



Research Article

Biodiversity Assessment of Urban Parks and Bela Forest, Gujranwala, Punjab, Pakistan

Ayesha Qaiser¹, Hafiz Muhammad Tahir^{1*}, Khalil Ali², Abu Huraira², Abid Hussainy², Fatima Ijaz¹, Ayesha Muzamil¹, Ayesha Afzal¹ and Rabia Fajar Ali¹

¹Department of Zoology, Government College University Lahore

²The Urban Unit (Urban Sector Planning & Management Services Unit), Planning & Development Board, Lahore, Punjab.

Article History

Received: July 27, 2025

Revised: November 05, 2025

Accepted: November 26, 2025

Published: May 02, 2026

Authors' Contributions

AQ, AA, AM, FI, RFA: Data curation; HMT: Conceptualization and supervision; KA: Investigation; A Huraira: Visualization; A Hussainy: Supervision. All authors have read and approved the final version of the manuscript.

Keywords

Urban biodiversity, Gujranwala, Bela Forest, Conservation, Conservation area



Copyright 2026 by the authors. Licensee ResearchersLinks Ltd, England, UK. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Abstract | The present study was conducted to assess the biodiversity of Gujranwala city, focusing on floral and faunal components found in urban parks and conservation area (Bela Forest). Field surveys were carried out for two weeks to record plant and animal species, supported by stakeholders' consultations. A total of 61 plant and 35 bird species were recorded during the survey. SWOT analysis revealed that most parks lack basic amenities (toilets, drinking water, seating etc.) and security particularly during evening hours. Outskirts of the Gujranwala city have scarce green spaces. Illegal logging, waste dumping, encroachment, sewage disposal into canals and parks were also observed. Invasive tree species like Paper Mulberry, Eucalyptus, and Conocarpus are adversely affecting native biodiversity, groundwater levels, and human health. These findings suggest that urban biodiversity can be improved by plantation of more native trees along with policy making and raising awareness. Significantly higher values of Menhinick (≥ 1.5), Shannon-Weiner (≥ 3.5), and Evenness index (≥ 0.87), calculated for plant biodiversity, were recorded at Gulshan Iqbal Park, Jinnah Park, Sheranwala Bagh, and Milaad e Mustafa. The higher values of diversity indices indicate a healthier, more balanced, and ecologically stable park. The urban residents of Gujranwala have access to an estimated 0.1 hectares of green space for every 1,000 individuals, with only 9.1% of the city's residents living within 400 meters of a park or green area, which is considerably lower than the international standards. The outcomes of the present study offer a baseline for subsequent research and urban biodiversity management initiatives.

Novelty Statement | This study presents the biodiversity assessment of urban parks and Bela forest ecosystems in Gujranwala, Pakistan. It provides baseline ecological data using standardized diversity indices to support urban conservation and sustainable green space planning.

To cite this article: Qaiser, A., Tahir, H.M., Ali, K., Huraira, A., Hussainy, A., Ijaz, F., Muzamil, A., Afzal, A. and Ali, R.F., 2026. Biodiversity assessment of urban parks and Bela forest, Gujranwala, Punjab, Pakistan. *Punjab Univ. J. Zool.*, 41(1): 85-94. <https://dx.doi.org/10.17582/journal.pujz/2026/41.1.85.94>

Introduction

As urban areas expand and more individuals relocate to cities, it becomes crucial to safeguard the nature within

these urban centers. With the rapid expansion of urban areas, the challenge of conserving biodiversity has gained global attention. Biodiversity refers to all living things, from genes to entire ecosystems (Purvis and Hector, 2000). Conservation of urban biodiversity is essential as it supports human health by supplying essential resources such as medicinal compounds, nutrient-rich food, and clean water. It further supports human by creating visually

Corresponding author: Hafiz Muhammad Tahir
dr.hafiztahir@gcu.edu.pk

appealing rich natural environments and spaces that foster the physical activity and social interaction (Van Genuchten, 2023). It strengthens ecosystem resilience which enable the ecosystem to sustain and adapt to climate change and other environmental pressures, helps preserve native species within rapidly urbanizing landscapes (Elmqvist *et al.*, 2015; Aronson *et al.*, 2017; Kumar, 2024), This also maintain the ecosystem services, such as pollination, nutrient cycling, and climate regulation.

Currently biodiversity is facing numerous threats due to anthropogenic activities which lead to significant ecological imbalances. Key factors include habitat destruction, climate change, invasive species, and pollution. Habitat destruction is a leading cause of biodiversity loss (Singh, 2014). Fragmentation divides habitats into smaller, isolated patches which hinders species movement and reproduction (Sher, 2022). Global warming also alters ecosystems, affecting species distribution and survival (Pec *et al.*, 2024). These threats not only endanger species but also compromise ecosystem services which are essential for human wellbeing.

Aim of current study is to assess the diversity of trees and animals especially birds and mammals in urban settings and Bela Forest of Gujranwala. Biodiversity assessment of Gujranwala's urban parks and Forest is crucial for evaluating ecological integrity, species composition, and habitat quality of these areas. It is also helpful in identify native and invasive species of plants and animals, anthropogenic impacts on fauna and flora and enhancing ecosystem services. The outcomes of the study not only provide a baseline for biodiversity management in Gujranwala but also reveal where the city stands in comparison to other urban centers of Punjab. Such assessments also provide baseline data crucial for long-term monitoring and policy-making.

Materials and Methods

Study area

Gujranwala city was selected to assess the diversity of trees and animals from urban settings and Bela Forest (Figure 1). Gujranwala is the seventh largest city of the Pakistan (Naz *et al.*, 2013). As per census Pakistan Bureau of Statistics (2023), the total population of Gujranwala is 25 million. The city has many developed and undeveloped parks which provided us better opportunity to assess biodiversity in urban areas. Table 1 presents the comprehensive list of parks included in the biodiversity assessment. Figure 2 depicts the spatial distribution of habitat types and conservation areas within Gujranwala. The field survey was conducted from February to March 2025.

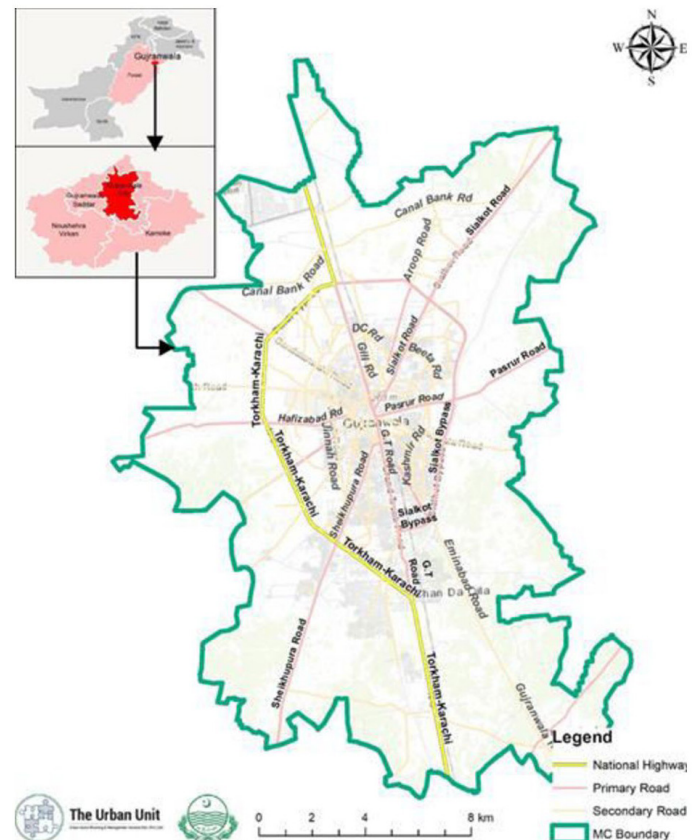


Figure 1: Geographical location map of Gujranwala.

Table 1: List of parks of and Gujranwala city.

S. No.	Parks of Gujranwala
1	Al Fatah Park
2	Aroop Park
3	Ayesha Bibi Park
4	Chahar Bagh
5	Ghulam Hussain Park
6	Gulshan Iqbal Park
7	Jinnah Park
8	Kashmir Park
9	Liaqat Park
10	Madar e Milat Park
11	Milad e Mustafa Park
12	Sheranwala Bagh

Collection of secondary source data

Prior to the collection of primary data, a comprehensive secondary research phase was undertaken. This involved an in-depth review of both peer-reviewed and grey literature, including official reports, policy documents, and datasets related to urban biodiversity, green and blue infrastructure, and environmental stressors specific to Gujranwala. Additionally, a series of consultative meetings were conducted with key institutional stakeholders, including representatives from the Parks and Horticulture Authority (PHA), Punjab Wildlife Department, and Forest Department. These engagements were essential for

integrating expert perspectives and institutional expertise on the composition, distribution, and threats to urban flora and fauna.

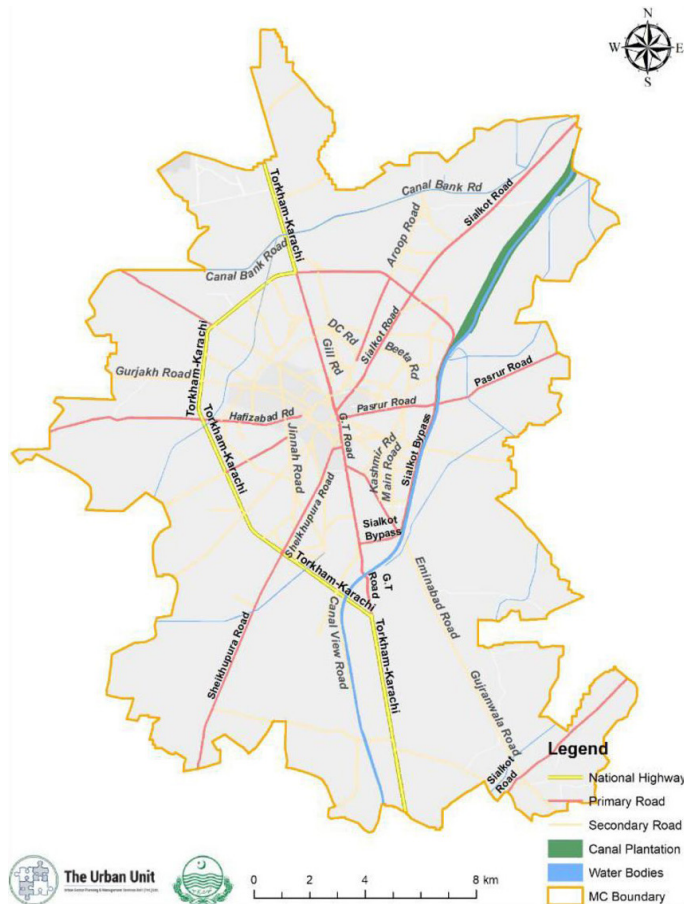


Figure 2: Spatial distribution of habitat and conservation area of Gujranwala.

The faunal diversity

To record the diversity of birds in different parks Point Count Method was used (Rosenstock *et al.*, 2002). This is a common bird monitoring technique where observers record bird species and their numbers at specific locations, or points. During this method randomly selected points at different locations (Gulshan Iqbal Park, Jinnah Park, Model Town Park, Sheranwala Bagh and Kashmir Park) were observed for a fixed time (30 minutes) while staying there to made observations and count all the birds detected by sight or sound within a predetermined radius (50 m). The process was replicated across multiple sites to gather comprehensive data on population sizes and species richness. The process was replicated across five sites mentioned as mentioned earlier.

The diversity of other animals, including reptiles and mammals was recorded in Bela Forest using Transect Method, which is a widely used technique to record the distribution and abundance of various animal species across a specific area (Hessenmöller *et al.*, 2013). A 3 km linear transect was selected within the Bela Forest and biodiversity survey was conducted by recording organisms

at standardized intervals along transect to record the species. The traces like footprints and hairs along with other clues, were also recorded to confirm the presence of specific animals.

The floral diversity

To record the plant diversity above listed parks were physically visited and number of plants of each species was recorded. Plant species were identified by examining phyllotaxy and floral morphology, using available literature and the electronic flora of Pakistan. However, photographs of unidentified plants were taken and plant parts were sampled and brought to the Government College University Lahore for identification consulting the plant biodiversity experts at the University. The plants were also categorized on basis of their ecological status as native, invasive and introduced species. The richness, diversity and evenness of plant species were calculated by using Menhinick Index, Shannon-Weiner Index and Evenness Index, respectively.

Diversity indices

Menhinick index: It is a measure of species richness. It gives the quantification of biodiversity within a community. It is straightforward and easy to compute. It is widely used in making ecological assessments (Ozkan *et al.*, 2024). The formula used to compute it is:

$$Dmn = S / \sqrt{N}$$

Where; S: Total number of species in the sample, N: Total number of individuals in the sample.

Shannon-weiner index

For the quantification of biodiversity and genetic diversity, the Shannon-Weiner Index was used. By considering both the number of species and their relative abundances, it measures the diversity of a community. It ranges from 0 (no diversity) to higher values indicating greater diversity (Ramezani, 2012). The index is calculated using following formula:

$$H = -\sum (p_i * \ln(p_i))$$

Where, p_i is the proportion of individuals of species i and $\ln$ is the natural logarithm.

Evenness index

The distribution of species abundances within an ecological community is assessed by using evenness index (E5). It is also known as modified Hill's ratio. A value closer to 1 indicates more even distribution, while a value closer to 0 indicates dominance of a single species or genotype (Grünwald *et al.*, 2003). E5 is less sensitive to changes in the total number of species or genotypes in the sample that's why it is used (Neher *et al.*, 2004). The formula is as

follows:

$$E5 = (1/(\sum p_i^2))/\ln(N) \text{ or } E5 = ((1/(\sum p_i^2)) - 1)/(\ln(N) - 1)$$

Where: p_i : represents the relative abundance of the i -th genotype (or species) in the sample; N : is the total number of genotypes (or species) in the sample. $\ln$: is the natural logarithm.

SWOT analysis

This analysis was used to identify strengths, weaknesses, opportunities, and threats related to biodiversity and conservation efforts in Gujranwala. For this analysis, data were systematically collected on public facilities available within the parks, identified deficiencies, daily visitor counts across different parks, and staff availability. This comprehensive data was collected for a thorough assessment of park infrastructure, usage patterns and management capacity to inform sustainable urban green space planning and addressing biodiversity challenges (Gürel and Tat, 2017).

Health and well-being assessment

Structured interviews were conducted with the visitors to gather insights on user perceptions regarding park conditions and overall well-being. Additionally, the availability and accessibility of green spaces in Gujranwala were assessed by analyzing the population residing within a 400-meter radius of parks or green areas. The collected data were subsequently compared against established international benchmarks for urban green space provision and accessibility.

Results

Faunal profile of Gujranwala

A total number of 35 bird species were recorded from the Parks of the Gujranwala urban area. Out of 35 birds, 30 were local or resident birds, while 5 were the migratory birds. This number also include the species which were not physically observed but reported by the local stakeholders. The common birds recorded during the survey include Shikra, White-throated kingfisher, Litter swift, Cattle egret, Red-vented bulbul, Purple sunbird, Black kite, House sparrow, House crow, Common myna, Bank myna, Little brown dove, Common babbler and Pied bush chat.

In the Bela Forest Jungle cat, Golden jackal, Squirrel, Wild boar, Stray dogs and Rats were recorded. Figure 3 is showing number of five most common birds observed at different parks in Gujranwala. Detail list of bird species with their common and scientific names along with IUCN status are enlisted in Table 2.

Floral profile of Gujranwala

A total of 61 tree species were recorded from the

urban parks and Bela Forest. Out of 61 plant species recorded from Gujranwala only 3 were invasive species, 24 introduced and 34 native species. A detailed list of plant species is given in Table 3. Common plants include certain species of Ficus, Neem, Palm species, Peepal, Sukh chain, Amaltas, Ulta ashoq, Alstonia, Kachnar, Conocarpus, Mulberry, Eucalyptus, Banyan, Palms and Bottlebrush. Figure 4 is showing the number tree species recorded from different Parks. Gulshan Iqbal Park (34) shows highest number of tree species followed by Sheranwala Park (33), Milaad e Mustafa Park (33), Jinnah Park (29), Liaqat Park (20), Madar e Millat Park (18), Al-Fatah Park (14), Chahar Baagh (10), Ghulam Hussain Park (9), Kashmir Park (GT Road) (5), Ayesha Bibi Park (5) and Aroop Park (3).

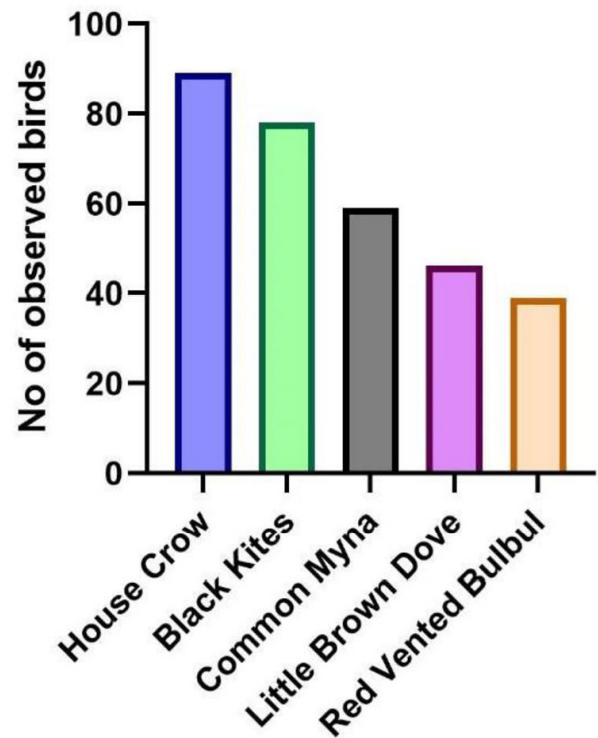


Figure 3: Five most common birds in urban areas of Gujranwala.

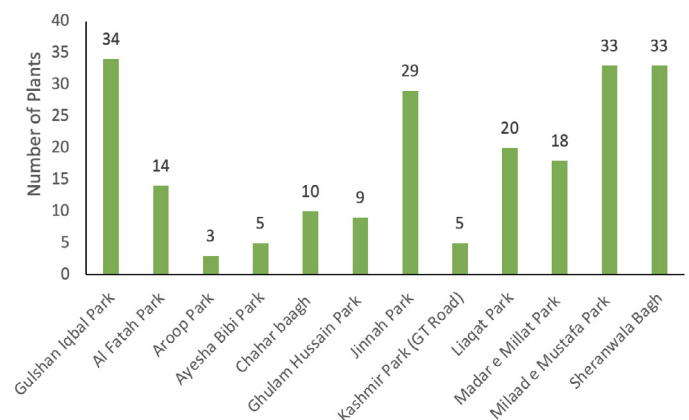


Figure 4: Trees distribution in different parks of Gujranwala.

Table 2: List of birds recoded from parks and conserved areas (Bela forest) of Gujranwala.

S. No.	Common name	Scientific name	IUCN status
1	House Sparrow	<i>Passer domesticus</i>	LC
2	Common Myna	<i>Acridotheres tristis</i>	LC
3	Rock Pigeon	<i>Columba livia</i>	LC
4	Red-vented Bulbul	<i>Pycnonotus cafer</i>	LC
5	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	LC
6	Laughing Dove	<i>Spilopelia senegalensis</i>	LC
7	Indian Koel	<i>Eudynamys scolopaceus</i>	LC
8	House Crow	<i>Corvus splendens</i>	LC
9	Jungle Babbler	<i>Argya striata</i>	LC
10	Pied Myna	<i>Gracupica contra</i>	LC
11	Bank Myna	<i>Acridotheres ginginianus</i>	LC
12	White-throated Kingfisher	<i>Halcyon smyrnensis</i>	LC
13	Common Kingfisher	<i>Alcedo atthis</i>	LC
14	Little Egret	<i>Egretta garzetta</i>	LC
15	Cattle Egret	<i>Bubulcus ibis</i>	LC
16	Black Kite	<i>Milvus migrans</i>	LC
17	Shikra	<i>Accipiter badius</i>	LC
18	Green Bee-eater	<i>Merops orientalis</i>	LC
19	Asian Green Bee-eater	<i>Merops leschenaultia</i>	LC
20	Purple Sunbird	<i>Cinnyris asiaticus</i>	LC
21	Indian Robin	<i>Copsychus fulicatus</i>	LC
22	Oriental Magpie-Robin	<i>Copsychus saularis</i>	LC
23	Common Tailorbird	<i>Orthotomus sutorius</i>	LC
24	Ashy Prinia	<i>Prinia socialis</i>	LC
25	Rose-ringed Parakeet	<i>Psittacula krameri</i>	LC
26	Brown-headed Barbet	<i>Psilopogon zeylanicus</i>	LC
27	Common Hoopoe	<i>Upupa epops</i>	LC
28	Indian Roller	<i>Coracias benghalensis</i>	LC
29	Common Swallow	<i>Hirundo rustica</i>	LC
30	Common Rock Chat	<i>Cercomela fusca</i>	LC
31	Indian Ring Dove	<i>Streptopelia decaocto</i>	LC
32	Little Brown Dove	<i>Streptopelia senegalensis</i>	LC
33	Red Turtle Dove	<i>Streptopelia tranquebarica</i>	LC
34	Common Babbler	<i>Turdoides caudatus</i>	LC
35	Common Hoopoe	<i>Upupa epops</i>	LC

Diversity indices

Figure 5 is showing biodiversity indices of different parks of Gujranwala. Gulshan Iqbal Park, Jinnah Park, Sheranwala Bagh, and Milaad e Mustafa Park represent high values of biodiversity with elevated Menhinick (≥ 1.5) and Shannon-Weiner indices (≥ 3.5), indicating a rich and diverse species presence. Their Evenness values (≥ 0.87) reflect a more balanced distribution among species. In contrast, Al Fatah, Aroop, and Ayesha Bibi Parks show

low diversity and evenness, with all indices indicating poor ecological richness and dominance of a few species. Kashmir Park and Chahar Baagh have moderate Menhinick index values but low evenness and Shannon-Weiner scores, suggesting that species are not evenly distributed.

Table 3: List of plant species recorded from different urban parks and protected area (Bela forest) of Gujranwala.

S. No	Common name	Scientific name	Ecological status
1	Aerocaria	<i>Araucaria araucana</i>	Introduced
2	Amaltas	<i>Cassia fistula</i>	Local
3	Amrood	<i>Psidium guajava</i>	Introduced
4	Anaar	<i>Punica granatum</i>	Local
5	Anjeer	<i>Ficus carica</i>	Introduced
6	Arjun	<i>Terminalia arjuna</i>	Local
7	Bakain (Darek)	<i>Melia azedarach</i>	Local
8	Beri (Indian jujube)	<i>Ziziphus mauritiana</i>	Local
9	Boardh	<i>Ficus benghalensis</i>	Local
10	Bottle Brush	<i>Callistemon viminalis</i>	Introduced
11	California fan palm	<i>Washingtonia filifera</i>	Introduced
12	Cedar	<i>Cedrus deodara</i>	Local
13	Chandani	<i>Tabernaemontana divaricata</i>	Local
14	Citrus (mosambi)	<i>Citrus limetta</i>	Introduced
15	Conocarpus	<i>Conocarpus erectus</i>	Invasive
16	Date palm	<i>Phoenix dactylifera</i>	Introduced
17	Devil Tree (Alstonia)	<i>Alstonia scholaris</i>	Introduced
18	Gab	<i>Diospyros blancoi</i>	Introduced
19	Gold mohar	<i>Delonix regia</i>	Introduced
20	Gul e cheen	<i>Plumeria rubra</i>	Introduced
21	Ipil ipil (Epple epple)	<i>Leucaena leucocephala</i>	Introduced/ Invasive
22	Jacaranda	<i>Jacaranda mimosifolia</i>	Introduced
23	Jamun	<i>Syzygium cumini</i>	Local
24	Jhar Beri (Wild jujube)	<i>Ziziphus nummularia</i>	Local
25	Jia Patta (Patta jin)	<i>Putranjiva roxburghii</i>	Local
26	Kachnar	<i>Bauhinia variegata</i>	Local
27	Kanair	<i>Nerium oleander</i>	Local
28	Kari patta	<i>Murraya koenigii</i>	Local
29	Lagerstroemia	<i>Lagerstroemia speciosa</i>	Local
30	Lasoor	<i>Cordia dichotoma</i>	Local
31	Louqath	<i>Eriobotrya japonica</i>	Introduced
32	Mango	<i>Mangifera indica</i>	Local
33	Melaleuca	<i>Melaleuca quinquerervia</i>	Introduced/ Invasive
34	Molsari	<i>Mimusops elengi</i>	Local

Table continued on next page.....

S. No	Common name	Scientific name	Ecological status
35	Nag phali	<i>Heterophragma adenophyllum</i>	Local
36	Neem	<i>Azadirachta indica</i>	Local
37	Oak	<i>Quercus spp.</i>	Local
38	Peepal	<i>Ficus religiosa</i>	Local
39	Pilkhan	<i>Ficus virens</i>	Local
40	Pine	<i>Pinus wallichiana</i>	Local
41	Pygmy date palm	<i>Phoenix roebelenii</i>	Introduced
42	Queen palm	<i>Syagrus romanzoffiana</i>	Introduced
43	Ras phali	<i>Grewia asiatica</i>	Local
44	Royal palm	<i>Roystonea regia</i>	Introduced
45	Rubber plant	<i>Ficus elastica</i>	Introduced
46	Safeda (River Red Gum)	<i>Eucalyptus camaldulensis</i>	Invasive
47	Safeda (Lemon-scented)	<i>Eucalyptus citriodora</i>	Invasive
48	Sausage tree (Kheera)	<i>Kigelia africana</i>	Introduced
49	Seedha Ashoq	<i>Saraca asoca</i>	Local
50	Sheesham	<i>Dalbergia sissoo</i>	Local
51	Shehtoot	<i>Morus alba</i>	Introduced
52	Shirin	<i>Colchicum autumnale</i>	Introduced
53	Silk floss	<i>Ceiba speciosa</i>	Introduced
54	Silver Oak	<i>Grevillea robusta</i>	Introduced
55	Silver Thatch Palm	<i>Coccothrinax argentata</i>	Introduced
56	Sohanjana	<i>Moringa oleifera</i>	Local
57	Sukh Chaen	<i>Pongamia pinnata</i>	Local
58	Sumbal	<i>Bombax ceiba</i>	Local
59	Terminalia	<i>Terminalia mentalis</i>	Introduced
60	Ula ashoq	<i>Polyalthia longifolia</i>	Local
61	Weeping Fig	<i>Ficus benjamina</i>	Introduced

sessions with the community, institutions and stakeholders.

Strengths

Gujranwala city possess diverse ecosystems with multiple green spaces such as Jinnah Park, Gulshan-e-Iqbal Park, Sheranwala Bagh, Aroop Park, Liaquat Park, and Chahar Bagh and Nawaz Sharif Park. Jinnah Park is well-maintained with walking tracks, seating and play areas, Gulshan Iqbal Park attracts families and fitness enthusiasts while Sheranwala Bagh holds historical significance and hosts cultural events. These green areas not only serves as recreational hubs but also support migratory and native birds. Wildlife and PHA departments in collaboration of Yar Madadgar NGO are actively working to plant native trees in parks, installing birds houses and soil recharging system in different parks. A parrot house has also been established in Gulshan-e-Iqbal Park. Wildlife Department conducts raids against illegal bird hunting and trading in the area as result of which population of sparrows which was under threat is once again increasing rapidly. Bela Forest is contributing significantly to the conservation of habitat and environmental education. It also acts as a natural carbon sink with native trees (Sheesham, Kikar, Mulberry, Suck chain etc.) and wildlife and serves as recreational hub by providing people access with the nature. Initiatives like “Clean and Green Pakistan,” urban forestry, and plantation drives are actively working for the improvement of green infrastructure in city. In Gujranwala, the engagement of school and citizen plays an important role in environmental awareness.

Weakness

Basic amenities like public toilets, restrooms, prayer rooms, wifi facility, clean drinking water, waste bins and seating desks are not available in most of the parks including smaller parks (Al-Fatah, Ayesha Bibi Park). Central city areas have parks but outskirts have limited number of green spaces. Security issues (low staffing, poor lightening and drug use) were observed in Kashmir Park and Liaquat Park. Illegal logging, waste dumping, and encroachment was reported by the stakeholders. Pollution from industrial waste and sewage disposal into canals was also recorded, which is significantly affecting water quality and aquatic life. Invasive tree species like Paper Mulberry, Eucalyptus, and Conocarpus are posing negative impacts on native biodiversity, groundwater levels, and human health. Poor management was observed in Al-Fatah and Chahar Park. These parks have broken boundaries, lack security, and insufficient maintenance. No dedicated biodiversity research and monitoring system is available in the city.

Opportunities

To promote Eco-Tourism in Bela Forest bird-watching towers and educational signage should be installed. Water coolers and plastic waste management containers should be

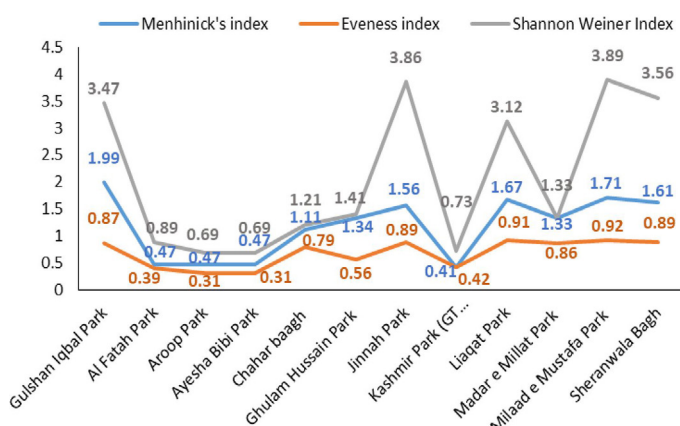


Figure 5: Biodiversity indices of different sites of Gujranwala.

SWOT analysis of Gujranwala city

The SWOT analysis of Gujranwala city was conducted based on the field assessment and repeated consultation

installed through cooperation of Nestlé, Coca-Cola, Sufi Ghee etc. Solar lights, rainwater harvesting, and digital apps for reporting park's related issues should also be added. Expanding parks, green corridors, and mini forests can reconnect fragmented habitats. The involvement of community in awareness campaigns and conservation drives can enhance environmental stewardship. Butterfly gardens and bird sanctuaries can be established in major parks of Gujranwala like Jinnah Park, Gulshan-e-Iqbal Park, Sheranwala Bagh etc. to attract visitors. Adopt a park initiative for maintenance may be introduced especially in the parks located in housing societies. Cross-sector collaboration between public departments, private stakeholders, and academia can bring expertise and funding to biodiversity-focused projects.

Threats

In markets, there is illegal selling of bird's species like house sparrows and falcons, despite bans. In Gatwala Forest, poachers target wintering ducks and cranes using illegal nets. Wildlife Department lacks patrol vehicles, while local police rarely assist. There is lack of public awareness, only few person know that harming birds can pose heavy fines under Punjab Wildlife Act. Emissions from vehicles, factories, and construction activities are degrading air and soil quality leading to biodiversity decline. Littering, vandalism, and illegal use of public green spaces such as Al-Fatah Park pose risks to wildlife and plant health. Shrinking of green spaces increase human-wildlife conflicts, such as stray dog attacks or loss of bird nesting sites due to pesticide use and pollution. Invasive trees like Eucalyptus, Conocarpus, and Paper Mulberry continue to compete with native flora. These invasive trees fail to support species like the Indian Robin and Red-vented Bulbul in urban environments.

Health and well-being assessment

The availability of green spaces is significantly below international standards in Gujranwala, with only 0.1 hectares of green space per 1,000 people. Moreover, only 19.1% of Gujranwala's population resides within 400 meters of a park or green area. Figure 6 is showing population living near green spaces and open ground in Gujranwala.

Discussion

As urbanization accelerates across Pakistan, urban cities like Gujranwala face many challenges in preserving their biological diversity. Current study aimed to assess the biodiversity status of Gujranwala urban parks and Bela Forest. The findings of this study underscore the urgent need for biodiversity action plans for this rapidly developing city. Parks serve as the biodiversity hotspots and play crucial role in biodiversity conservation by providing habitats for various species and maintain ecological balance.

They preserve native species of diverse plants and animals and are critical for maintaining species richness despite the urban matrix (Nielsen *et al.*, 2014). When designing urban parks, it is important to think about the needs of different types of species, like birds, insects, and plants. Each group depends on different things to survive. For example, birds may need trees to build nests, while insects might need flowers or moist soil. By including a mix of plants, water, shade, and open areas, parks can support more kinds of wildlife. This helps in making better plans to protect many species in cities (Khurshida, 2022).

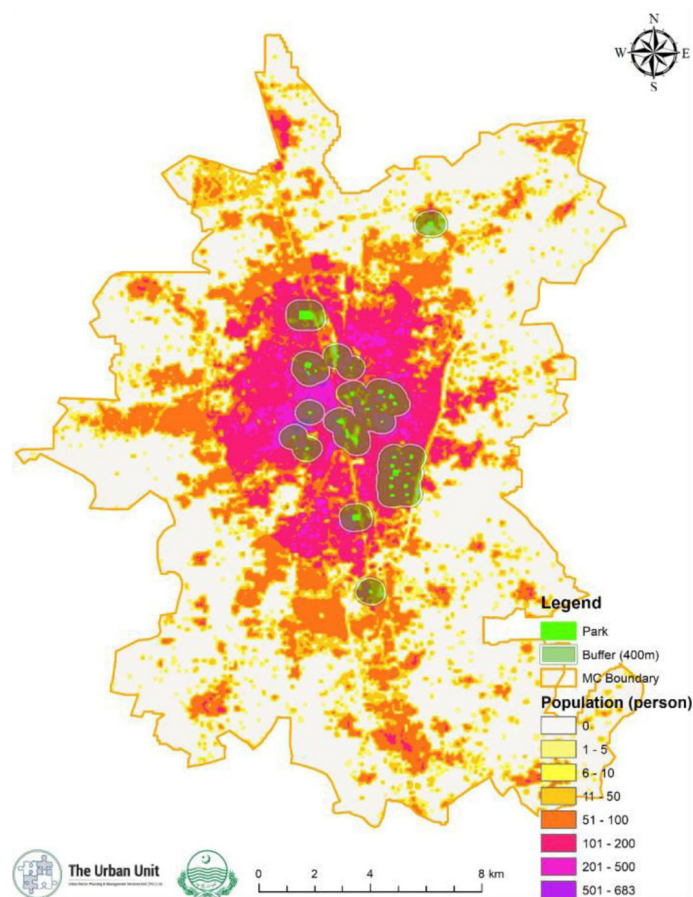


Figure 6: Population living near green spaces and open ground in Gujranwala.

The Gujranwala city support diverse bird species, with 35 species recorded. The majority of birds are local or resident species, while a smaller portion comprises migratory birds. Common urban birds such as the House sparrow, Common myna, Red-vented bulbul, House crow, and Black bite were frequently recorded in the area. In terms of mammalian fauna, Gujranwala's Bela Forest is home to species such as the Jungle cat, Golden jackal, Wild boar, and Squirrel, suggesting the presence of more natural and forested habitats in the area. Present research was carried out in the month of February-March, but if the observation period or duration would have been extended then there would have been chances of a high number of observed species. Also, migratory birds typically have a seasonal trend and recoded number of species may

vary with time of survey. The study carried out by [Altamash et al. \(2012\)](#) reported 41 bird species in urban regions of Gujranwala but 35 bird species were seen in our study. This difference is possibly because of difference in timing of study conduction. Another study identified 24 bird species from different nesting sites such as electricity towers and transmission lines in Gujranwala with House crow and Black kite as the most common birds in Gujranwala ([Noreen and Sultan, 2022](#)).

A total of 61 tree species were recorded from Gujranwala urban parks. In Gujranwala, common plant species include Ficus, Neem, Palm species, Peepal, Sukh chain, Amaltas, Ulta ashok, Alstonia, Kachnar, Conocarpus, Mulberry, Eucalyptus, Banyan, Palms and Bottlebrush. Gujranwala hosts a higher proportion of native species (34 out of 61). The number of introduced species is 24, indicating a higher dependency on native flora in its urban green areas. The number of invasive species is 3, suggesting ecological threat from these plants. Invasive plants significantly impact local plant life by outcompeting them for resources, altering habitats, and reducing biodiversity ([Rai and Singh, 2020](#)).

This city is comprised of parks with range of high, moderate, and low levels of tree biodiversity. It reflects variability in ecological status across different parks of the city. Top parks in the city (e.g., Jinnah, Gulshan Iqbal, Milaad e Mustafa) exhibit high species richness, diversity, and evenness, indicating healthier and more balanced ecosystems. Low-performing parks in the city (e.g., Al Fatah, Ayesha Bibi) show poor biodiversity scores, dominated by few species, suggesting a need for conservation or restoration efforts.

The outcome of SWOT analysis showed that the presence of well-maintained parks in Gujranwala (Jinnah Park, Gulshan-e-Iqbal Park, and Model Town Park) supports a wide range of floral and faunal diversity. They also attract more visitors and provide peaceful environment. They can be a great source of revenue generation. Protected areas also play a vital role in conserving biodiversity by protecting habitats that support threatened species, thereby helping to prevent biodiversity loss ([Ozkan et al., 2024](#)). Protected areas like Bela Forest (Gujranwala) are the source of biodiversity hub as they conserve many species like sparrows, jackal, cat, bull, deer, bat species and much more. These protected areas can be used as grounds for conserving many kinds of species including threatened and endangered. The absence of boundary walls, lack of security and facility of toilets is major problem among parks of Gujranwala (Al-Fatah and Chahar Park) which is needed to be addressed. Moreover, the lack of basic requirements such as clean drinking water and restrooms evident in Gulshan-e-Iqbal Park (Gujranwala) negatively affects visitor comfort and safety. People don't like to visit

such parks as they are not user-friendly. Such parks can be maintained and improved by implementing certain laws and regulations. The presence of invasive species in the parks such as Paper Mulberry, Eucalyptus, and Conocarpus is major threat to local species. Paper Mulberry spread rapidly in forest zones and significantly affect local ecosystems ([Apetorgbor and Bosu, 2011](#)). Eucalyptus spp. invasions threaten native biodiversity by disrupting ecosystem stability and integrity thus, it negatively impact native plant species ([Badalamenti et al., 2018](#)). Conocarpus outcompetes native plants for resources, disrupting local biodiversity and potentially leading to the extinction of endemic species and its presence can alter habitat structures, affecting the overall ecosystem functions and services that native species provide ([Sesay et al., 2024](#)).

Complete eradication of invasive flora is not possible but step-wise measures can be taken to encourage plantation of native species in parks and discourage invasive tree species in plantation derives. Habitat fragmentation is caused by the urban sprawl and leads to loss of many species. This issue can be solved by expanding parks and establishing connections between ecological corridors. Promoting ecotourism and raising awareness about species conservation not only support environmental protection but also contribute to revenue generation. Major threats to biodiversity include climate change, pollution, deforestation, and urbanization, all of which have negative effects on the environment. It is essential to implement effective solutions (stricter environmental regulations, sustainable land use, protected area expansion, emission reduction, green technologies, public awareness campaigns, reforestation, pollution control, eco-friendly urban planning etc.) to minimize these threats in order to ensure the conservation of local biodiversity.

Health and Well Being Assessment in Gujranwala is crucial due to fluctuating environmental conditions. Health of residents is adversely affected by various factors i.e., high pollution levels, rapid urbanization and loss of green spaces. During the survey in various parks, most of the visitors were of the view that green spaces have significant impact on their physical and mental health. They feel relaxed and fresh from their frustrated lives after visiting these parks.

As recommended by the World Health Organization (WHO) cover area for green spaces must be 9 square meters per person but in Gujranwala 0.1 hectares of green space per 1,000 people is available as calculated using City Biodiversity Index as compared to 0.9 hectares/1,000 persons which is an international standard. This shortfall highlights a critical gap in urban planning concerning environmental health and community wellbeing. Only 9.1% of Gujranwala's population is residing within 400 meters of a park or green area underlines the urgent need

for targeted interventions to enhance green infrastructure and ensure equitable access across the city.

Currently limited published data is available regarding the urban biodiversity assessment. In the absence of previous records focusing specifically urban biodiversity, the current study offers a foundation for future research and long-term monitoring of biodiversity in the rapidly urbanizing cities. This biodiversity assessment of Gujranwala city not only provides a baseline for understanding the current state of urban flora and fauna but also highlights urgent management needs. Strategic planning and its proper implementation are crucial for the preservation and enhancement of existing biodiversity. These goals can be achieved through the active involvement of the government, non-governmental organizations (NGOs), and the local community.

Declarations

Acknowledgement

This study was supported by the Urban Unit, Lahore under the Government of Punjab's Planning and Development (P and D) Department, for GIS mapping and analysis.

Funding

This survey based study was funded by Urban Unit Planning and Development Department, Punjab, Pakistan.

IRB approval

The study was approved by departmental review board of Zoology Department, GC University Lahore.

Ethical statement

The study was conducted as per international standards. During the study no animal was harmed or killed.

Data availability statement

Data is available and can be provided on request.

Generative AI and AI-assisted technology statement

The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Statement of conflict of interest

The authors have declared no conflict of interest.

References

Altaf, M., Javid, A., Umair, M. and Khan, A.M., 2012. Status of wild birds and mammals in urban habitats of Gujranwala, Punjab, Pakistan. *Punjab Univ. J.*

Zool., **27**: 9–12.

Apetorgbor, M.M. and Bosu, P.P., 2011. Occurrence and control of paper mulberry (*Broussonetia papyrifera*) in southern Ghana. *Ghana J. For.*, **27**: 40–51.

Aronson, M.F.J., Lepczyk, C.A., Evans, K.L., Goddard, M.A., Lerman, S.B. and MacIvor, J.S., 2017. Biodiversity in the city: Key challenges for urban green space management. *Front. Ecol. Environ.*, **15**: 189–196. <https://doi.org/10.1002/fee.1480>

Badalamenti, E., Carapezza, R. and La Mantia, T., 2018. The ongoing naturalisation of *Eucalyptus* spp. in the Mediterranean Basin: New threats to native species and habitats. *Austral. For.*, **81**: 239–249. <https://doi.org/10.1080/00049158.2018.1533512>

Elmqvist, T., Setälä, H., Handel, S.N., van der Ploeg, S., Aronson, J., Blignaut, J.N., Gómez-Baggethun, E., Nowak, D.J., Kronenberg, J. and de Groot, R., 2015. Benefits of restoring ecosystem services in urban areas. *Curr. Opin. Environ. Sustain.*, **14**: 101–108. <https://doi.org/10.1016/j.cosust.2015.05.001>

Grünwald, N.J., Goodwin, S.B., Milgroom, M.G. and Fry, W.E., 2003. Analysis of genotypic diversity data for populations of microorganisms. *Phytopathology*, **93**: 738–746. <https://doi.org/10.1094/PHTO.2003.93.6.738>

Gürel, E. and Tat, M., 2017. SWOT analysis: A theoretical review. *J. Int. Soc. Res.*, **10**: 994–1006. <https://doi.org/10.17719/jisr.2017.1832>

Hessenmöller, D., Elsenhans, A.S. and Schulze, E.D., 2013. Sampling forest tree regeneration with a transect approach. *Ann. For. Res.*, **56**: 3–14. <https://doi.org/10.15287/afr.2013.30>

Khurshida, A., 2022. Detecting nestedness in city parks for urban biodiversity conservation. *Urban Ecosyst.*, **25**: 1839–1850. <https://doi.org/10.1007/s11252-022-01272-1>

Intergovernmental Panel on Climate Change (IPCC). 2021. Climate change 2021: The physical science basis. *Contribution of working group I to the sixth assessment report of the intergovernmental panel on climate change* (eds. V. Masson-Delmotte, P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou). Cambridge University Press. <https://www.ipcc.ch/report/ar6/wg1/>

Kumar, V., 2024. Biodiversity: Importance and climate change impacts. *Curr. Res. Med. Sci.*, **3**: 14–19. <https://doi.org/10.56397/CRMS.2024.09.03>

Naz, N. and Hussain, D.S.U.H., 2013. Historical perspective of urban development of Gujranwala. *J. Res. Archit. Plann. Depart. Archit. UET Lahore*.

Neher, D.A., Bongers, T. and Ferris, H., 2004. *Computation of nematode community indices [Workshop presentation]*. Society of Nematologists

- Workshop, Estes Park, Co. Dilbagh Singh, S.C. (2024). Biodiversity and Conservation.
- Nielsen, A.B., van den Bosch, M., Maruthaveeran, S. and van den Bosch, C.K., 2014. Species richness in urban parks and its drivers: A review of empirical evidence. *Urban Ecosyst.*, **17**: 305–327. <https://doi.org/10.1007/s11252-013-0316-1>
- Noreen, Z. and Sultan, K., 2022. Trees to towers shift: Power lines emerging as a novel habitat for birds in Gujranwala, Pakistan. *Pure Appl. Biol.*, **11**: 616–628. <https://doi.org/10.19045/bspab.20212.110063>
- Özkan, K., Özdemir, S., Şenol, A. and Küçüksille, E., 2024. A new species richness measure improved from Margalef and Menhinick indices. *Gazi Univ. J. Sci.*, **37**: 1056–1064. <https://doi.org/10.35378/gujs.1336792>
- Öztürk, M., 2024. Protected areas and conservation of biodiversity. *NUST J. Natl. Sci.*, **9**: 218. <https://doi.org/10.53992/njns.v9i4.218>
- Pakistan Bureau of Statistics, 2023. Home Pakistan Bureau of Statistics. Retrieved July 3, 2025, from <https://www.pbs.gov.pk/>
- Pecl, G.T., Stuart-Smith, J., Walsh, P., Bray, D.J., Kusumoto, B., Molinos, J.G., Burrows, M.T., Poloczanska, E.S. and Richardson, A.J., 2024. Biodiversity redistribution under climate change: Impacts on ecosystems and human well-being. *Science*, **383**: eabc3710.
- Purvis, A. and Hector, A., 2000. Getting the measure of biodiversity. *Nature*, **405**: 212–219. <https://doi.org/10.1038/35012221>
- Rai, P.K. and Singh, J.S., 2020. Invasive alien plant species: Their impact on environment, ecosystem services and human health. *Ecol. Indic.*, **111**: 106020. <https://doi.org/10.1016/j.ecolind.2019.106020>
- Ramezani, H., 2012. A note on the normalized definition of Shannon's diversity index in landscape pattern analysis. *Environ. Natl. Resour. Res.*, **2**: 54–60. <https://doi.org/10.5539/enrr.v2n4p54>
- Rosenstock, S.S., Anderson, D.R., Giesen, K.M., Leukering, T. and Carter, M.F., 2002. Landbird counting techniques: Current practices and an alternative. *Auk*, **119**: 46–53. <https://doi.org/10.1093/auk/119.1.46>
- Sesay, R.E.V., Sesay, F., Azizi, M.I. and Rahmani, B., 2024. Invasive species and biodiversity: Mechanisms, impacts, and strategic management for ecological preservation. *Asian J. Environ. Ecol.*, **23**: 82–95. <https://doi.org/10.9734/ajee/2024/v23i9600>
- Sher, A., 2022. Threats to biodiversity: Habitat change. In: *Textbook of environment and ecology* (ed. V. Singh). Springer. pp. 217–224. <https://doi.org/10.1093/hesc/9780197564370.003.0004>
- Singh, V., 2014. Threats to biodiversity. In: *Textbook of environment and ecology*. pp. 217–224. https://doi.org/10.1007/978-981-99-8846-4_14
- van Genuchten, E., 2023. How biodiversity impacts our health. In: *A guide to a healthier planet (Chapter 13)*. https://doi.org/10.1007/978-3-031-60128-6_2