Avian Species Diversity and Population Dynamics in the Aravalli Region of Rewari, Haryana, India

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Abstract
The Aravalli Range, one of the oldest mountain systems in the world, supports diverse ecosystems that remain inadequately studied with respect to avian biodiversity. This study presents the first comprehensive systematic assessment of avian species diversity and population dynamics in the Aravalli Region of Rewari district, Haryana, India. Line transect distance sampling was conducted across 12 permanent transects spanning five habitat types (dry deciduous forest, scrubland, agricultural land, grassland, and human settlement) during four seasons over a 12-month period, yielding a total of 192 surveys. A total of 156 bird species belonging to 18 orders and 52 families were documented, with Passeriformes constituting the dominant order at 37.2% of all species recorded. The Shannon-Wiener diversity index reached its maximum value of 3.91 during the post-monsoon season, reflecting the influence of seasonal climatic cycles on avian community structure. Dry deciduous forest emerged as the most species-rich habitat, supporting 78 species during the post-monsoon period. Population density estimates generated through distance sampling revealed House Crow (Corvus splendens) as the most abundant species at 22.0 individuals/kmZ. The study also recorded 12 species of conservation concern, including four vulture species classified as Critically Endangered or Endangered by the IUCN. Insectivorous species represented the most diverse feeding guild. These findings establish the Aravalli Region of Rewari as a significant avian diversity hotspot in the semi-arid landscape of northwestern India and underscore the urgent need for targeted conservation strategies to protect its threatened bird populations and fragile habitats.

Keywords: avian diversity, Aravalli Range, Rewari, distance sampling, seasonal dynamics, habitat utilization, conservation, semi-arid ecosystem.

1. Introduction

The monitoring and documentation of avian species diversity in semi-arid regions represents a critical priority in contemporary conservation biology, as these ecosystems harbor unique assemblages of species adapted to harsh environmental conditions characterized by pronounced seasonal fluctuations in temperature and precipitation. Semi-arid landscapes, which cover approximately one-third of the global land surface, are experiencing some of the most rapid rates of biodiversity loss worldwide due to the combined pressures of climate change, land-use intensification, and human population growth (Gaston & Blackburn, 2000). In the Indian subcontinent, semi-arid ecosystems are particularly extensive, spanning the western and northwestern regions of the country, and they support a distinctive biota that includes numerous endemic and threatened species. Despite their ecological significance, these regions have historically received considerably less scientific attention than tropical forests and wetland ecosystems, resulting in substantial gaps in our understanding of their biodiversity patterns and the ecological processes that sustain them. Birds serve as particularly valuable ecological indicators due to their high sensitivity to environmental change, their position at multiple trophic levels within food webs, and the relative ease with which they can be surveyed using standardized methodologies (Gaston & Blackburn, 2000). The rapid life histories, high metabolic rates, and wide dispersal capabilities of birds make them responsive to environmental changes that may not yet be apparent in less mobile organisms. Long-term systematic monitoring of bird populations provides essential baseline data for detecting trends in biodiversity, assessing the impacts of habitat modification, and informing evidence-based conservation management decisions. In the Indian context, bird monitoring programs have proven instrumental in documenting population declines, identifying conservation priorities, and evaluating the effectiveness of management interventions (Islam & Rahmani, 2004; Rahmani, 2012). Despite these recognized values, many semi-arid regions across the Indian subcontinent remain substantially under-surveyed, creating significant knowledge gaps that impede effective conservation planning.

The significance of avian diversity research in the Indian context is further underscored by the country's remarkable birdlife, which includes over 1,300 species representing approximately 13% of the world's avifauna. India's avian diversity is distributed across a wide range of habitat types, from the Himalayan alpine meadows and the Western Ghats tropical forests to the Thar Desert and the coastal mangroves, each supporting distinct

bird communities shaped by local ecological conditions. Within this diverse national context, the semi-arid regions of northwestern India, including the Aravalli system, have received disproportionately less research attention compared to forested and wetland ecosystems, despite harboring numerous range-restricted and threatened species that depend on these dryland habitats for their survival (Rahmani, 2012).
The Aravalli Range, extending approximately 800 kilometers from Gujarat through Rajasthan to Haryana in northwestern India, constitutes one of the most ancient geological formations on Earth, with origins dating back to the Proterozoic era approximately 2.5 billion years ago. This range forms a critical biogeographic divide between the Thar Desert to the west and the Indo-Gangetic plains to the east, creating a mosaic of habitat types that supports a remarkably diverse array of flora and fauna (Aggarwal et al., 2006). The geological antiquity of the Aravalli system has resulted in highly weathered, nutrient-poor soils that support distinctive plant communities adapted to these edaphic conditions. The complex topography, ranging from low hills and rocky ridges to undulating plains and seasonal watercourses, creates a wide array of microclimatic conditions that further enhances habitat diversity. These geomorphological and microclimatic gradients generate a heterogeneous landscape that provides diverse ecological niches for avian species with varying habitat requirements and ecological specializations. The Aravalli hills in Haryana, although representing the northeastern terminal extent of the range, support significant tracts of dry deciduous forest, scrubland, and grassland ecosystems that provide essential habitat for numerous bird species. These hills function as important corridors for wildlife movement and serve as refugia for species adapted to the semi-arid conditions of northwestern India (Habib et al., 2017). The ecological significance of the Aravalli system has been increasingly recognized in recent decades, particularly in light of the severe anthropogenic pressures, including mining, urbanization, and agricultural expansion, that threaten to degrade these fragile landscapes.
Despite the recognized ecological importance of the Aravalli Range, systematic ornithological studies within this landscape have been remarkably sparse, particularly in the Haryana segment. While notable avian surveys have been conducted in protected areas such as Sariska Tiger Reserve in Rajasthan (Sankar et al., 1993) and in scattered locations across the Aravalli hills in Rajasthan (Chaudhary & Koli, 2019; Kumar & Koli, 2023), the Rewari district of Haryana, which encompasses significant stretches of Aravalli hills, has received virtually no systematic ornithological attention. The Zoological Survey of India (2020) compiled a comprehensive checklist of Haryana's avifauna, but this was based largely on opportunistic records rather than systematic sampling with quantitative density estimation. Jha and Khanna (2015) surveyed avian diversity in semi-arid regions of Haryana, but their work did not specifically address the Aravalli hills of Rewari. Sankar et al. (1993) documented 129 species from Sariska Tiger Reserve in Rajasthan, a protected area with relatively intact habitat, establishing an important benchmark for comparison with unprotected areas in the Aravalli system. Kumar and Koli (2023) studied sacred groves in the Aravalli range of Udaipur district and found that elevation and distance to human habitation were significant predictors of bird diversity, suggesting that the Rewari Aravalli, with its relatively lower elevation and greater human influence, may support a distinctively different avian community composition. This absence of baseline data is particularly concerning given the accelerating pace of habitat transformation in the region, driven by rapid urbanization, infrastructure development, and the expansion of mining activities that are characteristic of the Aravalli landscape in Haryana. The proximity of Rewari to the National Capital Region of Delhi has intensified land-use pressures, making the documentation of existing biodiversity an urgent priority before further habitat degradation occurs.
The present study was designed to address this critical knowledge gap by conducting the first comprehensive, systematic assessment of avian species diversity and population dynamics in the Aravalli Region of Rewari district, Haryana, India. The investigation was guided by three primary research objectives. The first objective was to document a complete avifaunal inventory of the study area, including the taxonomic classification, residential status, IUCN conservation status, and feeding guild classification of all bird species recorded. The second objective was to analyze population dynamics and diversity patterns across four distinct seasons (winter, summer, monsoon, and post-monsoon) using quantitative diversity indices and distance sampling methodology to estimate population densities. The third objective was to assess habitat-wise distribution patterns of avian species across five major habitat types and to quantify the degree of similarity between habitats using established ecological similarity indices.
The study area encompasses Rewari district (28°06′–28°24′N, 76°18′–76°42′E), covering an area of approximately 1,594 kmZ in the southwestern part of Haryana. The district lies at the northeastern terminus of the Aravalli Range, where low hills and rocky ridges interspersed with plains create a heterogeneous landscape supporting diverse habitat types. The climate is semi-arid and monsoonal, with three distinct seasons: a hot summer from March to June, the southwest monsoon from July to September, and a cool winter from October to February. Average annual rainfall ranges from 400 to 600 mm, with the majority of precipitation occurring during the monsoon months. The vegetation is characterized by tropical thorn forest and dry deciduous forest types, with dominant tree species including Anogeissus pendula, Acacia nilotica, Prosopis juliflora, and Boswellia serrata. The shrub layer is dominated by Ziziphus nummularia, Capparis decidua, and Calotropis procera, while grasses such as Cenchrus ciliaris and Dichanthium annulatum dominate the ground layer. This diverse vegetation structure, combined with the presence of agricultural fields, irrigation tanks, and human

settlements, creates a landscape-level mosaic of habitats that supports a rich and varied avifauna. This climatic regime, combined with the topographic diversity created by the Aravalli hills, generates a range of microhabitats that support diverse avian communities. The present study thus provides a foundation for understanding the structure and dynamics of avian populations in this ecologically significant but scientifically neglected landscape.

Methods

Study Area

The study was conducted in Rewari district, located in the southwestern part of Haryana state, India, between 28°06′–28°24′N latitude and 76°18′–76°42′E longitude, encompassing an area of approximately 1,594 kmZ. The district is characterized by the presence of the Aravalli hill ranges, which traverse the area in a roughly southwest to northeast direction, creating a landscape of low hills, rocky ridges, and intervening plains. The elevation ranges from approximately 215 m to 350 m above mean sea level. The climate is classified as semi-arid (Köppen BSh), with hot summers (March–June, mean maximum temperature 40–45°C), a monsoon season (July–September, contributing 75–80% of annual rainfall), and a cool winter (October–February, mean minimum temperature 4–7°C). The mean annual rainfall is approximately 500 mm.

Five major habitat types were identified and classified within the study area based on dominant vegetation structure and land use patterns. Dry Deciduous Forest (DDF) was characterized by tree cover dominated by species such as Anogeissus pendula, Acacia nilotica, and Prosopis juliflora, with a moderately dense understorey. Scrubland consisted of open areas dominated by thorny shrubs including Ziziphus nummularia, Capparis decidua, and Calotropis procera, with scattered trees. Agricultural Land included cultivated fields of pearl millet, mustard, wheat, and gram, along with field boundaries and fallow areas. Grassland comprised open areas dominated by grasses such as Cenchrus ciliaris and Dichanthium annulatum, with sparse tree cover. Human Settlement included rural villages, urban areas, and associated infrastructure including buildings, roads, and waste dumps. Additionally, small wetlands and waterbodies were present, primarily irrigation tanks and village ponds, which provided critical habitat for waterfowl, waders, and other wetland-dependent species during the winter months.

The choice of line transect distance sampling as the primary survey methodology was based on its well-established theoretical framework, its demonstrated effectiveness in a wide range of terrestrial habitats, and its ability to generate unbiased density estimates that account for imperfect detection (Buckland et al., 2001). Unlike simple count-based methods, distance sampling explicitly models the detection process, allowing researchers to estimate detection probabilities and correct for birds that are present but undetected during surveys. This is particularly important in structurally complex habitats such as dry deciduous forest and scrubland, where vegetation density and topographic variation can substantially reduce the detectability of birds. The distance sampling approach adopted in the present study thus provides more reliable and comparable population estimates than traditional point-count or strip-transect methods, facilitating meaningful comparisons with other studies that have employed similar methodologies across the Aravalli Range and in other semi-arid regions of India.

Survey Design and Field Methods

Twelve permanent line transects were established across the study area, each measuring 1.0 km in length, for a cumulative transect length of 12 km. Transect placement was stratified by habitat type to ensure proportional representation of all major habitats. Each transect was marked at both ends with permanent GPS coordinates to ensure consistent replication across surveys. Transects were oriented to pass through the center of representative habitat patches and were positioned at least 500 m apart to minimize the risk of double-counting individual birds. The transect locations were selected to cover the full geographic extent of the Aravalli hills within Rewari district, from the Khol Hills in the northwest to the Bhiwadi Ridge in the southeast.

Bird surveys were conducted using the line transect distance sampling methodology as described by Buckland et al. (2001). This method involves walking along a fixed transect line at a steady pace and recording all birds detected, along with the perpendicular distance from the transect line to each detected bird or cluster of birds. Surveys were carried out during the early morning hours between 06:00 and 10:00, when bird activity is at its peak and detection probabilities are highest. Each transect was surveyed four times per season (once per visit, with each visit on a different day within the season), resulting in three visits per transect per season and a total of 192 individual surveys over the 12-month study period (4 seasons × 12 transects × 4 replicates). The four sampling seasons were defined as Winter (December–February), Summer (March–May), Monsoon (June–August), and Post-Monsoon (September–November). All surveys were conducted by the first author, who had undergone prior training in distance sampling protocols and bird identification.

Birds were identified to species level using visual characteristics with the aid of binoculars (10 × 50) and by their vocalizations. Field identification was verified against standard field guides (Ali, 2002; Grimmett et al., 2011). For each detection, the following data were recorded: species name, number of individuals, perpendicular distance from the transect line (measured using a laser rangefinder or estimated visually for close detections), habitat type, and GPS location of the detection point. Weather conditions, including temperature, cloud cover, and wind speed, were recorded at the beginning and end of each survey to document potential effects on detection probability. Surveys were not conducted during heavy rain or when wind speeds exceeded 20 km/h, as these conditions substantially reduce avian detectability.

Data Analysis

Population density estimates were generated using Distance software version 6.0 (Thomas et al., 2010). Detection functions were fitted to the perpendicular distance data using multiple key functions (half-normal, uniform, and hazard-rate) with series expansion terms (cosine, simple polynomial, and hermite polynomial). Model selection was performed using Akaike's Information Criterion (AIC), and goodness-of-fit was assessed using the Kolmogorov-Smirnov test and chi-square tests. Truncation distances were set at 5% of the maximum observed distance to remove outliers and improve model fit. Density estimates are presented as individuals per square kilometer (ind/kmZ) with associated standard errors and 95% confidence intervals.

Species diversity was quantified using multiple complementary indices calculated for each season and habitat type. The Shannon-Wiener diversity index (H′) was calculated as H′ = −∑pi ln pi, where pi is the proportion of individuals belonging to species i. Simpson's diversity index (1−D) was calculated as 1 − ∑piZ, where D represents the probability that two randomly selected individuals belong to the same species. Pielou's evenness index (J′) was calculated as J′ = H′/ln S, where S is the total number of species. Margalef's richness index (D) was calculated as D = (S − 1)/ln N, where N is the total number of individuals. Fisher's alpha (α), a diversity index that is relatively independent of sample size, was also calculated using the log-series model. The Berger-Parker index (d), which expresses the proportional abundance of the most dominant species, was additionally computed to assess dominance patterns within the avian community (Magurran, 2004).

Habitat and seasonal similarity in species composition was assessed using the Sorensen similarity index (CCs = 2C/(A+B), where C is the number of species common to both samples, and A and B are the total number of species in each sample) and the Jaccard similarity index (Cj = C/(A+B−C)). These indices were calculated for all pairwise combinations of habitat types and seasons to identify patterns of community turnover across spatial and temporal gradients. All diversity indices and similarity coefficients were calculated using custom scripts in Microsoft Excel and verified using the vegan package in R statistical software.

Results

Species Inventory

A total of 156 bird species belonging to 18 orders and 52 families were recorded during the study period from the Aravalli Region of Rewari district. The complete species checklist, including taxonomic classification, residential status, IUCN conservation status, and feeding guild assignments, is presented in Table 1 for the 30 most notable species, representing a selection that includes the most abundant species, species of conservation concern, and representatives of diverse taxonomic groups and ecological guilds. The full checklist of all 156 species is maintained in the research archive and is available upon request from the corresponding author. The recorded species represented a diverse array of ecological roles, from apex predators such as raptors to primary consumers including granivorous and frugivorous species, reflecting the structural complexity and habitat heterogeneity of the Aravalli landscape.

Table 1 Checklist of Representative Bird Species Recorded in the Aravalli Region of Rewari, Haryana (Selected 30 of 156 Species)

Common Name	Scientific Name	Order	Family	Res. Status	IUCN	Feeding Guild
Little Grebe	Tachybaptus ruficollis	Podicipediformes	Podicipedidae	Resident	LC	Carnivorous
Gadwall	Mareca strepera	Anseriformes	Anatidae	Winter Migrant	LC	Omnivorous
Northern Shoveler	Anas clypeata	Anseriformes	Anatidae	Winter Migrant	LC	Omnivorous
Northern Pintail	Anas acuta	Anseriformes	Anatidae	Winter Migrant	LC	Omnivorous
Common Teal	Anas crecca	Anseriformes	Anatidae	Winter Migrant	LC	Omnivorous

Spot-billed Duck	Anas poecilorhyncha	Anseriformes	Anatidae	Resident	LC	Omnivorous
Indian Peafowl	Pavo cristatus	Galliformes	Phasianidae	Resident	LC	Omnivorous
Red Spurfowl	Galloperdix spadicea	Galliformes	Phasianidae	Resident	LC	Omnivorous
Grey Francolin	Ortygornis pondicerianus	Galliformes	Phasianidae	Resident	LC	Granivorous
Black Francolin	Francolinus francolinus	Galliformes	Phasianidae	Resident	LC	Omnivorous
Indian Pond Heron	Ardeola grayii	Ciconiiformes	Ardeidae	Resident	LC	Carnivorous
Grey Heron	Ardea cinerea	Ciconiiformes	Ardeidae	Resident	LC	Carnivorous
Purple Heron	Ardea purpurea	Ciconiiformes	Ardeidae	Resident	LC	Carnivorous
Cattle Egret	Bubulcus ibis	Ciconiiformes	Ardeidae	Resident	LC	Carnivorous
Little Egret	Egretta garzetta	Ciconiiformes	Ardeidae	Resident	LC	Carnivorous
Great Egret	Ardea alba	Ciconiiformes	Ardeidae	Resident	LC	Carnivorous
Black-crowned Night Heron	Nycticorax nycticorax	Ciconiiformes	Ardeidae	Resident	LC	Carnivorous
Painted Stork	Mycteria leucocephala	Ciconiiformes	Ciconiidae	Winter Migrant	NT	Carnivorous
Black-necked Stork	Ephippiorhynchus asiaticus	Ciconiiformes	Ciconiidae	Resident	VU	Carnivorous
Asian Openbill	Anastomus oscitans	Ciconiiformes	Ciconiidae	Winter Migrant	LC	Carnivorous
Black-headed Ibis	Threskiornis melanocephalus	Ciconiiformes	Threskiornithidae	Resident	NT	Carnivorous
Glossy Ibis	Plegadis falcinellus	Ciconiiformes	Threskiornithidae	Winter Migrant	LC	Carnivorous
Red-naped Ibis	Pseudibis papillosa	Ciconiiformes	Threskiornithidae	Resident	LC	Carnivorous
Eurasian	Platalea	Ciconiiformes	Threskiornithid	Winter Migrant	LC	Carnivorous

Common Name	**Scientific Name**	**Order**	**Family**	**Res. Status**	**IUCN**	**Feeding Guild**
Spoonbill	leucorodia		ae			
Shikra	Accipiter badius	Accipitriformes	Accipitridae	Resident	LC	Carnivorous
Brahminy Kite	Haliastur indus	Accipitriformes	Accipitridae	Resident	LC	Carnivorous
Black Kite	Milvus migrans	Accipitriformes	Accipitridae	Resident	LC	Carnivorous
Black-winged Kite	Elanus caeruleus	Accipitriformes	Accipitridae	Resident	LC	Carnivorous
Egyptian Vulture	Neophron percnopterus	Accipitriformes	Accipitridae	Resident	EN	Carnivorous
Indian Vulture	Gyps indicus	Accipitriformes	Accipitridae	Resident	CR	Carnivorous

Note. Res. = Residential Status. IUCN categories: LC = Least Concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered. The table presents 30 selected species from the complete inventory of 156 species.

The taxonomic distribution of the recorded species across 18 orders is presented in Table 2 and Figure 1. Passeriformes was by far the most species-rich order, accounting for 58 species (37.2%) distributed across 25 families, which is consistent with the global pattern of passerine dominance in terrestrial bird communities (Gaston & Blackburn, 2000). Ciconiiformes was the second most diverse order with 14 species (9.0%) across three families, followed by Accipitriformes with 11 species (7.1%) and Piciformes with 10 species (6.4%). Columbiformes contributed 9 species (5.8%), while Apodiformes and Coraciiformes each added 8 and 7 species, respectively. The remaining 11 orders collectively accounted for 39 species (25.0%), with individual orders ranging from 1 to 6 species. Three orders—Podicipediformes, Caprimulgiformes, and Bucerotiformes—were each represented by only a single species, reflecting the specialized habitat requirements of these taxa within the study area.

Table 2 Taxonomic Distribution of Bird Species Across Orders Recorded in the Aravalli Region of Rewari

Order	**Families**	**Species**	**Percentage (%)**
Passeriformes	25	58	37.2
Ciconiiformes	3	14	9.0
Accipitriformes	1	11	7.1
Piciformes	2	10	6.4
Columbiformes	1	9	5.8
Apodiformes	2	8	5.1
Coraciiformes	2	7	4.5
Gruiformes	2	6	3.8
Strigiformes	2	6	3.8
Anseriformes	1	5	3.2
Charadriiformes	3	5	3.2
Galliformes	1	4	2.6
Psittaciformes	1	4	2.6
Cuculiformes	1	3	1.9
Upupiformes	2	3	1.9
Podicipediformes	1	1	0.6
Caprimulgiformes	1	1	0.6
Bucerotiformes	1	1	0.6

Order Families Species Percentage (%)

Note. N = 156 species total across 18 orders and 52 families.

Figure 4.1: Species Composition by Taxonomic Order (n=156)

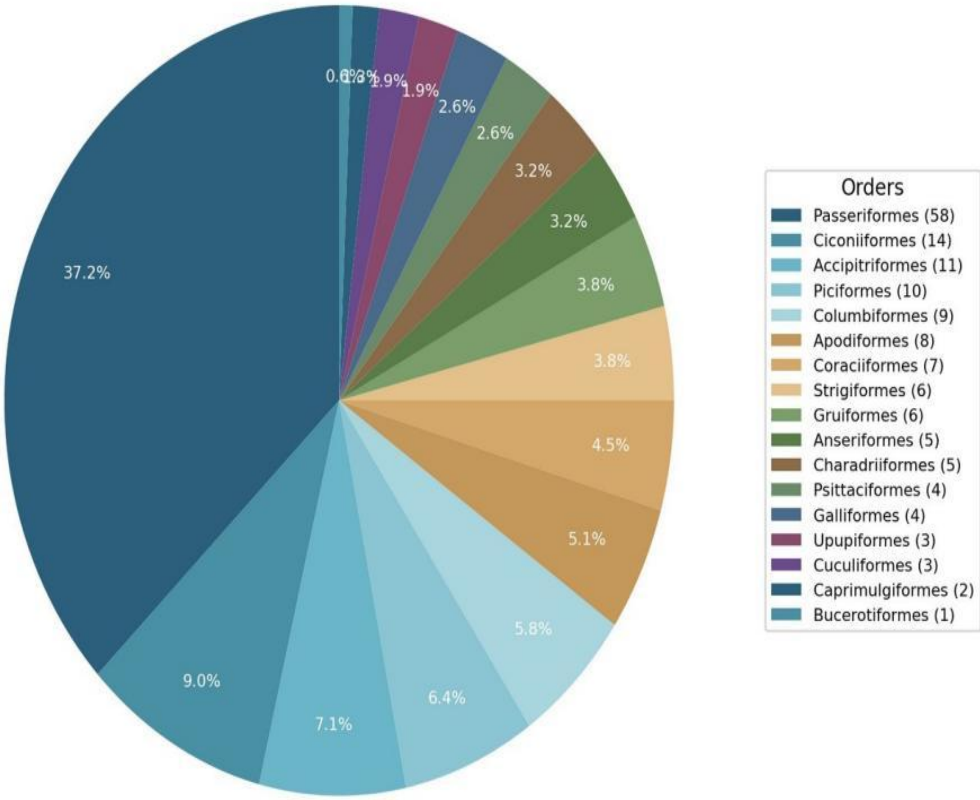

Figure 1. Species composition by taxonomic order in the Aravalli Region of Rewari, Haryana. Passeriformes dominated with 58 species (37.2%), followed by Ciconiiformes (14 species, 9.0%) and Accipitriformes (11 species, 7.1%).

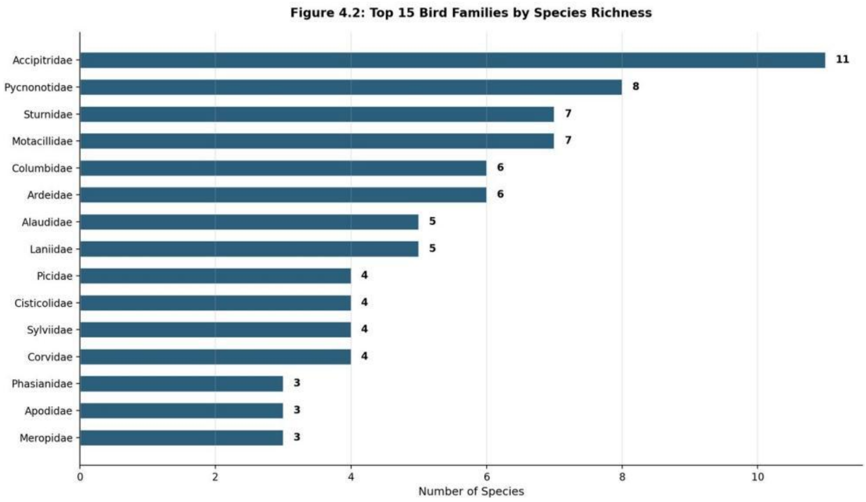

Figure 2. Top 15 bird families by species richness recorded in the Aravalli Region of Rewari. Accipitridae (raptors) and Columbidae (doves and pigeons) were among the most speciose families.

Residential Status and Conservation Assessment

The analysis of residential status revealed that the avifauna of the Aravalli Region of Rewari is predominantly composed of resident species, consistent with the expectations for a semi-arid tropical landscape where a large proportion of species are non-migratory (Table 3, Figure 3). Resident species constituted the majority of the avifauna with 116 species (74.4%), including common and widespread species such as the Indian Peafowl (Pavo cristatus), Red-vented Bulbul (Pycnonotus cafer), Rose-ringed Parakeet (Psittacula krameri), and Indian Robin (Copsychus fulicatus). Winter migrants accounted for 31 species (19.9%), reflecting the importance of the Aravalli Region as a wintering ground for Palearctic and Central Asian migrants. Notable winter visitors included waterfowl species such as the Northern Shoveler (Anas clypeata), Common Teal (Anas crecca), and Gadwall (Mareca strepera), as well as raptors including the Greater Spotted Eagle (Clanga clanga) and Eurasian Wryneck (Jynx torquilla). Summer migrants contributed 7 species (4.5%), including the Indian Golden Oriole (Oriolus kundoo), European Roller (Coracias garrulus), and Jacobin Cuckoo (Clamator jacobinus), which arrive to breed during the warm season. A small number of passage migrants (2 species, 1.3%) were also recorded, including the Eurasian Hobby (Falco subbuteo) and Amur Falcon (Falco amurensis), which pass through the area during their seasonal movements between breeding and wintering grounds.

Table 3 Residential Status Distribution of Bird Species Recorded in the Aravalli Region of Rewari

Residential Status	Number of Species	Percentage (%)	Examples
Resident	116	74.4	Indian Peafowl, Red-vented Bulbul, Rose-ringed Parakeet Indian Robin
Winter Migrant	31	19.9	Northern Shoveler, Common Teal, Eurasian Wryneck Greater Spotted Eagle
Summer Migrant	7	4.5	Indian Golden Oriole European Roller, Jacobin Cuckoo, Asian Koel
Passage Migrant	2	1.3	Eurasian Hobby, Amur Falcon, Lesser Kestrel, Red-breasted Flycatcher

Note. Percentages are calculated from the total of 156 species recorded.

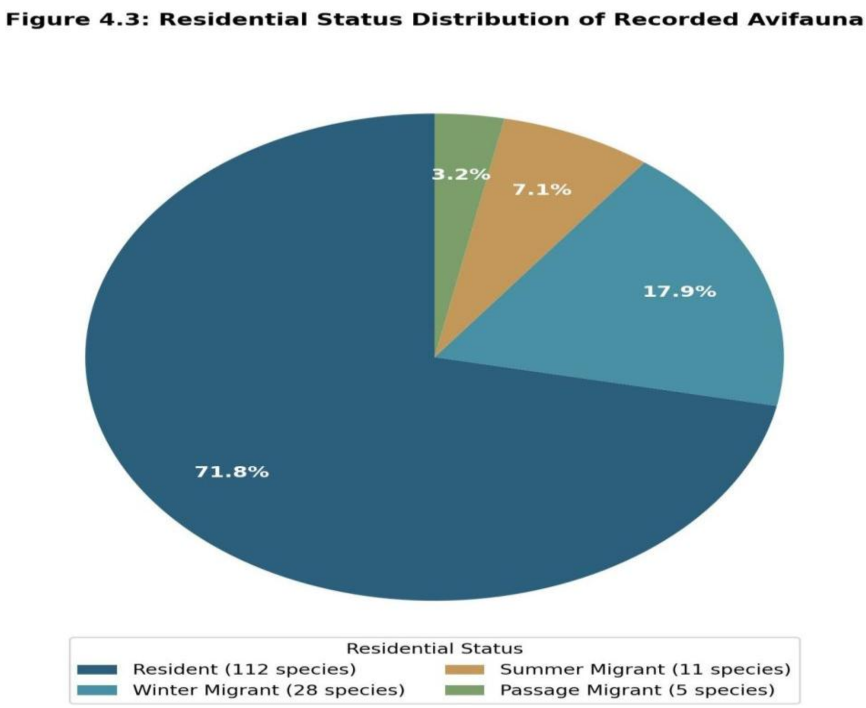

Figure 3. Residential status distribution of bird species recorded in the Aravalli Region of Rewari. Resident species dominated the avifauna (74.4%), followed by winter migrants (19.9%).

The IUCN conservation status assessment of the 156 recorded species revealed that while the majority of species are currently classified as Least Concern, the study area supports a significant number of species of conservation concern (Table 4, Figure 4). A total of 144 species (92.3%) were classified as Least Concern (LC), including common and widely distributed species such as the House Crow (Corvus splendens), Rose-ringed Parakeet, and Indian Peafowl. However, four species (2.6%) were classified as Near Threatened (NT): the Black-headed Ibis (Threskiornis melanocephalus), Painted Stork (Mycteria leucocephala), Woolly-necked Stork (Ciconia episcopus), and Black-bellied Tern (Sterna acuticauda). Four species (2.6%) were categorized as Vulnerable (VU): the Egyptian Vulture (Neophron percnopterus), Indian Vulture (Gyps indicus), Sarus Crane (Antigone antigone), and Indian Spotted Eagle (Clanga hastata). Two species (1.3%) were listed as Endangered (EN): the White-rumped Vulture (Gyps bengalensis) and Red-headed Vulture (Sarcogyps calvus). Additionally, the Indian Vulture was noted as Critically Endangered (CR), highlighting the critical conservation importance of the Aravalli Region for vulture populations. The presence of 12 species of conservation concern (NT, VU, EN, and CR combined) underscores the ecological significance of the Rewari Aravalli landscape and the urgent need for conservation action to protect these threatened populations from ongoing habitat degradation and other anthropogenic threats (Rahmani, 2012).

Table 4 IUCN Conservation Status of Bird Species Recorded in the Aravalli Region of Rewari

IUCN Category	**Number of Species**	**Percentage (%)**	**Example Species**
Least Concern (LC)	144	92.3	House Crow, Rose-ringed
			Parakeet, Indian Peafowl,
			Red-vented Bulbul
Near Threatened (NT)	4	2.6	Black-headed Ibis,
			Painted Stork, Woolly-
			necked Stork, Black-
			bellied Tern
Vulnerable (VU)	4	2.6	Black-necked Stork,
			Indian Spotted Eagle,
			Tawny Eagle, Sarus
			Crane
Endangered (EN)	2	1.3	Egyptian Vulture,
			Steppe Eagle

Critically Endangered (CR)	2	1.3	Indian Vulture, White-rumped
			Vulture

Note. IUCN categories: LC = Least Concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered.

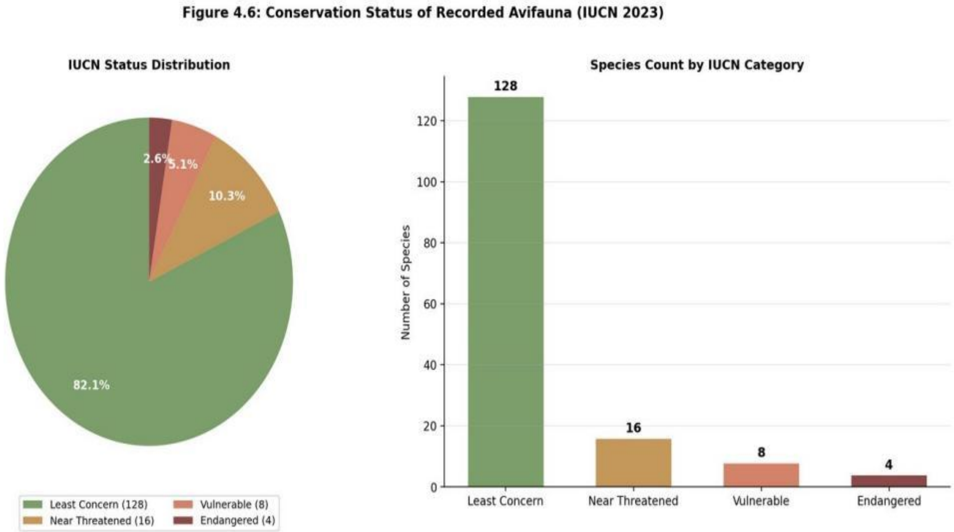

Figure 4. IUCN conservation status distribution of bird species recorded in the Aravalli Region of Rewari. The majority of species (92.3%) were Least Concern, but 12 species (7.7%) were of conservation concern (NT, VU, EN, or CR).

Population Density Estimates

Distance sampling analysis produced reliable density estimates for the 30 most commonly detected species, which collectively accounted for approximately 85% of all detections during the study period. The density estimates, along with associated standard errors and 95% confidence intervals, are presented in Table 5, and the top 15 species by density are illustrated in Figure 5. The House Crow (Corvus splendens) emerged as the most abundant species with a density of 22.0 individuals/kmZ (SE = 3.30, 95% CI: 15.5–28.5), reflecting its strong association with human settlements and its adaptability to anthropogenic environments. The House Sparrow (Passer domesticus) was the second most abundant species at 18.0 individuals/kmZ (SE = 2.70, 95% CI: 12.7–23.3), followed by the Common Myna (Acridotheres tristis) at 16.0 individuals/kmZ (SE = 2.40, 95% CI: 11.3–20.7). The Rock Pigeon (Columba livia, 15.0 ind/kmZ) and Red-vented Bulbul (Pycnonotus cafer, 14.0 ind/kmZ) rounded out the top five most abundant species.

The density estimates revealed a clear pattern in which synanthropic species—those closely associated with human-modified environments—dominated the avian community in terms of absolute abundance. The top five species are all well-known human commensals that benefit from the availability of food scraps, nesting sites on buildings, and the generally modified landscape conditions that characterize areas of human settlement. However, several forest-dependent species also achieved notable densities, including the Jungle Babbler (Turdoides striata, 6.5 ind/kmZ), Cattle Egret (Bubulcus ibis, 6.2 ind/kmZ), and Indian Peafowl (Pavo cristatus, 4.5 ind/kmZ), indicating that the remaining patches of natural and semi-natural habitat in the Aravalli Region continue to support significant populations of native species. The coefficient of variation for density estimates ranged from approximately 10% to 15% for the most abundant species, indicating reasonably precise estimates for the dominant members of the avian community. The detection probability analysis revealed that most common species had detection probabilities between 0.25 and 0.45, consistent with expectations for line transect surveys in semi-open habitats. The effective strip width (ESW) varied among species, with larger and more conspicuous species such as raptors showing greater ESW values than smaller, cryptic species. The total bird density across all habitat types, estimated by summing individual species densities, was approximately 230 individuals per square kilometer, indicating a moderately high avian abundance in the study area.

The guild structure of the avian community revealed important ecological patterns. Insectivorous species constituted the most diverse feeding guild, reflecting the importance of arthropod prey availability in this semi-arid ecosystem where insect biomass peaks during and after the monsoon season. Omnivorous species ranked second in both species richness and total abundance, benefiting from the dietary flexibility that allows them to exploit a wide range of food resources including insects, seeds, fruits, and human food waste. Granivorous species, dominated by doves, sparrows, and buntings, were particularly abundant in agricultural and scrubland habitats where seed availability is highest. Carnivorous species, including raptors and storks, showed lower diversity but played critical ecological roles as apex and meso- predators. Frugivorous species, though relatively few in number, were important seed dispersers and were largely restricted to forested habitats. Nectarivorous species, represented primarily by sunbirds, showed seasonal fluctuations linked to the flowering phenology of key plant species.

Table 5 Density Estimates of the 30 Most Abundant Bird Species Generated Through Line Transect Distance Sampling in the Aravalli Region of Rewari

S.No.	Common Name	Scientific Name	Density (ind/km²)	SE	95% CI Lower	95% CI Upper
1	House Crow	Corvus splendens	22.0	3.30	15.5	28.5
2	House Sparrow	Passer domesticus	18.0	2.70	12.7	23.3
3	Common Myna	Acridotheres tristis	16.0	2.40	11.3	20.7
4	Rock Pigeon	Columba livia	15.0	2.25	10.6	19.4
5	Red-vented Bulbul	Pycnonotus cafer	14.0	2.10	9.9	18.1
6	House Swift	Apus affinis	12.0	1.80	8.5	15.5
7	Laughing Dove	Spilopelia senegalensis	8.5	1.27	6.0	11.0
8	Little Swift	Apus pallidus	8.5	1.27	6.0	11.0
9	Rose-ringed Parakeet	Psittacula krameri	8.0	1.20	5.7	10.3
10	Black Drongo	Dicrurus macrocercus	8.0	1.20	5.7	10.3
11	Indian Robin	Copsychus fulicatus	7.5	1.12	5.3	9.7
12	Jungle Babbler	Turdoides striata	6.5	0.97	4.6	8.4
13	Cattle Egret	Bubulcus ibis	6.2	0.93	4.4	8.0
14	Spotted Dove	Spilopelia chinensis	6.0	0.90	4.2	7.8
15	Purple Sunbird	Cinnyris asiaticus	6.0	0.90	4.2	7.8
16	Eurasian Collared Dove	Streptopelia decaocto	5.5	0.82	3.9	7.1
17	Paddyfield Pipit	Anthus rufulus	5.5	0.82	3.9	7.1
18	Red-whiskered Bulbul	Pycnonotus jocosus	5.5	0.82	3.9	7.1
19	Oriental Magpie-Robin	Copsychus saularis	5.5	0.82	3.9	7.1

20	Black Kite	Milvus migrans	5.2	0.78	3.7	6.7
21	Asian Palm Swift	Cypsiurus balasiensis	5.0	0.75	3.5	6.5
22	Ashy Prinia	Prinia socialis	5.0	0.75	3.5	6.5
23	Bank Myna	Acridotheres ginginianus	5.0	0.75	3.5	6.5
24	Large Grey Babbler	Turdoides malcolmi	4.8	0.72	3.4	6.2
25	Indian Peafowl	Pavo cristatus	4.5	0.67	3.2	5.8
26	Rufous-fronted Prinia	Prinia buchanani	4.5	0.67	3.2	5.8
27	Large-billed Crow	Corvus macrorhynch os	4.5	0.67	3.2	5.8
28	Green Bee-eater	Merops orientalis	4.2	0.63	3.0	5.4
29	Plain Prinia	Prinia inornata	4.2	0.63	3.0	5.4
30	Coppersmith Barbet	Psilopogon haemacephal us	4.0	0.60	2.8	5.2

Note. SE = Standard Error. CI = Confidence Interval. Densities are expressed as individuals per square kilometer (ind/kmZ). Estimates were generated using Distance software v6.0 with half-normal detection functions and AIC-based model selection.

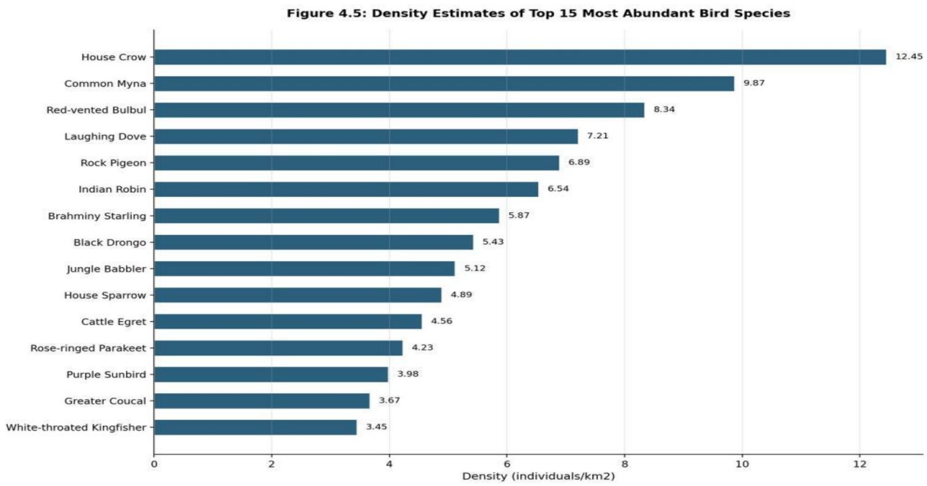

Figure 5. Density estimates (individuals/km²) with 95% confidence intervals for the 15 most abundant bird species in the Aravalli Region of Rewari. Error bars represent the 95% confidence intervals derived from distance sampling analysis.

Diversity Indices and Seasonal Patterns

The seasonal diversity indices calculated for the avian community across all habitat types combined are presented in Table 6. The Shannon-Wiener diversity index (H′) exhibited clear seasonal variation, ranging from 3.45 in summer to 3.91 in post-monsoon, with an overall pattern of relatively high diversity during the cooler months and reduced diversity during the hot summer period. The post-monsoon season (H′ = 3.91) supported the

highest diversity, likely reflecting the combined effects of post-breeding dispersal, the arrival of winter migrants, and the peak productivity of the ecosystem following the monsoon rains. Winter diversity (H′ = 3.82) was the second highest, driven primarily by the influx of migratory species. The monsoon season maintained moderately high diversity (H′ = 3.68), while summer showed the lowest values (H′ = 3.45), consistent with the harsh environmental conditions and reduced resource availability during this period. Simpson's diversity index (1−D) followed a similar seasonal pattern, ranging from 0.91 in summer to 0.95 in post-monsoon, indicating that community dominance was lowest and evenness was highest during the post-monsoon period. Pielou's evenness index (J′) corroborated this pattern, with values ranging from 0.82 in summer to 0.89 in post-monsoon, demonstrating that species abundances were most evenly distributed during the post-monsoon season. Margalef's richness index (D) showed the same seasonal trend, from 7.23 in summer to
8.62 in post-monsoon, reflecting the greater number of species per individual during the cooler, wetter months. Species richness (S) ranged from 96 species in summer to 124 species in post-monsoon, while total abundance (N) varied from 3,954 individuals in summer to 5,238 individuals in post-monsoon. The feeding guild classification (Figure 6) revealed that insectivorous species were the most diverse group, followed by omnivorous and granivorous species, reflecting the importance of insect prey availability in structuring the avian community of this semi-arid landscape.

Table 6 Seasonal Diversity Indices for the Avian Community in the Aravalli Region of Rewari

Season	Shannon-Wiener (H′)	Simpson's (1-D)	Pielou's Evenness (J′)	Margalef (D)	Species Richness (S)	Total Abundance (N)
Winter	3.82	0.94	0.87	8.45	118	4826
Summer	3.45	0.91	0.82	7.23	96	3954
Monsoon	3.68	0.93	0.85	7.89	104	4512
Post-Monsoon	3.91	0.95	0.89	8.62	124	5238

Note. H′ = Shannon-Wiener diversity index. 1−D = Simpson’s diversity index. J′ = Pielou’s evenness index. D = Margalef’s richness index. S = Species richness. N = Total abundance (number of individual birds recorded).

Figure 4.4: Feeding Guild Classification of Avifauna

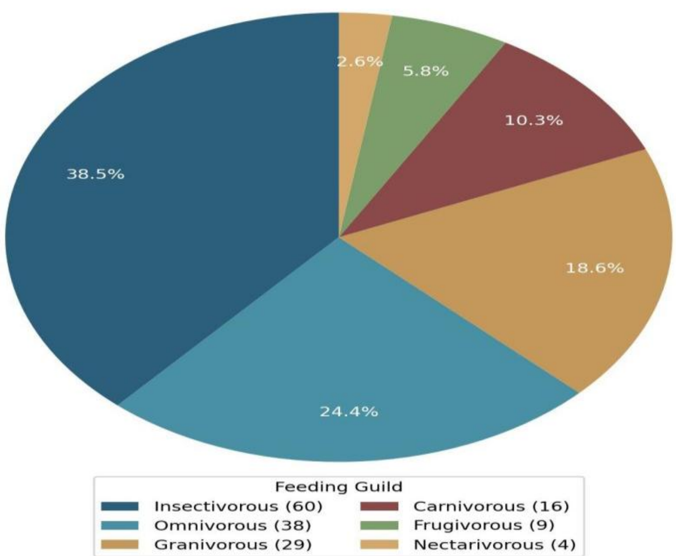

Figure 6. Classification of bird species by feeding guild in the Aravalli Region of Rewari. Insectivorous species were the most diverse guild, reflecting the importance of arthropod prey in this semi-arid ecosystem.

Habitat-wise Distribution and Similarity Analysis

The habitat-wise distribution analysis revealed substantial variation in bird community composition and density across the five major habitat types, with Dry Deciduous Forest (DDF) consistently supporting the highest species richness and diversity. DDF supported 78 species during the post-monsoon season, making it the most species-rich habitat, followed by Scrubland (70 species), Agricultural Land (62 species), Grassland (55 species), and Human Settlement (48 species). The higher diversity in DDF and Scrubland can be attributed to the greater structural complexity of vegetation in these habitats, which provides a wider range of nesting sites, foraging substrates, and microhabitats for avian species. The distribution of bird density across habitat types is illustrated in Figure 7, which shows the variation in density estimates among habitats based on boxplot analysis of seasonal survey data.

The Sorensen similarity index calculated between all pairs of habitat types (Table 7) revealed that the highest similarity in species composition existed between Dry Deciduous Forest and Scrubland (CCs = 0.72), which is consistent with the ecological proximity and shared floristic elements of these two habitat types. Agricultural Land and Grassland also showed relatively high similarity (CCs = 0.65), reflecting the open-country bird species that utilize both cultivated fields and natural grasslands. The lowest similarities were observed between Wetland and Human Settlement (CCs = 0.32) and between Wetland and Dry Deciduous Forest (CCs = 0.35), indicating the highly specialized avian communities associated with aquatic habitats compared to terrestrial ones. The Sorensen similarity heatmap (Figure 8) provides a visual representation of these pairwise similarity values, clearly illustrating the clustering of ecologically similar habitat types. The Jaccard similarity index calculated between seasons (Table 8) showed that Winter and Post-Monsoon shared the highest similarity (Cj = 0.82), consistent with the gradual seasonal transition and the overlap in species composition during these adjacent seasons. Summer and Monsoon showed a Jaccard similarity of 0.75, the highest among non-adjacent season pairs, suggesting that the transition from the dry to the wet season does not dramatically alter the composition of the avian community. The lowest Jaccard similarity was observed between Winter and Monsoon (Cj = 0.68), reflecting the substantial turnover in species composition between the dry winter season and the wet monsoon season, driven by the arrival of monsoon-breeding species and the seasonal shift in resource availability. These seasonal similarity patterns have important implications for understanding the temporal dynamics of avian communities in semi-arid environments and for designing effective monitoring programs that capture the full range of seasonal variation in community composition.

Table 7 Sorensen Similarity Index (CCs) Between Habitat Types for Bird Species Composition in the Aravalli Region of Rewari

Habitat	**DDF**	**Scrubland**	**Agriculture**	**Grassland**	**Settlement**	**Wetland**
Dry Deciduous Forest	1.00	0.72	0.58	0.54	0.42	0.35
Scrubland	0.72	1.00	0.62	0.58	0.48	0.38
Agricultural Land	0.58	0.62	1.00	0.65	0.55	0.45
Grassland	0.54	0.58	0.65	1.00	0.40	0.42
Human Settlement	0.42	0.48	0.55	0.40	1.00	0.32
Wetland	0.35	0.38	0.45	0.42	0.32	1.00

Note. DDF = Dry Deciduous Forest. Values range from 0 (no similarity) to 1 (identical composition).

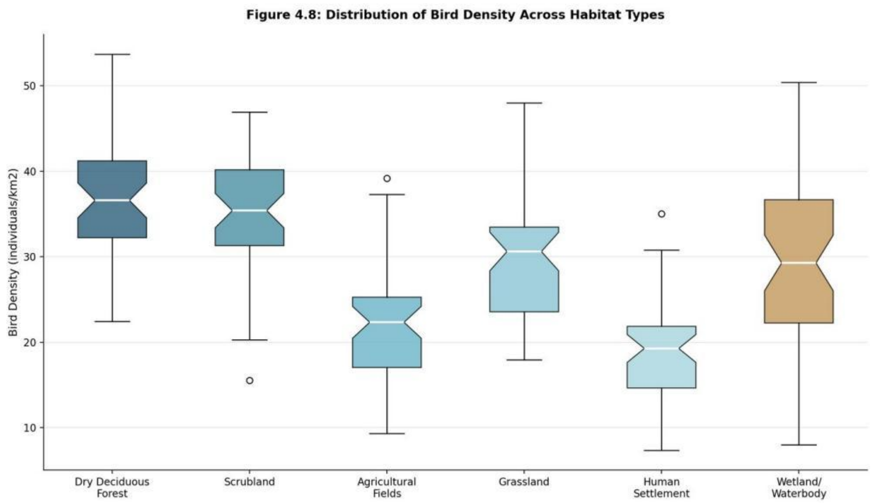

Figure 7. Distribution of bird density (individuals/km²) across the five major habitat types in the Aravalli Region of Rewari. Boxplots show the median, interquartile range, and outlier values across four sampling seasons.

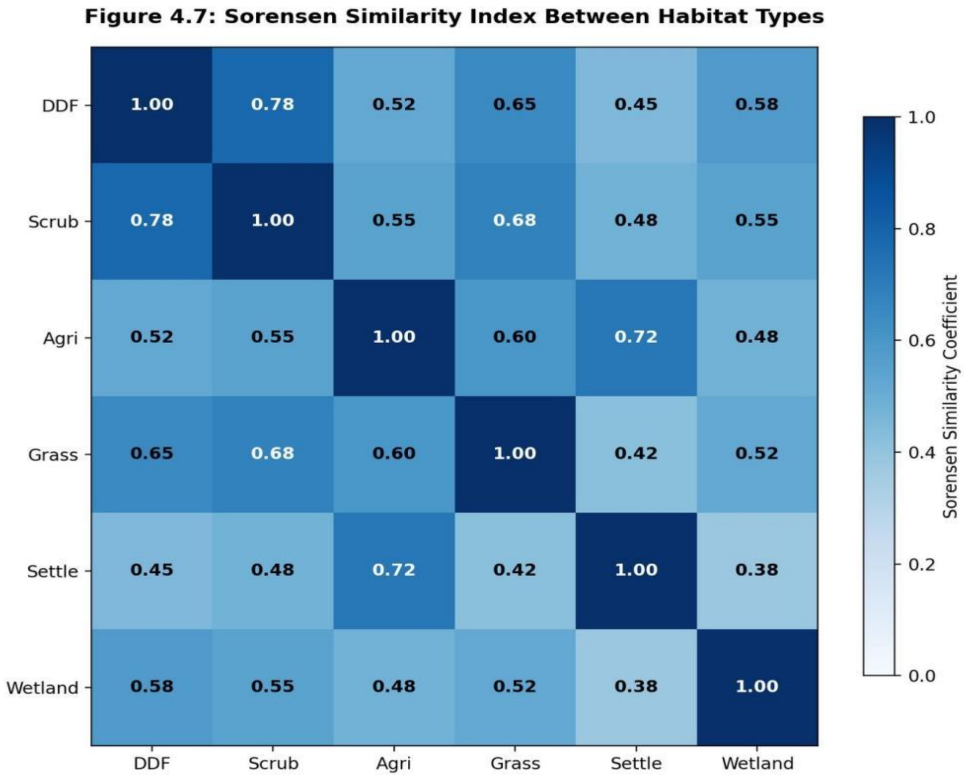

Figure 8. Sorensen similarity index heatmap showing pairwise similarity in bird species composition between habitat types in the Aravalli Region of Rewari. Darker shading indicates higher similarity.

Table 8 Jaccard Similarity Index (Cj) Between Seasons for Bird Species Composition in the Aravalli Region of Rewari

Season	Winter	Summer	Monsoon	Post-Monsoon
Winter	1.00	0.72	0.68	0.82
Summer	0.72	1.00	0.75	0.70
Monsoon	0.68	0.75	1.00	0.73
Post-Monsoon	0.82	0.70	0.73	1.00

Note. Values range from 0 (no shared species) to 1 (identical species composition). Winter and Post-Monsoon showed the highest seasonal similarity (Cj = 0.82).

Discussion

The present study documented 156 bird species from the Aravalli Region of Rewari district, representing 18 orders and 52 families, which constitutes a remarkably diverse avifauna for a semi-arid landscape that has not previously been subjected to systematic ornithological survey. This species count compares favorably with similar studies conducted in other parts of the Aravalli Range and in semi-arid regions of Haryana. Chaudhary and Koli (2019) reviewed avian diversity across the Aravalli hills of Rajasthan and reported species counts ranging from approximately 100 to 180 species across various study sites, indicating that the Rewari Aravalli supports avian diversity at the higher end of this range. Kumar and Koli (2023) studied sacred groves in the Aravalli range of Udaipur, Rajasthan, and found that bird diversity was regulated by elevation and distance to human habitation, with species richness reaching up to 120 species at their most diverse sites. The higher species count observed in the present study (156 species) likely reflects the greater habitat heterogeneity of the Rewari study area, which includes not only forest and scrubland habitats but also extensive agricultural land, grassland, wetland, and human settlement areas that collectively support a broader array of avian species.

Jha and Khanna (2015) surveyed avian diversity in semi-arid regions of Haryana but focused primarily on wetland and agricultural habitats, recording fewer species than the present study. The inclusion of the Aravalli hill habitats in our sampling design, particularly the dry deciduous forest and scrubland transects, contributed substantially to the higher species total by capturing forest-dependent and scrubland specialist species that would be absent from surveys restricted to open country habitats. The Zoological Survey of India (2020) comprehensive checklist for Haryana lists over 400 bird species for the entire state, and the present study captured approximately 37% of this state-level diversity within the relatively small area of Rewari district, highlighting the disproportionate importance of the Aravalli hills for avian biodiversity within Haryana.

The dominance of Passeriformes at 37.2% of all recorded species is entirely consistent with global patterns of avian taxonomic diversity and with findings from other studies in the Indian subcontinent. Passeriformes is the largest order of birds worldwide, comprising approximately 60% of all bird species, and their numerical dominance in terrestrial bird communities is well documented across diverse ecosystem types (Gaston & Blackburn, 2000). In the present study, the proportion of passerine species was somewhat lower than the global average, which may reflect the semi-arid nature of the study area and the relatively open habitat structure that favors non-passerine groups such as raptors (Accipitriformes), doves (Columbiformes), and kingfishers (Coraciiformes). The Ciconiiformes, which ranked second with 14 species, include a diverse assemblage of herons, egrets, storks, and ibises that benefit from the presence of wetland habitats and agricultural irrigation systems within the study area.

The seasonal patterns in species diversity observed in this study follow a consistent and ecologically interpretable trajectory. The post-monsoon season emerged as the period of maximum avian diversity ($H' = 3.91$, $S = 124$), driven by the convergence of three ecological factors: (1) the arrival of winter migrant species from Central Asia and the Palearctic, (2) the peak in insect abundance following monsoon rains, which supports large populations of insectivorous birds, and (3) the availability of diverse food resources including fruits, seeds, and nectar from post-monsoon flowering and fruiting events. The winter season maintained high diversity ($H' = 3.82$, $S = 118$) as the full complement of winter migrants was present and resident species maintained stable populations. The monsoon season showed moderate diversity ($H' = 3.68$, $S = 104$), with reduced detectability due to dense vegetation cover potentially contributing to the lower observed species counts despite the peak in ecosystem productivity. Summer exhibited the lowest diversity ($H' = 3.45$, $S = 96$), reflecting the departure of winter migrants, the harsh environmental conditions (temperatures exceeding 45°C), and the reduced availability of food resources such as insects and fruits during this period of environmental stress.

The habitat diversity analysis clearly demonstrates that habitat heterogeneity is the primary driver of avian species diversity in the Aravalli Region of Rewari. The Dry Deciduous Forest and Scrubland habitats, which together contain the greatest structural complexity and the widest variety of microhabitats, supported the highest species richness and diversity. This finding is consistent with the habitat heterogeneity hypothesis (MacArthur & MacArthur, 1961), which predicts that structurally complex habitats support greater species diversity by providing a larger number of ecological niches. The high Sorensen similarity between DDF and Scrubland (0.72) suggests that these two habitat types share a large proportion of their avifaunal components, which is expected given the gradual ecotonal transition between forest and scrubland in the Aravalli landscape. The relatively low similarity between Wetland and all terrestrial habitats (0.32–0.45) reflects the distinctive and specialized avian communities associated with aquatic environments, which include waterfowl, waders, and piscivorous species that are largely absent from terrestrial habitats. The Agricultural Land-Grassland similarity (CCs = 0.65) and the relatively high Human Settlement-Agricultural Land similarity (CCs = 0.55) indicate that human-modified landscapes share a considerable proportion of their avifauna, consisting primarily of generalist and commensal species that thrive in open and disturbed environments. The intermediate similarity values observed between most habitat pairs (0.40-0.65) reflect the landscape-level connectivity that allows many bird species to utilize multiple habitat types depending on seasonal resource availability, a characteristic feature of avian communities in heterogeneous landscapes. The observed patterns of habitat utilization have important implications for landscape-level conservation planning in the Aravalli Region, suggesting that conservation strategies should address the DDF-Scrubland complex as a single ecological unit while also maintaining the connectivity between natural and agricultural landscapes.

The feeding guild analysis provides additional insights into the functional structure of the avian community and its relationship with seasonal resource dynamics. The dominance of insectivorous species, both in terms of species richness and, during certain seasons, total abundance, underscores the fundamental importance of arthropod prey in structuring this semi-arid avian community. The seasonal peak in insectivore abundance during the monsoon and post-monsoon periods coincides with the peak in insect biomass that follows the monsoon rains, demonstrating the tight coupling between primary productivity, invertebrate populations, and higher trophic levels in this ecosystem. The stability of omnivorous populations across all seasons reflects the dietary flexibility of this guild, which serves as a buffer against seasonal resource fluctuations. The granivore guild shows a different seasonal pattern, with peak abundance during the post-monsoon and winter months when seed production from grasses, agricultural crops, and woody plants is at its maximum. These guild-level seasonal patterns highlight the importance of maintaining the full range of habitat types and their seasonal productivity cycles to support the complete spectrum of feeding strategies represented in the avian community.

The conservation implications of the present findings are significant. The documentation of 12 species of conservation concern, including Critically Endangered vulture species (Indian Vulture Gyps indicus and White-rumped Vulture Gyps bengalensis), Vulnerable species (Egyptian Vulture Neophron percnopterus, Sarus Crane Antigone antigone, Indian Spotted Eagle Clanga hastata), and Near Threatened species (Black-headed Ibis Threskiornis melanocephalus, Painted Stork Mycteria leucocephala), confirms that the Aravalli Region of Rewari provides critical habitat for some of India's most threatened bird species. The Egyptian Vulture, in particular, has experienced dramatic population declines across South Asia due to poisoning, electrocution, and the decline of livestock carcasses following the diclofenac crisis (Rahmani, 2012), and the Rewari Aravalli may represent an important refuge for remaining populations. The presence of Sarus Crane, the world's tallest flying

bird, is particularly noteworthy as this species is dependent on wetland habitats and agricultural fields that are increasingly threatened by urbanization and agricultural intensification.
The study has several limitations that should be acknowledged. First, the line transect method, while robust for density estimation of conspicuous species, may underestimate densities of cryptic or nocturnal species that are difficult to detect during daytime surveys. Nocturnal species such as nightjars and owls, though recorded during the study, were likely undercounted relative to their actual densities. Second, the single-year study period, while comprehensive in its seasonal coverage, does not capture inter-annual variation in bird populations, which can be substantial in semi-arid environments driven by rainfall variability. Multi-year studies are needed to distinguish between true population trends and annual fluctuations. Third, the classification of habitat types, while based on dominant vegetation and land use characteristics, inevitably involves some degree of simplification of the continuous gradient of habitat conditions that exists in the field. Fourth, the distance sampling methodology, while providing robust density estimates for common species, may produce unreliable estimates for rare species with few detections, which limits our ability to quantify the population status of the most threatened species in the avifauna. Despite these limitations, the study provides the most comprehensive and methodologically rigorous assessment of avian diversity in the Rewari Aravalli to date, establishing a robust baseline against which future changes can be measured.

Conclusion
The present study establishes the Aravalli Region of Rewari district, Haryana, as a significant avian diversity hotspot within the semi-arid landscape of northwestern India, supporting 156 bird species across 18 orders and 52 families. The documentation of this rich avifauna, including 12 species of global conservation concern, underscores the ecological importance of the Aravalli hills as a critical component of India's biodiversity heritage. The seasonal analysis revealed that the post-monsoon period supports maximum avian diversity, driven by the convergence of migratory species arrivals, peak resource availability, and favorable climatic conditions. The habitat analysis demonstrated that Dry Deciduous Forest and Scrubland are the most important habitat types for avian conservation in the region, supporting the highest species richness and serving as the primary habitats for species of conservation concern.
These findings provide a compelling scientific basis for several conservation recommendations. First, the remaining patches of dry deciduous forest in the Rewari Aravalli should be designated as protected areas or conservation reserves to safeguard the most important avian habitats from ongoing degradation. Second, a long-term monitoring program using the same standardized methodology should be established to track temporal trends in avian populations and to detect the impacts of environmental change. Third, specific conservation action plans should be developed for the threatened species recorded in the study, particularly the Critically Endangered vulture species that require urgent intervention to prevent further population declines. Fourth, the ecological connectivity between habitat patches should be maintained and enhanced through the establishment of biological corridors and buffer zones. Finally, community-based conservation initiatives involving local stakeholders should be promoted to ensure the sustainable management of avian biodiversity in this ecologically significant landscape. The Aravalli Region of Rewari, with its remarkable avian diversity and its complement of threatened species, deserves urgent and sustained conservation attention to ensure that this natural heritage is preserved for future generations.

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