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DIVERSITY AND ABUNDANCE OF AVIAN FUNA AT MAIN CAMPUS UNIVERSITY OF AGRICULTURE, FAISALABAD: A SYSTEMATIC FIELD SURVEYS

Original Article

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ABSTRACT

Background: Birds constitute a fundamental component of vertebrate diversity and provide indispensable ecological services including insectivory, pollination, seed dispersal, and nutrient cycling, thereby functioning as mobile linkages facilitating energy transfer within and between ecosystems. Despite their ecological significance, avian populations face escalating threats from habitat modification, agricultural intensification, pesticide exposure, and anthropogenic disturbances, with numerous species experiencing pronounced declines globally.

Objective: The present investigation aimed to assess avian diversity patterns and quantify anthropogenic impacts on bird communities across heterogeneous habitats within the University of Agriculture Faisalabad campus, while examining the influence of landscape composition on species abundance, distribution, and community structure.

Methods: Systematic field surveys were conducted twice weekly from January through May 2023 across three distinct habitat categories: urban areas (comprising academic departments, hostels, and residential colonies), agricultural zones (including crop fields and botanical gardens), and pond habitats (twelve freshwater fish ponds). Data collection employed complementary line transect and point count methods, with all avian observations recorded using standardized field protocols. Species identification was performed using regional field guides, and community structure was quantified through Shannon-Wiener diversity indices, evenness calculations, and dominance indices. Analysis of variance was applied to examine significant variations in bird populations across temporal and spatial gradients.

Results: A total of 2,601 individual birds representing 48 species across 12 orders were documented throughout the study period. Agricultural habitats supported the highest abundance with 1,013 individuals (38.95% of total observations), followed by pond areas with 889 individuals (34.18%), and urban environments with 699 individuals (26.87%). The Shannon-Wiener diversity index varied markedly across habitats, with pond areas exhibiting the greatest diversity (H'=3.784), followed closely by agricultural zones (H'=3.761), and urban areas demonstrating comparatively reduced diversity (H'=3.636). Evenness values followed a parallel pattern, with pond habitats showing the most equitable species distribution (J=0.977), agricultural areas exhibiting intermediate evenness (J=0.972), and urban environments displaying the lowest evenness (J=0.939). Dominance indices confirmed these patterns, with urban areas showing the highest concentration of abundance within few species (D=0.0354), while agricultural (D=0.0247) and pond habitats (D=0.0220) demonstrated more balanced community structures. Analysis of variance revealed statistically significant habitat-based differences in bird populations during January (p=0.005), February (p=0.007), March (p=0.008), and May (p=0.002), while April showed non-significant variation (p=0.088).

Conclusion: The findings demonstrate that agricultural and aquatic habitats within peri-urban institutional landscapes support substantially greater avian diversity and more equitable community structures compared to developed areas, underscoring the critical importance of habitat heterogeneity for biodiversity conservation. Urban environments exhibited reduced diversity and increased dominance by synanthropic species, reflecting the ecological filtering effects of anthropogenic modification. This research provides baseline data for monitoring environmental changes, assessing habitat loss impacts, and evaluating the consequences of contemporary agricultural practices on avian communities in human-dominated landscapes.

Keywords: Abundance; Agriculture; Biodiversity; Birds; Ecosystem; Population Dynamics; Urbanization.

INTRODUCTION

Birds represent one of the most diverse and widely distributed groups of vertebrate organisms, occupying nearly all ecological niches across the globe while providing multifaceted benefits to both natural and human-dominated ecosystems (1). The ecological significance of avian species stems predominantly from their foraging behaviors, which facilitate critical ecosystem processes including energy transfer, nutrient cycling, and trophic regulation across spatial scales (2). Through their daily activities, birds establish mobile linkages that connect disparate habitats, thereby enhancing ecosystem resilience and functional integrity. These avian-mediated services manifest in various forms, ranging from direct contributions such as insect population regulation and pollination to indirect benefits including seed dispersal and the maintenance of plant community structure (3). Particularly within tropical and island ecosystems, frugivorous birds serve as essential vectors for woody plant reproduction, facilitating the dispersal of large-seeded species that hold direct value for human populations through timber production, medicinal applications, and food security (4). In contemporary anthropogenic landscapes, birds continue to perform these vital functions despite increasing environmental pressures, often acting as keystone agents in habitat restoration initiatives and the preservation of botanical diversity (5,6).

The regulatory ecosystem services provided by birds derive fundamentally from their trophic interactions, with insectivory representing a paramount example of natural pest suppression mechanisms (7). Substantial evidence demonstrates that avian predation exerts significant top-down control on arthropod communities, effectively moderating herbivore populations and mitigating outbreak events that could otherwise compromise ecosystem stability (8). During breeding seasons particularly, granivorous species shift their dietary preferences toward invertebrate consumption, amplifying their regulatory impact across agricultural and natural landscapes (9). Empirical investigations consistently reveal that the presence of insectivorous birds correlates with enhanced plant growth parameters and increased agricultural productivity, suggesting their potential integration into integrated pest management strategies as biological control agents (10). Concurrently, scavenging avian species fulfill indispensable roles as detritivores, facilitating carcass decomposition while simultaneously regulating pathogen transmission and nutrient mobilization within terrestrial ecosystems (11). Colonial seabirds exemplify this nutrient translocation capacity through their concentrated guano deposits, which transfer marine-derived nutrients into coastal and insular environments, fundamentally altering soil chemistry and shaping plant community composition over ecological timescales (12,13). Conversely, the removal of such avian assemblages through anthropogenic disturbance or invasive predator introduction can precipitate cascading effects that destabilize entire plant communities (14).

Given their pronounced sensitivity to environmental perturbations and rapid behavioral responses to landscape modification, birds serve as reliable bioindicators for monitoring anthropogenic impacts on ecosystem structure and function (15). Their population dynamics reflect underlying environmental changes, making them valuable subjects for investigating the ecological consequences of industrialization, agricultural intensification, and land-use transformation. Alarming trends have emerged across multiple geographic regions documenting substantial population declines among numerous avian species, with insectivorous guilds exhibiting particularly pronounced reductions (16,17). Dietary specialization may mediate species vulnerability to environmental change through two primary mechanisms: directly, through diminished prey availability constraining energetic requirements, as corroborated by food supplementation experiments demonstrating resource limitation effects on demographic rates (18,19); and indirectly, through trophic linkages that expose insectivorous species to rapid environmental fluctuations affecting arthropod communities with their shorter generation times and heightened sensitivity to perturbations (20). Agricultural intensification represents a primary driver of these declines, with escalating pesticide applications directly impairing avian reproduction and survival while indirectly reducing food availability through herbicide-mediated suppression of weed communities that support insect prey populations (21,22). The progressive expansion of chemical inputs, coupled with increasingly sophisticated herbicidal formulations targeting diverse weed species, has precipitated long-term depletion of soil seed banks and concomitant reductions in insect biomass available to foraging birds (23). Consequently, both granivorous and insectivorous species have experienced population-level consequences through the combined effects of direct toxic exposure and indirect resource limitation.

The present investigation aims to comprehensively evaluate the population trends of avian species in relation to their dietary guilds while examining the mechanisms through which anthropogenic environmental modifications, particularly agricultural practices, influence these patterns. By synthesizing existing knowledge regarding avian ecological services and the pathways through which human activities disrupt these functions, this research seeks to elucidate the conservation implications of ongoing population declines and inform evidence-based management strategies for maintaining avian biodiversity and ecosystem functionality in human-modified landscapes.

METHODS

The investigation was conducted within the premises of the University of Agriculture Faisalabad, situated in central Punjab, Pakistan at coordinates 31°26'5" north and 73°4'7" east. The institutional campus encompasses approximately 2,550 acres (10.3 square kilometers) at an elevation of 190 meters above sea level, comprising a heterogeneous landscape that includes academic departments, residential colonies for faculty and staff, student hostels, agricultural research fields, botanical gardens, and twelve freshwater fish ponds. This diverse mosaic of habitat types provided an appropriate setting for examining avian population dynamics across contrasting environmental gradients ranging from urbanized structures to cultivated and semi-natural areas.

Field surveys were conducted systematically from January 2022 through May 2023, encompassing both winter and spring seasons to capture seasonal variations in avian community composition. Data collection was performed twice weekly, with surveys suspended during periods of severe climatic conditions such as heavy rainfall, dense fog, or extreme temperatures that could compromise detection probabilities and observer safety. Following standardized ornithological survey protocols, observation points were strategically established across three major habitat categories within the campus: urban areas (comprising academic departments, hostels, and residential colonies), cultivated areas (including agricultural fields and flower cultivations), and aquatic habitats (the twelve fish ponds). Sampling locations were selected based on preliminary reconnaissance to identify positions offering optimal visibility and maximum likelihood of bird encounters while ensuring representative coverage of each habitat type (1).

Two complementary field techniques were employed to comprehensively assess avian diversity and abundance patterns. The line transect method was implemented by establishing four randomly positioned 500-meter transects within the study area, with each transect traversed at a consistent pace of approximately one kilometer per hour to maintain detection consistency (2). During these surveys, all birds observed or heard within an estimated 50-meter detection radius were recorded using 10×50 magnification binoculars for visual confirmation. Transects were spaced sufficiently apart to minimize the probability of double-counting individual birds, and each transect walk was completed within 45 to 60 minutes during peak activity periods following sunrise. Concurrently, the point count method was employed at fixed stations distributed across the three habitat types, with each point count lasting ten minutes during which all avian species detected visually or acoustically were documented (3). Point count stations were positioned at least 250 meters apart to ensure independence of observations, and counts were conducted during the first four hours after dawn when avian activity levels are typically maximal.

Species identification was accomplished through direct observation supplemented by reference to established field identification guides for the region, with particular reliance on the comprehensive work of Grimmett and colleagues for accurate taxonomic classification (4). For each sampling event, detailed records were maintained including species identity, number of individuals, detection method (visual or auditory), habitat type, and prevailing environmental conditions. The cumulative survey effort encompassed approximately 20 to 25 kilometers of transect walks per sampling week, with systematic rotation of observation points across different times of day and days of the week to minimize temporal sampling bias. All field data were recorded on standardized data sheets and subsequently entered into electronic databases for analysis.

Statistical treatment of the collected data involved multiple analytical approaches to characterize avian community structure and temporal dynamics. Species diversity was quantified using the Shannon-Wiener diversity index (H'), which incorporates both species richness and relative abundance according to the formula $H' = -\Sigma p_i \ln p_i$, where p_i represents the proportion of individuals belonging to the ith species relative to the total number of individuals in the sample. Variance estimation for diversity indices followed standard computational procedures. Analysis of variance (ANOVA) was performed to examine significant variations in avian populations across temporal (monthly) and spatial (habitat type) gradients, with post-hoc comparisons conducted where appropriate to identify specific sources of variation. Species evenness was additionally calculated to assess the equitability of abundance distribution among species within each habitat type and sampling period. All statistical analyses were conducted using appropriate software packages with significance thresholds established at $\alpha = 0.05$. The complete dataset permitted comparative evaluation of avian diversity patterns between urban, cultivated, and aquatic habitats throughout the study duration, enabling assessment of how landscape composition influences bird community structure in this peri-urban agricultural setting.

RESULTS

The present investigation documented the avian community structure at the University of Agriculture Faisalabad through systematic surveys conducted from January to May 2023, during which a total of 2,601 individual birds were observed across three distinct habitat types. These observations encompassed 52 avian species distributed among 12 orders and 25 families, reflecting substantial taxonomic diversity within this peri-urban agricultural landscape. The most numerically dominant species throughout the study period was the house crow (Corvus splendens), contributing 133 individuals (5.11% of the total observed population), followed closely by the black kite (Milvus migrans) with 129 individuals (4.96%), and the hill pigeon (Columba rupestris) with 126 individuals (4.84%). The common myna (Acridotheres tristis) and house sparrow (Passer domesticus) also demonstrated pronounced abundance, contributing 112 and 113 individuals respectively. Several species exhibited intermediate population sizes, including the house swift (Apus apus) with 82 individuals, the Eurasian collared dove (Streptopelia decaocto) with 86 individuals, and the red-collared dove (Streptopelia tranquebarica) with 81 individuals. Conversely, species such as the shikra (Accipiter badius), shrike (Lanius cristatus), and Indian grey hornbill (Ocyceros birostris) were recorded in comparatively lower numbers, with populations of 25, 15, and 15 individuals respectively, indicating either natural rarity or specific habitat preferences limiting their detection frequency.

Spatial distribution analysis revealed marked heterogeneity in avian abundance across the three habitat categories examined. Agricultural areas supported the highest overall bird abundance with 1,013 individuals (38.95% of the total observed population), followed by pond habitats with 889 individuals (34.18%), and urban areas with 699 individuals (26.87%). Within agricultural zones, the black kite (49 individuals), common myna (43 individuals), house crow (42 individuals), and house sparrow (40 individuals) represented the most frequently encountered species, reflecting their adaptation to cultivated landscapes with open foraging opportunities. Pond habitats demonstrated distinctive community composition characterized by elevated abundances of wetland-associated species, including the black-crowned night heron (Nycticorax nycticorax), little egret (Egretta garzetta), and Indian pond heron (Ardeola grayii), alongside ubiquitous generalist species such as the house crow (40 individuals) and black kite (38 individuals). Urban areas exhibited dominance by synanthropic species including the house crow (51 individuals), hill pigeon (51 individuals), and house sparrow (40 individuals), demonstrating successful adaptation to anthropogenically modified environments. Less common but ecologically significant species such as the purple sunbird (Cinnyris asiaticus) maintained moderate populations across all habitat types, with 26 individuals in agricultural areas, 21 in pond habitats, and 20 in urban settings.

Species diversity analysis employing the Shannon-Wiener diversity index revealed consistently high values across all habitat types, indicating robust community structure with equitable species distribution. Pond habitats exhibited the highest diversity index value ($H' = 3.785$), followed closely by agricultural areas ($H' = 3.761$), while urban areas demonstrated marginally lower but still substantial diversity ($H' = 3.636$). Corresponding evenness values, which quantify the equitability of species abundance distributions, followed a parallel pattern with pond habitats showing the greatest evenness ($J = 0.978$), agricultural areas demonstrating intermediate values ($J = 0.972$), and urban areas exhibiting slightly lower evenness ($J = 0.939$). Dominance indices, representing the probability that two randomly selected individuals belong to the same species, were uniformly low across all habitats, with pond areas displaying the lowest dominance ($D = 0.0228$), followed by agricultural zones ($D = 0.0248$), and urban areas showing marginally higher dominance ($D = 0.0355$). These quantitative metrics collectively indicate that while urban environments support substantial avian diversity, they exhibit slightly greater numerical dominance by a subset of highly adaptable species compared to the more evenly distributed communities characteristic of agricultural and wetland habitats.

Temporal analysis of avian populations across the five-month study period revealed distinct seasonal fluctuations in both abundance and community composition. January surveys documented 591 individuals, with urban and pond habitats supporting particularly diverse assemblages including the house sparrow, common myna, black kite, and multiple heron species. February observations recorded 602 individuals, with agricultural areas exhibiting notably high species richness, particularly for the black kite, rose-ringed parakeet (Psittacula krameri), and various bulbul species. March surveys yielded 587 individuals, with urban areas dominated by house crows and hill pigeons while pond habitats maintained substantial populations of common mynas and wetland birds. April documented 578 individuals, representing the lowest monthly abundance, with species distribution remaining relatively consistent across habitats. May surveys recorded 598 individuals, with agricultural and pond habitats accommodating increased populations of adaptable species including the common myna, purple sunbird, and house crow. Analysis of variance examining habitat-based differences in species distribution demonstrated statistically significant variation during January ($p = 0.005$), February ($p = 0.007$), March ($p = 0.008$), and May ($p = 0.002$), confirming that avian community composition differed substantially among urban, agricultural, and pond habitats during these months. However, April failed to achieve statistical significance (p = 0.880), suggesting either temporary homogenization of bird communities across habitat types or reduced sample sizes limiting detection of existing spatial patterns.

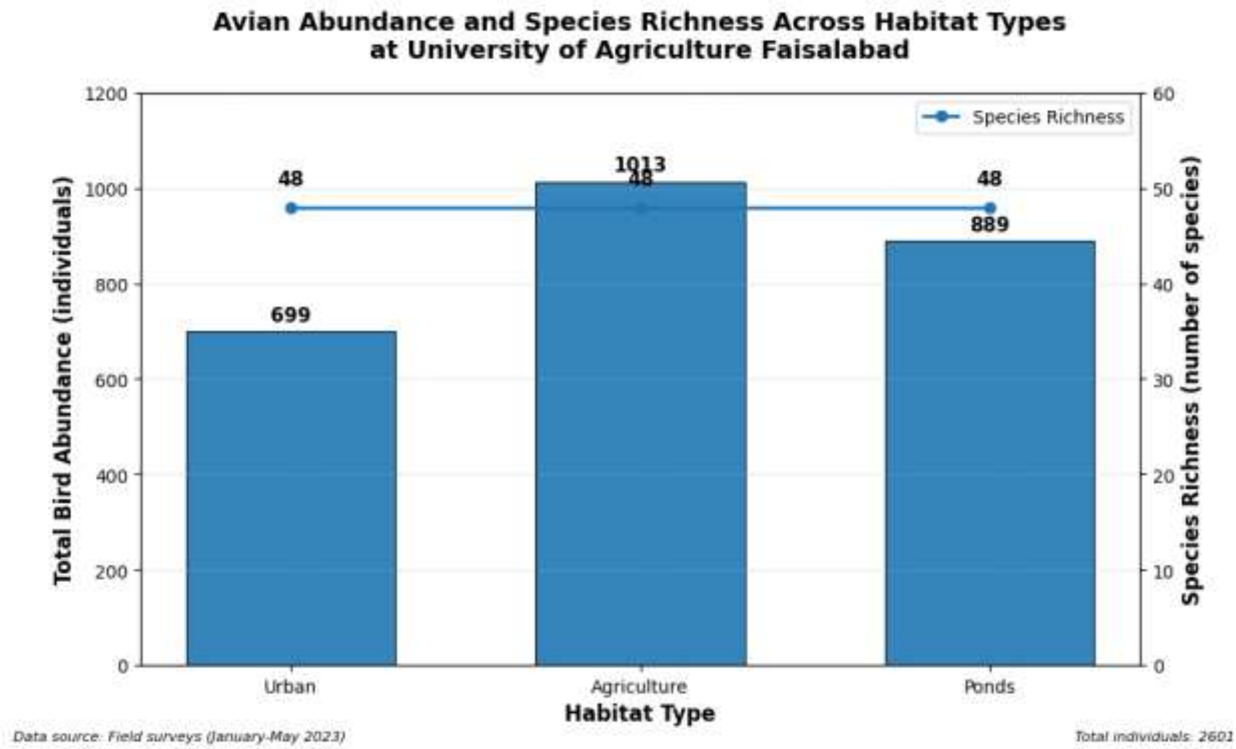

Figure 1 Avian Abundance and Species Richness Across Habitat Types At University of Agriculture Faisalabad

The cumulative dataset revealed important patterns in species-habitat associations, with several taxa demonstrating pronounced habitat specificity. Wetland-dependent species including the great egret (Ardea alba), Indian pond heron, and little grebe (Tachybaptus ruficollis) were predominantly or exclusively recorded in pond habitats, with 20 of 36 great egret observations (55.6%) occurring in these areas. Similarly, the common kingfisher (Alcedo atthis) demonstrated strong association with aquatic environments, with 23 of 36 observations (63.9%) recorded at pond sites. Conversely, species such as the jungle babbler (Argya striata) and ashy prinia (Prinia socialis) exhibited preferences for agricultural and scrub habitats, with 30 of 55 jungle babbler observations (54.5%) and 17 of 33 ashy prinia observations (51.5%) occurring in agricultural areas. Urban-adapted species including the house crow and house sparrow maintained substantial populations across all habitats but achieved maximum abundance in urban settings, with house crows exhibiting 51 of 133 observations (38.3%) in urban areas and house sparrows demonstrating 40 of 113 observations (35.4%) in these environments. Notably, several species demonstrated broad habitat tolerance, including the black kite (49 individuals in agricultural areas, 42 in urban settings, 38 in pond habitats) and common myna (43 in agricultural areas, 36 in urban settings, 33 in pond habitats), suggesting these generalist species possess behavioral flexibility enabling exploitation of resources across the landscape mosaic.

Table 1: Bird species recorded from the University of Agriculture Faisalabad

Sr. No.	Order	Family	Scientific Name	Urban Area	Agriculture Area	Ponds	Total
1	Passeriformes	Cisticolidae	P. socialis	4	10	7	21
		Hirundinidae	D. dasypus	24	20	17	61
		Sturnidae	A. ginginianus	6	12	18	36
		Ploceidae	P. philippinus	2	17	12	31
		Dicruridae	D.macrocercus	10	14	14	38
		Leiothrichidae	A. caudata	17	30	23	70
		Sturnidae	A. tristis	36	43	33	112
		Cisticolidae	O. sutorius	2	15	10	27
		Cisticolidae	P. gracilis	4	20	10	34
		Corvidae	C. splendens	51	42	40	133
		Passeridae	P. domesticus	40	40	33	113
		Muscicapidae	C. saularis	12	27	21	60
		Leiothrichidae	A. striata	15	23	17	55
		Cisticolidae	P. inornata	4	17	12	33
		Nectariniidae	C. asiaticus	21	26	20	67
		Pycnonotidae	P. cafer	33	38	27	98
		Corvidae	D.vagabunda	7	15	14	36
		Passeridae	P. hispaniolensis	24	21	16	61
		Leiothrichidae	A. earlei	10	22	16	48
		Pycnonotidae	P. leucotis	6	9	12	27
		Passeridae	G. xanthocollis	12	22	15	49
		Sturnidae	S. pagodarum	19	23	23	65
2	Accipitriformes	Accipitridae	A. virgatus	2	8	10	20
			M. migrans	42	49	38	129
			A. badius	5	10	10	25
3	Cuculiformes	Cuculidae	E. scolopaceus	11	12	14	37
			C. canorus	3	16	12	31
			C. sinensis	5	18	11	34
			C. micropterus	11	14	15	40
4	Piciformes	Picidae	D. benghalense	5	17	11	33

Sr. No.	Order	Family	Scientific Name	Urban Area	Agriculture Area	Ponds	Total
5	Pelecaniforme	Ardeidae	I. flavicollis	9	14	15	38
			A. alba	2	14	20	36
			A. grayii	18	16	20	54
			I. minutus	12	21	26	59
6	Coraciiformes	Meropidae	M. persicus	6	16	13	35
			M. philippinus	5	17	12	34
			M. orientalis	8	19	19	46
		Alcedinidae	A. atthis	5	8	23	36
7	Strigiformes	Strigidae	O. bakkamoena	3	11	12	26
8	Bucerotiformes	Upupidae	U. epops	14	21	21	56
		Bucerotidae	O. birostris	2	6	7	15
9	Apodiformes	Apodidae	A. apus	23	33	26	82
10	Columbiformes	Columbidae	S. decaocto	28	30	28	86
			C. rupestris	51	40	35	126
			S. senegalensis	23	19	25	67
			S. tranquebarica	23	36	22	81
11	Charadriiformes	Charadriidae	V. indicus	9	16	19	44
12	Psittaciformes	Psittaculidae	P. krameri	15	26	15	56
	Total			699	1013	889	2601

Seasonal and Monthly Diversity Trends

Data collected over five months (January-May) show fluctuations in bird populations. The house crow, black kite, and common myna consistently appeared in higher numbers across seasons, with seasonal variations evident among other species. The month of April recorded the lowest diversity significance level ($p=0.88$), indicating limited variation in species distribution across areas. In contrast, January, February, March, and May showed significant p-values ($p<0.05$) in ANOVA tests, confirming substantial habitat-based diversity in these months.

Table 2: Shannon-Weiner diversity index for diversity and abundance of birds at the University of Agriculture Faisalabad.

Site	Individuals	Individuals	Dominance	Shannon H	Evenness
Urban	48	699	0.0354661	3.636321468	0.93932644
Agriculture Area	48	1013	0.0247514	3.761335397	0.97161976
Ponds	48	889	0.0227987	3.784712947	0.9776586
Total	144	2601	0.0830162	11.1823698	2.8886048

The study revealed high species diversity and evenness across urban, agricultural, and pond habitats, with dominance values indicating minimal species monopolization. Agricultural and pond habitats displayed lower dominance (0.0247514 and 0.0227987, respectively) than urban areas (0.0354661), suggesting a more uniform species distribution. Overall, the Shannon H and evenness values underscore a robust species diversity and balanced distribution across the habitats.

Key Findings by Habitat and Season

January: A total of 591 individuals were observed, with urban and pond areas each housing diverse species like the house sparrow, common myna, and black kite. The significance of species distribution was confirmed by ANOVA (p=0.005).

February: Species richness was notably high in agricultural areas, particularly for birds like the black kite and rose-ringed parakeet (Psittacula krameri). The significant ANOVA value (p=0.007) affirmed substantial diversity across the three habitats.

March: In March, urban and agricultural areas held the highest diversity, with house crows and hill pigeons dominating urban settings. Pond areas showed notable representation by common mynas. The diversity in this month was significant (p=0.008).

April: Diversity was moderate, with dominant species such as the house crow and black kite across all habitats. Species such as the common myna and house sparrow showed substantial adaptability across areas. However, the statistical analysis for April did not yield significant results (p=0.88).

May: Significant diversity (p=0.002) was observed with agricultural and pond habitats accommodating larger populations of adaptable species like the common myna, purple sunbird, and house crow.

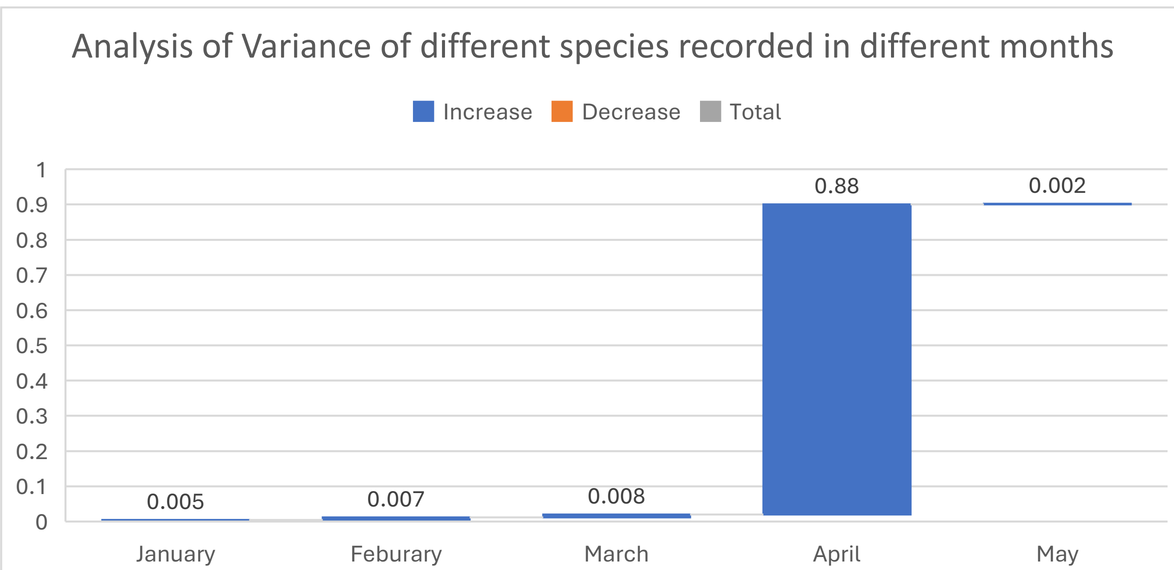

Figure 2 Analysis of Variance of Different Species Recorded in Different Months

DISCUSSION

The present investigation documented substantial avian diversity at the University of Agriculture Faisalabad, with 52 species identified across three distinct habitat types, reinforcing the ecological significance of peri-urban institutional landscapes as refugia for avian communities amid increasing anthropogenic pressure. The predominance of Passeriformes, representing nearly half of all recorded species, aligned with global patterns wherein this order exhibits remarkable adaptive capacity across diverse environmental gradients (1). The observed avian assemblage provided empirical support for the multifaceted ecological roles birds fulfill within modified landscapes, including insect population regulation, pollination services, seed dispersal mechanisms, and nutrient cycling processes that collectively underpin ecosystem functionality and resilience (2,3). These ecosystem services, while often operating through indirect pathways, ultimately sustain plant communities that generate oxygen, food resources, timber products, medicinal compounds, and contribute to flood mitigation, erosion control, aesthetic enrichment, and recreational opportunities for human populations (4). Furthermore, the documented foraging behaviors corroborated the conceptual framework positioning birds as mobile linkages facilitating energy transfer and nutrient flow both within and between adjacent ecosystems, while certain species demonstrated density-dependent consumption patterns capable of exerting top-down regulatory pressure on prey populations with cascading effects on plant community structure (5).

Agricultural areas emerged as the most species-rich habitats, supporting 1,013 individual observations compared to 889 individuals in pond habitats and 699 individuals in urban settings, a pattern attributable to the heterogeneous resource availability and structural complexity characteristic of cultivated landscapes. This finding corroborated previous investigations demonstrating that agricultural mosaics, when managed with moderate intensity, can sustain substantial avian biodiversity through provision of diverse foraging substrates, nesting opportunities, and seasonal resource pulses (6). The elevated abundance in agricultural zones likely reflected the convergence of multiple resource gradients, including insect prey associated with crop vegetation, seed resources from both cultivated plants and associated weeds, and edge habitats where field margins intersect with other landscape elements (7). Conversely, urban areas exhibited the lowest abundance and diversity indices, consistent with extensive literature documenting the negative consequences of habitat modification, noise pollution, anthropogenic disturbance, and structural simplification characteristic of built environments (8). Urbanization typically filters bird communities, favoring adaptable generalist species while excluding specialized taxa requiring specific habitat attributes, resulting in biotic homogenization wherein urban avifaunas increasingly resemble each other globally despite regional species pool differences (9). The intermediate diversity values observed in pond habitats underscored the importance of aquatic features as biodiversity hotspots within terrestrial matrices, providing essential resources for wetland-dependent species while simultaneously attracting generalist taxa seeking water sources and associated prey (10).

Temporal analysis revealed pronounced seasonal fluctuations in avian community composition, with winter months demonstrating elevated diversity compared to summer periods, a pattern consistent with previous investigations in South Asian subtropical environments (11,12). Several mechanistic explanations may account for this observed seasonality. Winter conditions typically prompt increased bird mobility as individuals expand foraging ranges in response to reduced food availability, while concomitant defoliation of deciduous vegetation enhances detectability during field surveys, potentially inflating observed richness values (13). Additionally, winter months in the study region coincide with the arrival of migratory species from higher latitudes, augmenting local assemblages with transient visitors seeking favorable wintering conditions (14). The reduced diversity documented during summer months may reflect multiple interacting factors, including elevated temperatures constraining bird activity patterns to early morning and late evening periods, dense foliar cover reducing detection probabilities, and breeding season behaviors that may decrease vocalization rates or increase cryptic behavior to avoid predator detection (15). The non-significant ANOVA result for April ($p = 0.880$) warranted particular consideration, as this deviation from the significant habitat-based differentiation observed in other months might indicate temporary homogenization of bird communities during transitional phenological periods, or alternatively, could reflect sampling stochasticity or unaccounted environmental covariates influencing detection probabilities (16).

The study documented concerning patterns of increasing abundance among garbage-adapted species, including house crows (*Corvus splendens*), common mynas (*Acridotheres tristis*), and black kites (*Milvus migrans*), which congregated in substantial numbers near campus waste disposal sites. This phenomenon illustrated the broader ecological syndrome whereby anthropogenic subsidies facilitate population increases of opportunistic generalists capable of exploiting novel resources, often at the expense of specialized species requiring natural foraging substrates (17). Open waste accumulation provided concentrated, predictable food sources that reduced foraging costs for these species, while surrounding mature trees offered abundant roosting sites, creating conditions conducive to the large evening aggregations observed during surveys (18). Concurrently, granivorous species such as red-vented bulbuls (*Pycnonotus cafer*) and house sparrows (*Passer domesticus*) maintained robust populations in agricultural areas where seed resources remained consistently available, suggesting that cultivated landscapes may function as demographic sources supporting populations that subsequently disperse into surrounding habitats (19). However, the ecological singularity of bird assemblages in urban and rural contexts has been well-documented, with urbanization progressively filtering communities toward taxonomic and functional homogenization as specialist species are replaced by widespread generalists (20). Habitat modifications associated with ongoing conversion of agricultural land to residential and commercial developments in peri-urban interfaces risk displacing sensitive species such as ashy prinias (*Prinia socialis*) and bee-eaters (*Merops* species), potentially accelerating the trajectory toward homogenized urban avifaunas dominated by a subset of highly adaptable taxa (21).

Quantitative diversity assessment using the Shannon-Wiener index revealed habitat-specific patterns consistent with the abundance data, with agricultural areas exhibiting high diversity (H' = 3.761) and evenness (J = 0.972), pond habitats demonstrating marginally greater diversity (H' = 3.785) and evenness (J = 0.978), and urban areas showing comparatively reduced diversity (H' = 3.636) and evenness (J = 0.939). The dominance index values corroborated these patterns, with urban environments displaying the highest dominance (D = 0.0355), indicating greater numerical concentration within a subset of species, whereas agricultural and pond habitats exhibited more equitable abundance distributions across species (D = 0.0248 and 0.0228, respectively). These quantitative metrics aligned with broader research demonstrating that anthropogenic landscape modification typically reduces species diversity and alters community structure in urbanizing regions (22). The elevated moisture gradients and vegetation complexity characteristic of agricultural areas likely provided essential resources supporting diverse assemblages, while pond habitats attracted birds through aquatic prey availability, including fish debris and aquatic invertebrates, enhancing both abundance and diversity (23). These findings collectively underscored the critical importance of maintaining habitat heterogeneity within human-dominated landscapes to support specialized species and preserve regional avian diversity (24).

Several methodological strengths enhanced the reliability of the present investigation. The systematic sampling approach employing complementary line transect and point count methods reduced detection biases associated with single-technique surveys, while the twice-weekly sampling frequency across five months provided robust temporal resolution for detecting seasonal patterns (25). The use of standardized diversity indices facilitated quantitative comparisons with existing literature, and the ANOVA approach enabled statistical confirmation of habitat-based differences in community composition. However, important limitations warrant consideration when interpreting these findings. The five-month study duration, while sufficient for documenting seasonal transitions between winter and spring, precluded assessment of interannual variability or longer-term population trends that might reveal directional changes in community structure (26). The absence of detailed vegetation characterization within each habitat type limited capacity to identify specific structural or compositional features driving species-habitat associations, representing an important avenue for future research (27). Additionally, the study did not systematically quantify anthropogenic disturbance gradients, such as pedestrian traffic intensity, vehicular noise levels, or artificial lighting, which might mediate species distributions beyond broad habitat categories (28). Perhaps most significantly, the investigation did not directly assess the relationship between dietary guilds and population trends, which would have addressed the stated objective regarding avian population dynamics in relation to feeding ecology. Future studies should incorporate detailed dietary characterization, preferably through combined observational and stable isotope approaches, to elucidate how trophic specialization mediates species vulnerability to ongoing environmental change (29).

The conservation implications arising from these findings merit serious consideration within urban planning frameworks. Strategic expansion of green infrastructure, including parks, lawns, and linear vegetation corridors, can enhance habitat connectivity and resource availability for avian communities (30). Prioritizing indigenous plant species in landscaping efforts provides familiar foraging and nesting substrates that native birds have evolved to utilize, potentially supporting more diverse assemblages than exotic ornamental plantings (31). Establishment of supplementary feeding stations for granivorous species, particularly during resource-scarce periods, may help sustain populations facing food limitations in modified landscapes, though such interventions require careful management to avoid dependency or disease transmission (32). Preservation of mature trees and strategic replanting in deforested areas maintains critical nesting substrates and roosting sites essential for species persistence. Pollution mitigation through improved waste management practices and wastewater treatment can reduce disturbances that exclude sensitive species while simultaneously addressing the anthropogenic subsidies that inflate populations of opportunistic scavengers (33). Public education initiatives fostering awareness of avian conservation values, combined with enforcement of existing protective legislation, can cultivate community support for biodiversity-oriented management (34). By integrating development objectives with ecologically sensitive landscape practices, urbanizing regions can potentially reconcile human infrastructure needs with the preservation of avian diversity, safeguarding rare species while fostering public appreciation for conservation values (35).

CONCLUSION

The present investigation successfully achieved its objective of evaluating anthropogenic impacts on avian diversity within a peri-urban institutional landscape, demonstrating that habitat modification significantly influences bird community structure across relatively small spatial scales. The findings confirmed that agricultural areas, with their heterogeneous vegetation structure and abundant food resources, supported the most diverse and equitably distributed avian assemblages, while urban environments exhibited reduced diversity and greater dominance by synanthropic species adapted to human-modified conditions. Pond habitats occupied an intermediate position, providing essential resources for both wetland-dependent and generalist species, thereby highlighting the conservation value of maintaining aquatic features within terrestrial matrices. The statistical analyses revealed significant temporal and spatial variations in bird populations, with seasonal fluctuations reflecting the interplay of migratory movements, resource availability, and detectability constraints. These results underscore the profound influence of anthropogenic landscape transformation on native avifauna, even within institutional campuses traditionally perceived as refugia for biodiversity. The increasing abundance of garbage-adapted species observed near waste disposal sites illustrated how anthropogenic subsidies can artificially inflate populations of opportunistic generalists, potentially at the expense of specialized taxa requiring natural foraging substrates. This research contributes to the growing body of evidence documenting urban-induced biotic homogenization and reinforces the imperative for integrating biodiversity considerations into urban planning frameworks. The findings suggest that maintaining habitat heterogeneity, preserving native vegetation, implementing sustainable waste management practices, and fostering public awareness represent essential strategies for conserving avian diversity in increasingly human-dominated landscapes. Ultimately, this study affirms that universities and similar institutions bear considerable responsibility for biodiversity stewardship, as their grounds can function either as ecological traps or as vital sanctuaries for avian communities depending upon management philosophies and practices adopted.

AUTHOR CONTRIBUTIONS

Author	Contribution
Aqsa Jameel	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Sufian*	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published

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