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Species composition and habitat associations of birds around Jhilmila Lake at Western Chure Landscape, Nepal

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Abstract Wetlands support around 27% of birds in Nepal, however, there is a paucity of information about bird diversity and the wetland habitat of Western Chure Landscape Nepal. The "point count" method along transects was carried out to evaluate the species composition and habitat associations of birds. A total of 2,532 individuals representing 152 species (winter: N = 140 and summer: N = 91) from 19 orders and 51 families were reported from Jhilmila Lake and its surrounding area. The number of birds was reported to be significantly higher during winter than in the summer season. The species diversity was also higher in winter (Shannon's index (H) = 4.38, Fisher's alpha = 30.67) than in summer (H = 4.21, Fisher's alpha = 34.69) as this area is surrounded by old-growth forest that provides available habitats for forest, grassland- and wetland-dwelling birds. This lake is an example of a wetland present in the Chure area that plays an important role in the conservation of biodiversity along with birds. Hence, we recommend its detailed study in terms of biodiversity and water quality.

Keywords: Chure, bird diversity, endangered, forest, wetland

Összefoglalás A vizes élőhelyek a nepáli madarak körülbelül 27%-át tartják fenn. A nepáli Western Chure Landscape területének fajdiverzitásáról és a vizes élőhelyéről kevés információ áll rendelkezésre. A madarak fajösszetételének és élőhelytársulásainak értékelésére a „pontszámlálás" módszert a transzektek mentén végeztük. A Jhilmila-tóról és környékéről összesen 19 rendbe, 51 családba és 152 fajba (télen: 140, nyáron: 91) tartozó 2532 példányt jelentettek. A madarak száma szignifikánsan magasabb volt télen, mint nyáron (t = 4,17, P = 0,0004). A fajdiverzitás is télen magasabb volt (Shannon index H = 4,38, 4,27 és 4,37 között mozog, Fisher alfa = 30,67), mint nyáron (H = 4,21, 4,12 és 4,23 között mozog, Fisher alfa = 34,69). A területet öreg erdők veszik körül, amelyek élőhelyet biztosítanak az erdő-, gyep- és vizes élőhelytől függő madarak számára. Ez fontos szerepet játszik a biológiai sokféleség, valamint a nyugat-nepáli Chure területe madárvilágának megőrzésében, ezért javasoljuk a biológiai sokféleség további részletes tanulmányozását.

Kulcsszavak: Chure, madár diverzitás, veszélyeztetett, erdő, vizes élőhely

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Introduction

Wetlands are highly productive and dynamic ecosystems of the earth and serve as the kidneys of the landscape, biological supermarket, and climate stabilizer (Basnet *et al.* 2016). Wetlands are beneficiary components of biodiversity for the productive ecosystems that are responsible for the sustainability of human and other ecological systems (Pal *et al.* 2021). Wetlands are vulnerable around the world. In fact, wetlands are often viewed as wastelands but these are ecologically important that provide the feeding and breeding ground for wildlife (Bhandari 1998). Western Nepal is famous for its wetland resources (Khatiwada *et al.* 2021). However, there are very few wetlands in the Chure region except some oxbow lakes and dry floodplain areas. The major lakes found in the Chure region of far western Nepal are Betkot, Jhilmila and Mudka (Khatiwada *et al.* 2021).

Nepal harbors 891 species of birds which is 8.87% of the total global bird species (BCN & DNPWC 2016, BCN 2022). Among the reported species, more than 19% of the birds (n = 167) are nationally threatened whereas 42 species are globally threatened and 37 are globally near threatened (BCN & DNPWC 2016, Inskipp *et al.* 2016). NPWC act 1973 listed nine birds (Himalayan Monal *Lophophorus impejanus*, Cheer Pheasant *Catreus wallichii*, Satyr Tragopan *Tragopan satyra*, Bengal Florican *Houbaropsis bengalensis*, Lesser Florican *Sypheotides indicus*, Great Hornbill *Buceros bicornis*, Sarus Crane *Grus antigone*, Black Stork *Ciconia nigra* and White Stork *Ciconia ciconia*) as protected birds (DNPWC 2020). Among nationally threatened birds, 27% of the birds are wetland dependent following 53% forest birds, 15% grassland and open area birds (BCN & DNPWC 2016).

The Chure region extends east to west covering about 12.8% area of Nepal. It is the youngest and most fragile mountain with a unique biodiversity. The Chure region mostly remained forested till the 1950s, but with the human population increment, deforestation in the Chure forest is occurring at an unprecedented rate (Subedi *et al*. 2021). The majority (76%) of the forest areas of the Chure region fall outside the protected areas. Chure provides a habitat for various rare and globally threatened species (Subedi *et al*. 2021). Altogether, 99 species of herpetofauna (24 species of amphibians and 75 species of reptiles), 378 species of birds, and 41 species of mammals, were recorded from the Chure region (Subedi *et al*. 2021).

Habitat selection is one of the major drivers of species distribution which lead to an increase in faunal diversity and provides breeding and feeding opportunities (Kim *et al.* 2018, Iswandaru *et al.* 2020). Forest, wetlands, grassland, agricultural land, human settlements, and open areas are major habitats found in western Nepal (Basnet *et al.* 2016, Grimmett *et al.* 2016, Baral & Inskipp 2020). Birds are the bio-indicators that signify the health and quality of the ecosystem (Bregman *et al.* 2014). Anthropogenic activities such as livestock pressure, human pressure, and unscientific agrochemical practices are the major factors that determine birds' diversity and compositions (Bregman *et al.* 2014). Seasonality is an important factor that affects the diversity and distribution of birds (Adhikari *et al.* 2019). The effects of seasonal changes can affect the abiotic and biotic components of that region. The altitude, aspect, habitat heterogeneity, and course of river changes are the major governing factors that affect the feeding and breeding ground of the birds (Basnet *et al.*

2016, Grimmett *et al.* 2016). These factors ultimately affect the distribution and diversity of the birds. The knowledge of the seasonal abundance of the birds for their habitats is crucial for bird conservation and management.

Majority of the studies have been concentrated on the wetlands of international importance such as Ramsar sites in Nepal (Kafle 2005, Chhetry 2006, Giri & Chalise 2008, Adhikari *et al.* 2018, Adhikari *et al.* 2019). The biodiversity of the wetlands outside the protected areas is less explored. Thus, numerous wetlands with, their biodiversity are being undermined, which makes them more vulnerable to degradation. It is suspected that several of them may get dried up before being documented and such a situation is more acute in the backwaters such as in the wetlands of Chure (Baral & Inskipp 2020). This study is intended to provide detailed information on species composition and habitat associations of birds around Jhilmila Lake, one of the holy and unique lakes at Chure region of Kanchnapur district, western Nepal.

Materials and Methods

Study area

The study was carried out around Jhilimila Lake (a wetland of the Western Chure Landscape) in Bhimdatta Municipality, Kanchanpur district covering an area of 8.5 ha. The area is located in the Middle Western part of the Chure region, South-west of far western Nepal at 29.067° N, 80.188° E, elevation 985 m asl *(Figure 1)*. The lake is surrounded by dense forest with a maximum depth of 11 m (Neupane *et al.* 2010). The average maximum temperature is 30.5 °C during June and July and the average minimum temperature is 17.5 °C during December with an annual 1,422.7 mm/year (DoF 2017). There is a relatively protected Sal Forest around Jhilmila Lake *(Figure 2)*.

Sal *(Shorea robusta)* is the most dominant and canopy-forming tree species. Other associated species include Sindure; Kamala amotto *(Mallotus philipensis)*, Kadam *(Adina cordifolia)*, Saaj; Lourel tree *(Terminalia alata)*, Jamun: Black plum *(Syzygium cumini)*, Bot Dhaiyanro; Small Flowered Crape Myrtle *(Lagerstroemia parviflora)* and Kusum; Honey tree *(Schleichera oleosa)*. Common shrub species include Rudilo; heart-leaf adina *(Pogostemon bengalensis)* and Damai fal *(Ardisia solanacea)*. Bijay Sal; Indian Kino tree *(Pterocarpus marsupium),* a protected species listed in the near threatened category in IUCN Red List.

This area provides shelter for various mammal species such as Spotted Deer *(Axis axis),* Wild Boar *(Sus scrofa)*, Jungle Cat *(Felis chaus)*, Northern Palm Squirrel *(Funambulus pennanti)*, Blue Bull *(Boselaphus tragocamelus)*, Bengal Fox *(Vulpes bengalensis)*, Leopard Cat *(Felis bengalensis)*, Rhesus Macaque *(Macaca mulatta)*, Terai Grey Langur *(Semnopithecus hector)* (Khatiwada *et al.* 2021). More than 100 species of birds have been reported (DoF 2017). Similarly, this area harbors fish species that include Grass Carp *(Cetanoharyngodon idella)*, Bighead Carp *(Hypophthalmichthys nobilis)*, Rohu *(Labeo rohita)*, Mangur *(Clarias batrachus)*, Black Carp *(Mylopharyngodon piceus)*, Silver Carp *(Hypophthalmichthys*

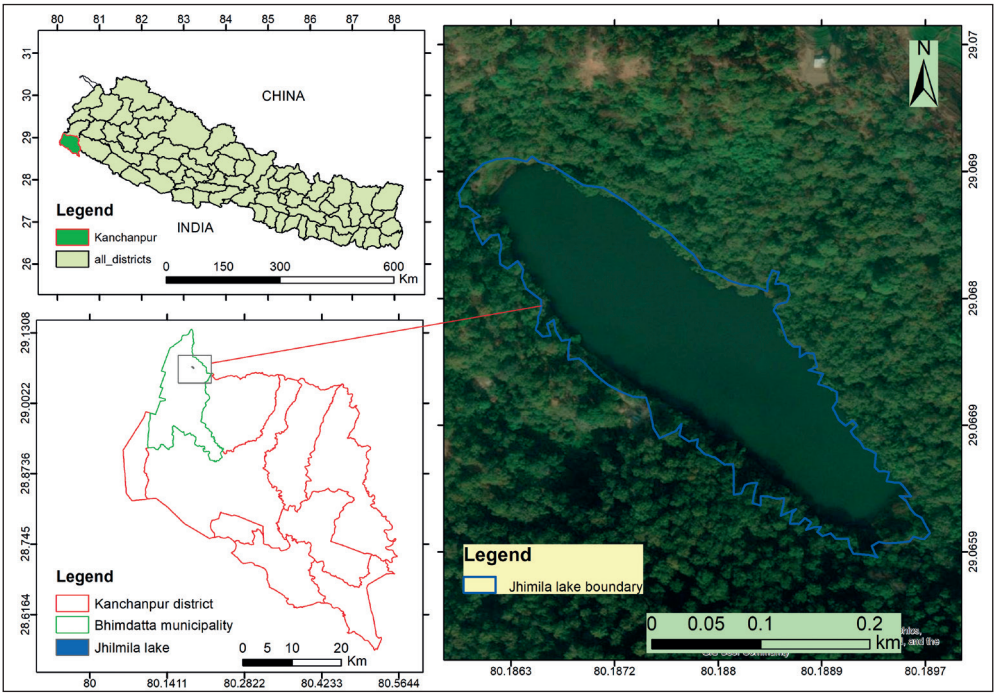

Figure 1. Map showing the study area and location of Jhilmila Lake at Western Chure Landscape, Nepal
1. ábra A Jhilmila-tó és a vizsgálati terület elhelyezkedése a Western Chure Területen, Nepálban

Figure 2. A glimpse of Jhilmila Lake at Western Chure Landscape, Nepal
2. ábra Egy pillantás a Jhilmila-tóra

molitrix). Herpetofauna includes Black-spined Toad *(Bufo melanostictus)*, Common Garden Lizard *(Calotes versicolor)*, Jerdon's Bull Frog *(Haplobatrachus crassus)*, Common Tree Frog *(Polypedates maculates)*, Marbled Cascade Frog *(Amolops marmoratus)*, Black Monitor Lizard *(Varanus bengalensis)*, North Indian Flapshell Turtle *(Lissemys punctata andersoni)*, Asiatic Rock Python *(Python morulus)*, Rat Snake *(Ptyas mucosa)* (DoF 2017).

Bird Survey

A bird survey was carried out following the "point count" method along transects near the bank of the lake and on the way from Jhilmila-wetland following detailed instructions provided by Bibby *et al.* (2000). A total of five transects were laid that ranged from 1.5 km to 2.5 km. In each transect, a minimum of 5 vantage points at each 500 m distance were established and scanned with binoculars (Nikon 8×42) to count the birds. At each point, bird species were counted for five minutes within the 50 m circular diameter by two observers. All the observed species were recorded with abundance by visual and auditory aids along with habitat types and environmental variables *(Table 1)* around the lake. The bird species were identified using the field guidebook for birds of Nepal (Grimmett *et al.* 2016).

The study was carried out for two seasons (summer and winter) of 2019–2020 at 6.00–10.00 and 16:00–18:00 by two observers. We also recorded the sound by using the sound recorder device (Sony E-018/022) of the birds which were not visible but singing that was identified by using the bird song database of Xeno-Canto (https://www.xeno-canto.org/). The zoological name, family, order and conservation status were identified with the help of the IUCN Red List (https://www.iucnredlist.org/) and the Status of Nepal's Birds: The National Red List Series Birds of Nepal (https://www.himalayannature.org/page/red-data-birds).

Table 1. The variables and parameters recorded during field study
1. táblázat A vizsgálat során rögzített változók és paraméterek

SN	Variables	Descriptions
1	Species variables	All the bird species reported in the field.
2	Habitat variables	Types of habitats depend upon the dominant species and condition of the sampling points. The birds were categorized as forest birds, grassland or open-area birds, wetland or wetland dependent birds and shrub or bush birds.
3	Conservation status	IUCN category of threatened status Threatened status as National Redlist data book
4	Migratory status	Residential and winter migratory birds and summer migratory birds
5	Feeding guilds	carnivores, herbivores, omnivores, frugivores, picivores, insectivores, nectivores and granivores
6	Environmental variables	Distance to road (RV), Distance to village or settlements (DV), Distance to water resources (DW), Number of livestock present (Nliv), number of fruiting trees present (NFT), Elevation (Ele)

The feeding guilds of the birds were categorized based on the major food habit. The birds were categorized into eight groups as carnivores, herbivores, omnivores, frugivores, piscivores, insectivores, nectivores and granivores (Grimmett *et al.* 2016). The habitats were categorized based on the dominant species present there. The distances from the village or settlements, roads, and water resources were measured as Euclidean distance from sampling using ArcGIS 10.7. Other variables such as the number of livestock, number of people present, and number of fruiting plants present were reported in each sampling point through direct observations *(Table 1)*.

Data analysis

The data were analyzed by using different statistical tools. A diversity index is a quantitative measure that reflects the composition of the community. These diversity indices are the measurement of biodiversity in different aspects such as richness, evenness and dominance (Morris *et al*. 2014). We used the Shannon-Wiener diversity index (*H*), Simpson index (1-D) and Evenness (e) were calculated as seasons. The significant test of seasonal abundance was examined by using a t-test at 95% confidence level.

A quantitative analysis known as a species discovery curve determines the minimum sampling size required to determine the number of species that represent a community (Willott 2001). This is a widely recognized methodology that is used by the study of Adhikari *et al.* (2019), La Sorte and Somveille (2020). To show whether the sampling effort was sufficient or not, we plotted the species discovery curve. The number of sampling points were placed on the X-axis and cumulative species on the Y-axis (Willott 2001).

Ecologists can visualize relative species abundance which is one of the main biodiversity components, using a rank abundance curve (RAC) or Whittaker plot (Izsák & Pavoine 2012, Avolio *et al.* 2019). This RAC aids in visualizing species richness and evenness (Yin *et al.* 2018). We used (RAC) or Whittaker plot to show the relative abundance of the birds., For this, the species were ranked as 1, 2, 3……based on the abundance of the birds from highest to lower. On plotting, the rank was placed on the X-axis and the relative abundance on the Y-axis (Izsák & Pavoine 2012, Avolio *et al.* 2019).

We used the Detrended Correspondence Analysis (DCA) of species to judge the appropriate test (Correa-Metrio *et al.* 2014) to test the relation of birds of different feeding guilds with habitat types. DCA found more than 4 gradient lengths (gradient length = 4.05). Hence, we selected Canonical Correspondence Analysis (CCA) to measure the associations of the species with habitat using CANOCO v. 4.56 (Ter Braak & Šmilauer 2009). The data are presented in the form of a biplot (Macfaden & Capen 2002). CCA helps to compare a complex relationship between feeding guilds and the habitat. For analyses, we applied a Monte-Carlo permutation test (using 499 unrestricted permutations) to identify the habitats that are significantly associated with the variation in the distribution of birds. During the analysis, we merged the herbivores, nectarivores and frugivores as herbivores feeding guilds because the numbers of species in these categories were low.

Generalized Linear Model (GLM) was used to show the relationship between the species richness and different predictors. The package «pscl» was used in R software version 4.0.0 (R

Core Team 2020) for GLM (Jackman 2020) with 'Poisson identity link function' to calculate coefficient, standard error, and P-value at 95% confidence level for all relationships between species richness and different variables such as distance to water resources (DW), distance to settlement (DS), distance to road (DR), number of fruiting plants *(Table 1)*.

Results

Bird species composition

A total of 2,532 individuals belonging to 19 orders, 51 families and 152 species (winter = 140 species, summer = 98 species) were recorded in our study *(Figure 3, Appendix 1)*. The most abundant species in the winter season belonged to Passeriformes (46.42%), followed by Piciformes (9.28%), Accipitriformes (6.42%) and Coraciiformes (5.71%). In the summer season, Passeriformes (53.06%) were the most abundant followed by Piciformes (9.18%), Coraciiformes (8.16%) and Cuculiformes (7.14%) respectively *(Figure 3)*. Among them, Jungle Babbler (3.64%) were the most abundant species in Jhilmila Lake followed by Common Peafowl (3.43%), Dusky Warbler (3.33%), and House Swift (3.0%) *(Appendix 1)*.

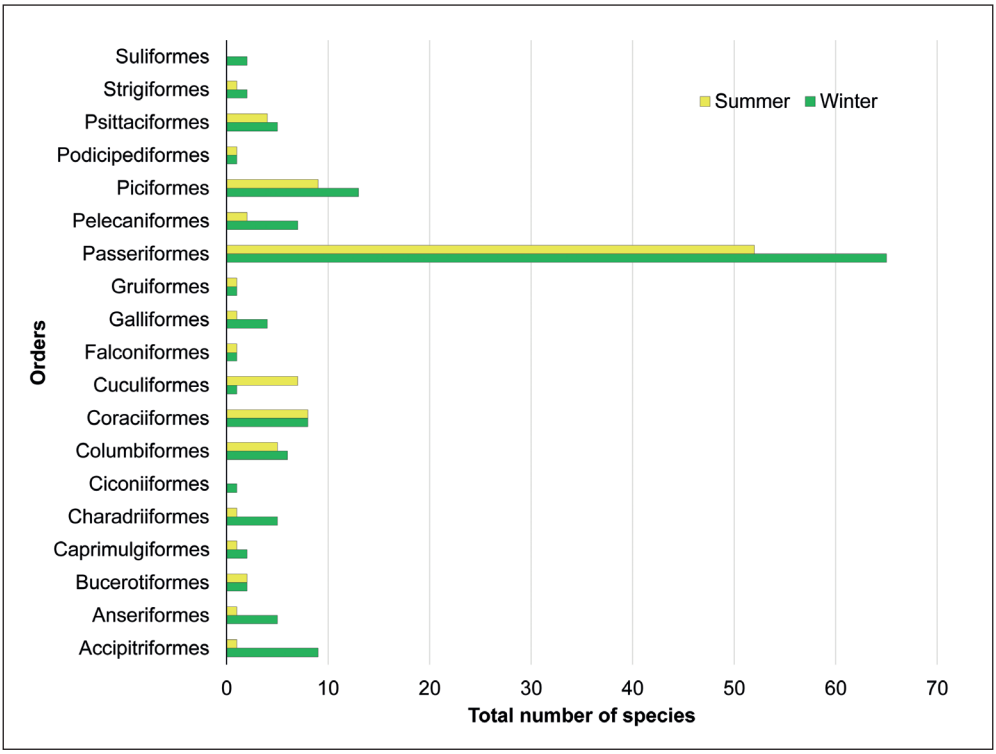

Figure 3. Bird species composition according to their taxonomic order in Jhilmila Lake area of Western Chure Landscape, Nepal

3. ábra Madárfajok összetétele taxonómiai sorrendjük szerint

Jhilmila Lake provides a habitat for 17.15% of the total bird species recorded from Nepal (N = 891). This study reported one globally critically endangered (White-rumped Vulture), one endangered (Egyptian Vulture), three vulnerable (Common Pochard, Great Slaty Woodpecker and Great Hornbill), and four globally near threatened birds (Alexandrine Parakeet, Dark-throated Oriole, Himalayan Griffon, and Asian Woollynecked). Among the reported birds, eight were also listed nationally threatened category (one critically endangered (White-rumped Vulture), two endangered (Great Slaty Woodpecker and Great Hornbill), two vulnerable (Himalayan Griffon and Egyptian Vulture), and three near threatened (Alexandrine Parakeet, Common Pochard and Asian Woollynecked) *(Figure 4, 5)*. This influences the conservation value of Jhilmila Lake.

The species richness of the birds was significantly higher in the winter season (t = 2.17, P = 0.02). The species diversity was higher in winter (Shannon index H = 4.72) than in summer (H = 4.38). There was no difference in the Simpson index of diversity during the winter and summer seasons (Simpson Dominance Index D = 0.01 in winter and D = 0.01 in summer season). The species evenness of birds (0.82) was higher in summer than in winter (evenness = 0.79) *(Table 2)*. The species discovery curve based on the cumulative number of species present in the sampling points showed linear trends and a greater number of species were reported with increasing the number of sampling points *(Figure 6)*.

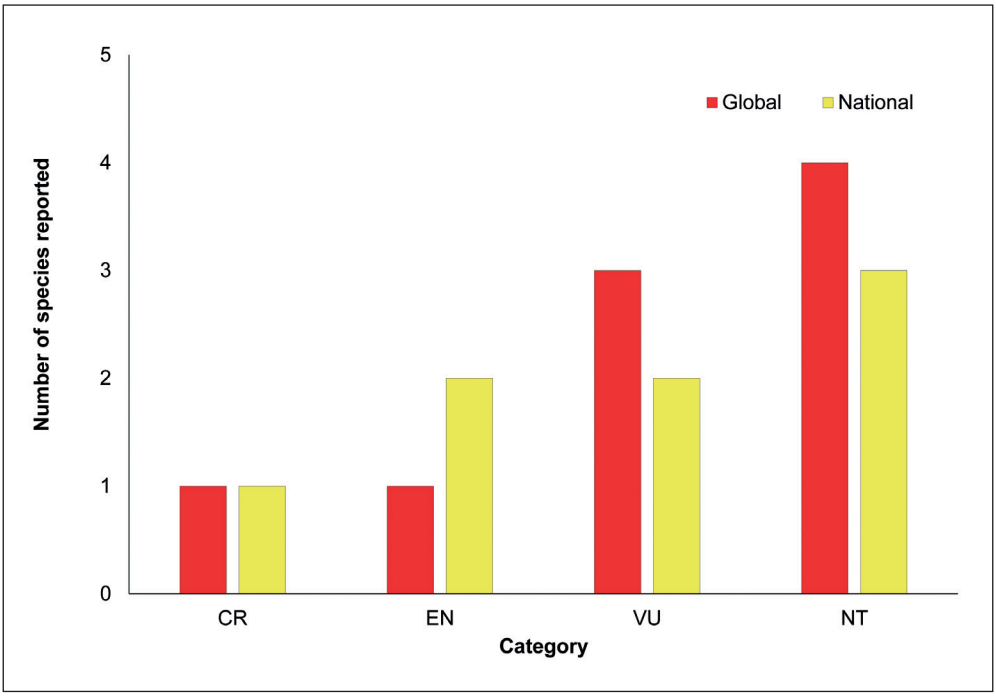

Figure 4. Globally and nationally threatened categories of the birds reported around Jhilmila Lake, here, CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened (NT)

4. ábra A Jhilmila-tó környékén jelentett madarak globálisan és országosan veszélyeztetett kategóriái, itt, CR – kritikusan veszélyeztetett, EN – veszélyeztetett, VU – sebezhető, NT – közel fenyegetett (NT)

Figure 5. Some globally and nationally threatened birds reported around Jhimila Lake, a. White-rumped Vulture *(Gyps bengalensis)*, category: globally and nationally Critically Endangered (CR), b. Egyptian Vulture *(Neophron percnopterus)*, globally Endangered (EN) but nationally Vulnerable (VU), c. Himalayan Griffon *(Gyps himalayensis)*, globally near threatened (NT) and nationally VU, d. Asian Woollynecked *(Ciconia episcopus)*, globally and nationally NT

5. ábra Néhány globálisan és országosan veszélyeztetett madárról számoltak be a Jhimila-tó környékén, a. bengáli keselyű *(Gyps bengalensis)*, kategória: globálisan és országosan kritikusan veszélyeztetett (CR), b. egyiptomi keselyű *(Neophron percnopterus)*, globálisan veszélyeztetett (EN), de országosan sebezhető (VU), c. Himalájai keselyű *(Gyps himalayensis)*, globálisan fenyegetett (NT) és országosan VU, d. ázsiai gyapjasnyakú gólya *(Ciconia episcopus)*, globálisan és nemzeti szinten NT

The species reported from the Jhilmila Lake area (n = 152) were ranked into 14 different categories in summer and 16 different categories in winter depending upon the number of individuals reported. The rank abundance curve (RAC) clearly showed that there were a low number of individuals reported in the case of high-ranking species and a higher relative species abundance in low-ranked species. The relative abundance of the birds in the summer season was relatively higher up to the 10th ranks and formed a steep slope curve after that the relative abundance was low. Comparatively, the species richness of the birds in the winter season was greater than in summer but the relative abundance of ranked species was lower up to ranked 10th after that increased as compared to summer *(Figure 7)*.

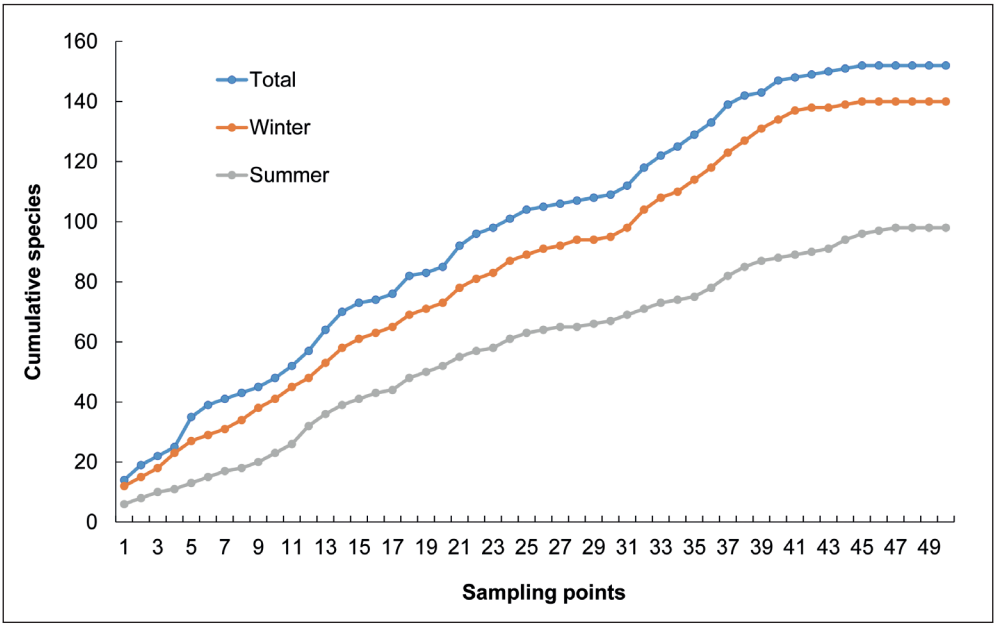

Figure 6. Species discovery curve for birds around Jhilmila Lake
6. ábra A fajok kumulatív görbéje a Jhilmila-tó körüli megfigyelési pontok száma alapján

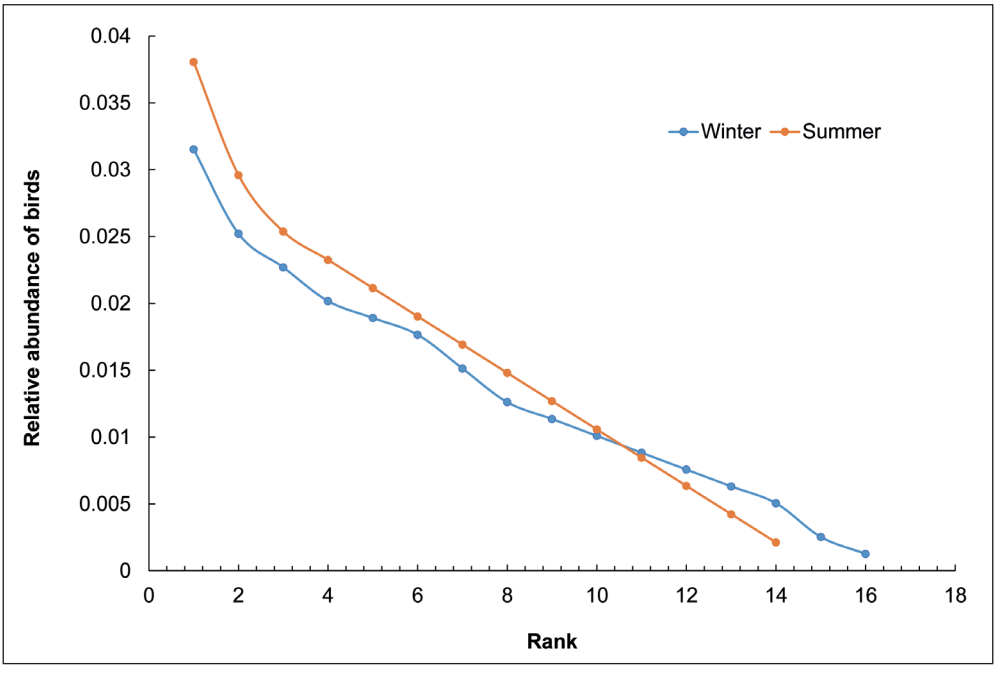

Figure 7. RAC of birds reported around Jhilmila Lake
7. ábra A Jhilmila-tó környéki madarak évszakonkénti relatív abundanciája

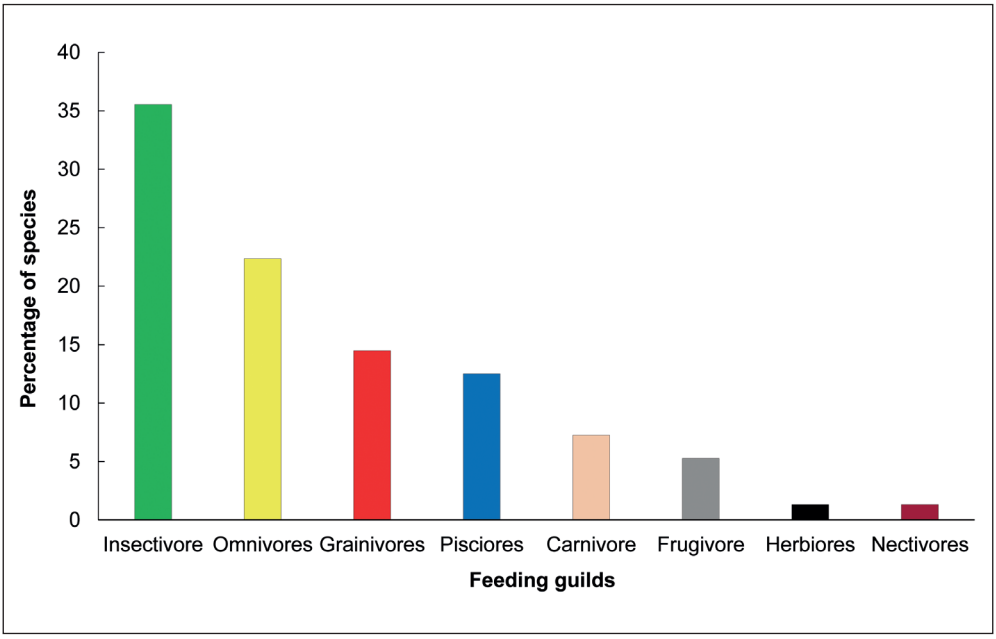

Figure 8. Bird species composition (%) based on their feeding guilds
8. ábra Madárfajok összetétele (%) táplálkozási besorolásuk alapján

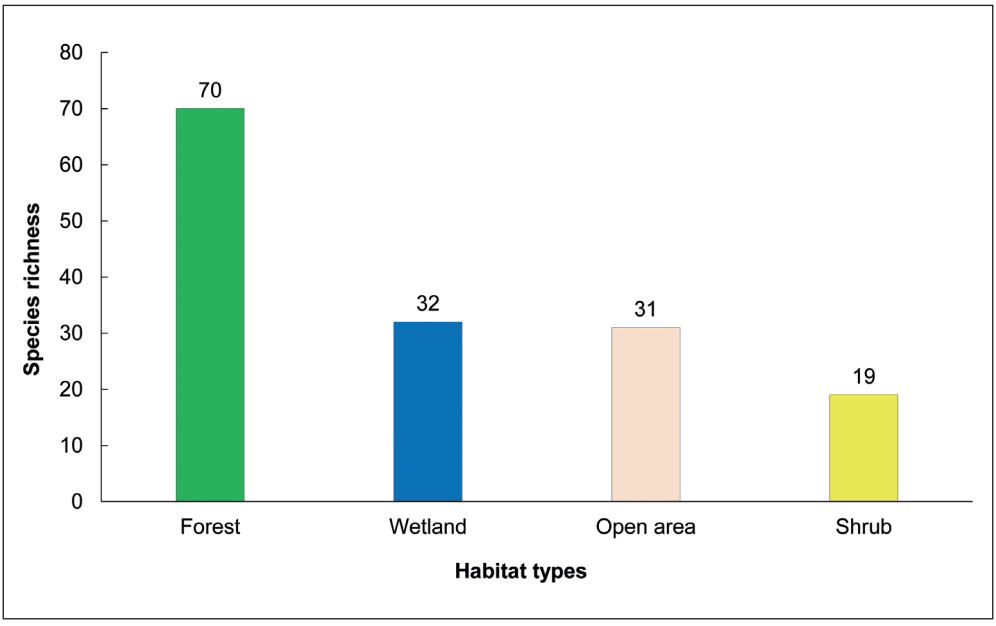

Figure 9. Bird species composition according to their habitat types around Jhilmila Lake
9. ábra Fajgazdagság élőhelytípusok szerint

More than 35% of birds were insectivores followed by omnivores (more than 22%), and granivores (more than 14%), similarly, herbivores and nectivores were the least reported (1.32%) *(Figure 8)*. We reported 70 species of forest birds, 32 species of wetland birds, 31 species of open-area birds, and 19 species of shrub or bush birds *(Figure 9)*.

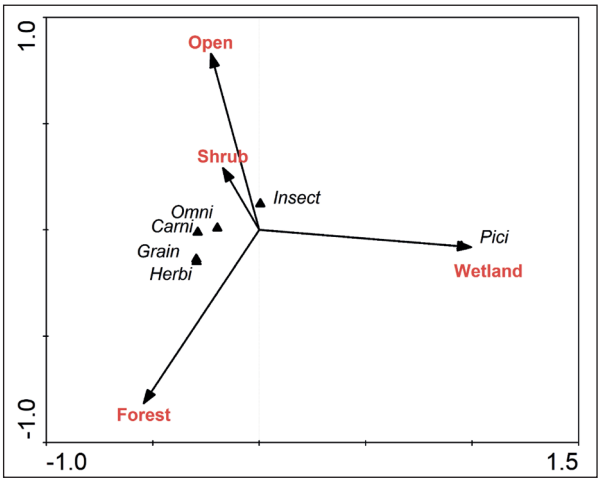

Figure 10. CCA ordination diagram (biplot) showing the bird species association with different habitats types around Jhilmila lake (Here, Open – open area birds, shrub – shrubland birds, Insect – insectivores, Omni – omnivores, Carni – carnivores, Grain – granivores, Herbi – herbivores, Pici – piscivores)

10. ábra CCA ordinációs diagram (biplot), amely a madárfajok társulását mutatja különböző élőhelytípusokkal a Jhilmila-tó körül (Open – nyílt terület, shrub – cserjés madarak, Insect – rovarevők, Omni – mindenevők, Carni – húsevők, Grain – magevők, Herbi – növényevők, Pici – halevők)

Habitat associations of birds

The CCA biplot diagram of the Monte-Carlo permutation test of the significance of all canonical axes clearly showed that omnivores, carnivores, granivores, and herbivore birds were significantly higher in the forest, shrub land, and open areas (agriculture fields, residential areas, and grassland) but piscivores birds were reported more in the wetland habitat (F = 1.55, P = 0.002, Trace = 0.91, with 499 permutations) *(Figure 10)*.

Results of GLM showed that species richness was significantly reported nearer to the roads during summer season (z = -2.089, P = 0.036), however, the relation was not significant during winter season (z = -0.952, P = 0.341). The distance to settlements showed a positive, but marginally significant association with the species richness of birds in winter (z = 1.686, P = 0.091) than in summer (z = 1.195, P = 0.23). The distance to water sources, and number of fruiting trees were also showed positive but non-significant relationship with species richness of birds in both seasons *(Table 3)*.

Table 2. Bird species diversity and dominance indices in Jhilmila Lake area at Western Chure Landscape, Nepal

2. táblázat Madárfajok diverzitása és dominancia indexei a Jhilmila-tó területén a Western Chure tájon, Nepálban

	Winter	Summer	Total
Simpson Dominance_D	0.01	0.01	0.01
Shannon_H	4.72	4.38	4.75
Evenness_e^H/S	0.79	0.82	0.76

Table 3. Generalized Linear Model (GLM) showed the relationship between species richness and different environmental variables in two seasons in Jhilmila Lake area at Western Chure Landscape, Nepal. Here, DR – distance to road, DS – distance to settlements, DW – distance to water sources

3. táblázat Az általánosított lineáris modellek eredményei, amelyek a fajgazdagság és különböző környezeti változók összefüggéseit mutatják két évszakban, a nepáli Nyugat-Chure régió Jhilmila tavánál meghatározott értékek alapján. DR – úttól mért távolság, DS – településtől mért távolság, DW – vízforrástól mért távolság

Summer				
Parameter	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	6.618	3.0704	2.155	0.031
DR	-0.003	0.002	-2.089	0.036
DS	0.001	0.001	1.195	0.23
DW	0.0003	0.002	0.202	0.83
No of fruiting trees	0.059	0.196	0.303	0.76

Winter				
Parameter	**Estimate**	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	6.506	3.414	1.906	0.05
DR	-0.002	0.002	-0.952	0.341
DS	0.002	0.001	1.686	0.091
DW	0.0006	0.002	0.362	0.717
No of fruiting trees	0.036	0.212	0.168	0.866

Discussion

This study assessed the diversity of birds in and around the Jhimila Lake located on the Chure hill of far western Nepal. Our findings indicate that the community structure of the birds such as species richness, abundance, and feeding habit in and around the lake proved this wetland and the associated forest is biologically significant and provide the breeding and feeding ground for the birds.

Bird species composition

Our study found the highest species richness and species diversity during winter seasons than summer seasons due to more winter migratory birds. This area supported a relatively high species diversity of avian fauna which could be attributed to different habitat types around the lake. This lake is unique and located in the Western Chure Landscape providing foraging and breeding opportunities for wetland and wetland-dependent birds. Higher species richness in the winter season than summer season has been reported in the various studies that were done in the various lakes of Terai regions, e.g. Beeshazari Lake (Adhikari *et al.* 2018), a Ramsar site, Sati Karnali Lake, Kailali, Nepal and Raani Lake, Shuklaphanta National Park, Nepal (Adhikari *et al.* 2022) in. We found more than 46% of Passeriformes

birds during winter and more than 53% during summer seasons, i.e. the abundance of Passeriformes was the highest and Ciconiiformes was the lowest as order Passeriformes was represented by a larger number of families and species (Grimmett *et al.* 2016). Passeriformes birds usually forage in large groups and prefer to stay close to agricultural fields and open areas where they found more food grains. Jhilmila Lake and its associated area alone contributed more than 17% of the bird species of Nepal, which showed the importance of this lake and associated areas for biodiversity conservation. Furthermore, this area harbored nine globally threatened bird species (one critically endangered, one endangered, three vulnerable, and four near threatened) among the 43 globally threatened birds (Inskipp *et al.* 2017, BCN 2022).

The species discovery curve for Jhilmila Lake areas indicated the suitable sampling effort for the birds. Our study used RAC to indicate the relation between relative abundance and rank abundance of birds in Jhilmila Lake areas.

Habitat associations of birds

Habitat use by the birds depends upon their feeding guilds. Habitat heterogeneity of the Jhilmila Lake area supported 152 species of birds. Comparatively, insectivore birds were reported more followed by omnivores, granivores, and piscivores birds. The wetland habitat, forest, grassland and open area supported different types of insects that increased the occurrence of insectivore birds (Adhikari *et al.* 2022). The forest around the Jhilmila Lake supported a large number of forest birds (n = 70) and the Jhilmila Lake alone supported 32 species of wetland birds. Our result indicated that this lake of the Chure range of Kanchanpur district provides the feeding and breeding ground to wetland birds. The report of wetland birds from Jhilmila Lake was less than the report of Adhikari *et al.* (2018) from Beeshazari Lake (n = 44), a Ramsar site in Nepal; the report of Lamsal *et al.* (2014) from Ghodaghodi Lake (n = 41), a Ramsar site but comparatively, the area of Jhilmila Lake is lower than these lakes as this lake is comparatively smaller than Beeshhazari and Ghodaghodi lakes. The study revealed that herbivores, granivores, carnivores and omnivore birds were related to the forest and shrubland habitat whereas the open area including grassland supported the insectivores. The number of fruiting trees present in the forest around the Jhilmila Lake area added more food available for the herbivore birds. Similarly, the wetland (lake area) supported the wetland birds. The abundance of the birds is dependent on the food available in that habitat (Kim *et al.* 2018).

The disturbances caused by motorable roads and human activity typically harm bird diversity and abundance (Alexander *et al.* 2019, da Silva & Silva 2020, Leveau & Leveau 2020). Contrarily, in this study, the birds' species richness increased with the decreasing distance to the road during both summer and winter. During these seasons, the movement of the people for worshiping purpose in Jhimila is comparatively more intensive by providing grains nearer the roads which increase the chances of food availability. As it is believed that this lake has a goddess superpower, people from India and Nepal used to visit this lake every month on the full moon during summer. It is believed that the goddess Jhilmila gives strength to fight against problems and brings prosperity to the family. The

lake area is surrounded by the forest but the human settlements are not farther than 1 to 2 km. However, the species richness increased by increasing the distance to settlement in both seasons. The farmland surrounding the forest provides a heterogeneous habitat that is utilized by birds (Moges *et al.* 2017, Callaghan *et al.* 2019). The presence of fruit trees also helps to increase the species richness of birds (Pandey *et al.* 2021) but the surrounding area of the lake is dominated by Sal forest and had fewer fruit trees, hence showing a constant relation.

Conclusion

The avian study in and around the Jhilmila Lake pointed out that this lake is ecologically and economically important and harbored 152 species of birds. It plays a vital role in providing breeding, feeding, and shelter to many birds. The surrounding area of this lake is dominated by Sal forest which decreased the number of frugivorous birds. The diversity of birds was comparatively lower in summer than in winter due to winter migratory birds. Variables such as habitat types, distance to water sources, distance to nearer settlements or agricultural lands, and the number of fruiting trees present determined the diversity and species richness of the birds. This holy lake protects the unique biodiversity of Western Chure Landscape but has less priority for conservation. Hence, this study is the baseline for the management and conservation of this important lake and suggested conducting an extensive biodiversity study.

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Appendix1. Bird species composition around Jhilmila Lake with their common name, scientific name, order, family, encounter rate, abundance, IUCN and NRDB threatened status
1. melléklet A madárfajok listája a Jhilmila-tó körül

SN	Common Name	Zoological name	Order	Family	Winter	Summer	Encounter rate	Abundance %	IUCN	NRDB
1	Shikra	*Accipiter badius* (Gmelin, 1788)	Accipitriformes	Accipitridae	2	0	2	0.21	LC	LC
2	Himalayan Buzzard	*Buteo buteo* Portenko, 1929	Accipitriformes	Accipitridae	2	0	2	0.21	LC	LC
3	Black-winged Kite	*Elanus caeruleus* (Desfontaines, 1789)	Accipitriformes	Accipitridae	2	1	3	0.32	LC	LC
4	White-rumped Vulture	*Gyps bengalensis* (Gmelin, 1788)	Accipitriformes	Accipitridae	2	0	2	0.21	CR	CR
5	Himalayan Griffon	*Gyps himalayensis* Hume, 1869	Accipitriformes	Accipitridae	4	0	4	0.43	NT	VU
6	Black Kite	*Milvus migrans* (Boddaert, 1783)	Accipitriformes	Accipitridae	6	0	6	0.64	LC	LC
7	Egyptian Vulture	*Neophron percnopterus* (Linnaeus, 1758)	Accipitriformes	Accipitridae	2	0	2	0.21	EN	VU
8	Crested Serpent Eagle	*Spilornis cheela* (Latham, 1790)	Accipitriformes	Accipitridae	2	0	2	0.21	LC	LC
9	Osprey	*Pandion haliaetus* (Linnaeus, 1758)	Accipitriformes	Pandionidae	2	0	2	0.21	LC	LC
10	Common Teal	*Anas crecca* Linnaeus, 1758	Anseriformes	Anatidae	7	0	7	0.75	LC	LC
11	Mallard	*Anas platyrhynchos* Linnaeus, 1758	Anseriformes	Anatidae	7	0	7	0.75	LC	LC
12	Common Pochard	*Aythya ferina* (Linnaeus, 1758)	Anseriformes	Anatidae	2	0	2	0.21	VU	NT
13	Lesser Whistling-duck	*Dendrocygna javanica* (Horsfield, 1821)	Anseriformes	Anatidae	6	2	8	0.86	LC	LC
14	Gadwall	*Mareca strepera* (Linnaeus, 1758)	Anseriformes	Anatidae	2	0	2	0.21	LC	LC
15	Great Hornbill	*Buceros bicornis* Linnaeus, 1758	Bucerotiformes	Bucerotidae	0	1	1	0.11	VU	EN
16	Indian Grey Hornbill	*Ocyceros birostris* (Scopoli, 1786)	Bucerotiformes	Bucerotidae	4	0	4	0.43	LC	LC
17	Common Hoopoe	*Upupa epops* Linnaeus, 1758	Bucerotiformes	Upupidae	2	2	4	0.43	LC	LC
18	House Swift	*Apus nipalensis* (Hodgson, 1836)	Caprimulgiformes	Apodidae	16	12	28	3.00	LC	LC
19	Alpine Swift	*Tachymarptis melba* (Linnaeus, 1758)	Caprimulgiformes	Apodidae	12	0	12	1.29	LC	LC
20	Grey-headed Lapwing	*Vanellus cinereus* (Blyth, 1842)	Charadriiformes	Charadriidae	2	2	4	0.43	LC	LC
21	Red-wattled Lapwing	*Vanellus indicus* (Boddaert, 1783)	Charadriiformes	Charadriidae	4	0	4	0.43	LC	LC

SN	Common Name	Zoological name	Order	Family	Winter	Summer	Encounter rate	Abundance %	IUCN	NRDB
22	Bronze-winged Jacana	*Metopidius indicus* (Latham, 1790)	Charadriiformes	Jacanidae	8	0	8	0.86	LC	LC
23	Common Sandpiper	*Actitis hypoleucos* Linnaeus, 1758	Charadriiformes	Scolopacidae	4	0	4	0.43	LC	LC
24	Green Sandpiper	*Tringa ochropus* Linnaeus, 1758	Charadriiformes	Scolopacidae	2	0	2	0.21	LC	LC
25	Asian Woollyneck	*Ciconia episcopus* (Boddaert, 1783)	Ciconiiformes	Ciconiidae	2	0	2	0.21	NT	NT
26	Emerald Dove	*Chalcophaps indica* (Linnaeus, 1758)	Columbiformes	Columbidae	6	2	8	0.86	LC	LC
27	Oriental Turtle-dove	*Streptopelia orientalis* (Latham, 1790)	Columbiformes	Columbidae	4	4	8	0.86	LC	LC
28	Red Collared Dove	*Streptopelia tranquebarica* (Hermann, 1804)	Columbiformes	Columbidae	4	0	4	0.43	LC	LC
29	Rock Dove	*Columba livia* Gmelin, 1789	Columbiformes	Columbidae	12	14	26	2.79	LC	LC
30	Spotted Dove	*Spilopelia chinensis* (Scopoli, 1786)	Columbiformes	Columbidae	4	8	12	1.29	LC	LC
31	Eurasian Collared Dove	*Streptopelia decaocto* Frivaldszky, 1838	Columbiformes	Columbidae	2	4	6	0.64	LC	LC
32	Common Kingfisher	*Alcedo atthis* (Linnaeus, 1758)	Coraciiformes	Alcedinidae	5	4	9	0.97	LC	LC
33	Stork-billed Kingfisher	*Pelargopsis capensis* (Linnaeus, 1766)	Coraciiformes	Alcedinidae	2	0	2	0.21	LC	LC
34	Pied Kingfisher	*Ceryle rudis* (Linnaeus, 1758)	Coraciiformes	Alcedinidae	2	2	4	0.43	LC	LC
35	White-throated Kingfisher	*Halcyon smyrnensis* (Linnaeus, 1758)	Coraciiformes	Alcedinidae	9	4	13	1.39	LC	LC
36	Indian Roller	*Coracias benghalensis* (Linnaeus, 1758)	Coraciiformes	Coraciidae	3	3	6	0.64	LC	LC
37	Chestnut-headed Bee-eater	*Merops leschenaulti* Vieillot, 1817	Coraciiformes	Meropidae	4	4	8	0.86	LC	LC
38	Blue-headed Bee-eater	*Merops muelleri* (Cassin, 1857)	Coraciiformes	Meropidae	10	12	22	2.36	LC	LC
39	Asian Green Bee-eater	*Merops orientalis* Latham, 1802	Coraciiformes	Meropidae	18	6	24	2.58	LC	LC
40	Blue-tailed Bee-eater	*Merops philippinus* Linnaeus, 1766	Coraciiformes	Meropidae	0	6	6	0.64	LC	LC
41	Greater Coucal	*Centropus sinensis* (Stephens, 1815)	Cuculiformes	Cuculidae	0	2	2	0.21	LC	LC
42	Indian Cuckoo	*Cuculus micropterus* Gould, 1837	Cuculiformes	Cuculidae	0	4	4	0.43	LC	LC
43	Banded Bay Cuckoo	*Cacomantis sonneratii* (Latham, 1790)	Cuculiformes	Cuculidae	0	6	6	0.64	LC	LC

SN	Common Name	Zoological name	Order	Family	Winter	Summer	Encounter rate	Abundance %	IUCN	NRDB
44	Lesser Coucal	*Centropus bengalensis* (Gmelin, 1788)	Cuculiformes	Cuculidae	0	5	5	0.54	LC	LC
45	Common Cuckoo	*Cuculus canorus* Linnaeus, 1758	Cuculiformes	Cuculidae	0	3	3	0.32	LC	LC
46	Western Koel	*Eudynamys scolopaceus* (Linnaeus, 1758)	Cuculiformes	Cuculidae	0	4	4	0.43	LC	LC
47	Common Hawk-cuckoo	*Hierococcyx varius* (Vahl, 1797)	Cuculiformes	Cuculidae	2	2	4	0.43	LC	LC
48	Common Kestrel	*Falco tinnunculus* Linnaeus, 1758	Falconiformes	Falconidae	2	3	5	0.54	LC	LC
49	Kalij Pheasant	*Lophura leucomelanos* (Latham, 1790)	Galliformes	Phasianidae	2	0	2	0.21	LC	LC
50	Black Francolin	*Francolinus francolinus* (Linnaeus, 1766)	Galliformes	Phasianidae	4	0	4	0.43	LC	LC
51	Red Junglefowl	*Gallus gallus* (Linnaeus, 1758)	Galliformes	Phasianidae	4	0	4	0.43	LC	LC
52	Common Peafowl	*Pavo cristatus* Linnaeus, 1758	Galliformes	Phasianidae	25	7	32	3.43	LC	LC
53	White-breasted waterhen	*Amaurornis phoenicurus* (Pennant, 1769)	Gruiformes	Rallidae	4	5	9	0.97	LC	LC
54	Rufous-winged Lark	*Mirafra assamica* Horsfield, 1840	Passeriformes	Alaudidae	4	2	6	0.64	LC	LC
55	Scarlet Minivet	*Pericrocotus flammeus* (Forster, 1781)	Passeriformes	Campephagidae	4	2	6	0.64	LC	LC
56	Zitting Cisticola	*Cisticola juncidis* (Rafinesque, 1810)	Passeriformes	Cisticolidae	4	0	4	0.43	LC	LC
57	Common Tailorbird	*Orthotomus sutorius* (Pennant, 1769)	Passeriformes	Cisticolidae	4	6	10	1.07	LC	LC
58	Jungle Prinia	*Prinia sylvatica* Jerdon, 1840	Passeriformes	Cisticolidae	5	0	5	0.54	LC	LC
59	Common Green Magpie	*Cissa chinensis* (Boddaert, 1783)	Passeriformes	Corvidae	4	8	12	1.29	LC	LC
60	Red-billed Blue Magpie	*Urocissa erythroryncha* (Boddaert, 1783)	Passeriformes	Corvidae	2	2	4	0.43	LC	LC
61	Jungle Crow	*Corvus levaillantii* Lesson, 1831	Passeriformes	Corvidae	10	11	21	2.25	LC	LC
62	House Crow	*Corvus splendens* Vieillot, 1817	Passeriformes	Corvidae	7	0	7	0.75	LC	LC
63	Grey Treepie	*Dendrocitta formosae* Swinhoe, 1863	Passeriformes	Corvidae	2	2	4	0.43	LC	LC
64	Rufous Treepie	*Dendrocitta vagabunda* (Latham, 1790)	Passeriformes	Corvidae	4	3	7	0.75	LC	LC
65	Yellow-billed Blue Magpie	*Urocissa flavirostris* (Blyth, 1846)	Passeriformes	Corvidae	4	2	6	0.64	LC	LC
66	Ashy Drongo	*Dicrurus leucophaeus* Vieillot, 1817	Passeriformes	Dicruridae	5	5	10	1.07	LC	LC

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67	Black Drongo	*Dicrurus macrocercus* Vieillot, 1817	Passeriformes	Dicruridae	10	11	21	2.25	LC	LC
68	Lesser Racquet-tailed Drongo	*Dicrurus remifer* (Temminck, 1823)	Passeriformes	Dicruridae	4	0	4	0.43	LC	LC
69	Spangled Drongo	*Dicrurus bracteatus* (Gould, 1842)	Passeriformes	Dicruridae	4	0	4	0.43	LC	LC
70	Greater Racquet-tailed Drongo	*Dicrurus paradiseus* (Linnaeus, 1766)	Passeriformes	Dicruridae	6	6	12	1.29	LC	LC
71	White-rumped Munia	*Lonchura striata* (Linnaus, 1766)	Passeriformes	Estrildidae	3	3	6	0.64	LC	LC
72	Barn Swallow	*Hirundo rustica* Linnaeus, 1758	Passeriformes	Hirundinidae	12	10	22	2.36	LC	LC
73	Northern House Martin	*Delichon urbicum* (Linnaeus, 1758)	Passeriformes	Hirundinidae	15	10	25	2.68	LC	LC
74	Wire-tailed Swallow	*Hirundo smithii* Leach, 1818	Passeriformes	Hirundinidae	15	5	20	2.15	LC	LC
75	Brown Shrike	*Lanius cristatus* Linnaeus, 1758	Passeriformes	Laniidae	6	0	6	0.64	LC	LC
76	Long-tailed Shrike	*Lanius schach* Linnaeus, 1758	Passeriformes	Laniidae	12	6	18	1.93	LC	LC
77	Common Babbler	*Argya caudata* (Dumont, 1823)	Passeriformes	Leiotrichidae	4	3	7	0.75	LC	LC
78	Jungle Babbler	*Turdoides striata* (Dumont, 1823)	Passeriformes	Leiotrichidae	16	18	34	3.65	LC	LC
79	White-throated Laughingthrush	*Garrulax albogularis* (Gould, 1836)	Passeriformes	Leiotrichidae	0	9	9	0.97	LC	LC
80	White-crested Laughingthrush	*Garrulax leucolophus* (Hardwicke, 1815)	Passeriformes	Leiotrichidae	6	0	6	0.64	LC	LC
81	Rufous-necked Laughingthrush	*Garrulax ruficollis* (Jardine & Selby, 1838)	Passeriformes	Leiotrichidae	12	8	20	2.15	LC	LC
82	Black-napped Monarch	*Hypothymis azurea* (Boddaert, 1783)	Passeriformes	Monarchidae	4	0	4	0.43	LC	LC
83	Indian Paradise-flycatcher	*Terpsiphone paradisi* (Linnaeus, 1758)	Passeriformes	Monarchidae	0	4	4	0.43	LC	LC
84	White Wagtail	*Motacilla alba* Linnaeus, 1758	Passeriformes	Motacillidae	5	0	5	0.54	LC	LC
85	Gray Wagtail	*Motacilla cinerea* Tunstall, 1771	Passeriformes	Motacillidae	6	8	14	1.50	LC	LC
86	White-browed Wagtail	*Motacilla maderaspatensis* Gmelin, 1789	Passeriformes	Motacillidae	2	2	4	0.43	LC	LC
87	Oriental Magpie-robin	*Copsychus saularis* (Linnaeus, 1758)	Passeriformes	Muscicapidae	5	4	9	0.97	LC	LC
88	Grey Bushchat	*Saxicola ferreus* Gray, 1846	Passeriformes	Muscicapidae	2	2	4	0.43	LC	LC

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89	Common Stonechat	*Saxicola torquatus* (Linnaeus, 1766)	Passeriformes	Muscicapidae	10	8	18	1.93	LC	LC
90	Spotted Forktail	*Enicurus maculatus* Vigors, 1831	Passeriformes	Muscicapidae	4	2	6	0.64	LC	LC
91	Blue Whistling Thrush	*Myophonus caeruleus* (Scopoli, 1786)	Passeriformes	Muscicapidae	5	0	5	0.54	LC	LC
92	Small Niltava	*Niltava macgrigoriae* (Burton, 1836)	Passeriformes	Muscicapidae	5	1	6	0.64	LC	LC
93	White-winged Redstart	*Phoenicurus erythrogastrus* (Güldenstädt, 1775)	Passeriformes	Muscicapidae	4	0	4	0.43	LC	LC
94	White-capped Water-redstart	*Phoenicurus leucocephalus* (Vigors, 1831)	Passeriformes	Muscicapidae	5	0	5	0.54	LC	LC
95	Pied Bushchat	*Saxicola caprata* (Linnaeus, 1766)	Passeriformes	Muscicapidae	5	0	5	0.54	LC	LC
96	White-tailed Stonechat	*Saxicola leucurus* (Blyth, 1847)	Passeriformes	Muscicapidae	4	0	4	0.43	LC	LC
97	Indian Robin	*Saxicoloides fulicatus* (Linnaeus, 1766)	Passeriformes	Muscicapidae	2	2	4	0.43	LC	LC
98	Little Spiderhunter	*Arachnothera longirostra* (Latham, 1790)	Passeriformes	Nectariniidae	2	0	2	0.21	LC	LC
99	Crimson Sunbird	*Aethopyga siparaja* (Raffles, 1822)	Passeriformes	Nectariniidae	2	1	3	0.32	LC	LC
100	Indian Golden Oriole	*Oriolus kundoo* Sykes, 1832	Passeriformes	Oriolidae	5	5	10	1.07	LC	LC
101	Dark-throated Oriole	*Oriolus xanthonotus* Horsfield, 1821	Passeriformes	Oriolidae	4	4	8	0.86	NT	LC
102	Black-hooded Oriole	*Oriolus xanthornus* (Linnaeus, 1758)	Passeriformes	Oriolidae	0	4	4	0.43	LC	LC
103	Great Tit	*Parus major* Linnaeus, 1758	Passeriformes	Paridae	2	4	6	0.64	LC	LC
104	Chestnut-shouldered Bush-sparrow	*Gymnoris xanthocollis* (Burton, 1838)	Passeriformes	Passeridae	14	2	16	1.72	LC	LC
105	House Sparrow	*Passer domesticus* (Linnaeus, 1758)	Passeriformes	Passeridae	10	8	18	1.93	LC	LC
106	Yellow-vented Warbler	*Phylloscopus cantator* (Tickell, 1833)	Passeriformes	Phylloscopidae	4	0	4	0.43	LC	LC
107	Dusky Warbler	*Phylloscopus fuscatus* (Blyth, 1842)	Passeriformes	Phylloscopidae	20	11	31	3.33	LC	LC
108	Grey-hooded Warbler	*Phylloscopus xanthoschistos* (Gray, 1846)	Passeriformes	Phylloscopidae	0	1	1	0.11	LC	LC
109	Baya Weaver	*Ploceus philippinus* (Linnaeus, 1766)	Passeriformes	Ploceidae	4	4	8	0.86	LC	LC

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110	Black Bulbul	*Hypsipetes leucocephalus* (Gmelin, 1789)	Passeriformes	Pycnonotidae	10	8	18	1.93	LC	LC
111	Himalayan Bulbul	*Pycnonotus leucogenys* (Gray, 1835)	Passeriformes	Pycnonotidae	5	3	8	0.86	LC	LC
112	Red-vented Bulbul	*Pycnonotus cafer* (Linnaeus, 1766)	Passeriformes	Pycnonotidae	6	6	12	1.29	LC	LC
113	Red-whiskered Bulbul	*Pycnonotus jocosus* (Linnaeus, 1758)	Passeriformes	Pycnonotidae	8	6	14	1.50	LC	LC
114	Pale-footed Bush-warbler	*Hemitesia pallidipes* (Blanford, 1872)	Passeriformes	Scotocercidae	2	0	2	0.21	LC	LC
115	Chestnut-bellied Nuthatch	*Sitta cinnamoventris* Blyth, 1842	Passeriformes	Sittidae	8	3	11	1.18	LC	LC
116	Velvet-fronted Nuthatch	*Sitta frontalis* Swainson, 1820	Passeriformes	Sittidae	4	2	6	0.64	LC	LC
117	Jungle Myna	*Acridotheres fuscus* (Wagler, 1827)	Passeriformes	Sturnidae	5	5	10	1.07	LC	LC
118	Common Myna	*Acridotheres tristis* (Linnaeus, 1766)	Passeriformes	Sturnidae	10	10	20	2.15	LC	LC
119	Orange-headed Thrush	*Geokichla citrina* (Latham, 1790)	Passeriformes	Turdidae	8	4	12	1.29	LC	LC
120	Bar-winged Flycatcher	*Hemipus picatus* (Sykes, 1832)	Passeriformes	Vangidae	4	6	10	1.07	LC	LC
121	Oriental White-eye	*Zosterops palpebrosus* (Temminck, 1824)	Passeriformes	Zosteropidae	2	2	4	0.43	LC	LC
122	Grey-sided Bush Warbler	*Cettia brunnifrons* (Hodgson, 1845)	Passeriformes	Scotocercidae	12	12	24	2.58	LC	LC
123	Grey Heron	*Ardea cinerea* Linnaeus, 1758	Pelecaniformes	Ardeidae	4	7	11	1.18	LC	LC
124	Intermediate Egret	*Ardea intermedia* Wagler, 1829	Pelecaniformes	Ardeidae	8	0	8	0.86	LC	LC
125	Cattle Egret	*Bubulcus ibis* (Linnaeus, 1758)	Pelecaniformes	Ardeidae	4	0	4	0.43	LC	LC
126	Great White Egret	*Ardea alba* Linnaeus, 1758	Pelecaniformes	Ardeidae	2	0	2	0.21	LC	LC
127	Grey Heron	*Ardea cinerea* Linnaeus, 1758	Pelecaniformes	Ardeidae	2	0	2	0.21	LC	LC
128	Little Egret	*Egretta garzetta* (Linnaeus, 1766)	Pelecaniformes	Ardeidae	6	0	6	0.64	LC	LC
129	Red-napped Ibis	*Pseudibis papillosa* (Temminck, 1824)	Pelecaniformes	Threskiornithidae	2	5	7	0.75	LC	LC
130	Blue-throated Barbet	*Psilopogon asiaticus* (Latham, 1790)	Piciformes	Megalaimidae	5	2	7	0.75	LC	LC
131	Coppersmith Barbet	*Psilopogon haemacephalus* (Müller, 1776)	Piciformes	Megalaimidae	4	0	4	0.43	LC	LC

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132	Great Barbet	*Psilopogon virens* (Boddaert, 1783)	Piciformes	Megalaimidae	2	2	4	0.43	LC	LC
133	Brown-headed Barbet	*Psilopogon zeylanicus* (Gmelin, 1788)	Piciformes	Megalaimidae	4	0	4	0.43	LC	LC
134	Pale-headed Woodpecker	*Gecinulus grantia* (McClelland, 1840)	Piciformes	Picidae	7	3	10	1.07	LC	LC
135	Yellow-crowned Woodpecker	*Leiopicus mahrattensis* (Latham, 1801)	Piciformes	Picidae	5	0	5	0.54	LC	LC
136	Great Slaty Woodpecker	*Mulleripicus pulverulentus* (Temminck, 1826)	Piciformes	Picidae	2	1	3	0.32	VU	EN
137	Grey-capped Woodpecker	*Picoides canicapillus* (Blyth, 1845)	Piciformes	Picidae	4	0	4	0.43	LC	LC
138	Fulvous-breasted Woodpecker	*Dendrocopos macei* (Vieillot, 1818)	Piciformes	Picidae	4	6	10	1.07	LC	LC
139	Grey-headed Woodpecker	*Dendropicos spodocephalus* (Bonaparte, 1850)	Piciformes	Picidae	4	4	8	0.86	LC	LC
140	Rufous Woodpecker	*Micropternus brachyurus* (Vieillot, 1818)	Piciformes	Picidae	7	5	12	1.29	LC	LC
141	Brown-capped Pygmy Woodpecker	*Picoides nanus* (Vigors, 1832)	Piciformes	Picidae	7	3	10	1.07	LC	LC
142	Lesser Yellownape	*Picus chlorolophus* Vieillot, 1818	Piciformes	Picidae	2	4	6	0.64	LC	LC
143	Little Grebe	*Tachybaptus ruficollis* (Pallas, 1764)	Podicipediformes	Podicipedidae	5	2	7	0.75	LC	LC
144	Plum-headed Parakeet	*Psittacula cyanocephala* (Linnaeus, 1766)	Psittaciformes	Psittacidae	10	5	15	1.61	LC	LC
145	Red-breasted Parakeet	*Psittacula alexandri* (Linnaeus, 1758)	Psittaciformes	Psittacidae	15	0	15	1.61	LC	LC
146	Alexandrine Parakeet	*Psittacula eupatria* (Linnaeus, 1766)	Psittaciformes	Psittacidae	4	2	6	0.64	NT	NT
147	Slaty-headed Parakeet	*Psittacula himalayana* (Lesson, 1832)	Psittaciformes	Psittacidae	12	6	18	1.93	LC	LC
148	Rose-ringed Parrakeet	*Psittacula krameri* (Scopoli, 1769)	Psittaciformes	Psittacidae	6	4	10	1.07	LC	LC
149	Jungle Owlet	*Glaucidium radiatum* (Tickell, 1833)	Strigiformes	Strigidae	1	0	1	0.11	LC	LC
150	Asian Barred Owlet	*Glaucidium cuculoides* (Vigors, 1831)	Strigiformes	Strigidae	4	2	6	0.64	LC	LC
151	Little Cormorant	*Microcarbo niger* (Vieillot, 1817)	Suliformes	Phalacrocoracidae	4	0	4	0.43	LC	LC
152	Great Cormorant	*Phalacrocorax carbo* (Linnaeus, 1758)	Suliformes	Phalacrocoracidae	12	0	12	1.29	LC	LC