LAND USE GRADIENTS AND DISTRIBUTION OF BIRDS IN MANASLU CONSERVATION AREA, NEPAL

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NEPAL

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DECLARATION

I hereby declare that the work presented in this thesis has been done by myself, and has not been submitted elsewhere for the award of any degree. All sources of information have been specifically acknowledged by reference to the author(s) or institution(s).

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RECOMMENDATIONS

This is to recommend that the thesis entitled **"Land use gradients and distribution of birds in Manaslu Conservation Area, Nepal"** has been carried out by **Mr. Hem Bahadur Katuwal** for the partial fulfillment of Master's Degree of Science in Zoology with special paper Ecology and Environment. This is his original work and has been carried out under our supervision. To the best of our knowledge, this thesis work has not been submitted for any other degree in any institutions.

We recommend that the thesis has been accepted for partial fulfillment of the requirements for the Degree of Master of Science in Zoology specializing in "Ecology and Environment".

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Abstract

Though the Manaslu Conservation Area (MCA) is proposed as Important Bird Area, its biodiversity is less explored. My study focused on species richness and composition of birds in different land use types, elevational gradients and aspects in different seasons. I used point count method within 39 land use plots starting from 2200m to 3670m at the interval of 400m covering an area of 31.4 ha. R-software was used to perform all the statistical analysis. Altogether, 93 species of birds belonging to seven orders and 22 families were recorded. I found significant difference in species richness of birds within different land use types ($P(F)<0.001$, df=3, $\alpha=0.01$) due to effect of habitat heterogeneity and their preferences in different seasons. Higher species richness of birds were recorded in exploited forest, followed by natural forest, cultivated land and least in meadow, which accepted the intermediate disturbance hypothesis. TukeyHSD test highlighted more significant difference in mean of species richness of birds between both types of forest and meadow but not with cultivated land. Presence of woody vegetation, fruiting trees, scattered bushes, and hedges supported the large number of birds in the cultivated land. No significant difference in species richness of birds along elevational gradients ($P(F)> 0.3$, df=4, $\alpha=0.05$) and aspects ($P(F)>0.2$, df=1, $\alpha=0.05$) might be due to higher intervals, less number of elevational gradients and almost similar habitat types respectively. However, species richness of birds peaked slightly at 2600m (marginal significance) showing a humped shaped pattern. But the seasonal variation was strongly significant ($P(\chi 2)<0.001$, df=2). The species richness was higher in post-monsoon and lowest in pre-monsoon season. Length of gradient of DCA axis-I in pre-monsoon (7.12 SD) was higher than other season, suggesting higher beta diversity. However, the length of DCA axis-I of all three seasons (4.01 SD) too had strong beta diversity, more species turnover and dispersion of birds. This suggested that most of species had observed in only one season. Permutation result showed that altitude, natural forest and cultivated land were important environmental variables to structure the composition of birds. Presence of rare species had least effect in the composition and dispersion of birds. Deforestation, habitat fragmentation, poaching and lack of awareness were main threats to the avian community. Further research should be conducted to find out more interesting relation between birds and its habitat throughout the gradients of MCA.

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ABBREVIATIONS / ACRONYMS

MCA	Manaslu Conservation Area
BCN	Bird Conservation Nepal
DNPWC	Department of National Parks and Wildlife Conservation
C	Cultivated land
M	Meadow
E	Exploited Forest
F	Natural Forest
S	South facing slope
N	North facing slope
m	meter
df	Degrees of Freedom
km^2	Square Kilometer
No.	Number
P	Probability value
DCA	Detrended Corresponding Analysis
SD	Standard Deviation
ha	Hectare
χ^2	Chisquare

1. INTRODUCTION

1.1 Background

Birds are frequently used in monitoring the land use practices in forest and fragmented area (Turner 1996, Hutto and Young 2002, Schulze et al. 2004) due to their different habitat preferences (Chace and Walsh 2006, Jokimaki and Suhoven 1998). Mountains support large number of bird species (Ruggiero and Hawkins 2008) and are the hot spots for biodiversity (Körner 2004, Bomhard and Bertzky 2010). Many birds migrate to downhill during snowy seasons and migrate uphill, when the snow melts. The richness and composition of species varies according to land use and physiographic zones. Factors like vegetation types (MacArthur 1964, Terborgh 1977, Inskip 1989, Boren et al. 1999), temperature (Lennon et al. 2000, McCain 2007, Williams et al. 2009), climate change (Dale et al. 2001, Carey 2009), population size (Turner 1996), energy availability (Ding et al. 2005) and human induced disturbances (fire, deforestation) or habitat enrichments (buildings, plantings) (Brawn et al. 2001, Palita et al. 2011) strongly influence the variation of species richness of birds in mountain landscapes.

The pristine habitats of Himalaya are being disturbed and fragmented for livelihood over a time period (Christensen and Heilmann-Clausen 2009). Further, people are utilizing the remaining habitats haphazardly without considering the negative impacts of their activites. Major land use types like cultivated land (21%), no cultivated inclusions (7%), grassland (12%), forest land (37%), scrub forest and degraded forest (5%) and other lands (18%) (MPFS 1988/89) is changed to forest (29%), scrub and degraded forest (10.6%), grassland (12%), farmland (21%) and (7%) uncultivated land in a short decade (Bhuju et al. 2007). This signifies different forms of land use practices in mountain landscape (Kesslers et al. 2001). This pattern of utilization of natural landscape is different according to elevation and vegetation zone in mountain environment. Mass grazing of domestic livestock is very common in natural forest and meadows at high mountains. Many evidences of slash and burn can be found in the mountain landscape. Rapid expansion of human settlements and other developmental activities prior to forests have been confining the habitat of birds in narrow area which play an important role in structuring and altering the landscape of mountain region. As consequences, composition and structure of natural vegetation changes rapidly. Subsequently, the breeding habitat of bird reduces, subdivides and isolates which results in migration to suitable habitat or extinction of species from such area (Inskip 1989, Turner 1996, Collinge 1998, Fahrig 2002, BirdLife International 2003, Baral and Inskipp 2004, Baral and Inskipp 2005, Sekercioglu et al. 2008, Bennett and Saunders 2010, Palita et al. 2011).

At present, there are 871 species of birds in Nepal (BCN and DNPWC 2012), but one in five bird species are considered as threatened and over 100 species are on the edge of extinction due to habitats destruction (BCN and DNPWC 2011). Thus forest and other habitats should be managed and protected in an effective way to buffer threatened birds species (Forman et al. 1976, Blake and Loiselle 2000, BirdLife International 2003, Waltert 2005, Posa and Sodhi 2006, BCN and DNPWC 2011).

1.2 Rationale of the study

Different land use practices changes the habitat of birds which in turn alters its composition. On the other side of globe, many studies on bird's communities have been carried out in relation to bird's habitat along different land use practices and elevational gradients (Collinge 1998, Trzeinski et al. 1999, Clergeau et al. 2001, Fahrig 2001, Santos et al. 2002, Waltert et al. 2005, Palita et al. 2011). But in case of Nepal Himalaya, mostly checklists, threatened species assessment and identification manuals of birds have been published (Fleming et al. 1984, Grimmet et al. 2000 and 2003, BCN and DNPWC 2012). Habitat utilization of birds along elevational gradient is less observed in Nepal. People are not aware about the effect of habitat loss and fragmentation which is accelerating the habitat destruction. Because, human induced disturbances help to accelerate the landscape change (Chettri et al. 2005) and ultimately in regional distribution of birds (Allen and O'Connor 2000).

In Nepal, many studies in birds focused on lower landscapes due to easy accessibility. However, higher elevations are relatively less investigated. Thus, the biodiversity of Himalaya is poorly explored (Baniya 2010). The change in land use types has considerable effect in the distribution of the birds which is not yet explored. Knowing this fact, this research work is carried out to study the bird's relation to different land use types and elevational gradients.

1.2 Research Hypotheses

- Bird species richness is highest in moderately disturbed land use types (exploited forest) than other land use types (Intermediate disturbance hypothesis).
- Species richness of birds show humped shaped pattern (Mid elavational peak).

1.4 Objectives

The main objective is to investigate the species richness of birds in different habitat of each plot along elevational gradients in three different seasons. The specific objectives were to examine:

- The species richness of birds in different land use types, elevational gradients and aspects
- Seasonal variation and composition of birds in relation to land use, elevation and aspect
- Indentification of major threats to avian biodiversity

2. LITERATURE REVIEW

2.1 Species richness of birds in different land use types

Most of the avian studies in Nepal (Fleming et al. 1984, Inskip 1989, Grimmet et al. 2000 and 2003, BCN and DNPWC 2011) are concentrated on a broad scale of landscape approaches. They have identified the bird's habitat in different land use types like cultivated areas, grasslands, alpine zones, wetlands, bushes or scrubs, open or meadows, different forest type, rocky mountains, pond, lakes, rivers and streams. "The State of Nepal's Birds 2010" (BCN and DNPWC 2011) revealed facts about the habitat utilization of nationally threatened bird species (149). According to it, forest inhabited 79 species (53%), wetlands 40 species (27%), grasslands 23 species (15%), cultivation 12 species (8%), open country 14 species (9%), scrub seven species (5%), near human habitation four species (3%), and semi-desert one species (1%) of birds. Few species were found in more than one habitat.

Most species are habitat specific and respond especially to habitat structure (MacArther et al. 1962, MacArthur 1964). Estrada et al. (1997) discussed the distribution of birds in different land use types where they found more species in cultivated land, followed by forests, fences and pasture land. Laiolo (2004) analyzed 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. Waltert et al. (2005) observed higher diversity of birds in forest than farm land. Rimal (2006) found many species of birds in disturbed habitats than undisturbed one. Similarly, Basnet (2010) after analyzing the species richness and composition of breeding birds concluded more species richness can be found in moderately disturbed area than in disturbed one. Also, he argued of having higher alpha diversity in moderately disturbed area but higher beta diversity in the disturbed landscape. Martin and Blackburn (2010) concluded higher species richness of birds along cultivated lands than forest. However, he had no significant variation of birds between secondary and primary forest type. Fardila and Sjarmidi (2012) concluded that though the land use and other aspects of environments are interrelated, forest always has higher species richness of birds than other land cover.

Different land use practices influences the habitat, structure and composition of species (Boren et al. 1999, Brawn et al. 2001). Since the species are sparsely distributed, they are susceptible to loss from nature due to fragmentation (Turner 1996, Jetz et al. 2007). But, Collinge (1998) and Daily et al. (2001) have highlighted the positive correlation between size of fragmented habitats and number of species. Trzcinski et al. (1999) also came to conclusion that fragmentation doesn't always have consistent negative effect on the birds unless the species cope with changing environment. Simultaneously, Santos et al. (2002) concluded that species richness of bird depends upon the degree of habitat fragmentation. Thus, species richness increases as increased in habitat modification (Schulze et al. 2004, Waltert 2005). However, fewer species are only benefited through it.

2.2 Variation of species richness of birds along elevational gradients

Elevational gradients as a proxy are a powerful tool to study the responses of biotic communities to different environmental factors (Körner 2007). In general, species diversity of birds changes with the elevational gradients (Blake and Loiselle 2000). The range of elevational gradients of individual species is explored in the Bird's of Nepal (Fleming et al. 1984, Grimmet et al. 2000 and 2003). Basnet (2010) found higher species richness of birds in lower elevational zone (1400m-1700m) due to the edge effect. But he observed no marked change in species richness of birds between 1700m-2400m. McCain (2009) concluded the climate as a key influencing factor for the diversity of birds along elevational gradients.

Most of the research concluded that the species richness decreases monotically (unvarying) with increase in elevation (Hunter and Yonzon 1993, Kattan and Franco 2004) and with humped shaped pattern (Kesslers 2001, Lee et al. 2004, Ding et al. 2005, Herzog et al. 2005, Williams et al 2009) where the species richness peaked at the elevational range below 2000m. Price et al. (2003) had considerable variation in species richness of birds along the Himalaya. Such variation is due to different environmental gradients and isolating factors (Bomhard and Bertzky 2010). But, Jankowski et al. (2009) argued that elevation had least effect on the composition of the birds.

2.3 Seasonal effect on birds' community

The seasonal variation (climate and temperature) has direct influence and effect on the species richness of avian community. The food varies with the seasons ultimately the composition of the birds change accordingly. Cueto and de Casenave (2000) found more number of birds in spring (pre-monsoon) than in autumn (post-monsoon) season. Thakuri (2007) studied the seasonal diversity of birds in forest, riverine area, human settlement and agricultural land. He found more birds in forest than other land use during the summer season. But Khanal (2008) documented the higher diversity of birds in agricultural area than forest and grassland in winter season.

3. MATERIALS AND METHODS

3.1 Location and Physiography

Manaslu Conservation Area (MCA) is proposed as an Important Bird Area (IBA) of Nepal by Birdlife International (Baral and Inskip 2005). MCA lies within the latitude of 85º 29' 12.4" to 85 º11'51.114" N and the longitude of 28º20'25.6" to28º45' 6.68" E. of Gorkha District which belong to Mansiri Himal range of Himalayas. It is declared as third conservation area on December 28, 1998 with an area of 1663 sq km including seven Village Development Committe (VDC): Samagaun, Lho, Prok, Bihi, Sirdibas, Chumchet and Chhekampar. Annapurna Conservation Area lies on west and Tibetan Plateau on north and east, and mid part of Gorkha district to the south (KMTNC 2002, NTNC 2009).

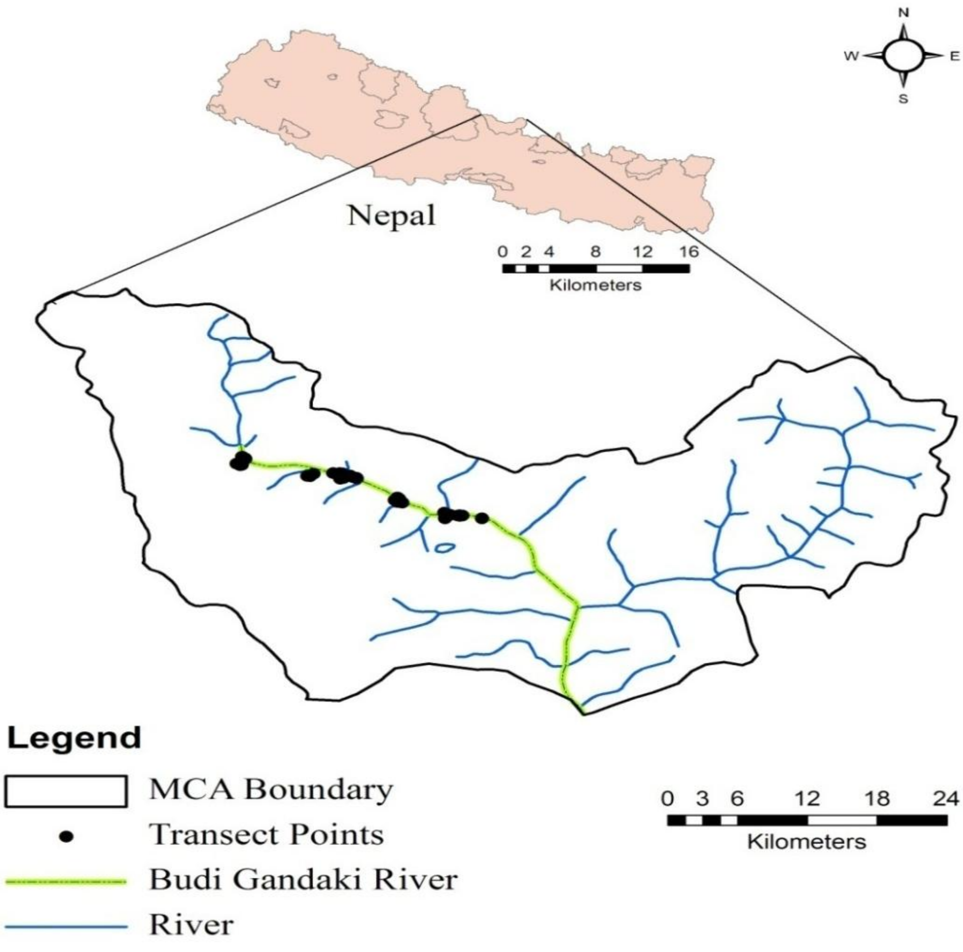

Figure 1 Map of MCA showing the transect points along the Budigandaki River

Table 1 The physiographic division of MCA according to Bhuju et al. (2007);

Bioclimatic zone	Elevation	Physiographic zone
Nival	Above 5000	High Himal
Upper Alpine	4501-5000	High Mountains
Lower Alpine	4001-4500	
Upper Sub-Alpine	3501-4000	
Lower Sub-Alpine	3001-3500	
Upper Temperate	2501-3000	Mid Hills
Lower Temperate	2001-2500	
Upper Sub-Tropical	1501-2000	
Lower Sub-Tropical	1001-1500	

The Budigandaki is the major river system originated from the Birendra Taal. Many tributaries are mixed on it. There are many snowpeaks, river valleys, steep slopes, glacier valleys, moraine deposits, crop fields, forest and deep gorges (NTNC 2009).

3.2 Climate

The climatic zones of MCA vary greatly from sub-tropical to nival bioclimatic zone (NTNC 2009). Precipitation is in the form of rainfall, drizzle and snow due to sharp decline of temperature in winter. Snow lies above of 5000m. The monsoon occurs between June and September which is about 75% of the total rainfall. The post-monsoon period in autumn (October to November) and the winter months (December to February) are usually dry (KMTNC 2002). Warmer temperature can be found in southern part, 30 ^{o}C in the summer to 10 ^{o}C in the winter, while northern part is very cold sometimes below freezing point.

3.3 Culture and ethnicity

The seven VDCs of MCA has different cultures and different ethenic people. The southern part is dominated by Brahmins, Chhetris, Thakuris, Kami, Sarki etc. who follow

Hinduism. The northern part is occupied by Lamas who follow Buddhism. Differnt style of monastries can be found in northen site (NTNC 2009).

3.4 Flora and Fauna

3.4.1 Flora of MCA

Significant variation in the vegetation pattern can be found from lower to higher elevation in the MCA. The bioclimatic zone has made such vast difference in the vegetation pattern. Bhuju et al. (2007) has classified the vegetation of MCA into 11 types, which are:

- Upper Alpine Meadow
- Moist Alpine Scrub
- Trans Himalayan Steppe
- Trans Himalayan High Alpine vegetation
- Birch-Rhododendron forest
- Fir forest
- Larch forest
- Upper Temperate Blue Pine forest
- Temperate Mountain Oak Forest
- Lower Temperate Oak forest
- Chir Pine and Broad-leaved forest

3.4.2 Fauna of MCA

MCA is home for 33 species of mammals, 110 species of birds and three species of herpeto fauna (KMTNC 2002, NTNC 2009). The mammalian fauna include Snow Leopard (*Uncia uncia*), Asiatic Black Bear (*Ursus thibetanus)*, Musk Deer (*Moschus chrysogaster)*, Assamese Macaque (*Macaca assamensis)*, Golden Jackal (*Canis aureus),* Himalayan Thar (*Hemitragus jemlahicus*), Yellow-throated Marten (*Martes flavigula),* Jungle Cat (*Felis chaus)*, Common Leopard (*Panthera pardus)*, Wild Boar (*Sus scrofa),* Barking Deer (*Muntiacus muntjak)*, Himalayan Goral (*Naemorhedus goral),* Blue Sheep (*Pseudois nayaur)* etc. The common birds are Kalij Pheasant (*Lophura leucomelanos),* Great Barbet (*Megalaima virens),* Eurasian Cuckoo (*Cuculus canorus),* Black Kite (*Milvus migrans),* Lammergeier (*Gypaetus barbatus),* Golden Eagle (*Aquila chrysaetos),* Long-tailed Shrike (*Lanius schach),* Large-billed Crow (*Corvus macrorhynchos),* Plumbeous Water Redstart (*Rhyacornis fuliginosus),* Green-backed Tit (*Parus monticolus),* Beautiful Rosefinch (*Carpodacus pulcherrimus),* White-winged Grosbeak (*Mycerobas carnipes),* Snow Pigeon (*Columba leuconota*), and Oriental Turtle Dove (*Streptopelia orientalis*). The herpeto fauna includes Himalayan Toad (*Bufo himalayanus*), Ranid Frog (*Rana sp*.) etc.

3.5 Research Design

I used a quasi-experimental landscape design to identify the different land use types in each elevation (Scheidegger et al. 2010). Tentative design was made with the help of topo-sheet of MCA (1:50000) and field observation was done before establishing the study sites. I observed the birds within the month of March-April (Pre-monsoon), July (Monsoon) of 2011 and October (Post-monsoon) of 2012. Four point counts (transects) were made in respective land use types on each elevational level starting from 2200 ± 50 m a.s.l to 3800 ± 50 m a.s.l. with 400m intervals at each elevational gradients. Same number of plots was laid on either side of the river valley at each elevational level i.e northern and southern aspect. Altogether, I planned to lay eight point counts in four land use types in one elevational gradient and overall 40 point counts within two opposite sides of Budi Gandaki River at MCA.

At each elevational level, following four land use types were considered (Scheidegger et al. 2010):

1. Natural forest: These are pristine forests or with a low anthropogenic influence. Forests include mainly pine trees and mixed broad leaf trees etc. They are normally far from the human settlement.
2. Exploited forest: With the average tree age >20 years, where the species composition is altered or exploited for agriculture, livestock, collection of fodders and fuels woods or plantation after intensive domestic or commercial forest managements.
3. Meadow: With less than 20% of tree coverage. Domestic livestock including goats, buffaloes, cows, yaks and horses graze or browse the vegetation.
4. Cultivated land: Areas with intensively managed, fertilized, sometimes irrigated and yearly ploughed. On slopes, fields are often terraced.

3.6 Bird survey techniques

3.6.1 Fixed radius point count method

Point counts are widely used technique to study the species-habitat relationships (Alldredge et al. 2007). I used fixed point count method for the survey of birds within the radius of 50m (Schulze et al. 2004, Waltert et al. 2005, Fardila and Sjarmidi 2012). It is a widely used approach for surveying birds in different land use types (Hutto et al. 1986). I scanned the birds from 6:30am to 11:00am in the morning. In each transect, I spent 30 minutes, but repeated observation of the same species was not counted. Some distance was moved within the marked circle to overcome the difficulty of terrain to observe cryptic birds. All flying bird above transects were not included in the list. I used Nikon binocular of magnification 10x50 and Canon camera of 35X for the effective study. I had used two field guides to Birds of Nepal (Fleming et al. 1984 and Grimmet et al. 2003) for the identification of birds in the field.

3.6.2 Call count method

For the birds, which could not be observed directly i.e. shy birds, I employed call count method for their identification. I recorded the unfamiliar calls with the help of a Sony recorder and identified it with the help of bird experts in Kathmandu.

3.7 Threats observation

I made interaction with the local people to find a possible threat to bird’s community. Intensive field visits and qualitative judgment helped me to observe the pace of deforestation and fragmentation closely. Lack of awareness was judged based on interaction with the local people. Based on observation, the term moderately (mod) and maximum (max) were used to denote extent of fragmentation and deforestation in the area. The canopy cover less than 40% were categorized as maximum fragmented or deforested; canopy cover less than 70% were categorized as moderately fragmented or deforested and above that no fragmentation or deforestation. This judgment was qualitative.

3.8 Data Analysis

I merged all three seaons data sets of birds into a single table to observe the overall impacts and following statistical analysis were performed:

3.8.1 Species Richness

Species richness was considered as the total number of species observed in a plot during the study period.

3.8.2 Analysis of Variance (ANOVA)

I used one-way ANOVA to find the significant difference in species richness of birds in different land use types, aspects, elevational gradients. I tested the following null hypotheses:

- H_o: There is no significant difference in the species richness of birds among land use types
- H_o: There is no significant difference in the species richness of birds between the aspects
- H_o: There is no significant difference in the species richness of birds along the elevational gradients

On significant data, Bartlett (1937) test was performed to check the homogeneity. Then Post Hoc analysis (Tukey's HSD test) was carried out within the result of ANOVAs to find more pair wise significant difference (multiple comparisons of mean) of species richness of birds within the environmental variables.

3.8.3 The Kruskal-Wallis Rank Sum Test

Kruskal-Wallis Rank Sum test was used to analyse the variation in species richness of birds in three different seasons. It is non parametric test which is alternative to ANOVA. The data of pre-monsoon seaason was not normal, so this test was performed.

3.8.4 Regression - Generalized Linear Model (GLM)

GLM is used to relate species richness to environmental variables (McCullagh and Nelder 1989). Species richness as the response variable is discrete data (count data) that expected to have a quasi-poisson distribution of error using log link function. The regression analysis reveals the specific pattern of change of response variables (species richness) with the predictor variables (elevation). I fitted first order of regression equation to species richness data within the elevational gradients. Since, there was no significant result, I proceed for second order of polynomial to fit marginal significant quadratic regression equation.

3.8.5 Species Composition and Detrended Correspondence Analysis

Gradual change in species composition can be expressed by ordination methods (Lepŝ and Ŝmilauer 2003). Species composition of sample plots was analyzed using Detrended Correspondence Analysis (DCA) an indirect ordination technique assuming a unimodal species response along environmental gradients (Hill and Gauch 1980, Lepŝ and Ŝmilauer 2003). Beta diversity of the plots was measured with the help of the length of the first DCA axis (Hill and Gauch 1980). Beta diversity is regarded as the measure of turnover of species along spatial or environmental gradients.

DCA was also used to explore and explain relationships between species occurrence and environmental conditions (using overlays). Species data represent the number of seasons a species was found on a plot (0-3). Species turnover between sites, i.e. beta diversity, was measured for all the seasons and for each individual season by estimating the length of the first DCA-axis measured in standard deviation (SD) units (Hill and Gauch 1980). I used the SD-units of first DCA ordination axes to measure the dispersion strength of the species composition. Different environmental variables were fitted as overlay on the DCA diagram. The environmental variables were different land use types, aspects and elevation. Besides elevation, with the elevational levels as ordinal values, all other environmental variables are categorical and treated as dummy variables (presence-absence variable for each category). The environmental variables were fitted posterior ordination. Permutation test was performed for 999 times to fit the best environmental variables and to get suitable statistical result. To analyze the influence of rare species on the ordination results, I excluded the species with less than 10 observations in all plots and carried out again a DCA analysis. In addition, DCA was recalculated with presence-absence data of the species. Afterwards, I compared the initial ordination (all species and occurrences in 0-3 seasons) and the two restricted ordinations (without rare species and with presence-absence data) with the help of procrustes analysis (Oksanen 2011). Procrustes rotation helps to compare two ordination results. It uses uniform scaling (expansion or contraction) and rotation to minimize the squared differences between two ordinations processes (Oksanen 2011).

3.8.6 Software used

I used R Console version 2.15.2 (R Development Core Team 2012) for box plots and one-way ANOVA, and used the R-package vegan (Oksanen 2011) for DCA analysis, overlays and permutation tests of environmental variables. R is free and widely used software program and basically works under the script designed by different experts. Once script is available, analysis will be fast and easy to interpret.

4. RESULTS

The study was conducted in an area of 31.3 ha within 39 land use types at elevation of 2200m (Gaup), 2600m (Namrung), 3000m (Tshyo), 3400m (Lho) and 3670m (Samagaun). I could not locate the last transect on 3800m as per design along The Budi Gandaki river, so it was established within elevation of 3670m where also, I could not find exploited forest towards south facing slope.

4.1 Species richness of birds at the plot level

Altogether, I recorded 93 species of birds belonging to seven order and 22 families. Higher species richness (59) was observed in post-monsoon season, followed by monsoon season (49) and the least in pre-monsoon season (40). Data of three seasons showed that north facing natural forest at 3400m had higher species (22) of birds, whereas south facing meadow at 2200m had the least (4). Passeriformes were the most abundant in the study sites in all three seasons whereas Common Hoopoe (*Upupa epops)* represented only Upupiformes order in post-monsoon season. At the plot level, most species were observed in only one season. Fewer species occurred in two seasons or were common to all the seasons (Figure 2). Large-billed crow (*Corvus macrorhynchos),* Blue Rock Pigeon (*Columba livia)*, Varigated Laughingthrush (*Garrulaxvariegates*), Blue Whistling Thrush (*Myophonus caeruleus),* Beautiful Rosefinch (*Carpodacus pulcherrimus)*, Greenish Warbler (*Phylloscopus trochiloides)* etc. were frequently observed in most of the plot during the study period. Smoky Warbler (*Phylloscopus fuligiventer),* Fire-capped Tit (*Cephalopyrus flammiceps)*, Lesser Whitethroat (*Sylvia curruca),* Goldcrest (*Regulus regulus),* Slaty-blue Flycatcher (*Ficedula tricolor),* White-bellied Redstart (*Hodgsonius phaenicuroides)* etc. were less frequent.

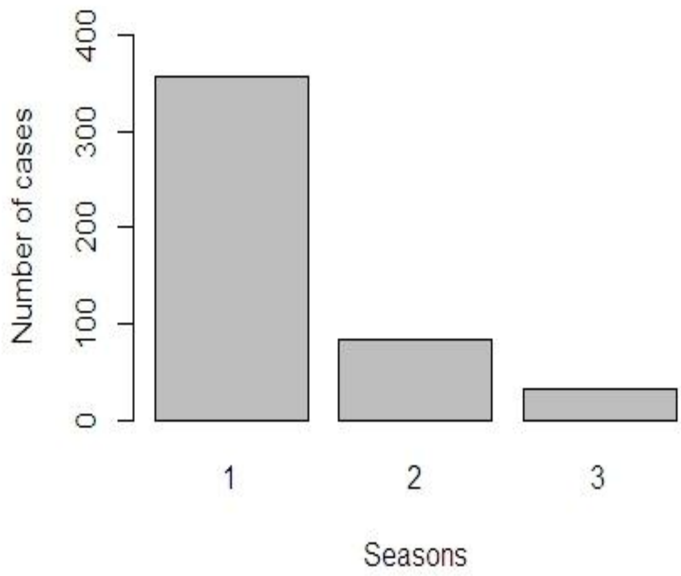

Figure 2 Bar plot showing the number of case a species observed in one, two or all three seasons at a plot level

4.2 Land use types and bird species richness

One way ANOVA showed a significant difference (P(>F) = 0.00133, α=0.01, df=3) in species richness of birds in different land use types (Table 2). More species richness was found in the exploited forest, followed by natural forest and the least in meadow. However, cultivated land too had abundant species of birds in all the visits (Figure 9).

Table 2 One-way ANOVA table between species richness of birds of all seasons and different land use types

	Df	Sum sq	Mean sq	F value	P (>F)	Remarks
LC	3	182.6	60.86	6.47	0.00133**	Significant
Residuals	35	329.0	9.40			

Significant code: **=0.01

The Bartlett's test showed homogeneity of data. Post Hoc analysis (Tukey HSD Test) revealed that there was more significant difference in species richness of birds between meadow and exploited forest and between meadow and natural forest in all the seasons. Similar marked significant variation was not observed among other land use types (Table 3). Thus, the main variation for the species richness of birds in different land use types is mainly due to major differences in meadow with both types of forest.

Table 3 Tukey HSD Test for Multiple Comparisons of more significant difference in species richness of birds with respect to different land use types: where e is exploited forest, f is natural forest, m is meadow and c is cultivated land

Land use type	P value (α=0.05)	Remarks
e-c	0.302	Not Significant
f-c	0.218	Not Significant
m-c	0.248	Not Significant
f-e	0.998	Not Significant
m-e	0.004	Significant
m-f	0.002	Significant

4.3 Species richness of birds along the elevational gradients

More or less similar species richness was observed at each elevational gradient. The difference was not significant (P(F)=0.33, α=0.05, df=4). However, median of species richness of birds peaked at 2600m and decreased gradually to higher levels (Figure 4). Less species richness was observed in 2200m (Figure 3).

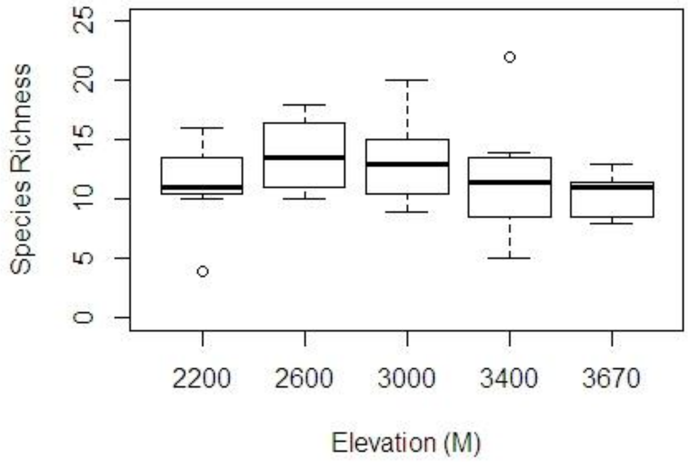

Figure 3 Box plot showing species richness of birds along the elevational gradients at MCA. The dark line in the box plot represents the median or mid value and its arm represents the quartile value of the species richness. There are outliers with the highest species richness at 3400m and the lowest species richness at 2200m.

4.4 Species richness of birds in relation to aspects

One way ANOVA showed no significant difference (Pr (F)=0.228, $\alpha=0.05$, df=1) in species richness of birds between two aspects. However, species richness was higher in north facing slope than in south facing slope (Figure 5).

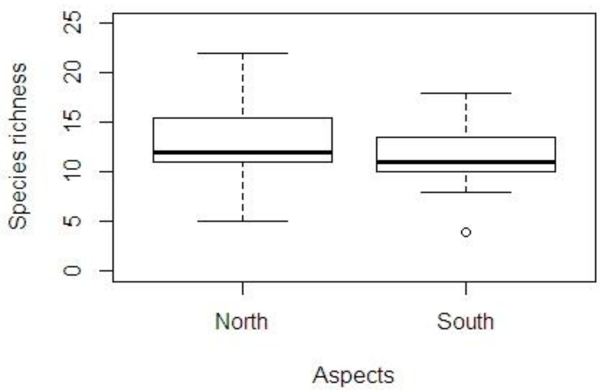

Figure 4 Box plot showing species richness of birds in two aspects at MCA. The outlier represents the lowest value of species richness.

4.5 Seasonal variation and species composition of birds

The Kruskal-Wallis rank sum test revealed that there was significant difference in species richness of birds in three different seasons ($P(\chi 2)<0.001$, df=2). The higher species richness was recorded in post-monsoon and the lowest in pre-monsoon season.

The length of DCA axis-I of pre-monsoon season was higher than others. Also, its higher value of axis length signifies higher beta diversity (Table 4). This supports that composition of bird communities are most different in pre-monsoon season than that of all. Less beta diversity was observed in post-monsoon season. The length of DCA axis-I (4.01) of all season also indicate the clear turnover of species composition throughout the year (Table 4).

Table 4 Result of DCA axis-I for different seasons with relation to species composition of birds

Value from DCA axis-I	Pre-monsoon	Monsoon	Post-Monsoon	All seasons
Axis Length	7.12	4.61	5.66	4.01

Table 5 Permutation test of different environmental variables with the 1st and 2nd DCA axis considering all seasons, where Alt is elevation (altitude), Asp.N is west aspect, Asp.S is east aspect, Lu.C is cultivated land, Lu.M is meadow, Lu.E is exploited forest and Lu.F is natural forest. P value based on 999 permutations

	DCA-I	DCA-II	r^2	P(>r)
Alt	-0.91	0.41	0.83	0.001***
Asp.N	0.16	0.98	0.18	0.043*
Asp.S	-0.16	0.98	0.18	0.043*
Lu.C	-0.39	-0.91	0.34	0.005**
Lu.M	-0.30	-0.95	0.13	0.115
Lu.E	0.76	0.64	0.10	0.169
Lu.F	0.16	0.98	0.38	0.001***

Note: Significant code: ***=0.001, **=0.01, *=0.05

The DCA diagram of all seasons highlighted the effect of elevation, natural forest, cultivated land, and both aspects as an important parameter for the species richness of the birds at MCA. These factors were significant ($P<0.05$) using a permutation test (Table 5). The DCA-axis I was significantly explained by elevation (alt) and axis II by land use types (cultivated land and natural forest) and aspects. CarRub (Blandford's Rosefinch *Carpodacus rubescens*), MycCar (White-winged Grosbeak *Mycerobas carnipes*), GarVar (Varigated Laughingthrush *Garrulax variegatus*), TarCya (Orange-flanked Bush Robin *Tarsiger cyanurus*) etc were affected by the elevational variation. The occurrence of birds like SeiWhi (Whistler's Warbler *Seicercus whistleri*), StrOri (Oriental Turtle Dove *Streptopelia orientalis*), PhyHum (Hume's Warbler *Phylloscopus humei*), NucCar (Spotted Nutcracker *Nucifraga caryocatactes*), PhyTro (Greenish Warbler *Phylloscopus trochiloides*) etc were influenced by forest of north facing slope. Similarly, species observed near to cultivated land of south facing slope were PyrPyr (Red-billed Chough *Pyrrhocorax pyrrhocorax*), AlcVin (White-browed Fulvetta *Alcippe vinipectus*), AntHod (Olive-backed Pipit *Anthus hodgsonii*), ColLiv (Rock Pigeon *Columba livia*), UpuEpo (Common Hoopoe *Upupa epops),* LanTep *(*Grey-backed Shrike *Lanius tephronotus)* etc. Many species were influenced by the combined environmental variables, for instance ParAte (Coal Tit *Parus ater*) was linked to forest of higher elevation, CarEry (Common Rosefinch *Carpodacus erythrinus*) inhabited cultivated land of higher elevation, AetNip (Green-tailed Sunbird *Aethopyga nipalensis)* and MyoCar (Blue Whistling Thrush *Myophonus caeruleus*) etc. were observed in south facing slope at middle elevation, (Figure 5).

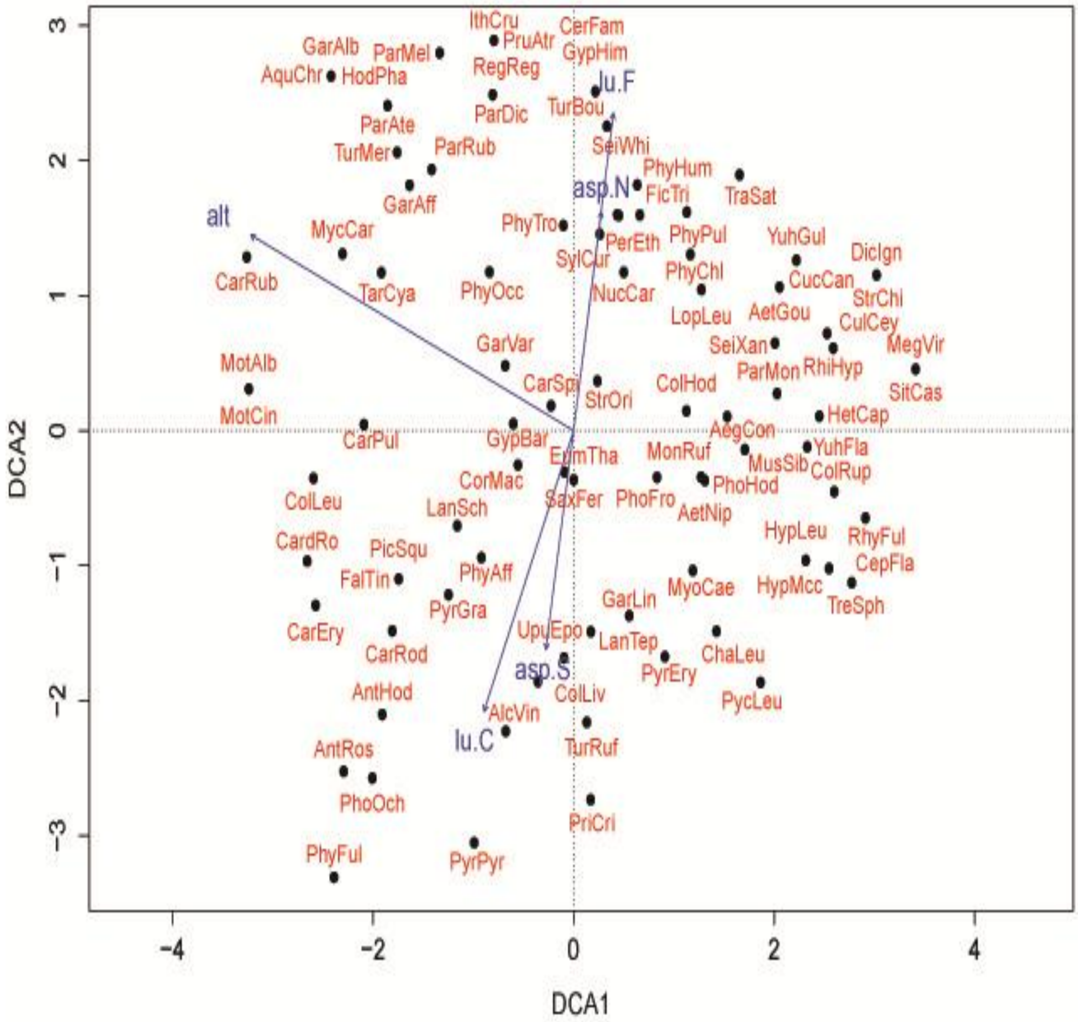

Figure 5 DCA diagram of species richness of birds of all seasons with the different environmental variables (cultivated land, natural forest, north and south aspects and elevation=altitude). The length of arrow represents the strength and importance in the ordination i.e., the correlation with the plot-scores on the first two DCA-axes. Three letters of generic and species names are used for the species denotation. For species codes refer to appendix I.

However, the DCA diagram of species with at least with 10 observations (excluding rare species) indicated that composition of frequent birds in all seasons dataset was mainly structured according to elevation, and land use types (forest vs. cultivated areas). These factors were significant ($P<0.05$) using a permutation test (Table 6).

Table 6 Permutation results of different environmental variables of DCA analysis with at least 10 observations of species (removing the rare species). Alt is elevation=altitude, Asp.N is North aspect, Asp.S is South aspect, Lu.C is cultivated land, Lu.M is meadow, Lu.E is exploited forest and Lu.F is natural forest. P-value based on 999 permutations

	DCA-I	DCA-II	r^2	pr(>r)
Alt	-0.85	0.52	0.75	0.001***
Asp.N	0.35	0.93	0.05	0.35
Asp.S	-0.35	0.93	0.05	0.35
Lu.C	-0.36	-0.93	0.36	0.001***
Lu.M	-0.38	-0.92	0.11	0.11
Lu.E	0.59	0.80	0.10	0.13
Lu.F	0.26	0.96	0.39	0.001***

Note: Significant code: ***=0.001

The corresponding DCA plot (Figure 6) is very similar to the previous one (Figure 5). It shows only important species in term of frequencies and demonstrates that the structure of the previous plot is not driven by rare species. The occurrence of birds like CarPul (Beautiful Rosefinch *Carpodacus pulcherrimus* and GarVar (Varigated Laughingthrush Garrulax variegates) etc. were clearly affected by elevation. Other birds like PyrGra (Yellow-billed Cough *Pyrrhocorax graculus*) or ColLiv (Rock Pigeon *Columba livia)* had affinity towards the cultivated land. PhyTro (Greenish Warbler *Phylloscopus trochiloides),* StrOri (Oriental Turtle Dove *Streptopelia orientalis*), PerEth (Long-tailed Minivet *Pericrocotus ethologus*) etc were observed in natural forest. GarAff (Black-faced Laughingthrush, *Garrulax affinis*) was observed in forest of higher elevation. ColLeu (Snow Pigeon *Columba leuconota*) was found in cultivated land of higher elevation. GarLin (Streaked Laughingthrush *Garrulax lineatus*) and MyoCar (Blue Whistling Thrush *Myophonus caeruleus*) were observed in middle elevation.

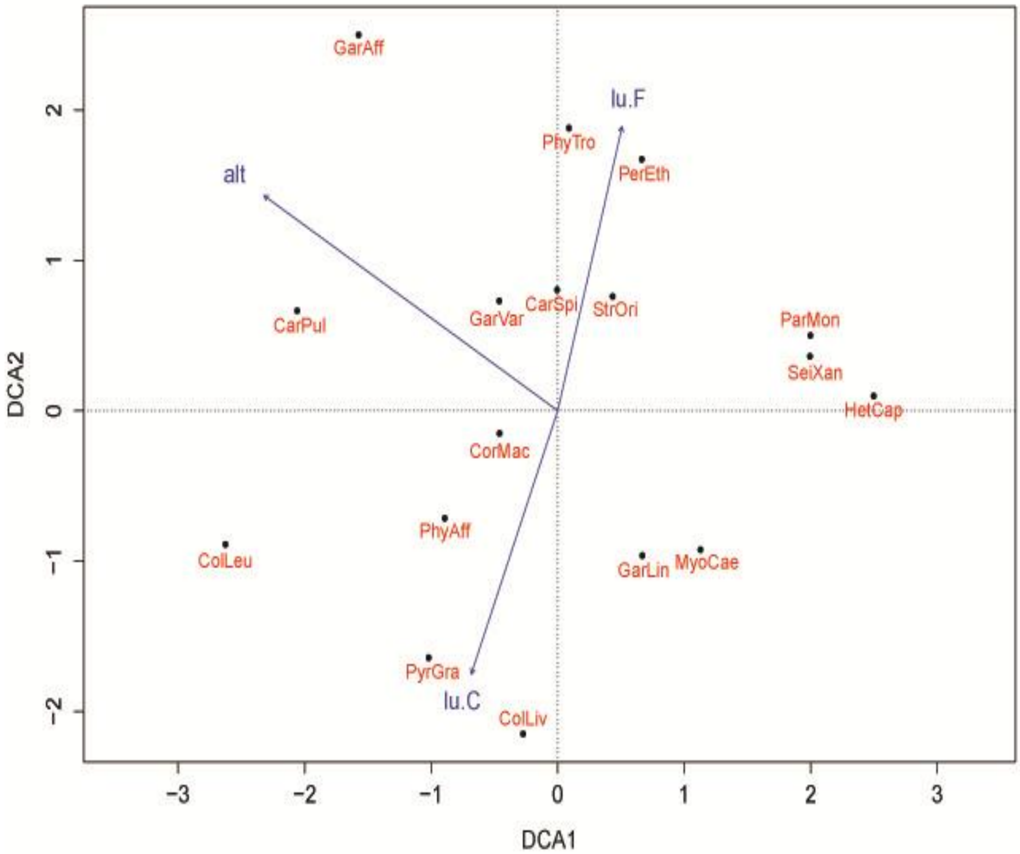

Figure 6 DCA diagram of species composition of birds with the different environmental variables (cultivated land, natural forest, and elevation) with atleast10 observations (excluding rare species) of species in the plot of all season. The length of arrow represents the strength and importance of the environmental variables in this scatter plot. Three letters of generic and species names are used for the species denotation.

Procrustes error analysis helped me to conclude that there were no bigger changes and axes were actually almost identical for the dataset of all seasons versus presences-absence data and all species versus excluding rare species.

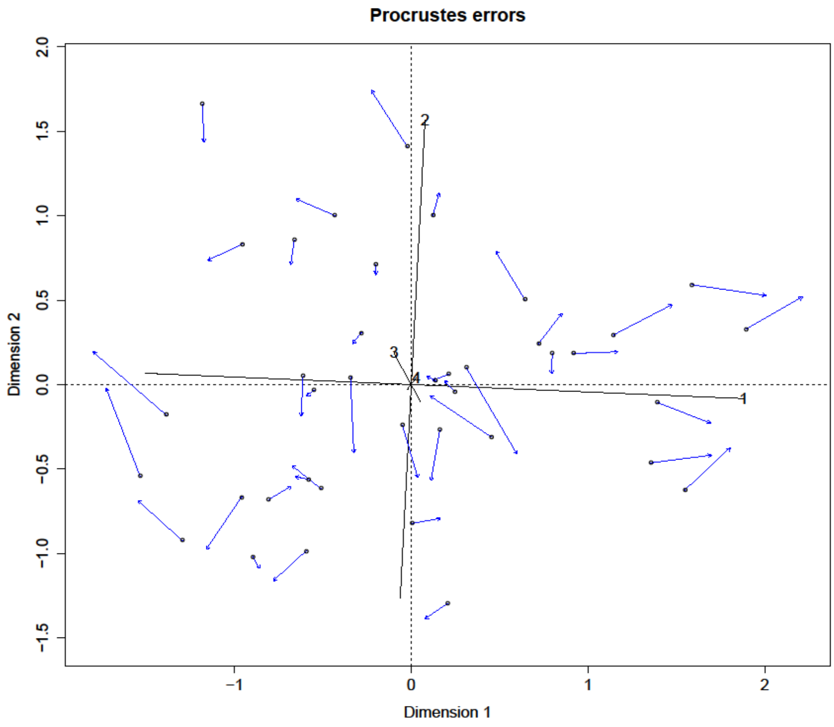

Figure 7 Procrustes errors analysis of DCA with the number of seasons the species were observed on the plots vs. presence-absence data

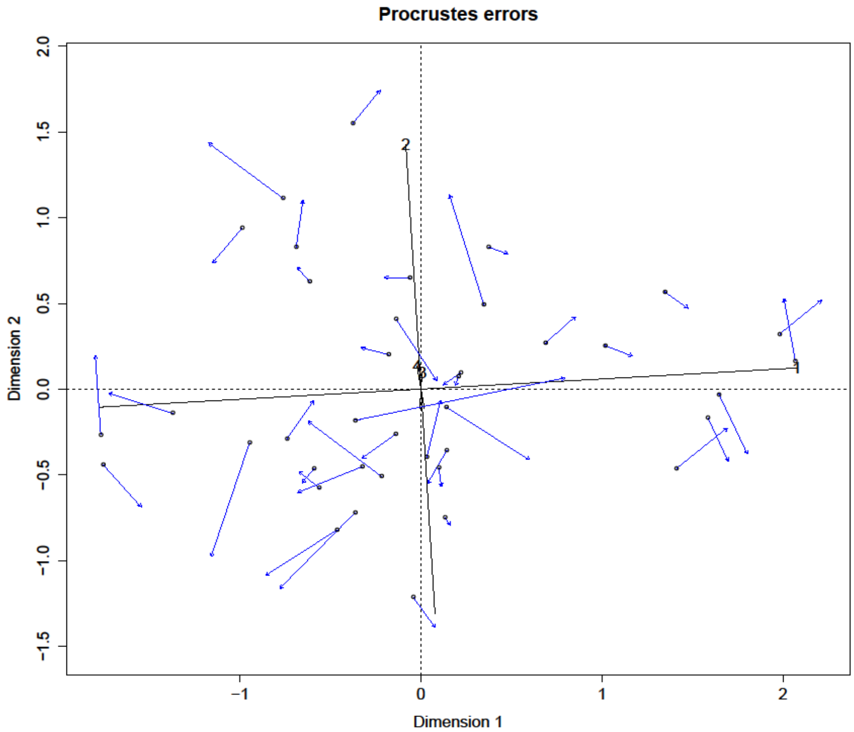

Figure 8 Procrustes errors analysis of the DCA with all species versus excluding rare species.

4.6 Tests for Research Hypotheses

I found higher species richness of birds in exploited forest (moderately disturbed land use type), followed by natural forest than other types of land use (Figure 3). The cultivated land had hold considerable number of species richness of birds. However, meadow had fewer species richness. Therefore, the intermediate disturbance hypothesis was accepted.

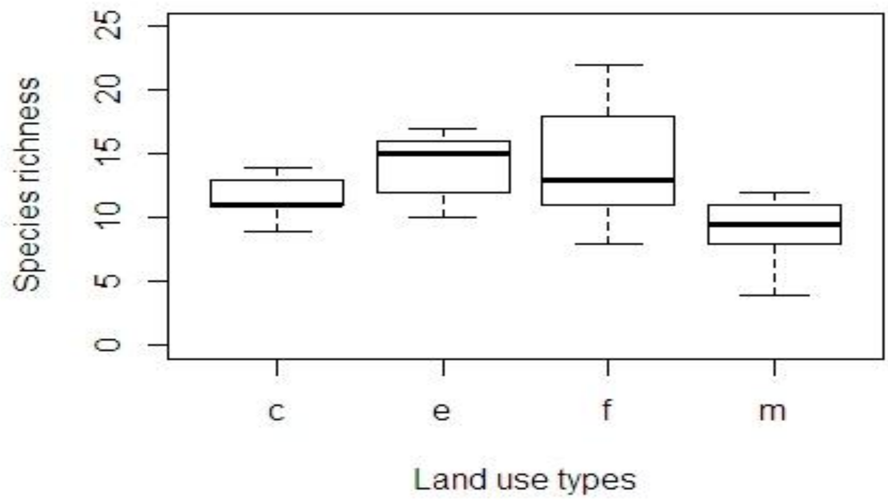

Figure 9 Box plot showing species richness of birds in different land use types at MCA. c represents cultivated land, e as exploited forest, f for natural forest and m as meadow.

The regression analysis did not reveal any significant pattern of change of species richness with elevation. The marginal significance of the change where quadratic term (P(F)>0.13) was more significant than linear one (P(F)>0.42). On considering the marginal significant value, species richness showed humped shaped pattern with elevation Thus, the species richness of birds peaked slightly at mid elevation level (2600m) showing a slight humped shaped pattern (Figure 3 and 10).

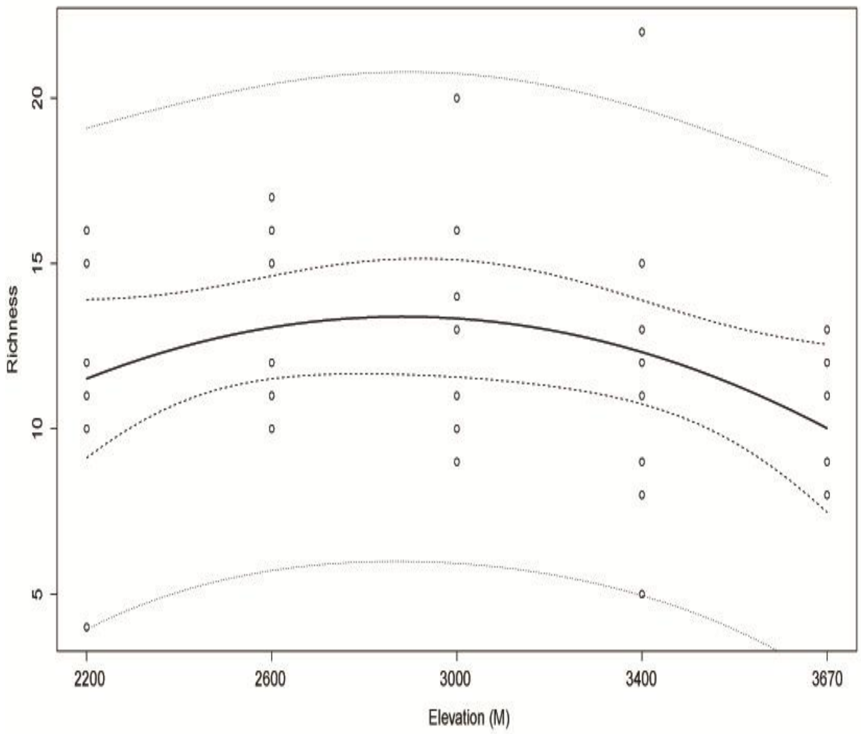

Figure 10 Species richness of birds (marginal significance) along the elevational gradients (Second order regression lines fitted with 95% confidence interval).

4.7 Threats to avian community

I found deforestation and habitat fragmentation as pertinent threats to the avian community (Table 7)**.** The pace of deteriorating the biodiversity is increasing day by day at MCA**.** However, in my study, fragmentation had negative impact on the distribution of birds. The south facing forests of 2200m, 3000m, 3400m and 3800m were relatively fragmented and were patchy distributed. People were not aware about the importance of birds in the ecosystem. Large-billed crow was hanged instead of scarecrow in the field to threaten other birds so as to protect their crops. I found few traps set for trapping the pheasants. Thus lack of awareness in people still hunts the survival of birds at MCA.

Table 7 Major threats to avian community based on my observation and community discussion at the study area, where N is north facing slope, S is south facing slope, Mod is moderately fragmented or deforested, Max is maximum deforested or fragmented

Threats to Avain Community	Elevational Gradients									
	2200m		2600m		3000m		3400m		3670m	
	N	S	N	S	N	S	N	S	N	S
Deforestation		Mod			Max		Max			
Habiat Fragmentaion		Mod				Max		Max		Max
Poaching			Trap seen				Trap seen			
Lack of Awareness		High					High			High

5. DISCUSSION

5.1 Species richness of birds in different land use types

The significant difference in species richness of birds in different land use types corresponds to the habitat selectivity of birds. Since birds are habitat specific, they respond differently to different habitat structure (MacArther et al. 1962, MacArthur 1964). Usually, the diversity of birds in forest is different from those of meadow and cultivated land. Nevertheless, forest is the prime habitat for most of the breeding birds (Trzcinski 1999, BCN and DNPWC 2011). On comparing mean of species richness of birds between both type of forest and cultivated land using TukeyHSD test, I found no significant variation (Table 3). However, more species were concentrated on exploited forest and followed by natural forest. The cultivated land too had considerable number of species of birds (Figure 9). Most of cultivated lands are the slash and burn of natural forest, has higher edge effect (Murcia 1995), play important role in the assemblage of birds population. In most of the cultivated land, woody vegetation, fruiting trees, scattered bushes and hedges were present, which supported higher population of birds. Pink-browed Rosefinch (*Carpodacus rodochrous),* Dark-throated Thrush (*Turdus ruficollis),* Grey Wagtail (*Motacilla cinerea),* Striated Prinia (*Prinia criniger)* etc. were observed in cultivated land only (Appendix I). Petit et al. (1999), Wolf et al. (2001), Laiolo (2004) and Ranganathan et al. (2008) had reported the beneficial aspects of cultivated land to bird community. The pattern and types of cropping were different according to elevation. Many species of birds visit to crop land during and after the ploughing of field mostly for feeding. When planted crops get higher and ripen, again the birds migrate to the area for feeding and sometimes to breed. Thus the cultivated lands are the most heterogeneous and diverse annually than other land use types. Estrada et al. (1997) and Martin and Blackburn (2010) found higher species diversity of birds in cultivated land than in forest zone. However, this fact was against Inskip (1989), Daily et al. (2001), Grimmet et al. (2000, 2003), Waltert et al. (2005), BCN and DNPWC (2011) and Fardila and Sjarmidi (2012) conclusion, where they argued of having higher diversity of birds in forest than in agricultural landscape. Thus habitat structure and complexity determine the species richness of birds (Kessler et al. 2001).

I found significant variation in mean number of species of birds between meadow and both type of forest (Table 3). Less species were found in meadow than forest. Black Redstart (*Phoenicurus ochruros*), Red-headed Bullfinch (*Pyrrhula erythrocephala*), Blandford's Rosefinch (*Carpodacus rubescens*) etc were meadow specific during my visits (Appendix I). Estrada et al. (1997) too had fewer species diversity of birds in pasture land. High cattle grazing and less availability of food in meadow holds less number of species whereas forest is the breeding habitat for large number of species (Grimmet et al. 2000 and 2003, BCN and DNPWC 2011). Thus forest birds and meadow birds were significantly different. My result concluded no significant difference in bird's diversity between the exploited and natural forest (Table 3). But in general, exploited forests harbor higher species than natural forests (Figure 5) supporting the intermediate disturbance hypothesis. However, highest species richness value was observed in the natural forest. White-bellied Redstart (*Hodgsonius phaenicuroides*), Blood Pheasant (*Ithaginis cruentus*), Wedge-tailed Green Pigeon (*Treron sphenura) etc.* were observed in natural forests. The intermediate disturbance hypothesis claims that more species can be found in moderately disturbed forest (Blair 1996, Vetaas 1997, Chettri et al. 2005, Baniya et al. 2009, Basnet 2010 and Panthi 2012). Martin and Blackburn (2010) found no significant difference in the distribution of birds in primary and regenerating secondary forest. But Schulze et al. (2004) concluded that secondary and agro-forestry stand as a good habitat for the biodiversity conservation because they can hold large number of species. White-collared Blackbird (*Turdus albocinctus),* Dark-sided Flycatcher (*Muscicapa sibirica),* Chestnut-bellied Rock Thrush (*Monticola rufiventris*) etc were observed in exploited forest during ny observation (Appendix I).

5.2 Species richness and elevational gradients

In most of the research, the species richness decreases monotically with increase in elevation (Hunter and Yonzon 1993, Kattan and Franco 2004). Some have found humped shaped pattern (Kesslers 2001, Lee et al. 2004, Ding et al. 2005, Herzog et al. 2005, Williams et al. 2009). The peak of the species richness of bird's lies in mid elevation zone, usually below 2000m (Lee et al. 2004, Herzog et al. 20005, Basnet 2010). In my study, species richness of birds did not vary significantly, so I calculated the marginal significance to know response of birds along elevation and many lines were fitted to see any major deviance. Then, species richness of birds showed slightly humped shaped structure with a slight peaked at 2600m and declined gradually (Figure 3 and 10). The non-significant relation might be due to high interval and less elevational gradients. Probably, the important factors for such variation in species richness of birds might be climatic variables (Sharma et al. 2009 and Popy et al. 2010) and due to response of existing habitat types and environmental variables (Schulze et al. 2004). The forests at 2600m were relatively thicker, cultivated land had fruiting tress and hedges, meadow was near to forest zone, which helped to support higher species richness of birds than other elevational gradients. Ruggiero and Hawkins (2008) found temperature as the most influencing factor for the change in species richness of birds in montane environment. My result coincides with Kattan and Franco (2004) study at internal Andean slope, where species richness of birds peaked at 2600m and gradual decline after that. Kessler et al. (2001) too had similar peaked in species richness of birds at around 2600-2800m. However, Herzog et al. (2005) found similar number of species of birds in between 1800m to 3250m. Herzog et al. (2005) and Sharma et al. (2009) explained that species diversity vary negligibly in higher elevations. However, some studies proclaimed that elevation play important role in the diversity birds (Blake and Loiselle 2000, Williams et al. 2009).

5.3 Species richness of birds between the aspects

Aspects play important role in the distribution of vegetation structure. Soil moistures, wind, and solar radiation are affected by the orientation of the mountain landscape. Thus, it plays important role in species composition and richness of the community (Nuzzo 1996). No significant variation in species richness of birds between the aspects in my study might be due to presence of almost similar habitat types required for birds. However, I found more species at north facing slope than in south facing slope (Figure 4). The north facing slope had thick patches of forest and had more sunlight. This influenced the occurrence of bird’s species in some area. Most species of birds get active after a sunshine to warm their body and easy available of their prey insects. However, the south facing slope too had considerable number of birds.

5.4 Seasonal variation and composition of birds

Environmental factors change according to seasons which alter species diversity in general. Detection of birds varies with species, observer and singing rates (Alldredge et al. 2007). Temperature and climate change according to seasons which ultimately affect the distribution of birds (Shoo et al. 2005). The distribution of birds in pre-monsoon, monsoon and post-monsoon was significantly different. More species were observed in post-monsoon season and least in pre-monsoon season. Birds were highly territorial for breeding activity in pre-monsoon season which had reduced its detection. Thus, fewer species might have observed in this season. But in post-monsoon season, juveniles were abundant. Parents have to move far to feed them. This increases their territory and can be easily observed. The pattern of terraced cultivation, flowering of plants varies with seasons. Availability of food, humidity, temperature also varies according to seasons. Thus seasonal variation strongly influences the species richness and distribution pattern of the birds (Cueto and de Casenave 2000, Shiu and Lee 2003). However, Lennon et al. (2000) found temperature as the most influencing factor for the seasonal change in the distribution of birds rather than habitat structure.

The overall species composition of birds in three different seasons showed the complete turnover of species suggesting higher dispersion and distribution. The species concentrated in one end of gradient of the DCA diagram (Figure 5 and 6) was different from that of the other end. Significant difference in length of gradients among seasons demonstrates the higher beta diversity in pre-monsoon than that of monsoon and post-monsoon. Such change in species composition of birds might be the results of habitat heterogeneity, elevation (Manel et al. 2000), availability of food, disturbances (Brawn et al. 2001, Lee et al. 2004, Williams et al. 2009, Fardila and Sjarmidi 2012), time period (Baniya et al. 2009) and edge effect (Turner 1997). The DCA diagram of overall seasons also showed similar pattern of having higher beta diversity and species turnover. Blake and Loiselle (2000), Christensen and Heilmann-Clausen (2009), Williams et al. (2009) and Panthi (2012) had similar species turn over in their study. Species composition of birds of overall year is mainly affected by elevation, forest and cultivated land, and aspects. Higher beta diversity can be attributed to habitat specification of birds (Jankowski et al. 2009) and variation in number of species (Baniya et al. 2009). However, when rare species were excluded, more or less similar results were obtained. Elevation, natural forest and cultivated land are the prime environmental factor to structure the species composition of birds at this time. Manel et al. (2000), Basnet (2010) and Fardila and Sjarmidi (2012) found forest, canopy of trees, its structure, slope and elevation as important factors influencing the composition and occurrence of birds. Procrustes analysis revealed that the presence of rare species had no stronger influence on composition of birds (Figure 8). Therefore, DCA analysis was quite robust.

5.5 Factors affecting the survival of birds

People have different views regarding the effect of habitat fragmentation on avian community. Collinge (1998), Trzcinski et al. (1999) and Daily et al. (2001) argued of having higher species richness of birds in fragmented habitats. However, in my study, fragmentation had negative impact on the distribution of birds. The forests on southern aspect were relatively fragmented and had patchy distribution. Relatively less species were observed in these forests**.** Traps were observed in forests for poaching pheasants and Large-billed Crows (*Corvus macrorhynchos*) were hanged instead of scarecrows in the crop fields. Deforestation is another important factor affecting the birds. Forests were heavily deforested for housing and export purposes. Thus, rural forests should be managed properly to protect the forest birds (Chapman and Reich 2007).

6. CONCLUSIONS and RECOMMENDATIONS

The species richness and seasonal composition of birds were assessed within different land use types, elevational gradients and aspects during pre-monsoon, monsoon and post-monsoon seasons at MCA. During my study period, I recorded 93 species of birds belonging to seven orders and 22 families within the area of 31.4 ha in 39 plots, from 2200m to 3670m at the interval of 400m along the catchment of Budi Gandaki River.

Species richness of birds was interrelated with the land use types. There were significant differences in species richness of birds among the land use types (Table 2). There was no marked variation in species richness of birds between forest and cultivated land. But the variation was prominent between forests and meadow. However, species richness of birds didn't vary significantly along elevational gradients and within the aspects. Many species were concentrated in exploited forest and north facing slope. Higher species were recorded in post-monsoon and least in pre-monsoon season. This suggests direct influence of seasons on the species richness of birds. The length of the first DCA axis for pre-monsoon indicated higher species turnover between the plots (beta diversity) in comparison to the other seasons. However, strong species turnover was also observed in overall seasons (Table 4). Elevation, natural forest and cultivated land were important environmental variables to structure the composition of birds in the area (Figure 6 and Table 6). Procrustes analysis concluded robustness of DCA analysis (Figure 7 and 8). Thus, birds were highly dispersed. Such significant difference in species richness of birds was due to the effect habitat modification, its utilization and behavior of the species.

During my study, many species were encountered within the exploited forest than other land use types (Figure 9). This helped to support the intermediate disturbance hypothesis. Besides it, species richness of birds peaked slightly at 2600m (marginal significance) showing humped shaped and decreased gradually (Figure 3 and 10).

Deforestation, habitat fragmentation, poaching and lack of awareness were main threats to birds in MCA

Based on my study, major recommendations are:

- The deforestation should be controlled (Trees were extensively cut for new settlements for toursits and exporting to Tibet).
- Fragmented habitat should be afforested and protected (Forests at 3000m, 3400m and 3670m on south face were relatively fragmented)
- Poaching should be checked out (Traps were observed in the plots of 3400m)
- Awareness program should be launched (Large-beilled Crow was hanged in cultivated land (photo-Appendix II) and deferstation was higher)
- More research in relation to birds and its habitat should be carried out from lower to higher elevations (No detail research work has been conducted yet)

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8. APPENDICES

I. List of species observed

S.N	Common Name	Scientific Name	Codes for DCA	Altitude (M)	Land use
1	Large-billed Crow	*Corvus macrorhynchos*	*CorMac*	2200-3700	C,M,E,F
2	Yellow-billed Cough	*Pyrrhocorax graculus*	*PyrGra*	2200-3700	C,M,E,F
3	Kalij Pheasant	*Lophura leucomelanos*	*LopLeu*	2200-3400	C,F
4	Blue Whistling Thrush	*Myophonus caeruleus*	*MyoCae*	2200-3700	C,M,E,F
5	Hill Pigeon	*Columba rupestris*	*ColRup*	2200	M
6	Rock Pigeon	*Columba livia*	*ColLiv*	2200-3700	C,M,E,F
7	Grey-hooded Warbler	*Seicercus xanthoschistos*	*SeiXan*	2200-3000	C,M,E,F
8	Greenish Warbler	*Phylloscopus trochiloides*	*PhyTro*	2200-3700	C,M,E,F
9	Green-backed Tit	*Parus monticolus*	*ParMon*	2200-3000	C,M,E,F
10	Blue-fronted Redstart	*Phoenicurus frontalis*	*PhoFro*	2200-3700	C,M,E,F
11	Spotted Dove	*Streptopelia chinensis*	*StrChi*	2200	E
12	Satyr Tragopan	*Tragopan satyra*	*TraSat*	2200	F
13	Great Barbet	*Megalaima virens*	*MegVir*	2200	F
14	Red-billed Chough	*Pyrrhocorax pyrrhocorax*	*PyrPyr*	2200-3400	C,M
15	Verditer Flycatcher	*Eumyias thalassina*	*EumTha*	2200	M
16	White-capped Water Redstart	*Chaimarrornis leucocephalus*	*ChaLeu*	2200-2600	E,M
17	Mountain Bulbul	*Hypsipetes mcclellandii*	*HypMcc*	2200	F
18	Fire-capped Tit	*Cephalopyrus flammiceps*	*CepFla*	2200	E
19	Himalayan Bulbul	*Pycnonotus leucogenys*	*PycLeu*	2200	C,E,F
20	Streaked Laughingthrush	*Garrulax lineatus*	*GarLin*	2200-3700	C,M,E,F
21	Varigated Laughingthrush	*Garrulax variegates*	*GarVar*	2200-3700	C,E.M.F
22	Eurasian Cuckoo	*Cuculus canorus*	*CucCan*	2600	F
23	Beautiful Rosefinch	*Carpodacus pulcherrimus*	*CarPul*	2600-3700	C,M,E,F
24	Hodgson's Redstart	*Phoenicurus hodgsoni*	*PhoHod*	2600	E
25	Chestnut-bellied Rock Thrush	*Monticola rufiventris*	*MonRuf*	2600	E
26	Black-faced Laughingthrush	*Garrulax affinis*	*GarAff*	3000-3700	C,M,E,F
27	Himalayan Griffon	*Gyps himalayensis*	*GypHim*	3000	F
28	Snow Pigeon	*Columba leuconota*	*ColLeu*	3000-3700	C,M
29	Pink-browed Rosefinch	*Carpodacus rodochrous*	*CarRod*	3000-3700	C
30	Grey Bushchat	*Saxicola ferrea*	*SaxFer*	2600-3000	C,M,E,F
31	Tickell's Leaf Warbler	*Phylloscopus affinis*	*PhyAff*	2200-3700	C,M,E,F
32	White-winged Grosbeak	*Mycerobas carnipes*	*MycCar*	3000-3700	C,F
33	Lammergier	*Gypaetus barbatus*	*GypBar*	3000	F
34	Rufus-vented Tit	*Parus rubidiventris*	*ParRub*	3000-3700	E,F
35	Common Raven	*Corvus corax*	*CorCor*	3400	F

36	Maroon-backed Accentor	*Prunella atrogularis*	*PruAtr*	3400	F
37	Coal Tit	*Parus ater*	*ParAte*	3000-3700	M,E,F
38	Golden Eagle	*Aquila chrysaetos*	*AquChr*	3700	F
39	Orange-flanked Bush Robin	*Tarsiger cyanurus*	*TarCya*	3000-3700	M,E,F
40	Dark-throated Thrush	*Turdus ruficollis*	*TurRuf*	2200	C
41	Oriental Turtle Dove	*Streptopelia orientalis*	*StrOri*	2200-3700	C,M,E,F
42	Black Bulbul	*Hypsipetes leucocephalus*	*HypLeu*	2200-2600	C,M,E,F
43	Grey-headed Canary Flycatcher	*Culicicapa ceylonensis*	*CulCey*	2200-2600	E,F
44	Rufous Sibia	*Heterphasia capistrata*	*HetCap*	2200-3000	C,M,E,F
45	Grey-backed Shrike	*Lanius tephronotus*	*LanTep*	2200-3000	C,M,E
46	Wedge-tailed Green Pigeon	*Treron sphenura*	*TreSph*	2200	F
47	Yellow-breasted Greenfinch	*Carduelis spinoides*	*CarSpi*	2200-3400	C,M,E,F
48	Green-tailed Sunbird	*Aethopyga nipalensis*	*AetNip*	2600	M,E,F
49	Dark-sided Flycatcher	*Muscicapa sibirica*	*MusSib*	2600	E
50	Speckleted Wood Pigeon	*Columba hodgsonii*	*ColHod*	2600-3000	E,F
51	Striped-throated Yuhina	*Yuhina gularis*	*YuhGul*	2600	F
52	Black-throated Tit	*Aegithalos concinnus*	*AegCon*	2600	C,E,F
53	Whiskered Yuhina	*Yuhina flavicollis*	*YuhFla*	2200-2600	M,E
54	Long-tailed Minivet	*Pericrocotus ethologus*	*PerEth*	2600-3000	C,E,F
55	White-collared Blackbird	*Turdus albocinctus*	*TurAlb*	3000	E
56	Ms Gould's Sunbird	*Aethopyga gouldiae*	*AetGou*	2200-3000	M,E
57	Western-crowned Warbler	*Phylloscopus occipitalis*	*PhyOcc*	3000-3400	E,F
58	Long-tailed Shrike	*Lanius schach*	*LanSch*	2600-3400	C,M,E
59	Scaly-bellied Woodpecker	*Picus squamatus*	*PicSqu*	3000	M
60	Spot-winged Tit	*Parus melanolophus*	*ParMel*	3400	E,F
61	Hume's Warbler	*Phylloscopus humei*	*PhyHum*	2200-3400	C,E,F
62	Blood Pheasant	*Ithaginis cruentus*	*IthCru*	3400	F
63	Common Rosefinch	*Carpodacus erythrinus*	*CarEry*	3000-3700	C,M
64	Spot-winged Rosefinch	*Carpodacus rodopeplus*	*CarRod*	3400	C
65	Rosy Pipit	*Anthus roseatus*	*AntRos*	3000-3700	M,C
66	White wagtail	*Motacilla alba*	*MotAlb*	3700	C
67	Grey Wagtail	*Motacilla cinerea*	*MotCin*	3700	C
68	Blandford's Rosefinch	*Carpodacus rubescens*	*CarRub*	3700	M
69	Eurasian Blackbird	*Turdus merula*	*TurMer*	3700	E
70	White-bellied Redstartt	*Hodgsonius phaenicuroides*	*HodPha*	3700	F
71	White-throated Laughingthrush	*Garrulax albogularis*	*GarAlb*	3700	F
72	Olive-backed Pipit	*Anthus hodgsonii*	*AntHod*	2200-3700	C,M,E,F
73	Striated Prinia	*Prinia criniger*	*PriCri*	2200	C
74	Yellow-bellied Fantail	*Rhipidura hypoxantha*	*RhiHyp*	2200-2600	M,E,F
75	Whistler's Warbler	*Seicercus whistleri*	*SeiWhi*	2200-3400	E,F
76	Fire-breasted Flowerpecker	*Dicaeum ignipectus*	*DicIgn*	2200	E
77	Pluembous Water Redstart	*Rhyacornis fuliginosus*	*RhyFul*	2200	E,F

78	Kashmir Nuthach	*Sitta cashmirensis*	*SitCas*	2200	F
79	Spotted Nutcracker	*Nucifraga caryocatactes*	*NucCar*	2200-2600	M,E,F
80	Common Hoopoe	*Upupa epops*	*UpuEpo*	2200	C
81	Lesser Whitethroat	*Sylvia curruca*	*SylCur*	2600	M
82	Red-headed Bullfinch	*Pyrrhula erythrocephala*	*PyrEry*	2600	M
83	Buff-barred Warbler	*Phylloscopus pulcher*	*PhyPul*	2600-3000	E,F
84	lemon-rumped Warbler	*Phylloscopus chloronotus*	*PhyChl*	2600-3000	M,E,F
85	Slaty-blue Flycatcher	*Ficedula tricolor*	*FicTri*	2600-3000	C,F
86	White-browed Fulvetta	*Alcippe vinipectus*	*AlcVin*	3000	C,M
87	Grey-creasted Tit	*Parus dichrous*	*ParDic*	3000-3700	E,F
88	Grey-winged Blackbird	*Turdus boulboul*	*TurBou*	3000	F
89	Common Kestral	*Falco tinnunculus*	*FalTin*	3000	M
90	Black Redstart	*Phoenicurus ochruros*	*PhoOch*	3400	M
91	Eurasian Treecreeper	*Certhia familiaris*	*CerFam*	3400	F
92	Goldcrest	*Regulus regulus*	*RegReg*	3400	F
93	Smoky Warbler	*Phylloscopus fuligiventer*	*PhyFul*	3700	M

II. Photoplates

Researcher at workin Monsoon/MCA-3400m(Lho)

Scaly-breasted Woodpecker

Large-billed Crow (Hanged in cultivated Land)

Speckleted Wood Pigeon

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