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Role of Ornamental Plants in Enhancing Urban Biodiversity and Ecosystem Services: A Review

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ABSTRACT

Urbanization has significantly reduced natural habitats, threatening biodiversity and ecosystem functioning in cities. Ornamental plants play a vital role in restoring urban ecological balance by providing food, shelter, and breeding habitats for pollinators, birds, and beneficial insects while improving aesthetic and environmental quality. This review highlights the contribution of ornamental plant diversity to enhancing urban biodiversity, supporting ecosystem services such as air purification, carbon sequestration, temperature regulation, stormwater management, and soil conservation. It also discusses sustainable landscaping practices, native ornamental species, and green infrastructure initiatives that promote resilient urban ecosystems. Integrating ornamental plants into urban planning can strengthen ecological sustainability, climate resilience, and human well-being.

Keywords: *Ornamental plants; urban biodiversity; ecosystem services; pollinators; urban green infrastructure.*

INTRODUCTION

More than half of the global population now lives in urban areas, and projections suggest that this share will exceed two-thirds by 2050 (United Nations, 2019). Urbanisation transforms natural habitats into impervious surfaces, fragments ecological networks, and generates heat, noise, and air pollution that erode the quality of life for residents and the persistence of urban wildlife (Aronson et al., 2017). In this context, urban green spaces, of which ornamental plantings form the most visible and managed component, are critical for sustaining biodiversity and delivering ecosystem services within the built environment (Cameron et al., 2012).

Ornamental plants encompass a diverse group of herbaceous annuals and perennials, geophytes, shrubs, climbers, and trees that are cultivated chiefly for their aesthetic appeal in parks, private gardens, street verges, balconies, green roofs and walls, and institutional landscapes (Cassani et al., 2023).

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Although decorative purposes dominate their selection, these plants simultaneously perform a wide range of ecological functions that align with the four categories of ecosystem services defined by the Millennium Ecosystem Assessment (2005): provisioning, regulating, supporting, and cultural services (Figure 1).

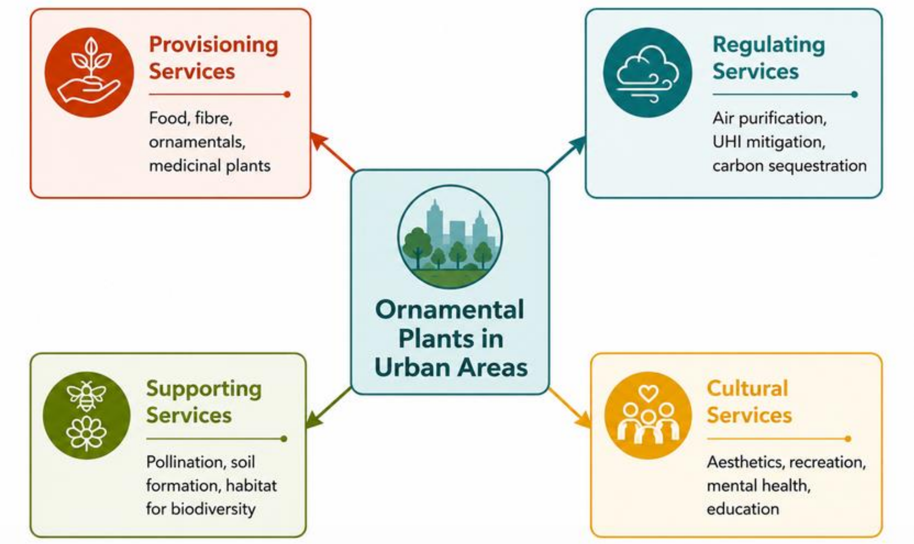

Figure1. Conceptual framework of ecosystem services provided by ornamental plants in urban environments

Despite their ubiquity, the ecological role of ornamental plants has been debated. Critics argue that exotic horticultural cultivars are often pollinator-poor, ecologically sterile, or invasive (Tallamy & Shropshire, 2009; & Burghardt et al., 2009). Conversely, recent empirical work shows that carefully selected ornamentals, including non-native species, can extend floral resources for pollinators, structure complex urban habitats, and substantially improve microclimatic and psychological outcomes (Salisbury et al., 2015; Erickson et al., 2020). The present review synthesises peer-reviewed literature published up to 2023 to evaluate the multifaceted contribution of ornamental plants to urban biodiversity and ecosystem services, and to identify evidence-based principles for designing ecologically functional ornamental landscapes.

2. Ornamental Plants and Urban Biodiversity

2.1 Habitat provision and floral resources

Urban ornamental landscapes offer a heterogeneous mosaic of microhabitats that can sustain a surprising diversity of taxa, from soil microorganisms and invertebrates to birds and small mammals (Goddard et al., 2010). Private gardens, in particular, contribute a disproportionate share of the total green area in many cities, and floristically rich gardens have been shown to support higher abundance and richness of bees, hoverflies, butterflies, and other invertebrates than floristically poor ones (Baldock et al., 2019). In a multi-city British study, residential gardens emerged as one of the most species-rich habitats in the urban matrix when assessed for pollinator visitation (Baldock et al., 2019).

Ornamental trees and shrubs deserve particular attention because they offer abundant floral biomass, structural complexity, and long-lived habitat. Mach and Potter (2018) demonstrated that flowering ornamental trees and shrubs are visited by an exceptionally broad range of bees in managed urban landscapes, supporting the 'trees for bees' principle (Donkersley, 2019). Aquatic ornamentals, including waterlilies (Nymphaea spp.), can additionally provide forage and water for pollinators during summer dearth periods (Erickson et al., 2020).

2.2 Native versus non-native ornamentals

The native-versus-exotic debate occupies a central place in urban biodiversity research. Native ornamentals tend to support specialist herbivores, including Lepidoptera larvae, more effectively than exotic congeners because they share co-evolutionary histories with local insect fauna (Tallamy & Shropshire, 2009; & Burghardt et al., 2009). However, pollinator communities, which are dominated by generalist foragers in urban areas, often visit both native and non-native ornamentals when floral rewards are accessible (Salisbury et al., 2015). Garbuzov and Ratnieks (2014) reported a 100-fold difference in attractiveness among garden plants and concluded that the best-performing cultivars include both native and non-native taxa.

Figure 2 summarises relative pollinator visitation rates compiled from multiple urban garden experiments. Native wildflowers and native woody species consistently lead, but single-flowered non-native ornamentals also perform strongly, while highly bred double-flowered cultivars support markedly fewer visitors due to inaccessible or absent nectar and pollen (Garbuzov & Ratnieks, 2014; & Erickson et al., 2020).

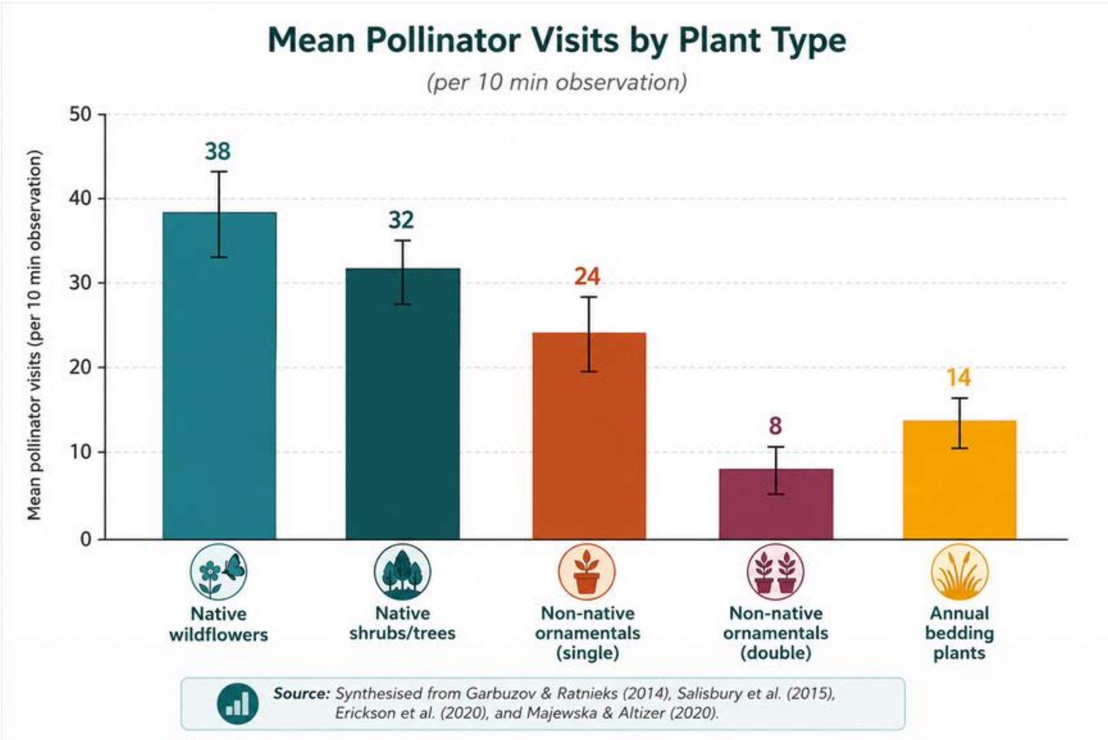

Figure2. Relative pollinator visitation rates across ornamental plant categories synthesised from urban garden studies

2.3 Faunal biodiversity beyond pollinators

Ornamental plantings also support vertebrate biodiversity. Dense shrub layers and fruit-bearing ornamental trees (e.g., Sorbus, Crataegus, Pyracantha) provide nesting sites and food for urban birds, while green walls and ivy-clad facades shelter spiders, beetles, and small reptiles (Madre et al., 2015). Soil biodiversity beneath ornamental beds frequently exceeds that under intensive lawns because of greater organic input, root diversity, and reduced mowing pressure (Smith et al., 2015).

3. Regulating Ecosystem Services

3.1 Urban heat-island mitigation

Vegetation cools urban surfaces through shading and evapotranspiration, two processes that directly counter the urban heat-island (UHI) effect. A systematic review of 105 empirical studies by Bowler et al. (2010) found that urban parks were, on average, 0.94 °C cooler than the surrounding built-up matrix during the day, with greater cooling under tree-dominated canopies. Subsequent reviews have confirmed that the magnitude of cooling depends on vegetation type, canopy cover, leaf-area index, and the spatial configuration of green patches (Aram et al., 2019; & Salmond et al., 2016).

Figure 3 compares mean daytime air-temperature differences across vegetation types. Tree-shaded streets, mixed urban parks, and ornamental urban forests provide the strongest cooling, frequently exceeding 3-5 °C below adjacent built-up areas, while lawns and isolated shrub borders deliver more modest reductions (Bowler et al., 2010; & Aram et al., 2019).

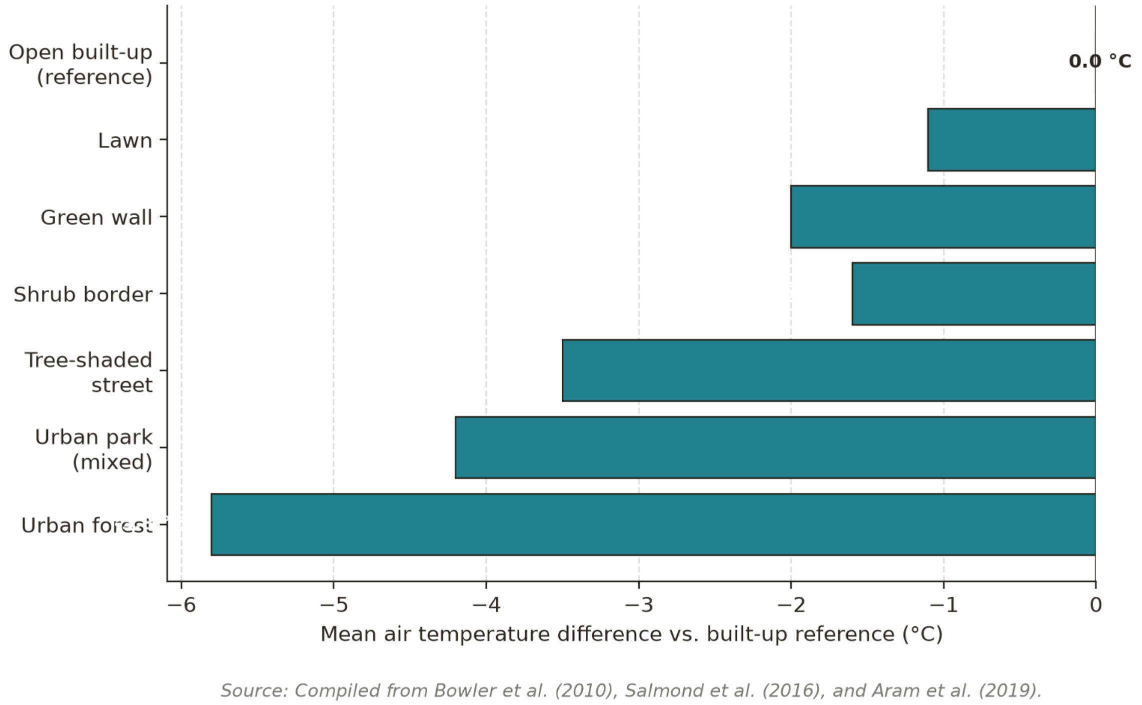

Figure3. Mean daytime cooling effect of different urban vegetation types relative to a built-up reference

3.2 Air-quality regulation

Ornamental trees and shrubs intercept particulate matter, absorb gaseous pollutants such as NO2, SO2, and O3, and contribute to oxygen production through photosynthesis (Nowak et al., 2014). Using the i-Tree model, Nowak et al. (2014) estimated that urban trees in the United States removed approximately 17.4 million tonnes of air pollutants annually, with a societal value of USD 6.8 billion. Leaf morphology matters: species with rough, hairy, or waxy leaves trap more particulates than those with smooth surfaces (Janhall, 2015). Pollutant-tolerant ornamentals such as Ficus, Bougainvillea, Nerium oleander, and Lagerstroemia speciosa are particularly valued in tropical and subtropical cities (Prajapati & Tripathi, 2008).

3.3 Carbon sequestration and stormwater management

Ornamental trees and large shrubs sequester carbon in above- and below-ground biomass and in long-lived woody tissues. Nowak and Greenfield (2018) reported that urban tree carbon storage in the United States amounted to roughly 643 million tonnes, with annual sequestration of about 25.6 million tonnes. Ornamental plantings also intercept rainfall, enhance soil infiltration, and reduce surface runoff, thereby alleviating pressure on stormwater systems (Berland et al., 2017). Bioretention features such as rain gardens, frequently planted with ornamental sedges, irises, and ferns, can remove suspended solids, nutrients, and heavy metals from urban runoff.

4. Cultural Ecosystem Services and Human Well-being

Cultural ecosystem services arise from the non-material benefits people derive from green spaces, including aesthetic enjoyment, recreation, social interaction, spiritual experience, and inspiration. Ornamental plantings are central to these services because their visual appeal anchors people's daily encounters with urban nature (Hartig et al., 2014). Exposure to ornamental gardens and parks has been associated with reduced stress, improved attention, lower blood pressure, and improved mood states across diverse populations (Kaplan, 1995; Hartig et al., 2014; & Bratman et al., 2019).

Biodiverse green spaces appear to deliver stronger psychological benefits than species-poor ones. Fuller et al. (2007) reported that the perceived restorative effect of urban parks increased significantly with plant and bird species richness. Schebella et al. (2019) and Wolch et al. (2014) similarly observed that the quality and structure of ornamental plantings, rather than mere green cover, mediated mental-health outcomes. Figure 4 summarises the major pathways through which ornamental plantings shape human well-being.

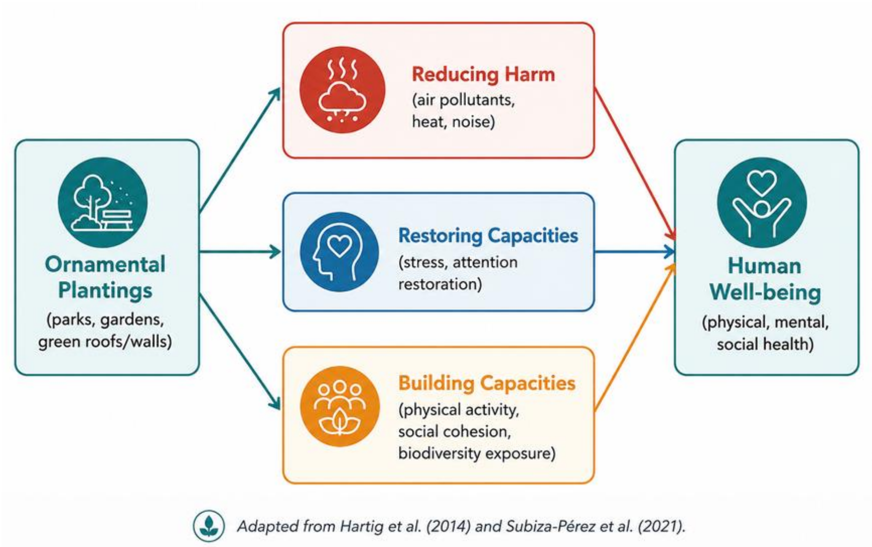

Figure4. Pathways linking ornamental plantings to human physical, mental, and social well-being

In addition, ornamental landscapes contribute to social cohesion through community gardening, horticultural therapy, environmental education, and the celebration of cultural heritage in themed gardens (Soga et al., 2017). They also confer significant economic value by increasing real-estate prices, supporting tourism, and stimulating the nursery and landscaping sector (Cassani et al., 2023).

5. Challenges, Trade-offs, and Risks

Despite their numerous benefits, ornamental plantings can also impose ecological costs. First, several ornamentals have escaped cultivation and become invasive, displacing native flora and altering ecosystem processes; examples include Lantana camara, Eichhornia crassipes, Ageratina adenophora, and Acer platanoides in different parts of the world (van Kleunen et al., 2018). The horticultural trade has been identified as the principal pathway for the introduction of invasive plant species globally (van Kleunen et al., 2018).

Second, intensive ornamental cultivation can involve high pesticide and fertiliser inputs, with downstream consequences for pollinators, soil biota, and water quality. Neonicotinoid residues have been detected in nursery-grown ornamentals at concentrations potentially harmful to bees (Lentola et al., 2017). Third, many double-flowered cultivars and sterile hybrids produce little or no nectar and pollen and therefore deliver minimal pollinator support despite their visual appeal (Garbuzov & Ratnieks, 2014). Fourth, monocultural ornamental displays simplify habitat structure and increase vulnerability to pests, pathogens, and climate extremes (Raupp et al., 2010).

Equity is an additional concern: ornamental green infrastructure is often unevenly distributed, with affluent neighbourhoods accumulating greater canopy cover and floral richness than lower-income areas, thereby reproducing environmental injustices (Wolch et al., 2014; & Jennings et al., 2016).

6. Strategies for Ecologically Functional Ornamental Landscapes

The literature converges on several evidence-based principles for designing ornamental landscapes that maximise biodiversity and ecosystem services while minimising costs. These include: (a) prioritising native and locally adapted species without categorically excluding useful non-native ornamentals (Salisbury et al., 2015); (b) avoiding documented invasive taxa and selecting cultivars verified for nectar and pollen production (Garbuzov & Ratnieks, 2014); (c) maintaining a continuous bloom calendar to support pollinators across seasons (Erickson et al., 2020); (d) layering trees, shrubs, herbs, and ground covers to provide multi-storey habitats (Mach & Potter, 2018); (e) integrating ornamental green roofs, green walls, rain gardens, and street trees to extend functional area in densely built precincts (Berland et al., 2017); (f) adopting integrated pest management to reduce pesticide load (Lentola et al., 2017); and (g) embedding equity considerations in planning so that ornamental green infrastructure is distributed across all neighbourhoods (Jennings et al., 2016).

Citizen-science programmes, community-led tree-planting drives, school gardens, and horticultural extension services are powerful instruments to translate these principles into practice and to foster stewardship of urban biodiversity (Goddard et al., 2010; & Soga et al., 2017).

CONCLUSION

Ornamental plants are far more than decorative elements of the urban fabric. The evidence synthesised in this review demonstrates that, when thoughtfully selected and managed, they contribute substantially to urban biodiversity through floral resources, habitat structure, and faunal support; deliver regulating services by mitigating heat, improving air quality, sequestering carbon, and managing stormwater; and underpin cultural services that promote mental and social well-being. At the same time, the risks of invasiveness, pesticide load, and ecological sterility associated with certain cultivars must be actively managed. A biodiversity-sensitive horticulture, grounded in ecological knowledge and equity, can transform ornamental landscapes into a central pillar of sustainable, climate-resilient, and liveable cities. Future research should integrate functional traits, long-term monitoring, and socio-cultural indicators to refine species selection and to quantify the full value of ornamental green infrastructure across diverse urban contexts.

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