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ASSESSMENT OF AVIAN BIODIVERSITY IN THE DARA ADAM KHEL REGION DISTRICT KOHAT, KHYBER PAKHTUNKHWA, PAKISTAN

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ABSTRACT

This study provides the first comprehensive documentation of avian biodiversity in the Dara Adam Khel region of District Kohat, situated within the transitional ecotone between the semi-arid plains and the north-western Himalayan foothills of Khyber Pakhtunkhwa, Pakistan. Conducted over a four-month period from November 2024 to February 2025, the study employed standardized ornithological survey methods—including point counts, transect walks, and photographic verification—to assess bird species richness, residency status, habitat preferences, and ecological roles. The survey was carried out across six strategically selected sites, encompassing two main habitat types: mountainous/forested areas and human-inhabited residential zones. A total of eleven avian species were recorded, spanning six orders, eleven families, and twelve genera. Notably, four species—*Garrulus lanceolatus* (Black-headed Jay), *Dendrocitta vagabunda* (Rufous Treepie), *Anthus similis* (Long-billed Pipit), and *Pycnonotus leucogenys* (Himalayan Bulbul)—were recorded in the region for the first time, expanding the known avifaunal range and adding novel insights to the region's biodiversity profile. Species documentation involved both visual and photographic observations, with identifications cross-verified using regional field guides and

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taxonomic references. Observed birds represented a wide range of ecological guilds, including omnivores, insectivores, scavengers, and granivores, indicating diverse habitat functions such as seed dispersion, pest control, and scavenging. Most species belonged to the order Passeriformes, consistent with global trends. The study also highlighted species sensitive to environmental and climatic variables, such as the *Bubulcus ibis* (Cattle Egret), which was seen only during rainfall events. Despite the ecological richness of the region, findings suggest an overall low avian diversity relative to comparable studies in nearby areas like Bajaur Valley and Kotal Wildlife Park. This decline appears to be linked to increasing anthropogenic pressures including habitat destruction, overgrazing, climate change, and noise disturbance, all of which compromise the ecological integrity of avian habitats. The study concludes that the Dara Adam Khel region, though underexplored, holds substantial ecological value and requires targeted conservation interventions. It underscores the urgent need for longitudinal biodiversity monitoring, habitat restoration, and policy-driven conservation strategies to safeguard avian diversity in this ecologically sensitive zone.

Key Words: Avian biodiversity, Dara Adam Khel, winter migratory birds, Habitat degradation, Conservation assessment.

Introduction

Biodiversity refers to the vast array of life forms that inhabit our planet, encompassing plants, animals, fungi, and microorganisms, all of which interact within complex ecosystems (Rawat & Agarwal, 2015). These organisms coexist in a delicate equilibrium, forming intricate ecological networks that sustain the Earth's life-support systems (Verma, 2017). Biodiversity is not merely a measure of the variety of species, but a critical component in ensuring the resilience and functionality of ecosystems. It underpins essential services such as pollination, nutrient cycling, soil formation, and climate regulation. Without robust biodiversity, humanity would face significant threats to food security, access to clean water, medicinal resources, and a stable climate (Chivian, 2002).

The presence of a diverse range of species enhances the productivity and stability of ecosystems (Johnson *et al*., 1996). Each organism, regardless of its size or ecological niche, contributes uniquely to maintaining natural balance (Pimm, 1991). For instance, pollinators like bees and birds facilitate plant reproduction, while predators and prey help regulate population dynamics (Saunders *et al*., 2016). Decomposers such as fungi and bacteria play vital roles in recycling nutrients, breaking down dead organic matter, and maintaining soil fertility. Ecosystems rich in biodiversity are inherently more resilient, better equipped to withstand and adapt to stressors such as climate change, disease outbreaks, and drought (Yousuf *et al.*, 2022). Moreover, biodiversity is foundational to key economic sectors—pharmaceuticals, agriculture, forestry, and fisheries. Many life-saving medicines are derived from biological sources, including various microorganisms, plants, and animal species. Agricultural biodiversity, involving a wide range of crop varieties and livestock breeds, ensures food security and adaptability to environmental changes (Sufiyan, 2022). Ecotourism, particularly in biodiversity-rich regions, serves as a significant source of income for many

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communities. Beyond material benefits, biodiversity holds immense cultural, spiritual, and psychological value. For many societies, nature is deeply embedded in folklore, religious practices, and artistic expression (McFarlane, 2012; Mazzuoli, 2025). Exposure to diverse natural landscapes and wildlife has been shown to enhance mental wellbeing and foster a deeper connection with the environment (Bell *et al*., 2016). The biological diversity around us can be likened to a vast, dynamic library—providing endless opportunities for scientific inquiry, discovery, and innovation (Audah, 2018). Studying different life forms not only expands our understanding of evolutionary processes but also supports advancements in technology and biomedicine (Cornish, 2004; Bowen *et al.*, 2007).

Birds (class *Aves*) are warm-blooded vertebrates distinguished by several unique adaptations including feathers, toothless beaks, high metabolic rates, and lightweight skeletal systems, all of which support their remarkable ability to fly (Olsen & Joseph, 2011). Avian biodiversity encompasses the vast range of bird species, their genetic variations, ecological roles, and interactions within ecosystems. The anatomy and physiology of birds reflect evolutionary adaptations to diverse environments. Their respiratory, skeletal, and muscular systems are highly specialized for flight, while aquatic birds have evolved additional morphological traits suited for swimming (McWilliams *et al*., 2017). Taxonomically, birds are divided into two major groups: *Palaeognathae* (primarily flightless species) and *Neognathae* (flight-capable birds), which together represent a global distribution of avian diversity (Hanson *et al.*, 2021). While some species are cosmopolitan, many are endemic and adapted to specific habitats or regions (Roberts, 1991). Bird species vary widely in size—from the tiny *Mellisuga helenae* (Cuban hummingbird) measuring just 55 mm to the towering *Struthio camelus* (ostrich), reaching 2800 mm in height (Shuka, 2023). Their habitats are equally diverse, ranging from wetlands, forests, and grasslands to agricultural fields, urban environments, and alpine zones (Yonezawa *et al*., 2017; Umar *et al*., 2018). Birds fulfil multiple ecological roles depending on their diets: granivores, frugivores, omnivores, and carnivores each contribute differently to ecosystem dynamics (Sahu *et al*., 2021a).

Birds engage in complex breeding behaviours, constructing nests in a variety of environments such as trees, shrubs, rocky outcrops, ground surfaces, and cavities (Ritchison, 2023). Depending on the species, clutch sizes can range from 2 to 26 eggs, with incubation periods varying from one to several weeks (van der Hoek *et al.*, 2017; Khan *et al.*, 2022a). As bioindicators, birds are susceptible to environmental change, making them valuable for assessing habitat quality, ecosystem health, and pollution levels (Chivian, 2002; Furness *et al.*, 2013). Ecologically, birds play indispensable roles. Many act as pollinators and seed dispersers, particularly in forested ecosystems, enhancing plant genetic diversity and facilitating vegetation regeneration (Whelan et al., 2008; MacArthur *et al.*, 1961). They contribute to natural pest control by feeding on insects and small vertebrates, offering significant benefits to agriculture (Avery, 2002; Dinesh *et al*., 2022). Birds also occupy various trophic levels—as predators, prey, and scavengers—contributing to ecological balance (Johnson *et al.*, 1990; White, 2008). Beyond ecological functions, birds enrich human life. Bird watching supports local economies and promotes environmental awareness. Birds have symbolic

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importance across cultures and are featured prominently in literature, mythology, and spiritual traditions (Sekercioglu, 2002; Moreman, 2014).

Human encroachment and unsustainable practices such as agriculture, charcoal production, and wood extraction have degraded bird habitats, resulting in loss of biodiversity and ecosystem services (Collina *et al*., 2021). At present, worldwide, there are about 9040 bird species (Portaccio et al., 2023). In Pakistan, approximately 660–670 bird species across 74 families and 272 genera have been identified (Saleem *et al.*, 2008). The national bird is the Chukar partridge (*Alectoris chukar*). Khyber Pakhtunkhwa, with its diverse topography—ranging from mountains and rivers to forests and valleys—supports a rich assemblage of avian fauna (Shah, 2011). In Bajaur Valley, located between 34˚38'–46˚N and 71˚20'–39˚E at elevations ranging from 1,117 to 2,400 meters, extensive surveys have identified diverse bird populations using point count and line transect methods (Khan *et al.*, 2023). Kotal Wildlife Park near Gulshan Abad Chowk, Kohat, houses both introduced and native bird species. This semi-green hilly habitat supports species such as the Grey Partridge, Black Partridge, Indian Ring Dove, Indian Grey Shrike, European Hoopoe, Silver Pheasant, Ring-necked Pheasant, and Common Peafowl. Other species include Common Crane, Grey Heron, Mrs. Hume's Pheasant, and various urban birds like the House Crow and Sparrow (Zareen *et al*., 2016).

Surveys conducted in Karak recorded 32 bird species from 26 families across 11 orders, with *Passeriformes* being the most abundant (Younas *et al*., 2017). These findings underscore the richness of avifaunal diversity and the urgent need for conservation measures, particularly in habitats under anthropogenic pressure. Keeping n view importance of avian biodiversity the current study was designed to describe the species richness and diversity of avian fauna in the Dara Adam Khel region by systematic field surveys and to identify the threats to bird diversity in the sampling area.

Materials and Methods

Study Area: Geographic and Administrative Context

The present study was carried out in Dara Adam Khel, a tehsil situated within the administrative boundaries of Kohat District, in the Khyber Pakhtunkhwa (KPK) province of Pakistan. Dara Adam Khel occupies a strategic geographical position with coordinates at approximately 33.684° North latitude and 71.516° East longitude. This location lies at the interface of several important districts, being bordered by Peshawar District to the north, Nowshera District to the east, and Orakzai District to the west. The total area of Dara Adam Khel Tehsil is estimated to be approximately 446 square kilometres, which includes the main town and its surrounding rural and mountainous terrain.

Topography and Habitat Types

The physical geography of Dara Adam Khel is characterized by a heterogeneous landscape that includes both mountainous regions and inhabited residential areas. For this ecological and ornithological study, the area was categorized into two distinct habitat types: (i) the mountainous or forested hills, representing the natural, relatively undisturbed environment, and (ii) the residential or town zones, which are marked by

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human settlements, built structures, and anthropogenic disturbances. This classification was essential for understanding the habitat preferences and distribution patterns of various bird species in response to ecological variables such as elevation, vegetation cover, and human activity.

Selected Field Sites within the Study Area

To ensure comprehensive spatial coverage, six specific field sites were selected within Dara Adam Khel based on their representativeness of both natural and urban habitats. These sites included Akhurawal, Bosti Khel, Kala Khel, Torchapar, Seda Ali Takh, and Warghar. Each of these locations offered a unique ecological setting, allowing the researchers to evaluate species diversity and abundance across varied environmental gradients. These sites were chosen through preliminary reconnaissance visits and consultations with local inhabitants familiar with the terrain and its wildlife.

Mapping and Visual Representation

To visually contextualise the study area, a map of Dara Adam Khel was generated and utilised to mark the boundaries and the exact locations of the surveyed sites. This cartographic representation assisted in spatial planning, site navigation during fieldwork, and later, in the interpretation of habitat-specific bird species distribution. A satellite or GIS-based image may be included here to enhance further understanding of the spatial dimensions and geographical features of the study area (Figure-1).

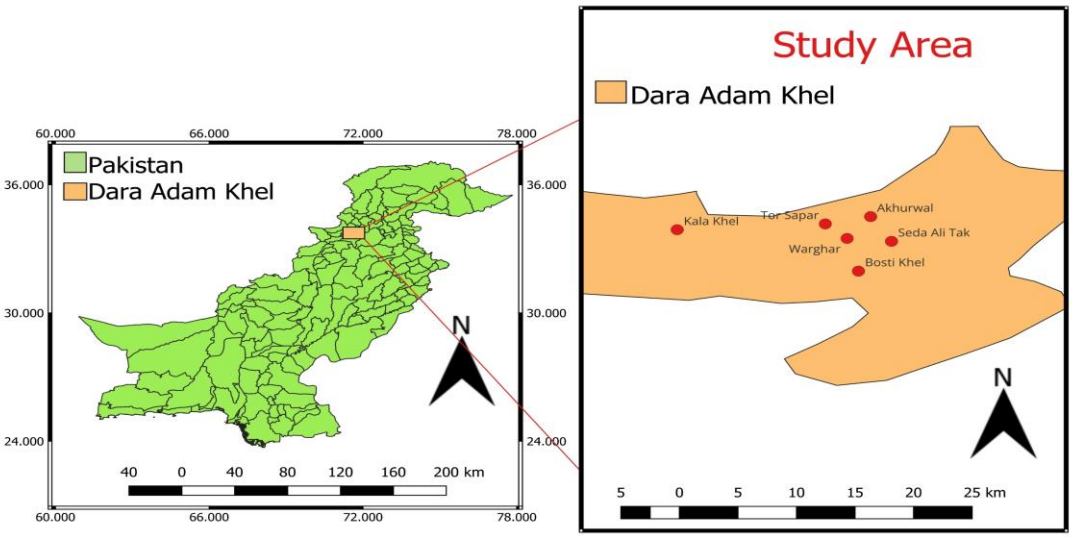


Figure-1: Map View of Dara Adam Khel (Prepared by QGIS APP)

Fieldwork Design and Sampling Protocol

Duration of Fieldwork

The field surveys were systematically conducted over four consecutive months, from

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November 2024 to February 2025. This time frame was strategically chosen to coincide with the winter season in northern Pakistan, a period known to host both resident and migratory bird species. Surveying an extended temporal scale allowed for capturing seasonal variations in bird presence and behaviour.

Frequency and Timing of Field Visits

Field visits were scheduled at a regular frequency of three times per week throughout the study period. This high sampling frequency ensured that a robust and representative dataset was collected while minimizing the chances of missing transient or weather-sensitive species. Each visit was carefully timed to coincide with the peak activity periods of avifauna, specifically the early morning hours between 7:00 AM and 9:00 AM and the late afternoon hours from 5:00 PM to 7:00 PM. These periods were selected based on established ornithological research indicating heightened bird activity related to foraging, singing, and territorial behaviours during these hours.

Spatial Sampling Radius and Site Consistency

To maintain consistency in observational efforts and minimize bias across habitat types, all observations were made within a defined spatial boundary of a 100-meter radius at each site. This fixed-radius sampling approach allowed the researchers to control for spatial heterogeneity and standardize comparisons across different locations. The same boundaries were maintained for each observation event, ensuring that repeat visits captured the same ecological context.

Methods of Bird Species Documentation

Direct Observation and Photographic Recording

Bird species were identified through direct field observations using the naked eye and binoculars, supplemented by photographic documentation using a high-resolution digital camera. Each observed species was carefully photographed to ensure accurate identification and to serve as a verifiable record. This method minimized identification errors, especially for species with subtle morphological differences.

Identification and Verification Procedures

Initial species identification was carried out in the field based on morphological features such as size, plumage coloration, beak shape, vocalizations, and flight patterns. These features were cross-checked against standard ornithological field guides specific to the South Asian region. In ambiguous cases, photographs were further examined post-fieldwork and species identities were verified through consultation with expert ornithologists and comparative analysis with online databases and published taxonomic keys. Only those species whose identity could be confidently verified were included in the final dataset.

Influence of Weather Conditions on Data Collection

Weather as a Determinant of Avian Presence

During the field surveys, weather conditions were found to have a noticeable influence on bird activity and visibility. A particularly notable observation concerned the Cattle

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Egret (*Bubulcus ibis*), locally referred to as "Ele", which was recorded exclusively during active rainfall events. This species demonstrated a rainfall-dependent foraging or migratory behaviour, as it was completely absent during dry days. The species was observed congregating in open areas during rain, likely exploiting insects and other small prey driven to the surface by the wet conditions. This behaviour was documented in detail and highlighted the importance of climatic factors in shaping avian activity patterns.

Limitations Due to Adverse Conditions

In order to maintain observer safety and data integrity, no field observations were carried out during adverse or hazardous weather conditions, such as heavy downpours, strong winds, or fog that significantly reduced visibility. These environmental constraints were acknowledged as unavoidable limitations and were accounted for in the final analysis of species presence and absence.

Data Analysis and Interpretation Framework

Although this study primarily employed qualitative and observational methods, careful efforts were made to ensure scientific rigor and repeatability. The frequency of sightings, consistency across different habitat types, and repeated observations of the same species at multiple sites were used as indicators of habitat preference, adaptability, and distribution range. Bird diversity was evaluated not only in terms of species richness (the number of different species recorded) but also in terms of their spatial occurrence and temporal patterns across the survey duration. These qualitative measures helped build a preliminary understanding of avian ecology in the Dara Adam Khel region and provided a foundation for future quantitative studies.

Ethical Considerations and Wildlife Protection

Throughout the course of the study, strict ethical guidelines for wildlife research were followed. No bird was harmed, trapped, or handled during the study. All data were collected through non-invasive means, and observations were carried out from a respectful distance to avoid disturbing the natural behaviour of the birds. The study was fully compliant with local and international guidelines for the ethical observation of wild bird species.

RESULTS

The current study was conducted during the winter months, from November 2024 to February 2025, to evaluate the avian biodiversity of the Dara Adam Khel region, located in District Kohat, Khyber Pakhtunkhwa Province, Pakistan. This region forms part of the transitional zone between the semi-arid plains and the forested hills of the north-western Himalayan foothills. As such, it encompasses a variety of natural and anthropogenic habitats, including dry scrublands, scattered woodlands, agricultural landscapes, and human settlements, each contributing to a mosaic of ecological niches that support avian diversity.

The primary objective of this investigation was to record and analyze the bird species occurring in the region during the winter season. Extensive field observations were

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conducted using standard ornithological survey techniques, including point counts, transect walks, and visual and acoustic identification. Species identification was confirmed through reference to regional field guides, taxonomic keys, and expert consultation. In total, eleven avian species were identified, representing six distinct avian orders, eleven families, and twelve genera, all belonging to the class Aves and phylum Chordata.

Among the species recorded, the order Passeriformes was the most dominant, accounting for the majority of observations. This order, commonly known as perching birds or songbirds, includes species that are often adapted to a variety of ecological conditions, from urban environments to natural forests. Families such as Corvidae, Pycnonotidae, and Sturnidae were well represented, indicating a healthy diversity of passerine birds in the region.

The Corvidae family, known for its intelligence and adaptability, was particularly diverse, with three genera observed: *Garrulus* (Black-headed Jay), *Dendrocitta* (Rufous Treepie), and *Corvus* (House Crow). These species were observed in both wooded and semi-urban environments, frequently foraging in open areas and near human settlements. The Pycnonotidae family was represented by two species: the widely distributed *Pycnonotus cafer* (Red-vented Bulbul) and *Pycnonotus leucogenys* (Himalayan Bulbul), both of which are characteristic of scrub forests and garden habitats. Their vocal presence and abundance suggest that they play a key ecological role in seed dispersal and insect population control.

The study also recorded migratory species such as the *Phylloscopus trochiloides* (Greenish Warbler), a small insectivorous bird that winters in South Asia after breeding in the Palearctic region. Its presence during the winter months confirms the ecological importance of the Dara Adam Khel region as a seasonal habitat for migratory birds, providing essential foraging and resting grounds during their long migratory journeys.

Wading and wetland-associated birds were represented by *B. ibis* (Cattle Egret), a species often seen foraging near livestock in open fields. This bird's opportunistic foraging behaviour allows it to thrive in human-altered landscapes, where it follows cattle or tractors to feed on disturbed insects and other invertebrates.

Columbiformes were represented by *Streptopelia decaocto* (Eurasian Collared Dove), a species commonly found in urban and semi-urban areas across Pakistan. Its adaptability to various environments and close association with human habitation make it one of the most successful dove species in the region.

The presence of *Anthus similis* (Long-billed Pipit), typically found in dry, grassy, and rocky areas, further indicates the diversity of microhabitats in the region, ranging from open fields to low hilly tracts. Its cryptic plumage and ground-foraging behavior make it well-suited to the local topography.

The compiled data suggest that the Dara Adam Khel region supports a moderate yet ecologically significant assemblage of bird species. This biodiversity is shaped by the region’s transitional geographic location, varied landscape, and mixed land-use patterns. The observed species are not only indicators of ecosystem health but also play essential ecological roles in pollination, pest control, seed dispersion, and food web dynamics.

The following table (Table 1) presents a conservation and residency Status of Avian

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Species Recorded in Dara Adam Khel, District Kohat (Nov 2024 – Feb 2025).

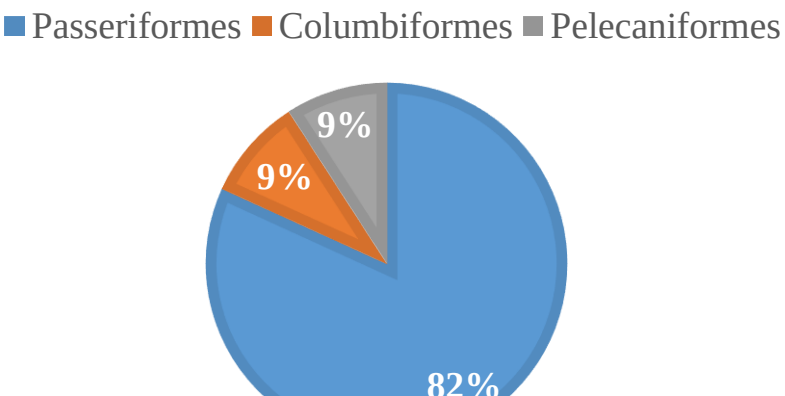
Table 1: Conservation and Residency Status of Avian Species Recorded in Dara Adam Khel, District Kohat (Nov 2024 – Feb 2025)

S. No	Species	Common Name	IUCN Status	Year	Residency Status
1	*G. lanceolatus*	Black-headed Jay	Least Concern	2024	Resident
2	*D. vagabunda*	Rufous Treepie	Least Concern	2018	Resident
3	*D. macrocercus*	Black Drongo	Least Concern	2024	Resident
4	*P. trochiloides*	Greenish Warbler	Least Concern	2024	Winter Migrant
5	*A. ginginianus*	Bank Myna	Least Concern	2018	Resident
6	*A. similis*	Long-billed Pipit	Least Concern	2024	Resident
7	*P. cafer*	Red-vented Bulbul	Least Concern	2018	Resident
8	*C. splendens*	House Crow	Least Concern	2018	Resident
9	*S. decaocto*	Eurasian Collared Dove	Least Concern	2019	Resident
10	*P. leucogenys*	Himalayan Bulbul	Least Concern	2024	Resident
11	*B. ibis*	Cattle Egret	Least Concern	2016	Resident / Migrant

The avifaunal survey of Dara Adam Khel revealed a diverse array of bird species, representing various families, ecological roles, and habitat preferences. A total of 11 bird species were documented during the study. Notably, four species were recorded for the first time in this area, thus contributing new insights to the regional ornithological data. These findings enhance the current understanding of avian biodiversity and distribution in semi-arid and forest-mosaic landscapes of Khyber Pakhtunkhwa, Pakistan.

Table 2: Relative Abundance of Bird Orders Observed in the Study Area

Taxonomic Order	Number of Individuals	Percentage (%)
Passeriformes	9	81.82
Columbiformes	1	9.09
Pelecaniformes	1	9.09
Total	**11**	**100**



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Figure-2: Proportion of bird species recorded in Dara Adam Khel (District Kohat), Khyber Pakhtunkhwa

The avifaunal dataset comprises records of eleven individual birds, representing three distinct taxonomic orders. The majority of observations belong to the order **Passeriformes**, accounting for nine individuals (81.82% of the total), including species such as *Garrulus lanceolatus*, *Dendrocitta vagabunda*, *Dicrurus macrocercus*, *Phylloscopus trochiloides*, *Acridotheres ginginianus*, *Anthus similis*, *Pycnonotus cafer*, *Corvus splendens*, and *Pycnonotus leucogenys*. The order Columbiformes is represented by a single individual of *Streptopelia decaocto*, constituting 9.09% of the total count. Similarly, the order Pelecaniformes is represented by one individual of *B. ibis*, also making up 9.09% of the dataset. This distribution highlights the predominance of passerines in the observed bird community, suggesting either a natural prevalence in the surveyed habitat or potential sampling bias towards small perching birds. Such composition data are well-suited for representation in a pie chart, where the proportional dominance of Passeriformes would be visually apparent, aiding in the interpretation of avian diversity patterns within the study area.

New Avifaunal Reported from Dara Adam Khel

***Garrulus lanceolatus* (Black-headed Jay)**

The Black-headed Jay (*Garrulus lanceolatus*) is a passerine bird belonging to the family Corvidae, which is widely recognized for its intelligence and complex social behaviours. Taxonomically, the species is classified under Class Aves, Order Passeriformes, Family Corvidae, Genus *Garrulus*, and Species *Garrulus lanceolatus*.



Figure-3 *Garrulus lanceolatus* (Black-headed Jay)

This species can be readily distinguished by its prominent black crest, head, and throat, which contrast with its striking bluish wings and tail, the latter marked with conspicuous black barring. Morphologically, the Black-headed Jay is a medium-sized

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bird measuring approximately 32–35 cm in length. Its plumage is predominantly buff-pink on the body, while its strong bill and bushy crest enhance its characteristic appearance. In terms of habitat preference, *G. lanceolatus* typically inhabits montane forests and scrublands at elevations ranging from 1,500 to 4,000 meters above sea level. The species demonstrates a degree of adaptability and is frequently observed near human settlements. Its omnivorous diet includes insects, seeds, berries, eggs, and anthropogenic food resources, indicating a flexible foraging strategy. The breeding season extends from April to July, during which the species constructs nests in trees. Clutches generally consist of 3–5 speckled eggs. Socially, the Black-headed Jay is an intelligent and vocal bird, displaying territoriality and often occurring in pairs or small social groups (Menon, T. (2020). Geographically, the distribution of *G. lanceolatus* spans the Western Himalayas, extending from Afghanistan across northern Pakistan, through the Indian Himalayas from Himachal Pradesh to western Nepal. In Pakistan, confirmed records exist from Gilgit-Baltistan, Azad Jammu and Kashmir, and sporadically from parts of Khyber Pakhtunkhwa, including Haripur. The present observation from Dara Adam Khel represents a noteworthy range extension within the region. Ecologically, the Black-headed Jay plays an important role in forest ecosystems. Its foraging and feeding activities contribute to seed dispersal and insect population regulation, thereby supporting overall ecosystem balance and forest regeneration (Bhatti *et al*., 2017).

Rufous Treepie (*Dendrocitta vagabunda*)

The Rufous Treepie (*Dendrocitta vagabunda*) is a conspicuous member of the family Corvidae, a group noted for its adaptability, vocal repertoire, and ecological significance. Taxonomically, the species is placed within Class Aves, Order Passeriformes, Family Corvidae, Genus *Dendrocitta*, and Species *D. vagabunda*.



Figure-4 *Dendrocitta vagabunda* (Rufous Treepie)

The species can be identified by its distinctive plumage, characterized by a rufous-brown body, contrasting black head and neck, and a long, graduated tail with bluish-grey central rectrices edged with black. Morphologically, the Rufous Treepie is a

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medium-sized bird, measuring approximately 45 cm in length. It possesses a stout black bill adapted for omnivorous feeding, along with strong legs well-suited for perching and foraging in both arboreal and terrestrial habitats. In terms of habitat preference, *D. vagabunda* occupies a wide range of environments, including open forests, groves, gardens, and urban landscapes across plains and foothill regions. Its feeding ecology reflects opportunistic omnivory, as it consumes fruits, seeds, insects, small reptiles, bird eggs, and human food waste, demonstrating its adaptability to both natural and anthropogenic environments. The breeding season of the Rufous Treepie generally occurs from April to June. During this period, pairs construct nests in trees, where they lay clutches of 3–5 eggs. Behaviorally, the species is bold, gregarious, and vocally diverse. It is often observed in pairs or small groups and is well known for its loud calls, inquisitive nature, and ability to mimic the sounds of other bird species. The global distribution of *D. vagabunda* spans the Indian subcontinent and parts of Southeast Asia, including India, Nepal, Bangladesh, Myanmar, and Thailand. Within Pakistan, the species is widespread across a variety of habitats, particularly in Khyber Pakhtunkhwa, where it inhabits forests, gardens, and foothill ecosystems. The record of this species from Dara Adam Khel adds to the regional avifaunal diversity and highlights the ecological richness of the area. Ecologically, the Rufous Treepie contributes significantly to ecosystem functioning. Through its diet and foraging behavior, it facilitates seed dispersal and aids in the regulation of insect populations, thereby promoting ecological balance in both natural and human-modified habitats (Basheer, Muhammad. 2012; Bibi *et al.,* 2020; Khan *et al.,* 2021).

Long-billed Pipit (*Anthus similis*)

The Long-billed Pipit (*Anthus similis*) is a small passerine bird belonging to the family Motacillidae, a group characterized by ground-dwelling insectivores adapted to open habitats. Taxonomically, the species is classified under Class Aves, Order Passeriformes, Family Motacillidae, Genus *Anthus*, and Species *A. similis*.



Figure-5 *Anthus similis* (Long-billed Pipit)

This species can be identified by its slender body, brown-streaked upperparts, pale underparts, and a distinct buff-colored supercilium (eye-stripe). Its relatively long bill, in comparison to other pipits, serves as a key distinguishing feature. Morphologically, *A. similis* measures approximately 16–17 cm in length and possesses long legs and a proportionally long tail, which are adaptations for terrestrial movement and foraging.

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The Long-billed Pipit is typically associated with open, dry habitats, including rocky hillsides, grasslands, and scrubby slopes. It forages primarily on the ground, where it feeds on insects, larvae, and other small invertebrates, thereby playing an important role in insect population regulation. The breeding season occurs between March and June, during which the species constructs simple nests in ground scrapes. Clutches usually consist of 3–5 eggs. Behaviorally, *A. similis* is well adapted to its environment through cryptic plumage and skulking habits, which enable it to remain inconspicuous in its preferred habitats. It is most often observed walking or running along the ground, taking flight only when disturbed. The global distribution of the Long-billed Pipit extends from sub-Saharan Africa through the Middle East, South Asia, and into parts of Southeast Asia, with a marked preference for dry, open landscapes. In Pakistan, the species occurs widely across the northern and western regions, including Balochistan, Khyber Pakhtunkhwa, and the Himalayan foothills. Within Khyber Pakhtunkhwa, it is a common resident, particularly in rocky hills, grasslands, and scrub-covered slopes. The record of this species from Dara Adam Khel provides further evidence of its widespread presence in suitable habitats across the region. From an ecological perspective, the Long-billed Pipit contributes to maintaining ecosystem balance by controlling insect populations. Furthermore, as a prey species for raptors, it occupies an important trophic position within the food web of dryland and montane ecosystems (Finch *et al.*, 2013; Tyler, S. (2021).

Himalayan Bulbul (*Pycnonotus leucogenys*)

The Himalayan Bulbul (*Pycnonotus leucogenys*) is a characteristic songbird of the family Pycnonotidae, a group widely distributed in Asia and noted for its ecological adaptability. Taxonomically, the species belongs to Class Aves, Order Passeriformes, Family Pycnonotidae, Genus *Pycnonotus*, and Species *P. leucogenys*.



Figure-6 *Pycnonotus leucogenys* (Himalayan Bulbul)

The species is easily distinguished by its contrasting plumage: a dark head, prominent white cheek patch, and a yellow vent, which serve as key field identification features. Morphologically, it is a medium-sized bulbul, averaging 20 cm in length, with a compact body, rounded head, slender black bill, and a long tail tipped with white, which enhances its conspicuous appearance in flight. In terms of habitat preference, the Himalayan Bulbul occupies a wide range of environments, including gardens, orchards, scrublands, and forest edges, often in close proximity to human settlements (John *et al.*,

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2017). Its feeding ecology is highly flexible, encompassing fruits, berries, nectar, insects, and even flower petals, reflecting its omnivorous and opportunistic foraging behavior. Breeding activity generally spans from March to August. During this period, the species constructs cup-shaped nests in shrubs or trees, where females typically lay 2–3 eggs. Behaviorally, *P. leucogenys* is a social, vocal, and active bird, frequently observed in pairs or small groups. Its adaptability has allowed it to thrive in both natural and urbanized landscapes. The global distribution of the Himalayan Bulbul extends across South and Central Asia, including Afghanistan, Pakistan, northern India, Nepal, and parts of Tajikistan. Within Pakistan, it is widespread throughout the northern regions and along the Himalayan foothills, while also occurring in urban green spaces. In Khyber Pakhtunkhwa, it is a common resident of gardens, orchards, and forested hills, particularly in areas such as Swat, Dir, and Peshawar. The record from Dara Adam Khel further supports its status as a locally abundant and ecologically significant species. Ecologically, the Himalayan Bulbul plays a vital role as both a seed disperser and a pollinator, contributing to plant regeneration and overall biodiversity maintenance. Its presence underscores the importance of maintaining mixed landscapes that sustain avian diversity (Kumar *et al.*, 2022).

Previously Known Avifauna in the Study Area

Black Drongo (*Dicrurus macrocercus*)

The Black Drongo (*Dicrurus macrocercus*) is a well-known passerine species of the family Dicruridae, recognized for its bold behavior and significant role in agricultural ecosystems. Taxonomically, the species belongs to Class Aves, Order Passeriformes, Family Dicruridae, Genus *Dicrurus*, and Species *D. macrocercus*.



Figure-7 *Dicrurus macrocercus* (Black Drongo)

This species is easily identified by its entirely glossy black plumage, striking red eyes, and distinctive forked tail, which serve as its most recognizable field characters. Morphologically, the Black Drongo is a medium-sized bird, averaging 28 cm in length, with pointed wings, a slightly curved bill, and strong legs, all of which are adaptations for its aerial insect-hawking lifestyle. The species exhibits a preference for open habitats, including agricultural fields, farmland, urban landscapes, and forest edges, where it is frequently observed perched conspicuously on wires, posts, or trees. It is primarily insectivorous, feeding on a wide range of flying insects, which it captures in mid-air with remarkable agility. Occasionally, it also preys upon small vertebrates,

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reflecting its opportunistic feeding habits. Breeding occurs between March and August. During this period, pairs construct cup-shaped nests in trees or sometimes on man-made structures. Clutches generally contain 3–4 eggs. Behaviorally, the Black Drongo is highly territorial and aggressive, often seen chasing away larger birds of prey or corvids, a behavior that enhances its dominance within its habitat. Globally, the distribution of *D. macrocercus* spans the Indian subcontinent and extends into Southeast Asia, where it thrives across a variety of habitats. Within Pakistan, it is widespread, occurring in agricultural landscapes, grasslands, and urban areas. In Khyber Pakhtunkhwa, the species is commonly encountered in open fields and farmland, where it coexists closely with human activities. Its presence in Dara Adam Khel adds to the avifaunal diversity of the region. From an ecological perspective, the Black Drongo provides significant ecosystem services by regulating insect populations. This natural pest control benefits agricultural productivity, underscoring the species' role in supporting human-managed ecosystems as well as natural ones (Kumawat *et al.*, 2024; Leanne *et al.*, 2025).

Greenish Warbler (*Phylloscopus trochiloides*)

The Greenish Warbler (*Phylloscopus trochiloides*) is a small migratory passerine belonging to the family Phylloscopidae, which comprises insectivorous leaf warblers adapted to forested and shrubby habitats. Taxonomically, the species is placed within Class Aves, Order Passeriformes, Family Phylloscopidae, Genus *Phylloscopus*, and Species *P. trochiloides*.



Figure-8 *Phylloscopus trochiloides* (Greenish Warbler)

This species is identified by its olive-green upperparts, pale whitish underparts, and a faint supercilium (eyebrow stripe), which are characteristic but subtle features that aid in field identification. Morphologically, the Greenish Warbler is a small, slender bird, measuring approximately 11–12 cm in length. It possesses a thin, pointed bill suited for insectivory and rounded wings adapted for sustained migratory flight. The preferred habitats of *P. trochiloides* include open woodlands, forest edges, and scrub in temperate and montane regions. It is a highly active forager, often observed gleaning insects and spiders from foliage with rapid movements, frequently flicking its wings and tail while foraging. The breeding range of the Greenish Warbler lies in temperate forests across northern and central Asia, including Russia and parts of Central Asia. The species typically nests in cup-shaped structures constructed close to the ground or in low

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shrubs. During the non-breeding season, it undertakes long-distance migrations to South Asia, wintering across India, Nepal, Bangladesh, and southern Pakistan. In Pakistan, it occurs as a migrant, most commonly recorded in Khyber Pakhtunkhwa during spring and autumn, where it passes through forested and hilly areas such as Dara Adam Khel. Ecologically, *P. trochiloides* plays a role in regulating insect populations within its habitats, contributing to forest health and functioning as an indicator species of ecosystem integrity. Its presence in Dara Adam Khel underscores the area's importance as a migratory corridor and stopover site for passerine species (Collinson, Jon Martin. 2001; Kovylov *et al.*, 2012; Väli *et al.*, 2020).

Bank Myna (*Acridotheres ginginianus*)

The Bank Myna (*Acridotheres ginginianus*) is a colonial starling species belonging to the family Sturnidae, known for its adaptability to human-modified landscapes and social roosting behavior. Taxonomically, it is classified under Class Aves, Order Passeriformes, Family Sturnidae, Genus *Acridotheres,* and Species *A. ginginianus*.



Figure-9 *Acridotheres ginginianus* (Bank Myna)

This species is characterized by its greyish plumage, conspicuous orange bare skin around the eyes, and brick-red bill and legs, which distinguish it from other sympatric myna species. Morphologically, the Bank Myna is a medium-sized, robust bird with a slightly curved bill and a short tail, features that facilitate its omnivorous feeding habits. *A. ginginianus* commonly inhabits urban environments, agricultural landscapes, and riparian zones, where it is often observed roosting communally in large numbers. Its feeding ecology is omnivorous and opportunistic, encompassing grains, fruits, insects, food scraps, and small invertebrates. This dietary flexibility enhances its ability to thrive in areas of high human activity. Breeding occurs colonially, typically from spring through summer. The species nests in riverbanks, wall crevices, and other cavities, where clutches of 4–6 eggs are laid. Behaviorally, the Bank Myna is highly gregarious and vocal, frequently forming large flocks that create conspicuous communal roosts. The global distribution of the Bank Myna is restricted to the Indian subcontinent, with populations established in India, Nepal, Bangladesh, and eastern Pakistan. Within Pakistan, it is primarily confined to the Punjab region and parts of southern Khyber

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Pakhtunkhwa, where it occupies urban and agricultural habitats. The present record from Dara Adam Khel adds to its documented range and highlights the adaptability of this species in expanding its distribution. Ecologically, the Bank Myna provides important ecosystem services by helping regulate insect populations and consuming waste in both urban and rural landscapes. Its communal roosting also influences nutrient cycling in local ecosystems (Khera *et al.*, 1986; Abed *et al.*, 2019; Shakshi *et al.*, 2023).

The Red-vented Bulbul (*Pycnonotus cafer*)

The Red-vented Bulbul (*Pycnonotus cafer*) is one of the most widespread members of the family Pycnonotidae, widely recognized for its adaptability to diverse habitats, including human-dominated landscapes. Taxonomically, the species is placed within Class Aves, Order Passeriformes, Family Pycnonotidae, Genus *Pycnonotus*, and Species *P. cafer*.



Figure-10 *Pycnonotus cafer* (Red-vented Bulbul)

This species is easily identified by its black head, short crest, white underparts, and the diagnostic red patch located beneath the tail. Morphologically, it is a medium-sized, stout passerine with a slightly curved bill and a long tail, features that support its varied feeding habits and active lifestyle. The Red-vented Bulbul is highly adaptable and commonly occupies gardens, scrublands, orchards, and urban areas. Its feeding ecology is omnivorous, including fruits, nectar, insects, and small invertebrates, which allows it to exploit a wide range of natural and anthropogenic food resources. Breeding typically occurs during spring and summer, when the species constructs cup-shaped nests in shrubs or trees. Clutches usually consist of 2–4 eggs. Behaviorally, *P. cafer* is noisy, social, and conspicuous, frequently observed in pairs or small groups and recognized for its persistent vocalizations. Globally, the Red-vented Bulbul is native to the Indian subcontinent and parts of the Middle East, including India, Nepal, Sri Lanka, and Iran. In Pakistan, it is most commonly found in the southern regions, particularly Punjab and Sindh, while its presence in Khyber Pakhtunkhwa is limited. The observation of *P. cafer* in Dara Adam Khel is notable, as it suggests either local range expansion or seasonal movement into the area. Ecologically, the Red-vented Bulbul is an important seed disperser and insect predator, contributing significantly to ecosystem balance, plant regeneration, and pest regulation. Its adaptability and ecological services

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underscore its importance within both natural and modified habitats (Kumar, Anil. 2004; Thibault *et al.*, 2018; Nowakowski *et al.*, 2019).

House Crow (*Corvus splendens*)

The House Crow (*Corvus splendens*) is a widely distributed member of the family Corvidae, known for its adaptability to human settlements and its ecological role as both a scavenger and pest regulator. Taxonomically, the species belongs to Class Aves, Order Passeriformes, Family Corvidae, Genus *Corvus*, and Species *C. splendens*.



Figure-11 *Corvus splendens* (House Crow)

The species can be readily distinguished by its glossy black plumage, contrasted by a grey neck and breast, sharp black beak, and dark eyes. Morphologically, it is a medium-sized crow with a strong, stout bill and a slightly rounded tail, well-suited for both scavenging and opportunistic predation. *Corvus splendens* primarily inhabits urban areas, coastal regions, and rural settlements, where it is strongly associated with human activity. Its feeding ecology is omnivorous and opportunistic, encompassing insects, small animals, fruits, food scraps, and garbage. This dietary flexibility underpins its success in expanding far beyond its native range. Breeding generally occurs in spring and summer. The species typically nests in tall trees or on buildings, where it lays clutches of 3–5 eggs. Socially, the House Crow is highly intelligent, vocal, and adaptable. It is frequently seen in groups, displaying complex problem-solving abilities and strong social interactions. Globally, *C. splendens* is native to South Asia, but due to human-mediated dispersal, it has expanded its distribution to East Africa, the Middle East, parts of Europe, and beyond. In Pakistan, it is abundant throughout the country, including Khyber Pakhtunkhwa, where it thrives in both urban and rural environments. The record from Dara Adam Khel aligns with its known association with human settlements. Ecologically, the House Crow provides both benefits and challenges. It contributes to waste cleanup and pest control but also competes with native bird species, scavenges nests, and can become a nuisance in densely populated areas. Its ecological duality highlights the need for balanced management in regions where it coexists with

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native avifauna (Fraser *et al.,* 2015; Anjum *et al*., 2021; Johan *et al.,* 2022).

Eurasian Collared Dove (*Streptopelia decaocto*)

The Eurasian Collared Dove (*Streptopelia decaocto*) is a medium-sized columbid species belonging to the family Columbidae, notable for its rapid expansion across much of the globe. Taxonomically, it is placed within Class Aves, Order Columbiformes, Family Columbidae, Genus *Streptopelia*, and Species *S. decaocto*.



Figure-12 *Streptopelia decaocto* (Eurasian Collared Dove)

This species is readily identified by its pale gray-buff plumage, long tail with white-tipped feathers, and a characteristic narrow black half-collar on the nape. Morphologically, it has a slim body, small head, pink legs, and a relatively slender bill, features that contribute to its graceful appearance and adaptability to various environments. The Eurasian Collared Dove is highly adaptable and thrives in a wide range of habitats, including urban, suburban, and agricultural landscapes. It is often associated with human settlements, where it roosts in trees, buildings, or open spaces. The species is diurnal and easily adjusts to both rural and city environments, making it one of the most successful dove species in modified landscapes. Its feeding ecology is primarily granivorous, consisting of seeds and grains, which it usually forages on the ground in open fields, farmyards, or near human habitations. Breeding occurs throughout much of the year, with a peak during spring and summer. The species constructs flimsy nests in trees, shrubs, or man-made structures, laying two white eggs per clutch. Behaviorally, *S. decaocto* is social and often seen in pairs or small groups. It is known for its soft, repetitive cooing call, and males frequently engage in bowing displays during courtship. Globally, the Eurasian Collared Dove is native to Asia and Europe but has undergone significant range expansion, colonizing North America, Africa, and parts of the Middle East. Within Pakistan, it is abundant and widespread, including across Khyber Pakhtunkhwa, where it occurs in both urban and rural settings. Its presence in Dara Adam Khel reflects the species' ability to establish in diverse human-dominated habitats. Ecologically, *S. decaocto* contributes to seed dispersal and serves as prey for raptors and other predators. However, its adaptability and prolific breeding may also result in competition with native dove and pigeon species, making it an ecologically influential yet sometimes problematic bird in areas where it thrives (ROMAGOSA *et al.,* 2002; Bled *et al.,* 2011; Zoltán *et al.,* 2017).

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Cattle Egret (*Bubulcus ibis)*

The Cattle Egret (*Bubulcus ibis*) is a small, cosmopolitan heron belonging to the family Ardeidae, widely recognized for its association with grazing livestock and agricultural landscapes. Taxonomically, it is classified under Class Aves, Order Pelecaniformes, Family Ardeidae, Genus *Bubulcus*, and Species *B. ibis*.



Figure-13 *Bubulcus ibis* (Cattle Egret)

This species is distinguished by its white plumage, thick yellow bill, and the presence of orange-buff plumes on the head, chest, and back during the breeding season. Morphologically, it has a compact body, relatively short legs, and a short neck compared to other herons, adaptations that facilitate its terrestrial foraging behavior. The Cattle Egret is strongly associated with grasslands, farmlands, and wetlands, where it often follows livestock or agricultural machinery to capture insects and small vertebrates disturbed by their movement. Its feeding ecology is opportunistic, with a diet dominated by insects but extending to amphibians, reptiles, and other small prey. Breeding occurs colonially, typically in trees or shrubs near wetlands. Nests are constructed from twigs, and clutches usually consist of 3–5 pale blue eggs. Social by nature, the species often forages in flocks and becomes highly vocal during the breeding season. Globally, *B. ibis* is native to Asia, Africa, and Europe but has successfully expanded its range worldwide, becoming one of the most widespread herons due to its adaptability. In Pakistan, the species is abundant and widely distributed, including across Khyber Pakhtunkhwa, where it is frequently observed near wetlands, agricultural fields, and grazing areas. Its occurrence in Dara Adam Khel aligns with its ecological preference for human-modified habitats and open landscapes. Ecologically, the Cattle Egret provides valuable ecosystem services by controlling insect populations around livestock, thereby reducing pest pressure. It also plays an integral role in wetland food webs, contributing to ecological stability in both natural and anthropogenic habitats (Ducommun *et al.*, 2009; Massa *et al.*, 2014; Kioko *et al.*, 2016).

Discussion

The present study provides foundational insight into the avian diversity of the Dara Adam Khel region, a relatively underexplored area in District Kohat, Khyber

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Pakhtunkhwa, Pakistan. To the best of current academic knowledge, no prior systematic ornithological surveys have been conducted in this particular region, making this research a significant contribution to regional biodiversity data. Comparative references from prior studies in other districts, such as Bajaur Valley and Kohat's Kotal Wildlife Park, have been instrumental in contextualizing these findings and identifying broader ecological trends in Khyber Pakhtunkhwa. Pakistan is home to a rich avifauna, with approximately 660–670 bird species classified under 74 families and 272 genera (Saleem *et al.*, 2008). These species exhibit considerable ecological diversity, occupying a range of habitats from mountainous terrains and river valleys to forest ecosystems and human-modified environments. The Bajaur Valley, lying at an elevation of 1117 to 2400 meters and studied through standardized point count and line transect methods (Bibby *et al.*, 1992; Buckland *et al.*, 2001), has revealed notable avian richness. Similarly, in Kotal Wildlife Park of Kohat, a high diversity of both native and artificially introduced bird species, including *Alectoris chukar*, *Pavo cristatus*, and *Upupa epops*, reflects the area's ecological heterogeneity and conservation potential.

In contrast to these well-documented regions, the avian diversity documented in the Dara Adam Khel region during the present study, conducted from November 2024 to February 2025, was markedly limited. Only eleven bird species were recorded, including *Gracula lanceolatus*, *Dicrurus vagabunda*, *Dicrurus macrocercus*, *Phylloscopus trochiloides*, *Acridotheres ginginianus*, *Acridotheres similis*, *Passer domesticus*, *Corvus splendens*, *Streptopelia decaocto*, *Psittacula leucogenys*, and *B. ibis*. The avian assemblage was dominated by the order Passeriformes, consistent with global patterns wherein this order constitutes the majority of bird species. However, the relatively low species richness in this study may indicate anthropogenic and environmental pressures adversely affecting avifaunal diversity in the region.

A key finding of this study is the evident decline in avian diversity in Dara Adam Khel, which appears to be driven by multiple ecological stressors. Habitat loss, largely due to deforestation, agricultural encroachment, urban sprawl, and infrastructural development, emerges as the most critical threat. The destruction and fragmentation of shrubland, grassland, and forest habitats have significantly reduced suitable nesting and foraging sites, especially for ground-nesting and canopy-dependent bird species.

Another substantial pressure is overgrazing by domestic livestock, which not only depletes native vegetation but also disrupts the soil and undergrowth structure. This alters the microhabitats that are essential for many bird species, particularly during breeding seasons. The cumulative effect is a reduction in both food availability and protective cover, leading to population decline or local extinction of sensitive species. Climatic variability, exacerbated by global climate change, further compounds these challenges. Fluctuating temperature and precipitation regimes have disrupted the migration patterns and reproductive timing of several species. Birds that traditionally migrate to the region during specific seasons now either fail to arrive or arrive asynchronously with local ecological cues, such as peak food availability. This temporal mismatch can lead to breeding failures and reduced juvenile survival.

Additionally, anthropogenic disturbances—including noise pollution from vehicles, construction, and routine human activity—exert a particularly detrimental effect on bird behavior. Disturbance during critical periods such as nesting and roosting often results

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in nest abandonment or relocation to suboptimal habitats, leading to population fragmentation and a further decrease in reproductive success. These patterns underscore the urgent need for focused conservation interventions in Dara Adam Khel. The limited species recorded and the environmental stressors observed point to the degradation of what may once have been a more biologically rich region. While it is possible that some seasonal variation may account for the limited bird counts—given that surveys were conducted during winter months—the observed trends are nonetheless indicative of a larger ecological decline. This study thus serves as a call to action for broader biodiversity surveys, habitat restoration efforts, and the implementation of regionally tailored conservation strategies.

The present research not only fills a critical gap in the documentation of avian biodiversity in an underreported area of Khyber Pakhtunkhwa but also provides evidence of significant threats that could lead to long-term losses in regional avifauna if left unaddressed. Future studies should adopt longitudinal sampling across seasons, combined with habitat quality assessments, to develop a comprehensive understanding of species dynamics and guide evidence-based conservation planning.

Conclusion

The avifaunal survey conducted in Dara Adam Khel represents a critical step toward understanding and documenting bird diversity in a largely understudied region of Khyber Pakhtunkhwa, Pakistan. Through systematic observations over four winter months, the study recorded eleven bird species, including four that had not previously been documented in the area. These new records underscore the ecological significance and previously under recognized biodiversity of the region. The study highlights the complex interplay between natural and anthropogenic habitats, revealing that even in human-modified landscapes, particular bird species have shown notable adaptability and ecological function. However, the limited overall species richness in comparison to adjacent areas suggests a disturbing trend of ecological decline. Habitat degradation from urban expansion, agricultural encroachment, overgrazing, and infrastructure development has resulted in the fragmentation of natural habitats, loss of foraging and nesting grounds, and disruption of migratory patterns. Additionally, climate variability and human disturbances such as noise and pollution have further exacerbated the pressures on bird populations. Despite these challenges, the observed presence of both resident and migratory species reflects the area's potential to serve as a critical habitat corridor within the broader avian migration network. This research not only fills a vital data gap but also provides a foundational reference for future ecological assessments and conservation efforts aimed at protecting the unique avifauna of this transitional Himalayan landscape.

Recommendations

Based on the findings of this study, immediate and targeted conservation actions are essential to preserve and enhance the avian biodiversity of Dara Adam Khel.

Long-term ecological monitoring should be institutionalized, with surveys conducted across multiple seasons to capture the full spectrum of resident, migratory, and transient species.

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This will help track population trends and seasonal variations, providing valuable insights into the effects of climate change and land-use alterations. Concurrently, habitat restoration initiatives should be prioritized, particularly in forested and scrubland areas that serve as vital nesting and foraging grounds.

Reforestation with native plant species, protection of riparian zones, and the establishment of ecological buffers around critical habitats can help mitigate the impact of anthropogenic encroachment.

Grazing management strategies must also be implemented to prevent overgrazing and restore vegetation cover essential for ground-nesting birds.

Public awareness campaigns and community-based conservation programs can foster local stewardship, particularly by involving residents in bird monitoring and ecotourism initiatives.

Noise pollution and habitat fragmentation caused by unchecked development should be addressed through stricter enforcement of environmental regulations and urban planning guidelines that integrate biodiversity considerations.

Furthermore, collaboration with regional wildlife authorities and ornithologists is essential for maintaining accurate avifaunal databases and guiding evidence-based policy.

Special attention should be given to migratory species, whose presence indicates the region's role in broader ecological networks, and whose protection requires Tran's boundary conservation coordination.

Overall, this study calls for a multi-pronged strategy integrating research, community engagement, habitat management, and policy support to ensure the long-term conservation of avian diversity in Dara Adam Khel.

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