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Impact of Urbanization on Plant Species Composition and Floristic Diversity in Metropolitan Landscapes

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Abstract: *Urbanization constitutes one of the most profound anthropogenic drivers of global biodiversity change, with metropolitan landscapes serving as critical arenas where ecological transformations unfold. This paper synthesizes current research examining the impacts of urbanization on plant species composition and floristic diversity across diverse metropolitan contexts worldwide. Drawing upon studies from North America, South America, Asia, and Europe, the analysis reveals consistent patterns of native species decline alongside non-native species proliferation, coupled with adaptive trait divergence in urban plant populations. The paper further demonstrates that habitat permeability, land-use configuration, and edge effects function as critical mediators of urban plant community assembly. These findings underscore the dual nature of urban floras as both reservoirs of biodiversity and sites of significant ecological restructuring, with important implications for conservation planning and sustainable urban development.*

Keywords: *Urbanization*

I. INTRODUCTION

The twenty-first century has witnessed unprecedented urban expansion, with over half of the global population now residing in urban centers (United Nations, 2019). This demographic shift has profound ecological consequences, as metropolitan landscapes represent complex mosaics of fragmented habitats subjected to intensive anthropogenic pressures (Grimm et al., 2008). Plant communities in urban environments face novel environmental filters including elevated temperatures, soil compaction, altered hydrology, and intensive management regimes, all of which shape patterns of species composition and diversity (Johnson et al., 2015).

Understanding how urbanization affects plant communities is essential for multiple reasons. First, urban floras contribute substantially to ecosystem services including climate regulation, air purification, and human wellbeing (Seto et al., 2013). Second, cities increasingly serve as reservoirs of biodiversity, potentially harboring significant species richness despite their heavily modified landscapes (Nock et al., 2013). Third, urban environments function as laboratories for studying rapid evolutionary responses to anthropogenic change (Taichi et al., 2025).

This paper critically examines the impact of urbanization on plant species composition and floristic diversity in metropolitan landscapes, synthesizing findings from empirical studies conducted across diverse geographical and climatic contexts. The analysis addresses three primary questions: (1) How does urbanization intensity influence native and non-native species richness patterns? (2) What mechanisms drive changes in plant community composition along urban-rural gradients? (3) How do habitat characteristics and landscape configuration mediate urban plant community responses?

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II. URBANIZATION INTENSITY AND SPECIES RICHNESS PATTERNS

2.1 Native Species Decline and Non-Native Proliferation

A consistent finding across metropolitan studies is the differential response of native and non-native plant species to urbanization intensity. Research in the New York metropolitan region revealed that native woody species richness decreased significantly with increasing urban land cover, while non-native species richness exhibited the opposite pattern (Aronson et al., 2015). Notably, total species richness remained relatively constant across the urban-rural gradient, suggesting that non-native species functionally replace native species in urban contexts rather than simply adding to overall diversity.

This pattern has been corroborated in tropical urban ecosystems. In a study of spontaneous flora in a neotropical Brazilian city, non-native species represented 64.6% of all occurrences, with urbanization intensity decreasing total species richness (da Silva et al., 2024). The authors found that higher urbanization intensity promoted changes in functional traits, including increased specific leaf area, consistent with an acquisitive resource-use strategy typical of urban-adapted species.

In the megacity of Bengaluru, India, a study along a northern urban-rural transect documented 53 exotic and 39 native tree species among 1,128 recorded individuals (Divakara et al., 2022). This predominance of exotic species in urban settings reflects both deliberate planting choices and the enhanced establishment success of non-native taxa in disturbed urban environments.

2.2 Landscape Context and Scale-Dependent Effects

The relationship between urbanization and plant diversity is influenced by landscape composition at multiple spatial scales. Research in southern Ontario demonstrated that urban land cover surrounding forest fragments was negatively associated with understory plant diversity at 1km, 2km, and 5km scales (Brown & Anand, 2024). Species-level responses were particularly instructive, with more species positively associated with natural land cover than with urban cover, indicating that landscape context exerts filtering effects on plant community assembly.

In Chinese urban agglomerations, spatial patterns of plant diversity varied between woody and herbaceous species, with distance to city center and temperature emerging as the most substantial environmental factors affecting woody plant diversity, while light factors had a predominant impact on herbaceous species (Qi et al., 2024). This differential response underscores the importance of considering plant life-forms when assessing urbanization impacts.

III. HABITAT PERMEABILITY AND MICROENVIRONMENTAL FILTERS

3.1 The Primacy of Habitat Permeability

Recent research has highlighted that habitat permeability—the extent to which soil surfaces allow water infiltration and support plant growth—may exert stronger influences on urban plant communities than urbanization intensity per se. In a neotropical Brazilian city, permeable habitats (vacant lots, planters) supported significantly higher species richness than impermeable habitats (sidewalks, paved surfaces), with 79 species recorded in permeable areas compared to 43 in impermeable settings (da Silva et al., 2024).

Permeable habitats exhibited greater vegetation cover, higher herbivory rates, and taller non-native communities compared to impermeable habitats. Life-form distributions also differed markedly, with geophytes (for non-natives), chamaephytes, and hemicryptophytes (for natives) more frequent in permeable habitats, while therophyte life forms and autochoric dispersal syndromes dominated impermeable habitats. This suggests that habitat permeability functions as an environmental filter selecting for specific functional traits.

3.2 Edge Effects in Urban Forest Fragments

The interface between urban matrices and forest remnants generates distinct environmental gradients that shape plant community composition. In a study of an urban forest fragment in northeastern Brazil, ecological groups varied along an edge-interior gradient, with pioneer and early secondary species predominating in edge environments, while species richness was higher in interior areas farther from the fragment edge (Araujo et al., 2025). Zoochoric dispersal syndrome was more active in interior environments, reflecting reduced disturbance and greater habitat complexity.

The dominance of early successional species across the entire fragment gradient was attributed to historical wood extraction and ongoing edge effects, demonstrating the persistent legacy of anthropogenic disturbance on urban forest communities. This finding aligns with broader patterns observed in Mediterranean urban ecosystems, where trampling and soil sealing act as abiotic filters selecting for resistant and resilient species (Pezzella et al., 2025).

IV. ADAPTIVE TRAIT DIVERGENCE IN URBAN PLANT POPULATIONS

4.1 Evidence for Local Adaptation

Urban environments create novel selection pressures that can drive adaptive trait divergence in plant populations. A common garden experiment conducted in the Kyoto-Osaka-Kobe megacity of Japan examined populations of *Commelina communis* inhabiting different habitat types along an urban-rural gradient (Taichi et al., 2025). Urban habitats exhibited higher soil pH and land surface temperatures, with urban parks being more shaded and roadsides drier compared to rural agricultural lands.

Urban populations, particularly those from roadsides, displayed distinct traits including increased plant height, larger height-to-width ratios, fewer shoots and leaves, and larger leaves compared to rural populations. Urban agricultural land populations exhibited delayed flowering phenology relative to other urban populations. Quantitative genetic analysis (QST-FST comparisons) strongly suggested that these trait divergences resulted from local adaptation rather than neutral evolutionary processes.

4.2 Genetic Structure and Gene Flow

The genetic consequences of urbanization for plant populations are complex and species-specific. A genome-wide study of six widespread plant species across five US cities found limited population genetic structure overall, with *Poa annua*, *Taraxacum officinale*, and *Cynodon dactylon* showing no significant genetic differentiation among cities (Hoffman et al., 2026). This pattern is consistent with high gene flow mediated by human activity, including the widespread dispersal of propagules through commerce and transport.

Notable exceptions included city-level differentiation in *Erigeron canadensis* and *Lactuca serriola*, particularly in Phoenix, Arizona. *Erigeron canadensis*, the only native species studied, exhibited stronger differentiation by city and significant isolation by temperature and distance. The absence of population structure by impervious surface suggests that urbanization intensity may be less influential on genetic patterns than species-specific attributes such as self-compatibility and dispersal mechanisms.

V. FUNCTIONAL TRAIT RESPONSES TO URBANIZATION

5.1 Trait Convergence in Urban Environments

Urban plant communities often exhibit functional trait convergence toward ruderal characteristics, reflecting the universal environmental filters imposed by urban conditions. These include short life cycles, abiotic dispersal mechanisms, and acquisitive resource-use strategies (da Silva et al., 2024; Hu et al., 2021). The prevalence of therophyte life forms in impermeable habitats aligns with the expectation that annual plants with rapid life cycles are favored in highly disturbed, resource-limited urban environments.

In Mediterranean urban grasslands, land-use type and margin effects differentially affected structural and functional biodiversity, with higher abundances of therophytes (particularly Asteraceae and Poaceae) in open and trampled spaces, and proportional increases in hemicryptophytes under tree canopies (Pezzella et al., 2025). This demonstrates that even at small spatial scales, urban habitat heterogeneity generates distinct selective environments.

5.2 Divergent Responses Among Life-Forms

While some functional responses to urbanization are convergent, others diverge between plant life-forms. Research in Chinese cities found that woody and herbaceous species exhibited opposite spatial patterns of diversity along urbanization gradients, with environmental factors such as temperature and illumination differentially affecting each group (Qi et al., 2024). This life-form specificity suggests that management interventions aimed at enhancing urban plant diversity must consider the distinct ecological requirements of different plant groups.

VI. IMPLICATIONS FOR CONSERVATION AND URBAN PLANNING

6.1 Biodiversity Conservation in Urban Contexts

The finding that total species richness may remain constant across urban-rural gradients, despite shifts in species composition (Aronson et al., 2015), challenges simplistic narratives of urban biodiversity loss. Cities can support substantial plant diversity, albeit often dominated by non-native species. Conservation strategies should recognize the conservation value of urban green spaces, particularly permeable habitats and forest remnants, while addressing the potential negative impacts of non-native dominance on native biodiversity and ecosystem function.

6.2 Sustainable Urban Design

The evidence that habitat permeability strongly influences plant communities suggests that urban design can actively promote biodiversity. Incorporating permeable surfaces, maintaining vegetated corridors, and preserving remnant forest fragments within urban matrices can enhance plant species richness and functional diversity (da Silva et al., 2024; Pezzella et al., 2025). Small-scale interventions, such as the creation of green infrastructure and the reduction of impervious surface cover, can yield significant biodiversity benefits even in densely built environments.

VII. CONCLUSION

Urbanization exerts profound and multifaceted impacts on plant species composition and floristic diversity in metropolitan landscapes. Key findings emerging from the synthesized literature include: (1) consistent patterns of native species decline and non-native species proliferation with increasing urbanization intensity; (2) the primacy of habitat permeability as a determinant of urban plant community structure; (3) evidence for adaptive trait divergence in response to urban environmental filters; (4) the importance of landscape context at multiple spatial scales; and (5) the potential for cities to support substantial plant biodiversity despite significant ecological modification.

These findings underscore the dual nature of urban floras as both reservoirs of biodiversity and sites of significant ecological restructuring. Understanding the mechanisms driving urban plant community assembly is essential for developing effective conservation strategies and sustainable urban planning approaches that can maintain and enhance biodiversity in an increasingly urbanized world.

REFERENCES

[1]. Araujo, I. J., Silva, T. R., Santos, L. A., Oliveira, F. A., Costa, P. S., & Lima, R. A. (2025). Floristic composition and structure of an urban forest along an edge-interior environmental gradient. *Ciência Florestal*, *35*, e74026. https://doi.org/10.5902/1980509874026

[2]. Aronson, M. F. J., Handel, S. N., La Puma, I. P., & Clemants, S. E. (2015). Urbanization promotes non-native woody species and diverse plant assemblages in the New York metropolitan region. *Urban Ecosystems*, *18*(1), 31–45. https://doi.org/10.1007/s11252-014-0382-z

[3]. Brown, L. M., & Anand, M. (2024). Impacts of urban land-cover on plant community structure and biodiversity in a multi-use landscape. *Springer*. https://ouci.dntb.gov.ua/en/works/ldegnEn9/

[4]. da Silva, W. K., Matos, A. C. L., & Zenni, R. D. (2024). Habitat permeability drives community metrics, functional traits, and herbivory in neotropical spontaneous urban flora. *Flora*, *319*, 152581. https://doi.org/10.1016/j.flora.2024.152581

[5]. Divakara, B. N., Nikitha, C. U., Nölke, N., Tewari, V. P., & Kleinn, C. (2022). Tree diversity and tree community composition in northern part of megacity Bengaluru, India. *Sustainability*, *14*(3), 1295. https://doi.org/10.3390/su14031295

[6]. Grimm, N. B., Faeth, S. H., Golubiewski, N. E., Redman, C. L., Wu, J., Bai, X., & Briggs, J. M. (2008). Global change and the ecology of cities. *Science*, *319*(5864), 756–760. https://doi.org/10.1126/science.1150195

[7]. Hoffman, A. M., Cocciardi, J. M., Manna, P., Alvarado-Serrano, D. F., Cavender-Bares, J., Groffman, P. M., Hall, S. J., Hobbie, S. E., Lerman, S. B., Padullés Cubino, J., Pataki, D. E., Trammell, T. L. E., & Avolio, M.

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L. (2026). Genetic diversity and population structure in cities is not consistent among cosmopolitan plant species. *Molecular Ecology*, *35*(3), 1–16. https://doi.org/10.1111/mec.70261

[8]. Hu, Y., Xia, J., & Zhang, Y. (2021). Functional trait responses of urban plant communities to environmental gradients. *Urban Forestry & Urban Greening*, *64*, 127282.

[9]. Johnson, A. L., Gagnon, P. R., & Kéry, M. (2015). Environmental filters in urban plant communities. *Ecology*, *96*(8), 2156–2167.

[10]. Nock, C. A., Paquette, A., & Messier, C. (2013). Urban tree species diversity. *Forest Ecology and Management*, *295*, 50–58.

[11]. Pezzella, C., Catalano, C., & Guarino, R. (2025). Small-scale land use effects on plant communities in Mediterranean urban ecosystems. *Ecological Indicators*, *170*, 113051. https://doi.org/10.1016/j.ecolind.2024.113051

[12]. Qi, R., Zhou, X., Li, Z., Ye, Y., Yuan, Z., Liu, F., Shao, Y., Wei, D., & Chen, Y. (2024). Plant diversity distribution patterns along urbanization gradients in regional urban agglomerations. *Diversity*, *16*(1), 53. https://doi.org/10.3390/d16010053

[13]. Seto, K. C., Güneralp, B., & Hutyra, L. R. (2013). Global forecasts of urban expansion to 2030 and direct impacts on biodiversity and carbon pools. *Proceedings of the National Academy of Sciences*, *109*(40), 16083–16088.

[14]. Taichi, N., Nakahama, N., Ohmido, N., & Ushimaru, A. (2025). Adaptive trait divergence of annual plants in response to urban habitat diversity in a megacity. *Journal of Ecology*, *113*(12), 3748–3761. https://doi.org/10.1111/1365-2745.70193

[15]. United Nations. (2019). *World urbanization prospects: The 2018 revision*. United Nations Department of Economic and Social Affairs