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Research article

Avifaunal diversity inside and outside protected area: A case of Sundarijal Forest and Changunarayan Forest, Kathmandu Valley, Nepal

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Abstract

This study aimed to compare the diversity of birds between protected and non–protected areas that are similar in climatic and geographical features. The study was carried out in three different habitat types (forest, agricultural land and wetland) of protected Sundarijal and non-protected Changunarayan areas. Field data were collected using a "Point Count Approach" in transects which were laid in different habitat types (Forest, Agricultural land & Wetland). Shannon-Wiener and Margalef Diversity Indices were used to calculate the diversity of birds and Pielou's Evenness was used to calculate the evenness of bird species. Also, the national and global conservation status of bird species was categorized based on the National Red List Series and IUCN Red List of Threatened Species. The result shows that, a total of 114 species of birds, of which 89 species from the Changunarayan and 80 species from Sundarijal were recorded. The overall Shannon-Weiner diversity, Pielou's evenness, and Margalef's richness index were higher in Changunarayan (H1 = 4.16, E1 = 0.92, and R1 = 12.85) than in Sundarijal (H2 = 3.65, E2 = 0.83, R2 =11.77). Our study has shown the highest Shannon-Weiner Index (H1=3.99) and Margalef's richness index (R1=11.51) in Forest in Changunarayan. However, in Sundarijal, the highest Shannon-Weiner index (H2=3.49) was found in farmland and Margalef's richness index (R2=9.54) was documented highest for the wetland. Among the total recorded species, 109 and 110 species were categorized as least concerned nationally and globally, respectively while 4 globally threatened and 5 nationally threatened species were recorded in our study site. Our study showed that both protected and non-protected areas support the diversity and richness of birds. Hence priority should be given to both areas for the conservation of birds.

Keywords: Bird diversity; Evenness; Protected area, Richness; Threatened birds

1 | Introduction

Birds are an important component of nature and are a part of the natural food chain in different ecosystems (Whelan et al. 2008). Understanding the diversity and distribution of birds and other organisms is important in terms of understanding the adaptability, survival and extinction rates of species and providing knowledge that can be used to protect particular species of birds and other components of biodiversity that are correlated with them (Kremen 1992). Bird diversity acts as a strong bioindicator signal (Bhatt & Joshi 2011). They indicate the health of an ecosystem as they are sensitive to environmental change and status of biodiversity as a whole (Chettri 2010). Nepal is rich in avian diversity due to its amazingly diverse climatic and topographical variations within the country that have provided a variety of forests and ecosystem types (Poudel et al. 2021). A total of 886 bird species have been recorded from Nepal (BCN 2022). Out of which, 168 species have been assessed as nationally threatened, 64 are Critically Endangered, 64 are vulnerable, and 22 are Data Deficient (Inskipp et al. 2016). A total of 43 species of birds are globally threatened; 43 are globally near-threatened species, followed by 9 that are Regionally endangered species in Nepal (Inskipp et al. 2016; DNPWC & BCN 2019; BCN 2022). Out of these, the spiny babbler (*Acanthoptila nipalensis*) is the only endemic bird in Nepal (BCN 2022).

The major habitat of birds includes forests, wetlands and grasslands (Browder et al. 2021). Alpine habitat, forest land, scrub, wetlands, grassland, agricultural land and

human settlements are the key habitats found in Nepal (Basnet et al. 2016; Grimmett et al. 2016; Baral & Inskipp 2020). The diversity of habitats ranging from bare rock and scrub in the alpine zone to tropical forest in the lowlands support the diverse bird species. A diverse range of avifauna species can be found in the Terai, Churia (Siwalik), and Bhabar ranges (Shrestha 2003). Avifauna shows variation in habitat components and traits, showing the quality of the forest landscape in which, they live (Moning & Muller 2008). In terms of avifaunal composition, each habitat has its unique characteristics, and any change in vegetation composition would alter the avifaunal community (Acevedo & Aide 2008). Furthermore, thirty-seven Important Bird and Biodiversity Areas (IBAs) have been identified in Nepal, which include forests, grasslands, and freshwater ecosystems (MoFE 2018). Most of the Nepal's IBAs lie at relatively low altitudes (78–1000 m), including three of the most important protected areas: Chitwan National Park, Shuklaphanta National Park and Koshi Tappu Wildlife Reserve (BCN 2020). These protected areas in Nepal are playing a crucial role in the conservation and promotion of the IBAs (Inskipp et al. 2013). Also, researchers have argued and demonstrated that areas outside formal PAs are worth conserving because they provide alternative habitats and refuges for maintaining viable populations of both resident and migratory bird species (Shrestha et al. 2010; Cox & Underwood 2011; Dudley et al. 2014; DNPWC 2020).

Many studies on bird diversity and its distribution were done in Europe (Benedetti et al. 2022) and Asia (Bell & Chiappe 2022), but there are very few similar studies for Asia in general (Lei et al. 2015; Kottawa-Arachchi & Gamage 2015), particularly Nepal (Dangaura et al. 2020; Neupane et al. 2022; Ghimire et al. 2021; Engstrom et al. 2020). In Nepal, past studies of bird species have been mostly concentrated in the protected areas and Ramsar sites (Jha & Dhakal 2022; Kunwar et al. 2023; Neupane et al. 2020; Khadka et al. 2022; Shrestha et al. 2010; Pandey et al. 2020; Limbu & Subba 2011). Previous research has shown that anthropogenic activities such as the construction of infrastructure, roads, and dams in wetlands, pollution, habitat encroachment, and habitat degradation by invasive and alien species have threatened the habitats of birds in forests, wetlands, grasslands, and bush areas. (Junk et al. 2013). Food and water scarcity, overgrazing and use of pesticides, pollution from households and industrial discharges and agricultural run-off is seriously degrading the habitat of birds which are posing serious threats to the birds of Nepal (Inskipp et al. 2016).

Shivapuri Nagarjun National Park (SNNP) consists of 318 species of birds (BCN & DNPWC 2018), which indicate SNNP as an Important Bird and Biodiversity Area (IBA) (Baral & Inskipp 2005). The diversity and distribution of birds have been immensely studied in protected area, including SNNP. But the difference in bird diversity between protected and non-protected areas is not well

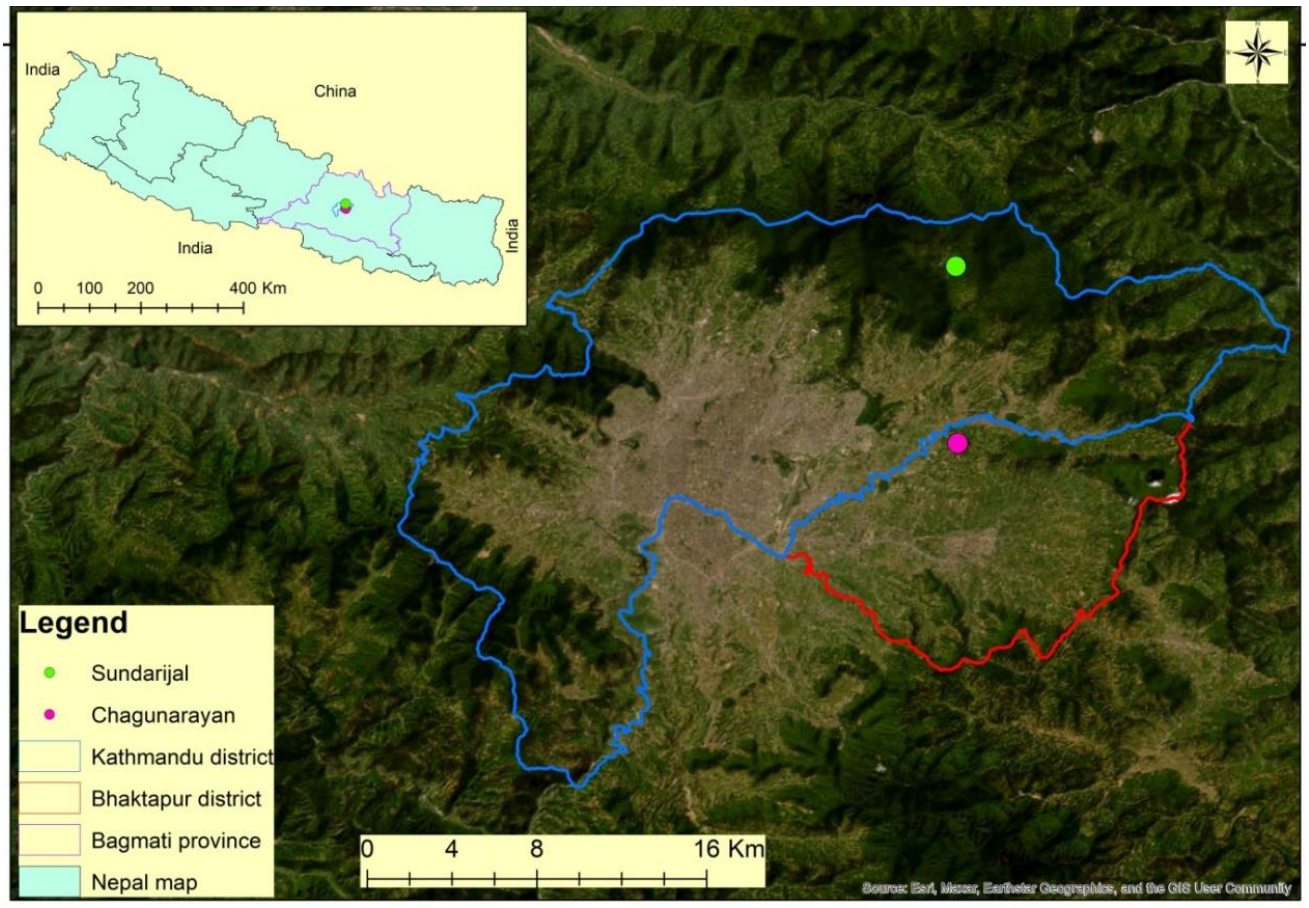

Figure 1. Map of the Kathmandu Valley showing two forest patches of this study

documented. In this study, we compared bird diversity between Sundarijal (referred to as a protected area (Shivapuri Nagarjun National Park) and Changunarayan (referred to as a non-protected area). The goal of this research was to better understand the richness, diversity, and assemblage of bird species in three different habitat types: forest land, agricultural land, and wetland of Changunarayan and Sundarijal. This research could provide up-to-date information on the avifauna in the area and aid in the preparation of baseline data on bird diversity.

2 | Materials and methods

2.1 | Study area

The study was conducted in the Sundarijal sector of Shivapuri Nagarjun National Park (referred to as a protected and undisturbed area) and Changunarayan World Heritage Site (referred to as a non-protected and disturbed area). These two areas are moreover similar in geography and climatic conditions. However, because of the natural uniqueness and exquisiteness, the number of visitors is comparatively high in Sundarijal than in Changunarayan.

Sundarijal is located in the northeastern section of the Kathmandu valley, between latitudes of 27°45', 27° 52' N and longitudes of 85° 15', 85° 30' E in Kathmandu district. The climate is sub-tropical with an average maximum temperature 24°C in May and a minimum 3.5°C in January. The average annual precipitation is 2586mm with heavy monsoon rainfall between June and September (Department of Hydrology and Meteorology, Kakani Weather Station, 1994–2003 AD). *Schima-Castanopsis* Forest dominates the lower height, Oak laurel forest dominates the middle level, and Oak rhododendron forest dominates the higher elevation. The Himalayan black bear (*Ursus thibetanus*), common leopard (*Panthera pardus*), jungle cat (*Felis chaus*), and rhesus monkey (*Macaca mulatta*) have all been spotted in the vicinity. The white-capped redstart (*Chaimarrornis leucocephalus*), mountain bulbul (*Ixos mcclellandii*), and rufous-gorgeted flycatcher (*Ficedula strophiata*) are all common bird species in the area.

Changunarayan World Heritage site lies 18km east of Kathmandu Valley, between latitudes of 27.68913° or 27° 41' 21" N and longitudes of 85.44962° or 85° 26' 59" E (Changunarayan Municipality 2017) in Bhaktapur district. The district falls under the subtropical climatic region where the climate is fairly pleasant, generally rainy season starts in June and ends in September (CBS 2012). The average annual temperature is 19.07°c and the average annual rainfall is 1140.3mm respectively (GON 2019). Changunarayan is one such site in the valley that consists of a natural forest floor (Maharjan et al. 2007) that forms a suitable habitat for diverse bird species. The core zone of the Heritage site consists of a native forest floor dominated by *Schima-Castanopsis* Forest which is partly covered by Pine-forest with a patch of Miyawaki plantation. Great barbet (*Megalaima virens*), black kite (*Milvus migrans*), rufous tree-pie (*Dendrocitta vagabunda*), Himalayan black-lored tit (*Parus xanthogenys*), red-vented bulbul (*Pycnonotus cater*), etc. are common bird species of the area (Fig. 1).

2.2 | Field Data Collection

The research took place over 60 days (30 days in Sundarijal and 30 days in Changunarayan) from February to April 2022. In each habitat type, three transects were established (Forest, Agricultural land, and Wetland). Along transect, a bird survey was conducted using the "Point count" approach (Bajagain et al. 2020; Bhusal et al. 2020). Depending on the shape of the wetland, agricultural land, and forest patch, the length of the transect walk ranged from 400 to 500 meters. The survey was conducted by two observers in the early morning (07:00–10:00 hours) when the majority of birds were active and soaring in search of food. The point was fixed in every 100m interval along the transects. At each point count station, fifteen-minute time was allotted for the observation of birds. Two observers scanned for birds in all directions. Birds flying overhead were eliminated to reduce the potential of double counting. The birds that flew behind the observers, however, were not recorded. Birds were methodically scanned and studied by the naked eye and field binoculars (Bushnell 10*40) at each point count station. The observed birds were photographed with a Canon camera EOS T6 (70–300mm). Mackinnon's list was used to record the species seen as described by Bibby et al. (2000). Similar methods were adopted to study the seasonal diversity of birds in Nagarjun forest of Shivapuri Nagarjun National Park (Jha et al. 2020). The recorded bird species were identified and taxonomically classified using Birds of the Indian Sub-continent (Grimmett et al. 2016).

2.3 | Data analysis

All the data were pooled and analyzed with MS Excel. Shannon-Wiener and Margalef Diversity Indices were calculated for bird diversity. Shannon-Wiener Index gives the information of the community composition of the species: higher the value, higher the species diversity. The value of 1.99 and below indicates very low diversity while value of 3.5 and above indicates very high diversity (Baliton et al. 2020). Margalef index denotes the species richness, with higher value representing higher richness. Species evenness was calculated by Pielou's Evenness. It describes the pattern of relative species abundances in a community, with value ranging from 0 (no evenness) to 1 (complete evenness). The obtained values were then compared between bird families, habitat types, and study sites.

Shannon-Wiener diversity index (H) = $-\sum_{i=1}^{n} Pi * lnPi$

Pielou's Evenness (E) = $\frac{H}{Hmax}$, here, Hmax= ln(S)

Margalef's' richness index (R) = $\frac{S-1}{\ln(N)}$

Where, Pi=proportion of individuals belonging to the i^{th} species, S= number of species and N= total count/number of individuals.

The conservation status of birds is categorized based on the Status of Nepal's Birds: The National Red List Series (Inskipp et al. 2016). While global status was based on the IUCN Red List of Threatened Species (IUCN 2023).

3 | Results

In this study, we recorded a total of 114 species of birds, of which 89 species were from the Changunarayan and 80

Table 1: Family-wise diversity indices, evenness, and species richness

S.N.	Families	S1	S2	H1	H2	E1	E2	R1	R2
1	Accipitridae	5	3	1.27	0.77	0.78	0.69	0.98	0.60
2	Aegithalidae	1	1	0	0	0	0	0	0
3	Alcedinidae	1	1	0	0	0	0	0	0
4	Apodidae	1	1	0	0	0	0	0	0
5	Ardeidae	1	1	0	0	0	0	0	0
6	Campephagidae	3	1	0.91	0	0.83	0	0.67	0
7	Cettiidae		1		0		0		0
8	Charadriidae	1	1	0	0	0	0	0	0
9	Ciconiidae	1		0		0		0	
10	Cinclidae		1		0		0		0
11	Cisticolidae	1	1	0	0	0	0	0	0
12	Columbidae	7	4	1.33	0.38	0.68	0.27	1.43	0.67
13	Corvidae	5	6	1.59	1.58	0.99	0.88	0.83	1.40
14	Cuculidae	5	2	1.60	0.69	0.41	1	1.03	0.72
15	Dicruridae	2	3	0.65	1.04	0.93	0.41	0.27	
16	Estrildidae	1		0		0		0	
17	Eurylaimidae	1	1	0	0	0	0	0	0
18	Hirundinidae	1	1	0	0	0	0	0	0
19	Laniidae	3	2	0.97	0.59	0.88	0.86	0.65	0.51
20	Leiothrichidae	1	4	0	1.02	0	0.73	0	0.92
21	Megalaimidae	2	2	0.62	0.69	0.89	1	0.28	0.48
22	Motacillidae	1	2	0	0.58	0	0.84	0	0.42
23	Muscicapidae	9	13	1.95	2.13	0.89	0.83	1.78	2.43
24	Nectariniidae	1	1	0	0	0	0	0	0
25	Oriolidae		1		0		0		0
26	Paridae	2	2	0.69	0.37	1	0.53	0.26	0.24
27	Passeridae	2	1	0.67	0	0.97	0	0.62	0
28	Phasianidae	1	1	0	0	0	0	0	0
29	Phylloscopidae	4	3	1.35	0.92	0.97	0.84	0.83	0.55
30	Picidae	3	4	1.08	1.07	0.98	0.77	0.96	1.44
31	Psittaculidae	3	1	0.86	0	0.78	0	0.58	0
32	Pycnonotidés	4	4	1.18	0.93	0.85	0.67	0.68	0.62
33	Rhipiduridae	1		0		0		0	
34	Scolopacidae		1		0		0		0
35	Sittidae	2	2	0.67	0.63	0.97	0.91	0.43	0.91
36	Stenostiridae	2	2	0.65	0.54	0.94	0.78	0.33	0.23
37	Strigidae	2	1	0.66	0	0.96	0	0.38	0
38	Sturnidae	3	2	0.78	0.59	0.71	0.85	0.49	0.34
39	Timaliidae	2	1	0.24	0	0.35	0	0.36	0
40	Turdidae	2		0.63		0.91		0.91	
41	Upupidae	1		0		0		0	
42	Zosteropidae	1	1	0	0	0	0	0	0
	Overall	**89**	**80**	**4.16**	**3.65**	**0.92**	**0.83**	**12.85**	**11.77**

(Abbreviations: Changunarayan (S1 = number of species, H1 = Shannon-Weiner Diversity, E1 = Pielou's evenness, R1 = Margalef's richness index) and Sundarijal (S2= number of species, H2 = Shannon-Weiner Diversity, E2 = Pielou's evenness, R2 = Margalef's richness index)

Table 2. Habitat-wise diversity indices, evenness, and species richness

Habitats	S1	S2	H1	H2	E1	E2	R1	R2
Forest	68	55	3.99	3.35	0.94	0.83	11.51	9.29
Farmland	69	41	3.92	3.49	0.92	0.94	11.39	7.77
Wetland	52	56	3.74	3.43	0.94	0.85	9.52	9.54
Overall	**189**	**152**	**10.75**	**10.27**	**2.8**	**2.62**	**32.42**	**26.6**

Abbreviations: Changunarayan (S1= number of species, H1 = Shannon-Weiner Diversity, E1 = Pielou's evenness, R1 = Margalef's richness index) and Sundarijal (S2= number of species, H2 = Shannon-Weiner Diversity, E2 = Pielou's evenness, R2 = Margalef's richness index)

species from the Sundarijal. The list of the birds is shown in Appendix 1. We found that the overall Shannon-Weiner diversity H1=4.16, Pielou's evenness E1=0.92, and Margalef's richness index R1=12.85 for the Changunarayan. And H2=3.65, E2=0.83, and R2=11.77 for the Sundarijal. Higher the values of H, E and R mean higher species diversity, evenness and species richness in the Changunarayan than the Sundarijal.

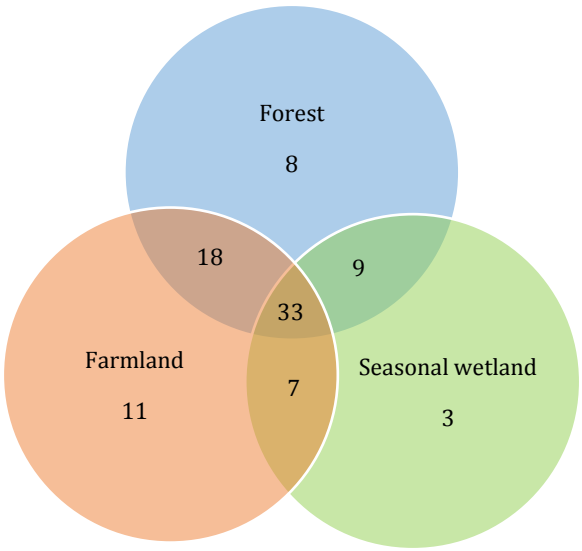

Figure 2. Habitat-wise species number in Changunarayan

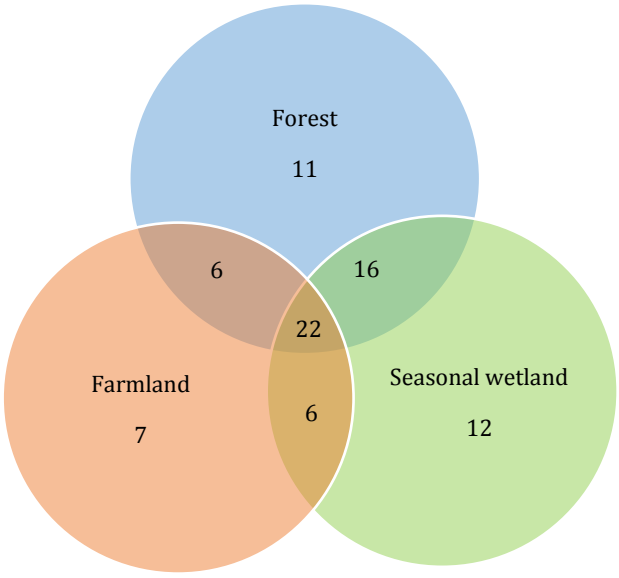

Figure 3. Habitat-wise species number in Sundarijal

3.1 | Family-wise bird diversity in Changunarayan and Sundarijal

A total of 38 families were represented from Changunarayan, while a total of 36 families were recorded from Sundarijal. In both study site, the family–Muscicapidae has the highest Shannon-Weiner diversity (H1=1.95 and H2=2.13), followed by Cuculidae (H1=1.60) in Changunarayan and Corvidae (H2=1,58) in Sundarijal. In Changunarayan, evenness was highest for the family-Paridae (1), followed by Corvidae (0.98) and Picidae (0.98). While evenness was highest for the family - Cuculidae (1) and Megalaimidae (1), followed by Sittidae (0.91) in Sundarijal. In both forests, species richness was also highest for the family – Muscicapidae (R1=1.78 and R2=2.43), followed by Columbidae (1.62) in Changunarayan and Picidae (1.44) in Sundarijalas shown in (Table 1).

3.2 | Habitat-wise bird diversity in Changunarayan and Sundarijal

In Changunarayan, the highest number of bird species was recorded in farmland (n=69), followed by forest (n=68) and seasonal wetland (n=52). Farmland alone constituted 11 species of birds, while eight species were reported from the forests and three from seasonal wetlands only (Fig. 2). In the Sundarijal, the highest number of bird species were recorded in seasonal wetlands (n=56), followed by forest (n=55) and farmland (n=41). Seasonal wetlands alone constituted 12 species of birds, while 11 species were reported from the forests and seven from seasonal wetlands only (Fig. 3).

In Changunarayan, the highest Shannon-Weiner index was for forests (H1=3.99) and the lowest for wetlands (H1=3.74). Evenness was similar for forests and wetlands (E1=0.94) and lower for farmland (H1=0.92). While species richness was highest for forests (R1=11.51) and lowest for wetlands (9.52). In Sundarijal, the Shannon-Weiner index and evenness were highest for farmland (H2=3.49 and E2=0.94) and lowest for forest (H2=3.35 and E2=0.83). However, species richness was highest for wetlands (R2=9.54) (Table 2).

3.3 | Conservation status of birds

Among the total recorded species, 109 and 110 species were categorized as least concerned nationally and globally, respectively (Appendix 1). While, three species (*Aquila nipalensis*, *Gyps himalayensis*, and *Pterorhinus caerulatus*) are categorized as vulnerable in Nepal. *Aquila nipalensis* is globally categorized as endangered species. In the Changunarayan, out of the 89 species, nationally, 86 species fall under least concern category, two under near threatened, and one under vulnerable. While concerning the global status, 86 species are under least concern, two under near threatened, and one under endangered category.

In case of Sundarijal, among the recorded birds, 76 species are nationally least concerned, three are vulnerable, and one is near threatened. Further, 77 species are globally least concerned, two near threatened, and one endangered (Appendix 1).

4 | Discussion

The present study compared the overall bird diversity in Sundarijal (referred to as a protected area) and Changunarayan World Heritage site (referred to as a non-protected area). The study revealed the presence of 114 species belonging to 38 families in the Changunarayan and 36 families in the Sundarijal. The documentation of 114 bird species suggests both the study sites has healthy avian diversity. The study area is habitat to 12.86% of 886 bird species documented in Nepal (DNPWC 2018). Understanding the diversity and distribution of species of birds is important in terms of understanding adaptability, survival and extinction rate of species and to design effective and sustainable bird conservation strategies (Bagajain et al. 2020). Currently, the study on avian diversity is conducted in different parts of Nepal. There have been substantial efforts in avian research in Nepal; however, it is biased to critical areas and species (Inskipp et al. 2017). For examples: 132 species of birds belonging to 44 families were recorded during the study carried out at the Institute of Forestry Complex, Hetauda (Bajagain et al. 2020). Dhakal et al. (2020) had recorded 33 species of water birds in Khaste Lake Complex, Nepal. Bhusal et al. (2021) also reported 164 species of birds belonging to 59 families in the Machhapalan Complex. This diversification in species composition might be due to time duration, season, and coverage area of the study site. However, the difference in bird diversity between protected and non-protected areas is comparatively less explored. Understanding the distribution of bird diversity in and outside PAs can be valuable to conservation managers and planners to formulate conservation strategies. Although PAs are central to global biodiversity conservation, non-protected areas are increasingly recognized as potentially important for the long-term conservation of biota (Dahal et al. 2014). Similar to our study, a comparison of bird diversity in protected and non-protected wetlands of western lowlands of Nepal was made in the study by Adhikari et al. (2022). Our results indicate that overall bird diversity was higher in non-protected Changunarayan than in protected Sundarijal signifying the importance of non-protected areas for species conservation. However, our obtained result is in contrast with the findings of Adhikari et al. (2022) and Dahal et al. (2014) who have reported higher bird diversity in protected wetlands compared to non-protected wetlands. In Nepal, 95.73% of avifaunal diversity is documented within the protected areas. Out of 124 bird species of lowland, Nepal, 24% were recorded in forests outside the PAs and 45% of species were common to the PAs, national forest, and community-based forest area. Even though the PAs is a strong habitat for global biodiversity, the non-protected area is also equally significant for conserving biodiversity (Dahal et al. 2014). Researchers have argued and demonstrated that areas outside formal PAs are worth conserving, as they provide alternative habitats for maintaining viable populations of migratory and residential bird species. Relatively more species of birds were reported in the Changunarayan area. This might be due to Changunarayan being relatively larger in terms of area than Sundarijal and the large areas comparatively harbor more species because of higher habitat heterogeneity and lower extinction rates (Hawkins & Porter 2001). Moreover, higher bird diversity in Changunarayan might be due to the presence of many ponds, abundant food sources such as fishes, aquatic plants, planktons, invertebrates and suitable habitat for breeding. Nevertheless, our result contradicts with the findings made by Bhusal et al. (2021) and Bajagain et al. (2020) where a greater variety of species was reported in the Machhapalan complex than in Institute of Forestry complex despite being relatively small in area coverage. The species-specific traits such as dietary preference, habitat specialization, and migratory behaviors have a significant influence on species distributions and richness variation (Carnicer et al. 2011). Avian diversity is co-related with different environmental variables (Basnet et al. 2016; Voskamp et al. 2017). Multiple factors like land area, geometric constraints, climate, food availability, productivity, evolutionary history, habitat structure, and human-induced disturbances play prominent roles in avian diversity (Rahbek et al. 2012; Hu et al. 2022).

Our results have revealed that species belonging to the Muscicapidae family had the highest Shannon-Weiner diversity (H1=1.95 and H2=2.13) and Margalef's Richness index (R1=1.78 and R2=2.43) in both the study sites. These results also align with a study in Machhapalan Complex, Hetauda (Bhusal et al. 2021). In contrast to our study, the highest number of species was reported under the Corvidae family in the study made by Bajagain et al. (2020) and Chaudhari et al. (2009). The reason behind the Muscicapidae found as the most diverse family might be because of being one of the largest bird families with great variability in morphology and behavior (Zhao et al. 2023). Nevertheless, our study has clearly indicated that species evenness was highest for the family Paridae (E1=1) in Changunarayan and Cuclidae (E2=1) in Sundarijal respec-ively. This result denotes that species belonging to Paridae family can tolerate greater level of anthropogenic disturbances whereas species belonging to Cuclidae

family are disturbance intolerant. Strict forest management that restricts the removal of standing dead trees, fallen timber for firewood and canopies by pruning is now urgently needed in Changunarayan to increase the diversity of disturbance intolerant species.

Our study also reported higher Shannon's Diversity Index (H1=3.99) and Margalaf's Richness Index (R1=3.74) in forest habitats than in wetland habitats in Changunarayan whereas Pielou's Evenness Index (E1=0.94) was similar in both forest and wetland habitat. It signifies the importance of both forest and wetland for species conservation. Similar results had been recorded by Bhusal et al. (2021) and Khatri et al. (2019) in Machhapalan Complex and Phewa Wetland, Nepal where wetland-dependent birds were dominated by forest birds. In contrast to our study, Bajagain et al. (2020) reported a higher Shannon's Diversity Index (H=4.08) in a wetland associated with a grassland habitat than in a forest habitat (H=4.06) in the Institute of Forestry Complex, Hetauda. Forest being one of the major habitats of bird species provides nesting, wintering sites and thermal refugia (Dangaura et al. 2020). A large variety of species ranging from least concerned to threatened species is found in the forest. Moreover, forests attract a large variety of avifauna because they provide suitable habitats for most birds, especially those birds that are associated with vegetation and for most; the existing trees are a vital component of their life cycle (Koli 2014). However, in Sundarijal Shannon-Weiner Diversity Index and Evenness were highest for farmland (H2=3.49 and E2=0.94) whereas species richness was highest for wetlands (R2=9.54). This result also aligns with a study made by Hung-Ming et al., 2020 where Shannon Diversity Index and Species Richness were recorded as higher in farmland and wetland. Wetland supports large congregation of large number of migratory and resident bird species as it has high nutritional value as well as productivity (Thapa et al. 2012). Wetlands provide major ecosystem services for feeding and breeding places of a large number of threatened birds. Birds are the most prominent and significant component of freshwater wetland ecosystems and their presence or absence may indicate the ecological conditions and the health of the wetlands (Rajpar & Zakaria 2010). The Wetland of Nepal supports a total of 40 (27%) nationally threatened birds (DNPWC 2017). Furthermore, wetlands are suitable for avifauna as they provide shelter, food, suitable nesting and roosting sites for different group of birds (Adhikari et al. 2022). Our results indicate that bird community structure (i.e. species richness, abundance and composition) varied notably within different habitat. Every habitat type such as forest, wetland and farmland support a considerable bird diversity of different feeding guilds. The prominent reason for the selection of different habitats by birds could be the presence of different vegetation types. Moreover, the variation in species diversity in different habitats might be due to food availability such as insects, fishes, frogs, lizards, mouse, grains, fruits, vegetable matter and water availability, vegetation cover, and the influence of anthropogenic activities.

Of the 42 globally threatened and 167 nationally threatened species of birds in Nepal (DNPWC & BCN 2018) 4 globally threatened and 5 nationally threatened species were recorded in our study site. Similar to our study, the conservation status of recorded birds was assessed in the study made by Bhusal et al. (2021), where 2 globally threatened and 9 nationally threatened species were recorded. However, out of 132 species recorded in the Institute of Forestry Complex, Hetauda only the Steppe eagle was recognized as globally threatened and 2 species were recognized as nationally threatened (Bajagain et al. 2020). Moreover, Khatri et al. (2019) also reported 7 globally threatened and 12 nationally threatened species in the Phewa wetland, Nepal. None of the recorded threatened species in our study site falls under the protected bird species list of Nepal (BCN & DNPWC 2011). The findings of our study are again supported by the study made by Bhusal et al. (2021) where they have clearly stated that none of the threatened species recorded in the areas falls under the protected bird species list of Nepal. Livestock pressure and anthropogenic disturbances are the prominent threats to birds in the study site as the study sites are located nearer to human settlements. Number of livestock present within the habitat of threatened birds caused a significantly negative effect on species richness and abundance of threatened birds. Human pressure can be considered as one of the major causes of habitat disturbance of threatened birds. Collection of grasses, forest products and fishing from the wetlands are the major activities of people within the study sites. Therefore, our study strongly suggests that maintaining heterogeneous habitats with low human disturbances could be a better strategy for the long-term survival of threatened birds in the study areas. Conservation action plan for threatened bird species should be meticulously prepared and immediately implemented. Furthermore, more field-based scientific research works is necessary to prepare a lucid picture about avifauna for the area. In addition to this, species conservation plan that focused on population monitoring and habitat enhancement is urgently needed.

5 | Conclusions

This study compared the avifaunal diversity in forests inside and outside the protected area system. The Sundarijal Forest inside the protected area exhibited greater diversity in terms of family and species of conservation concern, while the non-protected area displayed a higher number of overall species. Nevertheless, despite non- protected status, the remarkable presence of avifaunal diversity in Changunarayan Forest emphasizes the necessity of conservation efforts beyond protected areas. While Sundarijal has already established itself as a prominent bird-watching site, the local government of Changunarayan should consider developing the area as a designated bird-watching site to enhance its tourism sector. Moreover, special attention should be given to farmland habitat in Changunarayan due to the presence of a higher

number of species in such habitat and observed disturbance of haphazard land plotting.

Overall, this study highlights the need for conservation measures, habitat management, and public awareness initiative to safeguard avifaunal diversity in both protected and non-protected areas to contribute to the long-term preservation of the bird population. The fact that non-protected areas hold a great diversity of birds can't be neglected. So, Government, as well as conservation organizations, need to hold hands in hand for the planning and implementation of effective conservation measures with robust scientific studies of such areas.

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Authors' contributions

Pokharel, N. designed research, and collected data; Pokharel, N, and Phuyal N. analyzed and wrote the manuscript. All authors contributed critically to the drafts and gave final approval for publication.

Conflicts of interest

Authors declare no conflict of interest.

References

Acevedo, M. A. and Aide, T. M. 2008. Bird community dynamics and habitat associations in karst, mangrove and Pterocarpus forest fragments in an urban zone in Puerto Rico. Caribbean Journal of Science **44**(3):402–416.

Adhikari, J. N., Khatiwada, J. R., Adhikari, D., Sapkota, S., Bhattarai, B. P., Rijal, D. and Sharma, L. N. 2022. Comparison of bird diversity in protected and non-protected wetlands of western lowlands of Nepal. Journal of Threatened Taxa **14**(1):20371–20386.

Bajagain, S., Pokhrel, S., Baniya, S., Pradhan, A., Paudel, S. and Joshi, I. D. 2020. Avifaunal diversity of Institute of Forestry Complex, Hetauda Metropolis, Nepal. Forestry: Journal of Institute of Forestry, Nepal **17**:83–101.

Baliton, R., Landicho, L., Cabahug, R. E., Paelmo, R. F., Laruan, K., Rodriguez, R., et al. 2020. Ecological services of agroforestry systems in selected upland farming communities in the Philippines. Biodiversitas Journal of Biological Diversity **21**(2):707–717.

Baral, H. S. and Inskipp, C. 2005. *Important Bird Areas in Nepal: key sites for conservation*. Bird Conservation Nepal.

Baral, H. S. and Inskipp, C. 2020. Birds of Nepal: their status and conservation especially with regards to watershed perspectives. In G. R. Regmi, & F. Huettmann (Eds.), Hindu Kush-Himalaya watersheds downhill: Landscape ecology and conservation perspectives. Springer International Publishing AG. pp. 435-458.

Basnet, T. B., Rokaya, M. B., Bhattarai, B. P., &Münzbergová, Z. 2016. Heterogeneous landscapes on steep slopes at low altitudes as hotspots of bird diversity in a Hilly Region of Nepal in the Central Himalayas. PloS ONE **11**(3):e0150498.

BCN and DNPWC. 2018. Birds of Nepal: An Official Checklist, Kathmandu Nepal.

BCN and DNPWC. 2011. The state of Nepal's birds 2010. *Kathmandu: Bird Conservation of Nepal and Department of National Parks and Wildlife Conservation*.

Bell, A. and Chiappe, L. M. 2022. The Hesperornithiformes: a review of the diversity, distribution, and ecology of the earliest diving birds. Diversity **14**(4):267.

Benedetti, Y., Morelli, F., Callaghan, C. T. and Fuller, R. 2022. Distribution and protection of avian specialization in Europe. Global Ecology and Biogeography **31**(1):10–24.

Bhatt, D. and Joshi, K. K. 2011. Bird assemblages in natural and urbanized habitats along elevational gradient in Nainital district (western Himalaya) of Uttarakhand state, India. Current Zoology **57**(3):318–329.

Bhusal, K. P., Rana, D. B., Joshi, A. B., Chaudhary, I. P., Ghimire, P. and Pandey, M. 2020. Diversity and abundance of winter wetland birds in Jagdishpur reservoir Ramsar Site, Kapilvastu, Nepal. Danphe **29**(1):1–14.

Bhusal, N. 2021. Avian diversity and abundance in the Machhaplan complex, Hetauda, Nepal. Forestry: Journal of Institute of Forestry, Nepal **18**(01):90–106.

Bibby, C., Jones, M. and Marsden, S. 2000. Expedition field techniques: Bird surveys, Birdlife International.

Carnicer, J., Brotons, L., Stefanescu, C. and Penuelas, J. 2012. Biogeography of species richness gradients: linking adaptive traits, demography and diversification. Biological Reviews **87**(2):457–479.

Central Bureau of Statistics (CBS). 2012. National Population and Housing Census. Kathmandu, Nepal: National Planning Commission Secretariat, Government of Nepal.

Changunarayan Municipality. 2017. "The Distinction of Changunarayan", [Brochure]

Chaudhari, U. K., Kafle, G., & Baral, H. S. 2009. Avifaunal diversity of Khata Corridor Forest. Journal of Wetlands Ecology **2**:48–56.

Chettri, N. 2010. Cross-taxon congruence in a trekking corridor of Sikkim Himalayas: Surrogate analysis for conservation planning. Journal for Nature Conservation **18**(2):75–88.

Cox, R. L. and Underwood, E. C. 2011. The importance of conserving biodiversity outside of protected areas in Mediterranean ecosystems. PloS ONE **6**(1):e14508.

Dahal, B. R., McAlpine, C. A. and Maron, M. 2014. Bird conservation values of off-reserve forests in lowland Nepal. Forest Ecology and Management **323**:28–38.

Dangaura, H. L., Pandey, N., Chand, D. B., & Bhusal, K. P. 2020. Avian richness of the Basanta Protected Forest, far-western lowland Nepal: Implication for conservation. Nepalese Journal of Zoology **4**(2):68–84.

Department of National Parks and Wildlife Conservation and Bird Conservation Nepal. 2018. Birds of Nepal: An Official Checklist, Kathmandu, Nepal, 40pp.

Dhakal, H., Ghimire, M., Poudel, A. K., Ghimire, P. and Bhusal, K. P. 2020. Avian diversity of Khaste Lake Complex, Pokhara Valley, Nepal. Minivet **3**:17–25.

DNPWC. 2017. Department of National Park and Wildlife Conservation, Nepal. Available https://dnpwc.gov.np

DNPWC. 2020. Protected areas of Nepal. Department of National Parks and Wildlife Conservation (DNPWC) Nepal, Kathmandu, Nepal. Downloaded on 20 January 2020. http://www.dnpwc.gov.np

DNPWC and BCN. 2019. An official checklist of the birds. Department of National Parks and Wildlife Conservation, Bird Conservation Nepal.

DNPWC and BCN. 2018. Birds of Nepal: an official checklist. *Kathmandu: Department of National Parks and Wildlife Conservation*.

DNPWCand BCN 2018. Birds of Nepal: An official checklist. Department of National Park and Wildlife Conservation and Bird Conservation Nepal, Kathmandu.

Engstrom, R. T., Edenius, L., Thapa, T. B., Bidari, B., Gurung, A. and Mikusiński, G. 2020. Bird communities of two forest types in Chitwan Valley, Nepal. Ornithological Science **19**(1):29–40.

Ghimire, A., Rokaya, M. B., Timsina, B., Bílá, K., Shrestha, U. B., Chalise, M. K. and Kindlmann, P. 2021. Diversity of birds recorded at different altitudes in central Nepal Himalayas. Ecological Indicators **127**:107730

GON. 2019. *Environment statistics of Nepal, 2019.* Government of Nepal, Kathmandu.

Grimmett, R., Inskipp, C. and Inskipp, T. 2016. *Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives*. Bloomsbury Publishing. birds Hawkins, B. A., & Porter, E. E. (2001). Area and the latitudinal diversity gradient for terrestrial. Ecology Letters **4**(6):595–601.

Hawkins, B. A. and Porter, E. E. 2001. Area and the latitudinal diversity gradient for terrestrial birds. Ecology Letters **4**(6):595–601.

Hu, H., Wang, Y., McDonald, P. G., Wroe, S., O'Connor, J. K., Bjarnason, A. et al. 2022. Earliest evidence for fruit consumption and potential seed dispersal by birds. Elife **11**:e74751.

Inskipp, C., Baral, H. S., Inskipp, T. and Stattersfield, A. 2013. The state of Nepal birds 2010. Journal of Threatened Taxa **5**(1):3473–3503.

Inskipp, C., Baral, H. S., Phuyal, S., Bhatt, T. R., Khatiwada, M., Inskipp, T., et al. 2016. The status of Nepal's birds: the national red list series. Zoological Society of London, UK, 628.

Inskipp, C., Baral, H.S., Inskipp, T.P., Khatiwada, A.P., Khatiwada, M.P., Poudyal, L.P. and Amin, R. 2017. Nepal's National Red List of Birds. Journal of Threatened Taxa **9**:9700–9722.

IUCN 2023.The IUCN Red list of Threatened Species Version 2022-2. https://iucnredlist.org.

Jha, P. K. and Dhakal, D. P. 2022. Seasonal Abundance and Diversity of Waterbirds of Rapti river from Sauraha to Kasara of Chitwan National Park, Nepal. International Research Journal of MMC (IRJMMC) **3**(2):47–58.

Jha, V. M., Jha, S. K., Jha, V. M. and Jha, S. K. 2020. Sleep: Evolutionary and Adaptive Changes in Birds and Mammals. Sleep: Evolution and Functions 37–59.

Khadka, B., Pathak, A., Wilson, J., Paudel, P., Acharya, P., Ram, A. and Adhikari, L. 2022. From human settlement region to bird dominated grassland: Avian diversity in the Padampur grassland of Chitwan National Park, Nepal. Journal of Biological Studies **4**(4):167–183.

Khatri, N. D., Neupane, B., Timilsina, Y. P. and Ghimire, S. 2019. Assessment of avifaunal diversity and threats to them in Phewa wetland, Nepal. Forestry: Journal of Institute of Forestry, Nepal **16**:31–47.

Koli V. K. 2014. Diversity and status of avifauna in Todgarh-Raoli Wildlife Sanctuary, Rajasthan, India. Journal of Asia-Pacific Biodiversity **7**(4):401–407.

Kottawa-Arachchi, J. D. and Gamage, R. N. 2015. Avifaunal diversity and bird community responses to man-made habitats in St. Coombs Tea Estate, Sri Lanka. Journal of Threatened Taxa **7**(2):6878–6890.

Kremen, C. 1992. Assessing the indicator properties of species assemblages for natural areas monitoring. Ecological Applications 2:203–217.

Kunwar, N., Pandey, N., Singh, K. D. and Bhattarai, B. P. 2023. Bird diversity along an elevational gradient in ShivapuriNagarjun National Park, Nepal. Our Nature **21**(1):1–15.

Lei, F., Qu, Y., Song, G., Alström, P. and Fjeldså, J. 2015. The potential drivers in forming avian biodiversity hotspots in the East Himalaya Mountains of Southwest China. Integrative Zoology **10**(2):171–181.

Limbu, K. P. and Subba, B. R. 2011. Status of key faunal species in Koshi Tappu Wildlife Reserve after Koshi flood disaster 2008. Nepalese Journal of Biosciences **1**:41–54.

Maharjan, S. R., Bhuju, D. R. and Khadka, C. 2007. Plant Community Structure and Species Diversity in Ranibari Forest, Kathmandu. Nepal Journal of Science and Technology **7**:35.

MoFE. 2018. Integrated Lake Basin Management Plan of Lake Cluster of Pokhara Valley, Nepal (2018-2023). Ministry of Forests and Environment, Kathmandu, Nepal.

Moning, C. and Müller, J. 2008. Environmental key factors and their thresholds for the avifauna of temperate montane forests. Forest Ecology and Management **256**(5):1198–1208.

Neupane, B., Dhami, B., Panthee, S., Stewart, A. B., Silwal, T. and Katuwal, H. B. 2022. Forest Management Practice Influences Bird Diversity in the Mid-Hills of Nepal. Animals **12**(19):2681.

Neupane, J., Khanal, L. and Chalise, M. K. 2020. Avian diversity in Kaligandaki River basin, Annapurna Conservation Area, Nepal. International Journal of Ecology and Environmental Sciences **46**(2):99–110.

Pandey, N., Khanal, L. and Chalise, M. K. 2020. Correlates of avifaunal diversity along the elevational gradient of Mardi Himal in Annapurna Conservation Area, Central Nepal. Avian Research **11**(1):1–14.

Poudel, B., Neupane, B., Joshi, R., Silwal, T., Raut, N. and Thanet, D. R. 2021. Factors affecting the species richness and composition of bird species in a community managed forest of Nepal. Journal of Threatened Taxa **13**(9):19212–19222.

Rahbek, C., Hansen, L.A. and Fjeldså, J. 2012 One degree resolution database of the global distribution of birds. Natural History Museum of Denmark, University of Copenhagen, Denmark.

Rajpar, M. N. and Zakaria, M. 2010. Density and diversity of water birds and terrestrial birds at Paya Indah Wetland Reserve, Selangor Peninsular Malaysia. Journal of Biological Sciences **10**(7):658–666.

Shrestha, T. K. 2003. *Wildlife of Nepal: a study of renewable resources of Nepal Himalayas*. Steven Simpson Books.

Shrestha, U. B., Shrestha, S., Chaudhary, P. and Chaudhary, R. P. 2010. How representative is the protected areas system of Nepal? Mountain Research and Development **30**(3):282–294.

Thapa, J. B., & Saund, T. B. 2012. Water quality parameters and bird diversity in Jagdishpur Reservoir, Nepal. Nepal Journal of Science and Technology **13**(1):143-155.

Voskamp, A., Baker, D. J., Stephens, P. A., Valdes, P. J. and Willis, S. G. 2017. Global patterns in the divergence between phylogenetic diversity and species richness in terrestrial birds. Journal of Biogeography **44**(4):709–721.

Whelan, C. J., Wenny, D. G. and Marquis, R. J. 2008. Ecosystem services provided by birds. Annals of the New York Academy of Sciences **1134**(1):25–60.

Zhao, M., Burleigh, J. G., Olsson, U., Alström, P. and Kimball, R. T. 2023. A near-complete and time-calibrated phylogeny of the Old-World flycatchers, robins and chats (Aves, Muscicapidae). Molecular Phylogenetics and Evolution **178**:107646.

Appendix 1. List of birds in Changunarayan and Sundarijal Forests

S.N.	Family name	Scientific name	Common name	Chagunarayan (N)			Sundarijal (N)			Conservation status	
				F	FL	WL	F	FL	WL	Nat.	Glob.
1	Accipitridae	*Accipiter badius*	Shikra	2		3				LC	LC
2	Accipitridae	*Aquila nipalensis*	Steppe eagle	8	7			2	7	VU	EN
3	Accipitridae	*Buteo refectus*	Himalayan buzzard	2	3	2				LC	LC
4	Accipitridae	*Gyps himalayensis*	Himalayan griffon						1	VU	NT
5	Accipitridae	*Hieraaetus pennatus*	Booted eagle	2						LC	LC
6	Accipitridae	*Milvus migrans*	Black kite	1	17		4		14	LC	LC
7	Aegithalidae	*Aegithalos concinnus*	Black- throated tit				4		3	LC	LC
8	Aegithalidae	*Aegithalosiredalei*	Red-headed tit	2	3					LC	LC
9	Alcedinidae	*Halcyon smyrnensis*	White-throated kingfisher	7	7	6			2	LC	LC
10	Apodidae	*Aerodramus brevirostris*	Himalayan swiftlet					5		LC	LC
11	Apodidae	*Apus nipalensis*	House swift	6	2					LC	LC
12	Ardeidae	*Bubulcus ibis*	Cattle egret		6	8		3	4	LC	LC
13	Campephagidae	*Coracina macei*	Large cuckooshrike	4	7					LC	LC
14	Campephagidae	*Pericrocotus brevirostris*	Short-billed minivet	2						LC	LC
15	Campephagidae	*Pericrocotus flammeus*	Scarlet minivet	1	3	2	1		2	LC	LC
16	Cettiidae	*Horornis flavolivaceus*	Aberrant bush warbler				3		2	LC	LC
17	Charadriidae	*Vanellus indicus*	Red-wattled lapwing		1	1			2	LC	LC
18	Ciconiidae	*Ciconia episcopus*	Asian woollyneck			1				NT	NT
19	Cinclidae	*Cinclus pallasii*	Brown dipper						3	LC	LC
20	Cisticolidae	*Orthotomus sutorius*	Common tailorbird	7	11		1		3	LC	LC
21	Columbidae	*Columba livia*	Rock pigeon		32		34	10	37	LC	LC
22	Columbidae	*Columba pulchricollis*	Ashy wood pigeon	2						LC	LC
23	Columbidae	*Spilopelia chinensis*	Spotted dove						1	LC	LC
24	Columbidae	*Streptopeliadecaocto*	Eurasian collared dove		2	2	1	1	3	LC	LC
25	Columbidae	*Streptopelia orientalis*	Oriental turtle-dove	6	8	7			2	LC	LC
26	Columbidae	*Streptopelia tranquebarica*	Red collared-dove		1	1				LC	LC
27	Columbidae	*Treron phoenicopterus*	Yellow-footed green-pigeon		4					LC	LC
28	Columbidae	*Treron sphenurus*	Wedge-tailed green-pigeon			1				LC	LC
29	Corvidae	*Corvus macrorhynchos*	Large-billed crow	1	8	7	7		3	LC	LC
30	Corvidae	*Corvus splendens*	House crow	7	20		2	3	1	LC	LC
31	Corvidae	*Dendrocitta formosae*	Grey treepie	1	10		1			LC	LC
32	Corvidae	*Dendrocitta vagabunda*	Rufous treepie	1	5	2		1	1	LC	LC
33	Corvidae	*Urocissa erythroryncha*	Red-billed blue magpie	9	6	10	1		5	LC	LC
34	Corvidae	*Urocissa flavirostris*	Yellow-billed blue-magpie				5	5		LC	LC
35	Cuculidae	*Centropus sinensis*	Greater coucal	2	2	4	1		2	LC	LC
36	Cuculidae	*Cuculus canorus*	Common cuckoo	7	4					LC	LC
37	Cuculidae	*Cuculus micropterus*	Indian cuckoo	7	4					LC	LC
38	Cuculidae	*Eudynamys scolopaceus*	Asian koel	3	2	4				LC	LC
39	Cuculidae	*Phaenicophaeus tristis*	Green-billed malkoha	2	3	4	2			LC	LC
40	Dicruridae	*Dicrurus aeneus*	Bronzed drongo					2		LC	LC
41	Dicruridae	*Dicrurus hottentottus*	Hair-crested drongo	4	3	6				LC	LC
42	Dicruridae	*Dicrurus leucophaeus*	Ashy drongo					2		LC	LC
43	Dicruridae	*Dicrurus macrocercus*	Black drongo	1	6	8	2	1	1	LC	LC
44	Estrildidae	*Lonchura striata*	White-rumped munia		7					LC	LC
45	Eurylaimidae	*Psarisomus dalhousiae*	Long-tailed broadbill	3		2	5			LC	LC
46	Hirundinidae	*Hirundo rustica*	Barn swallow		2	6	3	4	8	LC	LC
47	Laniidae	*Lanius cristatus*	Brown shrike	2		2				LC	LC
48	Laniidae	*Lanius schach*	Long-tailed shrike	2	3		1		1	LC	LC
49	Laniidae	*Lanius tephronotus*	Grey-backed shrike	6	6		2	1	2	LC	LC
50	Leiothrichidae	*Garrulax leucolophus*	White-crested laughingthrush				9	5		LC	LC
51	Leiothrichidae	*Pterorhinus albogularis*	White-throated laughingthrush		5		5	4		LC	LC
52	Leiothrichidae	*Pterorhinus caerulatus*	Gray-sided laughingthrush				1			VU	LC
53	Leiothrichidae	*Trochalopteron lineatum*	Streaked laughingthrush					2		LC	LC
54	Megalaimidae	*Psilopogon asiaticus*	Blue-throated barbet	2	6	2	1		3	LC	LC
55	Megalaimidae	*Psilopogon virens*	Great barbet	8	10	4	2		2	LC	LC
56	Motacillidae	*Anthus hodgsoni*	Olive-backed pipit	5			3		5	LC	LC
57	Motacillidae	*Motacilla alba*	White wagtail					1	2	LC	LC
58	Muscicapidae	*Chaimarrornis leucocephalus*	White-capped water redstart				7	4	9	LC	LC
59	Muscicapidae	*Copsychus saularis*	Oriental magpie robin	4	4	2		1		LC	LC
60	Muscicapidae	*Cyornis rubeculoides*	Blue-throated blue-flycatcher	2						LC	LC
61	Muscicapidae	*Enicurus maculatus*	Spotted forktail						2	LC	LC
62	Muscicapidae	*Eumyias thalassinus*	Verditer flycatcher	5	5	7	2	3		LC	LC

63	Muscicapidae	*Ficedula albicilla*	Tiaga flycatcher	1	4		1		5	LC	LC
64	Muscicapidae	*Ficedula strophiata*	Rufous-gorgeted flycatcher	2		2	8	5	6	LC	LC
65	Muscicapidae	*Myiomela leucura*	White-tailed robin	4						LC	LC
66	Muscicapidae	*Myophonus caeruleus*	Blue whistling-thrush	1	3	9	8	5	9	LC	LC
67	Muscicapidae	*Niltava macgrigoriae*	Small niltava	2	2	3	3	3	3	LC	LC
68	Muscicapidae	*Niltava sundara*	Rufous-bellied niltava					3	2	LC	LC
69	Muscicapidae	*Phoenicurus frontalis*	Blue-fronted redstart	6	7	3		2	2	LC	LC
70	Muscicapidae	*Rhyacornis fuliginosa*	Plumbeous water redstart				12	4	23	LC	LC
71	Muscicapidae	*Saxicola caprata*	Pied bushchat				2	1	1	LC	LC
72	Muscicapidae	*Saxicola ferreus*	Grey bushchat						3	LC	LC
73	Nectariniidae	*Aethopyga siparaja*	Crimson sunbird		4	3		2		LC	LC
74	Oriolidae	*Oriolus traillii*	Maroon oriole				1		1	LC	LC
75	Paridae	*Machlolophus xanthogenys*	Himalayan black-lored tit	6	8	8	43	4	3	LC	LC
76	Paridae	*Parus major*	Cinereous tit	9	8	5	2	4	1	LC	LC
77	Passeridae	*Passer domesticus*	House sparrow		2		7	5	9	LC	LC
78	Passeridae	*Passer montanus*	Eurasian tree sparrow		3					LC	LC
79	Phasianidae	*Lophura leucomelanos*	Kalij pheasant		1	2	1			LC	LC
80	Phylloscopidae	*Phylloscopus chloronotus*	Lemon-rumped leaf-warbler	2	2	3				LC	LC
81	Phylloscopidae	*Phylloscopus humei*	Hume's leaf-warbler	4	5	4	8		4	LC	LC
82	Phylloscopidae	*Phylloscopus trochiloides*	Greenish warbler					4		LC	LC
83	Phylloscopidae	*Phylloscopus whistleri*	Whistler's warbler	2	3	2				LC	LC
84	Phylloscopidae	*Phylloscopus xanthoschistos*	Grey-hooded warbler	3	5	2	9	7	5	LC	LC
85	Picidae	*Dendrocopos hyperythrus*	Rufous-bellied woodpecker				1			LC	LC
86	Picidae	*Dendrocopos macei*	Fulvous-breasted woodpecker	2	1		2	2	1	LC	LC
87	Picidae	*Micropternus brachyurus*	Rufous woodpecker	3	5	2				LC	LC
88	Picidae	*Picumnus innominatus*	Speckled piculet	1	1		1			LC	LC
89	Picidae	*Picus canus*	Gray-headed woodpecker				1			LC	LC
90	Psittaculidae	*Alexandrinus krameri*	Rose-ringed parakeet	9	11					LC	LC
91	Psittaculidae	*Psittacula himalayana*	Slaty-headed parakeet		4					LC	LC
92	Psittaculidae	*Palaeornis eupatria*	Alexandrine parakeet	2	4		2			NT	NT
93	Pycnonotidés	*Hypsipetes leucocephalus*	Black bulbul	1	11	5			3	LC	LC
94	Pycnonotidés	*Ixos mcclellandii*	Mountain bulbul	2		1	9	6		LC	LC
95	Pycnonotidés	*Pycnonotus cafer*	Red-vented bulbul	1	12	13	6	5	12	LC	LC
96	Pycnonotidés	*Pycnonotus leucogenys*	Himalayan bulbul	6	5	7	25	13	44	LC	LC
97	Rhipiduridae	*Rhipidura albicollis*	White-throated fantail			2				LC	LC
98	Scolopacidae	*Actitis hypoleucos*	Common sandpiper						1	LC	LC
99	Sittidae	*Sitta cinnamoventris*	Chestnut-belliednuthatch						2	LC	LC
100	Sittidae	*Sitta frontalis*	Velvet-fronted nuthatch	4		2				LC	LC
101	Sittidae	*Sitta himalayensis*	White-tailed nuthatch	4			1			LC	LC
102	Stenostiridae	*Chelidorhynx hypoxanthus*	Yellow-bellied fantail	4		8	27	10	15	LC	LC
103	Stenostiridae	*Culicicapa ceylonensis*	Grey-headed canary-flycatcher	2		5	3	7	6	LC	LC
104	Strigidae	*Athene brama*	Spotted owlet	3	2	3	3			LC	LC
105	Strigidae	*Glaucidium radiatum*	Jungle owlet	4		1				LC	LC
106	Sturnidae	*Acridotheres fuscus*	Jungle myna	5	9	5				LC	LC
107	Sturnidae	*Acridotheres tristis*	Common myna	1	19		6	7		LC	LC
108	Sturnidae	*Sturnia malabarica*	Chestnut-tailed starling		2				5	LC	LC
109	Timaliidae	*Cyanoderma pyrrhops*	Black-chinned babbler	1						LC	LC
110	Timaliidae	*Erythrogenys erythrogenys*	Rusty-cheeked scimitar-babbler	5	6	3	4		3	LC	LC
111	Turdidae	*Turdus atrogularis*	Black-throated thrush		2					LC	LC
112	Turdidae	*Zoothera dauma*	Scaly thrush		1					LC	LC
113	Upupidae	*Upupa epops*	Common hoopoe		2					LC	LC
114	Zosteropidae	*Zosterops palpebrosus*	Indian white-eye	2	1	5	28	12	17	LC	LC

Abbreviations: F = Forest, FL = Farmland, WL = Wetland, Nat. = National, Glob. = Global