Bird Species Diversity and Relative Abundance in Suryabinayak Municipality, Bhaktapur

A Dissertation submitted to the Central Department of Botany, Tribhuvan University for the partial fulfilment of the requirements for M.Sc. in Biodiversity and Environmental Management (BEM)

Submitted by

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DECLARATION

I, Urusha Sinkhwal, hereby declared that this thesis entitled "**Bird Species Diversity and Relative Abundance in Suryabinayak Municipality, Bhaktapur**" is my original research work and all other sources of the information used are duly acknowledged. I have not submitted it or any of its part to any other universities for any academic award.

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RECOMMENDATION

This is certified that the dissertation work entitled "Bird Species Diversity and Relative Abundance in Suryabinayak Municipality, Bhaktapur" submitted by Ms. Urusha Sinkhwal has been carried out under our supervision. To the best of our knowledge, the dissertation is primarily based on the result of her research work and has not been submitted for any other degree. We recommend the dissertation work to be accepted for the partial fulfilment of Master of Science in Biodiversity and Environment management (M.Sc. BEM).

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LETTER OF APPROVAL

The M.Sc. dissertation entitled **"Bird Species Diversity and Relative Abundance in Suryabinayak Municipality, Bhaktapur"** submitted to Central Department of Botany, Tribhuvan University by Ms. Urusha Sinkhwal has been accepted as partial fulfillment for the requirements of Master's Degree in Biodiversity and Environmental Management (MSc BEM).

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Urusha Sinkhwal

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LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
BCN	Bird Conservation Nepal
CDZ	Central Department of Zoology
CITES	Convention on International Trades in Endangered Species of Flora and Fauna
DNPWC	Department of National Parks and Wildlife Conservation
GIS	Geographic Information System
GPS	Global Positioning System
Ho	Null Hypothesis
IUCN	International Union for Conservation of Nature
km	Kilometer
m	Meter
NTNC	National Trust of Nature Conservation
SPSS	Statistical Package for the Social Sciences
TU	Tribhuvan University

ABSTRACT

The purpose of this study was to asses the diversity, distribution and relative abundance of avifauna in different habitat types in Suryabinayak Municipality, Bhakatpur, Nepal This study was conducted in December 2018 and June 2019 covering dry and wet seasons. Point count method was used to investigate the relative abundance of birds in Suryabinayak A total of 112 species of birds were recorded from the study area during two seasons. The highest species richness was found in order Passeriformes with 76 bird species and the order was Gruiformes and Charadriformes with 1 species. Maximum numbers of species were recorded during winter season. Species richness was in forest followed by agriculture, edge, and forest and settlement area. There was a insignificant difference in species richness of birds between two seasons (χ^2= 54.8, df = 111 (n=112, p = 1) and among habitats (F = 4.198, df= 3 (n=4), P < 0.006). The diversity index of birds of Suryabinayk Municipality showed high biodiversity. Out of 112 bird species, 41 species were uncommon in its relative abundance, 31 species were frequent, 26 species were common and 14 species were found abundant. Similarly, resident species were higher while migrant species were very few. Also, most of the birds belong to least concern in IUCN red list of threatened species, two species were Globally and three species were Nationally Threatened were recorded. Of the total recorded species, nine species are included in appendix II and one in appendix III of CITES.Study showed that Suryabinayk Municipality areas are good sites for bird watching activities and should be promoted for bird tourism.

CHAPTER I
INTRODUCTION

1.1 Background

Information on bird diversity have been widely considered as an important preliminary for biodiversity conservation planning, monitoring and for identifying conservation actions. Bird diversity is considered as surrogates for the health status of ecosystem and status of overall biodiversity (Chettri 2010, Pakkala et al. 2014, Pierson et al. 2015). Anthropogenic drivers have caused large-scale habitat destruction, fragmentation and degradation, necessitating an assessment of the impacts of such changes. Understanding diversity of bird communities in different habitats is essential to understand the community structure and niche relationships, as well to delineate the importance of regional or local landscapes for avian conservation (Kattan and Franco 2004, Chettri 2010, Singh et al. 2013).

Nepal, the Himalayan country is rich in landscape heterogeneity that supports diverse flora and fauna, including 8.87 % of the global bird species (DNPWC 2018). Such high avian diversity is primarily due to the diverse climatic and topographic variations within a short distance which create a diverse ecosystem and forests. Faunal diversity of Nepal is the overlap of Palearctic Realm and Oriental (Indo-Malayan) Realm, supporting tropical to alpine bio-climatic regions (Inskipp et al.2016). The birds of the Himalayan zone are related to Europe and North Asia and those of Oriental are related to southern Nepal. Birds are important for ecological functioning of our environment such as indicators of pollution, seed dispersal, scavenging and as predators of insect pests (Schimelis and Afework 2009). The major habitat of birds includes forests, wetlands and grasslands and other areas (rocks, scrub etc.).

At present, 887 species of birds have been recorded from Nepal. The order Passeriformes has the highest representation among the bird species (465 spp.), followed by Chradriiformes (68 spp.), Falconiformes (59 spp.), Piciformes (33 spp.), Anserformes (33 spp.), Ciconiformes (27 spp.), Galliformes (21 spp.), Colubiformes (33 spp.) (Shrestha (2016), Inskipp et. al (2008). A total of 35 globally threatened species including 19 near threatened and 15 restricted-range species are recorded in Nepal (BCN 2018). Spiny Babbler (*Turdoides nipalensis*) is an endemic species to Nepal while 9 species are protected by the National Park and Wildlife Conservation Act 1973 which are White stork (*Ciconia ciconia*), Black stork (*Ciconia nigra*), Himalayan Monal (*Lephophorus impejanus*), Styr

Tragopan (*Tragopan satrya*), Cheer Pheasant (*Calreus wallichii*), Bengal Florican (*Houbaropsis bengalensis*), Lesser Florican (*Sypheotides indicia*), Sarus crane (*Grus Antigone*), Great hombill (*Buceros bicornis*) as well as 111 birds are enlisted in Convention on International Trades in Endangered Species of Flora and Fauna category (DNPWC 2018). More than 130 breeding and wintering species (15 %) of the birds are now considered as nationally threatened. As many as 8 species of birds have become extinct from Nepal (BCN 2018).

Birds occupy almost all habitat types and diversity of birds often serves as a good indicator of overall diversity of a given area (Furness and Greenwood 1993). The species richness and community structure of birds vary from region to region and it depends on habitat conditions (Recher 1969, Pearson 1977). Biogeographically, diverse habitats are the major factors for high species richness of bird as well as other faunal communities, which ranges from lush moist forests and sparse alpine deserts to luxuries grasslands in lowland Tarai (BCN and DNPWC 2011). Major habitat for Nepal's bird consists of forest, wetland and grassland. Forest and bushes hold 77% of Nepal's breeding birds (Grimmet et al. 2000). Habitat structure and floristic composition are known to have a significant role in determining the occurrence of bird species (Wiens and Rotenberry 1981, Rice et al. 1984). Seasonal changes in climate is an additional prominent characteristic of mountain Himalayas to escape from extreme heat and cold as well as breeding. These birds again return back to their homeland when the climate is favourable. About 150 species migrate when ecosystems that can influence the temporal dynamics of bird species richness and composition (Blake 2000, Stevens 1992, Renner et.al. 2012). Birds in mountain environments are sensitive to seasonal variation in climate, due to resource bottlenecks for food and water availability and to temperature regulation requirements (Stevens 1992, Renner et.al. 2012). In Nepal, seasonal migration of birds is closely linked to changes between the dry and monsoon seasons. Summer migration usually starts during March and May (pre-monsoon season; sometimes migration is extended to monsoon season in June and July) and winter migration starts during the post-monsoon season in September (Fleming et.al.1984, Grimmett et.al.2011)). Almost two thirds (62%) of the 878 bird species of Nepal have been classified primarily as residents, but only a small number of these birds are actually sedentary and most of them are elevation migrants over short distances (Grimmett 2000). Analyses of bird guilds, defined as functional groups of species that use resources in a similar way (Simberloff et. al. 1991), in other parts of the world have

demonstrated that seasonal migration is often the most prevalent in insectivores (Brooks 1997) and coincides with fruit ripening for frugivorous species.

The major threats of birds of Nepal are poaching and illegal trade, habitat loss and destruction due to agricultural activities, overgrazing, overharvesting for fodder and poisoning. Habitat loss is the major threat. About 86% of the birds are at risk under habitat loss (Birdlife Nepal 2013). Some invasive alien weeds, for instance water hyacinth in wetlands, pose serious threats and recently the climber *Mikania micrantha,* which can rapidly smother all terrestrial habitats. There is generally lack of awareness amongst the poor people on the importance and conservations of birds. This small patch supports more species of bird's life and other animals. Hence, this study was designed to explore the diversity and conservation status of the birds in Suryabinayak Municipality, Bhaktapur.

1.2 Rationale of the study

Birds are one of the most widely distributed animals, living in diverse landscapes. They show a substantial variety of distribution patterns and often prefer to live in heterogeneous environments. Changes in vegetation composition can affect the quality and quantity of habitats for birds in terms of food, water and cover, which can further affect their diversity, abundance and distribution (Western and Grimsdell, 1979).. Now-a-days, habitats of avifauna are decreasing due to the destruction of natural habitats and human disturbances.

Suryabinayak is an important recreational destination with a great potential of wildlife including bird diversity. Much of studies and survey on bird diversities are focused in conservation area and endangered species but the area like Bhaktapur is not studied well. This area includes the settlement area, river, and forest area as well as the agricultural land gradients. Suryabinayak Ganesh mandir is a famous religious place of the Bhaktapur where picnic spot is established so that recreational activities have created lots of problem on habitat, breeding and feeding activities of bird. Data on avifauna of this area is not adequate to assess conservation needs. Only little information from records of bird watchers, nature guides etc. are available. Baseline survey and data are necessary for the proper conservation and management initiatives. Hence, this study is essential to provide data on seasonal diversity and habitat association of birds of that area.

1.3 Objectives of the study

The main objective of this study was to explore the diversity and relative abundance of bird in Suryabinayak Municipality, Bhaktapur.

The specific objectives were as follows:

- To explore the species richness and evenness of birds in different habitats
- To explore the seasonal variation in bird species richness
- To identify major threats and threatened species

1.4 Limitation of the study

This study was conducted in Suryabinayk municipality at a limited period of six-months i. e. December 2018 and June 2019 for two seasons (winter and summer). Data collection was not possible for all seasons and the whole municipality. Study of flying raptors and nocturnal birds was not done. Survey of birds in the evening was not done.

CHAPTER II
LITERATURE REVIEW

2.1 Status of birds

MacAuthur and MacArthur (1961) reported that the patterns of bird diversity are driven by fundamental biogeographic factors, within tropical and sub-tropical countries supporting the highest species richness of bird. They said that the majority of studies on bird community were focused on the understanding of the structure of a community based on the population. The relationships between habitat and diversity in avian communities in Panama, Illionis, Texas and Bahamas were examined by Karr (1968), Karr and Roth (1971). Karr (1976) reported on seasonality, resource availability and community diversity in the tropical bird communities in Panama during the period 1968 and 1969. Wiens and Rotenberry (1981) studied the relationship between the distribution of birds, their abundance and habitat characteristics at a regional scale, using surveys conducted over three consecutive years in the shrub steppe of the north-western Great Basin of North America. Wiens (1989) analysed the availability of food, detectability and capture, location of nesting sites, availability of nesting materials, presence of predators and competitors are the major factors known to influence the population of birds. Fischer et al. (1999) studied that a key element in the study of diversity is the relative abundance of different species at a site and non-profit source pollution; these areas also provide habitat and movement corridors for wildlife as well as benefits to fish population. He said that, if avian habitat is management objective, manager should consider managing the riparian zone that is at least 100m wide.

Nepal has 220 years of recorded scientific ornithological research work. The most important ornithological contributions came in the mid-19th century by Brian H. Hodgson. Various contributions have been made since then significantly by various authors. Fleming et al. (1976) produced the first field guide of the birds of Nepal. Many of the facts in guide described about birds of Nepal arising from their own studies of birds in Nepal. Carol and Tim Inskipp contributed several books and papers further updating status of Nepal's birds. (Cocker and Inskipp 1988). Hodgson's contributions to Nepal's ornithology remain unparalleled. Many studies on birds were conducted in Nepal on focusing on species richness. Basnet et al. (2005) recorded a total of 110 species of bird at Raja Rani Community Forest Bhogteny, Morang. One study in summer (BCN 2016) has been conducted till the date despite of being rich in bird diversity with final checklist of 233

species (BCN 2016). In 2016 BCN and DNPWC recorded 878 species of birds where the number of birds species is 887 has been recorded from Nepal in 2018 by BCN and DNPWC, 2018.

2.2 Bird diversity on different habitats

Seasonal differences in habitat can range from shifts in tree-species used by resident species to the use of drastically different areas by migrant birds (Conner 1981, Hutto 1986, Morrison et al. 1985, Terborgh 1989, Block 1991). Darveau et al. (1995) compared bird abundance and species composition in riparian forest strip of varying width and founds that riparian strip at least 60 m wide is needed to sustain forest dwelling birds. Estrada et al. (1997) studied the distribution of birds in different land use types where they found more species in cultivated land, followed by forests, fences and pasture land. According to (Fischer 2000) to encourage a diverse avian community, riparian corridors should be as wide and as long as possible and be relatively free from improved road, human settlement and other potential impacts. Retaining riparian vegetation of proper width not only minimizes the impacts of erosion. Brawn et al. (2001) found that Different land use practices influences the habitat, structure and composition of species of birds. Tewes et al. (2004) evidenced that the physical structure of a plant community, i.e., how the foliage is distributed vertically, may be more important than the actual composition of plant species. In most habitats, plant communities determine the physical structure of the environment, and therefore, have a considerable influence on the distributions, abundance and diversity of birds and interactions of other animal species. Laiolo (2004) analysed birds on mixed forest, pure juniper forest, dwarf rhododendron shrubbery and cultivations land. He found higher diversity of birds in mixed forest whereas terraced cultivation acts as a prime habitat for the wintering birds. Chettri et al. (2005) found that avian richness peaked at moderately disturbed sites. John (2005) conducted bird diversity is peak at intermediate level of human settlement primarily because of colonization of intermediately disturbed forest by early successional native species. In contrast, species richness was relatively higher for natural forest than for other land use types (Palomino and Carrascal 2006). Ranganathan et al. (2007) found that farmland also has been an important habitat for bird. Some bird species are habitat specific though some are generalist. Currently, due to land uses changes it is difficult to find forest habitat covering large areas. For example, near towns, most of the land has been converted to settlement and farmlands. Differences in requirement among bird species have caused specificity on habitat requirement (Buckley and Freckleton, 2010).

For example, Mountain plover (*Charadrius mountainus*) feeds primarily on insects (grasshoppers, crickets, beetles, flies, ants); uses ground for nesting and prefer short grass while Mongolian sand plover (*Charadrius atrifrons*) feeds on invertebrates (molluscs, worms, crustaceans especially crabs and insects), uses tree for nesting and prefer shore of the lakes. Fardila and Sjarmidi (2012) said that though the land use and other aspects of environments are interrelated, forest always has higher species richness of birds than other land cover.

Rimal (2006) found many species of birds disturbed habitats than undisturbed one. Khanal (2008) documented higher species richness of birds along cultivated lands than forest than forest and grassland during winter season while studying on Nawalparasi forest due to the suitable climate during winter season. Similarly, Basnet (2010) after analysing the species richness and composition of breeding birds concluded more species richness can be found in moderately disturbed area than in disturbed one. In addition, he argued of having higher alpha diversity in moderately disturbed area but higher beta diversity in the disturbed landscape. Katuwal (2013) found higher species richness of birds in exploited forest, followed by natural forest, cultivated land and least in meadow, which accepted the intermediate disturbance hypothesis. Aryal (2013) studied on avian diversity along elevation and land use gradient in Ghunsa Valley of Kanchenjunga Conservation Area and concluded that the species richness was higher in natural forest followed by exploited forest, cultivated land and meadows. Chpagain (2014) reported that species richness is higher in forest habitats than the corridor and settlement habitats in Barandabhar Corridor Forest in Chitwan. Pokharel (2015) found more in forest Number of species followed by corridor and settlement area in in Betana Wetland area Belbari, Morang. Adhikari et al. (2018) recorded the highest number of birds in the forest as compared to other habitats. But, species richness per unit of land cover area was found higher in grasslands (98 species) followed by wetlands (51 species).

2.3 Seasonal diversity and abundance of birds

Smythe, (1974) studied Seasonal variation in avian community structure decreases with increasing vegetation complexity. This is apparently due to the increased buffering of the physical environment by the more complex vegetation. Karr (1976) found that Seasonal stability of the habitat affects species composition and abundance of birds. Bird species that face seasonal irregularities in the availability of food sources have two alternatives. A bird

may shift to feeding on other resources, or it may move to another area where the original food resource is available. Where there is no seasonal irregularity in food availability and other factors are held constant, a species can maintain itself throughout the year. Robertson and Hackwell (1995) analysed the Seasonal variation in climatic pattern have direct impact on bird species richness. The structural and functional organization of ecosystem changes as accordance to change in seasons which has direct impact on avian diversity. A seasonal change in species diversity of birds occurs in forests due to their foraging behaviour. Lincoln (1998) conducted the seasonal distribution of birds is affected by their migration patterns. Migration is not a voluntary one, but is one of necessity caused by climatic conditions such as the food supply and the length of the daylight. Cueto and de Casenave (2000) in the coastal woodlands of the reserve, 'El Destino', Buenos Aires Province, Argentina found a greater number of birds in spring (pre-monsoon) than in autumn (post-monsoon) but species richness did not show changes during the annual cycle. Herzog et al. (2003) also found minimum abundance of birds in winter season in a study in central Bolivia. Murgui (2007) studied on effects of seasonality on bird species in urban parks of Valencia (Spain). He concluded that in the breeding period i.e., in spring and summer bird richness became higher than in the winter season. Harsha and Hosetti (2009) recorded maximum species in Early winter (102) which was followed by summer (96), spring (90), late winter (85) respectively in Lakkavalli range forest of western Ghat, India.

Poudel (2005) reported higher bird diversity in winter than in summer in Kirtipur due to the suitable climatic condition in winter. Basnet et al. (2005) studied the bird diversity and their status at Raja Rani Community Forest, Morang. He found the high species richness in winter followed by spring (64 species) autumn (63 species) and summer (61 species). Malla (2006) and Khadka (2017) found higher species richness in winter and spring than other seasons in Nagarjun Forest, of the central mid-hill of Nepal. On his study bird species richness was higher in the disturbed habitat condition. Similarly, Rimal (2006) recorded the highest number of species in spring and lowest in monsoon in Shivapuri National Park. He found more birds in forest than other land use during the summer season. Thakuri (2007) also concluded that majority of the birds were found within forested areas than in riverine, agricultural land, marshes, urban and human settlement areas while studying in Satikhel and Dallu community forests of Seshnarayan VDC on Seasonal Diversity and Community Composition of Birds. Giri (2008) found 31 species of birds in winter and 17 species of birds in summer season in Fewa Lake, Pokhara. Ghimire (2009) reported the highest bird

richness in Sal Forest and the lowest in mix forest in a study on seasonal diversity and habitat utilization of birds in the BCF of Chitwan.Katuwal (2013) recorded the high species richness of birds in post- monsoon season and low in the pre-monsoon season in Manaslu Conservation Area. Seasonal changes often correspond to different life- style requirements and migratory strategies of birds. Aryal (2013) found higher species richness in spring than in the winter in Kanchenjunga Conservation Area. Parajuli (2016) recorded 130 species of birds in winter season and 74 species in summer season.

2.4 Threats and conservation

Guisan and Zimmermann (2000) conducted the factors that influence the distribution of organisms; it becomes possible to use conservation tools necessary for the survival of endangered species of the geographical areas. Westphal et al., *(*2006) studied the forests have been converted to urban settlement, agricultural field and pastureland, sometimes to open land. These human activities have an impact on bird species abundance, distribution and diversity due to isolation and fragmentation. Cordeiro, (2005) reported the decline in abundance and loss of species due to human interference have been observed in the tropics. Tyabji (2002) described the disappearance of bird species and the steep drop in their numbers in Chitwan's rivers and streams over the past 15 years. Water pollution from untreated effluent from the towns of Bharatpur and Narayanghat and the Bhrikuti paper mill, river poisoning to obtain fish, the increased use of pesticides, particularly on the rice crop, human disturbance, and the spread of Water Hyacinth *Eichhornia crassipes* on lakes and ponds, all threaten the habitat of Chitwan's waterbirds. At Koshi, hunting and trapping birds for food and for sale at the market regularly takes place (Giri 2002c). According to Kafle et al. *(*2007), widespread threats include drainage for agriculture, unsustainable harvesting of resources, diversion and abstraction of water for farmland irrigation, overgrazing of shorelines and marshes, widespread mining of gravel from riverbeds and the possibility of new dams, e.g. the Koshi High Dam project that was proposed in 2009. Many species are suffering from water pollution, hunting, trapping, disturbance and destruction of feeding and nesting sites. Water pollution from agricultural chemicals has been identified as a particularly serious threat to lowland wetlands. A 2011 BCN study found that Nepal is a safe market for illegal bird traders. However, only a small number of traders were found to be Nepalese who trapped local species, mainly pheasants, water birds, parakeets and owls.

CHAPTER III
MATERIALS AND METHODS

3.1 Study area

Suryabinayak Municipality lies on the southern part of Bhaktapur Municipality about 15 km east of the capital city, Kathmandu. It lies between 27°37' N to 27°40' N latitude and 85°23' to 85°29'E longitude with elevation range from 1372 to 2025 m above mean sea level (Figure 1). The total area of Suryabinayak Municipality is 42.45 sq. km. The study area covered 8 sq.km of wards 6, 7 and 8. It includes Sipadol in the east, Katunje in the west and Gundu in the south. The area is popular as it has Ganesh temple. The Suryavinayak hill is a continuous ridge.There are 21 community forests managed by Suryabinayak community forest user group which were handed over as community forests from the District Forest Office, Bhaktapur. Its operation plan was last revised for the 10 years in 15th July 2012. Recently, the Cabinet of the central government, February 2015 decided to construct National Zoological Garden in Suryabinayak, Bhaktapur. The project aims to create a safe haven for the wildlife in the forest area, spread along the 245.2 ha hectares and a 16-km perimeter covering seven community forests of Suryabinayak Gundu, Sipadol and Katunje villages.

The study was carried in forest patch, corridor between the settlement and agricultural land. The lower elevation covered by the settlement area; middle area covered by the agricultural land while the uplands were mostly cover by the forest.

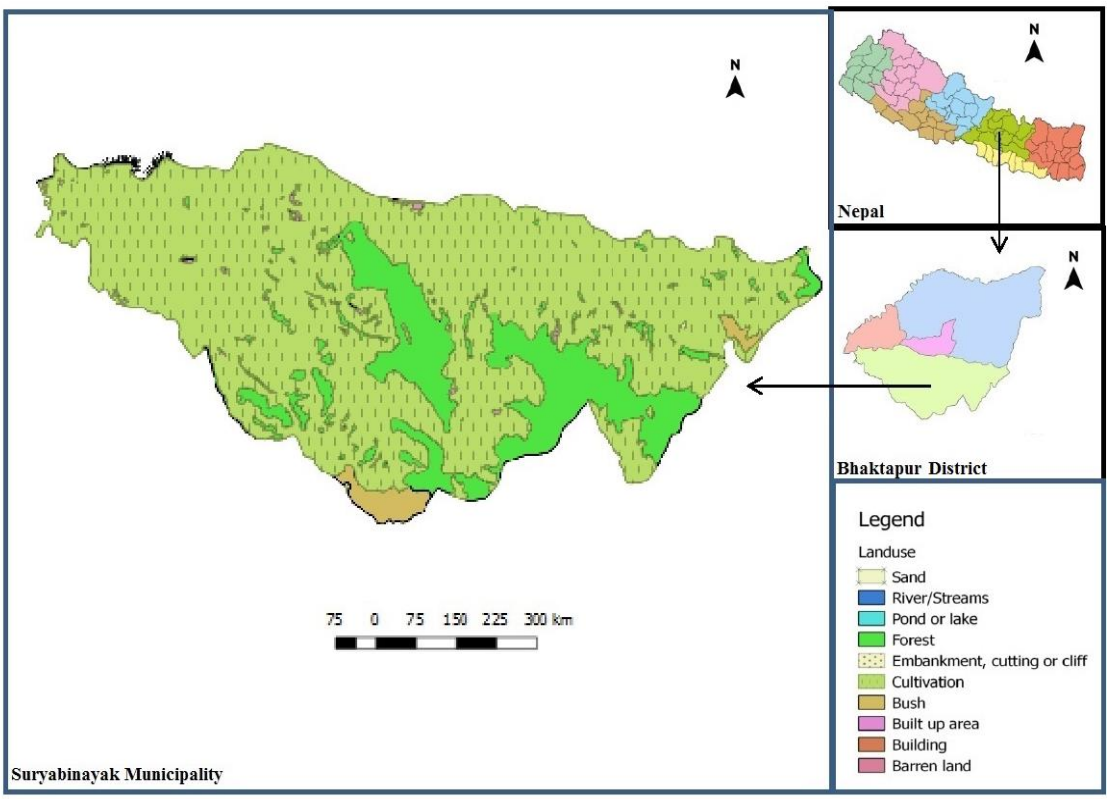

Figure 1: Map showing study area.

3.1.1 Climate

The climate of the study area is subtropical type. It has four distinct seasons: pre monsoon from March to May, monsoon from June to September, post monsoon from October to November and winter from December to February. There is no meterological station in Bhaktapur so that temperature and rainfall was studied according to the Kathmandu airport station which is the nearest station of the study area.

According to a 50-year climate data (1968-2018) provided the Department of Hydrology and Metrology (2019). The average annual temperature is 25℃ in the station Kathmandu airport area of Nepal. The warmest month of the year is May, with an average temperature of 28℃. Usually, January is the coldest month in Kathmandu, with an average temperature 18℃. The temperature difference between the hottest month (May) and the coldest month (January) is 10℃. The extreme annual maximum temperature recorded in the station Kathmandu airport, is 36.6°C on 7th June 1989 and for the extreme minimum temperature is -3.5°C on 11th January 1978. Months with the largest precipitation are July, August, September with 676 mm precipitation. Most precipitation occurs in July with an average precipitation 241 mm. The annual amount of precipitation in Kathmandu is 2156 mm. The

extreme rainfall ever recorded in the station Kathmandu airport of Nepal is 177mm on 23rd July 2002. The difference between the highest precipitation (July) and the lowest precipitation (December) is 89mm (Figure 2, 3 and 4).

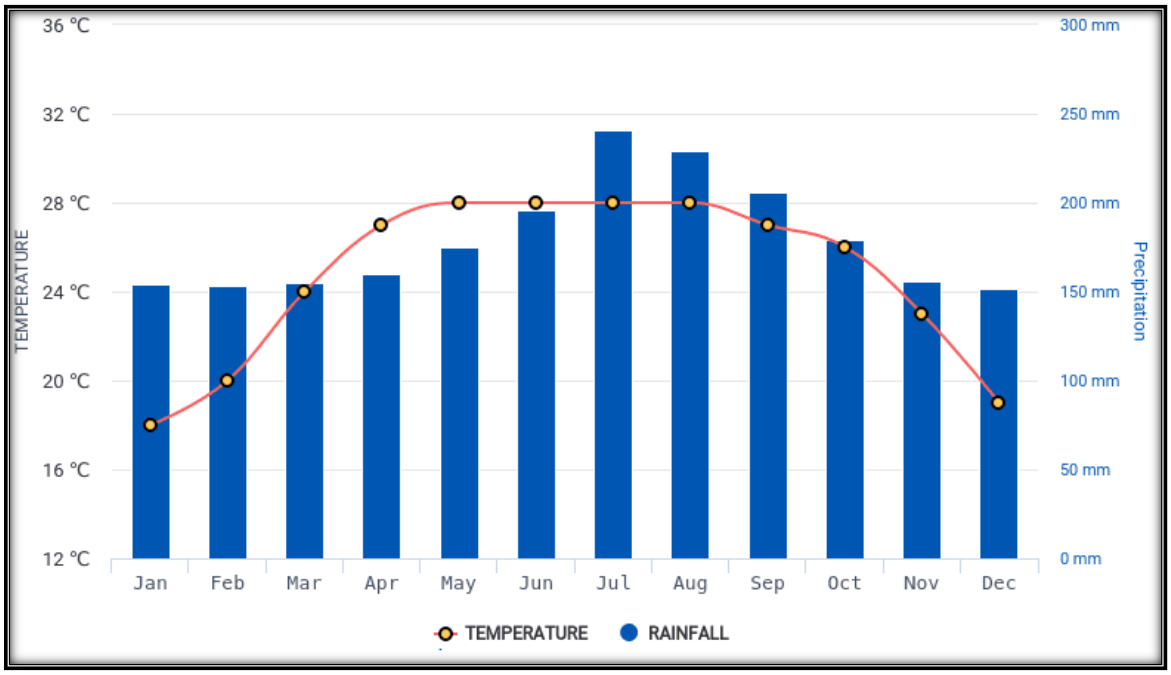

Figure 2: Monthly average temperature and precipitation of Kathmandu station recorded from 1968- 2018

(Source: Department of Hydrology and Metrology, 2019)

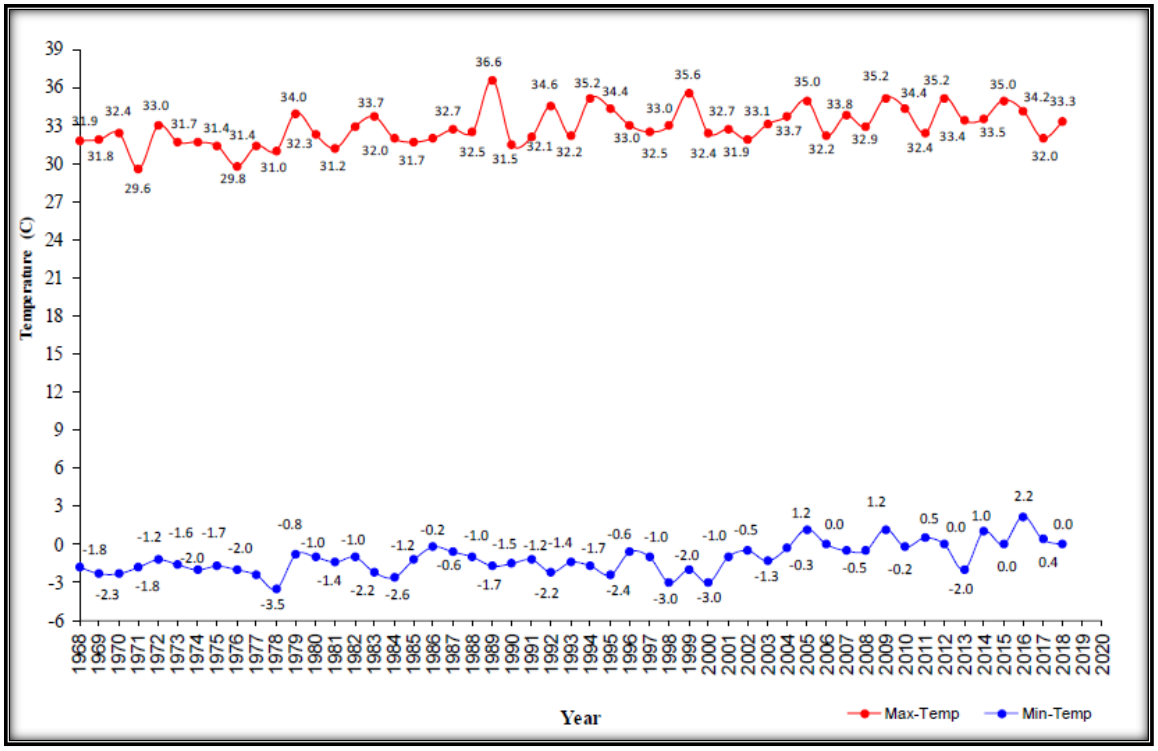

Figure 3: Annually extreme temperature of Kathmandu station recorded from 1968-2018

(Source: Department of Hydrology and Metrology,2019)

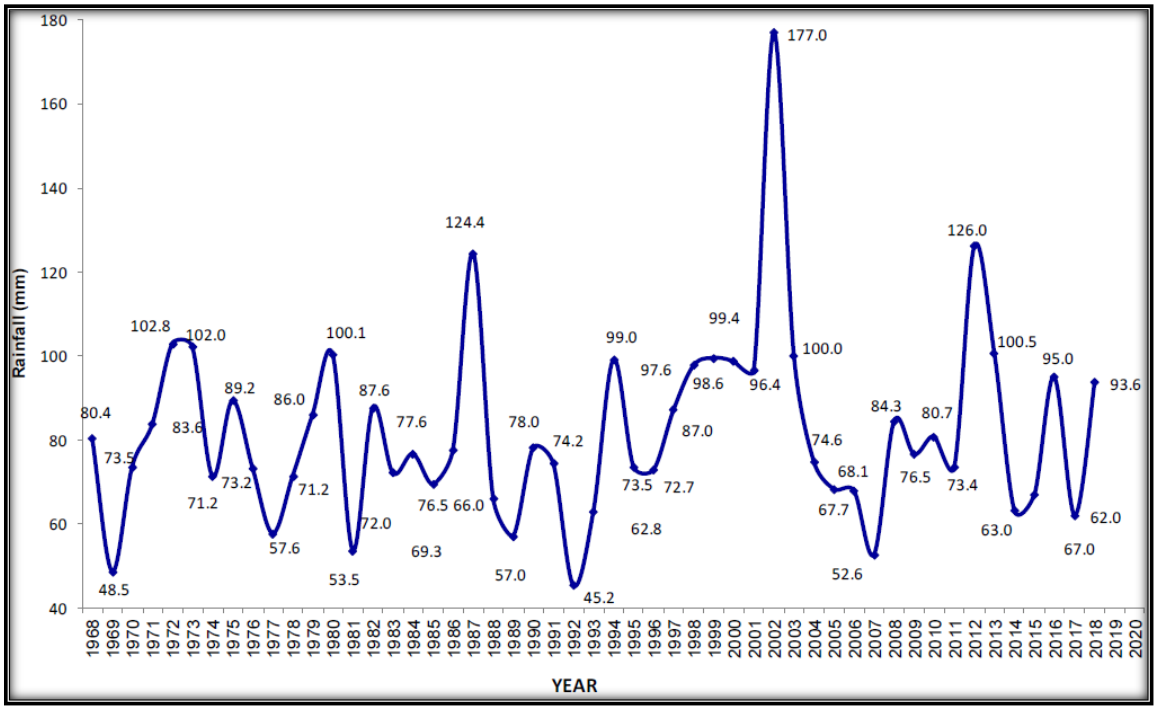

Figure 4: Annually extreme rainfall of Kathmandu station recorded from 1968- 2018
(Source: Department of Hydrology and Metrology,2019)

3.1.2 Flora (vegetation)

The Suryavinayak hill is a continuous ridge. Suryabinayak forest is one of the most touristic forest areas of the district. Suryabinayak community forest is a natural, mixed and broadleaved forest. The major species of this forest are *Schima wallichii*, *Castanopsis indica*, *Rhododendron arboreum*, *Myrica esculenta*, *Quercus* spp.

Castanea tribuloides, *Schima wallichii* and *Myrica esculenta* are the most frequent and dominant species towards north slope. At south slope, *Syzygium cumini*, *Rhododendron arboreum* and *Schima wallichii* are the most dominant species. The major associated tree species are *Schima wallichii*, *Lyonia ovalifolia* at west slope. *Castanea tribuloides* and *Schima wallichii* dominant species towards east slope. Among shrubs *Cleyera ochnacea* is the most frequent and dominant species at west, east and south slopes. *Lyonia ovalifolia* is the associated species at west slope and *Hypericum uralum*, *Melastoma melabathricum* at east slope. *Hypericum uralum*, *Castanea tribuloides* and *Osyris wightiana* dominant species at south slope. Regarding herbs, *Eragrostis* sp. was the most dominant at west and north slopes. *Oxalis corniculata* as well as *Imperata cylindrica* is the dominant species at west and east slope. *Drymaria cordata* is the most frequent and dominant species at north slope.

3.1.3 Fauna

Fifteen species of mammals were recorded in Bhaktapur District (Gosai et. al. 2014). Common mammals include Small Indian Mongoose (*Herpestes aurupunctuatus*), Orange-bellied Himalayan Squirrel (*Dremomys lokriah*), Rhesus Macaque (*Maccaca mullata*), field rat (*Bandicota maxima*), Indian flying fox (*Pteropus gangeteus*), Shrew (*Sorex* sp), *Rhinoliphus* spp. etc. Chinese Pangolin (*Manis pentadactyla*) is one of the endanger species found in Suryabinayak forest. Common species of bird species are Sikhra (*Accipiter badius)*, Himalayan Buzzard (*Buteo refectus)*, Steppe Eagle (*Aquila nipalensis)*, Kalij Pheasant (*Lophura leucomelanos*, Flycatcher *(Cyornis rubeculoides)*, Grey Bushchat (*Saxicola ferreus)*, Rusty-cheeked Scimitar-babbler (*Erythrogenys erythrogenys)*, Common Cuckoo (*Cuculus canorus)*, House Swift (*Apus nipalensis)*. Rat Snake (*Ptyas mucosa mucosa*), Common Indian Skink (*Lampropholis guichenoti***)**, Garden Lizard (*Calotes versicolor*) are common reptiles found in Suryabinayak forest.

3.1.4 Culture and ethnicity

The study area is surrounded by villages inhabited by Newars along with other groups such as Brahman and Chhetri, Gurung, etc. Majority of villagers near the forest area depend on the forest for their livelihood. Main occupation of villagers is agriculture and animal husbandry. Rice (*Oryza sativa*), Wheat (*Triticum* spp.), Corn (*Zea Mays*) and Millet (*Eleusine coracana*) are major crops in the area, whereas Mustard (*Brassica campestris*), Potato (*Solanum tuberosum*), and legumes are grown as minor crops. Livestock is the major component of the agricultural system in the area. The main livestock groups are cattle, buffalo, goat, pig and poultry etc.

3.2 Research design

3.2.1 Sampling of birds

The line transect sampling method was used to evaluate the bird diversity and their habitat association. Line transects methods with an ingrained tendency to have lower bias and higher precision are useful for the detection of birds (Buckland 2006; Gale et al., 2009). A total of five-line transects were laid down to cover major habitat types. The birding routes cover different habitats i.e. forest, agricultural land, corridor and settlement areas. Each transect was used as the reference points for the plots setting. Observations of birds were carried out at every 300m interval of transect and the distance between the two transects was designed 500m apart from each other. Based on the preliminary reconnaissance survey and findings from literature review, a potential habitat in the study area was mapped using the QGIS version 2.18. The potential habitat was further stratified into four habitat types: settlements, agricultural land, corridor (between forests, settlement and agriculture) and forest. Using Fishnet in QGIS 2.18, 0.2 square kilometre grid was overlaid to generate equal sample number in each zone to assess the species diversity and habitat parameters. The centre point of the sample grids was marked and uploaded in GPS for easy finding of plots on the ground. Altogether 50 plots were established for the observation of birds in the study area.

3.2.2 Bird survey techniques

Fixed point count method was used for the survey of birds within the radius of 50m. Fixed point count method is widely used approach for surveying birds in different land use types (Hutto et al. 1986, Shultz et al. 2004, Waltert et al. 2005, Fardila and Sjarmidi 2012) and to study the species-habitat relationships (Alldredge et al. 2007). Birds observation were

done early in the morning from 6:30 AM to 11:30 AM. At each plot, 15 minutes was spent but repeated observation of the same species was not count. A Bushnell binocular (magnification 8x40) and Canon camera (50X) was used for the effective survey of bird. A field guidebook Birds of Nepal (Grimmet et al. 2003) was used for the identification of birds and GPS used to mark the location of the plots. Photograph of unidentified species were identified with the help of bird expert in Kathmandu. Call Count Method was employed within the plots for the identification of shy birds that cannot be observed directly. Unfamiliar calls were recorded with the help of a recorder and identify them with the help of bird experts of Friends of Birds.

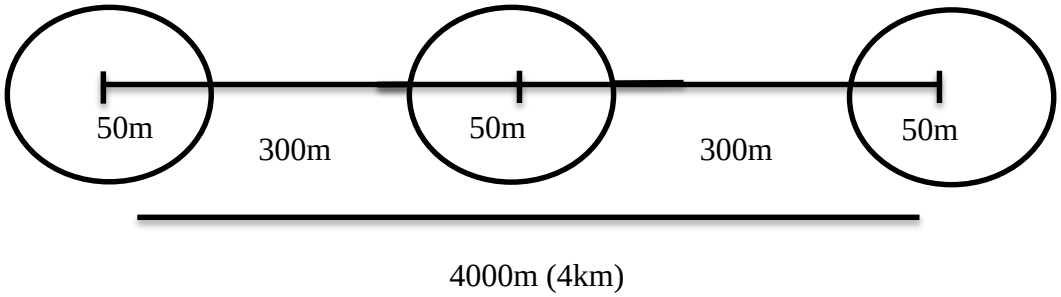

Figure 5: Observation point using point count method

3.2.3 Threat Assessment

Potential threats of birds were qualitatively judged based on intensive field visit and questionnaire. Altogether, 64 households were included in the study using a random sampling method with more than 200 m household interval distance. Based on preliminary survey, possible threats were categorized into five major types as habitat destructions, forest fire, poaching, overgrazing and use of pesticides. Extents of threats were identified by counting the total sites where sign of each threats type were observed.

Category of threatened bird's status was identified with the help of IUCN and CITES threat categories. It was categorised as critically endangered, endangered, vulnerable, near threatened and to respective CITES appendix.

3.3 Data analysis

The computer-based Microsoft Excel was used for collected data in tabulated form. Species richness of the birds was calculated by using SPSS- software and Chi Square test was used to calculate the seasonal variation of species richness between the two seasons. Also, one way ANOVA was used to see the significant difference in species richness of birds in different land use types in two different seasons. Following statistical tools were used:

Shannon-Wiener's Diversity Index

Shannon Weiner diversity index (Shannon and Weaver 1949) was used to calculate the species diversity of particular area which is calculated as:

$H' = -\sum_{i=1} Pi \, Ln \, Pi$

Or, if Pi= ni/N

Where,

H = Index of species diversity

H' = Shannon Wiener Diversity index

Pi = The proportion of individuals in the i^{th} species = $\frac{ni}{N}$

ni = Importance value for each species (number of individuals)

N = Natural Logarithm (Total number of individuals)

Evenness index

To calculate whether species was distributed evenly across seasons and across different land use type, evenness index was used (Shannon and Weaver 1949). It was determined by the equation;

$E = H'/H_{max}$

Where:

$E = H'/H_{max}$

E= Evenness index

H' = Shannon Wiener Diversity index

H_{max} = Natural log of total number of species

Relative Abundance

Relative abundance of avian species was determined by using encounter rates that give crude ordinal scales of abundance (Bibby et al., 1998, Lowson et al. 1998) **(**Table 1). It was determined by the equation;

Encounter rate= ((Total of number individual birds observed)/ (Period hour in observation)*10

Table 1 : Using encounter rates to give a crude ordinal scale of abundance (From Lowson et al. 1998)

Abundance category (number of individuals/10 field hours)	**Abundance score**	**Ordinal scale**
<0.1	1	Rare
0.1 - 2.0	2	Uncommon
2.1 - 10.0	3	Frequent
10.1 - 40.0	4	Common
40.0 +	5	Abundant

CHAPTER IV
RESULTS

4.1 Species diversity

A total of 5070 individuals of birds belong to 112 species from 13 orders and 42 families were recorded during this study (Appendices 1). Order Passeriformes had the highest diversity (76 species; 26 families) followed by Cuculiformes and Falconiformes (six species; two families in each order). Order Piciformes had 5 species and 2 families. Columbiformes had 4 species and 1 family. Similarly, Pelecaniformes and Coraciformes (three species; one family), Psittaciformes and Strigiformes (two species; one family), Gruiformes and Charadriformes (one species; in each family). Among the Order Passeriformes, we recorded higher number of birds on the families Muscicapidae in this study period (Figure 6 and 7).

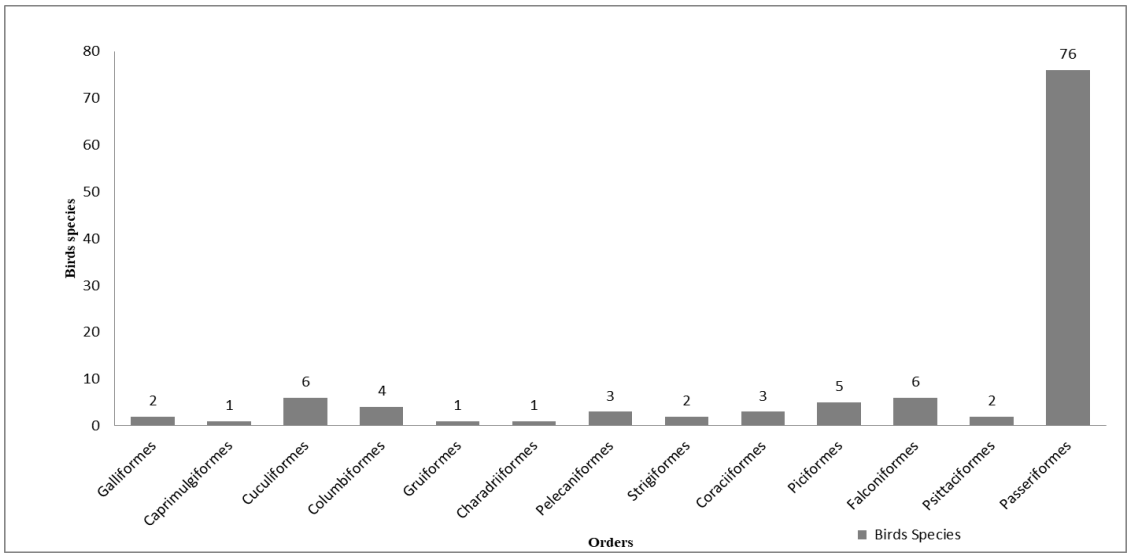

Figure 6: Number of bird species in different orders

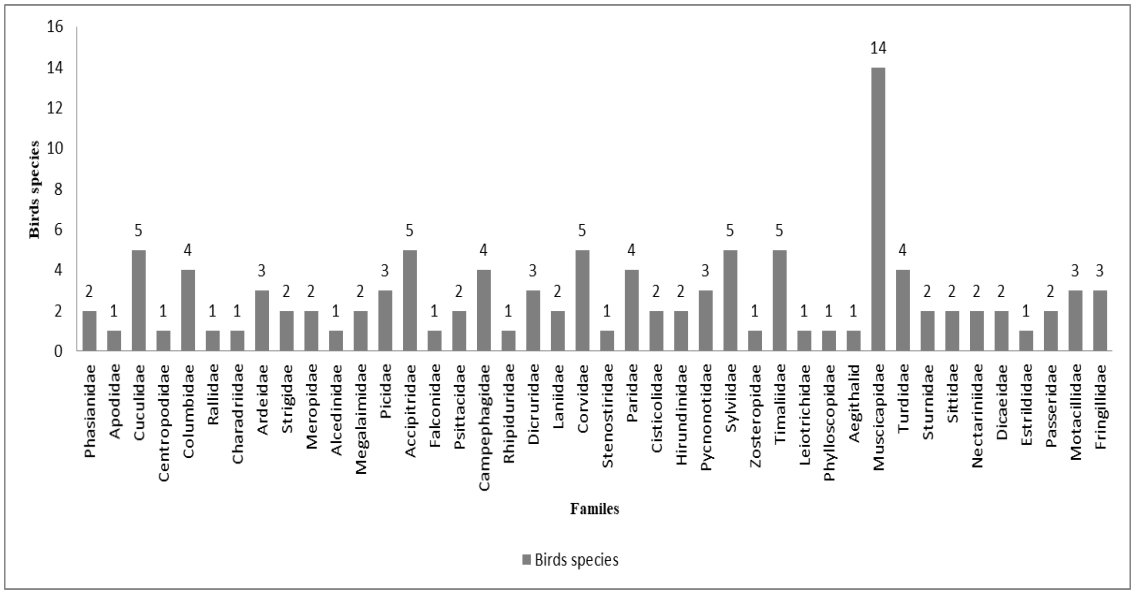

Figure 7: Numbers of bird species in different families

4.2 Seasonal variation of bird

Ten out of 13 orders of birds were recorded in both winter and summer seasons. Three order Galliformes, Gruiformes and Charadriiformes were found only in the summer season. Around 79% (89 species) of bird species were resident, followed by winter migrants (4%; 5 species) and the 10% (11 species) were summer and remaining (6%; 7 species) partial migrant. (Appendices 1).

Eighty-eight species of birds were recorded in winter seasons belonging to 9 orders and 37 families. Similarly, eighty- one species of birds were recorded in summer seasons belonging to 13 order and 35 families. Fifty-five bird species were found common in both winter and summer seasons (Table 2). Higher bird abundance was found in the winter season than in summer.

Shannon winner diversity index showed that winter season (H = 3.74) had more diverse bird assemblage than summer season (H= 3.33) (Table 2). Evenness index also showed that birds were more evenly distributed in winter season (E=0.84) than summer (E=0.76) (Table 2).

Species such as Asian Koel (*Eudynamys scolopaceus*), Blue-capped Rock Thrush (*Monticola cinclorhynchus*), Blue-throated Blue-flycatcher (*Cyornis rubeculoides*), Bonelli's Eagle (*Aquila fasciata*), Chestnut-bellied Nuthatch (*Monticola rufiventris*), Chestnut-capped Babbler (*Timalia pileata*), Chestnut-headed Bee-eater (*Merops*

leschenaultia) etc. were seen during summer season. Blue-bearded Bee-eater (*Nyctyornis athertoni*), Blue-fronted Redstart (*Phoenicurus frontalis*), Bronzed Drongo (*Dicrurus aeneus*), Buff-barred Warbler (*Phylloscopus pulcher*), Chestnut-bellied Rock Thrush (*Monticola rufiventris*), Common Kestrel (*Falco tinnunculus*), Common Rosefinch (*Carpodacus erythrinus*), Common Stonechat (*Saxicola torquatus*) etc. were seen during winter season. Alexandrine Parakeet (*Psittacula eupatria*), Ashy Drongo (*Dicrurus leucophaeus*), Barn Swallow (*Hirundo rustica*), Eurasian Tree Sparrow (*Passer montanus*), Great Barbet (*Psilopogon virens*), House Crow (*Corvus splendens*), Oriental Magpie-robin (*Copsychus saularis*) were seen on both seasons (Appendices 2).

Table 2: Comparison of Species richness and evenness of bird recorded during winter and summer seasons

Seasons	Order	Family	Number of Species	Number of Birds	Shannon Diversity (H)	Evenness Index (E)
Summer	13	35	81	2696	3.33	0.76
Winter	9	37	88	2374	3.74	0.84

Chi-square statistics were used to examine association between categorical variables (seasonality and species richness). There was an insignificant association at 5% significance level between seasonality and species richness (χ^2= 54.804, df = 111 (n=112), p = 1) (Table 3). The p-value of 1 is much higher than the commonly accepted level of 0.05. Hence, the null hypothesis was not rejected.This test conclued that bird species diversity was high in their favourable climate.

Table 3: Chi-square test between species richness between two seasons

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	54.804[a]	111	1.000
Likelihood Ratio	75.956	111	.996
N of Valid Cases	169		
a. 224 cells (100.0%) have expected count less than 5. The minimum expected count is .48.			

4.3 Habitat Associations and Bird Diversity

The highest number of species sightings was in the agriculture land comprising of the others. In the agriculture area, a total of 2413 individuals belonging to 93 species were recorded. In the edge, a total of 781 individuals were recorded representing 70 bird species. Similarly, in forest a total of 495 individuals and 54 species were recorded. The area with the highest individuals and fewest species was settlement. In the settlement area, a total of 1381 individuals belonging to 20 species were recorded (Table 4).

Shannon winner diversity index showed that the most diverse habitat was the agriculture (H = 3.69) followed by the edge (H=3.65) forest (H=3.34), and finally the settlement area which is heavily disturbed habitat (H= 2.23) (Table 4).

In evenness index birds were more evenly distributed in edge (E=0.86), than agriculture (E=0.81), forest (E=0.84) settlement (E=0.74) (Table 4). In this study greater similarity was found between agriculture, edge and forest in terms of species composition compared to areas with high disturbance and human encroachment, such as settlement. The result of this investigation also demonstrated that as the structure of the vegetation changed and the amount of disturbance increased, the abundance of bird sightings also decreased.

Chestnut-capped Babbler (*Timalia pileata*), Chestnut-headed Bee-eater (*Merops leschenaultia*), Dark-breasted Rosefinch (*Procarduelis nipalensis*), Green-billed Malkoha (*Phaenicophaeus tristis*), Paddy field Pipit (*Anthus hodgsoni*), Striated Prinia (*Prinia crinigera*) etc. were recorded in the agriculture habitat. Chestnut-bellied Rock Thrush (*Monticola rufiventris*), Green-tailed Sunbird (*Aethopyga nipalensis*), Hill Partridge (*Arborophila torqueola*), Laughing thrushes (*Garrulax* sp.) etc were recorded species. Scaly Thrush (*Zoothera dauma*) was only seen in forest area. Alexandrine Parakeet (*Psittacula eupatria*), Ashy Drongo (*Dicrurus leucophaeus*), Asian Koel (*Eudynamys scolopaceus)*, Black Kite (*Milvus migrans*), Black-lored Tit (*Machlolophus xanthogenys*), Blue Whistling-thrush (*Myophonus caeruleus*), Blue-throated Barbet (*Psilopogon asiaticus*) etc were seen in agricultural, edge and forest. Oriental Turtle-dove (*Streptopelia orientalis*) was seen in all four habitats (Appendices 2).

Table 4 : Comparison of Species richness and evenness of bird recorded in different habitats

Habitats	Order	Family	Number of species	Number of birds	Shannon Diversity (H)	Evenness Index (E)
Agriculture	12	38	93	2413	3.69	0.81

Habitats	Order	Family	Number of species	Number of birds	Shannon Diversity (H)	Evenness Index (E)
Edge	12	33	70	781	3.65	0.86
Forest	10	25	54	495	3.34	0.84
Settlement	7	17	20	1381	2.23	0.74

4.4 Bird diversities in different land use types in different seasons

Among four different habitats, agriculture was found more diverse in both seasons. Shannon winner diversity index showed that agriculture (H = 3.43) had more diverse bird in summer as well as in winter (H= 3.69). Similarly, Shannon winner diversity index is less in settlement in both seasons. Evenness index showed that birds were more evenly distributed in edge and less distributed in settlement in both seasons which were moderately disturbed land use type with heterogeneous vegetation type (Table 5).

Table 5: Bird diversities in different land use types in different seasons

Seasons	Habitat	Order	Family	Number of Species	Number of Birds	Shannon Diversity (H)	Eveness Index (E)
Summer	Agriculture	12	31	67	1364	3.43	0.82
	Edge	11	30	52	419	3.32	0.84
	Forest	10	24	40	218	3.07	0.83
	Settlement	4	10	15	695	1.96	0.72
Winter	Agriculture	12	38	74	1049	3.69	0.85
	Edge	12	33	54	362	3.52	0.88
	Forest	7	25	32	277	3.03	0.87
	Settlement	7	17	18	686	2.40	0.83

One way ANOVA revealed that there was significant different ($F = 4.198$, $df= 3$ ($n=4$), $P < 0.006$) in bird diversity among the habitats in two different seasons. The calculated value of One-way ANOVA) at 5% level of significance and 3 df ($n=4$) was higher ($F=4.198$) than tabulated value ($F =2.60$). So, the null hypothesis was rejected i.e., prevalence of habitats in the species richness (Table 6).

Table 6 : ANOVA test of bird diversity among the habitats in two different seasons

Source of Variation	Sum of Squares	Df	Mean Square	F	P-value (Sig.)
Between Groups	12264.602	3	4088.201	4.198	.006
Within Groups	1193800.635	1226	973.736		
Total	1206065.237	1229			

4.5 Relative abundance of species

Abundance score and ordinal scale of birds calculated by encounter rate revealed that most avian species, 41 species and 31 species found within the ordinal rank of uncommon and frequent respectively. Least species of birds was recorded as "common" (n=26) and as "abundant" (n=14) (Figure 8).

The relative abundance was higher during summer season than in winter season although the species richness was higher during winter season than in summer season. From the total 81 bird species recorded in summer season, many bird species were recorded as uncommon (n=31) followed by the rank of frequent (n=27), common (n=15) and abundant (n=8) (Figure 9). Similarly, out of 88 winter species, 38 species were uncommon, 20 species were frequent, 24 species were common and 6 was abundant (Figure 9).

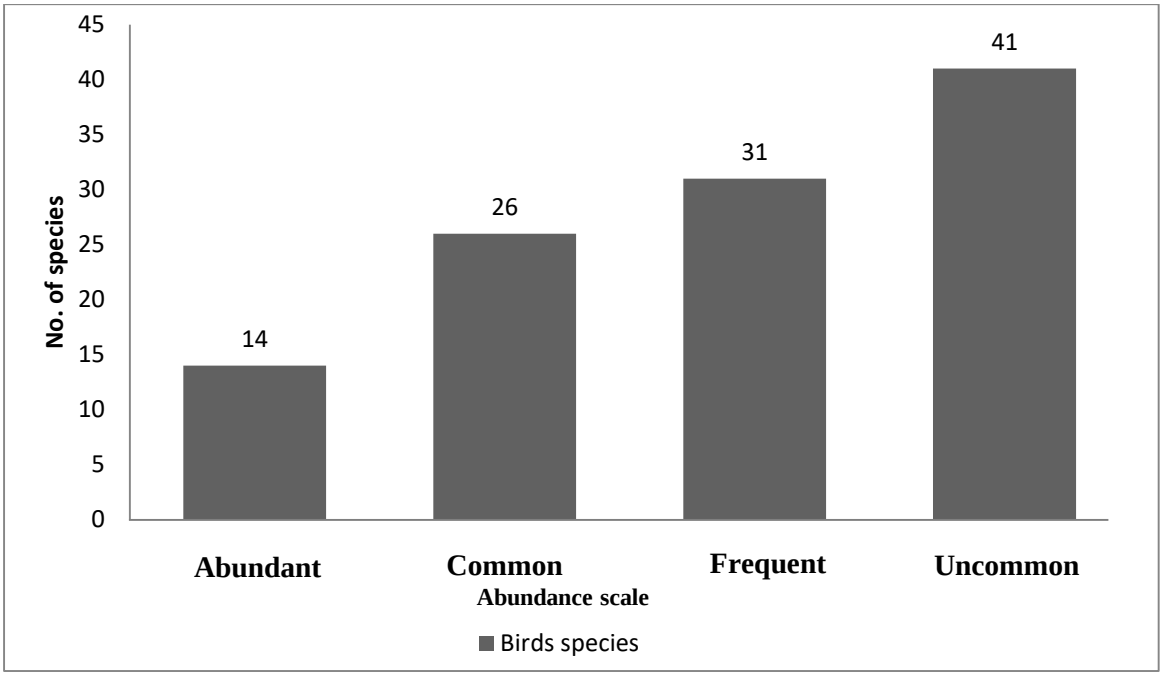

Figure 8: Local abundance status of birds

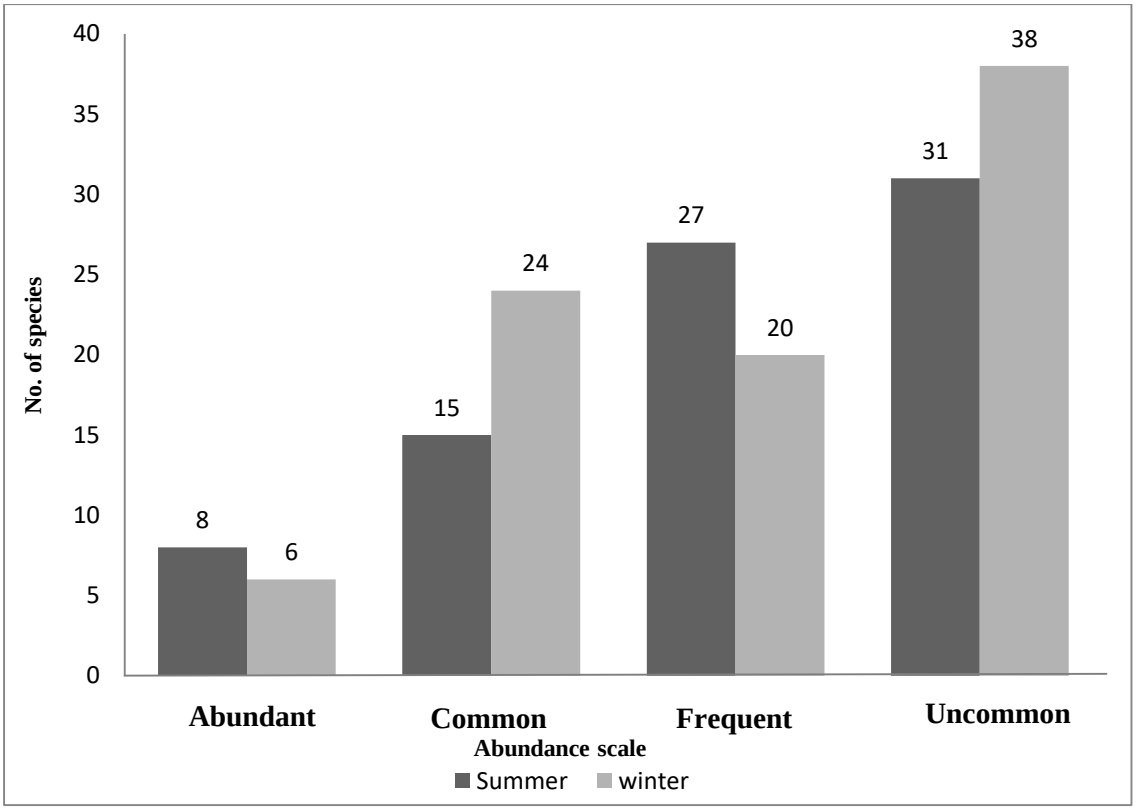

Figure 9: Status of local abundant category of bird species between two seasons

4.6 Threats to birds

Habitat destructions were serious threats in the study area (Figure 10). Presence of the Ganesh Mandir and the picinic spots different types of recreational activities of human inside the forest area have created disturbances to the bird. There were poaching of bird for the purpose of meat. The local people used catapult to kill birds and jungle fowl. Uncontrolled and non-recommended use of pesticides and fertilizers by farmers were found in the agricultural areas.

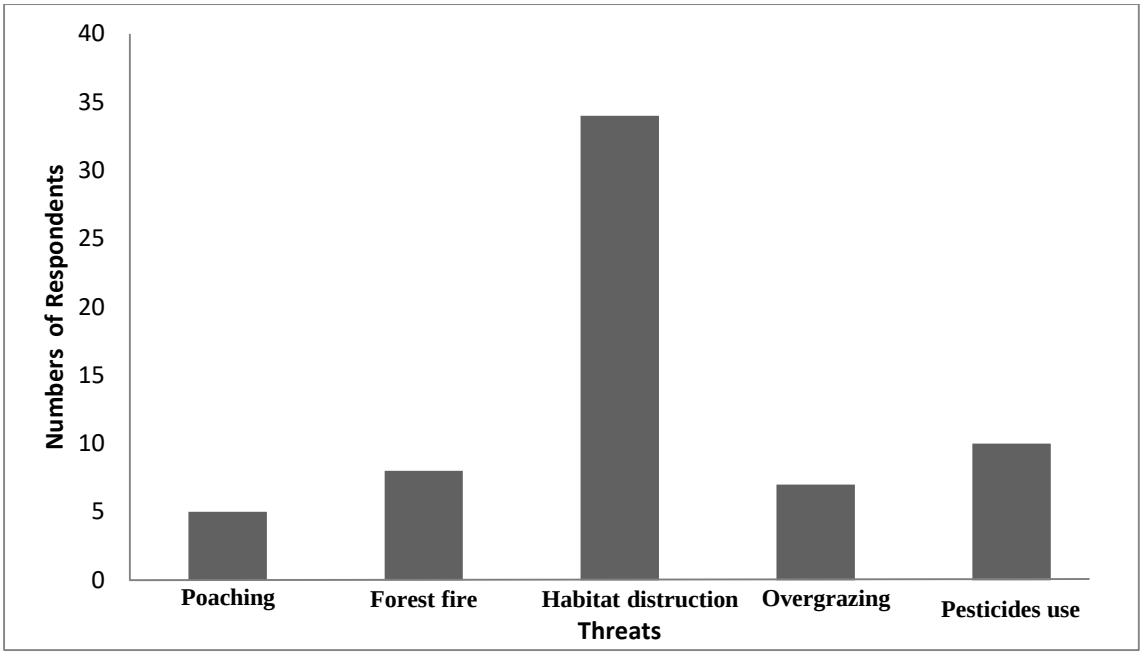

Figure 10: Threats to birds

4.7 Threatened bird species of Suryabinayak

Of the total recorded species, two species were Globally Threatened species viz. Alexandrine Parakeet (*Psittacula eupatria*), Steppe Eagle (*Aquila nipalensis*) and three species were Nationally Threatened species viz. Alexandrine Parakeet (*Psittacula eupatria*), Steppe Eagle (*Aquila nipalensis*) and Scaly Laughingthrush (*Garrulax subunicolor*). Out of three Nationally Threatened species, two species were Near Threatened and one species was vulnerable (Table 7). Similarly, total of 2 globally threatened species each of them from Endangered and Near threatened (Table 7).

Similarly, Kalij Pheasant (*Lophura leucomelanos*) and 9 species of birds included Alexandrine Parakeet (*Psittacula eupatria*), Asian Barred Owlet (*Glaucidium cuculoides*), Black Kite (*Milvus migrans*), Himalayan Buzzard (*Buteo refectus*), Bonelli's Eagle (*Aquila fasciata*), Shikra (*Accipiter badius*), Spotted Owlet (*Athene brama*),Steppe Eagle (*Aquila nipalensis*) and Common Kestrel (*Falco tinnunculus*) are listed in CITES category III and II were recorded; respectively (Table 7).

Table 7 : Status of Threatened Birds on the Basis of IUCN Red List 2018 and CITES Category

S.N	Species	Scientific name	CITES category	IUCN category	
				Global Status	National Status
1.	Alexandrine Parakeet	*Psittacula eupatria*	II	NT	NT
2.	Asian Barred Owlet	*Glaucidium cuculoides*	II		
3.	Black Kite	*Milvus migrans*	II		
4.	Himalayan Buzzard	*Buteo refectus*	II		
5.	Bonelli's Eagle	*Aquila fasciata*	II		
6.	Shikra	*Accipiter badius*	II		
7.	Spotted Owlet	*Athene brama*	II		
8.	Steppe Eagle	*Aquila nipalensis*	II	EN	VU
9.	Scaly Laughingthrush	*Garrulax subunicolor*			NT
10.	Kalij Pheasant	*Lophura leucomelanos*	III		
11.	Common Kestrel	Falco tinnunculus	II		

Endangered (EN) and Vunerable (VU)) and Near Threatened (NT)

CHAPTER V
DISCUSSION

5.1 Bird species richness

The study revealed the presence of 112 species of birds belonging to 13 orders and 42 families in the Suryabinayak Municipality, Bhaktapur. The documentation of 112 bird species suggests the Suryabinayak Municipality has the high bird diversity which is 12.62 % of the total bird species recorded in Nepal (DNPWC and BCN 2018). The study area was small and surveys were carried out within a period, higher species richness was found (H=3.64 and E= 0.77). About 320 species of birds have been recorded in the Shivapuri-Nagarjun National Park (SNNP, 2017). Bird diversity in those areas wasn't so good in Suryabinayak Municipality and its associated area compared to Shivapuri forest of Shivapuri-Nagarjun National Park, Kathmandu. This investigation revealed that nearly one third of avian species of the SNNP. The number of bird species in my study seems low when compared to the record of 168 found in Suryabinayak forest (Katuwal et,al 2016) which could be limited to study area and covering two seasons of summer and winter only. Although the survey was carried out within a short period time the observation, reveals that the study area supports a healthy avian diversity. The high bird species richness evinces uniquiness and exquisiteness of the study area.

The highest number of species was recorded from the Passeriformes order and Muscicapidae family of the total identified species. The study conducted by (Chaudhary et al. 2009) the highest number of species from Passeriformes order in Khata corridor Forest, Nepal. Passeriformes was also numerically the dominant order in the study carried out by (Husein et al. 2019) in Nansebo Forest, Southern Ethiopia. (Kandel et al. 2018, Thakuri et al. 2018) also found the Muscicapidae as the most common and diversely represented family during the study conducted in Kanchanjunga landscape of Eastern Himalayas and Western Nepal respectively.

5.2 Bird species in different season

The result of the present study showed the higher bird diversity during winter season comparison to summer season which is probably due to increase in local movement of birds in search of food resources and easy detection of birds as in this season defoliation of the plants occur which made birds to be detected easily. Species richness significantly increased from pre-monsoon to the monsoon and post-monsoon seasons. This demonstrates

that the precipitation regime driven by monsoon has a strong impact on the seasonal distribution and species richness of birds in central part of the Nepal. The high species richness might be attributed to diverse habitat conditions and seasonality in environmental factors like light, temperature, humidity, precipitation, food availability, vegetation, flowering of plants, etc. The result was in agreement with the study conducted by (Katuwal et al. 2018, Tzortzakaki, et al. 2018) where the higher number of species was recorded in winter season than in summer season. Acharya (2013) reported the diversity of bird was found higher in winter season in Bardiya National Park because of the flowering in early winter assured food availability. During the winter season the rate of migration of bird species found high i.e. most of the foreign bird species were migrated during winter season. Assemblage of many migratory birds in the winter season due to favorable ecological and climatic conditions also contributed to high species richness (Parajuli 2016). Due to migration timing, as well as the availability of thick leaves on trees and bird being less vocal during the breeding period could influence in counting summer migrants (Katuwal et al. 2018). In this season, breeding of most of the birds occurred which might lead to the increase in the number of the species. Harsha and Hosetti (2009) reported flowering in the early winter assure food availability could be contributed for high species richness. Assemblage of many migratory birds in the winter season due to favourable ecological and climatic condition has also contributed for high species richness. However, Aryal (2013) found less species during winter season in Ghunsa valley of Kanchanjunga Conservation Area because landscapes above 3,000m were covered by snow in winter season. Birds are unable to tolerate the high temperature in summer season so that low species were recorded in summer. This is similar with the finding of (Abie et al. 2019) where the species abundance was higher in summer season as wet season created conducive environmental condition for bird species in terms of food, cover and other habitat requirements to had high distribution in the study area. Bird migration also changes the number of bird species in different seasons and habitats (Baniya et al. 2009). Different studies such as Aryal (2013), Chapagain (2014). Ghimire (2009), Levey (1988) and Murgui (2007) have shown that species richness was highest during monsoon season and lowest during winter season.

5.3 Bird species in different habitats

Complexity and the nature of habitats and micro habitats constitute a valuable factor that determines the species composition and diversity in a particular area. Thereby several bird species tend to find their own suitable habitats where they have access and resources to

feed and breed. Highly complex habitats provide wide array of opportunities to higher number of bird species as they are enriched with wide range of foods and other resources to sustain lives. In the present study, birds were observed in forests, edge, agriculture land and settlements whereas the maximum abundance of species was associated towards agriculture (93 species) followed by edge (70 species), forest (54 species) and cultivated area (20 species). It is because the Paddy, wheat, grains, vegetables, fruiting trees comprises of a greater number of sources (food, feeding sites, roosting, nesting sites, etc.). Nsor et al. (2014) reported farming activities, grazing pressure, and bushfires as the factors affecting bird diversity. Relatively high species diversity of avian fauna in the area could be attributed to the various habitat types (vegetation types) that constitute the area and these could provide them different arrays of foraging opportunities and nesting sites (Girma et al. 2017). The study conducted by (Kiros et al. 2018) where the higher number of species in shrub land were found which might be due to the vegetation composition that could create variations in food sources, nesting and protection opportunities based up on the bird's habitat preference and feeding habits. The shrubs attract more number of insectivorous birds by providing the required food resources to them. Besides the food supply, the shrubs also serve as ideal perching sites for the insectivore birds. Flowering plants support wide variety of birds as they feed on nectars, berry, fruits and seeds (Brook and Berkead 1991). The variation in species dominance among different habitats could be attributed to the presence food availability, suitable cover and nesting sites, adaptation or tolerance level of the species and the degree of the threats presented in the habitats (Girma et al. 2017). Human settlement at some levels might limit avian productivity by diminishing resources, increasing nest predation, competition for resources, and brood parasitism (Marzluff et al. 2001). Bird species richness and community structure differ from region to region (Richards, 1969, Pearson, 1975). Because these habitats are comprised of more resources in terms of shrubs and food source, which will provide the feeding and foraging sites for birds (especially insectivorous birds). Most of the birds were utilized edge as the prime habitat because of the easy assessment of food materials and edge effect. Edge is taken as prime habitat for most birds and also breeding birds (Grimmet et al. 2003). Forests, especially corridor site with the human settlements support a higher number of avifaunal diversity (BirdLife International 2008). Rimal (2006) found higher species richness in undisturbed forests than in disturbed one. Inskipp (1989) also suggested that forests are the important habitats for wintering birds and passage migrants. Distribution of feeding guilds is too governed by food availability and landscape heterogeneity along the urban–rural

gradients (Chace and Walsh 2006; Jokimaki et al.2009; Samia et al. 2015). Decline of insectivore richness along the urban areas was reported in different studies (Blair and Johnson 2008; Leveau 2013; Plass and Wunderle 2013; Rija et al. 2014) largely due to the fact that the richness and abundance of insects are low with increasing urbanization (Clark et al. 2007; reviewed in Jones and Leather 2012). Similarly, a low number of birds' species in urban areas may be due to the lack of sufficient fruiting trees in human-dominated landscapes. Various studies such as Inskipp (1989), Daily et al. (2001), Grimmet et al. (2003), Waltert et al. (2004, 2005), DNPWC (2011), Fardila and Sjarmidi (2012), Aryal (2013), Chapagain (2014), Pokharel (2015), Parajuli (2016) and Adhikari et. al (2018) have shown that species richness decreases from natural forest to agricultural land in different protected and unprotected areas of Nepal.

5.4 Relative abundance of species

The number of uncommon species registered at suryabinayak municipality was high. Those species which have low number of individuals relative to the effort made during the survey compared to others were grouped in the uncommon category. Large number of bird species were found to be ranked under uncommon based on their relative abundance scores. This might be related to vegetation complexity, inconspicuousness of small birds, roosting and feeding. Ryan and Owino (2006) suggested that the presence of large number of uncommon species in certain area could be related to the breeding nature, large home range and niche of the species; besides the degradation of the habitat. In addition, Karr (1976) suggested that the number of individual birds varied independently within the study area. Some species abandon the specified area, decreasing both in the number of species and individuals, while others may have a reduced number but may be present as a few scattered individuals throughout the year. Even species with a relatively stable population will tend to show variation in abundance and occupancy over time (Gaston et al., 2000). The rarity of the African Finfoot is related to the degradation or patchiness of the habitat. According to Wilson and Comet (1996), the absence or rarity of several species appeared to be related to habitat condition. Thiollay (1994) suggested that species that are consistently rare have either large home range or patchily distributed.

The relative abundance of bird species during wet and dry seasons might be related to the availability of food, habitat condition and breeding season of the species. Therefore, species distribution and abundance can be influenced by seasonal variation. Many factors could account for this. For example, Karr (1976) related the seasonality in the number of bird

species with the availability of resources such as food and vegetation strata and found that the number of bird species varied seasonally with peaks in the late dry and early wet seasons.

The Alexandrine Parakeet, Barn Swallow, Black-Lored Tit, Cattle Egret, Common Myna, Common Tailorbird, Grey-Hooded Warbler, House Crow, House Sparrow, Jungle Crow, Jungle Myna, Red-Vented Bulbul, Rock Pigeon, Tree Sparrow birds with high number of sightings; they accounted for 65.06 % of the total relative abundance. This might be due to more stable source of food for these species. As some evidence justified that unless most birds should migrate, their food supplies in their ranges would be rapidly depleted and then they would starve and die. This evidence also indicated that breeding is other cause for migration of birds (Mayntz, 2017). Asian Koel was the most common and found only in summer season and Common Stonechat was most common winter season in the study area. The reason might be related to its ecological adaptations. The relative abundance of birds in the study area is related to the availability of food, habitat condition and breeding season of the species. Similar result was also obtained by Girma and Afework (2009) who reported positive correlation between bird species richness and the availability of vegetation strata. Similarly, Chace et al. (2006) reported that birds respond to changes in vegetation composition and structure, which in turn affects their food resources.

5.5 Threats to birds in Suryabinayak

Bird populations are at risk due to the loss of natural habitats. Birds in Suryabinayak Municipality were seriously threatened by Pollution, habitat fragmentation and degradation, mining, poaching etc. Human-induced disturbances such as firewood extraction, grazing, and logging may cause subtle to major landscape change. Poaching of birds either for meat or for pet was common in the study area. Local ethnic groups below the age of 20 were found engaged in poaching activities. Children with catapult were encountered in the study area. Some of the birds like Parakeet, Dove, Cuckoo and myna were found adopted in cage around settlements. Rapid deforestation of forests and other large-scale human disturbances have increased concern about their effect on vegetation structure as well as on bird communities (Schulte and Niemi 1998). It is evident that harvesting resources for human use causes thinning of woodlands (Griffin and Muick 1990), affects vegetation structure and composition (Block and Brennan 1993; Chettri et al. 2001), reduces canopy structure, and brings about changes in the age and size distribution of stands (Sundriyal and Sharma 1996; Aigner et al. 1998). Such changes affect

occupancy and resource use patterns of birds (Block and Brennan 1993; Chettri et al. 2001). However, in order to understand bird community structures and their relationships with variations in vegetation types, it is important to relate them to changed habitats (Wiens and Rotenberry 1981). Therefore, it is vitally important to assess the relationship between birds and habitat changes. Recent studies show that climate change and invasive species are two major drivers of ecosystem degradation and biodiversity loss (Lamsal et al., 2017).

5.6 Threatened bird species of Suryabinayak

Of the 42 globally threatened and 167 nationally threatened species of birds in Nepal (DNPWC and BCN 2018), 2 globally threatened and 3 nationally threatened species were recorded. Baral et al., 2013 reported nine globally threatened and 13 nationally threatened species in Koshi Tappu Wildlife reserve and its adjoining areas. There were four, 20 and one species of birds recorded in Sagarmatha National Park and its Buffer Zone included in CITES Appendix I, II and III respectively (SNP 2016). Khatri et al. (2019) also recorded 7 globally threatened and 12 nationally threatened species in Phewa Wetland, Nepal. Katuwal et al. (2015) reported two nationally threatened species Barn Owl (*Tyto alba*) and Pied Thrush (*Zoothera wardii*) from Chandragiri Hill. Similaryly, Thakuri (2013) reported 3 globally threatened species and 3 nationally threatened species in Manaslu Conservation Area.

CHAPTER VI
CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

This study showed that Suryabinayak Municipality is rich in bird diversity comprising 112 species belonging to 13 orders and 42 families. Order Passeriformes was found dominating order which comprise 76 species and 26 families and Gruiformes was found least dominating order comprising only one species and one family. Among 112 species, 89 species were resident, 5 species were winter visitor and 11 species were summer visitor and 7 were migratory species in summer as well as winter.

Shannon winner diversity index and Evenness index revealed more diverse bird assemblage during winter season than summer. Similarly, Shannon winner diversity index and Evenness index showed that agriculture had more diverse bird assemblage than edge, forest, and settlement. Chi-square ($\chi 2$) at 5% level of significance showed that there was an insignificant association between birds species richness and the seasons which revealed that bird species richness is find high in their favourable climate. One way ANOVA showed that there was significant different in bird diversity among the habitats in two different seasons. Bird species richness was found high in moderately disturbed land use type than other supporting intermediate disturbance hypothesis.

Out of 112 bird species recorded in study area, 41(36.61%) were uncommon with encounter rates 0.1-2, 31(27.68%) species were frequent with encounter rates 2-10, 26(23.21%) were common in its relative abundance with encounter rates 10-40 and 14 (12.5%) were found abundant with encounter rates 40^{+}. Of the 112 recorded species, two species were Globally Threatened species and three species were Nationally Threatened species of IUCN Red List 2018.Similarly, nine species are included in appendix II and one in appendix III of CITES.

Habitat fragmentation and degradation, pollution at the industrial belt, poaching, use of pesticides by the farmers at the agricultural land, mining and lack of awareness were the major threats to birds around the study area.

6.2 Recommendations

Based on this research, following recommendation were made which will be useful for conservation and further study of avian fauna of Suryabinayak Municipality.

- Disturbance created by the lots of visitors (e.g., loud sound, waste materials, plucking flowers etc.) has to be controlled in the forest area near the picnic spot at Ganesh mandir periphery.
- Poaching, keeping of cage birds and use of pesticides should be controlled and awareness program about the importance of birds should be launched for the long-term conservation of bird.
- Population and habitat monitoring of threatened birds in Suryabinayak should be conducted for their conservation.
- Promotion of Suryabinayak sacred forest has to be done for increasing the bird watching tourism.

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APPENDICES

Annex I

1. Checklist of Bird Species Observed

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
	GALLIFORMES											
		Phasianidae										
1			Hill Partridge	*Arborophila torqueola*	1	0.4	U		+	LC		R
2			Kalij Pheasant	*Lophura leucomelanos*	2	0.8	U		+	LC	III	R
	CAPRIMULGIFORMES											
		Apodidae										
3			House Swift	*Apus nipalensis*	48	19.2	C	+	+	LC		R
	CUCULIFORMES											
		Cuculidae										
4			Asian Koel	*Eudynamys scolopaceus*	39	15.6	C		+	LC		PM
5			Asian Emerald Cuckoo	*Chrysococcyx maculatus*	*3*	1.2	U	+		LC		SV
6			Indian Cuckoo	*Cuculus micropterus*	13	5.2	F	+	+	LC		SV

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
7			Common Cuckoo	*Cuculus canorus*	22	8.8	F		+	LC		SV
8			Green-billed Malkoha	*Phaenicophaeus tristis*	10	4	F	+		LC		PM
		Centropodidae										
9			Greater Coucal	*Centropus sinensis*	1	0.4	U	+		LC		R
	COLUMBIFORMES											
		Columbidae										
10			Rock peigon	*Columba livia*	643	257.2	A	+	+	LC		R
11			Spotted Dove	*Streptopelia chinensis*	1	0.4	U		+	LC		R
12			Oriental Turtle-dove	*Streptopelia orientalis*	94	37.6	C	+	+	LC		R
13			Eurasian Collared-dove	*Streptopelia decaocto*	28	11.2	C	+	+	LC		R
	GRUIFORMES											
		Rallidae										
14			White-breasted Waterhen	*Amaurornis phoenicurus*	1	0.4	U		+	LC		R
	CHARADRIIFORMES											

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
		Charadriidae										
15			Red-wattled Lapwing	*Vanellus indicus*	1	0.4	U		+	LC		SV
	PELECANIFORMES											
		Ardeidae										
16			Indian Pond-heron	*Ardeola grayii*	1	0.4	U		+	LC		R
17			Cattle Egret	*Bubulcus ibis*	210	84	A	+	+	LC		R
18			Little Egret	*Egretta garzetta*	14	5.6	F		+	LC		R
	STRIGIFORMES											
		Strigidae										
19			Asian Barred Owlet	*Glaucidium cuculoides*	8	3.2	F	+	+	LC	II	R
20			Spotted Owlet	*Athene brama*	47	18.8	C	+	+	LC	II	R
	CORACIIFORMES											
		Meropidae										
21			Blue-bearded Bee-eater	*Nyctyornis athertoni*	2	0.8	U	+		LC		SV

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
22			Chestnut-headed Bee-eater	*Merops leschenaulti*	2	0.8	U	+		LC		WV
		Alcedinidae										
23			White-breasted Kingfisher	*Halcyon smyrnensis*	24	9.6	F	+	+	LC		R
	PICIFORMES											
		Megalaimidae										
24			Great Barbet	*Psilopogon virens*	51	20.4	C	+	+	LC		R
25			Blue-throated Barbet	*Psilopogon asiaticus*	19	7.6	F	+	+	LC		R
		Picidae										
26			Speckled Piculet	*Picumnus innominatus*	2	0.8	U		+	LC		R
27			Grey-capped Woodpecker	*Picoides canicapillus*	57	22.8	C	+	+	LC		R
28			Fulvous-breasted Woodpecker	*Dendrocopos macei*	46	18.4	C	+	+	LC		R
	FALCONIFORMES											
		Accipitridae										
29			Steppe Eagle	*Aquila nipalensis*	9	3.6	F	+		Global Status-EN,	II,	WV

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
										National Status-VU		
30			Shikra	*Accipiter badius*	4	1.6	U	+	+	LC	II	R
31			Black Kite	*Milvus migrans*	63	25.2	C	+	+	LC	II	R
32			Himalayan Buzzard	*Buteo refectus*	4	1.6	U	+		LC	II	WV
33			Bonelli's Eagle	*Aquila fasciata*	2	0.8	U	+		LC	II	SV
		Falconidae										
34			Common Kestrel	*Falco tinnunculus*	1	0.4	U	+		LC	II	PM
	PSITTACIFORMES											
		Psittacidae										
35			Alexandrine Parakeet	*Psittacula eupatria*	137	54.8	A	+	+	Global Status/ National Status-NT	II	R
36			Rose-ringed Parakeet	*Psittacula krameri*	26	10.4	C	+	+	LC		R
	PASSERIFORMES											
		Campephagidae										

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
37			Long-tailed Minivet	*Pericrocotus ethologus*	3	1.2	U	+	+	LC		R
38			Scarlet Minivet	*Pericrocotus flammeus*	13	5.2	F	+	+	LC		R
39			Black-winged Cuckooshrike	*Coracina melaschistos*	6	2.4	F		+	LC		R
40			Indian Cuckooshrike	*Coracina macei*	13	5.2	F	+		LC		R
		Rhipiduridae										
41			White-throated Fantail	*Rhipidura albicollis*	3	1.2	U	+		LC		R
		Dicruridae										
42			Black Drongo	*Dicrurus macrocercus*	43	17.2	C	+	+	LC		R
43			Ashy Drongo	*Dicrurus leucophaeus*	17	6.8	F	+	+	LC		R
44			Bronzed Drongo	*Dicrurus aeneus*	1	0.4	U	+		LC		R
		Laniidae										
45			Long-tailed Shrike	*Lanius schach*	46	18.4	C	+	+	LC		R
46			Grey-backed Shrike	*Lanius tephronotus*	36	14.4	C	+	+	LC		R
		Corvidae										

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
47			Grey Treepie	*Dendrocitta formosae*	36	14.4	C	+	+	LC		R
48			Red-billed Blue Magpie	*Pyrrhocorax pyrrhocorax*	71	28.4	C	+	+	LC		R
49			House Crow	*Corvus splendens*	465	186	A	+	+	LC		R
50			Large-billed Crow	*Corvus macrorhynchos*	195	78	A	+	+	LC		R
51			Large Cuckooshrike	*Coracina macei*	4	1.6	U	+	+	LC		R
		Stenostiridae										
52			Yellow-bellied fantail	Chelidorhynx hypoxanthus	2	0.8	U	+		LC		R
		Paridae										
53			Green-backed Tit	*Parus monticolus*	2	0.8	U		+	LC		R
54			Grey-crested Tit	*Parus dichrous*	3	1.2	U	+		LC		R
55			Great Tit	*Parus major*	36	14.4	C	+	+	LC		R
56			Black-lored Tit	*Machlolophus xanthogenys*	106	42.4	A	+	+	LC		R
		Cisticolidae										
57			Striated Prinia	*Prinia crinigera*	2	0.8	U		+	LC		R

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
58			Common Tailorbird	*Orthotomus sutorius*	112	44.8	A	+	+	LC		R
		Hirundinidae										
59			Barn Swallow	*Hirundo rustica*	189	75.6	A	+	+	LC		R
60			Red-rumped Swallow	*Cecropis daurica*	4	1.6	U		+	LC		R
		Pycnonotidae										
61			Black Bulbul	*Hypsipetes leucocephalus*	16	6.4	F	+	+	LC		R
62			Himalayan Bulbul	*Pycnonotus leucogenys*	48	19.2	C	+	+	LC		R
63			Red-vented Bulbul	*Pycnonotus cafer*	219	87.6	A	+	+	LC		R
		Sylviidae										
64			Greenish Warbler	*Phylloscopus trochiloides*	2	0.8	U	+		LC		PM
65			Buff-barred Warbler	*Phylloscopus pulcher*	3	1.2	U	+		LC		R
66			Hume's Leaf-warbler	*Phylloscopus humei*	85	34	C	+		LC		R

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
67			Grey-bellied Tesia	*Tesia cyaniventer*	5	2	F	+		LC		R
68			Chestnut-headed Tesia	*Cettia castaneocoronata*	1	0.4	U		+	LC		R
		Zosteropidae										
69			Oriental White-eye	*Zosterops palpebrosus*	95	38	C	+	+	LC		R
		Timaliidae										
70			Streak-breasted Scimitar-babbler	*Pomatorhinus ruficollis*	7	2.8	F	+		LC		R
71			Rusty-cheeked Scimitar-babbler	*Erythrogenys erythrogenys*	71	28.4	C	+	+	LC		R
72			Chestnut-capped Babbler	*Timalia pileata*	1	0.4	U		+	LC		R
73			Black-chinned Babbler	*Cyanoderma pyrrhops*	14	5.6	F	+	+	LC		R
74			Nepal Fulvetta	*Alcippe nipalensis*	25	10	C		+	LC		R
		Leiotrichidae										
75			Laughing thrushes	Garrulax sp.	1	0.4	U		+	LC		R
		Phylloscopidae										

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
76			Grey-hooded Warbler	*Phylloscopus xanthoschistos*	156	62.4	A	+	+	LC		R
		Aegithalid										
77			Black-throated Tit	*Aegithalos concinnus*	31	12.4	C	+	+	LC		R
		Muscicapidae										
78			Chestnut-bellied Rock Thrush	*Monticola rufiventris*	3	1.2	U		+	LC		R
79			Blue-capped Rock Thrush	*Monticola cinclorhynchus*	6	2.4	F		+	LC		SV
80			Oriental Magpie-robin	*Copsychus saularis*	80	32	C	+	+	LC		R
81			Dark-sided Flycatcher	*Muscicapa sibirica*	1	0.4	U	+		LC		SV
82			Verditer Flycatcher	*Eumyias thalassinus*	17	6.8	F	+	+	LC		SV
83			Blue-throated Blue-flycatcher	*Cyornis rubeculoides*	3	1.2	U	+		LC		SV
84			Spotted Forktail	*Enicurus maculatus*	19	7.6	F		+	LC		R

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
85			Grey-headed Canary-flycatcher	*Culicicapa ceylonensis*	35	14	C	+	+	LC		PM
86			Taiga Flycatcher	*Muscicapidae ficedula*	4	1.6	U	+		LC		PM
87			Slaty-blue Flycatcher	*Ficedula tricolor*	4	1.6	U	+	+	LC		R
88			Blue-fronted Redstart	*Phoenicurus frontalis*	6	2.4	F	+		LC		R
89			Grey Bushchat	*Saxicola ferreus*	14	5.6	F	+	+	LC		R
90			Pied Bushchat	*Oenanthe pleschanka*	6	2.4	F	+	+	LC		R
91			Common Stonechat	*Saxicola torquatus*	23	9.2	F	+		LC		R
		Turdidae										
92			Scaly Laughingthrush	*Garrulax subunicolor*	1	0.4	U		+	National status-NT		SV
93			Dark-throated Thrush	*Turdus ruficollis*	1	0.4	U		+	LC		WV
94			Blue Whistling-thrush	*Myophonus caeruleus*	16	6.4	F	+	+	LC		R
95			Scaly Thrush	*Zoothera dauma*	1	0.4	U		+	LC		R

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
		Sturnidae										
96			Common Myna	*Acridotheres tristis*	266	106.4	A	+	+	LC		R
97			Jungle Myna	*Acridotheres fuscus*	121	48.4	A	+	+	LC		R
		Sittidae										
98			Chestnut-bellied Nuthatch	*Sitta cinnamoventris*	5	2	F		+	LC		R
99			Velvet-fronted Nuthatch	*Sitta frontalis*	1	0.4	U		+	LC		R
		Nectariniidae										
100			Green-tailed Sunbird	*Aethopyga nipalensis*	1	0.4	U	+		LC		R
101			Crimson Sunbird	*Aethopyga siparaja*	15	6	F	+	+	LC		R
		Dicaeidae										
102			Plain Flowerpecker	*Dicaeum minullum*	9	3.6	F	+	+	LC		R
103			Fire-breasted Flowerpecker	*Dicaeum ignipectus*	9	3.6	F	+	+	LC		R
		Estrildidae										
104			White-rumped Munia	*Lonchura striata*	3	1.2	U	+	+	LC		R

S.N	Order	Family	Common Name	Scientific name	No.	Abu.	L. Abu.C	WV	SV	IUCN	CITES Status	Migration
		Passeridae										
105			House Sparrow	*Passer domesticus*	305	122	A	+	+	LC		R
106			Eurasian Tree Sparrow	*Passer montanus*	175	70	A	+	+	LC		R
		Motacillidae										
107			Olive-backed Pipit	*Anthus hodgsoni*	31	12.4	C	+	+	LC		R
108			Paddyfield Pipit	*Anthus rufulus*	5	2	F		+	LC		R
109			White Wagtail	*Motacilla alba*	18	7.2	F	+		LC		WV
		Fringillidae										
110			Common Rosefinch	*Carpodacus erythrinus*	2	0.8	U	+		LC		PM
111			Dark-breasted Rosefinch	*Procarduelis nipalensis*	3	1.2	U	+		LC		R
112			Yellow-breasted Greenfinch	*Carduelis spinoides*	25	10	C	+		LC		R

C.S. = Conservation Status, LC= Least Concern, NT= Near Threatened, VU= Vulnerable, M.P. = Migratory pattern, R= Resident, WV= Winter Visitor, SV= Summer Visitor, PM= Partial Migrant, IV= Irregular Visitor, L.Abu.C= Local abundance category C= Common, U= Uncommon, F= Frequent, A= Abundant.. I=CITES Appendix I, II= CITES Appendix II, #= Nationally Threatened, *= Globally Threatened.

2. List of birds recorded in different habitats in different seasons

S.N	Birds species	Summer				Winter				Grand Total
		Agriculture	Edge	Forest	Settlement	Agriculture	Edge	Forest	Settlement	
1	Alexandrine Parakeet	54	23	7	2	22	14	13	2	137
2	Ashy Drongo	9	4	3				1		17
3	Asian Barred Owlet	1	2			1	1		3	8
4	Asian Emerald Cuckoo					1	2			3
5	Asian Koel	22	10	7						39
6	Barn Swallow	71			54	19	2		43	189
7	Black Bulbul	1				9	3	3		16
8	Black Drongo	16	4		1	22				43
9	Black Kite	21	6	1		21	8	6		63
10	Black-chinned Babbler	4	2	3		1	4			14
11	Black-lored Tit	16	20	12		18	27	13		106
12	Black-throated Tit		17	2		8	1	3		31
13	Black-winged Cuckooshrike	5		1						6
14	Blue Whistling-thrush	3	5	2		4	2			16
15	Blue-bearded Bee-eater					2				2
16	Blue-capped Rock Thrush	4	1	1						6
17	Blue-fronted Redstart					1	1	4		6
18	Blue-throated Barbet	7	3	6		2		1		19

S.N	Birds species	Summer				Winter				Grand Total
		Agriculture	Edge	Forest	Settlement	Agriculture	Edge	Forest	Settlement	
19	Blue-throated Blue-flycatcher	1	2							3
20	Bonelli's Eagle	2								2
21	Bronzed Drongo						1			1
22	Buff-barred Warbler					3				3
23	Cattle Egret	59	20	3	18	52	6		52	210
24	Chestnut-bellied Nuthatch		5							5
25	Chestnut-bellied Rock Thrush						3			3
26	Chestnut-capped Babbler	1								1
27	Chestnut-headed Bee-eater	2								2
28	Chestnut-headed Tesia		1							1
29	Common Cuckoo	14	3	5						22
30	Common Kestrel							1		1
31	Common Myna	71	33	5	67	18	11		61	266
32	Common Rosefinch					2				2
33	Common Stonechat					18	5			23
34	Common Tailorbird	45	10	2		42	3		10	112
35	Crimson Sunbird	9	1				4	1		15
36	Dark-breasted Rosefinch					3				3
37	Dark-sided Flycatcher					1				1

S.N	Birds species	Summer				Winter				Grand Total
		Agriculture	Edge	Forest	Settlement	Agriculture	Edge	Forest	Settlement	
38	Dark-throated Thrush			1						1
39	Eurasian Collared-dove	14			3	11				28
40	Eurasian Tree Sparrow	44			41	35			55	175
41	Fire-breasted Flowerpecker	5		1		1		2		9
42	Fulvous-breasted Woodpecker	3	6	1		25	11			46
43	Great Barbet	24	6	3		5	9	4		51
44	Great Tit	8	1	1		8	12	6		36
45	Greater Coucal					1				1
46	Green-backed Tit	2								2
47	Green-billed Malkoha					10				10
48	Greenish Warbler							2		2
49	Green-tailed Sunbird						1			1
50	Grey Bushchat	7		1		6				14
51	Grey Treepie	8	3	8		1	6	12		38
52	Grey-backed Shrike	10				16	7		3	36
53	Grey-bellied Tesia					2		3		5
54	Grey-capped Woodpecker	2	3	3		4	18	27		57
55	Grey-crested Tit					3				3
56	Grey-headed Canary-flycatcher		3	1		4	7	20		35

S.N	Birds species	Summer				Winter				Grand Total
		Agriculture	Edge	Forest	Settlement	Agriculture	Edge	Forest	Settlement	
57	Grey-hooded Warbler	35	26	40		33	4	18		156
58	Hill Partridge		1							1
59	Himalayan Bulbul	30		1		16	1			48
60	Himalayan Buzzard					3	1			4
61	House Crow	168	20		99	99	11		68	465
62	House Sparrow	49	1		119	14	1		121	305
63	House Swift	18	4	7		4	3	12		48
64	Hume's Leaf-warbler					43	20	22		85
65	Indian Cuckoo		1			17				18
66	Indian Cuckooshrike	1	3	9						13
67	Indian Pond-heron					1				1
68	Jungle Myna	39	9		2	38	8		25	121
69	Kalij Pheasant			2						2
70	Large Cuckooshrike		1				1	2		4
71	Large-billed Crow	45	33	11	6	55	11	22	12	195
72	Laughing thrushes						1			1
73	Little Egret	2				12				14
74	Long-tailed Minivet			1		1		1		3
75	Long-tailed Shrike	1	1			19	1	1	23	46

S.N	Birds species	Summer				Winter				Grand Total
		Agriculture	Edge	Forest	Settlement	Agriculture	Edge	Forest	Settlement	
76	Nepal Fulvetta						7	18		25
77	Olive-backed Pipit	1				22	6	2		31
78	Oriental Magpie-robin	27	3		11	24	4		11	80
79	Oriental Turtle-dove	19	11	10	4	27	10		13	94
80	Oriental White-eye	22	23	26		7	7	10		95
81	Paddyfield Pipit	5								5
82	Pied Bushchat	3				1	2			6
83	Plain Flowerpecker		2	4		2	1			9
84	Red-billed Blue Magpie	9	11	19		6	9	17		71
85	Red-rumped Swallow	4								4
86	Red-vented Bulbul	83	3		25	68	1		39	219
87	Red-wattled Lapwing	1								1
88	Rock peigon	156	55		243	38	8		143	643
89	Rose-ringed Parakeet	3	3	1		6	11		2	26
90	Rusty-cheeked Scimitar-babbler	17	3	2		36	13			71
91	Scaly Laughingthrush	1								1
92	Scaly Thrush			1						1
93	Scarlet Minivet	8				3		2		13
94	Shikra		1			3				4

S.N	Birds species	Summer				Winter				Grand Total
		Agriculture	Edge	Forest	Settlement	Agriculture	Edge	Forest	Settlement	
95	Slaty-blue Flycatcher	8				1				9
96	Speckled Piculet					2				2
97	Spotted Dove					1				1
98	Spotted Forktail	14	5							19
99	Spotted Owlet		1				46			47
100	Steppe Eagle					9				9
101	Streak-breasted Scimitar-babbler					7				7
102	Striated Prinia	2								2
103	Taiga Flycatcher						1	3		4
104	Velvet-fronted Nuthatch		1							1
105	Verditer Flycatcher	12	1	1		3				17
106	White Wagtail					18				18
107	White-breasted Kingfisher	14	2	3		3	2			24
108	White-breasted Waterhen	1								1
109	White-rumped Munia	1				2				3
110	White-throated Fantail					3				3
111	Yellow-bellied fantail						2			2
112	Yellow-breasted Greenfinch							25		25

S.N	Birds species	Summer				Winter				Grand Total
		Agriculture	Edge	Forest	Settlement	Agriculture	Edge	Forest	Settlement	
	Grand Total	**1364**	**419**	**218**	**695**	**1049**	**362**	**277**	**686**	**5070**

3. Total Orders and Families of the Birds Recorded in Study Area

Order	Family	Number Of Species
GALLIFORMES	Phasianidae	2
CAPRIMULGIFORMES	Apodidae	1
CUCULIFORMES	Cuculidae	5
	Centropodidae	1
COLUMBIFORMES	Columbidae	4
GRUIFORMES	Rallidae	1
CHARADRIIFORMES	Charadriidae	1
PELECANIFORMES	Ardeidae	3
STRIGIFORMES	Strigidae	2
CORACIIFORMES	Meropidae	2
	Alcedinidae	1
PICIFORMES	Megalaimidae	2
	Picidae	3
FALCONIFORMES	Accipitridae	5
	Falconidae	1
PSITTACIFORMES	Psittacidae	2
PASSERIFORMES	Campephagidae	4
	Rhipiduridae	1
	Dicruridae	3
	Laniidae	2
	Corvidae	5
	Stenostiridae	1
	Paridae	4
	Cisticolidae	2
	Hirundinidae	2
	Pycnonotidae	3
	Sylviidae	5
	Zosteropidae	1
	Timaliidae	5
	Leiotrichidae	1

Order	Family	Number Of Species
	Phylloscopidae	1
	Aegithalid	1
	Muscicapidae	14
	Turdidae	4
	Sturnidae	2
	Sittidae	2
	Nectariniidae	2
	Dicaeidae	2
	Estrildidae	1
	Passeridae	2
	Motacillidae	3
	Fringillidae	3
	Total	**112**

Annex II

Bird Survey Data Sheet

Date:			
Plot no:			
Elevation :			
Habitat:			
Weather:			
Time :			
S.N.	**Bird Species**	**No. of Birds**	**Observation**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

Annex III

Questionnaire survey data sheet

Date:-

Name of Respondent:

Age:

Sex:

Occupation:

Address:

1. Do you know the bird diversity of Nepal?
   Yes….. No……

2. Do you know any bird related research has been carried out in this area before?
   Yes….. No……

3. Have you seen the nests of birds? Yes….. No…… If seen, in which habitat the nests were found?
   a. Tree b. Bush c. Ground d. Any……

4. Do people get any kinds of benefits from birds?
   Yes….. No……

5. According to your opinion and experience what are main threats to birds?
   ……..

6. Have you noticed that any hunting persists in your area?
   Yes….. No……

7. Is here practice to keep pet bird?
   Yes….. No……

8. Do the animals grazing in the forest affect the bird?
   Yes……. No……..

9. Do the human activities affect the birds?
   Yes……No…… If yes, which type of activities did you see?

10. Have you seen somebody snaring, illegal trading of the bird?
    Yes…… No……

11. Do the people poach birds?
    Yes…….. No……

12. For what purposes people poach birds?
    (Mention the purposes)……

13. Who poaches the birds?
    a. locals b. Outsiders c. Other

14. Do you think it is necessary to conserve birds?
    Yes….. No……

15. Do you fell here is essential of birds and bio diversity conservation awareness education?
    Yes….. No……

16. Do NGOs, INGOs, Government run program for the conservation of habitat of birds?
    Yes……. No……

PHOTOPLATES

Blue-bearded Bee-eater

Chestnut-bellied Rock Thrush

Oriental White-eye

Great Tit

common rose finch

Himalayan Bulbul

Black-throated Tit

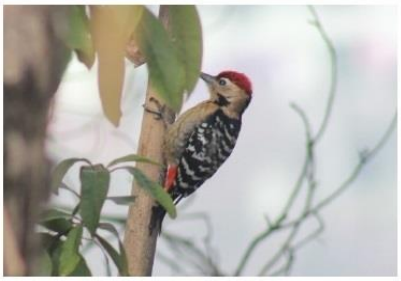
Great Barbet

Black-lored Tit

Grey-backed Shrike

Alexandrine Parakeet

Spotted Owlet



Fulvous-breasted Woodpecker

House Crows

Black Drongo

Indian Pond-heron

Rock peigon

Steppe Eagle

Paddyfield Pipit

White Wagtail

White-breasted Kingfisher

Oriental Turtle-dove

Oriental Magpie-robin

Large-billed Crow

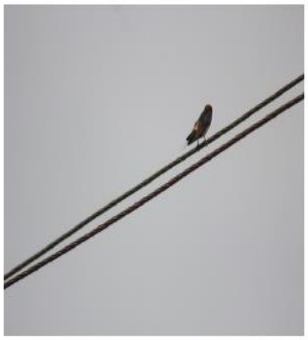
Rusty-cheeked Scimitar Babbler

Red-vented Bulbul

Red-billed Blue Magpie

Chestnut-headed Bee-eater

Grey-capped Woodpecker



Red-rumped Swallow

Barn Swallow

Himalayan Bulbul

Blue Whistling Thrush

White-breasted Waterhen

Blue-throated Barbet

Pied Bushchat

Verditer Flycatcher

Olive-backed Pipit

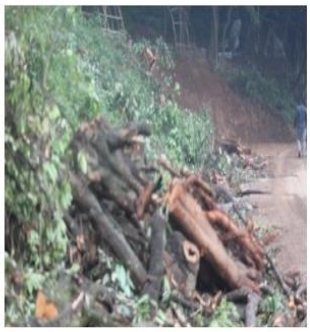
Common Myna

Great tit

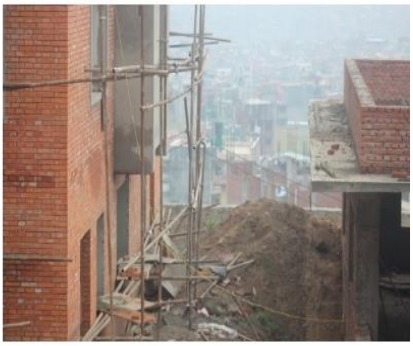
Cattle Egret

Suryabinayak municipality area

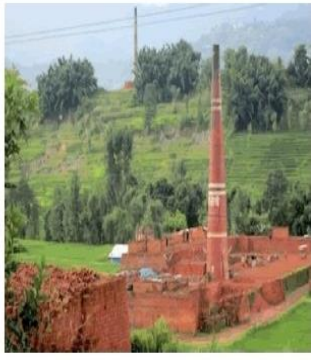
Field visit



Disturcted area along suryabinayak forest



Settlement area along suryabinayak forest



Birck construction area along agricultural land

Data collection in field

Black kite

Grey-hooded Warbler

Eurasian Tree Sparrow

Crimson Sunbird

Asian barred owlet

Scarlet Minivet

Grey tree pie

Rusty-cheeked Scimitar-babbler

Long-tailed Shrike

Eurasian Collared Dove

Common Tailorbird