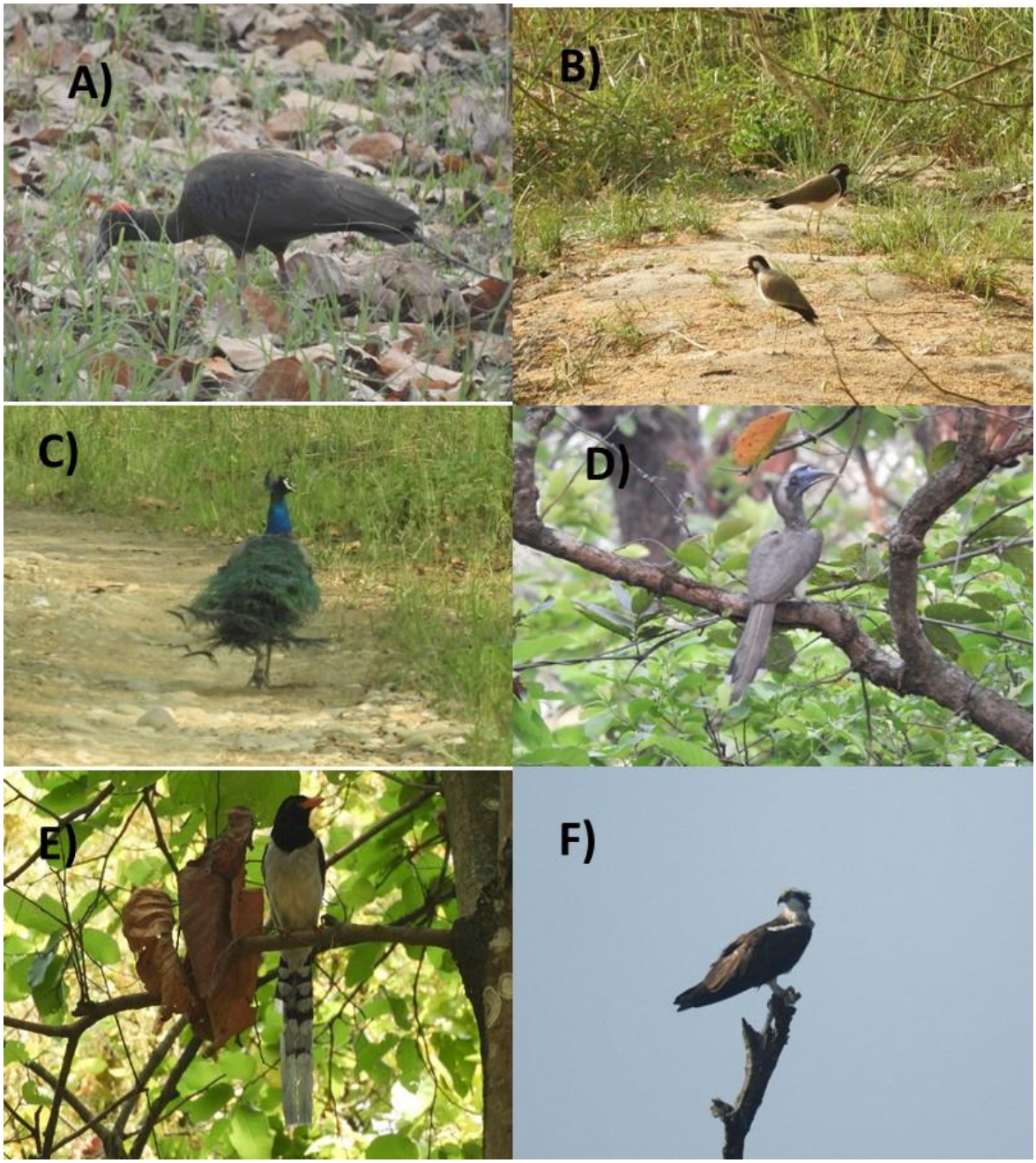

Figure 38. Birds of Rani lake A) Red-naped ibis B) Red-wattled lapwing C) Indian peafowl D) Indian grey hornbill E) Yellow-billed blue magpie F) Osprey

3.3.4.2 MAMMALS

The extensive open grasslands and wetlands rani lake supports habitat for a wide range of fauna including Bengal tiger, Common leopard, Sloth bear, Swamp deer, Asian elephant and Hispid hare (Henshaw 1994). One-horned rhinoceros were translocated from Chitwan National Park to establish a third viable population in the country. During field survey, a total of 263 individual of mammals from ten species were recorded. Seven species (Northern red muntjac, Laguna, Rhinoceros, Chital, Terai grey langur, Rhesus monkeys and Wild boar) were observed visually whereas; three species (Fishing cat, Porcupine and Tiger) were identified from sign survey (Appendix Table S20). Rani lake is the major habitat for three species of endangered mammalian species (Bengal

tiger, Swamp deer and Hog deer), two vulnerable species (Indian rhinoceros and Fishing cat) and one Near threatened species (Tarai gray langur) (Table 13).

TABLE 13. THREATENED MAMMALS RECORDED FROM RANI LAKE

SN	COMMON NAME	SCIENTIFIC NAME	IUCN
1	Hog deer	Axis porcinus (Zimmermann, 1780)	EN
2	Bengal Tiger	Panthera tigris (Linnaeus, 1758)	EN
3	Fishing cat	*Prionailurus viverrinus* (Bennett, 1833)	VU
4	One horned Rhinoceros	Rhinoceros unicornis Linnaeus, 1758	VU
5	Tarai Gray Langur	Semnopithecus hector (Pocock, 1928)	NT

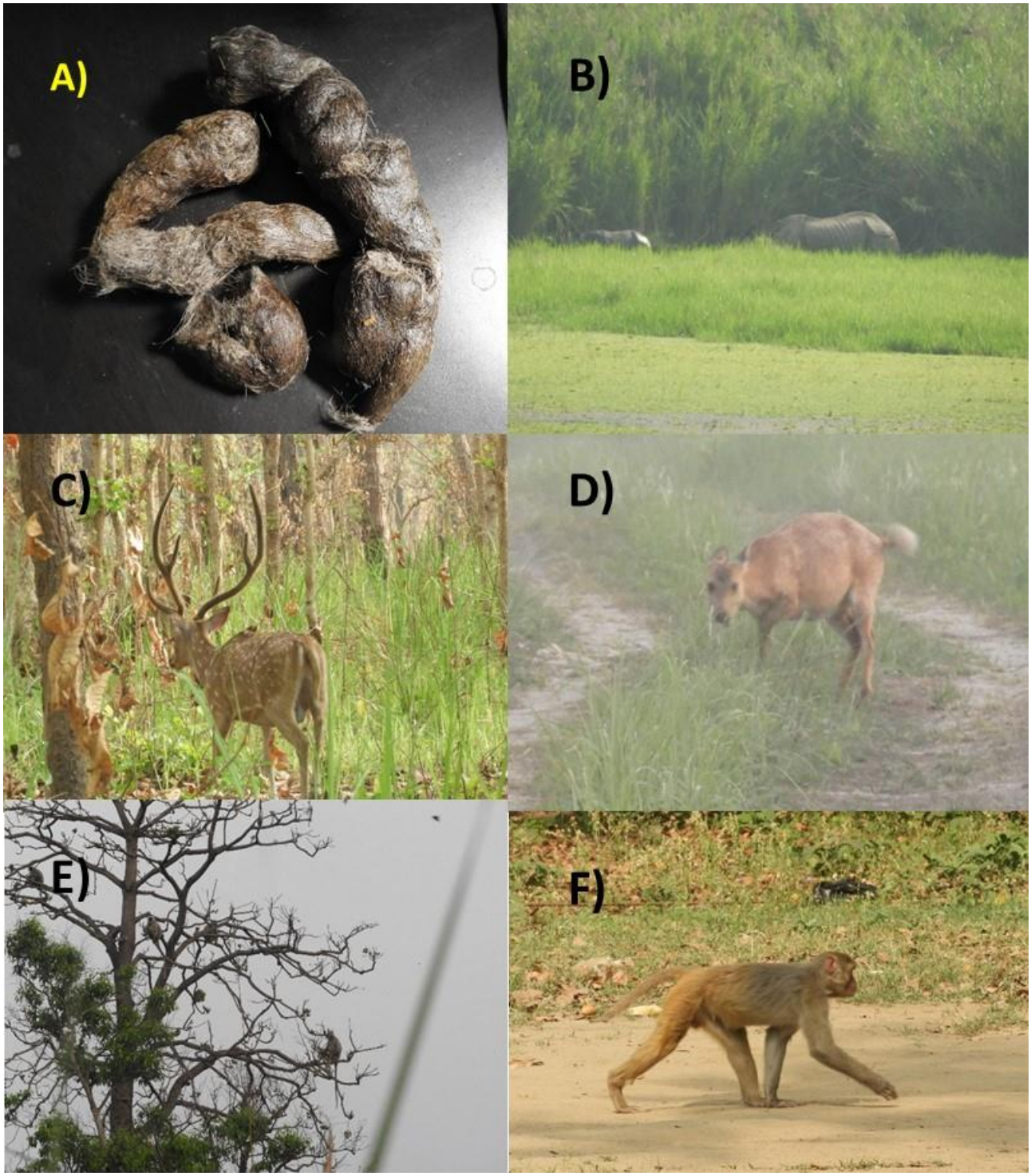

Figure 39. Mammal in Rani lake and its surrounding A) Scat of Bengal Tiger B) A female Rhinoceros with her calf C) Chilal D) Hog deer E) A troop of Tarai Grey Langur F) Rhesus monkey

3.3.4.3 AMPHIBIANS

A total of 87 individual of amphibian belonging to 10 species and three families were recorded from Rani lake area. The most abundant species in the areas were *E. cynophlyctis* (64%) followed by *H. tigerinus* (17.2%), *D. stomaticus* (9.2%), *H. crassus* (8%) and *M. teraiensis* (8%) respectively (Fig. 40). The Suklaphanta area also supports high diversity of amphibians (*Hoplobatrachus tigerenis*, *Hoplobatrachus*

crasus, *Duttaphrynus melanostictus*, *Duttaphrynus stomaticus*, *Sphaerotheca maskeyi*, Uperodon systoma, *Polypedates maculatus*, and *Polypedates taeniatus*) (Appendix Table S12).

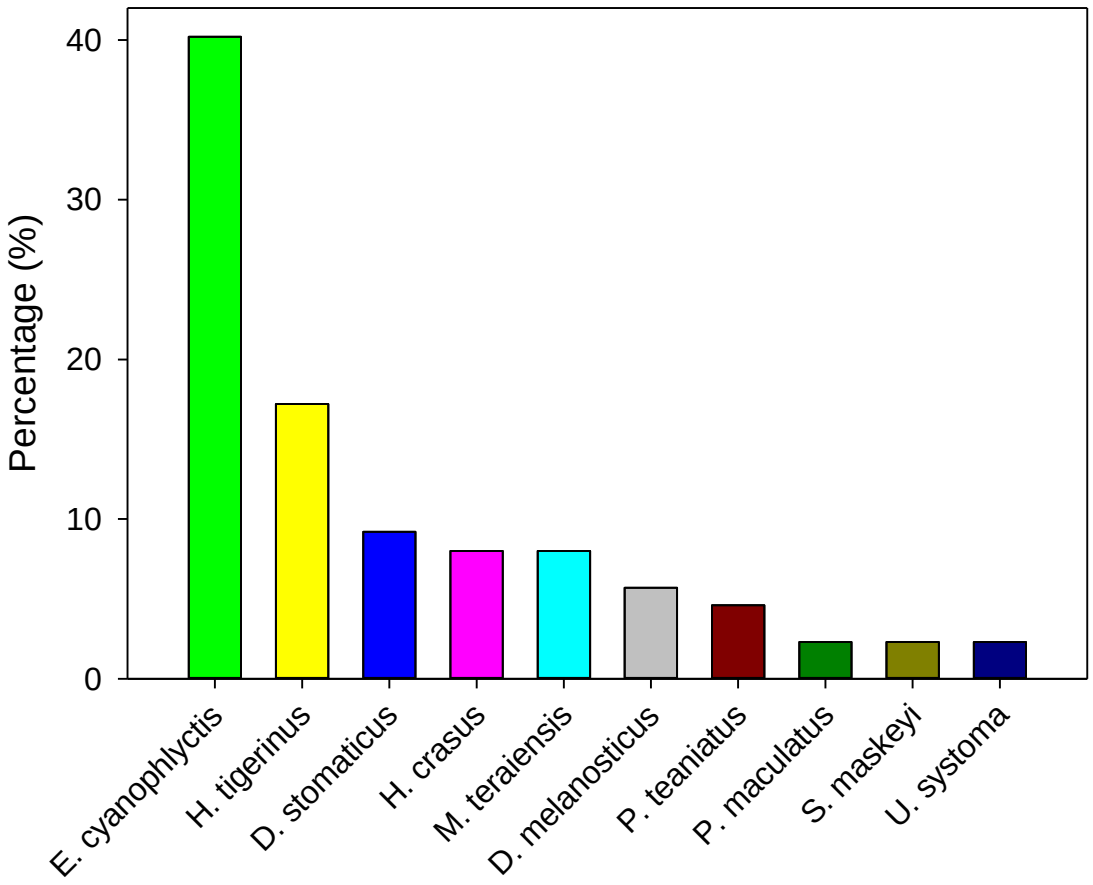

Figure 40. Percentage of amphibian species recorded in Rani lake

3.3.4.4 REPTILES

During survey period, 10 species of snakes, four species of turtle and a lizard and a varanidae lizard were recorded. Rani lake area supports excellent habitat for some of the reptiles like: Mugger crocodile, Indian rock python, golden monitor lizard, Common cobra, Common krait and Oriental rat snake (Appendix Table S16).

3.3.4.5 FISHES

Rani Lake provides an important habitat for fishes. During survey period, six species of fishes were observed in Rani lake: Kabai (*Anabus testudineus*), Sidhre (*Punticus chola*), Kande Gainche (*Lepidocephalus guntea*), Andha Bam (*Monopterus cuchia*), Chuche Bam (*Mastacembelus armatus*) and Tilapia (*Oreochromis mossambica*) (Appendix Table S8).

3.3.4.6. MACRO INVERTEBRATES

Dragonflies are an important indicator of good health of aquatic ecosystem. They only lay eggs in or near fresh water so they are much sensitive to water pollution than damselfly. Different ecological factors like acidity, temperature, type and amount of aquatic vegetation, nature of water (like lotic and lentic) etc. affects the distribution of nymphs of dragonflies. Dragonflies prefer heterogenous vegetation and can be regarded as reliable indicator of human disturbance of wetlands like

construction of dams, human pressure etc. Damselflies are more sensitive than dragonflies because of their smaller body size and small home range.

Water scorpion are most commonly found predator in aquatic habitat which is dorsoventrally flattened with raptorial legs. They are sluggish which are most abundant in shallow littoral region of wetlands. They are recorded in degraded wetlands with high siltation pressure and associated with vegetation like Rani lake. Diving beetles are predacious beetles which feed on most of invertebrates, fish eggs fry etc. they prefer clean fresh near littoral zone with leaves of macrophytes (Table 14).

TABLE 14. MACROINVERTEBRATES OF RANI LAKE

SN	COMMON NAME	SCIENTIFIC NAME	PHYLUM
1	Nymph of Dragonfly	Aeschnidae- Odonata	Arthropoda
2	Nymph oy Damselfly	Libellulidae- Odonata	Arthropoda
3	Water bug	Saldidae-Hemiptera	Arthropoda
4	Diving beetle	Dytiscidae- Coleoptera	Arthropoda
5	Water scorpion	Nepidae- Hemiptera	Arthropoda

3.3.4.7 VEGETATION

Rani Lake is located inside the Shuklaphanta National Park, Shuklaphanta is known for large swath of grasslands. The lake is surrounded by dense Sal (*Shorea robusta*) forest. Associated tree species are Kusum (*Scheleira oleosa*), Saaj (Terminalia alata), Rohini (*Mallotus phillipensis*). Wetland indicator tree species Jamun (*Syzygium cuminii*) and riverine indicator tree species Bhellar (*Trewia nudiflora*) were also common around the lakes. Common shrub species include Rudilo (*Pogostemon bengalensis*), Asare (*Murraya koenighii*) and Bhati (*Clerodendrum viscosum*). The lake is surrounded by elephant grass (*Saccharum spontaneum*), Narenga (*Narenga porphyrocoma*) on south, west and east. We recorded a total of 77 species of flowering plants in the forest surrounding the lake. A high value tree species Vijaya Sal (*Pterocarpus marsupium*) is also found in the surrounding forest (Appendix Table S22).

Macrophytes

The lake is habitat of diverse macrophytes. There are free floating macrophytes (Azolla Pinnata and Pistia Stratiotes) and rooted floating hydrophte namely *Utricularia auras*, there are several emergent marcophyes which can grow in aquatic to terresterail habitat. The lake is invaded by invasive species *Pistia stratiotes (*Fig. 41A) and might have impacts on wetland plants (Appendix Table S23).

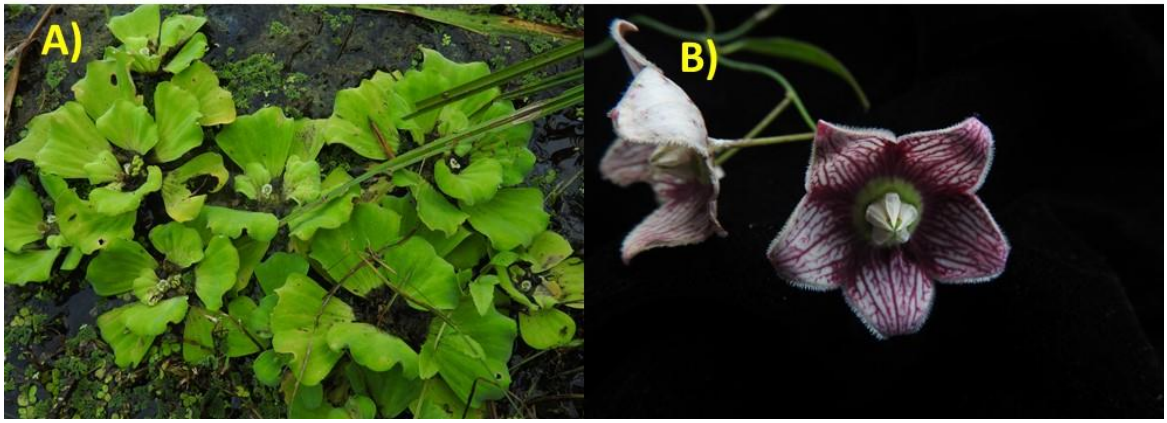

Figure 41. Indicator aquatic plants of Rani Lake A. *Pistia stratiotes*: an invasive species B. *Oxystelma esculentum*: An aquatic climber in Rani Lake

3.3.5 ECOSYSTEM SERVICES

This lake is located inside the Suklaphanta National Park, hence collection of natural products, fodder, firewood, snails, fish from this lake is legally prohibited.

3.3.6 THREATS

Due to high rate of siltation, eutrophication and natural succession, this lake is in highly degraded condition.

3.4 RAMAROSHAN LAKE COMPLEX

3.4.1 PHYSIOGRAPHY

Ramaroshan is a landscape complex located in the northeastern corner of Achham district in Ramaroshan Rural Municipality ward No 5 bordering with district of Kalikot in the east and Bajura in the North (Fig. 42). The landscape has wider elevational gradient, which ranges from 1000 meter above sea level (masl) to 3800 masl. Parallel to its elevational gradient the landscape has wider climatic gradient which ranges from subtropical to subalpine climatic zones. Ramaroshan landscape is popularly known as "१२ बण्ड १८खण्ड " by local residents, that means the landscape consists of 12 lakes and 18 pastures/meadows. Along with wetlands and pastures forests make Ramroshan complex a beautiful landscape (Fig 42). The Ramaroshan forest is the proposed protected forest of Nepal that covers 3051.29 ha area. Among the total area, 30 ha is covered by the wetland following dense forest (2954.26ha), grassland (55.05ha), rivers and streams (10.98ha).

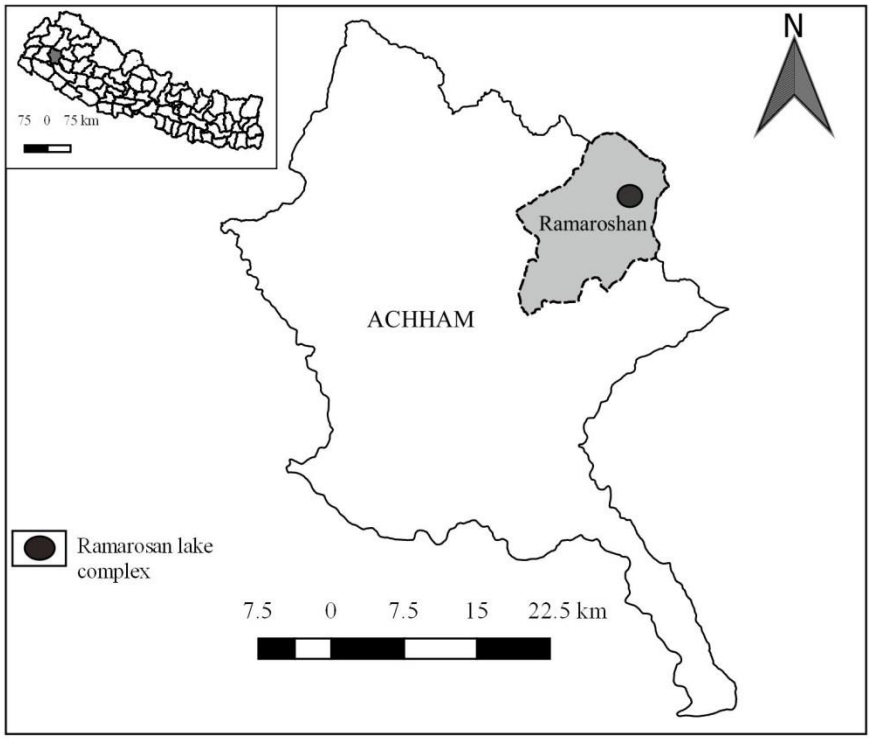

Figure 42. Map showing the location of Ramaroshan complex. Ramaroshan is the complex of more than 12 lakes and Kailash Khola

3.4.2 HYDROLOGICAL FEATURES

Ramaroshan area is known for its wetland complex. There are 12 lakes and ponds of varying size and shapes. Most of the wetlands are permanent in nature. These wetlands are fed through different sources including small stream, surface recharge, and seepages from hill and direct precipitation. Among them, Jingale is the largest lake which covers 12 ha area. Jingale lake is surrounded by three wetlands namely Batulla, Lamadaha and Lisse Daali. The Lamadaha feeds water from the small streams that flow from the sloppy mountain. Then, the water discharged from Lamidaha feeds the Jingale lake (Table 16). Jingale lake consequently feeds to Batulla and outlet of Batulla leads to Upper (Mathillo) Dhaunne and then Lower (Tallo) Dhaunne. Kailash Khola drains the water from Ramaroshan lake complex and surrounding mountains (Table 16).

3.4.3 WATER QUALITY

Physio-chemical characteristics of Ramaroshan lake were described based on samplings at ten sites of major lakes such as Batula, Jingale, Laami daha, Lisse dali. The average pH of the lake complex was 5.53 i.e. basic in nature which supports only alkaline loving plants and aquatic animals. The average temperature of the water of lakes was 18.52^{0}C in the month of May (summer), 0^{0}C and lower during winter (January) (personal communication with local people). The average nitrate, nitrite and ammonium were 0.001, 0.55, 0.5mg/l respectively this is due to the effects of the litter and excreta of local livestock. The average dissolved oxygen was relatively lower (5.34ppm) in the lakes of Ramaroshan complex, which is not sufficient for the aquatic creatures, hence the diversity of fish was low in this lake complex (Table 15).

TABLE 15. CHEMICAL CHARACTERISTICS OF WATER IN WETLANDS OF WESTERN NEPAL	
WATER QUALITY PARAMETER	RAMAROSHAN LAKES
Conductivity	51.48 S/m
Temperature	18.52^{0}C
Total Iron	0mg/l
pH	5.53
Nitrate	0.01mg/l
Nitrite	0.55mg/l
Dissolved oxygen	5.34ppm
Ammonium	0.50mg/l

3.4.4 WETLAND STATUS

Lakes and ponds of Ramaroshan are natural and permanent. They are located in the foot slope of hills and valley bottoms. Slopes around the wetlands are subject to gulley erosion and landslide. Impacts of gully erosion can be observed in most of the wetlands. A lake namely Lisse Daali found severely impacted by landslide and 80% of this lake is converted into grassland and forest. The Geraha lake is completely missing and converted into the cropland. During the emergency period (2054) the dams of the lake was damaged by the Maoist and converted into crop land (Personal communication with local people). Likewise, village Dalyana is very famous for potato and Marsee rice (local rice). The local people thought that the production of potato became low due to the wet environment of the lake, hence they cut the dam of the lake drained in Kailash River. Now, the lake is completely missing.

TABLE 16. LIST OF WETLANDS OF RAMAROSHAN AND THEIR STATUS				
S.N.	NAME OF LAKE	AREA (HA)	ELEVATION (M)	WETLAND STATUS
1	Jigaale (Janghale, Jingaale)	21.5	2410	Largest in the complex, Shrinking from eastern corner
2	Batulla	3.2	2400	Siltation in all the direction due to gully erosion
3	Laami Daha	1.1	2450	Siltation due to gully erosion, the western part of this lake is shrinking due to heavy load of silts and gravel received from streams named Dusha nala and Suka nala during rainy season.
4	Lisse Daali	0.65	2450	Shrinking, siltation due to landslide
5	Taaule Lake	-	2525	Shrinking and going to missing soon. More than 70% of the lake is converted into grassland and forest.
6	Tallo Dhaune	0.55	2250	Shrinking

TABLE 16. LIST OF WETLANDS OF RAMAROSHAN AND THEIR STATUS				
S.N.	NAME OF LAKE	AREA (HA)	ELEVATION (M)	WETLAND STATUS
7	Mathillo Dhaune	1.63	2300	Change not explored
8	Gaagre Lake	-	2490	Very small amount of water in dry season
9	Dauthe khal (Baulegadaa)	-	2780	Lake located in highest elevation
10	Raame Lake	-	2350	Consists of three small ponds. Shrinking and drying up due to water diversion /management
11	Dalyana Lake	-	1800	Dried up due to water diversion/management, Now it is converted into crop land.
12	Geraha Lake	2.2	1400	Missing (During emergency period, the Maoists destructed the dam of Geraha Lake and converted into crop land, source-personal communication with local people)

Data source: Field observation (2019) and profile of Division forest office Achham

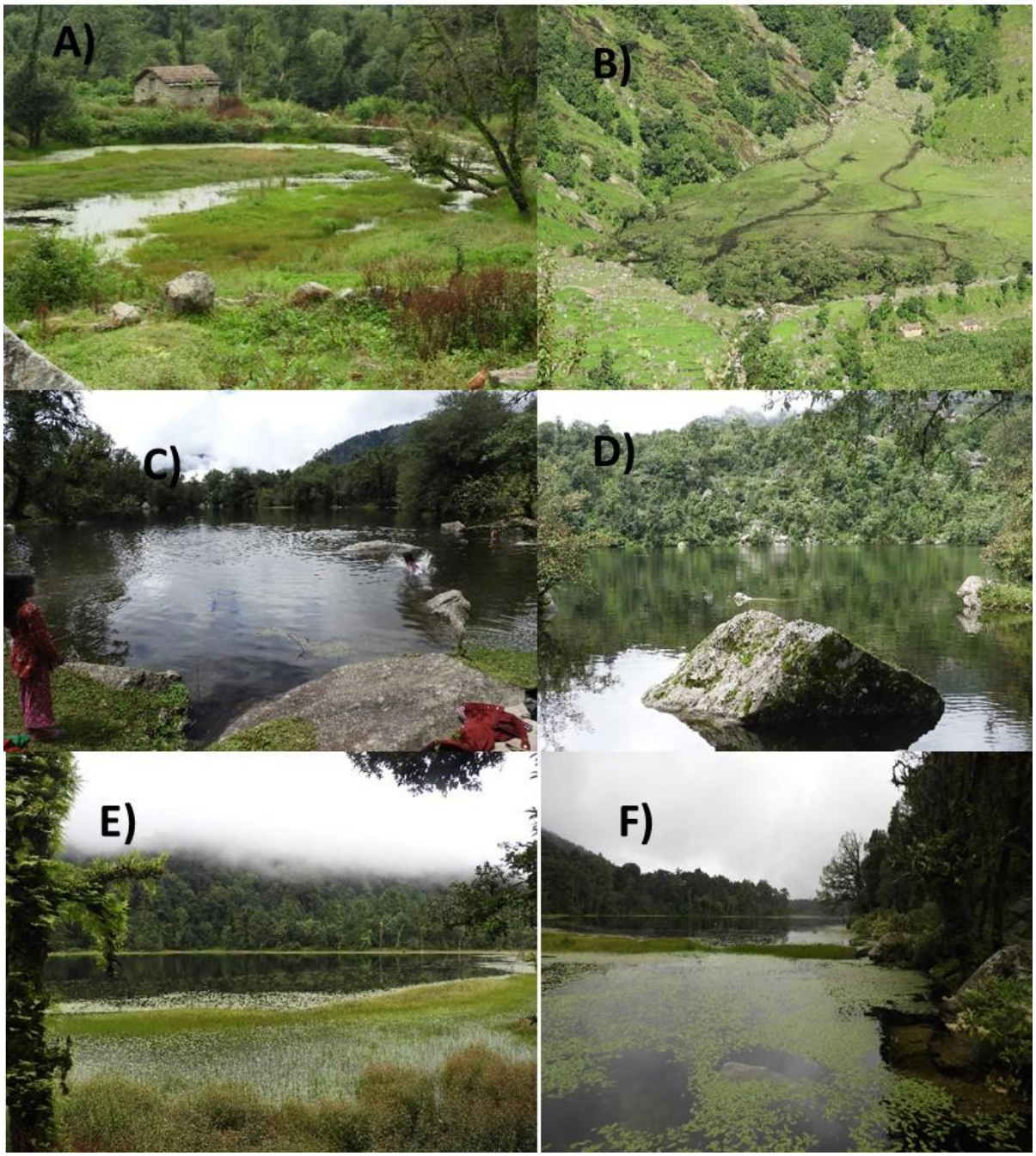
A)
B)
C)
D)
E)
F)

Figure 43. Lakes of Ramaroshan Area A) Rame lake B) Geraha Lake C) Tallo Dhaune D) Mathillo Dhaune E) Batulla Lake F) Jingale Lake G) Lisa Daali H) Laamidah I) Dauthe Khal J) Dalyana Lake but now converted into crop land

3.4.5 PASTURES IN RAMAROSHAN

Ramaroshan area has several patches of pastures in between the forest. Both natural and semi-natural pastures are present in the area. Pastures located in the higher elevation in Chakadanda are natural while pastures located in the lower elevation and in between the forests are semi-natural. Major pastures like Kinimini, Rasune (Roshan), Rame and Baagfal are semi natural. Kinimini is the beautiful and flat pasture formed in the valley between Chakadanda (North) and Baagfal pasture is located in in the eastern part of the Ramaroshan near Kalikot-Achham Boarder. Dadil pasture is located in the highest elevation up to 3900 m in Chakadanda. This pasture is in exposed slope and might be natural and is used mainly for sheep and cows grazing. Nowadays, the Ramaroshan Rural municipality completely band for pasture in Rasune and Rame area (Fig 44). The local government removed all of the Kharka from these areas for its protection naturally.

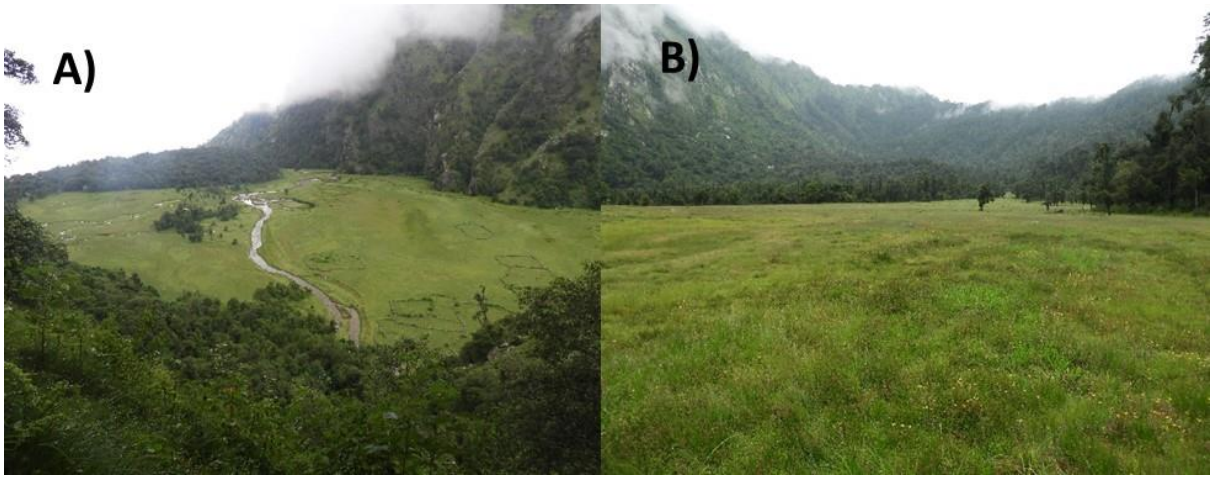

Figure 44. Pastures in Ramaroshan A) Kinimini B) Rasun

3.4.6 BIODIVERSITY

Ramaroshan landscape is a heterogeneous landscape in terms of physiography, ecosystems, climate and land cover. This heterogeneity makes the landscape a custodian of higher diversity of habitats, flora and fauna. The landscape complex includes several threatened taxa of flora and fauna.

3.4.6.1 MAMMALS

A total of 11 species of mammals were recorded in this study. Among them Himalayan pika (23%) had the height abundance followed by Rhesus macaque (17.6%), Assam Macaque (14.1%) (Fig. 44). Based on anecdotal information, Ramaroshan lake complex harbors habitat for 13 species of mammals that belongs to 4 orders, 9 Families, 12 genera and one unidentified otter species (Appendix Table S20). Among them, five species are legally protected by NPWC Act 1973 by the government of Nepal. They are Leopard (*Panthera pardus*), Red Panda (*Ailurus fulgens*), Asiatic Black Bear (*Ursus thibetanus*), Clouded Leopard (*Neofelis nebulosa*) and Himalayan Goral (*Naemorhedus goral*). The Red panda has been categorized as 'Endangered" under the IUCN red list category. Similarly, the Himalayan Black Bear and Leopard is categorized as Vulnerable under IUCN status. There are six species of mammals listed under the CITES Appendix I (Common leopard, Clouded leopard, Himalayan goral and Asiatic black bear).

TABLE 17. THREATENED MAMMALS RECORDED FROM RAMAROSHAN LAKE

S.N.	COMMON NAME	SCIENTIFIC NAME	IUCN
1	Red Panda	*Ailurus fulgens*	EN
2	Common Leopard	*Panthera pardus*	VU
3	Himalayan Black bear	*Ursus thibetanus*	VU
4	Clouded Leopard	*Neofelis nebulosi*	VU
5	Assam Macaque	*Macaca assamensis*	NT
6	Himalayan Goral	*Naemorhedus goral*	NT

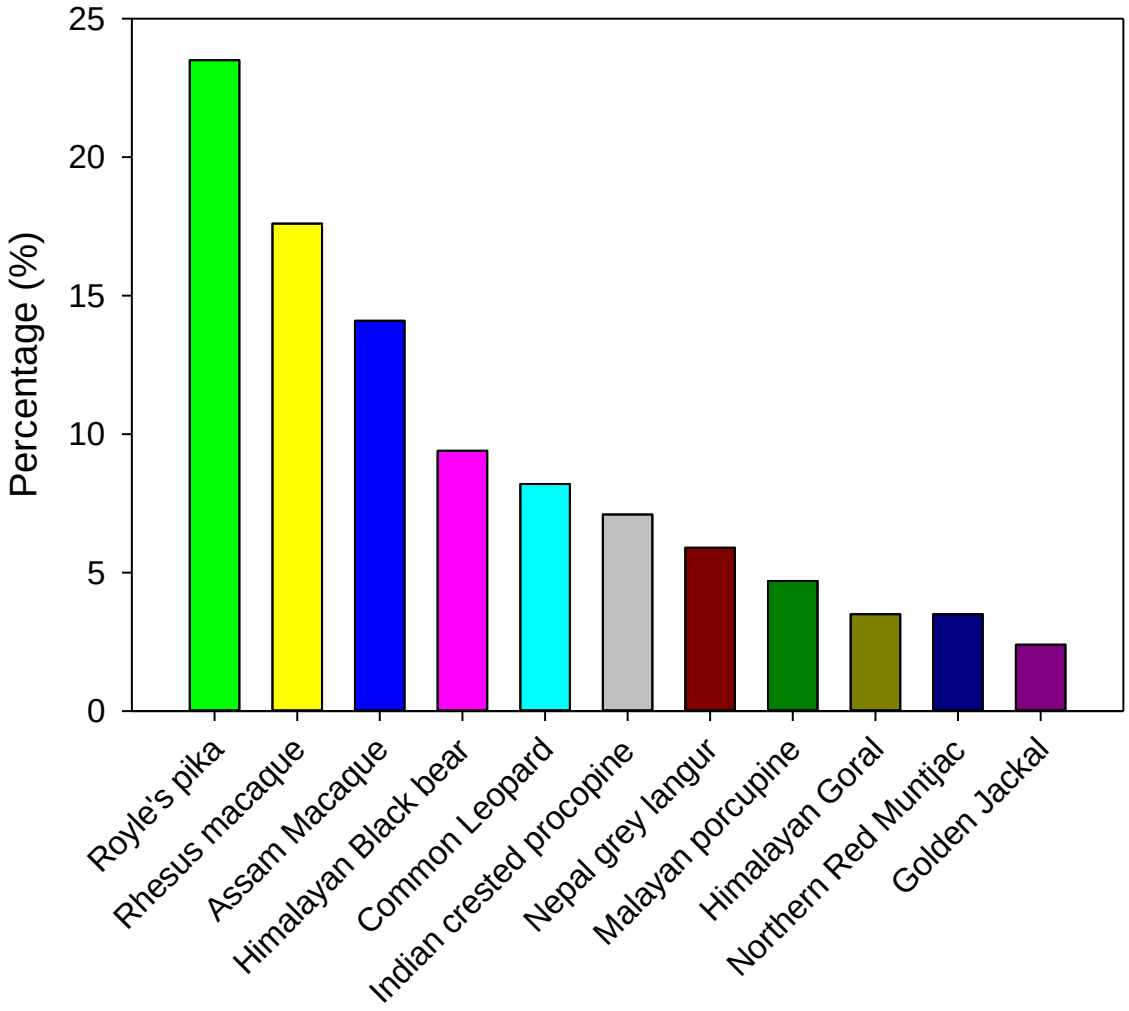

Figure 45. Percentage of mammalian species recorded in Ramaroshan lake complex

Figure 46. Mammals of Ramaroshan Area A) Scat of Leopard B) Royle's pika C) Nepal grey langur D) Quail of Indian crested porcupine

3.4.6.2 BIRDS

Status of birds

This study reported that Ramaroshan lake complex supports the habitat for 1018 individuals (winter=523 and summer=495) of birds classified under 79 species of 33 families and 15 orders (Appendix Table S4). The most abundant species were from order Passeriformes (62%) followed by Anseriformes (8%), Columbiformes (8%) and Piciformes (5%) in the winter season (Fig. 46). In summer season, Passeriformes (69%) were most abundant followed by Columbiformes (8%), Piciformes (7%) and Anseriformes (3%) respectively in Ramaroshan lake complex (Fig. 47).

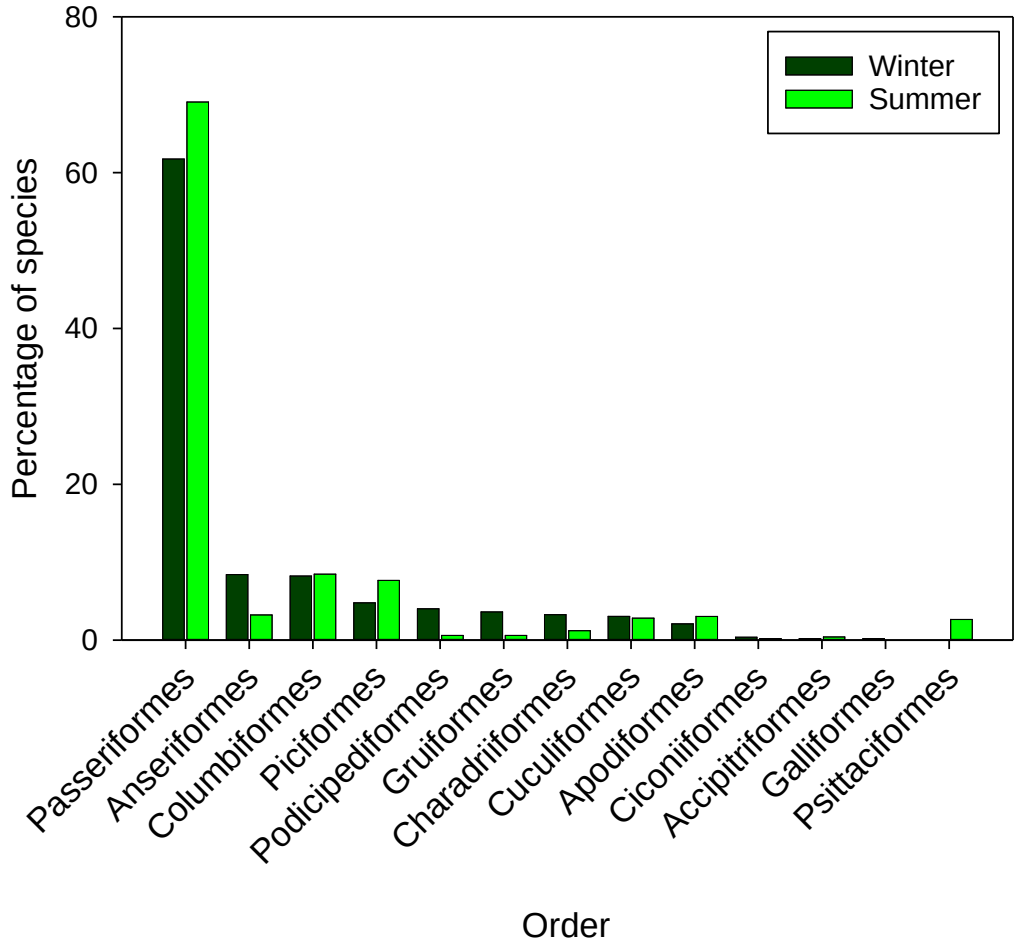

Figure 47. Number of bird species recorded according to their taxonomic order in Ramaroshan lake complex

Among them, Common myna (N=48, 4.7%) were must abundant species in the Ramaroshan lake complex followed by Himalayan bulbul (N=41, 4.0%), Red-vented bulbul (N=35, 3.4%), and Oriental turtle dove (N=33, 3.2%) (Appendix Table S4).

Most of them are residential in nature with few winter and summer visitors (Appendix Table S4). The 'most common' ten bird species of this region are Red-vented Bulbul (*Pycnonotus cafer*), Common Myna (*Acridotheres tristis*), Blue Whistling Thrush (*Myophonus caeruleus*), Long-tailed Minivet (*Pericrocotus ethologus*), Verditer Flycatcher (*Eumyias thalassinus*), Plumbeous Water Redstart (*Rhyacornis fuliginosa*), Large-billed Crow (*Corvus macrorhynchos*), Grey Bushchat (*Saxicola ferreus*), Rufous Sibia (*Malacias capistratus*) and Red-headed Bullfinch (*Pyrrhula erythrocephala*). The common avian fauna recorded during our winter survey includes Eurasian Coot (*Fulica atra*), Little Grebe (*Tachybaptus ruficollis*), Mallard (*Anas platyrhynchos*), Eurasian Wigeon (*Anas Penelope*), Common Teal (*Anas crecca*), Grey Wagtail (*Motacilla cinera*), and Common Sandpiper (*Actitis hypoleucos*).

Species diversity and seasonal variation of birds in Ramaroshan lake complex

The species diversity of birds in Ramaroshan complex was significantly more in summer season (Shannon index H= 4.068 ranges from 3.969 to 4.071, Fisher alpha= 23.51) than winter (H= 3.968, ranges from 3.876 to 3.977, Fisher alpha= 20.24). There was no significant variation in species dominace index and Simpson index of diversity during winter and summer seasons (Dominace index

D= 0.0223, Simpson index of diversity (1-D) = 0.977 in winter and D=0.02004, 1-D=0.98 in summer season).

TABLE 18. BIRD'S DIVERSITY AND DOMINANCE INDICES IN RAMAROSHAN LAKE COMPLEX.

	WINTER			SUMMER		
	AVERAGE	LOWER	UPPER	AVERAGE	LOWER	UPPER
Dominance_D	0.02235	0.0219	0.02592	0.02004	0.01984	0.02341
Simpson_1-D	0.9776	0.9741	0.9781	0.98	0.9766	0.9802
Shannon_H	3.968	3.876	3.977	4.068	3.969	4.071
Evenness_e^H/S	0.789	0.7197	0.7966	0.8006	0.7252	0.8031
Equitability_J	0.9436	0.9218	0.9459	0.9482	0.9251	0.9489
Fisher_alpha	20.24	20.24	20.24	23.51	23.51	23.51

The fishing and collection of natural products, livestock grazing in and around Ramaroshan complex is very common. The local people used pastures for livestock grazing. The local people fully depend upon the forest for firewood, timbers and fodder collection. The lake name Lisa Dalli is going to disappear due to heavy siltation carried by flooding in the rivers and inlets. The species evenness of birds (0.78) and Jacob's coefficient of equality (0.9436) was lesser in winter than summer (evenness=0. 8006, Jacob's coefficient of equality= 0.9482) (Table 18).

Status of birds in Ramaroshan area according to their preferred habitat types

Ramaroshan lake complex has altitudinal variation (2200 to 2850m altitude) and variation in habitat types. As mean domen effect, the distribution of the birds was low as increasing altitude above 2000m. The Ramaroshan area is the proposed protected forest of far western Nepal. The lake systems are surrounded by pasture lands (called KHARKA), large grasslands, dense forest. More than 12 lakes provide the habitat for many migratory wetland birds. A total of 15 species of wetland birds were recorded from the lakes of Ramaroshan areas followed by 35 forest birds, 15 open area dependent birds and 14 shrub habitat dependent birds (Fig. 47, Appendix Table S5).

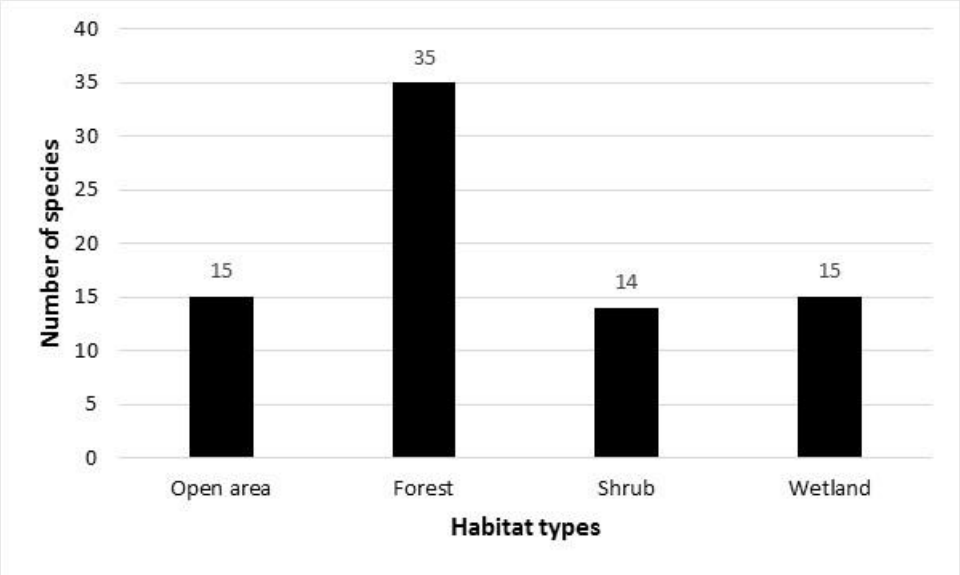

Figure 48. Status of birds as their preferred habitat types recorded in and around Ramaroshan complex

Conservation value of Ramaroshan Lake Complex for Birds

Ramaroshan complex harbors 8.9% of total bird species recorded from Nepal (N=886). This study recorded one globally Endangered bird (Egyptian Vulture Neophron percnopterus), Three globally vulnerable birds (Asian Woolly necked Ciconia episcopus and Cheer Pheasant (Catreus wallichii) and one globally near threatened bird (Northern Lapwing (Vanellus vanellus) (Table 18).

TABLE 19. IUCN THREATENED CATEGORY OF THE BIRDS RECORDED FROM RAMAROSHAN COMPLEX

SN	COMMON NAME	SCIENTIFIC NAME	IUCN STATUS
1	Egyptian Vulture	*Neophron percnopterus*	EN
2	Asian Wolly necked	*Ciconia episcopus*	VU
3	Cheer Pheasant	*Catreus wallichii*	VU
4	Northern Lapwing	*Vanellus*	NT

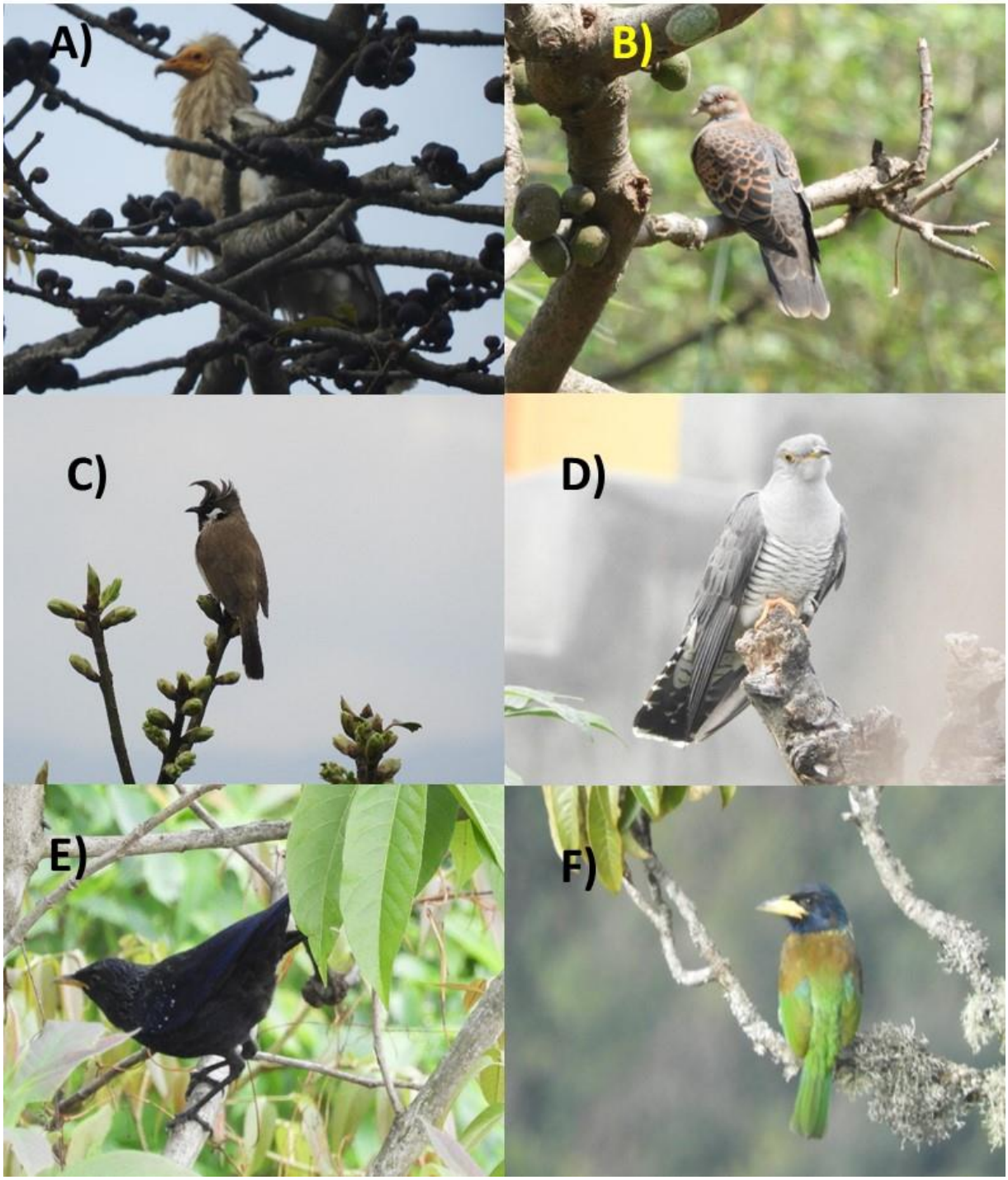

Figure 49. Birds of Ramaroshan Area- A) Egyptian Vulture B) Oriental Turtle Dove C) Himalayan Bulbul D) Eurassian Cuckoo E) Blue Whistling Thrush F) Great Barbet

3.4.6.3 AMPHIBIAN

A total of 121 individual of amphibian from seven species and five families were recorded from Ramaroshan wetland complex. The most abundant species in the areas were *Nanorana legibii* (50.4%) followed by *Duttaphrynus himalayanus* (32.2%) and *H. tigerinus* (5.8%) respectively (Fig. 50). The Ramaroshan complex is an important area for amphibian species and harbors some of the endemic amphibians (*Nanorana minica* and *Amolops* sps) (Appendix Table S12)

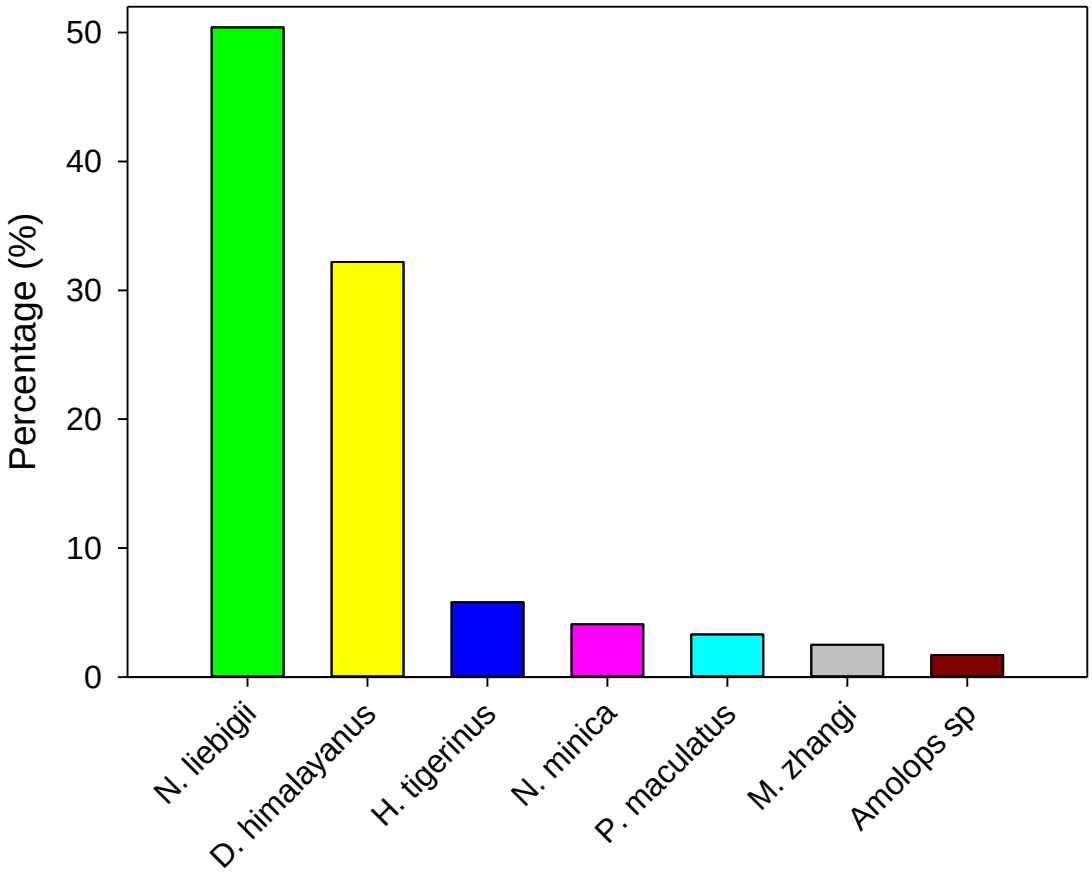

Figure 50. Percentage of amphibian species recorded in Ramaroshan wetland complex

3.4.6.4 REPTILES

A total of five species of reptiles were recorded. Among them, *Laudakia tuberculata* (48%) (Fig 51) were must abundant in the area followed by the *Calotes versicolor* (25%) and *Mabuya carinata* (21.4%) respectively (Appendix Table S17).

Figure 51. Himalayan Rock Lizard (*Laudakia tuberculate*)

3.4.6.5 FISHES

A total of three species of fishes were recorded. Among them, Budhe Asala (*Schizothorax nepalensis*) (62%) were must abundant in the area followed by Tikhe Asala (*Schizothorax richardsonii*) (33%) and Garra (*Garra gotyla*) (5%) respectively (Appendix Table S9).

3.4.6.6 MACRO INVERTEBRATES

Dragonflies are an important indicator of good health of aquatic ecosystem. They only lay eggs in or near freshwater so they are much sensitive to water pollution than damselfly. Different ecological factors like acidity, temperature, type and amount of aquatic vegetation, nature of water (like lotic and lentic) etc. affects the distribution of nymphs of dragonflies. Dragonflies prefer heterogenous vegetation and can be regarded as reliable indicator of human disturbance of wetlands like construction of dams, human pressure etc. Damselflies are more sensitive than dragonflies because of their smaller body size and small home range.

Water scorpion are most commonly found predator in aquatic habitat which is dorsoventrally flattened with raptorial legs. They are sluggish which are most abundant in shallow littoral region of wetlands. They are recorded in degraded wetlands with high siltation pressure and associated with vegetation. Diving beetles are predacious beetles which feed on most of invertebrates, fish eggs fry etc. they prefer clean fresh near littoral zone with leaves of macrophytes. Water scavenger beetles are good swimmers and sometimes crawl on land too. They are herbivorous which generally feeds on detritus, decaying vegetation, algae and helps in nutrient cycling (Table 20).

TABLE 20. MACRO INVERTEBRATES OF RAMAROSHAN			
SN	COMMON NAME	SCIENTIFIC NAME	PHYLUM
1	Nymph of Dragon fly	Aeschnidae- Odonata	Arthropoda
2	Nymph of Damselfly	Libellulidae- Odonata	Arthropoda
3	Common Sergeant	*Athyma perius*	Arthropoda
4	Lime	*Papilio demoleus*	Arthropoda
5	Yellow orange tip	*Ixias pyrene*	Arthropoda
6	Indian Red Admiral	*Vaneaas indica*	Arthropoda
7	Chocolate pansy	*Junonia iphita*	Arthropoda
8	Ringed argus	*Callerebia annada*	Arthropoda
9	Pale grass blue	*Pseudozizeeria maha*	Arthropoda
10	Indian cabbage white	*Pieris canidia*	Arthropoda
11	Hill Jezabel	*Delias belladonna*	Arthropoda
12	Common bluebottle	*Graphium sarpedon*	Arthropoda
13	Plain Tiger	*Danaus chrysippus*	Arthropoda
14	Common map	*Cyrestis thyodamas*	Arthropoda

3.4.6.7 VEGETATION

Although Ramaroshan complex comprises area between 1000 to 3900 masl, we have assessed forest and grassland vegetation only between 2200-2700 masl. The area is the mosaics of forest, grasslands and lakes. The area has Oak forest where dominant species is *Quercus semcarpifolia* and other associated species are *Aesculus indica*, *Tsuga dumosa*, *Lindera pulcherrima*, *Symplocos ramosissima*, *Neolitsea pallens*, *Prunus cornuta*, *Rhododendron arboretum* etc. *Taxus wallichiana* a high value medicinal plant has notable population in the region. The species has been listed in IUCN red list as endangered species. The species has also been listed in CITES appendix III. A total of 169 species of plants are recorded during transect walk between 2200-2600 masl in Ramaroshan complex.

Figure 52. Aquatic plants of Ramaroshan lake complex A. *Rorippa nasturtium*-aquaticum: An aquatic plant B. *Potamogeton nodosus*: an submerged aquatic plant in Jingale lake C. *Ranunculus trichophyllus*: an aquatic plant in Batula lake D. Succession in wetlands, Rame Lake

Macrophytes

Ramaroshan wetlands have several aquatic and wetland dependent plant species. Altogether 30 species of macrophytes have been recorded from the wetland complex. There are floating, submerged and emergent wetland plants, where most of the plants were either emergent or submerged. *Scirpus compressus, Scirpus sinensis, Polygonum hydropier* are among the emergent plants growing near the shore and marshy areas. Ceratophyllum species and *potamogeton nutans* are the dominant submerged plants. *Nelumbo nucifera* was only one rooted floating macrophyte in the Ramaroshan complex. Submerged plants have larger share in fresh biomass which indicates that these groups of macrophytes have larger shares in primary productivity of the wetland.

Jingale and Batula lake are among the largest lake where there was clear vegetation zonation from shore to the lake interior. Our field assessments have revealed three types of vegetation zonation within these two lakes.

3.4.6.7 LAND USE AND LAND USE CHANGE

Local farmers have been using Ramroshan landscape has been used by local farmers since long time. Most of the settlements in the areas lie below the catchment of lakes and ponds. Nearest settlement is Dalyan, which is at one-hour distance from the major lakes. Jaant Lakela, Maithmandu, Dhane salla and Patlake are other nearby settlement. People from Rupsa village of kalikot district also used the forest at the boarder of Kalikot and Achham. Local people used the forest and pastures as summer

pastures. They used to herd buffalo, cows, sheep and goats in the areas. During winter season local herders used to bring the livestock down to the settlement. People also used to grow summer crops in the pastures. Potato was the most important and common crop grown in the pastures and forest gaps. It used to be grown up to 3000 m. Along with potato, wheat, maize and Taro (*Pidalu*) were also grown in the pastures but recently it has stopped with new development of protected forest process. Meadows are used to make summer farms by local farmers.

3.4.6.8 ECOSYSTEM SERVICES OF WETLANDS

Forest products: Presence of diverse ecosystem makes Ramaroshan landscape a rich in terms of ecosystem services and goods. Locally Forests are used for timber, firewood and fodder. Forest products such as fodder and leaf litter are integral part of agroforestry which go to farm through animals as organic manure. People collect and use several medicinal plants including *Panch Aaule, Jatamanshi, Bhutkesh and Kutki* from the area. Local People also use dried *Taxus* bark and leaves as tea.

Eco-tourism: Wetland, forests trails and pastures make Ramaroshan as an emerging attraction for ecotourism. Recently government of Nepal declared 100 new tourist destinations to promote tourism, Ramaroshan complex is one among them. Currently, more than 10,000 domestic tourists visited the area, of which most are from the Achham itself and neighboring districts. The Ramashoran rural municipality aims to promote tourism in the complex by advertising its biodiversity and landscape.

Cultural and aesthetic services: Ramaroshan lake complex has religious values. Pilgrims visiting Badimalika shrine – an important religious place in far western Nepal, passage along Ramaroshan lakes. It is customary that pilgrims take holy bath in the lakes while visiting Badimalika.

Water resource: Forested watershed and 12 wetlands are source of Kailash Khola. Kailash Khola and wetlands make the landscape rich in water sources. Kailash Khola is a perennial stream. It has been a source of water for irrigation and domestic uses (Fig 53B). Water from the lakes is used for drinking. Kailash Khola provides water for drinking and irrigation in the downstream. More than a half dozen micro hydropower has been established in the Kailash Khola. According to local people, along the Kailash Khola more than 50 Pani Ghatta (Fig. 53A) and water mills are in operations.

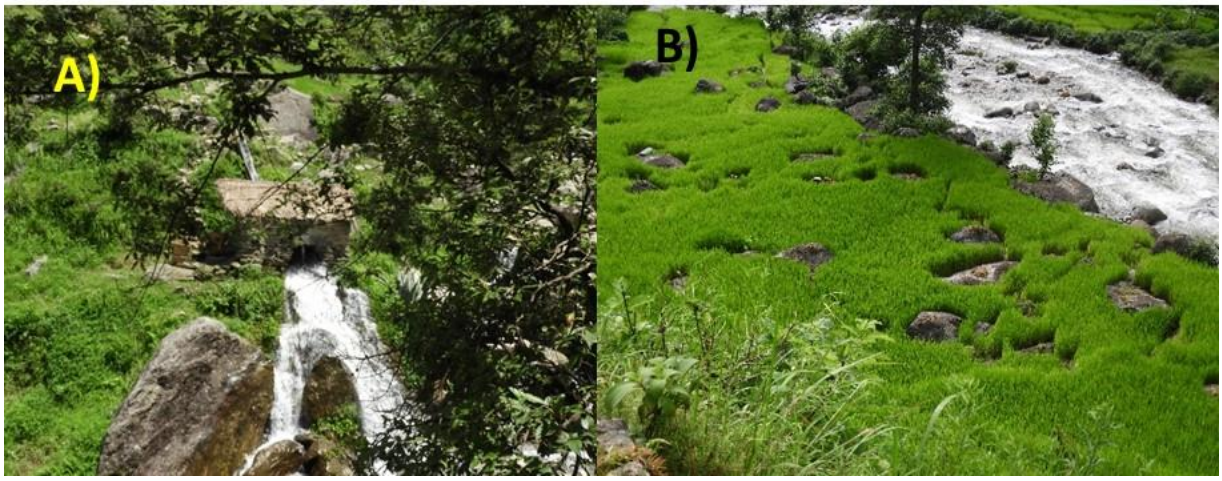

Figure 53. Uses of water resources A) Pani Ghatta B) Irrigated land by Kailash Khola

Fish and fishing cycle: Kailsah Khola and Ramaroshan lakes are known to provide home for Himalayan trout fish species, Asala. Local people catch fish and eat them dry and fresh. Asala fish is highly preferred due to its taste. During May to July, the local people used to capture fish from lakes and Kailash Khola. The community forest banded the fishing activities in the lake complex but the local people violet the rules and capture the fish. They catch fish using traditional gears such as Doko, Tiyari and Fishing stick (Fig. 54). They commonly made the temporarily dams in the rivers and streams and used Doko and nets to collect fish. The demand of the Asala fish has always been high in the local market and the travelers. They sell fish @ 400/kg in the local market.

Figure 54. A) Fishing activities used by Doko B) Fishing activities in Kailash river C) Interaction with fisher man D) Budhe Asala (*Schizothorax nepalensis*)

Ethnozoology of Frog and Fish: There is no mass harvesting of Anurans in Ramaroshan areas. Most of the people of that area are Chhetri who hardly eat frogs. The Magar community living the surrounding villages catch frog especially Kalo Paa (Nanorana) for food. Some people harvest frogs for its medicinal value. The locally called "Tame Bhyakuto" is mainly harvested for meat and its soup is used for the treatment of long fevers (Lamale). They generally collect frogs from Baishak to Shrawan. They generally collect frogs manually by hand picking. Usually male member of family collects frogs, but females are equally involved in collection.

Mostly non- poisonous and mild venomous snakes are found around Ramaroshan areas. But the people of that area believed that all the snakes are poisonous, and they used to kill when they saw the snakes. Before 2054 B.S., most of the people celebrated Nagpanchami as the festivals of snakes but after that they left their culture. But some old people even celebrate the Nagpanchami by pasting

the picture of snakes above the front door of their house. Some ethno medicinal importance of frogs and fish are as listed below:

1. Local Name: Garela fish
English Name: Striped loach
Scientific name: *Acanthocobitis botia* (Hamilton, 1822)
Parts used: Meat
Mode of Preparation: cooked and soup
Mode of administration: oral
Ailment category: Hermaphroditism, Sexual performance
IUCN Status: LC

2. Local Name: Asla
English Name: Asala
Scientific name: *Schizothorax richardsonii (Gray, 1832)*
Parts used: Meat
Mode of Preparation: cooked and soup
Mode of administration: oral
Ailment category: Fever, Weakness
IUCN Status: VU

3. Local Name: Mana Paa
English Name: Leibig's frog
Scientific name: *Nanorana liebigii* (Günther, 1860)
Parts used: Legs, Meat
Mode of Preparation: Dry, cooked and soup
Mode of administration: oral
Ailment category: Energy, stomach pain
IUCN Status: LC

4. Local Name: Pahelo pawa, sirke pawa
English Name: Tiger frog
Scientific name: *Hoplobatrachus tigerinus* (Daudin, 1802)
Parts used: Fat, Meat
Mode of Preparation: Oil, cooked meat
Mode of administration: Topical, cooked
Ailment category: Wounds, Energy, anemia
IUCN Status: LC

3.5 ECOSYSTEM SERVICES OF FROGS

3.5.1 DIET COMPOSITION OF FROG

We assessed diets of frogs captured during field sampling. Purpose of this analysis is to understand the insect species consumed by frogs. A total of 220 frogs were stomach flushed to extract stomach contents, of which 31 had empty stomachs and 20 completely digested food. Of the remaining 169 frogs of seven species that yielded stomach contents (Table 21). From these individuals, a total of 685 prey taxa from 13 major prey categories were extracted (Mean 4.1 ± SD 3.5, Range 1-21). Algae

and plants parts were excluded from dietary habit descriptions and comparisons. Overall, Hymenoptera was the most abundant order in the frog diet, comprising 35.8% of the total number of prey items, followed by Coleoptera (32.5%) (Table 21).

TABLE 21. PERCENTAGE OF PREY CONSUMED BY ANURAN FROGS IN RICE FIELDS OF WESTERN NEPAL

S.N	PREY CATEGORY	NO. OF PREY	NUMERIC PERCENTAGE
1	Hymenoptera	245	35.79
2	Coleoptera	222	32.41
3	Larva	42	6.13
4	Orthroptera	32	4.67
5	Diptera	28	4.09
6	Snail	28	4.09
7	Spider	23	3.36
8	Earthworm	21	3.07
9	Blattodea	20	2.92
10	Odonates	10	1.46
11	Crab	7	1.02
12	Lepidoptera	4	0.58
13	Anurophagy	3	0.42

One-way ANOVA showed that there was significant different between the number of preys consumed between the anuran species ($F = 10.7$, $P = <0.001$). Highest mean prey number was consumed by *D. melanostictus* (Fig. 55).

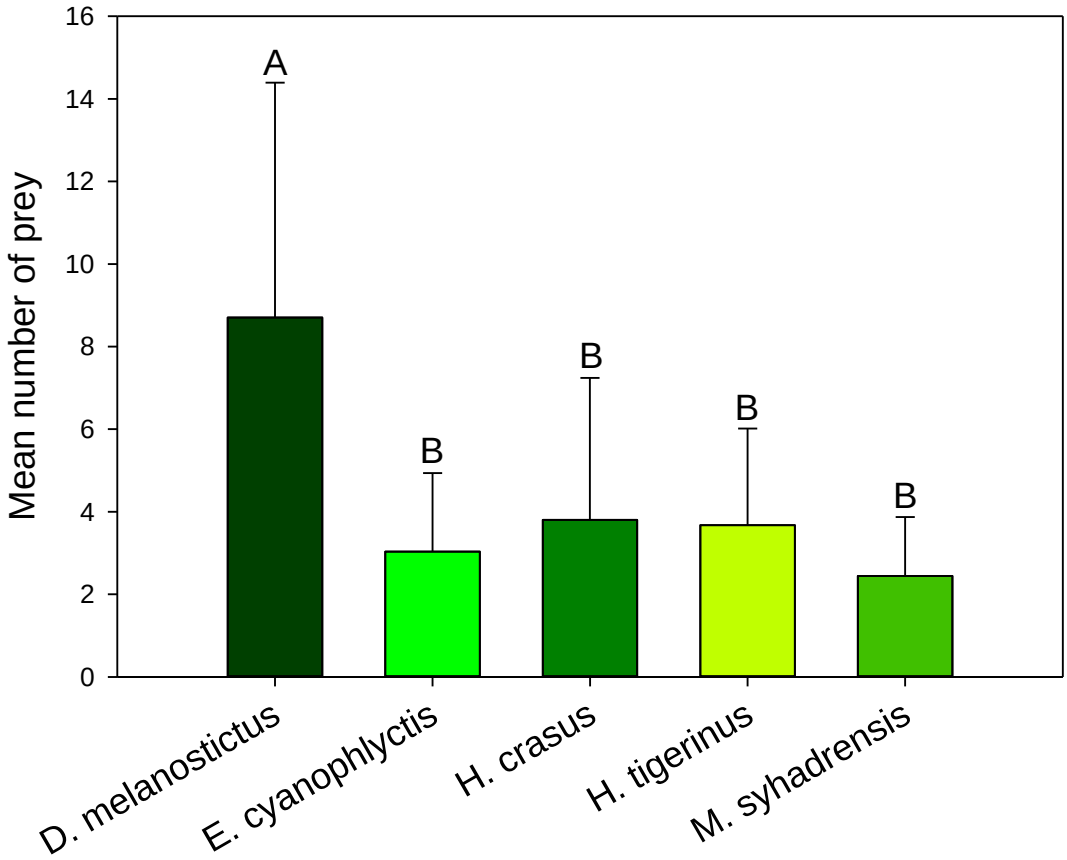

Figure 55. Mean (± SD) prey number consumed by anuran species. The difference in prey diversity difference between anuran species were calculated by One Way ANOVA. The letters are derived from pair-wise Turkey's test. Do not share same letters are significantly

3.5.1 CROP PEST AND HARMFUL INSECT CONSUMPTION BY FROG

Our results show that frogs in the rice fields consumed a significantly greater number of crop pests than non-pests (Mann-Whitney *U*-test = 55350.00, *P* = <0.001) (Fig. 57). All of the anuran species in the rice field consumed significantly higher number of crop pest (Fig. 56) and harmful insects (Mann-Whitney *U*-test = 1365.000, *P* = <0.001).

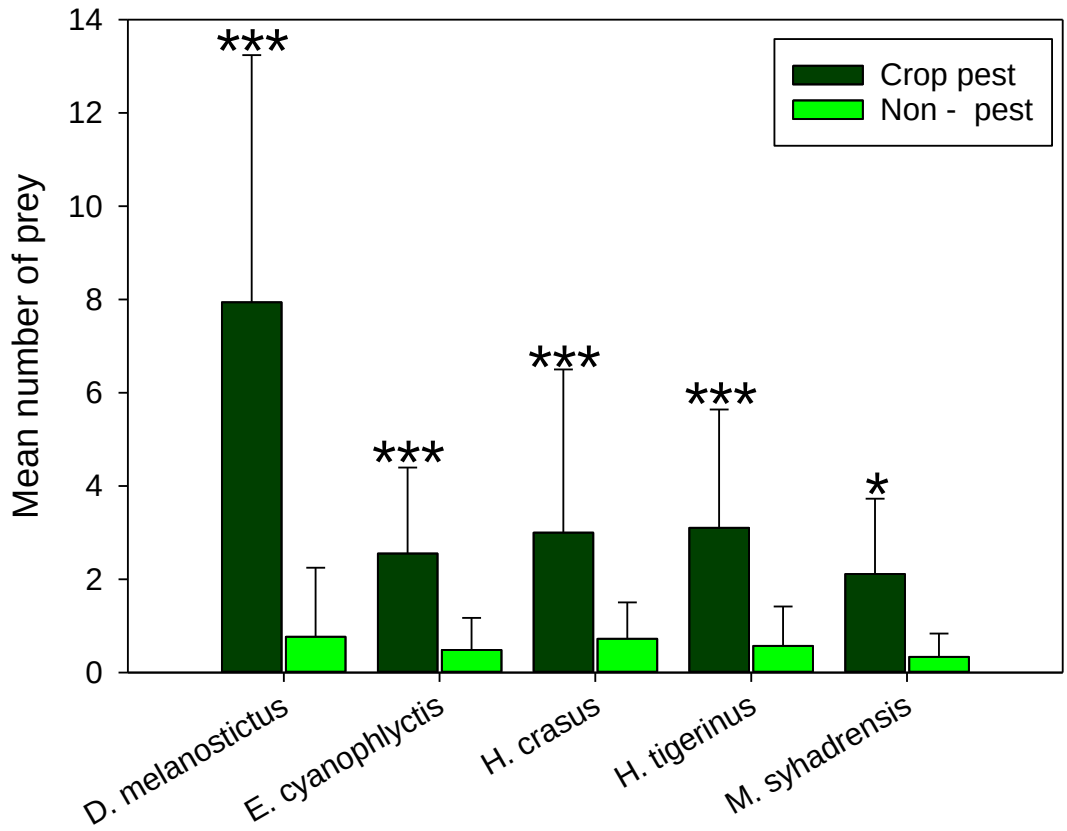

Figure 56. Mean (± SE) number of crop pests and non-pests consumed by the different frog species. The level of significance are from Mann-Whitney U-test (* = <0.05 and * = <0.001)**

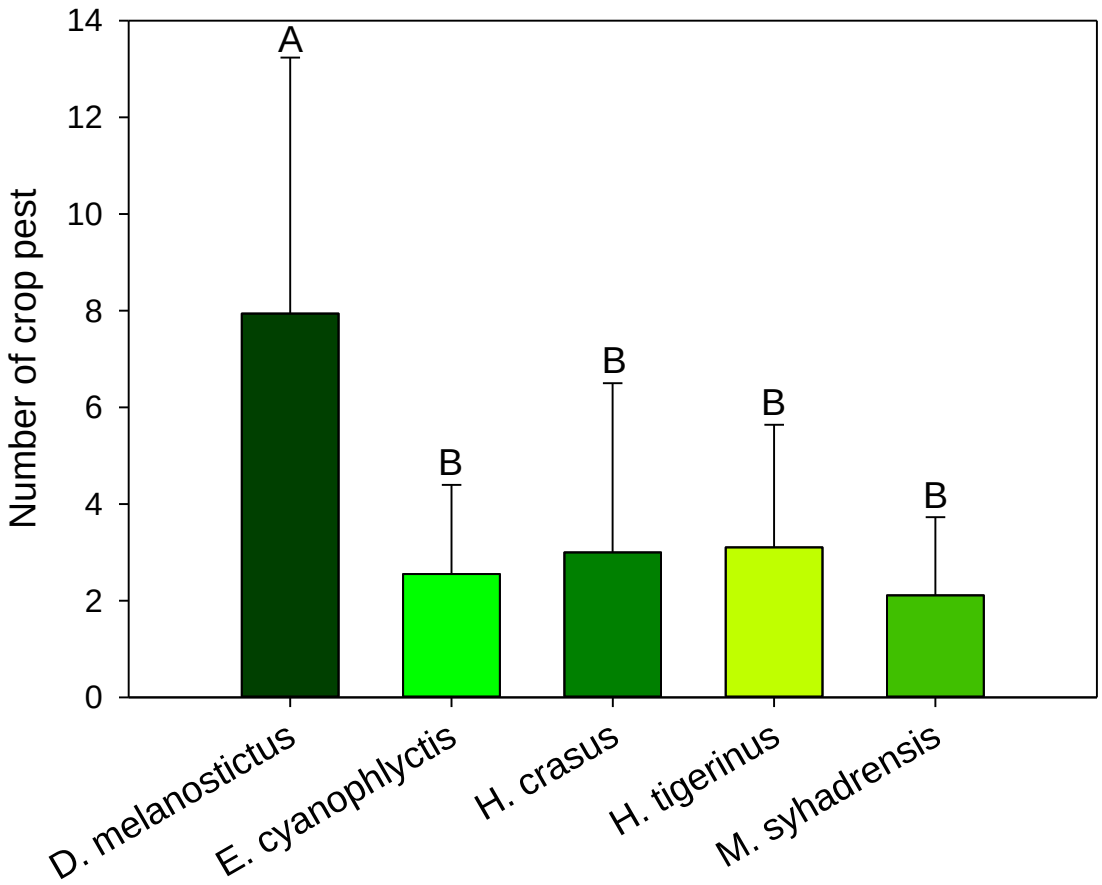

Figure 57. Mean (± SD) prey number of crop pest consumed by anuran species. The difference in crop pest consumption between anuran species were calculated by One Way ANOVA. The letters are derived from pair-wise Turkey's test. Do not share same letters are significant.

3.6. CULTURAL SERVICES OF HERPETOFAUNA

Herpetofauna i. e. amphibians and reptiles have important place in cultural and religious life of people in Nepal. Frogs, snakes, tortoise and lizards have different values and meanings in societies. Snakes, for examples are believed to absorb poison from the atmosphere and hence purify the air we breathe in. Specific examples of cultural services of herpetofauna are provided in this report.

3.6.1 NAG PANCHAMI

The Nag Panchami or festival of snakes is celebrated on the fifth day of the moonlit fortnight in the month of Shravan (July /August) according to the Hindu calendar. In Hindu culture, snakes are regarded as the important god and helper of the other gods. Hindu mythologies are filled with lakes and stories about snakes.

- According to Vishnu Puran, Lord Vishnu sleep on the bed of Sheshnag on the cosmic ocean.
- In Krishna Chalitra, Kalinag provided the shed and protected from rain to lord Krishna, when his father Basudev carried him to Gokul from Mathura to save from King Kangsa.

- Lord Shiva wears Nag or Snake as ornaments (Fig. 58).

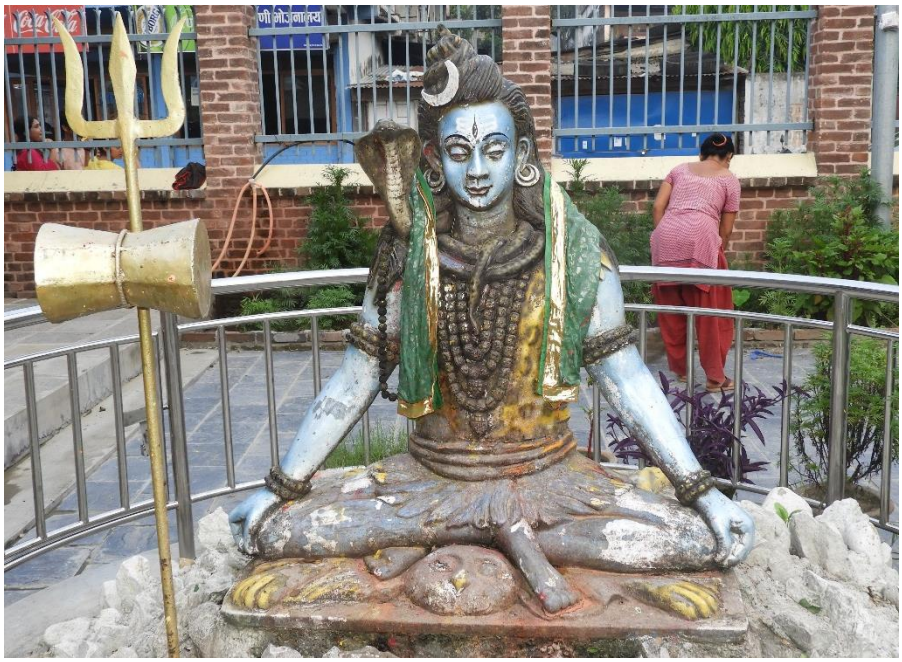

Figure 58. Statue of lord Shiva wearing the ornament of snake or Nag

It is quite understandable that Nepal with such mythological background celebrates Nag Panchami in honor of snakes every year. During the festival people bathe the snakes with milk ensuring their families freedom from danger of snakes. There are numerous legends related with Nag Panchami.

- One legend has it that a farmer accidentally killed some little serpents. The angry mother of the serpents took revenge by biting and killing the farmer and his family except one daughter who was offering prayers to the *Nags*. This act resulted in the revival of the farmer and his family. Ever since, Nag Panchami is celebrated in Nepal every year.

- According to Mahabharata, on the day of Shravan Panchami, Lord Krishna defeated Nag Kalia, a wicked serpent and put an end to his evil deeds. The same day is remembered and celebrated as Nag Panchami.

- Another legend says that Kathmandu Valley was a big lake once. When Manjushree exhausted the lake to make space for settlements, Nagas became angry. To protect themselves against the angers of nagas, people offered to worship the serpents on a certain date in their habitats.

The Hindu people in all parts of Nepal celebrate the festival of Nag Panchami by pasting the pictures of the Nag (Karkat Nag or Muga snake *Hemibungarus macclellandii*, Kaliya Nag or Raj goman *Ophiophagus Hannah*, Takshyaka Nag or Golden tree snake *Chrysopelea ornate* and others) or the serpent divinity, above the main entrance gate of their houses (Fig. 58 A and B). In the picture, the mantras mention eight principal nags, namely Ananta, Vashuki, Padhmanavha, Karkat, Shankhapala, Dhartarashtra, Takshyaka, and Kaliya. People also offer food items such as milk and honey in order to make Nag Dev happy and ensure good health and prosperity. When happy, snakes are believed to confer plenty of rain, which is good for crops but if the serpents become angry, people fall ill, and no

amount of medication can restore their health, so people worship and try to make the deity happy by offering cow's milk, lava, barley, sesame, nuts and other religious items.

Figure 59. A. Showing group of Kaliya Nag B. Showing evil of Krishna and Sheshnag and protect the Krishana from rain

3.6.2 MARRIAGE OF FROGS

In many cultures, amphibians are symbols of and connected to divine powers of fertility, regeneration and rebirth. Most of the people of Terai and mid-hill of Nepal arranged the wedding of two frogs (The male frog called Varun and female frog called Varsha). This is an age-old tradition that if frogs are wedded, then Indra Dev, the god of rain will be pleased, and monsoon will come. This marriage ceremony was performed on Saturday as the locals are believed that this marriage will bring rain since that day. To organize the wedding, two frogs - a male and a female - were brought from two different villages and marriage ceremony was performed as per Vedik or Hindu traditions in the presence of many guests and villagers. This marriage is very common in Jyapu (Newar) community.

3.6.3 CROAKING THE FROG INDICATE FORECASTING OF THE MONSOON

Frogs are generally considered as "Indra Dut" i.e., messenger of Lord Indra: The God of Rain. Male frogs produce croaking voice for the attraction of female for mating during their breeding seasons. Farmers believe that frogs announce the beginning of the monsoon rains and they safeguard village ponds and streams for human shrines. Toads are said to come out of their holes in great quantity before a rain. Hence, croaking the frog indicate the forecasting of the monsoon.

Likewise, in Newar communities in some places frogs are worshipped in the full moon day of Shrawn in the rice field. It is believed that frog helped to kill the devil called 'Ghantakarna'.

3.6.4 TURTLE: THE KURMA AWATAR

A number of themes are idolized in Hindu mythology and scriptures such as Vedas, Purans and the Bhagawad Geeta. According to Hindu mythology, the world is believed to rest on the backs of four

elephants who stand on the shell of a turtle. In Hinduism, Akupara is a turtle who carries the world on his back. Lord Vishnu is believed to have taken the form of a turtle, an incarnation known as Kurma awatar (Fig. 60), the second incarnation (Kurma means turtle, awatar means incarnation in Sankrit) to save the earth from destruction (Mahapralaya). As described in Hindu mythology, the upper shell of the turtle indicates the sky and the lower shell indicates the earth. The long lifespan of turtle symbolized the longevity of life.

Figure 60. Art of Kurma Awatar inside the temple of Harihar temple, Narayangard

3.6.5 MONITOR LIZARD

The skin of Monitor Lizard is used to make the musical instrument called "Khaijadu" which is played in religious occasion. It is believed that the instrument using the skin of Monitor Lizard gives good and pleasing music which makes god happy.

3.7 FOOD CHAIN

Wetlands are complex ecosystem consisting of components starting from producers to top consumers. Green grass and aquatic plants are the primary consumers which directly uptake the energy from Carbondioxide and water in the presence of sunlight. Many micro invertebrates (zooplanktons) and macro invertebrates (Arthropods and molluscs), herbivore fish, herbivore mammals such as deer, monkeys etc. depend upon the aquatic plants for their food, i.e. primary consumers. Frogs, insectivore birds, lizards, wetland birds (Asian open billed, kingfisher) directly depend upon the insects, molluscs and hervore fish for their food, hence called secondary consumers. Here, one species depends upon the many primary consumers hence, the food chain becomes complex. Wetland dependent birds such as storks, herons, carnivore mammals such as fishing cat, leopard, indian palm civet, raptors such as fishing eagle, black shoulder kite are directly depended on secondary and primary consumer for food hence called tertiary consumers. Vultures are the scavenger birds hence, use to uptake dead body of all type of large animals (e.g mammals) for their food, hence also listed in top consumers. The consumers have the opportunity of multi selection of the prey hence, the energy flow diagram show the complex interlocked patterns of food chain. The food web is prepared on the basis of flora and fauna recorded from Satti karnali Lake (Fig. 61).

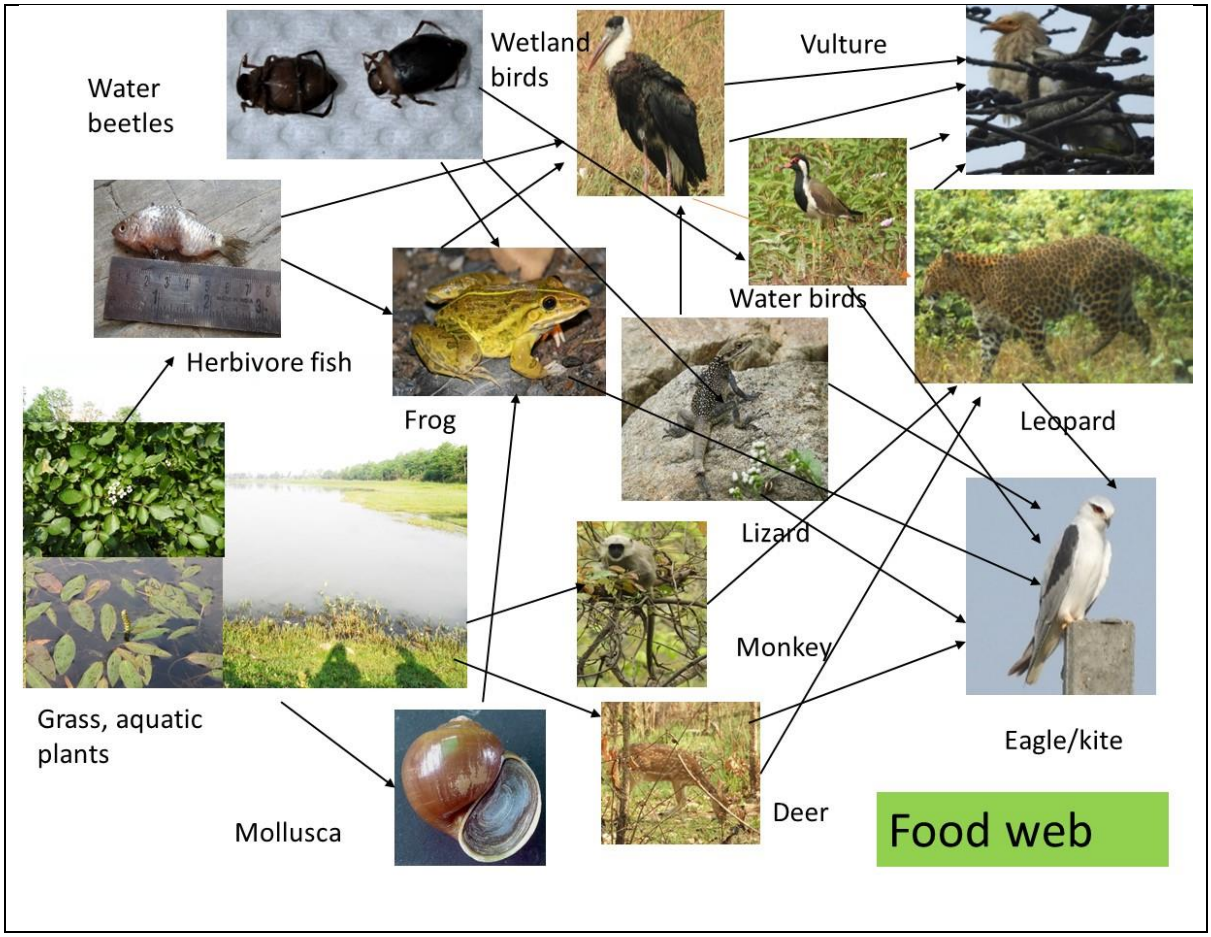

Figure 61. General food web of Lakes: A reference of Satti Karnali lake

Ecological pyramids of number

The ecological pyramid indicates the symbolic graphic representation of the interrelationship between the different trophic levels in an ecosystem (Fig. 62). This pyramid is constructed on the basis of the flora and fauna recorded in the lakes of Mahakali and Karnali River Basins.

Producers: Algae, blue green algae and green plants are producers in the wetland ecosystems. We have found Chara, Spirogyra and several macrophytes in wetlands. They range from seasonal to perennial. They are major producers converting carbon into plant biomass.

Consumers: The next level in the food chain is the consumers that consume the producers and they are categorized as *primary*, *secondary*, or *tertiary*.

i. Primary consumers: The primary consumers are the organisms that directly depend upon the producers for food. Herbivore fishes, tadpoles of frogs, water beetles, snails, slugs, water bugs, deer (Chilake, hog deer, swamp deer) recorded from studied lakes were the examples of primary consumers.

ii. Secondary consumers: Secondary consumers are the organisms that consume the primary consumers for food. The carnivore fishes, frogs, insectivore birds, piscivores birds such as storks, king fishers, egrets, mammals such as fishing cat, leopard, jungle cat etc. are the major secondary consumers that were recorded from studied lake systems.

iii. Tertiary consumers (top consumers): The animals which depend upon the primary and secondary consumers for food. Birds of prey, snakes (python), fishing cat etc. are the major examples of recorded animals as tertiary consumers.

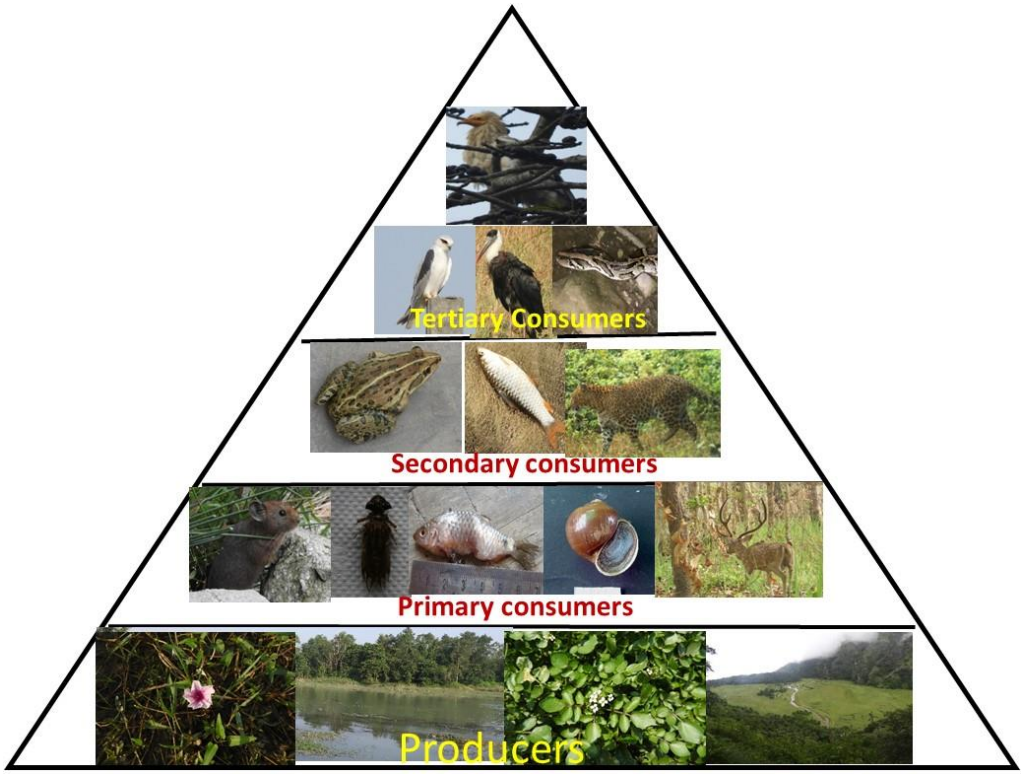

Figure 62. Ecological pyramid of number of lake ecosystem

4. DISCUSSION

4.1. BIODIVERSITY PATTERNS IN MAHAKALI AND KARNALI BASIN

This study assessed the diversity and conservation status of birds, mammals, amphibians, reptiles, fish, aquatic invertebrates (snails) and vascular plants in the four selected wetlands. The results show that Satti Karnali and Rani lake are excellent habitat for birds, mammals, herpetofauna and fish. Western lowland Nepal support more than 450 bird species, among them 13 species are globally threatened (Poudyal and Chaudhary 2019, Baral and Inskipp 2009). We recorded four globally vulnerable wetland birds: Lesser Adjutant (*Leptoptilos javanicus*), Great Slaty Woodpecker (*Mulleripicus pulverulentus*), Asian Woolly-necked (*Ciconia episcopus*), Red watelled Lapwing (*Vanellus indicus*) and four globally near threatened birds: Grey-headed Fish-eagle (*Icthyophaga ichthyaetus*), River Lapwing (*Vanellus duvaucelii*), Oriental Darter (*Anhinga melanogaster*), Painted Stork (*Mycteria leucocephala*). Rani lake is the largest lake in the Shuklaphanta National Park and supports many globally threatened bird species: Black Stork (*Ciconia nigra*), Black Bittern (*Dupetor flavicollis*), Yellow Bittern (*Ixobrychus sinensis*) and Striated Grassbird (*Megalurus palustris*). Based on survey results, Rani and Satti Karnali provides important wintering and breeding grounds for water birds and also serves as a stopover site for migrant species.

According to local people, tigers and leopard are occasional visitors in the Sati Karnali community forest. During the survey, we recorded the scat and pugmark of the common leopard. Based on the

signs, Smooth-coated otter and Fishing cat were recorded from the Satti Karnali area. Rani lake area supports the key globally threatened mammals, most of them are wetland dependent: Tiger (*Panthera tigris*), Hispid Hare (*Caprolagus hispidus*), Greater One-horned Rhinoceros (*Rhinoceros unicornis*), Asiatic Elephant *(Elephas maximus*) and Swamp deer (*Cervus duvaucelii*) (Henshaw 1994, Pradhan et al. 2008, Jnawali et al. 2011, Aryal et al. 2012, Flagstad et al. 2012). This lake act as the major waterhole for wildlife and is used by rhino and elephant for wallowing.

In comparison to Rani and Satti Karnali, Jhilmila and Ramaroshan lake had a lower diversity of birds and mammals. Jhilmila lake and its surrounding forest lies in the Churia range and has religious and cultural significance. Ramaroshan lake lies in the temperate zone and lower richness can be expected in comparison to lower elevational areas because species richness of birds and other vertebrate declines with increasing elevation in the Nepal Himalayas (Paudel and Šipoš 2014, Khatiwada et al. 2019).

Wetlands support diverse flora on which wetlands birds forage. We have recorded free floating to emergent species of macrophytes growing in different littoral zones of lakes/ponds. This study reported a new species of plants namely *Enhydra fluctuans* (Asteraceae Family).

4.2. THREATS TO FRESHWATER ECOSYSTEMS

Freshwater ecosystems are among the mostly heavily exploited ecosystems in the earth and have been facing serious threats from multiple sources. Anthropogenic activity is the major threat to freshwater ecosystem followed by climate induced actions and other natural processes. Fishing, grazing and conversion of wetlands for farming practices are the major threats to aquatic ecosystem in the survey wetlands except Rani lake. Further, introduction of invasive species (commercial fishes – in Jhilmila lake), use of fertilizer and pesticides further deteriorate the water health of wetlands (Budha 2010). Rani and Ramaroshan lakes are declining because of siltation and eutrophication. In the terai, a majority of ox-bow lakes have been facing the problem of siltation and ecological decline. For example, Ghodaghodi lake complex, Rani lake and Jhilmila lake are dominated by emergent and amphibious vegetation (Baral and Inskipp 2009, Budha 2010, Lamsal et al. 2014). Moreover, over-exploitation of aquatic biodiversity also imposed serious threat to aquatic biodiversity. Amphibians and reptiles have long been used by humans as food and medicine (Gonwouo and Rödel 2008, Khatiwada and Haugaasen 2015). Local people in the Ramroshan areas use Paha frogs (*Nanorana* and *Amolops* species) as food and medicines. Studies have shown that frogs are an important source of livelihood for many people (Khatiwada and Haugaasen 2015) and remain an integral part of local medicinal heritage (Mohneke et al. 2011). Particular species are collected in large scale and over-collecting may lead to local extinctions or severe population declines. *Quasipaa* frogs in China have become rare, some being even in danger of extinction, due to over-exploitation (Chan et al. 2014). As many amphibian species predictably aggregate for reproduction or hibernation, this makes them particularly vulnerable to intensive collecting efforts. Recent studies have indicated that commercial or subsistence harvesting has contributed to a decline in many reptile species (Webb et al. 2002). Khatiwada and Haugaasen (2015) revealed that *Paa* and *Amolops* are the most exploited frog species by the local people for food and medicinal purposes in mountainous parts of Nepal. This heavy exploitation may also lead to local or global declines and even extinctions through unsustainable collection (Warkentin et al. 2009). Monitoring of these species and collection activities is therefore a conservation priority in the study area and elsewhere in Nepal.

4.3. DIETARY HABIT OF FROGS AND THEIR ROLE AS A BIOLOGICAL PEST CONTROL AGENT

Most of anurans are considered as a generalist predator and possessed a large food spectrum. The large proportion of invertebrates' fauna in the diet signifying that large number of sympatric species co-exist in the given resource and space. We studied the dietary habit of five sympatric species in the rice fields and Ants and beetles are most frequently abundant insect prey. Clarke (1974) reported that ants and beetles play an important role in the anurans diet. High ant consumption by frog is usually explained the high abundance in hot and humid region. We found that ants and beetles were the most preferred food for Bufonidae frogs and also regarded as ant-specialist predators (Hirai and Matsui 2002, Khatiwada et al. 2016). Hymenopterans were the principal prey of Bufonidae frogs in this study and elsewhere (Strüssmann et al. 1984, Bonansea and Vaira 2007, Santana and Juncá 2007, Sabagh and Carvalho-e-Silva 2008, Duré et al. 2009, Quiroga et al. 2009, de Carvalho Batista et al. 2011). These species are also regarded as a peri-anthropic species, often found nearby human settlements and also tolerate some domestic pollution (Schleich and Kästle 2002). *E. cyanophlyctis* is also regarded as a peri-anthropic anuran found around small ditches, pond and puddles and the feeding habits showed great similarity with Bufoniade frogs. *H. tigerinus* and *H. crasus* are mostly aquatic and found in paddy field with water in all the times and diet is comprised of higher percentage of Coleoptera followed by Lepidoptera and Hemiptera. The high consumption those mentioned prey could probably due to the fact that this class of insect like wet environment with plenty of hiding places. *L. syhadrensis* and *L. teraiensis* showed similar dietary pattern. They were also aquatic and recorded from pady field filled with water. Moths and catterpiller were most preferred prey of these species.

Consumption of beetles and ants may reflect the greater availability of these insects in the rice fields but might also be strategy of anurans to avoid competition with other predators. This type of competition avoidance also noted by (Clarke 1974). Consumption of food is directly related to the energy uptake and avoidance competition (Vogel 2005).

This study recorded all the frog species feeding variety of invertebrates and vertebrate prey in the rice paddy fields; therefore; we predicted that there could exist a high dietary overlap between them. We expected that the dietary overlap could get reduced in rainy season because fallow land and grassland get flooded with rainwater increasing food resource and space. Although, our result revealed the high degree of dietary overlap between anuran species in both dry and rainy season. All the studied anuran frog species were mostly sympatric and showed high dietary overlap in the rice fields.

Our study also shows that frogs in the rice fields of lower Karnali and Mahakali River Basins consume more insects that were classified as pests than non-pests. Some of the notorious rice crop pests identified in dietary samples include grasshoppers, caterpillars, crickets, insect larvae, leaf hoppers, aphids, and mole crickets. This empirical study provides evidence that frogs are benefit to farmers in rice paddies. In addition, frogs also consumed insect that are regarded as a disease vector and are potentially harmful to human health, for example: mosquitoes, houseflies and sandflies. Therefore, frogs act as a natural disease vector controller. Available studies have shown that tadpoles are major predator of mosquito eggs and larvae and are considered as a biological controller of mosquito (Mokany and Shine 2003, Mokany 2007, Bowatte et al. 2013). Therefore, conservation frog population reduces the crop pest and disease vectors.

4.4. WETLAND MANAGEMENT POLICIES AND PRACTICES

Nepal is a party to several multilateral environmental agreements (MEAs) including Convention on Biological Diversity [CBD] (1992), Ramsar Convention on wetlands (1971), Bonn Convention on the Conservation of Migratory Species of Wild Animals [CMS](1979), and these MEAs are relevant to wetland and wetland biodiversity. CMS was introduced for effective International cooperation for protection of migratory species and habitats. Nepal has designated 10 wetland sites as Ramsar sites which cover 60,000 ha of land. Nepal has endorsed wetland policy 2012 and prepared National biodiversity strategy and action plan (2014-2020). Selected species are protected under National parks and wildlife protection Act 1973. Aquatic animal protection act (1961) has provisions for conservation of wetlands and aquatic biodiversity. It bans using poisons and explosives in wetlands and prevents destroying water systems.

Following the new constitution of Nepal 2015 and its provision of state restructuring, Nepal has divided the jurisdiction of Federal, Provincial and Local governments. There are shared and individual rights of three governments. Annex 5 has rights of Federal government. Management of Wetland, National parks and Wildlife reserves is responsibility of federal government. Water resource use and forest management within a province is responsibility of provincial governments. Watershed management is under local governments. New Local Governance Act 2018 has provided authorities and responsibilities for local scale environment conservation. Local governments are capable of formulating polices, developing plans and implementing programs for biodiversity, wildlife, watershed and environment conservation. They can also designate and manage environmental protection zone. Local governments are responsible for preservation of water sources (*Muhan*). Similarly, Local governments can make plan for protection of native and endemic species. Local governments develop and monitor small scale water use plans.

Despite these policy and legal arrangement there are several issues related to wetland management, some of the prominent ones observed during the field work and review are listed here:

- Wetland policy and other MEAs to which Nepal is party often stress need for sustainable utilization of wetlands. However, dominant practices often highlight only economic value of wetlands overlooking their ecological roles.

- Wetland policy of Nepal (2003) is a specific policy for wetland sector. It sets out strategies for sustainable and wise use of wetlands of Nepal. It even has strategies for restoring the degraded wetlands. However, no visible action has been taken in this regard. It has also planned for preventing wetland degradation.

- Wetlands within Community Forests (CFs) are within jurisdiction of CF. CF management plant and activities are centered on the forest management and wetland management has not been integrated in forest operational plans (Ops).

- National parks and wildlife conservation act (NPWC Act 1973) is an important legal document for habitats and wildlife management in Nepal. The act enlists 27 mammals and nine birds and three reptiles under protected status. However only a very few aquatic/wetland species (Gengetic Dolphin, Python and Gharial) are protected under this Act. Amphibian and fish are not under protected status despite of their threats and dwindling populations. On top, population status for specific species in lower vertebrates groups is not well studied.

- Cooperation between two or more local governments is important for wetland management. However, such cooperation is not well practiced, for example in case of Jhilmila lake. Lake is located in Kanchanpur district and part of watershed is in Dadeldhura district, there exists cattle grazing in Dadeldhura side. Lake management committee and CF in Kailali part could not stop grazing in the catchment.

- There has been some tension between local governments and CF user groups regarding jurisdiction. This tension may influence negatively in wetland management.

- Current management of wetlands often emphasize tourism in wetlands. However, there lacks mechanism or conservation education program on reducing tourism impacts on wetlands [we observed that a team was having picnic near the inlet of lake in Ramarosghan. Similarly, a visitor was cutting down sapling of taxus wallichaina].

5. CHALLENGES DURING FIELD SAMPLING

1. Sampling in wetlands is complicated process given the occurrence of both horizontal and vertical zonation of life. We need more sophisticated logistics to get more precise results.

2. Difficult to perform field study in holey lakes like Jhilmila. Entry inside the lake is strictly prohibited.

3. Sampling in the vegetation covered lake and lake undergoing slow siltation like Rani lake and lakes in Ramaroshan is very difficult. The areas of the lake become swampy due to heavy siltation and eutrophication. Its physically risky to sample.

4. Difficult to perform sampling inside the lake of Suklaphanta National park. Collection of fish, frogs, Mollusca and other plants are fully restricted. Not only this, frogs are nocturnal in nature; we have to collect the frogs in the night time. But there is no provision of the entry inside the national park after 5 PM.

4. Analyzing the interrelationship between macrophytes and macroinvertebrates is crucial for understanding aquatic biodiversity. However, it is not easy to get sample due to site specific problems.

5. Identifying insects collected from stomach flush is challenging due to taxonomic expertise and lack of reference slides.

6. CONCLUSION

This study of Rani Lake and Jhilmila Lake in the Mahakali River Basin and Satti karnali Lake and Ramaroshan Lake in the Karnali River Basin demonstrates that lakes are ecologically and economically important. These lakes play a vital role by providing breeding, feeding and shelter to many flora and fauna. Local people directly or indirectly depended on aquatic products such as snails, fish, edible plants etc. Satti Karnali lake, a newly formed lake, provides critical habitat for many flora and fauna. A total of 116 species of birds including 4 species of globally vulnerable and 4 nearly threated birds; 11 species of mammals including endangered mammal- Ganges River Dolphin (*Platanista gangetica gangetica*), three vulnerable (Smooth-coated Otter, Leopard and Fishing); seven species of amphibian; eight species of reptiles including Indiana Rock Python; 29 species of fish; five species of aquatic insects; 14 species of fresh water mollusks; 61 species of territorial plants; and, 37 species of wetland dependent plants were recorded. Ethnic and marginalized groups such as Badi and Tharu depended on the lake for collecting fish, mollusks and edible plants. Out of 14 freshwater mollusks reported from the study area about six species found in the area were used as food by Tharu and Badi communities. Not only this, the community forest (Satti Karnali) collected annual revenue exceeding more than Eight Million Nepalese rupees (USD 95,000) by rattan alone. Livestock grazing, buffalo wallowing and over exploitation of natural resources from the lake such as over fishing, electro fishing, over collection of snails were the major threats to aquatic ecosystem in Satti Karnali.

Rani Lake, which is located inside the Suklaphanta National Park, plays a vital role in maintaining wetland ecosystem inside the park. However, this lake is shrinking due to natural succession and eutrophication. The study found that this lake supports 131 species of birds; 10 species of mammals including one horned rhinoceros, hog deer and royal Bengal tiger; 10 species of amphibian; 10 species of reptiles; six species of fish; more than ten species of macro invertebrates; 77 species of flowering plants; and, 22 species of aquatic plants. Livestock grazing and collection of natural resources are strictly prohibited in this lake area.

Likewise, Jhilmila Lake is located in the Churiya region and is a religious site visited by pilgrims from India and Nepal. Bathing and collecting natural products from the lake is fully prohibited. This lake supports 104 species of birds; seven species of mammals; six species of amphibians; six species of reptiles; three species of fish; more than seven species of macro invertebrates; 105 species of flowering plants; and, 15 species of wetland dependent plants. Livestock grazing and siltation are the major threats to the lake.

The Ramaroshan Lake complex consists of a cluster of 12 lakes (two of them have dried up). The lake complex is the main feeder of the Kailash Lake which is a tributary of Karnali River. These high-altitude lakes are economically, culturally and ecologically important. During field study, a total of 11 species of mammals including Leopard (*Panthera pardus*), Red Panda (*Ailurus fulgens*), Asiatic Black Bear (*Ursus thibetanus*), Clouded Leopard (*Neofelis nebulosa*), Himalayan Ghoral (*Naemorhedus goral*) and endangered species; 79 species of birds including one globally Endangered bird (Egyptian Vulture *Neophron percnopterus), t*hree globally vulnerable birds (Asian Woolly necked *Ciconia episcopus* and Cheer Pheasant (*Catreus wallichii*) and one globally near threatened bird (Northern Lapwing (*Vanellus vanellus*); five species of reptiles; seven species of amphibians; three species of fish including Budhe Asala (*Schizothorax nepalensis*) and Tikhe Asala (*Schizothorax richardsonii*); 14 species of macro invertebrates; 169 species of plants including 30 species of wetland dependent plants were recorded.

A concerted management effort by stakeholders at all levels is necessary to ensure sustained ecosystem services from the wetlands. Wetland policies and management plans should address the

spatial and temporal dynamics of wetland degradation and appreciate rich biodiversity and complex ecological system while treating water bodies and wetlands as a resource unit.

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APPENDIX

TABLE S1. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN SATTI KARNALI
ABUNDANCE (%) REFERS TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE (%)
1	Accipitriformes	Accipitridae	Grey-headed Fish-eagle	*Icthyophaga ichthyaetus (Horsfield, 1821)*	8	0.47
2	Accipitriformes	Accipitridae	Crested Serpent-eagle	*Spilornis cheela (Latham, 1790)*	2	0.12
3	Accipitriformes	Accipitridae	Black kite	*Milvus migrans (Boddaert, 1783)*	9	0.53
4	Anseriformes	Anatidae	Common Teal	*Anas crecca Linnaeus, 1758*	5	0.29
5	Anseriformes	Anatidae	Common Pochard	*Aythya ferina (Linnaeus, 1758)*	12	0.71
6	Anseriformes	Anatidae	Lesser Whistling-duck	*Dendrocygna javanica (Horsfield, 1821)*	55	3.24
7	Anseriformes	Anatidae	Common Shelduck	*Tadorna tadorna (Linnaeus, 1758)*	12	0.71
8	Bucerotiformes	Upupidae	Common Hoopoe	*Upupa epops Linnaeus, 1758*	4	0.24
9	Bucerotiformes	Bucerotidae	Indian grey hornbill	*Ocyceros birostris (Scopoli, 1786)*	1	0.06
10	Caprimulgiformes	Apodidae	House swift	*Apus nipalensis (Hodgson, 1836)*	43	2.53
11	Charadriiformes	Charadriidae	Grey-headed Lapwing	*Vanellus cinereus (Blyth, 1842)*	2	0.12
12	Charadriiformes	Charadriidae	River Lapwing	*Vanellus duvaucelii (Lesson, 1826)*	11	0.65
13	Charadriiformes	Charadriidae	Yellow-wattled Lapwing	*Vanellus malabaricus (Boddaert, 1783)*	19	1.12
14	Charadriiformes	Jacanidae	Bronze-winged Jacana	*Metopidius indicus (Latham, 1790)*	8	0.47
15	Charadriiformes	Scolopacidae	Green Sandpiper	*Tringa ochropus Linnaeus, 1758*	9	0.53
16	Charadriiformes	Scolopacidae	Marsh Sandpiper	*Tringa stagnatilis (Bechstein, 1803)*	8	0.47
17	Charadriiformes	Charadriidae	Red watelled Lapwing	*Vanellus indicus (Boddaert, 1783)*	10	0.59

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18	Ciconiiformes	Ciconiidae	Lesser Adjutant	*Leptoptilos javanicus (Horsfield, 1821)*	2	0.12
19	Ciconiiformes	Ciconiidae	Asian Openbill	*Anastomus oscitans (Boddaert, 1783)*	28	1.65
20	Ciconiiformes	Ciconiidae	Asian Wollynecked	*Ciconia episcopus (Boddaert, 1783)*	9	0.53
21	Ciconiiformes	Ciconiidae	Painted Stork	*Mycteria leucocephala (Pennant, 1769)*	2	0.12
22	Columbiformes	Columbidae	Emerald Dove	*Chalcophaps indica (Linnaeus, 1758)*	17	1.00
23	Columbiformes	Columbidae	Oriental Turtle-dove	*Streptopelia orientalis (Latham, 1790)*	8	0.47
24	Columbiformes	Columbidae	Red Collared Dove	*Streptopelia tranquebarica (Hermann, 1804)*	9	0.53
25	Columbiformes	Columbidae	Eastern Spotted Dove	*Spilopelia chinensis (Scopoli, 1786)*	7	0.41
26	Columbiformes	Columbidae	Western Spotted Dove	*Spilopelia suratensis (Gmelin, 1789)*	5	0.29
27	Columbiformes	Columbidae	Spotted Dove	*Spilopelia suratensis (Gmelin, 1789)*	31	1.83
28	Coraciiformes	Alcedinidae	Common Kingfisher	*Alcedo atthis (Linnaeus, 1758)*	10	0.59
29	Coraciiformes	Coraciidae	Indian Roller	*Coracias benghalensis (Linnaeus, 1758)*	10	0.59
30	Coraciiformes	Meropidae	Chestnut-headed Bee-eater	*Merops leschenaulti Vieillot, 1817*	6	0.35
31	Coraciiformes	Meropidae	Blue-headed Bee-eater	*Merops muelleri (Cassin, 1857)*	30	1.77
32	Coraciiformes	Meropidae	Asian Green Bee-eater	*Merops orientalis Latham, 1802*	36	2.12
33	Coraciiformes	Alcedinidae	Piled Kingfisher	*Ceryle radis (Linnaeus, 1766)*	2	0.12
34	Coraciiformes	Alcedinidae	White breasted kingfisher	*Halcyon smyrnensis (Linnaeus, 1758)*	26	1.53
35	Coraciiformes	Meropidae	Green Bee-eater	*Merops orientalis Latham, 1802*	8	0.47

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ABUNDANCE (%) REFERS TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

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36	Coraciiformes	Meropidae	Blue-tailed Bee-eater	*Merops philippinus Linnaeus, 1766*	60	3.54
37	Cuculiformes	Cuculidae	Greater Coucal	*Centropus sinensis (Stephens, 1815)*	4	0.24
38	Cuculiformes	Cuculidae	Indian Cuckoo	*Cuculus micropterus Gould, 1837*	3	0.18
39	Cuculiformes	Cuculidae	Banded Bay Cuckoo	*Cacomantis sonneratii (Latham, 1790)*	4	0.24
40	Cuculiformes	Cuculidae	Lesser Coucal	*Centropus bengalensis (Gmelin, 1788)*	15	0.88
41	Cuculiformes	Cuculidae	Common Hawk-cuckoo	*Hierococcyx varius (Vahl, 1797)*	4	0.24
42	Galliformes	Phasianidae	Black Francolin	*Francolinus francolinus (Linnaeus, 1766)*	4	0.24
43	Galliformes	Phasianidae	Red Junglefowl	*Gallus gallus (Linnaeus, 1758)*	8	0.47
44	Galliformes	Phasianidae	Common Peafowl	*Pavo cristatus Linnaeus, 1758*	43	2.53
45	Gruiformes	Rallidae	White-breasted Waterhen	*Amaurornis phoenicurus (Pennant, 1769)*	3	0.18
46	Gruiformes	Rallidae	Common coot	*Fulica atra Linnaeus, 1758*	5	0.29
47	Gruiformes	Rallidae	Watercock	*Gallicrex cinerea (Gmelin, 1789)*	10	0.59
48	Passeriformes	Sturnidae	Jungle Myna	*Acridotheres fuscus (Wagler, 1827)*	31	1.83
49	Passeriformes	Nectariniidae	Little Spiderhunter	*Arachnothera longirostra (Latham, 1790)*	4	0.24
50	Passeriformes	Leiotrichidae	Common Babbler	*Argya caudata (Dumont, 1823)*	10	0.59
51	Passeriformes	Cisticolidae	Zitting Cisticola	*Cisticola juncidis (Rafinesque, 1810)*	8	0.47
52	Passeriformes	Muscicapidae	Oriental Magpie-robin	*Copsychus saularis (Linnaeus, 1758)*	21	1.24
53	Passeriformes	Dicruridae	Ashy Drongo	*Dicrurus leucophaeus Vieillot, 1817*	10	0.59

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ABUNDANCE (%) REFERS TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE (%)
54	Passeriformes	Dicruridae	Black Drongo	*Dicrurus macrocercus Vieillot, 1817*	32	1.89
55	Passeriformes	Dicruridae	Lesser Racquet-tailed Drongo	*Dicrurus remifer (Temminck, 1823)*	4	0.24
56	Passeriformes	Passeridae	Chestnut-shouldered Bush-sparrow	*Gymnoris xanthocollis (Burton, 1838)*	25	1.47
57	Passeriformes	Scotocercidae	Pale-footed Bush-warbler	*Hemitesia pallidipes (Blanford, 1872)*	4	0.24
58	Passeriformes	Hirundinidae	Barn Swallow	*Hirundo rustica Linnaeus, 1758*	46	2.71
59	Passeriformes	Pycnonotidae	Black Bulbul	*Hypsipetes leucocephalus (Gmelin, 1789)*	20	1.18
60	Passeriformes	Estrildidae	White-rumped Munia	*Lonchura striata (Linnaus, 1766)*	10	0.59
61	Passeriformes	Alaudidae	Rufous-winged Lark	*Mirafra assamica Horsfield, 1840*	27	1.59
62	Passeriformes	Campephagidae	Scarlet Minivet	*Pericrocotus flammeus (Forster, 1781)*	12	0.71
63	Passeriformes	Muscicapidae	Grey Bushchat	*Saxicola ferreus Gray, 1846*	4	0.24
64	Passeriformes	Muscicapidae	Common Stonechat	*Saxicola torquatus (Linnaeus, 1766)*	24	1.41
65	Passeriformes	Leiotrichidae	Jungle Babbler	*Turdoides striata (Dumont, 1823)*	26	1.53
66	Passeriformes	Corvidae	Red-billed Blue Magpie	*Urocissa erythroryncha (Boddaert, 1783)*	4	0.24
67	Passeriformes	Sturnidae	Common Myna	*Acridotheres tristis (Linnaeus, 1766)*	33	1.94
68	Passeriformes	Alaudidae	Sand Lark	*Alaudala raylake (Blyth, 1844)*	4	0.24
69	Passeriformes	Muscicapidae	Oriental Magpie Robin	*Copsychus saularis (Linnaeus, 1758)*	3	0.18
70	Passeriformes	Corvidae	Jungle Crow	*Corvus levaillantii Lesson, 1831*	12	0.71
71	Passeriformes	Corvidae	Large-billed Crow	*Corvus macrorhynchos Wagler, 1827*	5	0.29

TABLE S1. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN SATTI KARNALI
ABUNDANCE (%) REFERS TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE (%)
72	Passeriformes	Corvidae	House Crow	*Corvus splendens Vieillot, 1817*	37	2.18
73	Passeriformes	Corvidae	Rufous Treepie	*Dendrocitta vagabunda (Latham, 1790)*	9	0.53
74	Passeriformes	Dicruridae	Black Drongo	*Dicrurus macrocercus Vieillot, 1817*	3	0.18
75	Passeriformes	Dicruridae	Greater Racquet-tailed Drongo	*Dicrurus paradiseus (Linnaeus, 1766)*	8	0.47
76	Passeriformes	Leiotrichidae	Rufous-necked Laughingthrush	*Garrulax ruficollis (Jardine & Selby, 1838)*	21	1.24
77	Passeriformes	Sturnidae	Asian-pied Starling	*Gracupica contra (Linnaeus, 1758)*	8	0.47
78	Passeriformes	Hirundinidae	Wire-tailed Swallow	*Hirundo smithii Leach, 1818*	50	2.95
79	Passeriformes	Monarchidae	Black-naped Monarch	*Hypothymis azurea (Boddaert, 1783)*	10	0.59
80	Passeriformes	Laniidae	Grey-backed Shrike	*Lanius tephronotus (Vigors, 1831)*	3	0.18
81	Passeriformes	Motacillidae	White Wagtail	*Motacilla alba Linnaeus, 1758*	10	0.59
82	Passeriformes	Motacillidae	White-browed Wagtail	*Motacilla maderaspatensis Gmelin, 1789*	9	0.53
83	Passeriformes	Oriolidae	Black-hooded Oriole	*Oriolus xanthornus (Linnaeus, 1758)*	16	0.94
84	Passeriformes	Passeridae	House Sparrow	*Passer domesticus (Linnaeus, 1758)*	72	4.24
85	Passeriformes	Muscicapidae	White-winged Redstart	*Phoenicurus erythrogastrus (Güldenstädt, 1775)*	4	0.24
86	Passeriformes	Muscicapidae	White-capped Water-redstart	*Phoenicurus leucocephalus (Vigors, 1831)*	10	0.59
87	Passeriformes	Muscicapidae	White-capped Water-redstart	*Phoenicurus leucocephalus (Vigors, 1831)*	5	0.29
88	Passeriformes	Ploceidae	Baya Weaver	*Ploceus philippinus (Linnaeus, 1766)*	17	1.00
89	Passeriformes	Cisticolidae	Jungle Prinia	*Prinia sylvatica Jerdon, 1840*	5	0.29

TABLE S1. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN SATTI KARNALI
ABUNDANCE (%) REFERS TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE (%)
90	Passeriformes	Pycnonotidae	Red-vented Bulbul	*Pycnonotus cafer (Linnaeus, 1766)*	6	0.35
91	Passeriformes	Pycnonotidae	Red-whiskered Bulbul	*Pycnonotus jocosus (Linnaeus, 1758)*	34	2.00
92	Passeriformes	Muscicapidae	White-tailed Stonechat	*Saxicola leucurus (Blyth, 1847)*	8	0.47
93	Passeriformes	Muscicapidae	Indian Robin	*Saxicoloides fulicatus (Linnaeus, 1766)*	4	0.24
94	Passeriformes	Zosteropidae	Oriental White-eye	*Zosterops palpebrosus (Temminck, 1824)*	4	0.24
95	Pelecaniformes	Ardeidae	Grey Heron	*Ardea cinerea Linnaeus, 1758*	8	0.47
96	Pelecaniformes	Ardeidae	Intermediate Egret	*Ardea intermedia Wagler, 1829*	10	0.59
97	Pelecaniformes	Ardeidae	Cattle Egret	*Bubulcus ibis (Linnaeus, 1758)*	10	0.59
98	Pelecaniformes	Threskiornithidae	Red-naped Ibis	*Pseudibis papillosa (Temminck, 1824)*	5	0.29
99	Pelecaniformes	Ardeidae	Indian Pond Heron	*Ardeola grayii (Sykes, 1832)*	3	0.18
100	Pelecaniformes	Ardeidae	Cattle Egret	*Bubulcus ibis (Linnaeus, 1758)*	68	4.01
101	Pelecaniformes	Ardeidae	Little Egret	*Egretta garzetta (Linnaeus, 1766)*	13	0.77
102	Piciformes	Picidae	Pale-headed Woodpecker	*Gecinulus grantia (McClelland, 1840)*	14	0.82
103	Piciformes	Picidae	Yellow-crowned Woodpecker	*Leiopicus mahrattensis (Latham, 1801)*	10	0.59
104	Piciformes	Picidae	Great Slaty Woodpecker	*Mulleripicus pulverulentus (Temminck, 1826)*	2	0.12
105	Piciformes	Picidae	Grey-headed Woodpecker	*Dendropicos spodocephalus (Bonaparte, 1850)*	4	0.24
106	Piciformes	Picidae	Rufous Woodpecker	*Micropternus brachyurus (Vieillot, 1818)*	8	0.47
107	Piciformes	Picidae	Brown-capped Pygmy Woodpecker	*Picoides nanus (Vigors, 1832)*	28	1.65

TABLE S1. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN SATTI KARNALI
ABUNDANCE (%) REFERS TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE (%)
108	Piciformes	Megalaimidae	Coppersmith Barbet	*Psilopogon haemacephalus (Müller, 1776)*	10	0.59
109	Piciformes	Megalaimidae	Brown-headed Barbet	*Psilopogon zeylanicus (Gmelin, 1788)*	4	0.24
110	Psittaciformes	Psittacidae	Plum-headed Parakeet	*Psittacula cyanocephala (Linnaeus, 1766)*	19	1.12
111	Psittaciformes	Psittacidae	Red-breasted Parakeet	*Psittacula alexandri (Linnaeus, 1758)*	18	1.06
112	Psittaciformes	Psittacidae	Slaty-headed Parakeet	*Psittacula himalayana (Lesson, 1832)*	54	3.18
113	Psittaciformes	Psittacidae	Rose-ringed Parrakeet	*Psittacula krameri (Scopoli, 1769)*	24	1.41
114	Suliformes	Phalacrocoracidae	Great Cormorant	*Phalacrocorax carbo (Linnaeus, 1758)*	8	0.47
115	Suliformes	Anhingidae	Oriental Darter	*Anhinga melanogaster Pennant, 1769*	1	0.06
116	Suliformes	Phalacrocoracidae	Little Cormorant	*Microcarbo niger (Vieillot, 1817)*	17	1.00

TABLE S2. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN JHILMILA LAKE
ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
1	Accipitriformes	Accipitridae	Black kite	*Milvus migrans (Boddaert, 1783)*	6	0.64
2	Bucerotiformes	Bucerotidae	Great horned bill	*Buceros bicornis Linnaeus, 1758*	1	0.11
3	Bucerotiformes	Upupidae	Common Hoopoe	*Upupa epops Linnaeus, 1758*	4	0.43
4	Caprimulgiformes	Apodidae	House swift	*Apus nipalensis (Hodgson, 1836)*	28	3.00
5	Charadriiformes	Charadriidae	Grey-headed Lapwing	*Vanellus cinereus (Blyth, 1842)*	4	0.43

TABLE S2. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN JHILMILA LAKE
ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
6	Charadriiformes	Jacanidae	Bronze-winged Jacana	*Metopidius indicus (Latham, 1790)*	8	0.86
7	Columbiformes	Columbidae	Emerald Dove	*Chalcophaps indica (Linnaeus, 1758)*	8	0.86
8	Columbiformes	Columbidae	Oriental Turtle-dove	*Streptopelia orientalis (Latham, 1790)*	8	0.86
9	Columbiformes	Columbidae	Red Collared Dove	*Streptopelia tranquebarica (Hermann, 1804)*	4	0.43
10	Columbiformes	Columbidae	Western Spotted Dove	*Spilopelia suratensis (Gmelin, 1789)*	8	0.86
11	Coraciiformes	Alcedinidae	Common Kingfisher	*Alcedo atthis (Linnaeus, 1758)*	9	0.97
12	Coraciiformes	Coraciidae	Indian Roller	*Coracias benghalensis (Linnaeus, 1758)*	6	0.64
13	Coraciiformes	Meropidae	Chestnut-headed Bee-eater	*Merops leschenaulti Vieillot, 1817*	8	0.86
14	Coraciiformes	Meropidae	Blue-headed Bee-eater	*Merops muelleri (Cassin, 1857)*	22	2.36
15	Coraciiformes	Meropidae	Asian Green Bee-eater	*Merops orientalis Latham, 1802*	8	0.86
16	Coraciiformes	Alcedinidae	Stork billed kingfisher	*Pelargopsis capensis (Linnaeus, 1766)*	2	0.21
17	Coraciiformes	Alcedinidae	White breasted kingfisher	*Halcyon smyrnensis (Linnaeus, 1758)*	3	0.32
18	Cuculiformes	Cuculidae	Greater Coucal	*Centropus sinensis (Stephens, 1815)*	4	0.43
19	Cuculiformes	Cuculidae	Indian Cuckoo	*Cuculus micropterus Gould, 1837*	8	0.86
20	Cuculiformes	Cuculidae	Banded Bay Cuckoo	*Cacomantis sonneratii (Latham, 1790)*	2	0.21
21	Cuculiformes	Cuculidae	Lesser Coucal	*Centropus bengalensis (Gmelin, 1788)*	13	1.39
22	Cuculiformes	Cuculidae	Common Hawk-cuckoo	*Hierococcyx varius (Vahl, 1797)*	4	0.43
23	Galliformes	Phasianidae	Kalij Pheasant	*Lophura leucomelanos (Latham, 1790)*	2	0.21

TABLE S2. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN JHILMILA LAKE
ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
24	Galliformes	Phasianidae	Black Francolin	*Francolinus francolinus (Linnaeus, 1766)*	4	0.43
25	Galliformes	Phasianidae	Red Junglefowl	*Gallus gallus (Linnaeus, 1758)*	4	0.43
26	Galliformes	Phasianidae	Common Peafowl	*Pavo cristatus Linnaeus, 1758*	32	3.43
27	Passeriformes	Sturnidae	Jungle Myna	*Acridotheres fuscus (Wagler, 1827)*	10	1.07
28	Passeriformes	Nectariniidae	Little Spiderhunter	*Arachnothera longirostra (Latham, 1790)*	2	0.21
29	Passeriformes	Leiotrichidae	Common Babbler	*Argya caudata (Dumont, 1823)*	7	0.75
30	Passeriformes	Cisticolidae	Zitting Cisticola	*Cisticola juncidis (Rafinesque, 1810)*	4	0.43
31	Passeriformes	Muscicapidae	Oriental Magpie-robin	*Copsychus saularis (Linnaeus, 1758)*	9	0.97
32	Passeriformes	Dicruridae	Ashy Drongo	*Dicrurus leucophaeus Vieillot, 1817*	10	1.07
33	Passeriformes	Dicruridae	Black Drongo	*Dicrurus macrocercus Vieillot, 1817*	21	2.25
34	Passeriformes	Dicruridae	Lesser Racquet-tailed Drongo	*Dicrurus remifer (Temminck, 1823)*	4	0.43
35	Passeriformes	Passeridae	Chestnut-shouldered Bush-sparrow	*Gymnoris xanthocollis (Burton, 1838)*	16	1.72
36	Passeriformes	Scotocercidae	Pale-footed Bush-warbler	*Hemitesia pallidipes (Blanford, 1872)*	2	0.21
37	Passeriformes	Hirundinidae	Barn Swallow	*Hirundo rustica Linnaeus, 1758*	22	2.36
38	Passeriformes	Pycnonotidae	Black Bulbul	*Hypsipetes leucocephalus (Gmelin, 1789)*	18	1.93
39	Passeriformes	Estrildidae	White-rumped Munia	*Lonchura striata (Linnaus, 1766)*	6	0.64
40	Passeriformes	Alaudidae	Rufous-winged Lark	*Mirafra assamica Horsfield, 1840*	6	0.64

TABLE S2. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN JHILMILA LAKE
ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
41	Passeriformes	Campephagidae	Scarlet Minivet	*Pericrocotus flammeus (Forster, 1781)*	6	0.64
42	Passeriformes	Phylloscopidae	Yellow-vented Warbler	*Phylloscopus cantator (Tickell, 1833)*	4	0.43
43	Passeriformes	Pycnonotidae	Himalayan Bulbul	*Pycnonotus leucogenys (Gray, 1835)*	8	0.86
44	Passeriformes	Muscicapidae	Grey Bushchat	*Saxicola ferreus Gray, 1846*	4	0.43
45	Passeriformes	Muscicapidae	Common Stonechat	*Saxicola torquatus (Linnaeus, 1766)*	18	1.93
46	Passeriformes	Leiotrichidae	Jungle Babbler	*Turdoides striata (Dumont, 1823)*	34	3.65
47	Passeriformes	Corvidae	Red-billed Blue Magpie	*Urocissa erythroryncha (Boddaert, 1783)*	4	0.43
48	Passeriformes	Sturnidae	Common Myna	*Acridotheres tristis (Linnaeus, 1766)*	20	2.15
49	Passeriformes	Corvidae	Jungle Crow	*Corvus levaillantii Lesson, 1831*	21	2.25
50	Passeriformes	Corvidae	House Crow	*Corvus splendens Vieillot, 1817*	7	0.75
51	Passeriformes	Hirundinidae	Northern House Martin	*Delichon urbicum (Linnaeus, 1758)*	25	2.68
52	Passeriformes	Corvidae	Grey Treepie	*Dendrocitta formosae Swinhoe, 1863*	4	0.43
53	Passeriformes	Corvidae	Rufous Treepie	*Dendrocitta vagabunda (Latham, 1790)*	7	0.75
54	Passeriformes	Dicruridae	Greater Racquet-tailed Drongo	*Dicrurus paradiseus (Linnaeus, 1766)*	12	1.29
55	Passeriformes	Leiotrichidae	White-throated Laughingthrush	*Garrulax albogularis (Gould, 1836)*	9	0.97
56	Passeriformes	Leiotrichidae	Rufous-necked Laughingthrush	*Garrulax ruficollis (Jardine & Selby, 1838)*	20	2.15
57	Passeriformes	Turdidae	Orange-headed Thrush	*Geokichla citrina (Latham, 1790)*	12	1.29

TABLE S2. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN JHILMILA LAKE
ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
58	Passeriformes	Hirundinidae	Wire-tailed Swallow	*Hirundo smithii Leach, 1818*	20	2.15
59	Passeriformes	Monarchidae	Black-naped Monarch	*Hypothymis azurea (Boddaert, 1783)*	4	0.43
60	Passeriformes	Motacillidae	White Wagtail	*Motacilla alba Linnaeus, 1758*	5	0.54
61	Passeriformes	Motacillidae	White-browed Wagtail	*Motacilla maderaspatensis Gmelin, 1789*	4	0.43
62	Passeriformes	Muscicapidae	Small Niltava	*Niltava macgrigoriae (Burton, 1836)*	6	0.64
63	Passeriformes	Oriolidae	Indian Golden Oriole	*Oriolus kundoo Sykes, 1832*	10	1.07
64	Passeriformes	Oriolidae	Dark-throated Oriole	*Oriolus xanthonotus Horsfield, 1821*	8	0.86
65	Passeriformes	Oriolidae	Black-hooded Oriole	*Oriolus xanthornus (Linnaeus, 1758)*	8	0.86
66	Passeriformes	Paridae	Great Tit	*Parus major Linnaeus, 1758*	6	0.64
67	Passeriformes	Passeridae	House Sparrow	*Passer domesticus (Linnaeus, 1758)*	18	1.93
68	Passeriformes	Muscicapidae	White-winged Redstart	*Phoenicurus erythrogastrus (Güldenstädt, 1775)*	4	0.43
69	Passeriformes	Muscicapidae	White-capped Water-redstart	*Phoenicurus leucocephalus (Vigors, 1831)*	5	0.54
70	Passeriformes	Phylloscopidae	Dusky Warbler	*Phylloscopus fuscatus (Blyth, 1842)*	31	3.33
71	Passeriformes	Phylloscopidae	Grey-hooded Warbler	*Phylloscopus xanthoschistos (Gray, 1846)*	1	0.11
72	Passeriformes	Ploceidae	Baya Weaver	*Ploceus philippinus (Linnaeus, 1766)*	8	0.86
73	Passeriformes	Cisticolidae	Jungle Prinia	*Prinia sylvatica Jerdon, 1840*	5	0.54
74	Passeriformes	Pycnonotidae	Red-vented Bulbul	*Pycnonotus cafer (Linnaeus, 1766)*	12	1.29
75	Passeriformes	Pycnonotidae	Red-whiskered Bulbul	*Pycnonotus jocosus (Linnaeus, 1758)*	14	1.50

TABLE S2. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN JHILMILA LAKE
ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
76	Passeriformes	Muscicapidae	Pied Bushchat	*Saxicola caprata (Linnaeus, 1766)*	5	0.54
77	Passeriformes	Muscicapidae	White-tailed Stonechat	*Saxicola leucurus (Blyth, 1847)*	4	0.43
78	Passeriformes	Muscicapidae	Indian Robin	*Saxicoloides fulicatus (Linnaeus, 1766)*	4	0.43
79	Passeriformes	Sittidae	Chestnut-bellied Nuthatch	*Sitta cinnamoventris Blyth, 1842*	11	1.18
80	Passeriformes	Corvidae	Yellow-billed Blue Magpie	*Urocissa flavirostris (Blyth, 1846)*	6	0.64
81	Passeriformes	Zosteropidae	Oriental White-eye	*Zosterops palpebrosus (Temminck, 1824)*	4	0.43
82	Pelecaniformes	Ardeidae	Grey Heron	*Ardea cinerea Linnaeus, 1758*	11	1.18
83	Pelecaniformes	Ardeidae	Intermediate Egret	*Ardea intermedia Wagler, 1829*	8	0.86
84	Pelecaniformes	Ardeidae	Cattle Egret	*Bubulcus ibis (Linnaeus, 1758)*	4	0.43
85	Pelecaniformes	Ardeidae	Little Egret	*Egretta garzetta (Linnaeus, 1766)*	6	0.64
86	Piciformes	Picidae	Pale-headed Woodpecker	*Gecinulus grantia (McClelland, 1840)*	10	1.07
87	Piciformes	Picidae	Yellow-crowned Woodpecker	*Leiopicus mahrattensis (Latham, 1801)*	5	0.54
88	Piciformes	Picidae	Great Slaty Woodpecker	*Mulleripicus pulverulentus (Temminck, 1826)*	2	0.21
89	Piciformes	Picidae	Grey-capped Woodpecker	*Picoides canicapillus (Blyth, 1845)*	4	0.43
90	Piciformes	Picidae	Grey-headed Woodpecker	*Dendropicos spodocephalus (Bonaparte, 1850)*	8	0.86
91	Piciformes	Picidae	Rufous Woodpecker	*Micropternus brachyurus (Vieillot, 1818)*	12	1.29
92	Piciformes	Picidae	Great Slaty Woodpecker	*Mulleripicus pulverulentus (Temminck, 1826)*	1	0.11

TABLE S2. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN JHILMILA LAKE
ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
93	Piciformes	Picidae	Brown-capped Pygmy Woodpecker	*Picoides nanus (Vigors, 1832)*	10	1.07
94	Piciformes	Picidae	Lesser Yellownape	*Picus chlorolophus Vieillot, 1818*	6	0.64
95	Piciformes	Megalaimidae	Blue-throated Barbet	*Psilopogon asiaticus (Latham, 1790)*	7	0.75
96	Piciformes	Megalaimidae	Coppersmith Barbet	*Psilopogon haemacephalus (Müller, 1776)*	4	0.43
97	Piciformes	Megalaimidae	Great Barbet	*Psilopogon virens (Boddaert, 1783)*	4	0.43
98	Piciformes	Megalaimidae	Brown-headed Barbet	*Psilopogon zeylanicus (Gmelin, 1788)*	2	0.21
99	Psittaciformes	Psittacidae	Plum-headed Parakeet	*Psittacula cyanocephala (Linnaeus, 1766)*	15	1.61
100	Psittaciformes	Psittacidae	Red-breasted Parakeet	*Psittacula alexandri (Linnaeus, 1758)*	15	1.61
101	Psittaciformes	Psittacidae	Slaty-headed Parakeet	*Psittacula himalayana (Lesson, 1832)*	18	1.93
102	Psittaciformes	Psittacidae	Rose-ringed Parrakeet	*Psittacula krameri (Scopoli, 1769)*	10	1.07
103	Strigiformes	Strigidae	Jungle Owlet	*Glaucidium radiatum (Tickell, 1833)*	1	0.11
104	Suliformes	Phalacrocoracidae	Little Cormorant	*Microcarbo niger (Vieillot, 1817)*	4	0.43

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE.
ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
1	Accipitriformes	Accipitridae	Grey-headed Fish-eagle	*Icthyophaga ichthyaetus (Horsfield, 1821)*	3	0.17

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE. ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
2	Accipitriformes	Accipitridae	Crested Serpent-eagle	*Spilornis cheela (Latham, 1790)*	3	0.17
3	Accipitriformes	Accipitridae	Steppe Eagle	*Aquila nipalensis Hodgson, 1833*	2	0.12
4	Accipitriformes	Accipitridae	Lesser Fish-eagle	*Icthyophaga humilis (Müller & Schlegel, 1841)*	8	0.46
5	Accipitriformes	Accipitridae	Black kite	*Milvus migrans (Boddaert, 1783)*	9	0.52
6	Accipitriformes	Pandionidae	Osprey	*Pandion haliaetus (Linnaeus, 1758)*	4	0.23
7	Anseriformes	Anatidae	Common Teal	*Anas crecca Linnaeus, 1758*	4	0.23
8	Anseriformes	Anatidae	Mallard	*Anas platyrhynchos Linnaeus, 1758*	2	0.12
9	Anseriformes	Anatidae	Common Pochard	*Aythya ferina (Linnaeus, 1758)*	15	0.87
10	Anseriformes	Anatidae	Lesser Whistling-duck	*Dendrocygna javanica (Horsfield, 1821)*	10	0.58
11	Anseriformes	Anatidae	Common Shelduck	*Tadorna tadorna (Linnaeus, 1758)*	16	0.93
12	Anseriformes	Anatidae	Gadwall	*Mareca strepera (Linnaeus, 1758)*	4	0.23
13	Anseriformes	Anatidae	Ruddy Shelduck	*Tadorna ferruginea (Pallas, 1764)*	2	0.12
14	Anseriformes	Anatidae	Bar-headed Goose	*Anser indicus (Latham, 1790)*	5	0.29
15	Bucerotiformes	Upupidae	Common Hoopoe	*Upupa epops Linnaeus, 1758*	12	0.70
16	Bucerotiformes	Bucerotidae	Indian Grey Hornbill	*Ocyceros birostris (Scopoli, 1786)*	4	0.23
17	Caprimulgiformes	Apodidae	House swift	*Apus nipalensis (Hodgson, 1836)*	80	4.65
18	Charadriiformes	Charadriidae	Grey-headed Lapwing	*Vanellus cinereus (Blyth, 1842)*	8	0.46
19	Charadriiformes	Charadriidae	River Lapwing	*Vanellus duvaucelii (Lesson, 1826)*	7	0.41

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE. ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
20	Charadriiformes	Charadriidae	Yellow-wattled Lapwing	*Vanellus malabaricus (Boddaert, 1783)*	8	0.46
21	Charadriiformes	Scolopacidae	Common Sandpiper	*Actitis hypoleucos Linnaeus, 1758*	6	0.35
22	Charadriiformes	Jacanidae	Bronze-winged Jacana	*Metopidius indicus (Latham, 1790)*	24	1.39
23	Charadriiformes	Scolopacidae	Wood Sandpiper	*Tringa glareola Linnaeus, 1758*	2	0.12
24	Charadriiformes	Scolopacidae	Green Sandpiper	*Tringa ochropus Linnaeus, 1758*	17	0.99
25	Charadriiformes	Scolopacidae	Marsh Sandpiper	*Tringa stagnatilis (Bechstein, 1803)*	6	0.35
26	Charadriiformes	Charadriidae	Red-wattled Lapwing	*Vanellus indicus (Boddaert, 1783)*	9	0.52
27	Ciconiiformes	Ciconiidae	Black Stork	*Ciconia nigra (Linnaeus, 1758)*	4	0.23
28	Ciconiiformes	Ciconiidae	Asian Openbill	*Anastomus oscitans (Boddaert, 1783)*	17	0.99
29	Ciconiiformes	Ciconiidae	Woolly necked Stork	*Ciconia episcopus (Boddaert, 1783)*	4	0.23
30	Ciconiiformes	Ciconiidae	Painted Stork	*Mycteria leucocephala (Pennant, 1769)*	2	0.12
31	Columbiformes	Columbidae	Emerald Dove	*Chalcophaps indica (Linnaeus, 1758)*	16	0.93
32	Columbiformes	Columbidae	Rock pigeon	*Columba livia Gmelin, 1789*	8	0.46
33	Columbiformes	Columbidae	Eastern Spotted Dove	*Spilopelia chinensis (Scopoli, 1786)*	16	0.93
34	Columbiformes	Columbidae	Oriental Turtle-dove	*Streptopelia orientalis (Latham, 1790)*	8	0.46
35	Columbiformes	Columbidae	Red Collared Dove	*Streptopelia tranquebarica (Hermann, 1804)*	8	0.46
36	Columbiformes	Columbidae	Western Spotted Dove	*Spilopelia suratensis (Gmelin, 1789)*	13	0.76
37	Coraciiformes	Alcedinidae	Common Kingfisher	*Alcedo atthis (Linnaeus, 1758)*	10	0.58

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE. ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
38	Coraciiformes	Coraciidae	Indian Roller	*Coracias benghalensis (Linnaeus, 1758)*	10	0.58
39	Coraciiformes	Meropidae	Chestnut-headed Bee-eater	*Merops leschenaulti Vieillot, 1817*	8	0.46
40	Coraciiformes	Meropidae	Blue-headed Bee-eater	*Merops muelleri (Cassin, 1857)*	22	1.28
41	Coraciiformes	Meropidae	Asian Green Bee-eater	*Merops orientalis Latham, 1802*	27	1.57
42	Coraciiformes	Alcedinidae	Stork billed kingfisher	*Pelargopsis capensis (Linnaeus, 1766)*	2	0.12
43	Coraciiformes	Alcedinidae	Stork billed kingfisher	*Pelargopsis capensis (Linnaeus, 1766)*	1	0.06
44	Coraciiformes	Alcedinidae	White breasted kingfisher	*Halcyon smyrnensis (Linnaeus, 1758)*	16	0.93
45	Coraciiformes	Meropidae	Blue-tailed Bee-eater	*Merops philippinus Linnaeus, 1766*	73	4.24
46	Cuculiformes	Cuculidae	Greater Coucal	*Centropus sinensis (Stephens, 1815)*	4	0.23
47	Cuculiformes	Cuculidae	Indian Cuckoo	*Cuculus micropterus Gould, 1837*	6	0.35
48	Cuculiformes	Cuculidae	Western Koel	*Eudynamys scolopaceus (Linnaeus, 1758)*	4	0.23
49	Cuculiformes	Cuculidae	Banded Bay Cuckoo	*Cacomantis sonneratii (Latham, 1790)*	4	0.23
50	Cuculiformes	Cuculidae	Lesser Coucal	*Centropus bengalensis (Gmelin, 1788)*	15	0.87
51	Cuculiformes	Cuculidae	Common Hawk-cuckoo	*Hierococcyx varius (Vahl, 1797)*	4	0.23
52	Falconiformes	Falconidae	Red-necked Falcon	*Falco ruficollis Swainson, 1837*	4	0.23
53	Galliformes	Phasianidae	Common Quail	*Coturnix coturnix (Linnaeus, 1758)*	10	0.58
54	Galliformes	Phasianidae	Black Francolin	*Francolinus francolinus (Linnaeus, 1766)*	6	0.35
55	Galliformes	Phasianidae	Red Junglefowl	*Gallus gallus (Linnaeus, 1758)*	8	0.46

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE. ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
56	Galliformes	Phasianidae	Common Peafowl	*Pavo cristatus Linnaeus, 1758*	85	4.94
57	Gruiformes	Rallidae	White-breasted Waterhen	*Amaurornis phoenicurus (Pennant, 1769)*	3	0.17
58	Gruiformes	Rallidae	Common Coot	*Fulica atra Linnaeus, 1758*	10	0.58
59	Gruiformes	Rallidae	Watercock	*Gallicrex cinerea (Gmelin, 1789)*	13	0.76
60	Gruiformes	Rallidae	Ruddy-breasted Crake	*Zapornia fusca (Linnaeus, 1766)*	28	1.63
61	Passeriformes	Sturnidae	Jungle Myna	*Acridotheres fuscus (Wagler, 1827)*	23	1.34
62	Passeriformes	Nectariniidae	Little Spiderhunter	*Arachnothera longirostra (Latham, 1790)*	2	0.12
63	Passeriformes	Leiotrichidae	Common Babbler	*Argya caudata (Dumont, 1823)*	8	0.46
64	Passeriformes	Cisticolidae	Zitting Cisticola	*Cisticola juncidis (Rafinesque, 1810)*	7	0.41
65	Passeriformes	Muscicapidae	Oriental Magpie-robin	*Copsychus saularis (Linnaeus, 1758)*	27	1.57
66	Passeriformes	Dicruridae	Ashy Drongo	*Dicrurus leucophaeus Vieillot, 1817*	10	0.58
67	Passeriformes	Dicruridae	Black Drongo	*Dicrurus macrocercus Vieillot, 1817*	28	1.63
68	Passeriformes	Dicruridae	Lesser Racquet-tailed Drongo	*Dicrurus remifer (Temminck, 1823)*	4	0.23
69	Passeriformes	Passeridae	Chestnut-shouldered Bush-sparrow	*Gymnoris xanthocollis (Burton, 1838)*	26	1.51
70	Passeriformes	Scotocercidae	Pale-footed Bush-warbler	*Hemitesia pallidipes (Blanford, 1872)*	4	0.23
71	Passeriformes	Hirundinidae	Barn Swallow	*Hirundo rustica Linnaeus, 1758*	43	2.50
72	Passeriformes	Pycnonotidae	Black Bulbul	*Hypsipetes leucocephalus (Gmelin, 1789)*	21	1.22
73	Passeriformes	Estrildidae	White-rumped Munia	*Lonchura striata (Linnaus, 1766)*	10	0.58

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE. ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
74	Passeriformes	Alaudidae	Rufous-winged Lark	*Mirafra assamica Horsfield, 1840*	28	1.63
75	Passeriformes	Campephagidae	Scarlet Minivet	*Pericrocotus flammeus (Forster, 1781)*	13	0.76
76	Passeriformes	Muscicapidae	Grey Bushchat	*Saxicola ferreus Gray, 1846*	4	0.23
77	Passeriformes	Muscicapidae	Common Stonechat	*Saxicola torquatus (Linnaeus, 1766)*	27	1.57
78	Passeriformes	Leiotrichidae	Jungle Babbler	*Turdoides striata (Dumont, 1823)*	26	1.51
79	Passeriformes	Corvidae	Red-billed Blue Magpie	*Urocissa erythroryncha (Boddaert, 1783)*	4	0.23
80	Passeriformes	Sturnidae	Common Myna	*Acridotheres tristis (Linnaeus, 1766)*	29	1.69
81	Passeriformes	Alaudidae	Sand Lark	*Alaudala raylake (Blyth, 1844)*	2	0.12
82	Passeriformes	Corvidae	Jungle Crow	*Corvus levaillantii Lesson, 1831*	7	0.41
83	Passeriformes	Corvidae	Large-billed Crow	*Corvus macrorhynchos Wagler, 1827*	3	0.17
84	Passeriformes	Corvidae	House Crow	*Corvus splendens Vieillot, 1817*	24	1.39
85	Passeriformes	Corvidae	Grey Treepie	*Dendrocitta formosae Swinhoe, 1863*	4	0.23
86	Passeriformes	Corvidae	Rufous Treepie	*Dendrocitta vagabunda (Latham, 1790)*	7	0.41
87	Passeriformes	Dicruridae	Greater Racquet-tailed Drongo	*Dicrurus paradiseus (Linnaeus, 1766)*	6	0.35
88	Passeriformes	Leiotrichidae	Rufous-necked Laughingthrush	*Garrulax ruficollis (Jardine & Selby, 1838)*	22	1.28
89	Passeriformes	Hirundinidae	Wire-tailed Swallow	*Hirundo smithii Leach, 1818*	52	3.02
90	Passeriformes	Monarchidae	Black-naped Monarch	*Hypothymis azurea (Boddaert, 1783)*	10	0.58
91	Passeriformes	Laniidae	Long-tailed Shrike	*Lanius schach Linnaeus, 1758*	1	0.06

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE. ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
92	Passeriformes	Motacillidae	White-browed Wagtail	*Motacilla maderaspatensis Gmelin, 1789*	8	0.46
93	Passeriformes	Oriolidae	Black-hooded Oriole	*Oriolus xanthornus (Linnaeus, 1758)*	7	0.41
94	Passeriformes	Passeridae	House Sparrow	*Passer domesticus (Linnaeus, 1758)*	46	2.67
95	Passeriformes	Muscicapidae	White-winged Redstart	*Phoenicurus erythrogastrus (Güldenstädt, 1775)*	4	0.23
96	Passeriformes	Muscicapidae	White-capped Water-redstart	*Phoenicurus leucocephalus (Vigors, 1831)*	6	0.35
97	Passeriformes	Ploceidae	Baya Weaver	*Ploceus philippinus (Linnaeus, 1766)*	22	1.28
98	Passeriformes	Cisticolidae	Jungle Prinia	*Prinia sylvatica Jerdon, 1840*	9	0.52
99	Passeriformes	Pycnonotidae	Red-vented Bulbul	*Pycnonotus cafer (Linnaeus, 1766)*	12	0.70
100	Passeriformes	Pycnonotidae	Red-whiskered Bulbul	*Pycnonotus jocosus (Linnaeus, 1758)*	30	1.74
101	Passeriformes	Muscicapidae	White-tailed Stonechat	*Saxicola leucurus (Blyth, 1847)*	4	0.23
102	Passeriformes	Muscicapidae	Indian Robin	*Saxicoloides fulicatus (Linnaeus, 1766)*	4	0.23
103	Passeriformes	Leiotrichidae	Jungle Babbler	*Turdoides striata (Dumont, 1823)*	4	0.23
104	Passeriformes	Zosteropidae	Oriental White-eye	*Zosterops palpebrosus (Temminck, 1824)*	4	0.23
105	Pelecaniformes	Ardeidae	Grey Heron	*Ardea cinerea Linnaeus, 1758*	8	0.46
106	Pelecaniformes	Ardeidae	Intermediate Egret	*Ardea intermedia Wagler, 1829*	6	0.35
107	Pelecaniformes	Ardeidae	Indian Pond-heron	*Ardeola grayii (Sykes, 1832)*	10	0.58
108	Pelecaniformes	Ardeidae	Cattle Egret	*Bubulcus ibis (Linnaeus, 1758)*	9	0.52
109	Pelecaniformes	Threskiornithidae	Red-naped Ibis	*Pseudibis papillosa (Temminck, 1824)*	8	0.46

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE. ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
110	Pelecaniformes	Ardeidae	Great White Egret	*Ardea alba Linnaeus, 1758*	11	0.64
111	Pelecaniformes	Ardeidae	Purple Heron	*Ardea purpurea Linnaeus, 1766*	8	0.46
112	Pelecaniformes	Ardeidae	Indian Pond Heron	*Ardeola grayii (Sykes, 1832)*	20	1.16
113	Pelecaniformes	Ardeidae	Little Egret	*Egretta garzetta (Linnaeus, 1766)*	8	0.46
114	Piciformes	Picidae	Pale-headed Woodpecker	*Gecinulus grantia (McClelland, 1840)*	14	0.81
115	Piciformes	Picidae	Yellow-crowned Woodpecker	*Leiopicus mahrattensis (Latham, 1801)*	8	0.46
116	Piciformes	Picidae	Great Slaty Woodpecker	*Mulleripicus pulverulentus (Temminck, 1826)*	4	0.23
117	Piciformes	Picidae	Grey-headed Woodpecker	*Dendropicos spodocephalus (Bonaparte, 1850)*	7	0.41
118	Piciformes	Picidae	Rufous Woodpecker	*Micropternus brachyurus (Vieillot, 1818)*	7	0.41
119	Piciformes	Picidae	Brown-capped Pygmy Woodpecker	*Picoides nanus (Vigors, 1832)*	21	1.22
120	Piciformes	Picidae	Lesser Yellownape	*Picus chlorolophus Vieillot, 1818*	8	0.46
121	Piciformes	Megalaimidae	Coppersmith Barbet	*Psilopogon haemacephalus (Müller, 1776)*	9	0.52
122	Piciformes	Megalaimidae	Brown-headed Barbet	*Psilopogon zeylanicus (Gmelin, 1788)*	4	0.23
123	Psittaciformes	Psittacidae	Plum-headed Parakeet	*Psittacula cyanocephala (Linnaeus, 1766)*	39	2.27
124	Psittaciformes	Psittacidae	Red-breasted Parakeet	*Psittacula alexandri (Linnaeus, 1758)*	18	1.05
125	Psittaciformes	Psittacidae	Slaty-headed Parakeet	*Psittacula himalayana (Lesson, 1832)*	45	2.61
126	Psittaciformes	Psittacidae	Rose-ringed Parrakeet	*Psittacula krameri (Scopoli, 1769)*	22	1.28
127	Strigiformes	Strigidae	Spotted Owlet	*Athene brama (Temminck, 1821)*	2	0.12

TABLE S3. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RANI LAKE. ABUNDANCE (%) REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
128	Strigiformes	Strigidae	Jungle Owlet	*Glaucidium radiatum (Tickell, 1833)*	2	0.12
129	Suliformes	Phalacrocoracidae	Great Cormorant	*Phalacrocorax carbo (Linnaeus, 1758)*	10	0.58
130	Suliformes	Anhingidae	Oriental Darter	*Anhinga melanogaster Pennant, 1769*	2	0.12
131	Suliformes	Phalacrocoracidae	Little Cormorant	*Microcarbo niger (Vieillot, 1817)*	30	1.74

TABLE S4. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RAMAROSHAN LAKE COMPLEX. ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
1	Accipitriformes	Accipitridae	Egyptian Vulture	*Neophron percnopterus (Linnaeus, 1758)*	3	0.003
2	Anseriformes	Anatidae	Common Teal	*Anas crecca Linnaeus, 1758*	21	0.020
3	Anseriformes	Anatidae	Mallard	*Anas platyrhynchos Linnaeus, 1758*	29	0.028
4	Anseriformes	Anatidae	Eurasian Wigeon	*Mareca penelope (Linnaeus, 1758)*	10	0.010
5	Apodiformes	Apodidae	Pacific Swift	*Apus pacificus (Latham, 1802*	19	0.018
6	Apodiformes	Apodidae	Alpine Swift	*Tachymarptis melba (Linnaeus, 1758)*	8	0.008
7	Charadriiformes	Charadriidae	Northern Lapwing	*Vanellus vanellus (Linnaeus, 1758)*	7	0.007
8	Charadriiformes	Scolopacidae	Common Sandpiper	*Actitis hypoleucos Linnaeus, 1758*	16	0.015
9	Ciconiiformes	Ciconiidae	Asian Wolly necked	*Ciconia episcopus (Boddaert, 1783)*	3	0.003
10	Columbiformes	Columbidae	Speckled Wood Pigeon	*Columba hodgsonii Vigors, 1832*	17	0.016

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SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
11	Columbiformes	Columbidae	Eastern Spotted Dove	*Spilopelia chinensis (Scopoli, 1786)*	26	0.025
12	Columbiformes	Columbidae	Spotted Dove	*Spilopelia suratensis (Gmelin, 1789)*	14	0.014
13	Columbiformes	Columbidae	Oriental Turtle Dove	*Streptopelia orientalis (Latham, 1790)*	33	0.032
14	Cuculiformes	Cuculidae	Common Cuckoo	*Cuculus canorus Linnaeus, 1758*	22	0.021
15	Cuculiformes	Cuculidae	Indian Cuckoo	*Cuculus micropterus Gould, 1837*	10	0.010
16	Galliformes	Phasianidae	Cheer Pheasant	*Catreus wallichii (Hardwicke, 1827)*	1	0.001
17	Gruiformes	Rallidae	Common Coot	*Fulica atra Linnaeus, 1758*	22	0.021
18	Passeriformes	Sturnidae	Common Myna	*Acridotheres tristis (Linnaeus, 1766)*	13	0.013
19	Passeriformes	Hirundinidae	Nepal House Martin	*Delichon nipalense Horsfield & Moore, 1854*	10	0.010
20	Passeriformes	Muscicapidae	Spotted Forktail	*Enicurus maculatus Vigors, 1831*	3	0.003
21	Passeriformes	Muscicapidae	Verditer Flycatcher	*Eumyias thalassinus Swainson, 1838*	2	0.002
22	Passeriformes	Leiothrichidae	White- throated Laughing thrush	*Garrulax albogularis (Gould, 1836)*	10	0.010
23	Passeriformes	Laniidae	Long-tailed Shrike	*Lanius schach Linnaeus, 1758*	13	0.013
24	Passeriformes	Motacillidae	Grey Wagtail	*Motacilla cinerea Tunslakel, 1771*	7	0.007
25	Passeriformes	Muscicapidae	Plumbeous Water Redstart	*Phoenicurus fuliginosus (Vigors, 1831)*	5	0.005
26	Passeriformes	Muscicapidae	Black Redstart	*Phoenicurus ochruros (Gmelin, 1774)*	1	0.001
27	Passeriformes	Phylloscopidae	Grey-hooded Warbler	*Phylloscopus xanthoschistos (Gray, 1846)*	3	0.003
28	Passeriformes	Prunellidae	Brown Accentor	*Prunella fulvescens (Severtsov, 1873)*	7	0.007

TABLE S4. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RAMAROSHAN LAKE COMPLEX. ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
29	Passeriformes	Pycnonotidae	Black-crested Bulbul	*Pycnonotus flaviventris (Tickell, 1833)*	5	0.005
30	Passeriformes	Fringillidae	Red-headed Bullfinch	*Pyrrhula erythrocephala Vigors, 1832*	8	0.008
31	Passeriformes	Turdidae	Grey-winged Blackbird	*Turdus boulboul (Latham, 1790)*	2	0.002
32	Passeriformes	Sturnidae	Jungle Myna	*Acridotheres fuscus (Wagler, 1827)*	3	0.003
33	Passeriformes	Sturnidae	Common Myna	*Acridotheres tristis (Linnaeus, 1766)*	30	0.029
34	Passeriformes	Nectariniidae	Green-tailed Sunbird	*Aethopyga nipalensis (Hodgson, 1837)*	7	0.007
35	Passeriformes	Corvidae	Large-billed Crow	*Corvus macrorhynchos Wagler, 1827*	28	0.027
36	Passeriformes	Hirundinidae	Nepal House Martin	*Delichon nipalense Horsfield & Moore, 1854*	19	0.018
37	Passeriformes	Corvidae	Grey Treepie	*Dendrocitta formosae Swinhoe, 1863*	22	0.021
38	Passeriformes	Corvidae	Rufous Treepie	*Dendrocitta vagabunda (Latham, 1790)*	17	0.016
39	Passeriformes	Dicruridae	Ashy Drongo	*Dicrurus leucophaeus Vieillot, 1817*	5	0.005
40	Passeriformes	Dicruridae	Black Drongo	*Dicrurus macrocercus Vieillot, 1817*	5	0.005
41	Passeriformes	Muscicapidae	Spotted Forktail	*Enicurus maculatus Vigors, 1831*	6	0.006
42	Passeriformes	Muscicapidae	Verditer Flycatcher	*Eumyias thalassinus Swainson, 1838*	11	0.011
43	Passeriformes	Muscicapidae	Little Pied Flycatcher	*Ficedula westermanni (Sharpe, 1888)*	10	0.010
44	Passeriformes	Leiothrichidae	White- throated Laughing Thrush	*Garrulax albogularis (Gould, 1836)*	19	0.018
45	Passeriformes	Leiothrichidae	Striated Laughingthrush	*Grammatoptila striata (Vigors, 1831)*	26	0.025
46	Passeriformes	Leiothrichidae	Rufous Sibia	*Heterophasia capistrata (Vigors, 1831)*	31	0.030

TABLE S4. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RAMAROSHAN LAKE COMPLEX. ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
47	Passeriformes	Laniidae	Long-tailed Shrike	*Lanius schach Linnaeus, 1758*	5	0.005
48	Passeriformes	Motacillidae	Grey Wagtail	*Motacilla cinerea Tunslakel, 1771*	14	0.014
49	Passeriformes	Muscicapidae	Blue Whistling Thrush	*Myophonus caeruleus (Scopoli, 1786)*	19	0.018
50	Passeriformes	Oriolidae	Indian Golden Oriole	*Oriolus kundoo Sykes, 1832*	17	0.016
51	Passeriformes	Paridae	Green-backed Tit	*Parus monticolus Vigors, 1831*	27	0.026
52	Passeriformes	Passeridae	Russet Sparrow	*Passer cinnamomeus (Temminck, 1836)*	23	0.022
53	Passeriformes	Campephagidae	Long-tailed Minivet	*Pericrocotus ethologus*	16	0.015
54	Passeriformes	Muscicapidae	Plumbeous Water Redstart	*Pericrocotus ethologus Bangs & Phillips, 1914*	11	0.011
55	Passeriformes	Muscicapidae	Black Redstart	*Phoenicurus ochruros (Gmelin, 1774)*	9	0.009
56	Passeriformes	Phylloscopidae	Grey-hooded Warbler	*Phylloscopus xanthoschistos (Gray, 1846)*	20	0.019
57	Passeriformes	Prunellidae	Brown Accentor	*Prunella fulvescens (Severtsov, 1873)*	11	0.011
58	Passeriformes	Pycnonotidae	Red-vented Bulbul	*Pycnonotus cafer (Linnaeus, 1766)*	35	0.034
59	Passeriformes	Pycnonotidae	Black-crested Bulbul	*Pycnonotus flaviventris (Tickell, 1833)*	11	0.011
60	Passeriformes	Pycnonotidae	Himalayan Bulbul	*Pycnonotus leucogenys (Gray, 1835)*	43	0.042
61	Passeriformes	Fringillidae	Red-headed Bullfinch	*Pyrrhula erythrocephala Vigors, 1832*	9	0.009
62	Passeriformes	Muscicapidae	Pied Bushchat	*Saxicola caprata (Linnaeus, 1766)*	16	0.015
63	Passeriformes	Muscicapidae	Grey Bushchat	*Saxicola ferreus Gray, 1846*	17	0.016
64	Passeriformes	Sittidae	Velvet-fronted Nuthatch	*Sitta frontalis Swainson, 1820*	2	0.002

TABLE S4. BIRD SPECIES WITH THEIR NUMBER OF INDIVIDUALS OBSERVED IN RAMAROSHAN LAKE COMPLEX. ABUNDANCE (%) REFERS TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	ORDER	FAMILY	COMMON NAME	ZOOLOGICAL NAME	TOTAL ENCOUNTER	ABUNDANCE %
65	Passeriformes	Leiotrichidae	Jungle Babbler	*Turdoides striata (Dumont, 1823)*	1	0.001
66	Passeriformes	Turdidae	White-collared Blackbird	*Turdus albocinctus Royle, 1840*	8	0.008
67	Passeriformes	Turdidae	Grey-winged Blackbird	*Turdus boulboul (Latham, 1790)*	9	0.009
68	Passeriformes	Corvidae	Red-billed Blue Magpie	*Urocissa erythroryncha (Boddaert, 1783)*	26	0.025
69	Piciformes	Picidae	Himalayan Woodpecker	*Dendrocopos himalayensis (Jardine & Selby, 1835)*	2	0.002
70	Piciformes	Megalaimidae	Blue Throated Barbet	*Psilopogon asiaticus (Latham, 1790)*	2	0.002
71	Piciformes	Picidae	Himalayan Woodpecker	*Dendrocopos himalayensis (Jardine & Selby, 1835)*	7	0.007
72	Piciformes	Picidae	Rufous-bellied Woodpecker	*Dendrocopos hyperythrus (Vigors, 1831)*	8	0.008
73	Piciformes	Picidae	Grey-headed Woodpecker	*Dendropicos spodocephalus (Bonaparte, 1850)*	10	0.010
74	Piciformes	Picidae	Lesser Yellownpe	*Picus chlorolophus Vieillot, 1818*	2	0.002
75	Piciformes	Megalaimidae	Blue Throated Barbet	*Psilopogon asiaticus (Latham, 1790)*	12	0.012
76	Piciformes	Megalaimidae	Great Barbet	*Psilopogon virens (Boddaert, 1783)*	22	0.021
77	Podicipediformes	Podicipedidae	Little Grebe	*Tachybaptus ruficollis (Pallas, 1764)*	19	0.018
78	Psittaciformes	Psittacidae	Rose-ringed Parakeet	*Psittacula krameri (Scopoli, 1769)*	9	0.009
79	Psittaciformes	Psittacidae	Plum-headed Parakeet	*Psittacula cyanocephala (Linnaeus, 1766)*	4	0.004

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES

SN	COMMON NAME	*ZOOLOGICAL NAME*	ORDER	FAMILY	SATTI KARNALI	JHILMILLA	RANI	RAMAROSHAN	HABITAT TYPE
1	Alpine Swift	*Tachymarptis melba (Linnaeus, 1758)*	Apodiformes	Apodidae	0	0	0	√	Open area
2	Ashy Drongo	*Dicrurus leucophaeus Vieillot, 1817*	Passeriformes	Dicruridae	√	√	√	√	Shrub
3	Asian Green Bee-eater	*Merops orientalis Latham, 1802*	Coraciiformes	Meropidae	√	√	√	0	Open area
4	Asian Openbill	*Anastomus oscitans (Boddaert, 1783)*	Ciconiiformes	Ciconiidae	√	0	√	0	Wetland
5	Asian Wolly necked	*Ciconia episcopus (Boddaert, 1783)*	Ciconiiformes	Ciconiidae	√	0	√	√	Wetland
6	Asian-pied Starling	*Gracupica contra (Linnaeus, 1758)*	Passeriformes	Sturnidae	√	0	0	0	Open area
7	Banded Bay Cuckoo	*Cacomantis sonneratii (Latham, 1790)*	Cuculiformes	Cuculidae	√	√	√	0	Forest
8	Bar-headed Goose	*Anser indicus (Latham, 1790)*	Anseriformes	Anatidae	√	0	√	0	Wetland
9	Barn Swallow	*Hirundo rustica Linnaeus, 1758*	Passeriformes	Hirundinidae	√	√	√	√	Open area
10	Baya Weaver	*Ploceus philippinus (Linnaeus, 1766)*	Passeriformes	Ploceidae	√	√	√	0	Open area
11	Black Bulbul	*Hypsipetes leucocephalus (Gmelin, 1789)*	Passeriformes	Pycnonotidae	√	√	√	√	Forest
12	Black Drongo	*Dicrurus macrocercus Vieillot, 1817*	Passeriformes	Dicruridae	√	√	√	√	Forest
13	Black Francolin	*Francolinus francolinus (Linnaeus, 1766)*	Galliformes	Phasianidae	√	√	√	√	Wetland
14	Black kite	*Milvus migrans (Boddaert, 1783)*	Accipitriformes	Accipitridae	√	√	√	√	Forest

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	COMMON NAME	*ZOOLOGICAL NAME*	ORDER	FAMILY	SATTI KARNALI	JHILMILLA	RANI	RAMAROSHAN	HABITAT TYPE
15	Black Redstart	*Phoenicurus ochruros (Gmelin, 1774)*	Passeriformes	Muscicapidae	0	0	√	√	Wetland
16	Black Stork	*Ciconia nigra (Linnaeus, 1758)*	Ciconiiformes	Ciconiidae	√	0	√	0	Wetland
17	Black-crested Bulbul	*Pycnonotus flaviventris (Tickell, 1833)*	Passeriformes	Pycnonotidae	0	0	0	√	Forest
18	Black-hooded Oriole	*Oriolus xanthornus (Linnaeus, 1758)*	Passeriformes	Oriolidae	√	√	√	√	Open area
19	Black-naped Monarch	*Hypothymis azurea (Boddaert, 1783)*	Passeriformes	Monarchidae	√	√	√	0	Forest
20	Blue Throated Barbet	*Psilopogon asiaticus (Latham, 1790)*	Piciformes	Megalaimidae	0	0	0	√	Forest
21	Blue Whistling Thrush	*Myophonus caeruleus (Scopoli, 1786)*	Passeriformes	Muscicapidae	0	0	0	√	Forest
22	Blue-headed Bee-eater	*Merops muelleri (Cassin, 1857)*	Coraciiformes	Meropidae	√	√	√	√	Open area
23	Blue-throated Barbet	*Psilopogon asiaticus (Latham, 1790)*	Piciformes	Megalaimidae	0	√	√	0	Forest
24	Bronze-winged Jacana	*Metopidius indicus (Latham, 1790)*	Charadriiformes	Jacanidae	√	√	√	0	Wetland
25	Brown Accentor	*Prunella fulvescens (Severtsov, 1873)*	Passeriformes	Prunellidae	0	0	√	√	Open area
26	Brown-capped Pygmy Woodpecker	*Picoides nanus (Vigors, 1832)*	Piciformes	Picidae	√	√	√	0	Forest
27	Brown-headed Barbet	*Psilopogon zeylanicus (Gmelin, 1788)*	Piciformes	Megalaimidae	√	√	√	0	Forest
28	Cattle Egret	*Bubulcus ibis (Linnaeus, 1758)*	Pelecaniformes	Ardeidae	√	√	√	√	Wetland

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	**COMMON NAME**	***ZOOLOGICAL NAME***	**ORDER**	**FAMILY**	**SATTI KARNALI**	**JHILMILLA**	**RANI**	**RAMAROSHAN**	**HABITAT TYPE**
29	Cheer Pheasant	*Catreus wallichii (Hardwicke, 1827)*	Galliformes	Phasianidae	0	0	0	√	Forest
30	Chestnut-bellied Nuthatch	*Sitta cinnamoventris Blyth, 1842*	Passeriformes	Sittidae	0	√	0	0	Open area
31	Chestnut-headed Bee-eater	*Merops leschenaulti Vieillot, 1817*	Coraciiformes	Meropidae	√	√	√	0	Open area
32	Chestnut-shouldered Bush-sparrow	*Gymnoris xanthocollis (Burton, 1838)*	Passeriformes	Passeridae	√	√	√	0	Shrub
33	Common Babbler	*Argya caudata (Dumont, 1823)*	Passeriformes	Leiotrichidae	√	√	√	√	Forest
34	Common coot	*Fulica atra Linnaeus, 1758*	Gruiformes	Rallidae	√	0	√	√	Wetland
35	Common Cuckoo	*Cuculus canorus Linnaeus, 1758*	Cuculiformes	Cuculidae	√	0	√	√	Forest
36	Common Hawk-cuckoo	*Hierococcyx varius (Vahl, 1797)*	Cuculiformes	Cuculidae	√	√	√	0	Forest
37	Common Hoopoe	*Upupa epops Linnaeus, 1758*	Bucerotiformes	Upupidae	√	√	√	0	Open area
38	Common Kingfisher	*Alcedo atthis (Linnaeus, 1758)*	Coraciiformes	Alcedinidae	√	√	√	0	Wetland
39	Common Myna	*Acridotheres tristis (Linnaeus, 1766)*	Passeriformes	Sturnidae	√	√	√	√	Open area
40	Common Peafowl	*Pavo cristatus Linnaeus, 1758*	Galliformes	Phasianidae	√	√	√	0	Forest
41	Common Pochard	*Aythya ferina (Linnaeus, 1758)*	Anseriformes	Anatidae	√	0	√	0	Wetland
42	Common Quail	*Coturnix coturnix (Linnaeus, 1758)*	Galliformes	Phasianidae	√	0	√	0	Forest
43	Common Sandpiper	*Actitis hypoleucos Linnaeus, 1758*	Charadriiformes	Scolopacidae	√	0	√	0	Wetland

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	**COMMON NAME**	***ZOOLOGICAL NAME***	**ORDER**	**FAMILY**	**SATTI KARNALI**	**JHILMILLA**	**RANI**	**RAMAROSHAN**	**HABITAT TYPE**
44	Common Shelduck	*Tadorna tadorna (Linnaeus, 1758)*	Anseriformes	Anatidae	√	0	√	0	Wetland
45	Common Stonechat	*Saxicola torquatus (Linnaeus, 1766)*	Passeriformes	Muscicapidae	√	√	√	0	Shrub
46	Common Teal	*Anas crecca Linnaeus, 1758*	Anseriformes	Anatidae	√	0	√	√	Wetland
47	Coppersmith Barbet	*Psilopogon haemacephalus (Müller, 1776)*	Piciformes	Megalaimidae	√	√	√	0	Forest
48	Crested Serpent-eagle	*Spilornis cheela (Latham, 1790)*	Accipitriformes	Accipitridae	√	0	√	0	Forest
49	Dark-throated Oriole	*Oriolus xanthonotus Horsfield, 1821*	Passeriformes	Oriolidae	0	√	0	√	Forest
50	Dusky Warbler	*Phylloscopus fuscatus (Blyth, 1842)*	Passeriformes	Phylloscopidae	0	√	0	0	Shrub
51	Eastern Spotted Dove	*Spilopelia chinensis (Scopoli, 1786)*	Columbiformes	Columbidae	√	0	√	√	Open area
52	Egyptian Vulture	*Neophron percnopterus (Linnaeus, 1758)*	Accipitriformes	Accipitridae	0	0	0	√	Forest
53	Emerald Dove	*Chalcophaps indica (Linnaeus, 1758)*	Columbiformes	Columbidae	√	√	0	√	Forest
54	Eurasian pigeon	*Mareca penelope (Linnaeus, 1758)*	Anseriformes	Anatidae	0	0	0	√	Forest
55	Gadwall	*Mareca strepera (Linnaeus, 1758)*	Anseriformes	Anatidae	0	0	√	0	Wetland
56	Great Barbet	*Psilopogon virens (Boddaert, 1783)*	Piciformes	Megalaimidae	0	√	0	√	Forest

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	**COMMON NAME**	***ZOOLOGICAL NAME***	**ORDER**	**FAMILY**	**SATTI KARNALI**	**JHILMILLA**	**RANI**	**RAMAROSHAN**	**HABITAT TYPE**
57	Great Cormorant	*Phalacrocorax carbo (Linnaeus, 1758)*	Suliformes	Phalacrocoracidae	√	0	√	0	Wetland
58	Great horned bill	*Buceros bicornis Linnaeus, 1758*	Bucerotiformes	Bucerotidae	0	√	0	0	Forest
59	Great Slaty Woodpecker	*Mulleripicus pulverulentus (Temminck, 1826)*	Piciformes	Picidae	√	√	√	0	Forest
60	Great Tit	*Parus major Linnaeus, 1758*	Passeriformes	Paridae	0	√	0	0	Shrub
61	Great White Egret	*Ardea alba Linnaeus, 1758*	Pelecaniformes	Ardeidae	0	0	√	0	Wetland
62	Greater Coucal	*Centropus sinensis (Stephens, 1815)*	Cuculiformes	Cuculidae	√	√	√	0	Forest
63	Greater Racquet-tailed Drongo	*Dicrurus paradiseus (Linnaeus, 1766)*	Passeriformes	Dicruridae	√	√	√	0	Forest
64	Green Bee-eater	*Merops orientalis Latham, 1802*	Coraciiformes	Meropidae	√	0	0	0	Open area
65	Green Sandpiper	*Tringa ochropus Linnaeus, 1758*	Charadriiformes	Scolopacidae	√	0	√	0	Wetland
66	Green-backed Tit	*Parus monticolus Vigors, 1831*	Passeriformes	Paridae	0	0	0	√	Shrub
67	Green-tailed Sunbird	*Aethopyga nipalensis (Hodgson, 1837)*	Passeriformes	Nectariniidae	0	0	0	√	Open area
68	Grey Bushchat	*Saxicola ferreus Gray, 1846*	Passeriformes	Muscicapidae	√	√	√	√	Shrub
69	Grey Heron	*Ardea cinerea Linnaeus, 1758*	Pelecaniformes	Ardeidae	√	√	√	0	Wetland
70	Grey Treepie	*Dendrocitta formosae Swinhoe, 1863*	Passeriformes	Corvidae	0	√	√	√	Forest
71	Grey Wagtail	*Motacilla cinerea Tunslakel, 1771*	Passeriformes	Motacillidae	0	0	0	√	Wetland

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	**COMMON NAME**	***ZOOLOGICAL NAME***	**ORDER**	**FAMILY**	**SATTI KARNALI**	**JHILMILLA**	**RANI**	**RAMAROSHAN**	**HABITAT TYPE**
72	Grey-backed Shrike	*Lanius tephronotus (Vigors, 1831)*	Passeriformes	Laniidae	√	0	0	0	Open area
73	Grey-capped Woodpecker	*Picoides canicapillus (Blyth, 1845)*	Piciformes	Picidae	0	√	0	0	Forest
74	Grey-headed Fish-eagle	*Icthyophaga ichthyaetus (Horsfield, 1821)*	Accipitriformes	Accipitridae	√	0	√	0	Forest
75	Grey-headed Lapwing	*Vanellus cinereus (Blyth, 1842)*	Charadriiformes	Charadriidae	√	√	√	0	Wetland
76	Grey-headed Woodpecker	*Dendropicos spodocephalus (Bonaparte, 1850)*	Piciformes	Picidae	√	√	√	√	Forest
77	Grey-hooded Warbler	*Phylloscopus xanthoschistos (Gray, 1846)*	Passeriformes	Phylloscopidae	0	√	0	√	Shrub
78	Grey-winged Blackbird	*Turdus boulboul (Latham, 1790)*	Passeriformes	Turdidae	0	0	0	√	Shrub
79	Himalayan Bulbul	*Pycnonotus leucogenys (Gray, 1835)*	Passeriformes	Pycnonotidae	0	√	0	√	Forest
80	Himalayan Woodpecker	*Dendrocopos himalayensis (Jardine & Selby, 1835)*	Piciformes	Picidae	0	0	0	√	Forest
81	House Crow	*Corvus splendens Vieillot, 1817*	Passeriformes	Corvidae	√	√	√	0	Open area
82	House Sparrow	*Passer domesticus (Linnaeus, 1758)*	Passeriformes	Passeridae	√	√	√	0	Open area
83	House swift	*Apus nipalensis (Hodgson, 1836)*	Caprimulgiformes	Apodidae	√	√	√	0	Open area
84	Indian Cuckoo	*Cuculus micropterus Gould, 1837*	Cuculiformes	Cuculidae	√	√	√	√	Forest
85	Indian Golden Oriole	*Oriolus kundoo Sykes, 1832*	Passeriformes	Oriolidae	0	√	0	√	Forest

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	**COMMON NAME**	***ZOOLOGICAL NAME***	**ORDER**	**FAMILY**	**SATTI KARNALI**	**JHILMILLA**	**RANI**	**RAMAROSHAN**	**HABITAT TYPE**
86	Indian grey hornbill	*Ocyceros birostris (Scopoli, 1786)*	Bucerotiformes	Bucerotidae	√	0	√	0	Forest
87	Indian Pond Heron	*Ardeola grayii (Sykes, 1832)*	Pelecaniformes	Ardeidae	√	0	√	0	Wetland
88	Indian Robin	*Saxicoloides fulicatus (Linnaeus, 1766)*	Passeriformes	Muscicapidae	√	√	√	0	Open area
89	Indian Roller	*Coracias benghalensis (Linnaeus, 1758)*	Coraciiformes	Coraciidae	√	√	√	0	Open area
90	Intermediate Egret	*Ardea intermedia Wagler, 1829*	Pelecaniformes	Ardeidae	√	√	√	0	Wetland
91	Jungle Babbler	*Turdoides striata (Dumont, 1823)*	Passeriformes	Leiotrichidae	√	√	√	√	Shrub
92	Jungle Crow	*Corvus levaillantii Lesson, 1831*	Passeriformes	Corvidae	√	√	√	0	Forest
93	Jungle Myna	*Acridotheres fuscus (Wagler, 1827)*	Passeriformes	Sturnidae	√	√	√	√	Forest
94	Jungle Owlet	*Glaucidium radiatum (Tickell, 1833)*	Strigiformes	Strigidae	0	√	√	0	Forest
95	Jungle Prinia	*Prinia sylvatica Jerdon, 1840*	Passeriformes	Cisticolidae	√	√	√	0	Shrub
96	Kalij Pheasant	*Lophura leucomelanos (Latham, 1790)*	Galliformes	Phasianidae	0	√	0	0	Forest
97	Large-billed Crow	*Corvus macrorhynchos Wagler, 1827*	Passeriformes	Corvidae	√	0	√	√	Forest
98	Lesser Adjutant	*Leptoptilos javanicus (Horsfield, 1821)*	Ciconiiformes	Ciconiidae	√	0	0	0	Wetland
99	Lesser Coucal	*Centropus bengalensis (Gmelin, 1788)*	Cuculiformes	Cuculidae	√	√	√	0	Forest

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	**COMMON NAME**	***ZOOLOGICAL NAME***	**ORDER**	**FAMILY**	**SATTI KARNALI**	**JHILMILLA**	**RANI**	**RAMAROSHAN**	**HABITAT TYPE**
100	Lesser Fish-eagle	*Icthyophaga humilis (Müller & Schlegel, 1841)*	Accipitriformes	Accipitridae	0	0	√	0	Wetland dependent
101	Lesser Racquet-tailed Drongo	*Dicrurus remifer (Temminck, 1823)*	Passeriformes	Dicruridae	√	√	√	0	Forest
102	Lesser Whistling-duck	*Dendrocygna javanica (Horsfield, 1821)*	Anseriformes	Anatidae	√	0	√	0	Wetland
103	Lesser Yellownape	*Picus chlorolophus Vieillot, 1818*	Piciformes	Picidae	0	√	√	√	
104	Little Cormorant	*Microcarbo niger (Vieillot, 1817)*	Suliformes	Phalacrocoracidae	√	√	√	0	Wetland
105	Little Egret	*Egretta garzetta (Linnaeus, 1766)*	Pelecaniformes	Ardeidae	√	√	√	0	Wetland
106	Little Grebe	*Tachybaptus ruficollis (Pallas, 1764)*	Podicipediformes	Podicipedidae	0	0	0	√	Wetland
107	Little Pied Flycatcher	*Ficedula westermanni (Sharpe, 1888)*	Passeriformes	Muscicapidae	√	√	√	√	Open area
108	Long-tailed Minivet	*Pericrocotus ethologus*	Passeriformes	Campephagidae	0	0	0	√	Shrub
109	Long-tailed Shrike	*Lanius schach Linnaeus, 1758*	Passeriformes	Laniidae	0	0	√	√	Shrub
110	Mallard	*Anas platyrhynchos Linnaeus, 1758*	Anseriformes	Anatidae	0	0	√	√	Wetland
111	Marsh Sandpiper	*Tringa stagnatilis (Bechstein, 1803)*	Charadriiformes	Scolopacidae	√	0	√	0	Wetland
112	Nepal House Martin	*Delichon nipalense Horsfield & Moore, 1854*	Passeriformes	Hirundinidae	0	√	0	√	Open area
113	Northern Lapwing	*Vanellus vanellus (Linnaeus, 1758)*	Charadriiformes	Charadriidae	0	0	0	√	Wetland

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	**COMMON NAME**	***ZOOLOGICAL NAME***	**ORDER**	**FAMILY**	**SATTI KARNALI**	**JHILMILLA**	**RANI**	**RAMAROSHAN**	**HABITAT TYPE**
114	Orange-headed Thrush	*Geokichla citrina (Latham, 1790)*	Passeriformes	Turdidae	0	√	0	0	Forest
115	Oriental Darter	*Anhinga melanogaster Pennant, 1769*	Suliformes	Anhingidae	√	0	√	0	Wetland
116	Oriental Magpie Robin	*Copsychus saularis (Linnaeus, 1758)*	Passeriformes	Muscicapidae	√	√	√	0	Forest
117	Oriental Turtle Dove	*Streptopelia orientalis (Latham, 1790)*	Columbiformes	Columbidae	√	√	√	√	Forest
118	Osprey	*Pandion haliaetus (Linnaeus, 1758)*	Accipitriformes	Pandionidae	0	0	√	0	Forest
119	Pacific Swift	*Apus pacificus (Latham, 1802*	Apodiformes	Apodidae	0	0	0	√	Open area
120	Painted Stork	*Mycteria leucocephala (Pennant, 1769)*	Ciconiiformes	Ciconiidae	√	0	√	0	Wetland
121	Pale-footed Bush-warbler	*Hemitesia pallidipes (Blanford, 1872)*	Passeriformes	Scotocercidae	√	√	√	0	Shrub
122	Pale-headed Woodpecker	*Gecinulus grantia (McClelland, 1840)*	Piciformes	Picidae	√	√	√	0	Forest
123	Pied Bushchat	*Saxicola caprata (Linnaeus, 1766)*	Passeriformes	Muscicapidae	0	√	0	√	Shrub
124	Piled Kingfisher	*Ceryle radis (Linnaeus, 1766)*	Coraciiformes	Alcedinidae	√	0	0	0	Wetland
125	Plumbeous Water Redstart	*Phoenicurus fuliginosus (Vigors, 1831)*	Passeriformes	Muscicapidae	0	0	0	√	Wetland
126	Plum-headed Parakeet	*Psittacula cyanocephala (Linnaeus, 1766)*	Psittaciformes	Psittacidae	√	√	√	√	Forest
127	Purple Heron	*Ardea purpurea Linnaeus, 1766*	Pelecaniformes	Ardeidae	0	0	√	0	Wetland

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	**COMMON NAME**	***ZOOLOGICAL NAME***	**ORDER**	**FAMILY**	**SATTI KARNALI**	**JHILMILLA**	**RANI**	**RAMAROSHAN**	**HABITAT TYPE**
128	Red Collared Dove	*Streptopelia tranquebarica (Hermann, 1804)*	Columbiformes	Columbidae	√	√	√	0	Forest
129	Red Junglefowl	*Gallus gallus (Linnaeus, 1758)*	Galliformes	Phasianidae	√	√	√	0	Forest
130	Red watelled Lapwing	*Vanellus indicus (Boddaert, 1783)*	Charadriiformes	Charadriidae	√	0	0	0	Wetland
131	Red-billed Blue Magpie	*Urocissa erythroryncha (Boddaert, 1783)*	Passeriformes	Corvidae	√	√	√	√	Forest
132	Red-breasted Parakeet	*Psittacula alexandri (Linnaeus, 1758)*	Psittaciformes	Psittacidae	√	√	√	0	Forest
133	Red-headed Bullfinch	*Pyrrhula erythrocephala Vigors, 1832*	Passeriformes	Fringillidae	0	0	0	√	Shrub
134	Red-naped Ibis	*Pseudibis papillosa (Temminck, 1824)*	Pelecaniformes	Threskiornithidae	√	0	√	0	Wetland
135	Red-necked Falcon	*Falco ruficollis Swainson, 1837*	Falconiformes	Falconidae	0	0	√	0	Forest
136	Red-vented Bulbul	*Pycnonotus cafer (Linnaeus, 1766)*	Passeriformes	Pycnonotidae	√	√	√	√	Open area
137	Red-wattled Lapwing	*Vanellus indicus (Boddaert, 1783)*	Charadriiformes	Charadriidae	0	0	√	0	Wetland
138	Red-whiskered Bulbul	*Pycnonotus jocosus (Linnaeus, 1758)*	Passeriformes	Pycnonotidae	√	√	√	0	Forest
139	River Lapwing	*Vanellus duvaucelii (Lesson, 1826)*	Charadriiformes	Charadriidae	√	0	√	0	Wetland
140	Rock pigeon	*Columba livia Gmelin, 1789*	Columbiformes	Columbidae	0	0	√	0	Forest
141	Rose-ringed Parrakeet	*Psittacula krameri (Scopoli, 1769)*	Psittaciformes	Psittacidae	√	√	√	√	Forest

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES									
SN	COMMON NAME	*ZOOLOGICAL NAME*	ORDER	FAMILY	SATTI KARNALI	JHILMILLA	RANI	RAMAROSHAN	HABITAT TYPE
142	Ruddy Shelduck	*Tadorna ferruginea (Pallas, 1764)*	Anseriformes	Anatidae	√	0	√	0	Wetland
143	Ruddy-breasted Crake	*Zapornia fusca (Linnaeus, 1766)*	Gruiformes	Rallidae	0	0	√	0	Wetland
144	Rufous Sibia	*Heterophasia capistrata (Vigors, 1831)*	Passeriformes	Leiothrichidae	0	0	0	√	Forest
145	Rufous Treepie	*Dendrocitta vagabunda (Latham, 1790)*	Passeriformes	Corvidae	√	√	√	√	Forest
146	Rufous Woodpecker	*Micropternus brachyurus (Vieillot, 1818)*	Piciformes	Picidae	√	√	√	0	Forest
147	Rufous-bellied Woodpecker	*Dendrocopos hyperythrus (Vigors, 1831)*	Piciformes	Picidae	0	0	0	√	Forest
148	Rufous-necked Laughingthrush	*Garrulax ruficollis (Jardine & Selby, 1838)*	Passeriformes	Leiotrichidae	√	√	√	0	Forest
149	Rufous-winged Lark	*Mirafra assamica Horsfield, 1840*	Passeriformes	Alaudidae	√	√	√	0	Shrub
150	Russet Sparrow	*Passer cinnamomeus (Temminck, 1836)*	Passeriformes	Passeridae	0	0	0	√	Shrub
151	Sand Lark	*Alaudala raylake (Blyth, 1844)*	Passeriformes	Alaudidae	0	0	√	0	Wetland
152	Scarlet Minivet	*Pericrocotus flammeus (Forster, 1781)*	Passeriformes	Campephagidae	√	√	√	0	Shrub
153	Slaty-headed Parakeet	*Psittacula himalayana (Lesson, 1832)*	Psittaciformes	Psittacidae	√	√	√	0	Forest
154	Small Niltava	*Niltava macgrigoriae (Burton, 1836)*	Passeriformes	Muscicapidae	0	√	0	0	Forest
155	Speckled Wood Pigeon	*Columba hodgsonii Vigors, 1832*	Columbiformes	Columbidae	0	0	0	√	Forest

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES

SN	COMMON NAME	*ZOOLOGICAL NAME*	ORDER	FAMILY	SATTI KARNALI	JHILMILLA	RANI	RAMAROSHAN	HABITAT TYPE
157	Spotted Forktail	*Enicurus maculatus Vigors, 1831*	Passeriformes	Muscicapidae	0	0	0	√	Wetland
158	Spotted Owlet	*Athene brama (Temminck, 1821)*	Strigiformes	Strigidae	0	0	√	0	Forest
159	Steppe Eagle	*Aquila nipalensis Hodgson, 1833*	Accipitriformes	Accipitridae	0	0	√	0	Forest
160	Stork billed kingfisher	*Pelargopsis capensis (Linnaeus, 1766)*	Coraciiformes	Alcedinidae	√	√	√	0	Wetland
161	Striated Laughingthrush	*Grammatoptila striata (Vigors, 1831)*	Passeriformes	Leiothrichidae	0	0	0	√	Forest
162	Velvet-fronted Nuthatch	*Sitta frontalis Swainson, 1820*	Passeriformes	Sittidae	0	0	0	√	Shrub
163	Verditer Flycatcher	*Eumyias thalassinus Swainson, 1838*	Passeriformes	Muscicapidae	0	√	0	√	Open area
164	Watercock	*Gallicrex cinerea (Gmelin, 1789)*	Gruiformes	Rallidae	√	0	√	0	Wetland
165	Western Koel	*Eudynamys scolopaceus (Linnaeus, 1758)*	Cuculiformes	Cuculidae	0	0	√	0	Forest
166	Western Spotted Dove	*Spilopelia suratensis (Gmelin, 1789)*	Columbiformes	Columbidae	√	√	√	√	Open area
167	White breasted kingfisher	*Halcyon smyrnensis (Linnaeus, 1758)*	Coraciiformes	Alcedinidae	√	√	√	0	Wetland
168	White- throated Laughing thrush	*Garrulax albogularis (Gould, 1836)*	Passeriformes	Leiothrichidae	0	√	0	√	Forest
169	White Wagtail	*Motacilla alba Linnaeus, 1758*	Passeriformes	Motacillidae	√	√	√	0	Wetland
170	White-breasted Waterhen	*Amaurornis phoenicurus (Pennant, 1769)*	Gruiformes	Rallidae	√	0	√	0	Wetland

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES

SN	COMMON NAME	*ZOOLOGICAL NAME*	ORDER	FAMILY	SATTI KARNALI	JHILMILLA	RANI	RAMAROSHAN	HABITAT TYPE
171	White-browed Wagtail	*Motacilla maderaspatensis Gmelin, 1789*	Passeriformes	Motacillidae	√	√	√	0	Wetland
172	White-capped Water-redstart	*Phoenicurus leucocephalus (Vigors, 1831)*	Passeriformes	Muscicapidae	√	√	√	√	Wetland
173	White-collared Blackbird	*Turdus albocinctus Royle, 1840*	Passeriformes	Turdidae	0	0	0	√	Forest
174	White-rumped Munia	*Lonchura striata (Linnaus, 1766)*	Passeriformes	Estrildidae	√	√	√	0	Shrub
175	White-tailed Stonechat	*Saxicola leucurus (Blyth, 1847)*	Passeriformes	Muscicapidae	√	√	√	√	Shrub
176	White-throated Laughingthrush	*Garrulax albogularis (Gould, 1836)*	Passeriformes	Leiotrichidae	0	√	0	√	Forest
177	White-winged Redstart	*Phoenicurus erythrogastrus (Güldenstädt, 1775)*	Passeriformes	Muscicapidae	√	√	√	0	Wetland
178	Wire-tailed Swallow	*Hirundo smithii Leach, 1818*	Passeriformes	Hirundinidae	√	√	√	√	Open area
179	Wood Sandpiper	*Tringa glareola Linnaeus, 1758*	Charadriiformes	Scolopacidae	0	0	√	0	Wetland
180	Woolly necked Stork	*Ciconia episcopus (Boddaert, 1783)*	Ciconiiformes	Ciconiidae	√	0	√	√	Wetland
181	Yellow-billed Blue Magpie	*Urocissa flavirostris (Blyth, 1846)*	Passeriformes	Corvidae	0	√	0	√	Forest
182	Yellow-crowned Woodpecker	*Leiopicus mahrattensis (Latham, 1801)*	Piciformes	Picidae	√	√	√	0	Forest
183	Yellow-vented Warbler	*Phylloscopus cantator (Tickell, 1833)*	Passeriformes	Phylloscopidae	0	√	0	√	Shrub
184	Yellow-wattled Lapwing	*Vanellus malabaricus (Boddaert, 1783)*	Charadriiformes	Charadriidae	√	0	√	0	Wetland

TABLE S5. CUMULATIVE FORM OF BIRD SPECIES RECORDED FROM DIFFERENT FOUR LAKES WITH THEIR HABITAT TYPES

SN	COMMON NAME	*ZOOLOGICAL NAME*	ORDER	FAMILY	SATTI KARNALI	JHILMILLA	RANI	RAMAROSHAN	HABITAT TYPE
185	Zitting Cisticola	*Cisticola juncidis (Rafinesque, 1810)*	Passeriformes	Cisticolidae	√	√	√	0	Shrub

TABLE S6. FISH SPECIES RECORDED IN SATTI KARNALI LAKE WITH THEIR FIN FORMULA

SN	ORDER	FAMILY	LOCAL NAME	ZOOLOGICAL NAME	FIN FORMULA
1	Cypriniformes	Balitoridae	Botia	*Acanthobotis botia (Hamiton-Buchana, 1822)*	D13, P11, V8, A7, C17
2	Siluriformes	Bagridae	Kanti	*Aorichthys aor (Hamiton-Buchana, 1822)*	D1/7, P1/10, V6, A13, C17
3	Cypriniformes	Cyprinidae	Faketa	*Barilius barna Hamiton-Buchana, 1822*	D9; P15;V9;A13,C19;L1 39
4	Cypriniformes	Cyprinidae	Gurdeli	*Barilius bendelisis (Hamiton-Buchana, 1822)*	D9, P15, V9, A10, C18, L1 40
5	Cypriniformes	Cobitidae	Baghi	*Botia almorhae Gray, 1831*	D8, P8, V7, A2/5, C16, L1 115
6	Cypriniformes	Cyprinidae	Vyakur	*Catla catla Hamiton-Buchana, 1822*	D18;P19;V9;A8;C19;L1 43
7	Cypriniformes	Cyprinidae	Naini	*Cirrhinus mrigala Hamiton-Buchana, 1822*	D16, P18, V9, A8, C15, L1 43
8	Siluriformes	Schibeidae	Jalakapoor	*Clupisoma garua Hamiton-Buchana, 1822*	D1/7; P1/11; V6; A32; C17
9	Cypriniformes	Cyprinidae	Budhuna	*Cyprinus latius Hamiton-Buchana, 1822*	D11; P15; V9; A7; C19, L1 39
10	Siluriformes	Sisoridae	Telcapre	*GLypothorax trilineatus (Byth, 1779)*	D1/6/0, P10, V6, A12, C18
11	Cypriniformes	Cyprinidae	Thed	*Labeo angra Hamiton-Buchana, 1822*	D12; P17;V9;A8,C17;L1 44
12	Cypriniformes	Cyprinidae	Gardi	*Labeo dero (Hamiton-Buchana, 1822)*	D12; P16, V9;A8;C19, L1 41
13	Cypriniformes	Cyprinidae	Boi	*Labeo fimbriatus (Hamiton-Buchana, 1822)*	D20, P17, V9, A7, C19, L1 45
14	Cypriniformes	Cobitidae	Kande Gainche	*Lepidocephalus guntea Hamiton-Buchana, 1822*	D8; P8; V7; A7; C16; L1 115

TABLE S6. FISH SPECIES RECORDED IN SATTI KARNALI LAKE WITH THEIR FIN FORMULA					
SN	ORDER	FAMILY	LOCAL NAME	ZOOLOGICAL NAME	FIN FORMULA
15	Synbranchiformes	Synbranchidae	Gaichi machha	*Mastacembelus armatus Lecepede 1800*	D33/85, P23, A3/75, C15
16	Synbranchiformes	Synbranchidae	Bam	*Monopterus cuchia (Hamiton-Buchana, 1822)*	D very rudimentary, just a fold of skin; P, A, V and C absent
17	Siluriformes	Bagridae	Tengra	*Mystus bleekeri Day, 1877*	D 1/7; P1/9, V6; A9; C11
18	Siluriformes	Sisoridae	Katenga	*Nangra viridescens Hamiton-Buchana, 1822*	D1/8/0, P1/9, V6, A11, C17
19	Osteoglossiformes	Notopteridae	Lepsi/Palakea	*Notopterus notopterus (Pallas 1769)*	D9; P16;V6;A100,C19;L1 225
20	Perciformes	Nandidae	Dhoke	*Nundus nundus Hamiton-Buchana, 1822*	D13, P16, V1/5, A3/7, C15
21	Siluriformes	Siluridae	Nauni	*Ompok bimaculatus Bloch, 1797*	D4, P1/14, V8, A66, C18
22	Perciformes	Percoidei	Chanari	*Pseudambassis baculis Hamiton-Buchana, 1822*	D1/7/15, P13, V1/5, A3/17, C17
23	Cypriniformes	Psilorhynchidae	Titae	*Psilorhynchus pseudecheneis Menon and Datta, 1962*	D9, P19, V9, A7, C19, L1 48
24	Cypriniformes	Cyprinidae	Sidhre	*Punticus chola Day, 1873*	D11; P15; V9; A8; C19, L1 27
25	Cypriniformes	Cyprinidae	Thite pothi	*Punticus ticto Hamiton-Buchana, 1822*	D11; P13; V9; A8; C19, L1 25
26	Cypriniformes	Cyprinidae	Sidhre	*Puntius sophore (Hamiton-Buchana, 1822)*	D11, P15, V9, A8, C19, L1 23
27	Siluriformes	Siluridae	Rita	*Rita rita Bloch, 1797*	D1/6; P1/10; V8; A13; C19
28	Cypriniformes	Cyprinidae	Sahar	*Tor tor Hamiton-Buchana, 1822*	D12; P17;V9;A7;L1 25
29	Cypriniformes	Cyprinidae	Bohari	*Wallago attu (Hamiton-Buchana, 1822)*	D5;P 1/14; V10; A6; C17

TABLE S7. FISH SPECIES RECORDED IN JHILMILA LAKE WITH THEIR FIN FORMULA					
SN	ORDER	FAMILY	LOCAL NAME	ZOOLOGICAL NAME	FIN FORMULA
1	Perciformes	Chanidae	Garai	*Channa punctatus (Bloch, 1793)*	D11; P13; V9; A8; C19, L1 25

TABLE S7. FISH SPECIES RECORDED IN JHILMILA LAKE WITH THEIR FIN FORMULA

SN	ORDER	FAMILY	LOCAL NAME	ZOOLOGICAL NAME	FIN FORMULA
2	Siluriformes	Claridae	Mangur	*Clarias batrachus Linnaeus, 1758*	D65; P1/10;V6;A47,C17
3	Cypriniformes	Cyprinidae	Sidhre	*Punticus chola Day, 1873*	D11; P15; V9; A8; C19, L1 27

TABLE S8. FISH SPECIES RECORDED IN RANI LAKE COMPLEX WITH THEIR FIN FORMULA

SN	ORDER	FAMILY	LOCAL NAME	ZOOLOGICAL NAME	FIN FORMULA
1	Perciformes	Anabantidae	Kabai	*Anabus testudineus Bloch, 1795*	D16/9; P14;V1/5;A8/7;L1 27
2	Cypriniformes	Cobitidae	Kande Gainche	*Lepidocephalus guntea Hamiton-Buchana, 1822*	D8; P8; V7; A7; C16; L1 115
3	Synbranchiformes	Mastacembelidae	Chuche Bam	*Mastacembelus armatus Lacepaede, 1800*	D38/77; P23; A3/78; C16
4	Synbranchiformes	Synbranchidae	Andha Bam	*Monopterus cuchia (Hamiton-Buchana, 1822)*	D very rudimentary, just a fold of skin; P, A, V and C absent
5	Perciformes	Cichlidae	Tilapia	*Oreochromis mossambica Peters, 1852*	D16/10; P12;V1/5;A3/9;C19;L1 30
6	Cypriniformes	Cyprinidae	Sidhre	*Punticus chola Day, 1873*	D11; P15; V9; A8; C19, L1 27

TABLE S9. FISH SPECIES RECORDED IN RAMAROSHAN LAKE COMPLEX WITH THEIR FIN FORMULA

SN	**ORDER**	**FAMILY**	**LOCAL NAME**	**ZOOLOGICAL NAME**	**FIN FORMULA**
1	Cypriniformes	Cyprinidae	Tikhe Asala	*Schizothorax nepalensis Tarashima,1984*	D10, P18, V11, A9, C19, L1 105
2	Cypriniformes	Cyprinidae	Budhe Asala	*Schizothorax richardsonii Gray*	D11, P17, V10, A7, C19, L1 100
3	Cypriniformes	Cyprinidae	Garra	*Garra gotyla Gray, 1832*	D11, P15, V9, A7, C17, L1 33

TABLE S10. AMPHIBIAN SPECIES RECORDED IN SATTI KARNALI.
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
1	Black-spined Toad	*Duttaphrynus melanosticus* (Schneider, 1799)	Bufonidae	9 (4.36)
2	Marbled Toad	*Duttaphrynus stomaticus* (Liitken,1864)	Bufonidae	15 (7.28)
3	Skittering Frog	*Euphlyctis cyanophlyctis* (Schneider,1799)	Dicroglossidae	105 (50.97)
4	Jerdon's Bull Frog	*Hoplobatrachus crassus* (Jerdon,1853)	Dicroglossidae	15 (7.28)
5	Indian Bull Frog	*Hoplobatrachus tigerinus* (Daudin, 1802)	Dicroglossidae	32 (15.53)
6	Syhadra Frog	*Minervarya syhadrensis* (Annandale, 1919)	Dicroglossidae	2 (0.97)
7	NepaleseTerai Frog	*Minervarya teraiensis* (Dubois,1984)	Dicroglossidae	28 (13.59)

TABLE S11.AMPHIBIAN SPECIES RECORDED IN JHILMILA LAKE
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	TOTAL
1	Black-spined Toad	*Duttaphrynus melanosticus (Schneider,1799)*	Bufonidae	5 (9.08)
2	Marbled Toad	*Duttaphrynus stomaticus (Liitken,1864)*	Bufonidae	3 (5.88)
3	Skittering Frog	*Euphlyctis cyanophlyctis (Schneider,1799)*	Dicroglossidae	32 (62.74)
4	Indian Bull Frog	*Hoplobatrachus tigerinus (Daudin, 1802)*	Dicroglossidae	5 (9.8)
5	NepaleseTerai Frog	*Minervarya teraiensis (Dubois,1984)*	Dicroglossidae	4 (7.84)
6	Common Indian Tree Frog	*Polypedates maculatus (Gray,1830)*	Rhacophoridae	2 (3.92)

TABLE S12. AMPHIBIAN SPECIES RECORDED IN RANI LAKE
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
1	Black-spined Toad	*Duttaphrynus melanosticus (Schneider, 1799)*	Bufonidae	5 (5.37)
2	Marbled Toad	*Duttaphrynus stomaticus (Liitken,1864)*	Bufonidae	8 (8.60)
3	Skittering Frog	*Euphlyctis cyanophlyctis (Schneider,1799)*	Dicroglossidae	41 (44.08)
4	Jerdon's Bull Frog	*Hoplobatrachus crassus (Jerdon,1853)*	Dicroglossidae	7 (7.52)
5	Indian Bull Frog	*Hoplobatrachus tigerinus (Daudin, 1802)*	Dicroglossidae	15 (16.12)
6	NepaleseTerai Frog	*Minervarya teraiensis (Dubois,1984)*	Dicroglossidae	7 (7.52)
7	Common Indian Tree Frog	*Polypedates maculatus (Gray,1830)*	Rhacophoridae	2 (2.15)
8	Six-lined Tree Frog	*Polypedates teaniatus (Boulenger,1906)*	Rhacophoridae	4 (4.30)
9	Maskey's Burrowing Frog	*Sphaerotheca maskeyi (Schleich & Anders, 1998)*	Dicroglossidae	2 (2.15)
10	Marbled Balloon Frog	*Uperodon systomus (Schneider,1799)*	Microhylidae	2 (2.15)

TABLE S13. AMPHIBIAN SPECIES RECORDED IN RAMAROSHAN LAKE COMPLEX AREA.
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
1	Marbled Cascade Frog	*Amolops marmoratus (Blyth,1855)*	Dicroglossidae	2 (1.65)
2	Himalayan Toad	*Duttaphrynus himalayanus (Gunther,1864)*	Bufonidae	39 (32.23)
3	Indian Bull Frog	*Hoplobatrachus tigerinus (Daudin, 1802)*	Dicroglossidae	7 (5.78)
4	Myanmar Pelobatid Toad	*Megophyrus parva (Boulenger,1893)*	Megophryidae	3 (2.47)
5	Liebig's Paa Frog	*Nanorana legibii (Gunther, 1860)*	Dicroglosidae	61 (50.41)

TABLE S13. AMPHIBIAN SPECIES RECORDED IN RAMAROSHAN LAKE COMPLEX AREA.
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
6	Small Paa Frog	*Nanorana minica (Dubois,1975)*	Dicroglosidae	5 (4.13)
7	Common Indian Tree Frog	*Polypedates maculatus (Gray,1830)*	Rhacophoridae	4 (3.30)

TABLE S14. REPTILES SPECIES RECORDED IN SATTI KARNALI.
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
1	Common Garden Lizard	*Calotes versicolor versicolor (Daudin, 1802)*	Agamidae	7 (33.33)
2	White-spotted Skink	*Lygosoma albopunctatum (Gray, 1846)*	Scincidae	3 (14.28)
3	Dotted Garden Skink	*Lygosoma punctatum (Gmelin, 1799)*	Scincidae	1 (4.76)
4	Common Indian Skink	*Mabuya carinata (Schneider, 1801)*	Scincidae	4 (19.04)
5	Striped Grass Skink	*Mabuya dissimilis (Hallowell,1857)*	Scincidae	2 (9.52)
6	Spectacled Cobra	*Naja naja (Linnaeus, 1758)*	Elapidae	2 (9.52)
7	Bengal Monitor	*Varanus bengalensis (Dudin, 1802)*	Varanidae	1 (4.76)
8	Golden Monitor	*Varanus flavescens (Hardwicke & Gray,1827)*	Varanidae	1 (4.76)

TABLE S15. REPTILIAN SPECIES RECORDED IN JHILMILA
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
1	Common Garden Lizard	*Calotes versicolor versicolor (Daudin, 1802)*	Agamidae	5 (20.31)

TABLE S15. REPTILIAN SPECIES RECORDED IN JHILMILA
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
2	Nepalese Bent-toad Gecko	*Cyrtopodion nepalensis (Schleich & Kastle, 1998)*	Gekkonidae	2 (10.52)
3	Common House Gecko	*Hemidactylus fenatus (Dumeril & Bibron, 1836)*	Gekkonidae	2 (10.52)
4	Himalayan Rock Lizard	*Laudakia tuberculata (Hardwicke & Gray, 1827)*	Agamidae	2 (10.52)
5	Common Indian Skink	*Mabuya carinata (Schneider, 1801)*	Scincidae	7 (36.84)
6	Burmese Rock Python	*Python molurus bivttatus Kuhl, 1820*	Boidae	1 (5.26)

TABLE S16. REPTILIAN SPECIES RECORDED IN RANI LAKE
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
1	Common Vine Snake	*Ahaetulla nasuta (Lacepede, 1789)*	Colubridae	2 (5.55)
2	Checkered Keelback	*Amphiesma stolatum (Linnaeus, 1758)*	Colubridae	2 (5.55)
3	Indian Peacock Softshell Turtle	*Aspideretes hurum (Gray, 1831)*	Trionychidae	1 (2.77)
4	Common Cat Snake	*Boiga trigonata trigonata (Bechstein, 1802)*	Colubridae	2 (5.55)
5	Banded Krait	*Bungarus fasciatus (Schneider, 1801)*	Elapidae	2 (5.55)
6	Common Garden Lizard	*Calotes versicolor versicolor (Daudin, 1802)*	Agamidae	10 (27.77)
7	Mugger Crocodile	*Crocodylus palustris Lesson, 1831*	Crocodylidae	3 (8.33)
8	Common Bronzeback Treesnake	*Dendrelaphis tristis (Daudin, 1803)*	Colubridae	1 (2.77)
9	North Indian Flapshell Turtle	*Lissemys punctata andersoni, Webb, 1908*	Trionychidae	2 (5.55)
10	Common Wolf Snake	*Lycodon aulicus (Linnaeus, 1758)*	Colubridae	2 (5.55)

TABLE S16. REPTILIAN SPECIES RECORDED IN RANI LAKE
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE.

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
11	Tricarinate Hill Turtle	*Melanochelys tricarinata (Blyth, 1856)*	Bataguridae	1 (2.77)
12	Spectacled Cobra	*Naja naja (Linnaeus, 1758)*	Elapidae	2 (5.55)
13	Indian Roofed Turtle	*Pangshura tectum (Gray, 1831)*	Bataguridae	1 (2.77)
14	Asiatic Rat Snake	*Ptyas mucosa mucosa (Linnaeus, 1758)*	Colubridae	2 (5.55)
15	Burmese Rock Python	*Python molurus bivttatus Kuhl, 1820*	Boidae	2 (5.55)
16	Common Blind Snake	*Rhamphotyphlops braminus (Daudin, 1803)*	Typhlopidae	1 (2.77)

TABLE S17. REPTILIAN SPECIES RECORDED IN RAMAROSHAN LAKE COMPLEX
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	COMMON NAME	SCIENTIFIC NAME	FAMILY	ABUNDANCE (%)
1	Mountain Keelback	*Amphiesma platyceps (Blyth,1854)*	Coubridae	1 (3.57)
2	Common Garden Lizard	*Calotes versicolor versicolor (Daudin, 1802)*	Agamidae	7 (25)
3	Himalayan Rock Lizard	*Laudakia tuberculata (Hardwicke & Gray, 1827)*	Agamidae	12 (42.85)
4	Common Indian Skink	*Mabuya carinata (Schneider, 1801)*	Scincidae	6 (21.42)
5	Bengal Monitor	*Varanus bengalensis (Dudin, 1802)*	Varanidae	2 (7.14)

TABLE S18. MAMMALIAN SPECIES RECORDED IN SATTI KARNALI LAKE AREA
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	SCIENTIFIC NAME	ABUNDANCE (%)
1	Carnivora	Mustelidae	Smooth-coated Otter	*Lutrogale perspicillata (I. Geoffroy Saint-Hilaire, 1826)*	1 (0.67)
2	Carnivora	Felidae	Leopard	*Panthera pardus (Linnaeus, 1758)*	2 (1.34)
3	Carnivora	Felidae	Fishing Cat	*Prionailurus viverrinus (Bennett, 1833)*	1 (0.67)
4	Cetartiodactyla	Cervidae	Chilake	*Axis axis (Erxleben, 1777)*	65 (43.62)
5	Cetartiodactyla	Bovidae	Nilgai	*Boselaphus tragocamelus (Pallas, 1766)*	28 (18.79)
6	Cetartiodactyla	Cervidae	Northern Red Muntjac	*Muntiacus vaginalis (Boddaert, 1785)*	3 (2.01)
7	Cetartiodactyla	Platanistidae	Ganges River Dolphin	*Platanista gangetica gangetica (Roxburgh, 1801)*	2 (1.34)
8	Cetartiodactyla	Suidae	Wild boar	*Sus scrofa Linnaeus, 1758*	27 (18.21)
9	Lagomorpha	Leporidae	Indian Hare	*Lepus nigricollis F. Cuvier, 1823*	3 (2.01)
10	Primates	Cercopithecidae	Rhesus Monkey	*Macaca mulatta (Zimmermann, 1780)*	15 (10.06)
11	Rodentia	Hystricidae	Malayan Porcupine	*Hystrix brachyura Linnaeus, 1758*	2 91.34)

TABLE S19. MAMMALIAN SPECIES RECORDED IN JHILMILA AREA
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	NAME OF SPECIES	SCIENTIFIC NAME	TOTAL
1	Carnivora	Felidae	Wildcat	*Felis silvestris Schreber, 1777*	1 (0.57)
2	Carnivora	Herpestidae	Indian Grey Mongoose	*Herpestes edwardsii (É. Geoffroy Saint-Hilaire, 1818)*	4 (2.29)
3	Lagomorpha	Leporidae	Indian hare	*Lepus nigricollis F. Cuvier, 1823*	10 (5.74)
4	Primates	Cercopithecidae	Rhesus monkey	*Macaca mulatta (Zimmermann, 1780)*	124 (71.26)

TABLE S19. MAMMALIAN SPECIES RECORDED IN JHILMILA AREA
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	NAME OF SPECIES	SCIENTIFIC NAME	TOTAL
5	Cetartiodactyla	Cervidae	Northern Red Muntjac	*Muntiacus vaginalis (Boddaert, 1785)*	3 (1.72)
6	Cetartiodactyla	Bovidae	Himalayan Goral	*Naemorhedus goral (Hardwicke, 1825)*	1 (0.57)
7	Primates	Cercopithecidae	Tarai Gray Langur	*Semnopithecus hector (Pocock, 1928)*	31 (17.81)

TABLE S20. MAMMALIAN SPECIES RECORDED IN RANI LAKE COMPLEX AREA
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	SCIENTIFIC NAME	TOTAL
1	Cetartiodactyla	Cervidae	Hog deer	*Axis porcinus (Zimmermann, 1780)*	6 (2.28)
2	Cetartiodactyla	Cervidae	Chilake	*Axis axis (Erxleben, 1777)*	131 (49.80)
3	Rodentia	Hystricidae	Malayan Porcupine	*Hystrix brachyura Linnaeus, 1758*	4 (1.52)
4	Cetartiodactyla	Cervidae	Northern Red Muntajc	*Muntiacus vaginalis (Boddaert, 1785)*	3 (1.14)
5	Carnivora	Felidae	Tiger	*Panthera tigris (Linnaeus, 1758)*	2 (0.76)
6	Carnivora	Felidae	Fishig cat	*Prionailurus viverrinus (Bennett, 1833)*	4 (1.52)
7	Perissodactyla	Rhinocerotidae	Indain Rhinoceros	*Rhinoceros unicornis Linnaeus, 1758*	6 (2.28)
8	Cetartiodactyla	Suidae	Wild boar	*Sus scrofa Linnaeus, 1758*	27 (10.26)
9	Primates	Cercopithecidae	Tarai Gray Langur	*Semnopithecus hector (Pocock, 1928)*	43 (16.34)
10	Primates	Cercopithecidae	Rhesus monkey	*Macaca mulatta (Zimmermann, 1780)*	37 (14.06)

TABLE S21. MAMMALIAN SPECIES RECORDED IN RAMAROSHAN COMPLEX AREA
NUMBERS IN PARENTHESIS REFER TO TOTAL PERCENTAGE CONTRIBUTION OF EACH SPECIES TO THE TOTAL SAMPLE

SN	ORDER	FAMILY	COMMON NAME	SCIENTIFIC NAME	ABUNDANCE (%)
1	Rodentia	Hystricidae	Indian crested procopine	*Hystrix indica Kerr, 1792*	6 (6.81)
2	Lagomorpha	Ochotonidae	Royle's pika	*Ochotona roylei (Ogilby, 1839)*	20 (22.720
3	Carnivora	Canidae	Golden Jackal	*Canis aureus Linnaeus, 1758*	2 (2.27)
4	Rodentia	Hystricidae	Malayan porcupine	*Hystrix brachyura Linnaeus, 1758*	4 (4.54)
5	Primates	Cercopithecidae	Assam Macaque	*Macaca assamensis M'Clelland, 1840*	12 (13.63)
6	Primates	Cercopithecidae	Rhesus macaque	*Macaca mulatta (Zimmermann, 1780)*	15 (17.04)
7	Cetartiodactyla	Cervidae	Northern Red Muntjac	*Muntiacus vaginalis (Boddaert, 1785)*	3 (3.40)
8	Cetartiodactyla	Bovidae	Himalayan Goral	*Naemorhedus goral (Hardwicke, 1825)*	3 (3.40)
9	Carnivora	Felidae	Leopard	*Panthera pardus (Linnaeus, 1758)*	7 (7.95)
10	Primates	Cercopithecidae	Nepal grey langur	*Semnopithecus schistaceus Hodgson, 1840*	5 (5.68)
11	Carnivora	Ursidae	Himalayan Black bear	*Ursus thibetanus G. [Baron] Cuvier, 1823*	8 (9.09)
12	Carnivora	Ailuridae	Red Panda	*Ailurus fulgens F.G. Cuvier, 1825*	2 (2.27)
13	Carnivora	Felidae	Clouded Leopard	*Neofelis nebulosa (Griffith, 1821)*	1(1.13)

TABLE S22: MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI LAKE, JHILMILA LAKE AND RANI LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S.N.	SCIENTIFIC NAME	LOCAL NAME	SATTI KARNALI LAKE	JHILIMILA_LAKE	RANI LAKE
1	*Acacia catechu*	Khayer	1	1	1
2	*Achyranthes aspera*	Bippya kuro	1	1	1
3	*Adiantum philippense*	Fern	1	1	1
4	*Adina cordifolia*	Heledo	1	1	1
5	*Aegle marmelos*	Bel	1	1	1
6	*Aesandra butyracea*	Churee	0	1	0
7	*Ageratina adenophora*	Banmara	0	1	0
8	*Ageratum conyzoides*	Seto gandhe	1	0	0
9	*Ageratum houstonianum*	Nilo gandhe	1	1	0
10	*Amaranthus spinosus*	Lude	1	0	1
12	*Ardisia solanacea*	Damai fal	0	1	0
13	*Argemone Mexicana*	Thakali	1	0	1
14	*Arisaema costatum*	Sarpa makai	0	1	0
15	*Artemisia indica*	Titepati	0	1	0
16	*Arundinaria intermedia*	Nigalo	1	1	0
17	*Asclepias curassavica*	Unknown	0	1	0
18	*Asparagus racemosus*	kurilo	0	1	1
19	*Bauhinia purpurea*	tanki	0	1	1
20	*Bauhinia vahlii*	Bhorla	0	1	1
21	*Bauhinia variegate*	Koiralo	0	1	1
22	*Bidens pilosa*	Kalokuro	0	1	1
23	*Boehemeria esculentum*	Gargillo	0	1	1
24	*Bombax ceiba*	Simal	1	1	1
25	*Bridelia retusa*	Gaayo	0	1	1
26	*Buchanania cochinchinensis*	Pyaree	0	1	0

TABLE S22: MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI LAKE, JHILMILA LAKE AND RANI LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S.N.	SCIENTIFIC NAME	LOCAL NAME	SATTI KARNALI LAKE	JHILIMILA_LAKE	RANI LAKE
27	*Butea monosperma*	Palas	0	0	1
28	*Calamus tenuis*	Bet	1	0	0
29	*Callicarpa macrophylla*	Guyelo	1	1	1
30	*Calotropis gigantean*	aank 2	1	0	1
31	*Calotropis procera*	aank 1	1	1	0
32	*Cannabis sativa*	Gaja	1	1	0
33	*Cassia fistula*	Rajbrixya	0	1	0
34	*Centella asiatica*	Godtapre	1	1	1
35	*Ceraptoteris Thalictoroides*		0	0	1
37	*Cinnamomum tamala*	tejpat	0	1	0
38	*Cleistocalyx operculatus*	Cyamuno	0	1	0
39	*Clerodendrum viscosum*	Bhati	1	1	1
42	*Colebrookea oppositifolia*	Dhursele	0	1	0
43	*Conyza floribunda*	Solayo	1	0	0
44	*Crsaasocephalum crepedoidea*		1	1	1
45	*Cuscuta reflexa*	Aakashbeli	1	1	1
46	*Cynodon dactylon*	Dubo	1	1	1
47	*Cynoglossum lanceolatum*		1	1	1
48	*Cyperus esculentus*	Mothe jhar	0	0	1
49	*Cyperus rotundus*	Mothe	0	1	1
50	*Dalbergia sissoo*	Sisso	1	0	1
51	*Debregeasia longifolia*	Geethi	0	1	0
52	*Dendrocalamus strictus*	Bans	1	1	0
53	*Desmodium heterocarpun*	Bhatmase jhar	1	1	1
54	*Desmodium oojeinense*	Sadan	0	1	1
55	*Dicliptera bupleuroides*	Diclipta	1	1	1

TABLE S22: MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI LAKE, JHILMILA LAKE AND RANI LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S.N.	SCIENTIFIC NAME	LOCAL NAME	SATTI KARNALI LAKE	JHILIMILA_LAKE	RANI LAKE
56	*Digitaria ciliaris*	Banso	1	1	1
57	*Dillenia pentagyna*	Tatari	0	1	1
58	*Dioscorea bulbifera*	Tarul	1	1	1
59	*Diplazium esculentum*	Fern (leudo)	0	1	1
60	*Elaeagnus parvifolia*	Guhelo	0	1	0
61	*Eleusine indica*	Kodo ghans	0	1	1
62	*Engelhardia spicata*	Mauwa	0	1	0
63	*Erythrina stricta*	Faledo	0	1	0
64	*Eulaipsis binnata*	Babiyo	1	1	0
65	*Euphorbia hirta*	Dudhe	1	0	0
66	*Ficus benghalensis*	Bar	1	1	0
67	*Ficus glomerata*	Kharseto	1	0	1
68	*Ficus hispida*	Kharseto	1	1	0
69	*Ficus lacor*	Kavro	0	1	0
70	*Ficus religiosa*	Pipal	0	1	0
71	*Ficus Semicordata*	Khaniyo	1	0	0
72	*Flemingia strobilifera*	Bhatmase	0	1	1
73	*Garuga pinnata*	Dabdabe	0	1	0
74	*Gossypium arboreum*	Kapas	1	0	0
75	*Grewia optiva*	Bhimal	1	0	1
76	*Holarrhena pubescens*	Madeshi khiroo	0	1	1
78	*Hyptis sauvelons*		1	0	0
79	*Imperata cylindrical*	Siru	1	1	1
80	*Ipomea carnea*	Besarum	1	0	0
81	*Justicia procumbens*	Datiwan jhar	1	1	1
82	*Kyllinga brevifolia*	Thulo mothe	1	1	1

TABLE S22: MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI LAKE, JHILMILA LAKE AND RANI LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S.N.	SCIENTIFIC NAME	LOCAL NAME	SATTI KARNALI LAKE	JHILIMILA_LAKE	RANI LAKE
83	*Lagerstroemia parviflora*	Bad-dhairoo	0	1	0
84	*Lantana camara*	Thulo Banmara	1	0	0
85	*Leea crispa*	Galeni	0	1	0
86	*Lepidagathis purpuracaulis*		1	1	1
87	*Leucas cephalotes*		1	0	1
88	*Lippia nodiflora*	Lippia	1	0	0
89	*Litsea monopelakea*	Kutmero	1	1	1
90	*Lygodium flexosum*	Lute jhar	1		1
93	*Lyonia ovalifolia*	Angere	0	1	0
94	*Mallotus philippensis*	Sindure	1	1	1
96	*Mangifera indica*	aanp	1	1	0
97	*Millettia extensa*	Gauju	0	1	0
98	*Murraya koenigii*	Aasere	0	1	1
99	*Mussaenda macrophylla*	Dhobini	0	1	0
100	*Narenga porphyrocoma*				1
101	*Nerium indicum*	Nerium	0	1	0
102	*Oxalis corniculata*	Chari amilo	1	1	1
103	*Oxystelma esculentum*	Asclepiadaceae	1	0	0
104	Paspalum scrobiculatum	Ghode banso	1	0	1
105	*Phoenix humilis/acaulis*	thakal	0	1	0
106	*Phragmites karka*	Narkat	1	0	1
108	*Phyllanthus emblica*	Amala	1	1	1
109	*Pinus roxburghii*	Sallo	0	1	0
110	*Piper longum*	pipla	1	1	1
111	*Pistia stratiotes*	Pistia	0	0	1
112	*Plumbago zylanica*		1	1	1

TABLE S22: MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI LAKE, JHILMILA LAKE AND RANI LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S.N.	SCIENTIFIC NAME	LOCAL NAME	SATTI KARNALI LAKE	JHILIMILA_LAKE	RANI LAKE
113	*Pogostemon benghalensis*	Rudelo	1	1	1
114	*Pterocarpus marsupium*	Bijaya sal	0	1	0
115	Ranunculus sceleratus		1	1	1
116	*Reinwartia indica*	Pyauli		1	0
117	*Ricinus communis*	Andir	1	1	0
118	*Rubus ellipticus*	aiselu	1	1	0
119	*Saccharum spontaneum*	Kash	1	0	1
120	*Sarcococca confuse*	pipari	0	0	1
121	*Schleichera oleosa*	Kushum	0	0	1
122	*Selaginella involvens*	Selaginella	0	1	0
123	*Semecarpus anacardium*	Bhalayo	0	1	1
124	*Senna occidentalis*	Thulo tapre	1	1	0
125	*Senna tora*	Sano tapre	1	1	0
126	*Shorea robusta*	Sal	0	1	1
127	*Sida acuta*	Balu jhar	1	1	1
128	*Smilax sp*	Kukurdino	0	1	0
129	*Solanum nigrum*	Ninaune	1	0	0
130	*Solanum surattense*	Kantakari	1	0	0
131	*Sonchus asper*	Dudhe phul/Jhar	1	0	0
132	*Spatholobus parviflorus*	Debre lahara	0	1	1
133	*Syzigium cuminii*	jamun	1	1	1
134	*Tectona grandis*	Teak	1	0	0
135	*Terminalia tomentosa*	Saj	0	1	1
136	*Tetrastigma serrulatum*	Pani lahara	0	1	1
137	*Thevetia peruviana*	Karbir	0	1	0
138	*Thylepteris prolifera*		1	0	1

TABLE S22: MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI LAKE, JHILMILA LAKE AND RANI LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S.N.	SCIENTIFIC NAME	LOCAL NAME	SATTI KARNALI LAKE	JHILIMILA_LAKE	RANI LAKE
139	*Thysanolaena maxima*	Amriso	1	1	1
140	*Toona ciliate*	tunee	0	1	1
141	*Trewia nudiflora*	viller	1	0	1
142	*Triumfetta pilosa*	Dalle kurro	1	0	1
143	*Tropaeolum majus*	Musebelo	0	1	0
144	*Typha angustifolia*	Pater	1	0	1
145	Unknown1	Barkailo	1	0	0
146	Unknown2	Aaijeru (Parasitic)	0	1	0
147	Unknown3	Kalo bhalayo	1	1	0
148	*Urena lobate*	Jhadu jhar	1	1	1
149	*Urtica dioica*	sisno	0	1	0
150	*Woodfordia fruticose*	Dhairoo	0	1	0
151	*Xanthium strumarium*	Bhedekuro	1	1	0
151	*Xeromphis spinose*	Mayal kanda	0	1	0
152	*Zeuxine strateumatica*	Ground orchid	1	0	0
153	*Ziziphus nummularia*	Bayer	0	0	1

TABLE S23: AQUATIC MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI, RANI LAKE AND JHILMILA LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S N	NAME	NATURE OF HYDROPHYTES	SATTI KARNALI	RANI LAKE	JHILMILA LAKE
1	*Ageratum houstonianum*	Emergent	1	1	1
2	*Alternenthera sessilis*	Emergent	1	1	1
3	*Azolla natans*	Free floating	1	1	1
4	*Bothriochloa ischaemum*	Emergent	1	0	0
5	*Carex sp*	Emergent	1	1	1
6	*Carex Vesicaria*	Emergent	0	1	0

TABLE S23: AQUATIC MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI, RANI LAKE AND JHILMILA LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S N	NAME	NATURE OF HYDROPHYTES	SATTI KARNALI	RANI LAKE	JHILMILA LAKE
7	*Centella asiatica*	Emergent	1	1	1
8	*Ceratopteris thalictroides subspecies*	Emergent	1	1	0
9	*Chara braunii*	Emergent	1	1	1
10	*Colocasia esculenta*	Emergent	1	0	0
11	*Cynodon arcautas*	Emergent	1	1	0
12	*Cyperus difformis*	Emergent	1	0	0
13	*Cyrtococcum patens*	Emergent	1	0	0
14	*Diplazium esculentum*	Emergent	0	0	1
15	*Dryopteris erythrosora*	Emergent	0	1	0
16	*Eclipta alba*	Emergent	1	1	1
17	*Enhydra fluctuans*	Sumberged, emergent	1	0	0
18	*Equisetum arvense*	Emergent	0	1	0
19	*Fimbristylis species*	Emergent	1	0	0
20	*Hydrilla verticillata*	Submerged	1	1	0
21	*Imperata cylindrical*	Emergent	1	0	0
22	*Ipomoea aquatic*	Emergent	1	0	0
23	*Ipomoea carnea*	Emergent	1	0	0
24	*Ludwigia perrenia*	Emergent	0	1	0
25	*Nelumbo nucifera*	Rooted floating leaf	1	0	0
26	*Nymphea species*	Rooted floating leaf	1	0	0
27	*Oxalis corniculata*	Emergent	0	1	1
28	*Oxystelma esculentum*	Emergent	1	1	0
29	*Persicaria barbata*	Emergent	1	1	1
30	*Persicaria glabra*	Emergent	1	1	1
31	*Persicaria lapatifolia*	Emergent	1	1	0
32	*Phragmites karka*	Emergent	0	1	0

TABLE S23: AQUATIC MACROPHYTES PRESENT IN THE STUDY AREA (SATTI KARNALI, RANI LAKE AND JHILMILA LAKE):

HERE 1= PRESENCE AND 0= ABSENCE

S N	NAME	NATURE OF HYDROPHYTES	SATTI KARNALI	RANI LAKE	JHILMILA LAKE
33	*Pistia stratiotes*	Free floating	0	1	0
34	*Polygonum barbatum*	Emergent	1	1	1
35	*Portulaca oleracea*	Emergent	1	0	0
36	*Potamogeton natans*	Submerged	1	0	0
37	*Rumex crispus*	Emergent	1	0	0
38	*Schoenoplectus mucronatus*	Emergent	1	1	1
39	*Spirodela polyrhiza*	Free floating	1	1	0
40	*Spirogyra species*	Submerged	1	1	1
41	*Thylepteris prolifera*	Emergent	1	0	0
42	*Typha aungustifolia*	Emergent	1	0	0
43	Unknown grass 1	Emergent	1	0	0
44	Unknown grass 2	Emergent	1	1	1
45	Utricularia auras	Rooted floating leaf	0	1	0
46	Veronica anagallis-aquatica	Emergent	1	1	0

TABLE S24: MACROPHYTES PRESENT IN RAMAROSHAN LAKE COMPLEX

S.N.	SCIENTIFIC NAME	FAMILIY
1	*Acer campbelli*	Aceraceae
2	*Aconitum spicatum* (Bruhl) stapf	Ranunculaceae
3	*Aconogonum molle* (D.Don) Hara	Polygonaceae
4	*Aesculus indica* (Colebr.ex Cambess.) Hook.	Hippocastanaceae
5	*Allium tuberosum* Rottl.ex Sprengel	Liliaceae
6	*Allium wallichii* Kunth.	Liliaceae
7	*Anaphalis busua* (Buch.- Ham. ex D. Don.)	Asteraceae
8	*Anaphalis contorta* (D.Don) Hook.f.	Asteraceae
9	*Anaphalis triplinervis* (Sims) C. B. Clarke	Asteraceae

TABLE S24: MACROPHYTES PRESENT IN RAMAROSHAN LAKE COMPLEX		
S.N.	SCIENTIFIC NAME	FAMILIY
10	*Arenaria debilis* Hook. f. ex Edgew. & Hook. F.	Caryophyllaceeae
11	*Arenaria depauperata* (Edgew.)	Caryophyllaceeae
12	*Arisaema propinqum* Schott	Araceae
13	*Arundinella hookeri* Munro	Poaceae
14	*Asplenium ensiforme*	Aspleniaceae
15	*Balanophora species*	Balanophoraceae
16	*Barbaria intermedia* Boreau	Brassicaceae
17	*Berberis aristata* DC.	Berberidaceae
18	*Berberis asiatica* Roxb.ex DC.	Berberidaceae
19	*Berchemia flavescens* (Wall.) Brongn.	Rhamnaceae
20	*Bidens tripartita* L.	Asteraceae
21	*Bistorta amplexicaulis* (D.Don) Greene	Polygonaceae
22	*Bistorta milletii* H. Lev.	Polygonaceae
23	*Boerhavia diffusa* L.	Nyctaginaceae
24	*Calanthe tricarinata* Lindl.	Orchidaceae
25	*Cardiocrinum giganteum* (Wall.) Makino	Liliaceae
26	*Carex baccans* Nees	Cyperaceae
27	*Carex* species	Cyperaceae
28	*Cyperus species*	Cyperaceae
29	*Carpesium cernum* L.	Asteraceae
30	*Cephalanthera longifolia* (L.) Fritsch	Orchidaceae
31	*Cheilanthes dalhousie* Hook.	Pteridaceae
32	*Chromolaena adenophora*	Asteraceae
33	*Clinopodium umbrosum* (M. Bieb.) C. Koch	Lamiaceae
34	*Corydalis hookeri* Prain	Fumaricaceae
35	*Cotoneaster acuminatus* Lindl	Rosaceae
36	*Cotoneaster baciallaris* Wall.	Rosaceae
37	*Cotoneaster microphyllus* Wall.ex Lindl.	Rosaceae

TABLE S24: MACROPHYTES PRESENT IN RAMAROSHAN LAKE COMPLEX		
S.N.	SCIENTIFIC NAME	FAMILIY
38	Crassosephalum crepidoides	Compositace
39	*Cynodon dactylon* (L.) Pers.	Poaceae
40	*Cynoglossum zelanicum* (Vahl) Thunb. Ex Lehm.	Boraginaceae
41	*Cythula capitata* Moq.	Amaranthaceae
42	*Danthonia cumminsii* Hook .f.	Poaceae
43	*Daphne papyracea* Wall. ex Steud.	Thymelaeaceae
44	*Daphniphyllum himalense* (Benth.) Mull. Arg.	Daphniphyllaceae
45	*Dicrocephala benthamii* C.B.Clarke	Asteraceae
46	*Digitaria cruciata* (Nees ex Steudel)	Poaceae
47	*Dodecadenia grandiflora* Nees	Lauraceae
48	*Elaegnus parvifolia* Wall.	Elaegnaceae
49	*Elatostema monandrum* (Buch - Ham. ex D. Don.)	Urticaceae
50	*Elatostema obtusum* Wedd.	Urticaceae
51	*Elatostema sessile* J.R. and G.Forst.	Urticaceae
52	*Eleocharis congesta* D. Don	Cyperaceae
53	*Elsholtzia fruiticosa* (D. Don) Rehder	Lamiaceae
54	*Eltsholtzia strobilifera* Benth.	Lamiaceae
55	*Epilobium palustre* L.	Onagraceae
56	*Equisetum arvense*	
57	*Erigeron karvinskianus*	Asteraceae
58	*Euonymus tingens* Wall.	Celastraceae
59	*Fagopyrum tataricum* (L.) Gaertn.	Polygonaceae
60	*Fragaria nubicola* Lindl.	Rosaceae
61	*Fritillaria cirrhosa* D. Don	Liliaceae
62	Frittelaria royeli	Liliaceae
63	*Galinsoga parviflora* Cav.	Asteraceae
64	*Galinsuga ciliata* (Raf.) Blake	Asteraceae
65	*Galium elegans* Wall.ex Roxb.	Rubiaceae

TABLE S24: MACROPHYTES PRESENT IN RAMAROSHAN LAKE COMPLEX		
S.N.	SCIENTIFIC NAME	FAMILIY
66	Gaultheria fragratissima	Rosaceae
67	*Gaultheria nummularioides* D. Don	Ericaceae
68	*Geranium nepalense* Sweet	Geraniaceae
69	*Geum elatum* Wall. ex G. Don	Rosaceae
70	*Hedera nepalensis* K. Koch	Araceae
71	*Hemiphragma heterophyllum* Wall.	Scrophulariaceae
72	*Heracleum secies*	Apiaceae
73	*Hydrangea anomala* D. Don	Hydrangeaceae
74	*Hydrangea aspera Buch* -Ham ex D. Don	Hydrangeaceae
75	*Hypericum elodeoides* Choisy	Hydrangeaceae
76	*Ilex dyprena* Wall.	Aquifoliaceae
77	*Impatiens racemosa* DC.	Balsaminaceae
78	*Impatiens serrata* Benth.	Balsaminaceae
79	*Iris kemaonensis* D.Don	Iridaceae
80	*Jasminum humile* L.	Oleaceae
81	*Juncus articulatus* L.	Juncaceae
83	*Kyllinga brevifolia* Rottb.	Cyperaceae
84	*Lecanthus peduncularis* (Royle) Wedd	Urticaceae
85	*Lepisorus mehre* Fraser-Jenks	Pteridaceae
86	*Leucosceptrum canum* Sm.	Lamiaceae
87	*Lindera pulcherrima* (Nees) Benth.ex Hook.f.	Lauraceae
88	*Lobelia pyramidalis* Wall.	Lobeliaceae
89	*Lyonia ovalifolia* (Wall.) Drude	Lobeliaceae
90	*Lyonia villosa* (Hook. f.) Hand. - Mazz.	Ericaceae
91	*Mahonia nepaulensis* DC.	Berberidaceae
92	*Malaxis muscifera* (Lindl.) Kuntze	Orchidaceae
93	*Mazus surculosus* D.Don	Scrophulariaceae
94	*Microstegium nodum* (Trin.) A. Camus	Poaceae

TABLE S24: MACROPHYTES PRESENT IN RAMAROSHAN LAKE COMPLEX		
S.N.	SCIENTIFIC NAME	FAMILIY
95	*Myriactis nepalensis* Less	Asteraceae
96	*Myriophyllum spicatum* L.	Haloragaceae
97	*Oleandra wallichi*	Oleandraceae
98	*Onychium species*	Pteridaceae
99	*Ophioglossum Sp.*	Ophioglossaceae
100	*Origanum vulgare* L.	Lamiaceae
101	*Oxalis corniculata* L.	Oxalidaceae
102	*Paris polyphylla* Smith.	Liliaceae
103	*Parochetus communis* Buch -Ham ex D. Don	Fabaceae
104	*Parochetus communis* Buch.-Ham.	Fabaceae
105	*Persea odoratissima* (Nees) Kosterm.	Lauraceae
106	*Persicaria capitata* Buch -Ham ex D. Don	Polygonaceae
107	*Persicaria posumbo* Buch -Ham ex D. Don	Polygonaceae
108	*Pilea symmerica* Wedd.	Urticaceae
109	*Pilea umbrosa* Blume	Urticaceae
110	*Piptanthus nepalensis* (Hook.) D. Don	Fabaceae
111	*Plantago erosa* Wall.	Plantaginaceae
112	Planthera species	Orchidaceae
113	*Poa annua* L.	Poaceae
114	*Pogonantherum paniceum* (Lam.) Hackel	Poaceae
115	*Polypogon fugax* Nees ex Steudel	Poaceae
116	*Potamogeton crispus* L.	Potamogetonaceae
117	*Potamogeton lucens* L.	Potamogetonaceae
118	*Prinsepia utilis* Royle	Rosaceae
119	*Prunus cornuta* (Wall. ex Royle) Steud.	Rosaceae
120	*Pteracanthus lachenensis* (C. B. Clarke) Bremek	Acanthaceae
121	*Pyracantha crenulata* (D. Don) M. Roem.	Rosaceae
122	*Quercus semicarpifolia* Sm.	Fagaceae

TABLE S24: MACROPHYTES PRESENT IN RAMAROSHAN LAKE COMPLEX		
S.N.	SCIENTIFIC NAME	FAMILIY
123	*Rhododendron arboretum* Sm.	Ericaceae
124	Ribes gracillis	Rosaceae
125	*Ribes griffithii* Hook. f. & Thomson	Grossulariaceae
126	*Rorippa* Sp	Brassicaceae
127	*Rosa brunonianum*	Rosaceae
128	*Rosa macrocarpa*	Rosaceae
129	*Rosa microphylla Lindl.*	Rosaceae
130	*Rosa serecia*	Rosaceae
131	*Roscoea purpurea* Smith	Zingiberaceae
132	*Rubia manjith* Roxb. ex Fleming	Rubiaceae
133	*Rubus ellipticus* Sm.	Rosaceae
134	*Rubus nepalensis* (Hook.f.) Kuntze	Rosaceae
135	*Rubus* Sp	Rosaceae
136	*Rumex nepalensis* Spreng.	Polygonaceae
137	*Rumex nepaulensis* Spreng.	Polygonaceae
138	*Salix babylonica* L.	Salicaceae
139	*Salvia lanata*	Lamiaceae
140	*Sarcococca hookeriana Baill.*	Buxaceae
141	*Satyrium nepalense*	Orchidaceae
142	*Schissandra species*	Schisandraceae
143	*Schrophularia species*	Schrophulariaceae
144	*Senecio alatus* Wall.	Asteraceae
145	*Skimmia alatus* Wall.	Rutaceae
146	*Skimmia anquetilia*	Rutaceae
147	*Smilax elegans* Wall. ex Kunth	Smilacaceae
148	*Solanum nigrum* L.	Solanaceae
149	*Spiranthes sinensis*	Orchidaceae
150	*Stellaria media*	Caryophyllaceae

TABLE S24: MACROPHYTES PRESENT IN RAMAROSHAN LAKE COMPLEX		
S.N.	SCIENTIFIC NAME	FAMILIY
151	*Stellaria monosperma* Buch -Ham ex D. Don	Caryophyllaceae
152	*Stellaria nepalensis*	Caryophyllaceae
153	*Stephania gracilenta* Miers	Menispermaceae
154	*Strobilanthes species*	Acanthaceae
155	*Swertia aungustifolia*	Gentianaceae
156	*Swertia chirayita* (Roxb. ex Fleming) Karsten	Gentianaceae
157	*Symplocos paniculata* (Thunb.) Miq.	Symplocaceae
158	*Symplocos ramosissima* Wall. ex G. Don	Symplocaceae
159	*Tanacetum dolichophyllum* Kitam.	Asteraceae
160	*Taxus contorta* Griff.	Taxaceae
161	*Taxus wallichiana* Zucc., Abh. Akad. Muench.	Taxaceae
162	*Thalictrum virgatum* Hook. f. Thoms.	Ranunculaceae
163	*Thymus linearis*	Lamiaceae
164	*Unknown parasite*	Lisso
165	*Utricularia australis* R.Br.	Lentibulariaceae
166	*Valeriana hardwiki* Wall.	Valerianaceae
167	*Viburnum erubescens* Wall.	Caprifoliaceae
168	*Viburnum mullaha* Buch.-Ham. ex D. Don	Sambucaceae
169	*Viola betonicifolia* Sm.	Violaceae
170	*Zanthoxylum nepalense* Babu	Rutaceae

TABLE S25: AQUATIC MACROPHYTES (HYDROPHYTES) PRESENT IN RAMAROSHAN LAKE COMPLEX		
SN	NAME OF SPECIES	HABIT
1	*Barbaria intermedia*	Emergent
2	*Caltha scaposa*	Emergent
3	*Ceratophyllum species*	Submerged
4	*Chara species*	Submerged

TABLE S25: AQUATIC MACROPHYTES (HYDROPHYTES) PRESENT IN RAMAROSHAN LAKE COMPLEX

SN	NAME OF SPECIES	HABIT
5	*Eleocharis congesta*	Emergent
6	*Eragrostris species*	Emergent
7	*Grass 1*	Emergent
8	*Grass 2*	Emergent
9	*Grass 3*	Emergent
10	*Hydrilla verticilata*	Submerged
11	*Juncus articulatus*	Emergent
12	*Juncus luteocarpus*	Emergent
13	*Persicaria barbata*	Emergent
14	*Persicaria posumbo*	Emergent
15	*Plantago erosa*	Emergent
16	*Potamegeton filiformis*	Submerged
17	*Potamegeton nutans*	Floating
18	*Potomogeton crispus*	Submerged
19	*Ranunculus scleratus*	Emergent
20	*Ranunculus trichophyllus*	Submerged
21	*Rorippa nasturtium-aquaticum*	Emergent
22	*Rumex nepalensis*	Emergent
23	*Scirpus compressus*	Emergent
24	*Scirpus sinensis*	Emergent
25	*Spirogyra sp.*	Submerged
26	*Stellaria aquatica*	Emergent
27	*Typha aunustifolia*	Emergent
28	*Utricularia australis*	Submerged
29	*Nelumbo nucifera*	Rooted floating
30	*Polygonum hydropiper*	Emergent