



DOI: <https://doi.org/10.71317/kjard.2.10.2026.828>

Kashmir Journal of Academic Research and Development

Journal homepage: <https://rjsaonline.org/index.php/KJARD>



An Estimation of Migratory Birds' Population Density in Punjab, Pakistan, with Special Focus on Khushab and Mandi Bahauddin Districts

Ahmed Waqas

Department of Biological Sciences, The Superior University, Lahore (Sargodha Campus), Pakistan

Mumtaz Akhtar

Department of Biological Sciences, The Superior University, Lahore (Sargodha Campus), Pakistan; AG Niazi University Sargodha, Pakistan

Email: profdrmmumtaziqbal61@gmail.com

Jawad Ali Akhtar

Faculty of Agriculture and Environment, The Islamia University of Bahawalpur, Pakistan

Faiza Zubair

Department of Zoology, University of Sargodha, Pakistan

Arooj Fatima

Department of Biological Sciences, The Superior University, Lahore (Sargodha Campus), Pakistan

Aliza Sikandar

Department of Biological Sciences, The Superior University, Lahore (Sargodha Campus), Pakistan

Rukaya Rani

Department of Biological Sciences, The Superior University, Lahore (Sargodha Campus), Pakistan

Muhammad Iqbal Chaudhary

AG Niazi University Sargodha, Pakistan

ARTICLE INFO

ABSTRACT

Received:

August 30, 2026

Revised:

September 22, 2026

Accepted:

October 02, 2026

Available Online:

October 13, 2026

Keywords:

Migratory birds; population density; wetlands; Indus Flyway; Khushab; Mandi Bahauddin; Punjab; Pakistan.

Corresponding Author:

Mumtaz Akhtar

Email:

profdrmmumtaziqbal61@gmail.com

Migratory water birds are widely used as bio-indicators of wetland and floodplain ecosystem health, since their presence, abundance and distribution respond directly to habitat quality, water availability and disturbance pressure. Although Pakistan forms part of the Indus Flyway, one of Asia's major wintering corridors, quantitative, district-level density data remain scarce, especially for Punjab. This study quantified the population density and spatial distribution of migratory birds across nine habitat sites in Khushab and Mandi Bahauddin districts – namely Khabeki, Uchali and Jhalar lakes, Head Qadirabad, Head Rasul and Khanki Headworks, riverine floodplains, canals and ponds, and rice fields – over six survey rounds conducted between October 2025 and March 2026 using fixed-point counts, line transects and distance-based sampling across 354 ha. Across the survey period, 8,300 individuals belonging to 20 species were recorded, dominated by Common Teal, Eurasian Coot, Northern Pintail, Northern Shoveler and Mallard. Mean density across all sites was 3.91 birds/ha, peaking at 5.60 birds/ha in January before declining toward late season. Lakes and wetlands supported the highest densities, followed by headworks and barrages, while riverine floodplains and rice fields recorded comparatively lower values. Khushab's lake systems produced higher density than Mandi Bahauddin, even though the latter's more varied habitat mosaic yielded a larger cumulative count. Sites subject to greater grazing, fishing, pollution or pesticide exposure generally supported lower or more dispersed bird numbers. The results establish a district-level baseline for migratory bird density in an under-surveyed part of Punjab and point to the need for targeted wetland protection and disturbance-reduction measures.

Introduction

Every year, vast numbers of birds undertake seasonal movements between breeding and non-breeding grounds, tracking shifts in climate, food supply and habitat condition. Beyond their ecological significance, migratory birds perform functions such as pest regulation, seed dispersal and nutrient transfer across the landscapes they visit, and because their numbers track environmental conditions closely, they are routinely used to gauge ecosystem health [1].

South Asia's Indus Flyway, connecting breeding grounds in Central Asia and Siberia to wintering areas across Pakistan, brings large numbers of waterfowl, waders, cranes and passerines into the country's wetlands, rivers, reservoirs and farmland each winter [2, 17]. In Punjab province, the districts of Khushab and Mandi Bahauddin offer a range of such wintering habitat: the former centered on Khabeki, Uchali and Jhalar lakes, and the latter on the Head Qadirabad, Head Rasul and Khanki Headworks together with adjacent canals, ponds, floodplains and rice fields [1, 3, 18].

Despite this ecological importance, published work from Pakistan has largely been descriptive – recording which species occur and when – rather than quantifying how intensively birds actually use different habitat types [5, 6]. Density estimates fill this gap: they indicate habitat-use intensity, allow population trends to be tracked over time, and help direct conservation effort where it is most needed [5, 6]. For Khushab and Mandi Bahauddin specifically, structured density data of this kind have not previously been available [7, 19]. This study therefore set out to measure the population density and spatial distribution of migratory birds across the wetland, riverine and agricultural habitats of these two districts, and to assess how habitat type, season and human disturbance shape the patterns observed.

Materials and Methods

Study design and area

A field-based ecological survey combining descriptive and analytical components was used. The study covered nine habitat sites across the two districts: three lake/wetland sites in Khushab (Khabeki Lake, Uchali Lake, Jhalar Lake) and six habitat categories in Mandi Bahauddin (Head Qadirabad, Head Rasul, Khanki Headworks, riverine floodplains, canals and ponds, and rice fields), covering a total surveyed area of 354 ha.

Sampling and data collection

Bird counts were conducted using fixed-point counts at lake, headwork and canal/pond sites, and line transects across floodplain and rice-field habitats, with distance-based density estimation applied where appropriate [6]. Species were identified in the field using standard regional field guides [8]. For each observation, species identity, number of individuals, habitat type, location, behaviour, observation distance and visible disturbance indicators were recorded.

Survey schedule

Six survey rounds were carried out between October 2025 and March 2026 to capture early arrival, peak wintering and late-season/departure phases: 26 October 2025, 23 November 2025, 21 December 2025, 18 January 2026, 18 February 2026 and 10 March 2026.

Data analysis

Population density (birds/ha) was calculated by dividing the mean number of birds recorded per survey by the surveyed area, for each site, habitat type and district. Disturbance was scored on a 1 (very low) to 5 (very high) scale based on observed indicators such as grazing, fishing, agricultural activity, pollution and human movement, and compared against site-level density.

Results

Species composition

Twenty migratory and wetland-associated bird species belonging to eight families (Anatidae, Rallidae, Ardeidae, Recurvirostridae, Scolopacidae, Charadriidae, Laridae and Motacillidae) were recorded, totalling 8,300 detections. Common Teal, Eurasian Coot, Northern Pintail, Northern Shoveler and Mallard were the five most abundant species, together accounting for over half of all detections (Table 1).

Table 1. Dominant species recorded and their relative abundance

Common Name	Scientific Name	Family	Total Individuals	Relative Abundance (%)
Common Teal	Anas crecca	Anatidae	1,380	16.6
Eurasian Coot	Fulica atra	Rallidae	980	11.8
Northern Pintail	Anas acuta	Anatidae	870	10.5
Northern Shoveler	Spatula clypeata	Anatidae	760	9.2
Mallard	Anas platyrhynchos	Anatidae	520	6.3
Other 15 species	—	—	3,790	45.6
Total	—	—	8,300	100.0

Population density

The overall mean density across all sites was 3.91 birds/ha, rising to a peak of 5.60 birds/ha during the 18 January 2026 survey. Density was highest at Khabeki Lake (6.89 birds/ha at peak) and lowest in riverine floodplains and rice fields (Table 2).

Table 2. Habitat-wise abundance and mean density

Habitat Type	Surveyed (ha)	Area	Total Count	Mean Density (birds/ha)	Dominant Groups
Lakes and wetlands	137		3,706	4.51	Ducks, coots, gulls
Headworks/barrages	103		2,744	4.44	Ducks, herons, gulls
Riverine floodplains	50		723	2.41	Waders, sandpipers
Canals and ponds	24		503	3.49	Egrets, moorhens, ducks
Agricultural/rice fields	40		624	2.60	Waders, wagtails
Total	354		8,300	3.91	—

District-wise comparison

Khushab recorded a higher mean density (4.51 birds/ha) than Mandi Bahauddin (3.53 birds/ha), despite Mandi Bahauddin having a larger cumulative count (4,594 vs. 3,706 individuals) owing to its greater habitat diversity and surveyed area (Table 3).

Table 3. District-wise comparison of key parameters

Parameter	Khushab	Mandi Bahauddin
Surveyed area (ha)	137	217
Total cumulative count	3,706	4,594
Mean density (birds/ha)	4.51	3.53
Peak density in January (birds/ha)	6.42	5.09
Dominant habitat type	Lakes and wetlands	Headworks, canals, floodplains, rice fields

Seasonal variation

Bird abundance rose from October (788 individuals; 2.23 birds/ha) to a peak in January (1,984 individuals; 5.60 birds/ha), then declined through February and March (938 individuals; 2.65 birds/ha), consistent with a typical arrival-peak-departure wintering cycle.

Human disturbance

Sites with lower disturbance scores (e.g., Uchali Lake, score 1.8) generally supported higher and more stable densities than heavily disturbed sites such as rice fields (score 3.9) and riverine floodplains (score 3.7). This relationship was not strictly linear: Khanki Headworks maintained relatively high density (4.52 birds/ha) despite moderate disturbance, a pattern consistent with reports that even human-modified structures such as headworks and canals can provide functionally important waterbird habitat when permanent water is available (13).

Discussion

The results confirm that Khushab and Mandi Bahauddin districts provide ecologically significant wintering, feeding and resting habitat for migratory waterbirds along the Indus Flyway [20]. The dominance of Common Teal, Eurasian Coot, Northern Pintail, Northern Shoveler and Mallard mirrors patterns reported from other Punjab wetlands, where ducks, coots, herons, egrets and waders are the principal users of lakes, headworks and riverine wetlands [2, 14, 15].

The clear seasonal pattern, with density peaking in January and declining toward March, reflects the typical arrival-peak-departure cycle of wintering waterbirds and underscores the value of repeated, multi-round surveys over single-visit assessments for generating reliable population estimates [16, 21, 22, 23]. Habitat-wise, lakes and wetlands supported the highest densities, followed closely by headworks and barrages, reinforcing the established importance of permanent and semi-permanent water bodies for waterbird habitat quality relative to more open floodplain and agricultural habitats [12, 24, 25].

The contrast between the two districts is informative: Khushab's concentrated lake systems produced higher density, while Mandi Bahauddin's more varied habitat mosaic supported a larger total number of birds spread across a wider area. This distinction between density and total abundance is ecologically meaningful, as density reflects the intensity of habitat use whereas abundance is influenced by the extent of habitat available [9, 26, 27]. The two districts may therefore be considered complementary within the regional flyway network rather than directly comparable.

Human disturbance, including grazing, fishing, pollution, pesticide use and general human movement, was associated with lower or more dispersed densities at several sites, consistent with the broader pattern of wetland degradation reported across Pakistan and with findings elsewhere that disturbance can alter waterbird distribution [4, 10, 11, 28, 29]. However, the relationship was not absolute: some moderately disturbed sites with reliable water and feeding resources continued to support relatively high densities, suggesting that habitat suitability can partially offset disturbance pressure in the short term, though sustained pressure is likely to reduce habitat quality over time.

Conclusion and Recommendations

This study provides baseline, district-level density data for migratory birds in two previously under-studied areas of Punjab. Twenty species and 8,300 cumulative detections were recorded across 354 ha of lake, wetland, headwork, canal, pond, floodplain and agricultural habitat, with an overall mean density of 3.91 birds/ha and a January peak of 5.60 birds/ha. Lakes and wetlands, and to a lesser extent headworks and barrages, emerged as the most heavily used habitats, while human disturbance was linked to reduced or more dispersed bird use at several sites.

Based on these findings, regular seasonal monitoring (particularly during December-January), protection of key wetland sites from degradation, reduction of human disturbance through buffer zones, control of pollution and pesticide runoff, and stricter regulation of hunting and trapping are recommended to sustain migratory bird populations in Khushab and Mandi Bahauddin. These measures would support both wildlife conservation and the broader ecological health of Punjab's wetland systems.

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