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Comparative Analysis of bird diversity in two university campuses in the city of Huánuco, Peru

Análisis comparativo de la diversidad de aves en dos campus universitarios de la ciudad de Huánuco, Perú

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ABSTRACT

The evaluation of bird diversity in urban green spaces is fundamental for comprehed the ecological status of ecosystems and their capacity to sustain biological communities. The objective of this study was to compare the diversity, composition, and richness of birds in the campuses of the Universidad de Huánuco (UDH) and the Universidad Nacional Hermilio Valdizán (UNHEVAL), located in the city of Huánuco, Peru. The study had a descriptive and comparative approach through fieldwork conducted directly on both campuses. Species records were obtained through visual and auditory observation, photographic support, and the use of specialized applications (Merlin Bird ID and eBird). Data were analyzed through the Shannon–Wiener and Simpson diversity indices, the Chao1 richness estimator, and Pielou's evenness index. Sixteen bird species were recorded at UDH and six at UNHEVAL. The results evidenced higher diversity and evenness values at UDH, as well as greater potential richness according to Chao1, whereas UNHEVAL exhibited greater dominance by a few species. It was concluded that significant differences exist in the structure of bird communities between both campuses, mainly associated with vegetation cover and the level of human disturbance, highlighting the importance of university campuses as refuges for urban biodiversity.

Keywords: *conservation; bird diversity; urban avifauna; ecological indices; university campuses.*

RESUMEN

La evaluación de la diversidad de aves en espacios verdes urbanos es fundamental para comprender el estado ecológico de los ecosistemas y su capacidad para sostener comunidades biológicas. El objetivo del presente estudio fue comparar la diversidad, la composición y la riqueza de aves en los campus de la Universidad de Huánuco (UDH) y de la Universidad Nacional Hermilio Valdizán (UNHEVAL), ubicados en la ciudad de Huánuco, Perú. El estudio tuvo un enfoque descriptivo y comparativo, mediante un trabajo de campo realizado directamente en ambos campus. El registro de especies se realizó mediante observación visual y auditiva, apoyo fotográfico y uso de aplicaciones especializadas (Merlin Bird ID y eBird). Los datos fueron analizados mediante los índices de diversidad de Shannon-Wiener y Simpson, el estimador de riqueza de Chao1 y la equitatividad de Pielou. Se registraron dieciséis especies de aves en la UDH y seis en la UNHEVAL. Los resultados evidenciaron valores más altos de diversidad y equitatividad en la UDH, así como una mayor riqueza potencial según Chao1, mientras que la UNHEVAL presentó una mayor dominancia de pocas especies. Se concluyó que existen diferencias significativas en la estructura de las comunidades de aves entre ambos campus, asociadas principalmente a la cobertura vegetal y al nivel de perturbación humana, lo que resalta la importancia de los campus universitarios como refugios de biodiversidad urbana.

Palabras clave: *conservación; diversidad de aves; avifauna urbana; índices ecológicos; campus universitarios.*

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Introduction

The reduction in species diversity is one of the main environmental problems worldwide, as it affects the balance of ecosystems and human well-being (Benito et al., 2019). Birds are considered a key group for assessing these changes due to their sensitivity to habitat degradation and because they act as bioindicators of site conditions. In addition, they perform important ecological functions, such as seed dispersal and pest control (Serna-Lagunes et al., 2023). Urban growth accelerates the loss of natural habitats, resulting in fewer spaces available for birds to seek shelter, feed, and reproduce, and causing changes in their patterns of abundance and distribution (Benito et al., 2019). In response, university campuses constitute green spaces that can be preserved for bird conservation. Despite their ecological importance and potential as biodiversity refuges, university campuses have been little studied in terms of avian biodiversity (Castillo Palacios et al., 2014).

The assessment of bird diversity has become a useful tool for estimating the health or degradation of the urban environment, since species richness depends on resource availability and habitat structure (Vides-Hernández et al., 2017). Thus, the greater the heterogeneity of an urban green area, the greater its capacity to support both generalist and specialist species. In the case of university campuses, these areas feature heterogeneous spaces and structures, as well as a configuration of various species of trees, shrubs, and herbs, which can provide suitable conditions for bird survival (Benito et al., 2019). On the other hand, it has been demonstrated that urbanization favors the survival of certain opportunistic species, such as pigeons, due to their high adaptive capacity, which gradually affects and displaces native species that are more sensitive to habitat changes (Alba et al., 2025).

Various studies confirm the relevance of urban green spaces for the conservation of diverse bird species (Vides-Hernández et al., 2017). In Santiago, Chile, it was found that the structure of the urban habitat, determined by vegetation cover and impervious surfaces, directly influenced the prevalence of native species compared to exotic species (Benito et al., 2019). Likewise, in Mexico City, habitat quality was found to be essential for maintaining communities of insectivorous birds, reaffirming their role as environmental bioindicators (Ugalde-Lezama et al., 2022). Similarly, studies in the city of Manta, Ecuador, demonstrated that better-preserved green areas can maintain high species richness, even under anthropogenic pressure (Carrión-Zambrano et al., 2022). This evidence supports the value of birds as indicators of urban sustainability and ecological resilience in green ecosystems.

In cities across Peru, although urban studies are scarce, it has been demonstrated that bird diversity is closely associated with the extent and quality of green areas, as in the city of Iquitos, where bird diversity and vegetation were assessed in different urban areas, with 127 species recorded (Angulo-Pérez et al., 2022). In addition, it has been documented that university campuses can harbor a diversity of bird species, making them key green spaces within the urban matrix. In this regard, research conducted at the campus of Universidad Ricardo Palma (URP), in Lima, recorded twenty-two bird species belonging to fifteen families. This diversity was associated with tree cover and the management of the campus green areas (Arteaga-Chávez, 2017). Another example in Peru was the assessment of the campus of Universidad Nacional Agraria La Molina (UNALM), where Castillo Palacios et al. (2014) reported 48 species; this diversity was attributed to the heterogeneity of the campus's tree and shrub habitat. However, in cities such as Huánuco, there are no comparative studies analyzing the avifauna of university campuses, which creates a significant information gap.

In this context, the present study aims to compare the biodiversity, composition, and species richness of birds on the university campuses of Universidad de Huánuco (UDH) and Universidad Nacional Hermilio Valdizán (UNHEVAL).

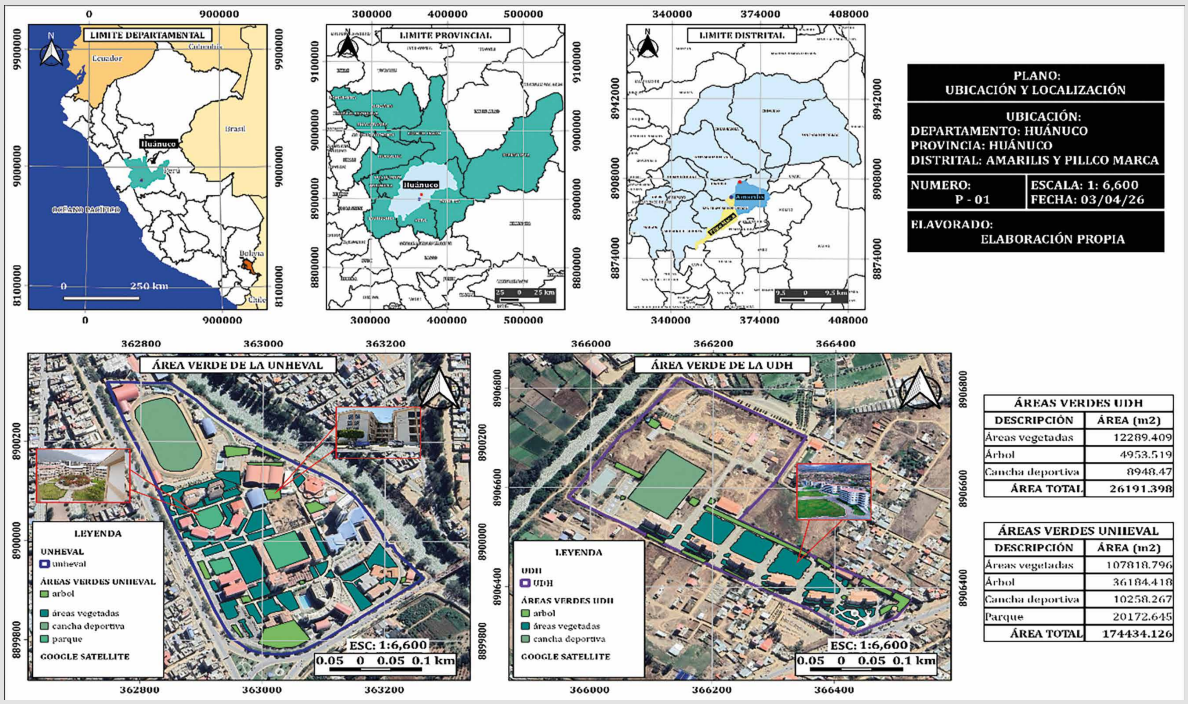
Methodology

The study was conducted on the university campuses of UDH (9°56'20" S, 76°14'30" W) and UNHEVAL (9°55'45" S, 76°13'55" W), both located in the city of Huánuco, Peru. Both universities are situated at opposite ends of the city. The UDH campus covers an area of 10.45 ha, whereas the UNHEVAL campus covers 13.92 ha. The green areas of both campuses are shown in Figure 1. The two study sites are immersed in an urban environment

and feature green spaces consisting of gardens, native trees, and exotic species, as well as built-up areas. The average altitude is approximately 1,900 m a.s.l., and the climate corresponds to a warm-temperate regime, with an average annual temperature of approximately 20 °C. UNHEVAL, specifically, is located within a highly consolidated urbanized area, as it is the closest to the center of the city of Huánuco, whereas UDH is located at the outskirts of the city, where the process of urban development consolidation can be observed.

Figure 1

Geographical location and distribution of green areas on the UNHEVAL and UDH campuses in Huánuco, Peru



Sampling Design

The study had a descriptive and comparative approach. Bird sampling was conducted in October 2025. Three sampling sessions were carried out each week, totaling nineteen days during which information was collected for the database.

On each campus, randomly selected linear observation transects were established and maintained consistently throughout the study period. The location of the sampling points was determined based on the presence of green areas and accessibility, aiming to represent the general conditions of each campus.

Sampling Procedure

Observations were conducted in the morning, between 6:30 and 8:30 a.m., a period during which bird activity is higher. The transects were surveyed, and all birds detected visually and aurally within the immediate area of the sampling point were recorded.

Species identification was carried out through direct observation using binoculars, photographic records, and specialized field guides, as well as with the support of the mobile applications Merlin Bird ID (Cornell Lab of Ornithology, 2023) and Bird ID, which facilitated the taxonomic verification of the recorded species.

Data Organization and Analysis

The values obtained for each index were analyzed and interpreted according to the criteria established by Magurran (2004), considering that higher values of the Shannon-Wiener index reflect greater diversity, whereas lower values of the Simpson index indicate lower species dominance. Subsequently, alpha diversity indices were estimated to describe the community structure, including the Shannon-Wiener and Simpson indices, expected richness estimated using the Chao1 estimator, and evenness of Pielou.

Shannon-Wiener Biodiversity Index (H):

$$H = - \Sigma (pi * \ln(pi))$$

Where H: Shannon-Wiener diversity index; pi: proportion of individuals of species i relative to the total number of individuals in the community; ln: natural logarithm (Shannon, 1948).

The Simpson index (D) was calculated as follows:

$$D = \Sigma pi*2$$

and was reported as (1-D), where higher values indicate greater diversity and lower dominance (Simpson, 1949).

Expected richness was estimated using the Chao1 estimator, which corrects for undersampling by considering rare species *(singletons and doubletons):*

$$Chao1 = S_{obs} + F1*2/2F2$$

Where:

S_{obs}: Number of observed species.

F1: number of species represented by a single individual (*singletons*).

F2: number of species represented by two individuals (*doubletons*) (Chao, 1984).

Additionally, Pielou's evenness index (J') was calculated, which measures the uniformity in the distribution of abundances among species, using J' = H'/ln(S). (Pielou, 1966).

Subsequently, the results of the indices were compared between the two university campuses (UNHEVAL and UDH) to identify differences in diversity values.

The data obtained in the field were recorded on field data sheets and subsequently organized using Past *software* (version 4.9) for the automatic calculation and statistical analysis of ecological indices (Hammer et al., 2001). Based on this information, frequency tables were prepared considering the number of individuals of each species recorded during each sampling session.

Statistical Analysis

To assess differences in bird diversity between the university campuses, each sampling session was considered the unit of analysis, using the daily values of species richness, total abundance, and diversity indices. Prior to the analysis, the assumptions of normality and homogeneity of variances were verified using the Shapiro-Wilk and Levene's tests, respectively. Subsequently, an independent-samples Student's t-test with Welch's correction was applied, using a significance level of $p < 0.05$. All statistical analyses were performed using Past *software* (Hammer et al., 2001).

Results

The information was organized by species and by day (from day 1 to day 19), allowing the data to be summarized in terms of abundance (number of individuals), diversity, and taxonomic composition.

Effort and Total Recorded Abundance

After summing the counts from the nineteen sampling days, a total of 2,764 individuals were recorded across both campuses. Of this total, UDH accounted for 1,672 individuals, while UNHEVAL accounted for 1,092, indicating a higher recorded abundance at UDH throughout the sampling period.

Dominance and Most Representative Species

At UDH, the species with the highest cumulative abundance was *Elliotomyia chionogaster* (372 individuals). Urban species such as Zenaida auriculata and Zonotrichia capensis also stood out. This assemblage suggests a community typical of urban areas/green spaces, where some generalist species reach high abundances while coexisting with several additional species that contribute to higher diversity. At UNHEVAL, the community was strongly dominated by At UDH, the species with the highest cumulative abundance was *Elliotomyia chionogaster* (372 individuals). Urban species such as *Zenaida auriculata and Zonotrichia* capensis also stood out. This assemblage suggests a community typical of urban areas/green spaces, where some generalist species reach high abundances while coexisting with several additional species that contribute to higher diversity. At UNHEVAL, the community was strongly dominated by *Spinus magellanicus* (514 individuals), followed by *Columba livia* (189) and Columbina cruziana (156). (514 individuals), followed by Columba livia (189) and *Columbina cruziana* (156).

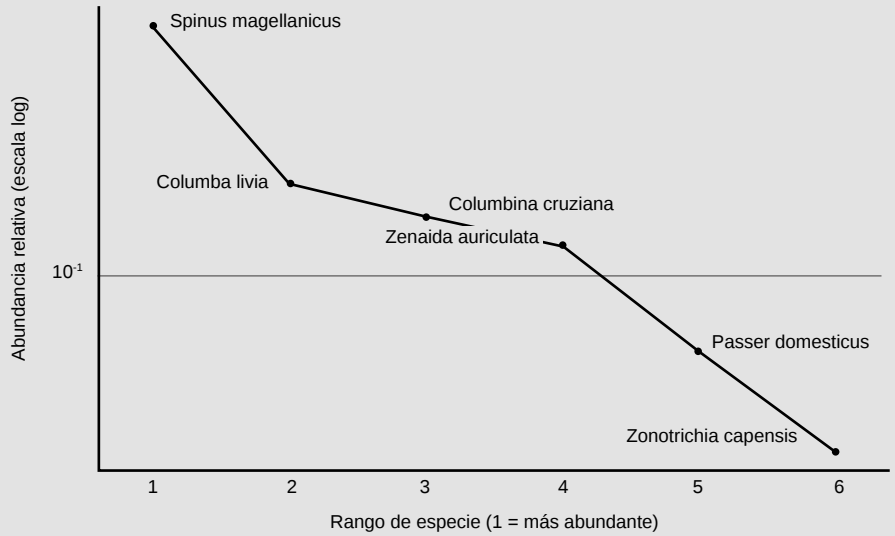
Taxonomic Structure (Order, Family, Genus, and Species) According to Abundance

At UDH, greater taxonomic richness was recorded, with four orders, eleven families, fifteen genera, and sixteen species. In contrast, UNHEVAL showed lower richness, with two orders, four families, six genera, and six species.

At UNHEVAL, a total abundance of 1,092 individuals was recorded, corresponding to six species (Figure 2). At the order level, abundance was distributed exclusively between Passeriformes (617; 56.50%) and Columbiformes (475; 43.50%), indicating a simpler taxonomic assemblage compared with UDH and with no contribution from additional orders.

Figure 2

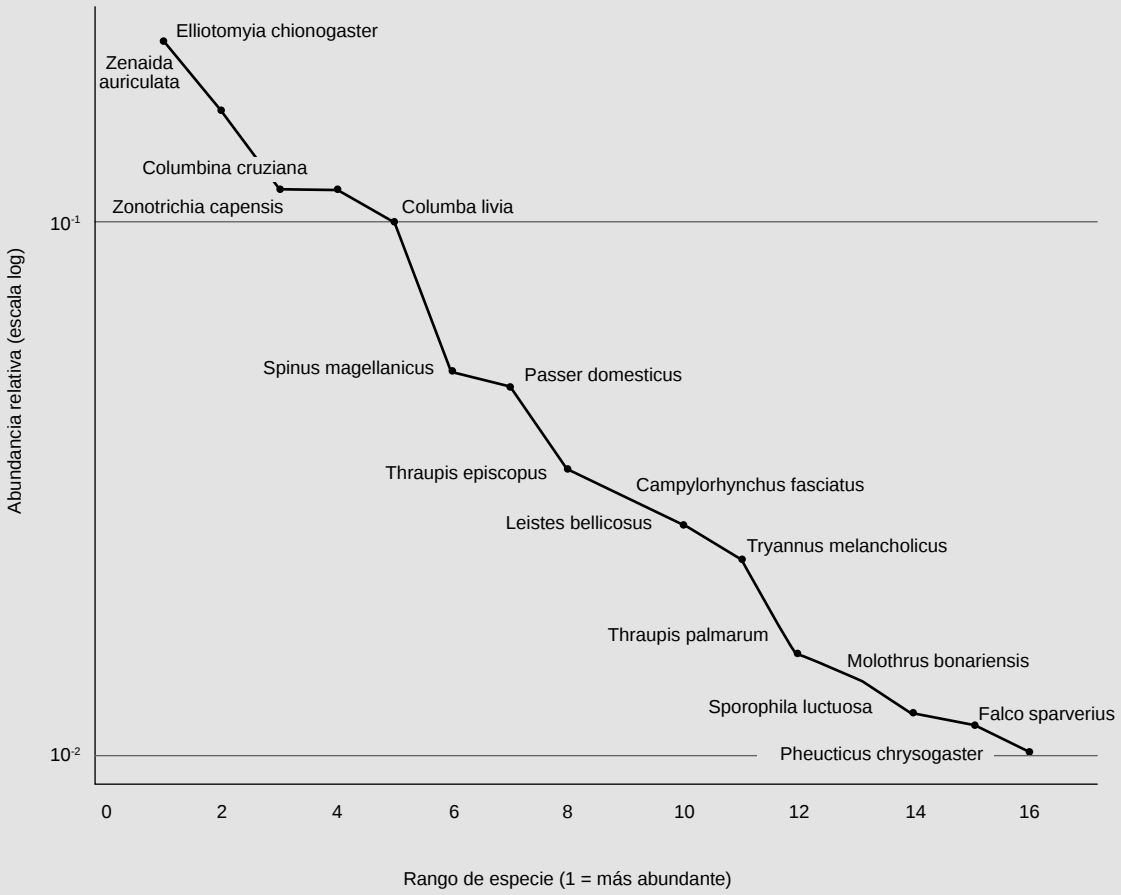
Rank-abundance curve of the bird community recorded at the UNHEVAL campus. The x-axis represents rank (1 = highest abundance), and the y-axis represents relative abundance on a logarithmic scale. Labels indicate the observed species; the shape of the curve summarizes the pattern of dominance and abundance distribution across the community



At UDH, a total abundance of 1,672 individuals was recorded, distributed among sixteen species (Figure 3). At the order level, abundance was concentrated mainly in Passeriformes (646 individuals; 38.64%) and Columbiformes (635 individuals; 37.98%). A third numerically important component was Caprimulgiformes (372; 22.25%), whereas Falconiformes made a minimal contribution (19; 1.14%).

Figure 3

Rank-abundance curve of the bird community recorded at the UDH campus. The x-axis represents the rank of each species (1 corresponds to the most abundant species), and the y-axis represents relative abundance on a logarithmic scale. The labels correspond to the recorded species



At the family level, dominance was consistent with that observed at the order level. Columbidae represented the most abundant component (635; 37.98%), followed by Trochilidae (372; 22.25%) and Passerellidae (195; 11.66%). At a second level of contribution were Thraupidae (103; 6.16%), Fringillidae (89; 5.32%), and Passeridae (83; 4.96%); the remaining families showed lower contributions, reflecting a structure with a strong numerical concentration in a few families, accompanied by a set of rare or poorly represented families.

The structure becomes more evident when examining genera and species. At UDH, the most abundant genera were *Elliotomyia* (372; 22.25%), Zenaida (275; 16.45%), *Zonotrichia* (195; 11.66%), Columbina (191; 11.42%), and *Columba* (169; 10.11%). This pattern indicates shared dominance between columbids and passerines, with a substantial contribution from Trochilidae concentrated in a single genus.

Accordingly, the most abundant species at UDH were *Elliotomyia chionogaster* (372; 22.25%), *Zenaida auriculata* (275; 16.45%), *Zonotrichia capensis* (195; 11.66%), *Columbina cruziana* (191; 11.42%), and *Columba livia* (169; 10.11%) (Figure 4). Collectively, these five species accounted for 71.9% of all individuals recorded at UDH, demonstrating a numerical pattern dominated by a few species, despite UDH having greater richness than the other campus.

Figure 4

Most representative bird species on the UDH campus: (a) Zenaida auriculata, (b) Falco sparverius, (c) Zonotrichia capensis, (d) Leistes bellicosus, (e) Elliotomyia chionogaster, and (f) Columbina cruziana.

At the family level, abundance showed an even more pronounced dominance pattern: Fringillidae was the most abundant family (514; 47.07%), followed by Columbidae (475; 43.50%). The remaining families contributed smaller proportions (Passeridae: 67; 6.14%, and Passerellidae: 36; 3.30%). Therefore, two families accounted for approximately 90.6% of the total abundance on the campus, characterizing UNHEVAL as an assemblage with high dominance and low numerical evenness.

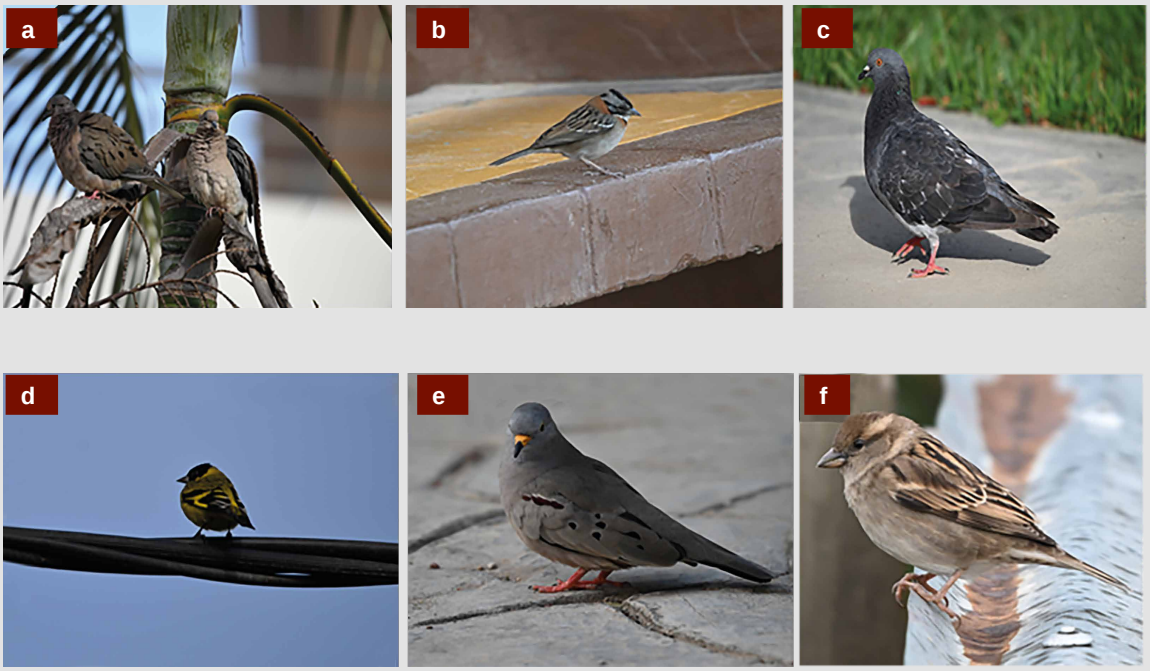
This pattern is maintained when examining the genera: *Spinus* (514; 47.07%) accounted for nearly half of the records, followed by *Columba* (189; 17.31%), *Columbina* (156; 14.29%), and *Zenaida* (130; 11.90%). Finally, at the species level (Figure 5), dominance was particularly evident in *Spinus magellanicus* (514; 47.07%), followed by *Columba livia* (189; 17.31%), *Columbina cruziana* (156; 14.29%), and *Zenaida auriculata* (130; 11.90%). These four species accounted for 90.6% of the total number of individuals at UNHEVAL, confirming a community strongly structured by a few numerically dominant species.

In comparative terms, UDH presented a higher total abundance and a structure in which, although dominance was present, abundance was distributed across more taxonomic levels, including important contributions from Caprimulgiformes and the family Trochilidae. In contrast, UNHEVAL exhibited a more simplified and highly concentrated assemblage, in which most of the abundance was accounted for by Fringillidae/Spinus and Columbidae, suggesting a community with lower numerical evenness.

Furthermore, when considering the shared taxa, UNHEVAL behaves as a subset of the assemblage observed at UDH (the species recorded at UNHEVAL are also present at UDH), but with a marked difference in dominance structure, since at UNHEVAL a single species (*Spinus magellanicus*) accounts for nearly half of the individuals.

Figure 5

Most representative bird species on the UNHEVAL campus: (a) Zenaida auriculata, (b) Zonotrichia capensis, (c) Columba livia, (d) Spinus magellanicus, (e) Columbina cruziana, and (f) Passer domesticus.



Species Richness and Diversity (UDH vs. UNHEVAL Comparison)

Sixteen species were recorded at UDH, whereas six species were recorded at UNHEVAL. Thus, UDH showed notably greater species richness, which is directly reflected in the diversity indices.

The indices calculated using the total abundance by species showed that UDH had greater diversity: H' = 2.349 (Figure 6A) and 1-D = 0.877 (Figure 6B), whereas UNHEVAL recorded H' = 1.473 and 1-D = 0.709. From an ecological perspective, this means that UDH not only had more species, but that abundance was also more evenly distributed among several species. At UNHEVAL, in contrast, the community was more concentrated in a few dominant species, which reduced effective diversity.

In Figure 6C, UDH shows high estimated richness (Chao1) and greater temporal variability. Based on the daily records (n = 19), the mean (red line) was 15.629. In addition, the observed values ranged from 12.25 to 22.0, indicating marked temporal heterogeneity in the estimated richness at this site.

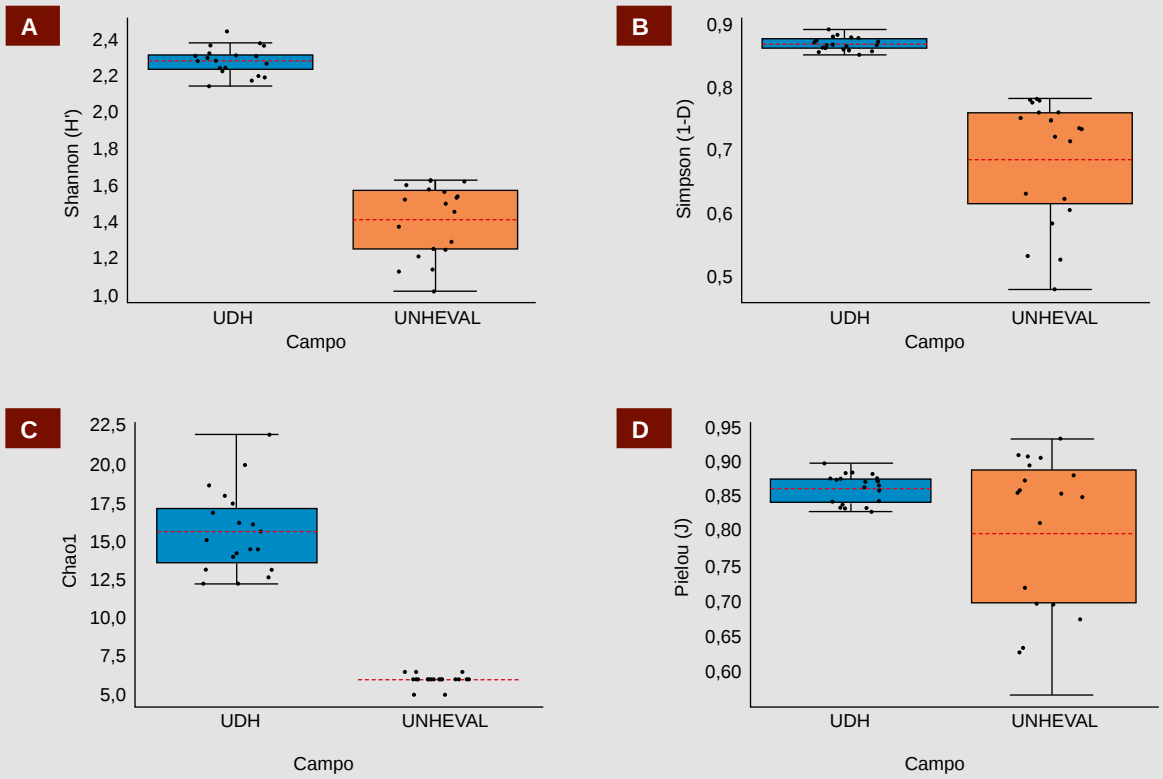
In contrast, UNHEVAL showed low and practically constant estimated richness. With the same sample size (n = 19), the mean (red line) was 5.97. The observed values showed a narrow range (5.0–6.5), confirming minimal variation in estimated richness at this site.

Pielou's evenness (J) (Figure 6D) was relatively high at both sites (UDH = 0.847, UNHEVAL = 0.822), suggesting that, among the species present, the distribution was not extremely uneven; however, at UNHEVAL, the upper limit of diversity is constrained by its low richness (only six species).

For the inferential comparison between the universities, an independent-samples Student's t-test with Welch's correction (robust to unequal variances) was applied. The analyses revealed statistically significant differences

Figure 6

Comparison of alpha biodiversity indices (Shannon, Simpson 1-D, estimated Chao1 richness, and Pielou's evenness (J)) between the UDH and UNHEVAL sites, calculated on a daily basis. The boxes represent the interquartile range (Q1–Q3), and the whiskers indicate dispersion; the points correspond to the observed daily values. The red line indicates the mean



between UDH and UNHEVAL for the four biodiversity indices evaluated: Shannon, Simpson 1-D, Chao1, and Pielou's evenness (J).

Table 1 summarizes comparisons between two bird communities at two university campuses using a Welch's t-test for four biodiversity indices. In all cases, the "Mean Difference (UDH-UNHEVAL)" column is positive, indicating that the mean values of the indices were higher at UDH than at UNHEVAL. For the Shannon index, the value was significantly higher at UDH ($t = 17.98$; $df = 23.37$; $p = 3.46 \times 10^{-15}$), with a mean difference of 0.87 units. This suggests that, at the UDH campus, the bird community exhibits a combination of a higher effective number of species and/or a more even distribution of abundances compared with UNHEVAL. The effect size was very large (Cohen's $d = 5.83$; Hedges' $g = 5.71$), indicating that the difference is not only statistically detectable but also ecologically pronounced. The Simpson index (1-D) also showed higher values at UDH ($t = 8.03$; $df = 18.40$; $p = 1.98 \times 10^{-7}$), with a mean difference of 0.18. Since Simpson (1-D) increases as dominance decreases, this result indicates that the bird community at UDH tends to be less dominated by a few species compared with UNHEVAL. The effect size was large ($d = 2.60$; $g = 2.55$). The Chao1 estimator was significantly higher at UDH ($t = 15.41$; $df = 18.74$; $p = 4.22 \times 10^{-12}$), with a mean difference of 9.65. Since Chao1 is intended to estimate "true" species richness by accounting for rare species, this pattern suggests that UDH not only records more observed species but also likely supports greater potential species richness, including infrequent species that may be less common or less detectable at UNHEVAL. The effect size was also very large ($d = 5.00$; $g = 4.89$). For Pielou's evenness (J), a statistically significant but smaller difference was detected ($t = 2.37$; $df = 19.22$; $p = 2.84 \times 10^{-2}$), with a mean difference of 0.064. This indicates that UDH exhibits slightly greater evenness in the distribution of abundances, although the contrast is moderate in magnitude ($d = 0.77$; $g = 0.75$).

Table 1

Prueba t de Welch (UDH vs. UNHEVAL) para los índices de biodiversidad

Index	t (Welch)	gl (Welch)	p-value	Mean Difference (UDH-UNHEVAL)	Cohen's d	Hedges g
Shannon (H')	17.98	23.37	3.46E-15	0.87	5.83	5.71
Simpson (1-D)	8.03	18.4	1.98E-07	0.18	2.6	2.55
Chao1	15.41	18.74	4.22E-12	9.65	5	4.89
Pielou (J)	2.37	19.22	2.841E-02	0.064	0.77	0.75

Discussion

Patterns of diversity and community structure differed between the university campuses. UDH exhibited greater species richness (S = 16) and diversity (H' = 2.35), with high evenness (J = 0.85) and lower dominance, whereas UNHEVAL recorded lower richness (S = 6), lower diversity (H' = 1.47), and marked dominance. This contrast suggests that the UNHEVAL community may be more concentrated in a few species, a pattern consistent with the environmental filtering typically observed in urban environments and with the prevalence of tolerant or generalist species under conditions of greater disturbance or habitat simplification (Garaffa et al., 2009; Silva et al., 2016). The greater diversity observed at UDH could be associated with greater microhabitat heterogeneity and vegetation structural complexity, which increases the number of available niches and favors the coexistence of more species. Studies in urban ecology have reported positive effects of habitat heterogeneity on bird richness, even within urban matrices (Sultana et al., 2021). The strong dominance of a few species at UNHEVAL can be discussed within the framework of urban biotic homogenization, in which communities tend to consist of reduced assemblages of urban-adapted and/or urban-exploiting species (McKinney, 2002), as well as the influence of anthropogenic resources, which may increase the relative abundance of opportunistic species in environments with high human presence. This disparity may be attributed to landscape heterogeneity and the extent of green areas. It has been demonstrated that diversity indices on university campuses increase proportionally with vegetation cover and the presence of shrub layers that provide foraging and nesting sites (Zhao et al., 2022).

The species richness recorded at UDH (sixteen species) is comparable to, although slightly lower than, that reported for other Peruvian university campuses, such as URP in Lima, where twenty-two species were recorded (Madrid Ibarra and Elías Cruzado, 2017), and to that found in studies conducted at the campus of the Central University of Ecuador, which reported twenty-six species (Arteaga Chávez, 2017). This reduction in species richness is characteristic of areas with high anthropogenic pressure or homogeneous vegetation structure, which tend to favor a reduced group of generalist species (Leveau et al., 2017).

The dominance of species such as *Elliotomyia chionogaster* (22.25%) at UDH and *Spinus magellanicus* (56.50% of Passeriformes) at UNHEVAL reflects the ability of these birds to adapt to urbanized environments. The significant presence of *Zenaida auriculata* and *Zonotrichia capensis* at both campuses is consistent with research conducted in Andean cities in Bolivia, Chile, and Argentina, where these species are classified as "urban exploiters" due to their generalist diet (mainly granivorous and insectivorous) and tolerance to human disturbance (Castro et al., 2026).

In particular, the high abundance of *Elliotomyia chionogaster* at UDH suggests a constant supply of floral resources on this campus, due to the abundant presence of *Spathodea campanulata* within the university grounds. In similar ecosystems, territorial hummingbirds have been observed to exhibit high levels of intraspecific and interspecific aggression to secure access to scarce resources in urban environments (Leveau et al., 2017). On the other hand, the dominance of a few species, which accounts for 71.9% of the total abundance at UDH, is consistent with the trend of "biotic homogenization" in cities in Peru, where overall species richness may be high, but evenness is low due to the proliferation of synanthropic species such as *Columba livia* (Muñoz-Pedreros et al., 2018).

The findings of this study reinforce research indicating that university campuses act as “biodiversity islands” that mitigate the negative effects of urbanization (Sanllorente et al., 2023). While UDH maintains a more complex taxonomic structure (four orders and eleven families), UNHEVAL exhibits a more simplified system. This difference highlights the need to implement landscape management strategies that include the planting of native flora and the preservation of dense vegetation patches in order to prevent the loss of specialist species inhabiting the densely urbanized core.

The university campuses of Huánuco not only serve an educational function but also play a key role in regional ecological connectivity (Jumilawaty et al., 2024). Long-term monitoring of these bird communities is essential for understanding how climate change and regional land-use changes affect the dynamics of resident and migratory species in the green areas of local universities.

Conclusions

The results of the study conclude that the UDH campus harbors a significantly more diverse and balanced bird community than UNHEVAL. This is reflected in the ecological indices; the Shannon–Wiener index values were consistently higher at UDH, indicating greater species richness and a more even distribution of abundances. Similarly, the lower Simpson index values at UDH confirm lower species dominance, in contrast to the higher values at UNHEVAL, where a few species account for most of the individuals recorded. A notable difference of nearly 3:1 was observed between UDH and UNHEVAL. This greater richness at UDH remained relatively stable throughout the monitoring period, ranging from twelve to sixteen species per day, whereas UNHEVAL remained consistently between five and six species per day. In addition, the Chao1 richness estimator suggests greater potential true species richness at UDH. Pielou’s evenness also showed distinct patterns: UDH exhibited consistently high and stable values, whereas UNHEVAL showed greater fluctuations and marked declines, indicating lower stability in its community structure.

This study provides evidence that two nearby university campuses can support distinct bird communities, even within a similar urban context. The consistency of the results (UDH showing higher values for Shannon, Simpson, and Chao1, and a more moderate but significant difference in Pielou’s evenness) supports the notion that a campus is not merely a “green space,” but rather an ecological unit whose habitat structure, management, and level of disturbance can modify the richness and functional composition of the avifauna. Furthermore, the study establishes a replicable baseline for medium- and long-term monitoring, which is useful for both research and university environmental management.

The observed pattern suggests that UDH not only exhibits greater richness (Chao1) but also greater effective diversity (Shannon and Simpson), which is consistent with a campus offering greater environmental heterogeneity (vegetation layers, microhabitats, food resources, and refuge/nesting sites) and lower disturbance pressure.

It is recommended to prioritize interventions that increase habitat structural complexity and resource availability, including increasing the number of native trees and shrubs, creating connected vegetation patches, and maintaining a diverse green matrix rather than relying solely on lawns. In parallel, measures to reduce disturbance should be implemented, as these can have a high impact at relatively low cost: regulating pedestrian and vehicular traffic in green areas, managing waste to prevent artificial trophic subsidies, and scheduling pruning and construction activities outside sensitive periods. Finally, it is recommended to establish a standardized monitoring program using the same sampling points, times, and seasons, complemented by accumulation/rarefaction curves and, where possible, turnover (beta-diversity) analyses to identify which components of the community explain the observed differences and to guide targeted actions for the campus with lower diversity.

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References

Alba, R., Marcolin, F., Ferrario, V., Assandri, G., Ilahiane, L., Cochis, F., Regaiolo, I., Rubolini, D., Caprio, E., & Chamberlain, D. (2025). Urban bird diversity and ecosystem services are shaped by fine-scale habitat features. *npj Urban Sustainability*, *5*(1), 114. https://doi.org/10.1038/s42949-025-00322-9

Angulo-Pérez, N. C., Armas-Silva, J. A., Díaz Alván, J., Torres-Vásquez, M. I., Pérez-Peña, P., and Pezo Díaz, R. (2022). Diversidad de aves y su relación con la vegetación en la ciudad de Iquitos, Loreto, Perú. *Ciencia Amazónica (Iquitos)*, *10*(1-2), 101-126. https://doi.org/10.22386/ca.v10i1-2.364

Arteaga Chávez, W. A. (2017). Diversidad de aves del campus universitario de la Universidad Central del Ecuador, Quito, Ecuador. *Siembra*, *4*(1), 172-182. https://doi.org/10.29166/siembra.v4i1.510

Benito, J. F., Escobar, M. A. H., and Villaseñor, N. (2019). Conservación en la ciudad: ¿cómo influye la estructura del hábitat sobre la abundancia de especies de aves en una metrópoli latinoamericana? *Gayana*, *83*(2), 114-125. https://doi.org/10.4067/S0717-65382019000200114

Carrión-Zambrano, P. E., Villavicencio-Cedeño, E. F., Becerra-Carrión, J. G., and Castillo-Ruperti, R. J. (2022). Monitoreo de riqueza y abundancia de avifauna urbana en dos áreas verdes de Manta, Ecuador. *FIGEMPA: Investigación y Desarrollo*, *14*(2), 102-110. https://doi.org/10.29166/revfig.v14i2.3729

Castillo Palacios, L., Castañeda Córdova, L., and Quinteros Carlos, Z. (2014). Aves del campus de la Universidad Nacional Agraria La Molina (Lima-Perú)-Una revisión de su abundancia, distribución y diversidad desde 1992 al 2010. *Ecología Aplicada*, *13*(1-2), 117-128. https://doi.org/10.21704/rea.v13i1-2.462

Castro, S. A., Rojas, P., Ray, C., & Jaksic, F. M. (2026). Urban native and non-native bird species are functionally redundant in Santiago, Chile. *Urban Ecosystems*, *29*, 52. https://doi.org/10.1007/s11252-026-01922-8

Chao, A. (1984). Nonparametric estimation of the number of classes in a population. *Scandinavian Journal of Statistics*, *11*(4), 265-270. https://www.jstor.org/stable/4615964

Cornell Lab of Ornithology. (2023). *Merlin Bird ID* (Version 3.5.2) [Mobile app]. Google Play Store. https://play.google.com/store/apps/details?id=com.labs.merlinbirdid.app

Garaffa, P. I., Filloy, J., & Bellocq, M. I. (2009). Bird community responses along urban-rural gradients: Does the size of the urbanized area matter? *Landscape and Urban Planning*, *90*(1-2), 33-41. https://doi.org/10.1016/j.landurbplan.2008.10.004

Hammer, Ø., Harper, D. A. T., & Ryan, P. D. (2001). PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica*, *4*(1), 1-9. https://palaeo-electronica.org/2001_1/past/issue1_01.htm

Jumilawaty, E., Saragih, J. E., & Nasution, A. L. A. (2024). Avian species and diversity on the campus of Universitas Sumatera Utara, Medan City. *IOP Conference Series: Earth and Environmental Science*, *1352*, 012074 https://doi.org/10.1088/1755-1315/1352/1/012074

Leveau, L. M., Jokimaki, J., & Kaisanlahti-Jokimäki, M.-L. (2017). Scale dependence of biotic homogenisation by urbanisation: A comparison of urban bird communities between central Argentina and northern Finland. *European Journal of Ecology*, *3*(2), 1-18. https://doi.org/10.1515/eje-2017-0011

Madrid Ibarra, F., & Cruzado Elías, C. (2017). Avistamiento de aves en el campus de la Universidad Ricardo Palma, Lima, Perú. *Biotempo*, *14*(2), 167-177. https://doi.org/10.31381/biotempo.v14i2.1667

Magurran, A. E. (2004). *Measuring biological diversity*. Blackwell Publishing.

McKinney, M. L. (2002). Urbanization, biodiversity, and conservation: The impacts of urbanization on native species are poorly studied, but educating a highly urbanized human population about these impacts can greatly improve species conservation in all ecosystems. *BioScience*, *52*(10), 883-890. https://doi.org/10.1641/0006-3568(2002)052[0883:UBAC]2.0.CO;2

Muñoz-Pedreros, A., González-Urrutia, M., Encina-Montoya, F., & Norambuena, H. V. (2018). Effects of vegetation strata and human disturbance on bird diversity in green areas in a city in southern Chile. *Avian Research*, *9*, 38. https://doi.org/10.1186/s40657-018-0130-9

Pielou, E. C. (1966). The measurement of diversity in different types of biological collections. *Journal of Theoretical Biology*, *13*, 131-144.

Sanllorente, O., Ríos-Guisado, R., Izquierdo, L., Molina, J. L., Mourocq, E., & Ibáñez-Álamo, J. D. (2023). The importance of university campuses for the avian diversity of cities. *Urban Forestry & Urban Greening*, *86*, 128038. https://doi.org/10.1016/j.ufug.2023.128038

Serna-Lagunes, R., Torres-Cantú, G. B., and García-Martínez, M. Á. (2023). Avifauna en fragmentos de bosque mesófilo de montaña y vegetación secundaria en el municipio de Huatusco, Veracruz. *CienciaUAT*, *18*(1), 6-24. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-78582023000200006

Shannon, C. E. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, *27*(3), 379-423.

Silva, C. P., Sepúlveda, R. D., & Barbosa, O. (2016). Nonrandom filtering effect on birds: Species and guilds response to urbanization. *Ecology and Evolution*, *6*(11), 3711-3720. https://doi.org/10.1002/ece3.2144

Simpson, E. H. (1949). Measurement of diversity. *Nature*, *163*, 688. http://dx.doi.org/10.1038/163688a0

Sultana, M., Corlatti, L., & Storch, I. (2021). The interaction of imperviousness and habitat heterogeneity drives bird richness patterns in south Asian cities. *Urban Ecosystems*, *24*, 335-344. https://doi.org/10.1007/s11252-020-01037-8

Ugalde-Lezama, S., Romero-Díaz, C., Tarango-Arámbula, L. A., and García-Núñez, R. M. (2022). Influencia del hábitat

en la diversidad de aves insectívoras en un sistema agroforestal enclavado en un bosque mesófilo de montaña. *CienciaUAT*, *16*(2), 6-25. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-78582022000100006

Vides-Hernández, G. L., Velado-Cano, M. A., Pablo-Cea, J. D., y Carmona-Galindo, V. D. (2017). Patrones de riqueza y diversidad de aves en áreas verdes del centro urbano de San Salvador, El Salvador. *Huitzil. Revista Mexicana de Ornitología*, *18*(2), 272-280. https://doi.org/10.28947/hrmo.2017.18.2.294

Zhao, Z., Borzée, A., Chen, S., Hui, S., & Zhang, Y. (2022). *Urban bird community assembly mechanisms and driving factors in university campuses in Nanjing, China.* Research Square. https://doi.org/10.21203/rs.3.rs-2195501/v1

Author contributions

MFAR[1]: conceptualization of the study, methodological design, field data collection, and preliminary analysis of bird diversity.

MAS[2]: identification of ornithological species, data processing, and preparation of distribution maps on university campuses.

HRC[3]: comparative statistical analysis (diversity indices such as Shannon and Simpson), writing of the results and discussion.

FECL[4]: overall project supervision, final manuscript writing, critical review, and primary correspondence.

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