Trait-based functional indices reveal contrasting carbon-storage and biodiversity-support potential across urban tree species and parks in Bogotá

Kristian Rubiano[1,2,*]

[1] *Jardín Botánico de Bogotá José Celestino Mutis, Bogotá, Colombia*

[2] *School of Sciences and Engineering, Universidad del Rosario, Bogotá, Colombia*

ORCID: https://orcid.org/0000-0002-8936-2037

[*] *Email address: kristian.rubianoc@gmail.com*; *kristian.rubiano@urosario.edu.co*

Abstract

Urban expansion increasingly challenges the capacity of cities to maintain ecological functions, while urban trees are expected to contribute to climate regulation and biodiversity conservation. However, urban forest management often lacks functionally explicit information linking species characteristics to their ecological potential and spatial variation across urban green spaces. Here, we assessed the functional potential of Bogotá's urban tree cover for aboveground carbon storage and biodiversity support using a trait-based functional-value framework. From a citywide inventory of 1,449,309 trees representing 476 species, we prioritized 59 species accounting for about 80% of all individuals and compiled functional traits, ecological attributes, conservation status, and documented resources for urban fauna. Species functional values were estimated for carbon storage, food provision, habitat and connectivity, and existence value, with the latter three integrated into a biodiversity functional value. Species-level values were scaled to individual-tree dimensions and aggregated across 31 urban parks, and spatial patterns in park-level values were evaluated using global Moran's I and local indicators of spatial association. The dominant species differed markedly across functional dimensions, indicating complementary rather than uniform functional profiles. Park-level functional values also varied substantially across the city. All five park-level dimensions showed significant positive spatial autocorrelation (Moran's I = 0.30–0.43; all $p < 0.001$), with recurrent high-value clusters in northeastern Bogotá. These results show that integrating species traits, ecological attributes, tree dimensions, and spatial information can reveal functional heterogeneity across scales ranging from species to urban green spaces and support more functionally explicit urban forest planning.

Keywords

Urban forestry, functional traits, ecosystem services, carbon storage, biodiversity conservation, functional value indices, urban green spaces, Bogotá.

1. Introduction

Urbanization is transforming ecological structure and functioning worldwide, while simultaneously increasing the importance of urban green infrastructure for maintaining environmental quality and human well-being. Urban trees are a particularly important component of this infrastructure because they can contribute to multiple ecosystem functions and services, including climate regulation, carbon storage, air-pollution mitigation, and the provision of resources and habitat for urban biodiversity (Bolund & Hunhammar, 1999; Gómez-Baggethun & Barton, 2013; Grote et al., 2016; O'Brien et al., 2022). However, the benefits provided by urban tree cover depend not only on the number of trees present but also on their species identity, ecological characteristics, functional traits, size, and spatial arrangement. Consequently, decisions regarding species selection, planting, and management can strongly influence the ecological performance of urban forests.

Despite this, urban tree management often lacks systematic and functionally explicit criteria for evaluating species and prioritizing planting decisions. Species selection can be constrained by incomplete ecological information, incompatibility between species characteristics and planting environments, and limited knowledge of how particular traits relate to desired ecosystem functions (Pataki et al., 2013; Grote et al., 2016; Núñez-Florez et al., 2019; Esperon-Rodriguez et al., 2025). This limitation is particularly relevant in highly managed urban ecosystems, where species assemblages are strongly shaped by human decisions and where environmental conditions differ substantially from those in natural ecosystems. A trait-based perspective, therefore, provides a useful framework for moving beyond purely taxonomic descriptions of urban forests toward assessments of how differences among species may influence ecosystem functioning.

Functional traits are morphological, physiological, phenological, or ecological attributes associated with organism performance and ecosystem processes (Díaz et al., 2007; Violle et al., 2007; Lavorel et al., 2011). Trait-based approaches have been widely used to investigate plant responses to environmental gradients and the relationships between biodiversity and ecosystem functioning, but their application to urban forestry and ecosystem-service assessment remains comparatively limited (Goodness et al., 2016; Schwarz et al., 2017). One approach to translating trait information into management-relevant information is to use specific functional value indices that combine functional traits and ecological characteristics associated with a particular ecosystem service

(Casanoves et al., 2011). For instance, some approaches have been developed to estimate the potential contribution of tree species to aboveground carbon storage and biodiversity conservation (Marinidou, 2009; Marinidou et al., 2013). Species-level functional values are subsequently weighted by individual-tree dimensions and aggregated across individuals, thereby allowing functional information to be scaled from species to trees and ultimately to whole-tree assemblages.

Marinidou et al. (2013) developed such a framework, originally for tree cover in transformed landscapes such as agricultural landscapes, but its structure makes it adaptable to other ecological and management contexts. In an urban application of this framework in Ibagué, Colombia, Núñez-Florez et al. (2019) combined functional traits and specific functional indices with hierarchical clustering to characterize plant functional types and identify species suitable for different urban planting environments. Their study demonstrated the potential of functional information to support urban tree selection, but applications that explicitly scale service-related functional values from species to individual trees and then to entire urban green spaces remain limited. This is an important gap because parks and other urban green areas differ not only in species composition but also in tree abundance and structural characteristics, potentially producing substantial spatial variation in their capacity to support ecosystem functions.

Bogotá provides a relevant setting in which to examine these relationships. Its urban tree cover comprises a species-rich assemblage established and managed under heterogeneous environmental and socioeconomic conditions (Escobedo et al., 2015; Rubiano, 2019; Moreno Barreto & Rubiano Calderón, 2020), yet systematic information linking the functional characteristics of its tree species to ecosystem-service potential remains limited. Existing urban-tree inventories and local trait datasets provide an opportunity to integrate species composition, functional traits, ecological characteristics, and individual-tree dimensions into a common assessment framework. Such an approach may help identify functional differences among species while also revealing how these differences translate into variation among urban green spaces.

Here, we assessed the functional value of Bogotá's urban tree cover in relation to two broad ecological dimensions: potential contribution to aboveground carbon storage and support for biodiversity conservation. First, we identified and taxonomically harmonized the most abundant tree species in the city's urban-tree inventory and compiled functional traits and ecological characteristics relevant to these dimensions. Second, we estimated species-level functional value indices for carbon storage and for three components of biodiversity conservation—food provision for urban fauna, habitat and connectivity provision, and species existence value—and integrated the latter into a biodiversity conservation functional value index. Third, we scaled these values to individual trees and tree assemblages across 31 urban parks using tree dimensions and abundance data. Finally, we evaluated the spatial structure of park-level functional values. We expected substantial functional differentiation among species and, given the heterogeneous composition and structure of Bogotá's urban green spaces, pronounced variation and spatial structuring of functional value among parks.

2. Materials and Methods

2.1 Study system and data sources

The study was conducted in the urban area of Bogotá, Colombia, and combined two complementary urban-tree datasets operating at different analytical scales. At the city scale, we used the Sistema de Información para la Gestión del Arbolado Urbano (SIGAU; https://jbb.gov.co/sigau/), the official database of trees in Bogotá's public space, administered by the Jardín Botánico de Bogotá José Celestino Mutis. The geospatial database used in this study corresponded to the July 2025 version and contained 1,449,309 individual-tree records. Available attributes included common and scientific names, geographic coordinates, species identifiers, total height, planting-site information, and other descriptive and dendrometric variables. SIGAU was used primarily to characterize the taxonomic composition and relative abundance of Bogotá's urban tree assemblage and to identify the most abundant species for subsequent functional characterization.

Individual- and site-level functional assessments were based on a second dataset containing complete tree censuses from urban parks in Bogotá. The dataset available for the present study comprised 31 parks distributed across the city (Fig. 1). The source study used a stratified random sampling design based on socioeconomic strata and restricted candidate neighborhood parks to areas between 0.1 and 1 ha to reduce variation in park size. Parks were selected from the 2015 geographic park layer of the Instituto Distrital de Recreación y Deportes using a random-selection routine implemented with ArcPy in Python 2.7. Complete tree censuses were conducted between April and June 2019.

For each censused tree, circumference at breast height (CBH) was measured with a tape at 1.3 m above ground and converted to diameter at breast height (DBH). Only individuals with DBH ≥ 10 cm were retained. The census also recorded total height, two perpendicular crown diameters (equatorial and polar), and geographic coordinates. Crown diameter was represented by the arithmetic mean of the two perpendicular measurements. Overall, the dataset contained 1,196 individuals representing 57 species and 33 families. It was selected for park-level analyses because it provided the individual dendrometric measurements required to scale species-level functional values to individual trees and, subsequently, to whole tree assemblages.

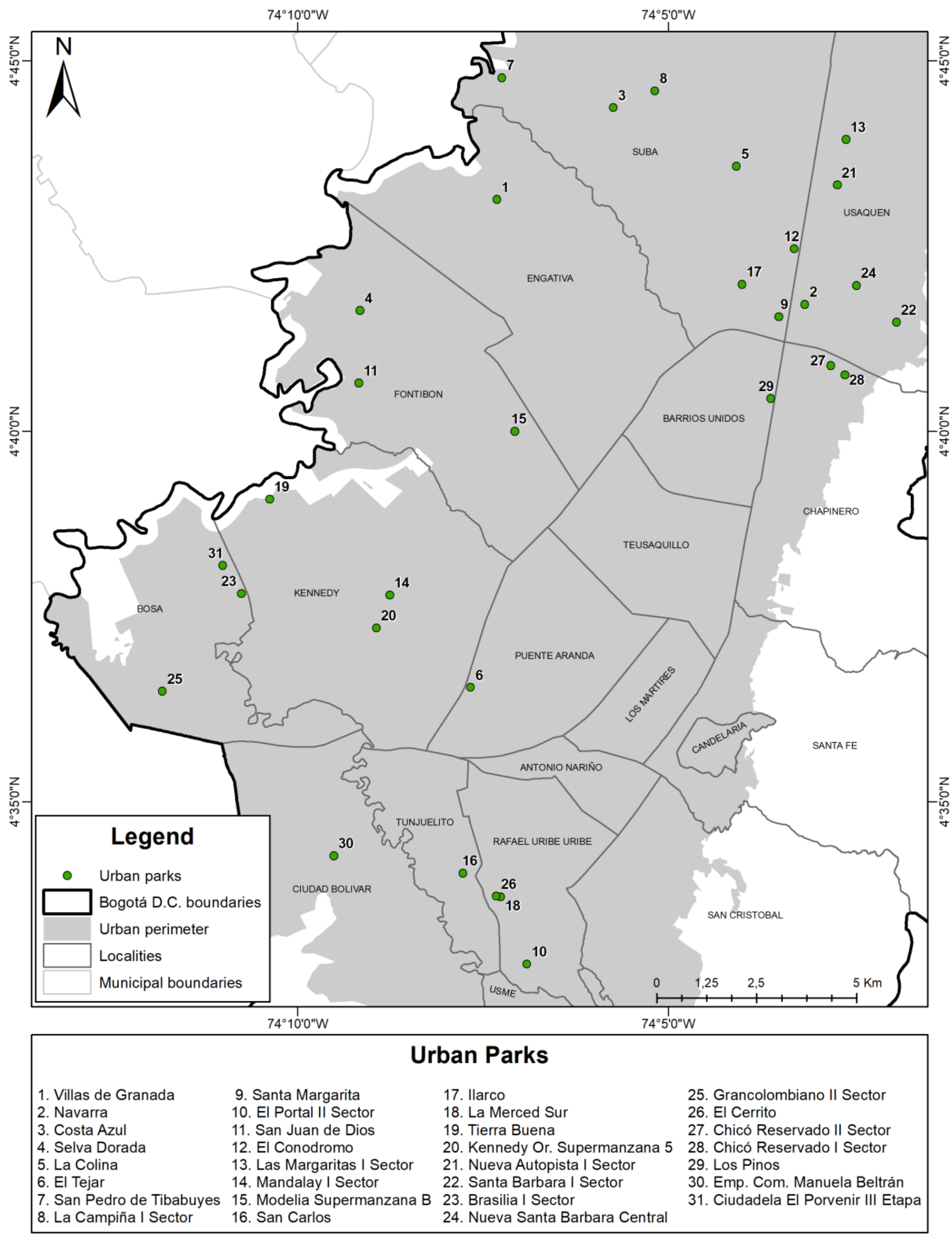

Figure 1. *Distribution of the urban parks included in the tree-cover analyses.*

2.2 Urban tree inventory, species prioritization, and taxonomic harmonization

The SIGAU database was processed in R to characterize the taxonomic composition of Bogotá's urban tree assemblage and identify the species to be included in the functional assessment. Prior to analysis, text fields were cleaned to remove formatting inconsistencies in scientific names and other attributes, including extra spaces and non-visible characters that could interfere with species aggregation. Because individuals assigned to the same scientific name were sometimes associated with different common names or species identifiers in SIGAU, records were aggregated using the scientific-name field (NOMBRE_CIENTIFICO) rather than common names or database-specific identifiers. Individual records were then summarized by scientific name to obtain species frequencies across the citywide inventory.

Species were ranked according to their abundance in SIGAU, and cumulative relative abundance was calculated from the resulting frequency distribution. To concentrate the functional characterization on species representing the dominant component of Bogotá's urban tree assemblage, species accounting collectively for approximately 80% of all individual-tree records were retained. This procedure yielded 59 prioritized species from the 476 species recorded in the processed SIGAU database.

Taxonomic names of the prioritized species were subsequently validated and harmonized before compiling functional-trait and ecological information. Taxonomic resolution was performed in R using the *WorldFlora* package (Kindt, 2020), which matches submitted scientific names against the World Flora Online (WFO) Plant List using exact and fuzzy matching procedures. Searches were conducted against the June 2025 version of WFO (World Flora Online, 2025). Accepted names and taxonomic authorities returned through this procedure were used to standardize species identities across the different trait, ecological, and interaction databases used in subsequent analyses.

The original SIGAU names and their corresponding accepted names were retained to maintain traceability between the city inventory and the harmonized functional database. This harmonization was particularly important because the functional assessment integrated information from multiple independent sources, where synonymy and nomenclatural differences could otherwise lead to failed or incorrect species matches.

2.3 Functional traits and ecological attributes

Functional traits and ecological attributes required to estimate species-level functional value indices were compiled from local and global databases, scientific literature, technical publications, and urban tree management guides. Following taxonomic harmonization, species names across the consulted datasets were checked and standardized to reduce mismatches due to synonymy or outdated nomenclature. The final functional database included variables related to aboveground carbon storage potential, documented food resources for urban fauna, habitat and connectivity provision, and species existence value.

Wood density was used as the species-level functional trait associated with the potential for aboveground carbon storage. Because wood density may vary intraspecifically across environmental conditions, measurements obtained locally in Bogotá were prioritized. Individual-level wood-density records were compiled from three datasets available through SiB Colombia (Rodríguez-Alarcón et al., 2019; Moreno Barreto, 2022; Rubiano Calderón & Moreno Barreto, 2022). After taxonomic harmonization, all available observations were combined, and the mean wood density was calculated for each species. For prioritized species lacking local measurements, values were supplemented using the global wood-density database of Chave et al. (2009) and Zanne et al. (2009), accessed through the *getWoodDensity* function of the *BIOMASS* R package (Réjou-Méchain et al., 2017). When species-level estimates were unavailable, genus- or family-level estimates were used, as specified by the function's procedure.

Food provision for urban fauna was characterized using four resource types: fruits, seeds, foliage or forage, and floral resources. Information was obtained from the Red de Interacciones Bióticas de Bogotá (RIBB; Del Risco et al., 2022). Animal–plant interactions involving prioritized tree species were classified according to interaction type and plant part. For each species, a resource type was coded as present when at least one corresponding interaction was documented in the processed RIBB dataset and absent otherwise. Unlike the original formulation of Marinidou et al. (2013), which additionally weights food resources by availability during critical dry-season periods, seasonality was not incorporated into the methodology of this study, following the simplification introduced for urban trees by Núñez-Florez et al. (2019).

Two traits were used to characterize potential habitat and connectivity provision for urban fauna: crown density and leaf phenology. Information for these traits was obtained primarily from technical guides and manuals describing urban trees from Bogotá and surrounding areas, including Álvarez Lucero et al. (2020). Crown density represented variation from open to dense crowns, whereas leaf phenology distinguished deciduous, semi-deciduous, and evergreen species. These traits follow the assumption that denser, more persistent foliage increases the structural availability of refuge, perching, and nesting resources for urban fauna.

Species existence value was characterized using native or introduced status, conservation status, wood density, maximum height, dispersal mode, and reproductive system. Species origin was determined primarily from local references describing Bogotá's urban vegetation, including Mahecha et al. (2010), Álvarez Lucero et al. (2010), and Álvarez Lucero et al. (2020). Global conservation status was obtained from the IUCN Red List dataset (IUCN, 2025). Species classified as Vulnerable, Endangered, or Critically Endangered were treated as threatened in the functional-index calculation; Near Threatened, Least Concern, Data Deficient, and Not Evaluated species did not activate the threat-status filter.

Maximum species height (Hmax) was estimated directly from SIGAU height records as the 95th percentile of total height to reduce sensitivity to extreme observations. Dispersal mode and reproductive system were compiled from global trait databases (Kattge et al., 2011; Maitner et al., 2018), regional references, including Álvarez Lucero et al. (2020), floristic sources, and, when necessary, complementary species-level references.

The original existence-value formulation of Marinidou et al. (2013) includes destructive pressure from human use and distinguishes multiple levels of dispersal dependence. For the Bogotá application, destructive-use pressure was retained mathematically in the formulation but fixed at zero for all species because harvesting pressure was considered inapplicable to the managed urban context. Dispersal mode was simplified to a binary classification distinguishing biotic from abiotic dispersal. The implications of these adaptations for index calculation are described in Section 2.4.

2.4. Species-level functional value indices

Species-level functional value indices were calculated following the framework developed by Marinidou (2009), Casanoves et al. (2011), and Marinidou et al. (2013), with adaptations for the urban context, based in part on Núñez-Florez et al. (2019), and additional modifications implemented in this study. The indices represent relative functional potential with respect to the ecological functions considered rather than direct measurements of ecosystem-service delivery. Higher values indicate greater potential contribution to the corresponding function.

2.4.1 Functional value for aboveground carbon storage

The functional value for aboveground carbon storage (FVC) was estimated from species wood density following Marinidou et al. (2013). Mean wood density was assigned to five ordinal classes: very light (<0.30 g cm^{-3}; $D_m = 1$), light (0.30–0.44 g cm^{-3}; $D_m = 2$), medium (0.45–0.59 g cm^{-3}; $D_m = 3$), dense (0.60–0.74 g cm^{-3}; $D_m = 4$), and very dense (≥0.75 g cm^{-3}; $D_m = 5$). The index was calculated as:

$$FVC = (D_m + 0.5) \times \frac{100}{5.5}.$$

This formulation yields five possible functional values: 27, 46, 64, 82, and 100, with higher values corresponding to higher wood-density classes. The index, therefore, represents species-level potential related specifically to aboveground carbon storage, rather than climate regulation in a broader sense.

2.4.2 Functional value for biodiversity conservation

Species functional value for biodiversity conservation (FVBD) was represented by three complementary components: food provision for urban fauna (FVFD), habitat and connectivity provision (FVHB), and species existence value (FVEX). Following the original framework, the three components were assigned equal weight:

$$FVBD = \frac{FVFD + FVHB + FVEX}{3}.$$

Núñez-Florez et al. (2019) omitted the existence value in their urban application and calculated the biodiversity value using only food and habitat provision. In the present study, FVEX was retained to incorporate conservation-related attributes, including native status and threat status, into the combined biodiversity index.

2.4.3 Food provision for urban fauna

The FVFD was estimated from four resource types: fruits (Fr), seeds (Sm), foliage or forage (Hj), and floral resources (Fl). Each resource was coded as a binary variable, with 1 indicating recorded provision and 0 indicating no recorded provision, according to the RIBB (Del Risco et al., 2022).

The original methodology additionally accounts for food availability during the dry season. We adopted the non-seasonal four-resource structure used by Núñez-Florez et al. (2019) and rescaled the function to span approximately 1–100:

$$FVFD = [6(Fr + Sm + Hj + Fl)]^{1.446} + 1.$$

Accordingly, FVFD increased with the number of documented resource types among the four categories considered.

2.4.4 Habitat and connectivity provision

The FVHB was estimated by combining crown density (D_c) and leaf persistence (P_n). Crown density was coded on an ordinal scale from 1 to 3 for open, medium, and dense crowns, respectively. Leaf persistence was represented by three categories: deciduous ($P_n = 1$), semi-deciduous ($P_n = 2$), and evergreen ($P_n = 3$). Following Marinidou et al. (2013), the index was calculated as:

$$FVHB = 3^{D_c - 1} \times P_n \times \frac{100}{27}.$$

Combinations of increasingly dense crowns and more persistent foliage produce progressively higher habitat-related functional values.

2.4.5 Species existence value

The FVEX was adapted more substantially from the original Marinidou formulation. In that framework, introduced status and threat status operate as filters: introduced species receive an existence value of zero, whereas species occurring in a recognized threat category receive the maximum value of 100. For the remaining species, existence value is determined from functional traits and ecological characteristics associated with species persistence and vulnerability.

The original model includes wood density category (D_m), maximum height (H_{max}), destructive pressure from human use, dispersal mode (D_s), and reproductive system (R_p). Destructive-use pressure was fixed at zero because its original interpretation concerns harvesting and direct exploitation in productive landscapes, which was deemed inapplicable to the managed urban trees evaluated here. D_s was also simplified from three classes to a binary variable that distinguishes autochorous/anemochorous species ($D_s = 0$) from zoochorous species ($D_s = 1$); the original category representing dependence on larger vertebrate dispersers was not used. R_p was coded as non-dioecious ($R_p = 0$) or dioecious ($R_p = 1$). H_{max} was classified into ≤15 m, >15–30 m, and >30 m classes, whereas the same five D_m categories classified for FVC were used (see section 2.4.1).

The modified equation reported for this study was:

$$FVEX = \left[\frac{6.5\left(\frac{D_m + 0.5}{5.5}\right) + 2.5\left(\frac{H_{\max} - 0.5}{2.5}\right) + 0.66\left(\frac{D_s + 1}{3}\right) + 0.33R_p}{2.27}\right]^{2.84}.$$

Together, these indices provided complementary species-level measures of carbon-related and biodiversity-related functional potential. They were subsequently combined with individual-tree dimensions to estimate functional values at the individual and park levels, as described below.

2.5 Urban park dataset

For individual- and park-level scaling, we used the 2019 park-census dataset described in Section 2.1. The complete analytical census contained 1,196 individuals representing 57 species and 33 families. Individual-tree records were taxonomically harmonized against WFO and linked to the species-level functional database using accepted scientific names. Only individuals for which the complete set of prioritized species-level functional values could be assigned were retained for scaling analyses. This procedure yielded 1,117 trees for subsequent individual- and park-level calculations.

The dimensional variables available for these individuals—DBH, total height, and mean crown diameter—were used in service-specific scaling procedures because the reference functional framework assigns different aspects of tree size to different ecological functions.

2.6 Scaling functional value from species to individual trees and urban parks

Species-level functional values characterize differences among taxa but not variation among individual trees. We therefore scaled these values to individual trees using service-specific dimensional functions adapted from the framework of Marinidou (2009), Casanoves et al. (2011), and Marinidou et al. (2013). Different combinations of DBH, total height, and crown diameter were used for carbon storage, food provision, habitat and connectivity, and existence value.

Tree dimensions were converted into service-specific dimensional metrics. DBH and total height were used for carbon-related value; DBH and crown diameter for food provision; total height and crown diameter for habitat and connectivity; and DBH and total height for existence value.

2.6.1 Individual-tree carbon-related functional value

For carbon storage, the dimensional component (Dim_C) was based on stem-diameter and total-height classes. Because stem diameter has a quadratic relationship with aboveground biomass, the diameter component was squared, whereas height entered linearly. The FVC, derived from wood density, was then combined with this dimensional metric using a dimensional formulation adapted from Marinidou et al. (2013).

In the reference formulation:

$$C_i = 0.5832\, CatDAP_{C,i}^2 (CatH_i - 0.5) IVF_{C,s},$$

where $CatDAP_C$ is the carbon-specific stem-diameter category, $CatH$ is the height category, and FVC is the carbon functional value of species s to which individual i belongs. This weighting gives progressively greater importance to larger individuals of species with greater wood-density-related functional value.

2.6.2 Individual-tree biodiversity-related functional values

At the individual-tree level, food-provision value combined species FVFD with a dimensional metric based on DBH and crown diameter. A maximum-capacity transformation was applied to limit the effect of the largest size classes before combining the dimensional metric with FVFD. Habitat and connectivity value combined FVHB with total height and crown diameter, with crown diameter entering quadratically and height linearly in the dimensional component. Existence value combined FVEX with a dimensional metric derived from DBH and total height and included a maximum-capacity transformation.

The resulting individual biodiversity-related values can be represented as:

$$FD_i = Dim_{FD,i}^* \times FVFD_s,$$

$$HB_i = \frac{Dim_{HB,i} \times FVHB_s}{4},$$

and

$$EX_i = Dim_{EX,i}^* \times FVEX_s,$$

where Dim^* denotes the corresponding maximum-capacity dimensional transformation. Individual-tree biodiversity functional value was then calculated by giving equal weight to the three components:

$$BD_i = \frac{FD_i + HB_i + EX_i}{3}.$$

This preserves the same equal-weighting assumption used to combine the three biodiversity components at the species level.

2.6.3 Aggregation to park-level functional value

Functional values were aggregated across all eligible trees within each park. For each functional component, the total park-level functional value was calculated as the sum of individual-tree values:

$$FV_{k,p} = \sum_{i=1}^{n_p} FV_{k,i},$$

where $FV_{k,p}$ is the total functional value of park p for functional component k, $FV_{k,i}$ is the corresponding value of individual tree i, and n_p is the number of analyzed trees in that park. This additive aggregation follows the original framework, in which site-level functional value is derived from the sum of the contributions of its constituent individuals. The resulting park values integrate three sources of variation: species composition, tree abundance, and individual-tree dimensions. To distinguish park-level values from species-level FVs, aggregated values are denoted C, FD, HB, EX, and BD hereafter.

For spatial visualization, the resulting park-level values were rescaled to a common 1–100 range; this transformation was used to facilitate graphical comparison among parks and functional indices rather than to redefine the underlying functional-value calculations.

2.7 Spatial analysis

Spatial patterns in park-level functional values were evaluated using global Moran's I and local indicators of spatial association (LISA; Anselin, 1995). Global Moran's I was used to assess whether parks with similar functional values exhibited spatial clustering across Bogotá. Positive values indicate spatial association among similar values, whereas negative values indicate spatial juxtaposition of dissimilar values.

A binary distance-band neighborhood was defined among the 31 parks using Euclidean distances between park centroids. A threshold of 4,700 m was selected because it ensured that every park had at least one neighbor and the resulting network formed a single connected graph. Neighbor weights were row-standardized (style = "W") in the *spdep* package (Bivand et al., 2008).

Local Moran's I statistics were used to identify significant local clusters and spatial outliers. Parks were classified as high-high, low-low, high-low, or low-high according to the sign of the standardized park value and local spatial association; associations with $p > 0.05$ were considered not significant. Spatial analyses were conducted separately for park-level carbon-related value (C), food provision (FD), habitat and connectivity (HB), existence value (EX), and integrated biodiversity value (BD).

3. Results

3.1 Urban-tree composition and species prioritization

The processed SIGAU database contained 1,449,309 individual-tree records assigned to 476 species. Species abundance was strongly uneven across the urban-tree assemblage, with a relatively small subset of species accounting for a large proportion of all recorded individuals (Fig. S1). The 59 most abundant species, representing approximately 12% of the recorded species richness, collectively accounted for about 80% of all individuals and were therefore retained for subsequent functional characterization (Table S1). *Sambucus nigra* was the most abundant species, accounting for approximately 6% of all records, followed by *Pittosporum undulatum* at 4.2%.

Taxonomic harmonization showed that nomenclatural inconsistencies were relevant even among these dominant species. The accepted scientific name differed from that recorded in SIGAU for 12 of the 59 prioritized taxa (20%; Table S2). These changes included synonymy and nomenclatural updates, such as replacing *Cupressus lusitanica* with the currently accepted *Hesperocyparis lusitanica*.

3.2 Species-level functional traits and functional values

Wood density varied markedly among the 59 prioritized species, ranging from 0.23 g cm^{-3} in *Smallanthus pyramidalis* to 0.80 g cm^{-3} in *Dodonaea viscosa* (Fig. 2). These values encompassed all five wood-density classes used to estimate the FVC. *Dodonaea viscosa* was the only species attaining the maximum FVC of 100, whereas 15, 21, 19, and three species were assigned values of 82, 64, 46, and 27, respectively. Thus, most of the prioritized species occupied intermediate carbon-related functional classes rather than either extreme of the index.

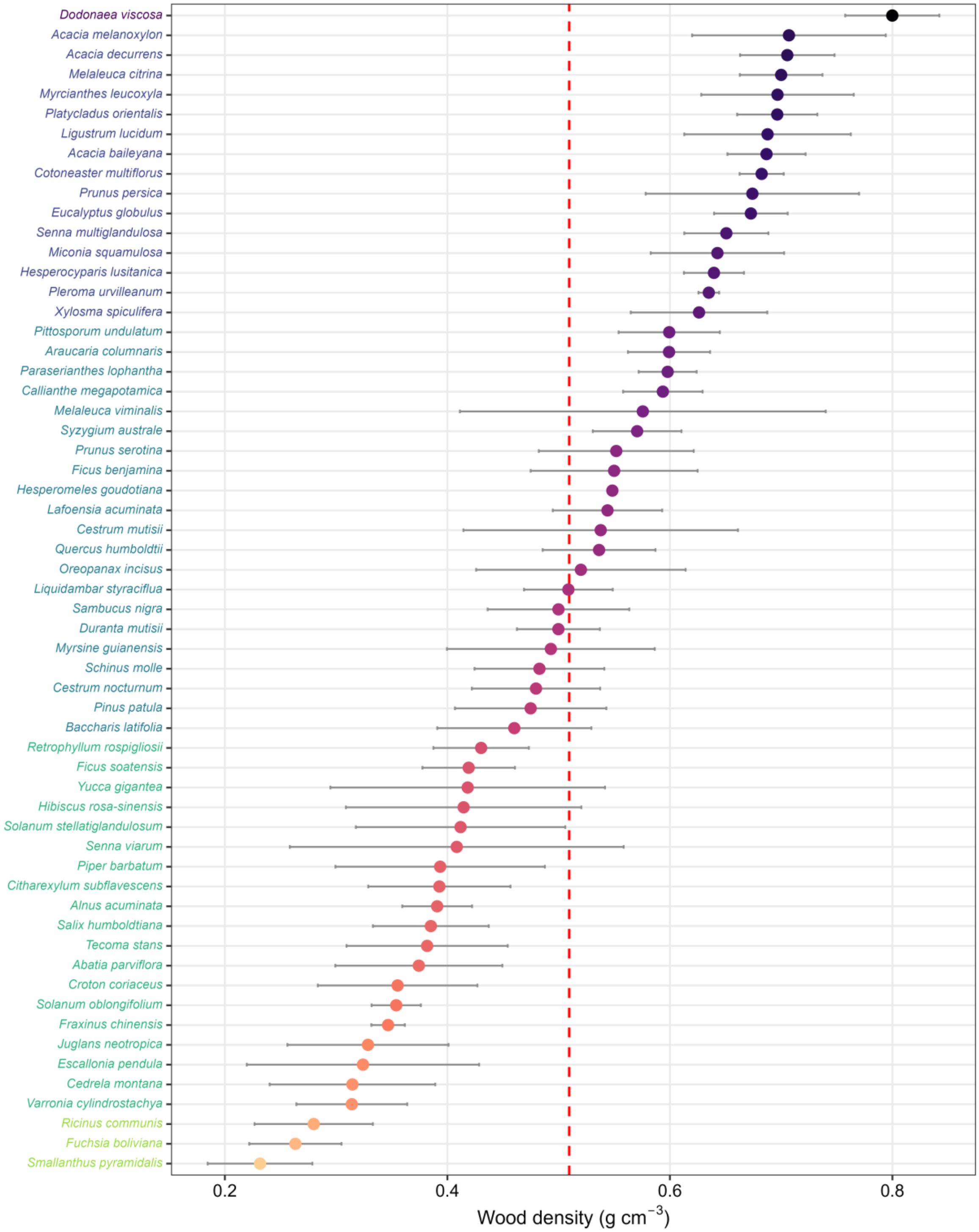

Figure 2. *Wood density of the 59 prioritized urban-tree species in Bogotá. Species are ordered and their labels colored according to their carbon-storage functional value (FVC) class (in descending order: 100, 82, 64, 46, and 27, respectively). Error bars represent the standard deviation, and the red dashed line indicates the mean wood density across species.*

FVFD also varied substantially among species (Fig. S2), spanning five observed values from 1 to 100, with a median of 37. The two most frequent values were 66 and 37, represented by 18 and 17 species, respectively. FVHB ranged from 7 to 100 across six observed values, with a median of 33 (Fig. S3). The FVEX was strongly skewed toward low values, with a median of 3 (Fig. S4). Four species attained the maximum value of 100: *Cedrela montana* and *Retrophyllum rospigliosii* were classified as Vulnerable, whereas *Juglans neotropica* and *Xylosma spiculifera* were classified as Endangered. Two additional species were classified as Near Threatened, while most prioritized species were classified as Least Concern or had not been evaluated (Fig. S5).

Integration of FVFD, FVHB, and FVEX resulted in FVBD values ranging from 4 to 73, with a median of 50 (Fig. 3). *Myrcianthes leucoxyla* attained the highest combined biodiversity-related functional value, whereas *Acacia baileyana* had the lowest. The broad variation among species and the differing positions of individual taxa across the component indices indicate that the three biodiversity-related dimensions capture complementary aspects of species' functional potential rather than yielding identical rankings of species (Fig. 3; Figs. S2–S4).

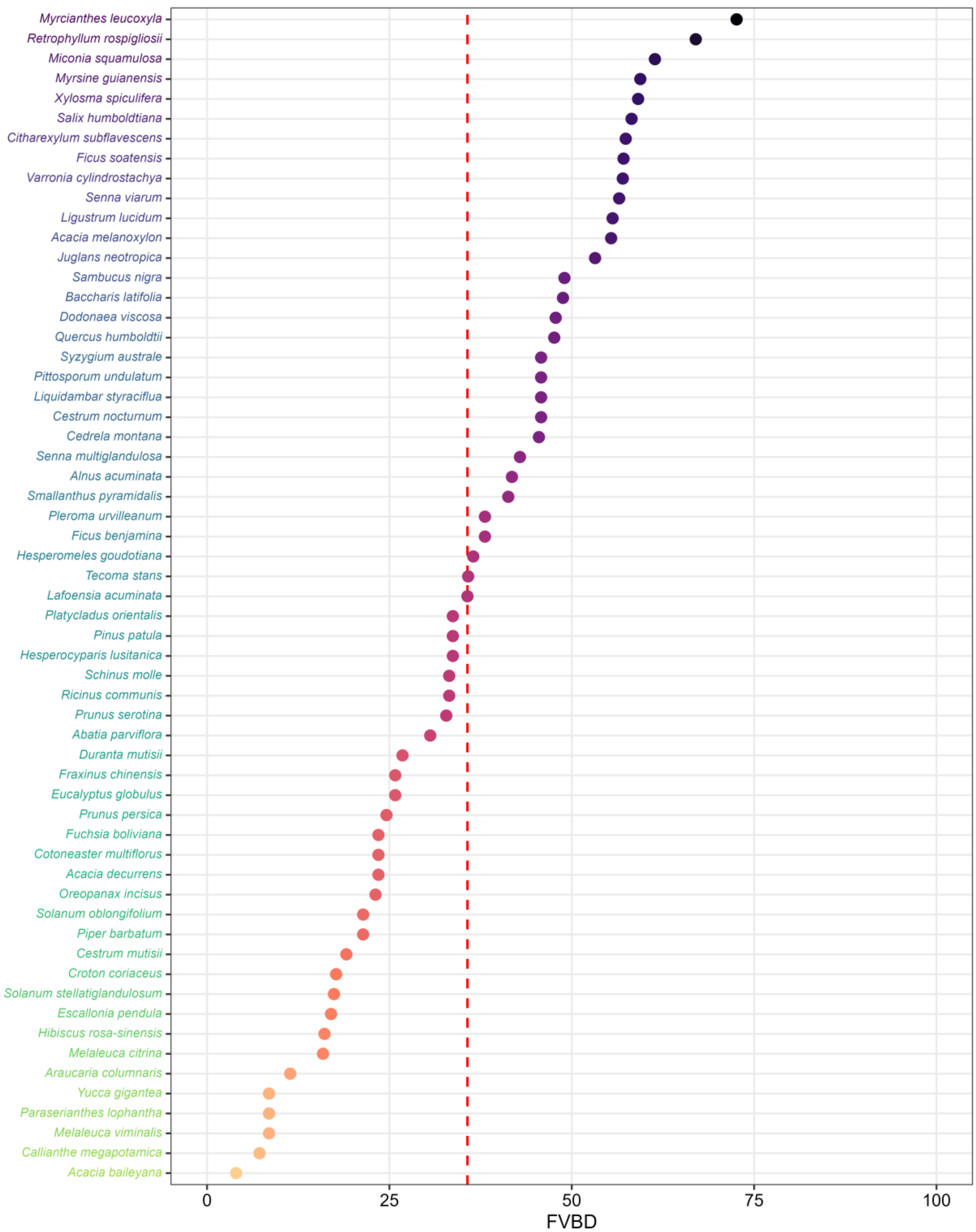

Figure 3. *Species functional value for biodiversity conservation (FVBD) of the 59 prioritized urban-tree species in Bogotá. Species are ordered and their labels colored according to FVBD value class; the red dashed line indicates the median value.*

3.3 Functional value across urban parks

Of the 1,196 trees in the park-census dataset, 1,117 were included in the park-level analyses across the 31 parks. Park-level functional values varied substantially among parks for all five evaluated dimensions (Figs. 4–5). Park-level carbon-related functional value (C) showed pronounced variation across the 31 parks (Fig. 4). Several parks located in the northern sector of Bogotá, including El Conódromo, Parques de la Colina, and Santa Bárbara Primer Sector, were among those with the highest aggregated values. In contrast, several of the sampled parks exhibited substantially lower values, indicating marked heterogeneity in the carbon-related functional potential of their tree assemblages.

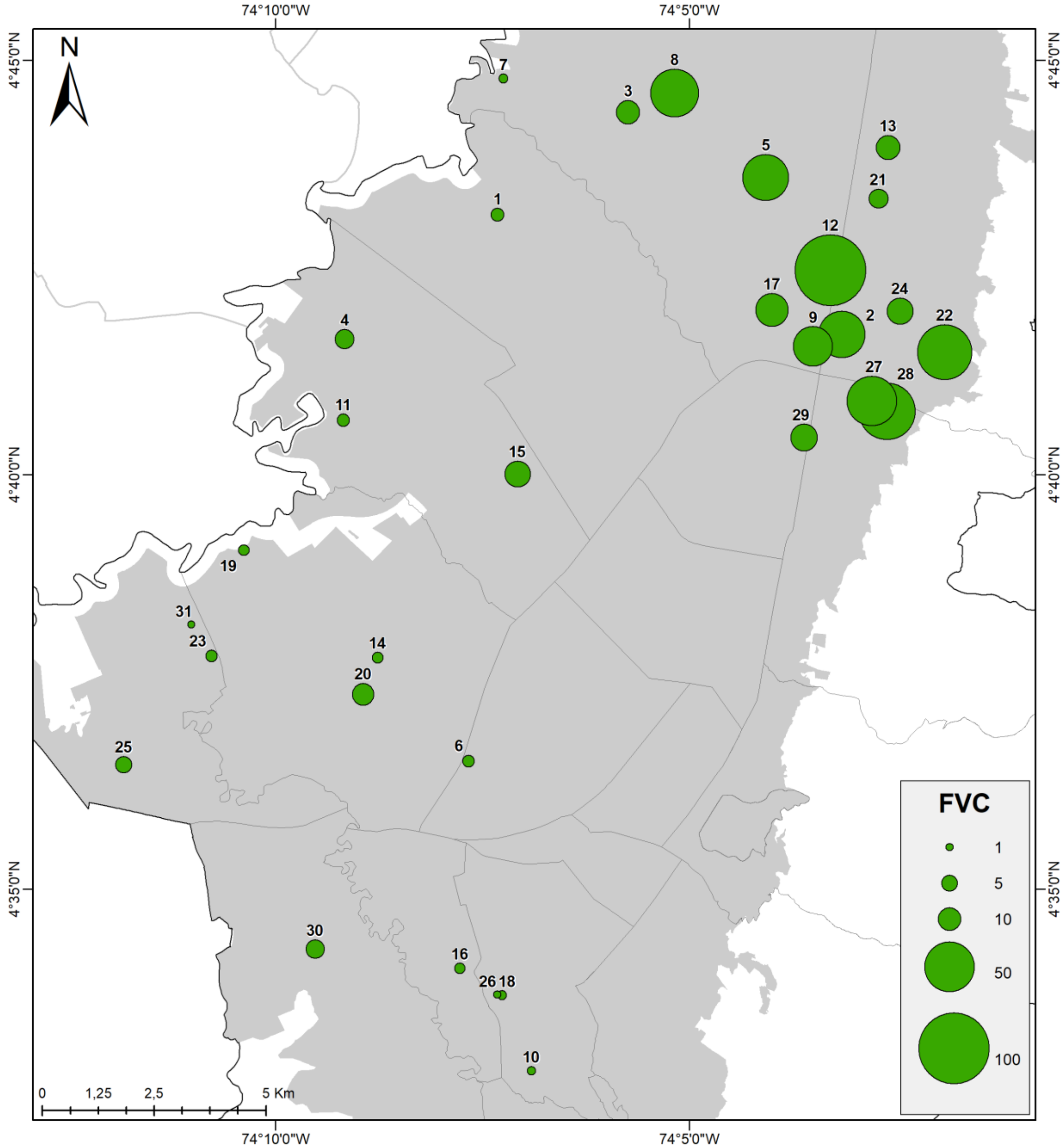

Figure 4. *Park-level carbon-related functional value (C) across the 31 urban parks analyzed in Bogotá. Circle size represents the park-level value rescaled to 1–100 for visualization; park IDs correspond to those in Figure 1.*

Comparable heterogeneity was observed for food provision, habitat and connectivity, existence value, and integrated biodiversity value (Fig. 5A–D). Parks with relatively high values in one biodiversity-related dimension frequently also showed high values in others, although park rankings varied among dimensions.

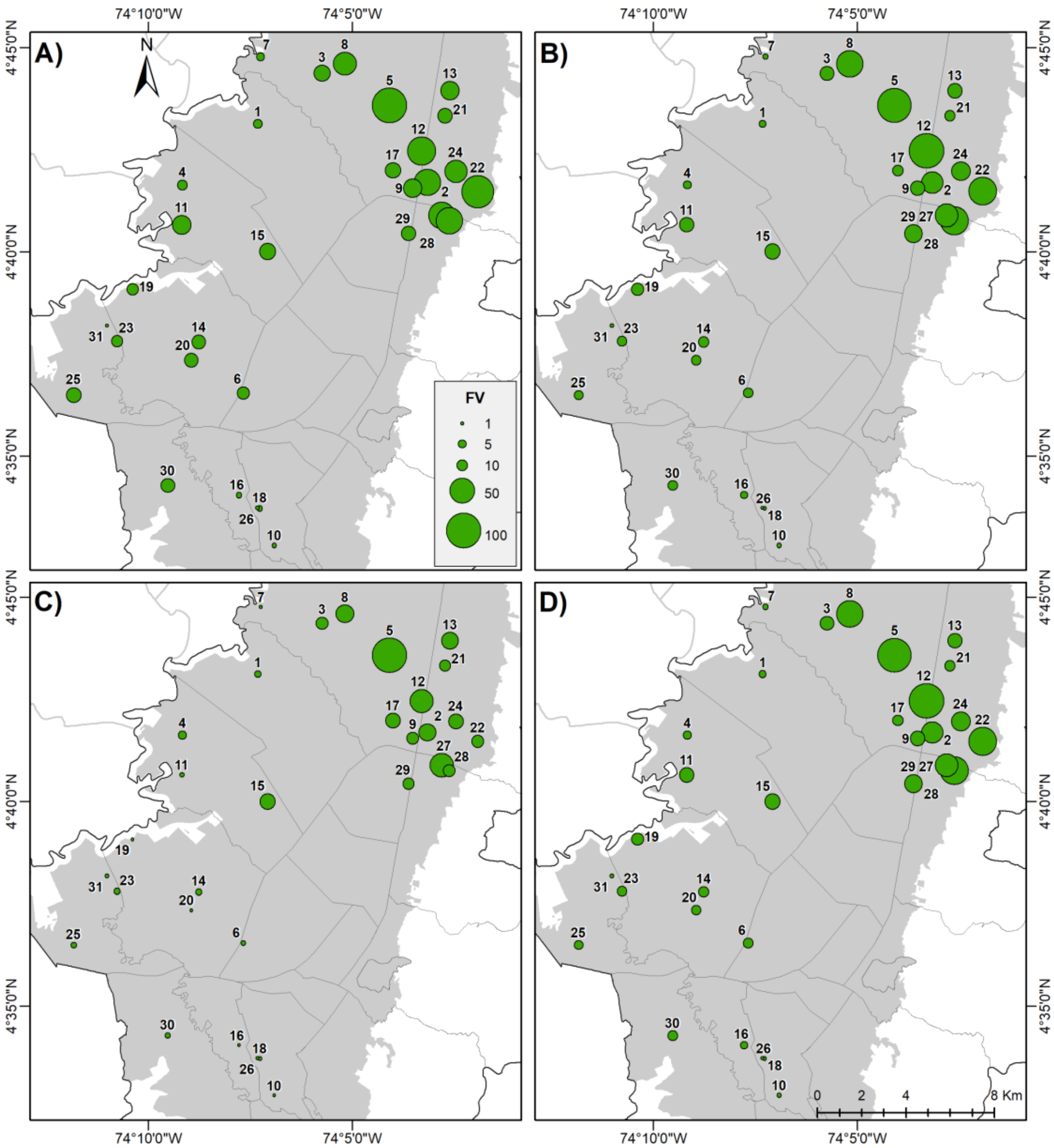

Figure 5. *Biodiversity-related park-level FVs across the 31 urban parks analyzed in Bogotá: (A) food provision (FD), (B) habitat and connectivity (HB), (C) existence value (EX), and (D)*

integrated biodiversity value (BD). Circle size represents the corresponding park-level value rescaled to 1–100 for visualization; park IDs correspond to those in Figure 1.

3.4 Spatial patterns of tree-cover functional value

All five park-level functional values showed positive and statistically significant global spatial autocorrelation (Moran's I = 0.30–0.43; all $p < 0.001$), indicating that parks with similar functional values tended to occur closer to one another than expected under spatial randomness. C and FD showed the strongest global spatial structure (I = 0.43 for both), followed by HB and BD (I = 0.36 for both); EX showed the weakest, although still positive, spatial autocorrelation (I = 0.30).

LISA identified significant local clusters and spatial outliers for all five functional dimensions (Figs. 6–7). High-high clusters were consistently concentrated in northeastern Bogotá, particularly in Usaquén, Chapinero, Suba, and Barrios Unidos, for both C (Fig. 6) and the four biodiversity-related values (Fig. 7A–D).

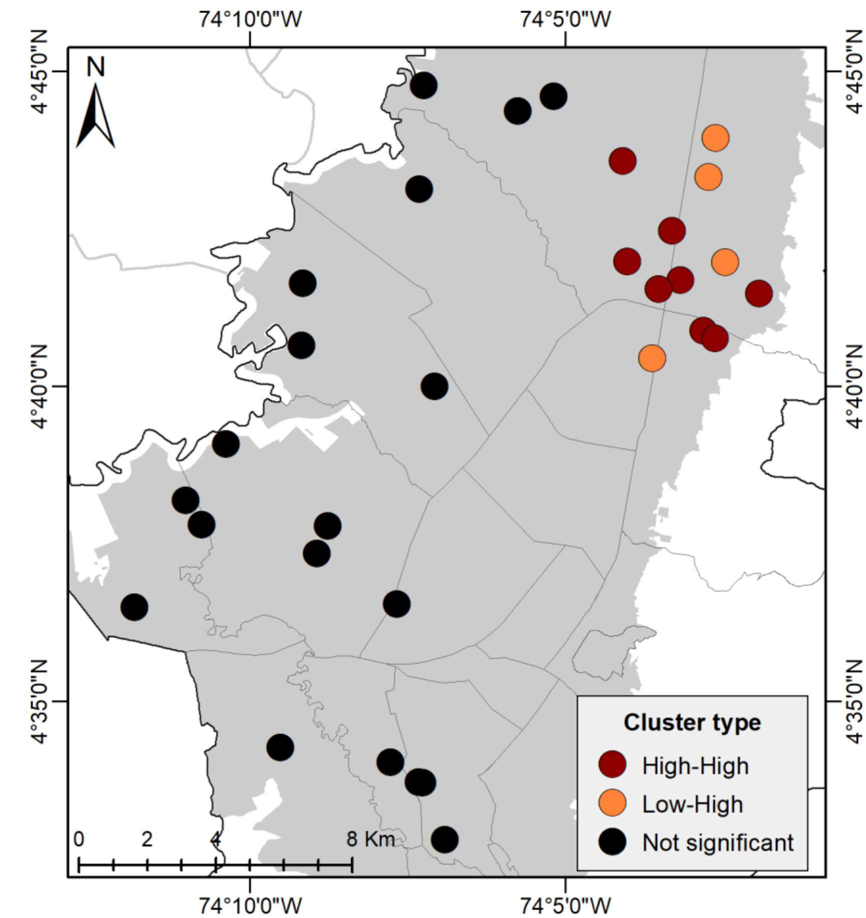

Figure 6. *Local indicators of spatial association (LISA) for park-level carbon-related functional value (C) across the 31 urban parks analyzed in Bogotá. Significant local clusters and spatial outliers are shown for* $p < 0.05$.

Low-high spatial outliers were also recurrent across the functional components. These corresponded to individual parks with comparatively low functional values located within neighborhoods characterized by higher values and occurred primarily in Usaquén, Suba, and Barrios Unidos (Figs. 6–7). By contrast, a significant low–low cluster was detected only for carbon-related value and consisted of a single park located in Tunjuelito in the southeastern sector of the city (Fig. 6). Most parks did not show statistically significant local spatial association for any of the evaluated functional components.

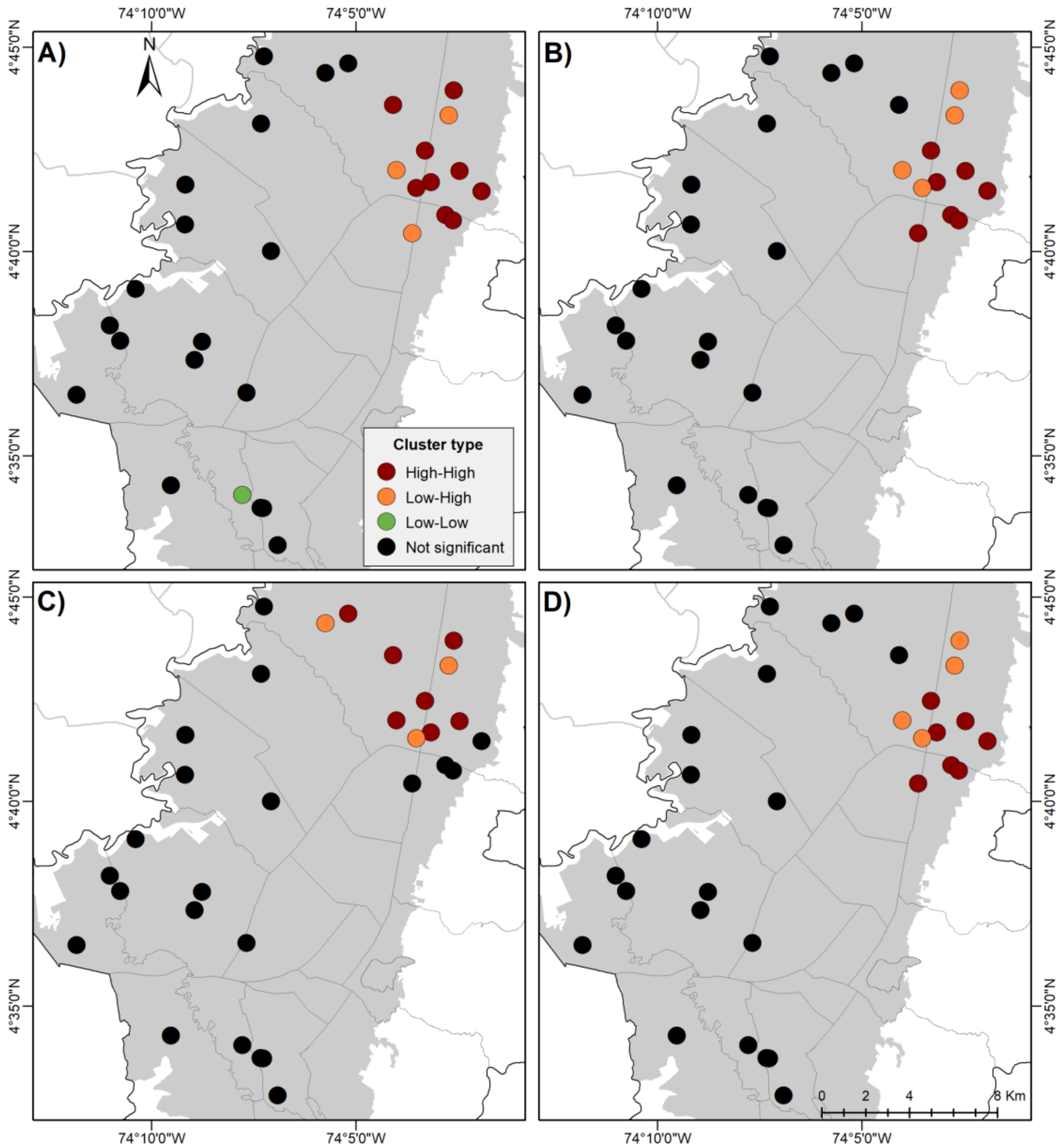

Figure 7. *Local indicators of spatial association (LISA) for biodiversity-related park-level functional values across the 31 urban parks analyzed in Bogotá: (A) FD, (B) HB, (C) EX, and (D) BD. Significant local clusters and spatial outliers are shown for p < 0.05.*

4. Discussion

4.1 Functional structure of Bogotá's urban-tree assemblage

Our results show that a relatively small subset of Bogotá's urban tree flora accounts for a large proportion of the individuals recorded in public spaces. Although 476 species were represented in the processed SIGAU inventory, only 59 species accounted for approximately 80% of all individuals. This concentration of abundance is ecologically relevant because ecosystem functioning can be disproportionately influenced by the traits of the most abundant species, as proposed by the mass-ratio hypothesis (Grime, 1998; Díaz et al., 2007; Smith et al., 2020). Consequently, high taxonomic richness at the city scale does not necessarily imply that ecosystem functioning is equally distributed among the species present.

Such dominance is also consistent with the highly filtered nature of urban plant assemblages. Urban floras result from a hierarchy of environmental and anthropogenic filters, including habitat transformation and fragmentation, urban environmental conditions, regional climate and biogeography, city development history, socioeconomic and cultural factors, biotic interactions, and deliberate human species selection (Williams et al., 2009; Pataki et al., 2013; Aronson et al., 2016). Human preferences can be particularly influential because much of the urban tree flora is deliberately planted according to aesthetic, management, cultural, or functional criteria. This means that the functional structure observed in Bogotá is not simply the outcome of ecological assembly but reflects the interaction between ecological constraints and long-term management decisions.

This interaction has important implications for urban ecosystem services. Species identity matters because tree species differ in morphology, life-history strategies, tolerance to urban stressors, and functional traits that influence ecosystem processes (Pataki et al., 2013; Williams et al., 2015; Grote et al., 2016). Previous work has therefore emphasized that urban-tree selection should move beyond taxonomic identity alone and explicitly consider functional attributes relevant to both site conditions and desired ecosystem services (Goodness et al., 2016; Grote et al., 2016; Núñez-Florez et al., 2019). Our results extend this reasoning by showing that the dominant species of Bogotá differ strongly in their potential contributions to carbon storage and biodiversity support.

The taxonomic validation of SIGAU further revealed that ecological analyses based on operational urban-tree inventories depend critically on nomenclatural consistency. Accepted scientific names differed from those recorded in SIGAU for 20% of the prioritized taxa. Taxonomic uncertainty can propagate through biodiversity analyses and, particularly in trait-based studies, can prevent or distort links with external databases of functional traits, conservation status, and species interactions (Guedes et al., 2025). This issue is especially relevant as urban tree inventories increasingly serve as infrastructure not only for tree management but also for ecosystem service assessment and ecological research (Nowak et al., 2008; Escobedo et al., 2015). Maintaining standardized scientific names and consistent taxonomic backbones would therefore substantially increase the analytical value of inventories such as SIGAU.

4.2 Functional differentiation among urban-tree species

The prioritized species showed substantial variation in all functional dimensions considered, indicating that Bogotá's dominant urban trees cannot be represented by a single hierarchy of ecological value. This result is consistent with the central premise of trait-based ecology: different functional traits mediate different ecosystem processes, and species can therefore contribute differently to multiple ecosystem services (Díaz et al., 2007; de Bello et al., 2010; Lavorel et al., 2011). Specific functional indices provide one means of translating these differences into service-related metrics by combining traits and ecological attributes relevant to particular ecological functions (Marinidou et al., 2013).

For FVC, wood density provided substantial differentiation among species. Wood density is associated with fundamental plant ecological strategies involving growth, mechanical support, longevity, and biomass accumulation (Chave et al., 2009; Díaz et al., 2016). The wide range observed among Bogotá's prioritized species therefore reflects contrasting ecological strategies represented within the urban flora. Importantly, locally measured wood-density values also showed different degrees of intraspecific variability. Previous research in Bogotá has demonstrated intraspecific variation in wood density and other traits in response to heterogeneous urban conditions (Moreno Barreto & Rubiano Calderón, 2020; Rubiano Calderón & Moreno Barreto, 2020; Salamanca-Fonseca et al., 2024), although responses can differ among species and environments. This supports using locally measured traits when available, as global species averages may not fully capture trait expression under local urban conditions.

At the same time, FVC should not be interpreted as a complete estimate of carbon storage at the species level. In the functional framework of Marinidou et al. (2013), species wood density provides the functional component of carbon-related value, whereas actual tree contribution also depends strongly on individual dimensions. The original methodology was explicitly designed to combine species identity with tree size rather than infer ecosystem-service provision from traits alone. This distinction is particularly relevant in urban forests, where tree age, growth, pruning, and available growing space can lead to substantial structural differences among individuals of the same species.

The biodiversity-related indices further illustrate the multidimensional nature of functional potential. Food provision, habitat and connectivity, and existence value represent different ecological dimensions and produced contrasting species rankings. This follows the conceptual formulation of Marinidou et al. (2013), in which biodiversity conservation is represented by food and habitat provision for fauna, together with the intrinsic or conservation value of the tree species themselves. The integrated FVBD therefore captures information that cannot be represented by a single trait.

Most species had at least one food-resource type documented for urban fauna, and FVFD increased with the number of recorded resource categories among fruits, seeds, foliage/forage, and floral resources. Because these categories were coded as presence-absence variables, FVFD represents the breadth of documented resource types rather than their abundance, temporal availability, or intensity of use by fauna. This distinction is important because interaction-based indicators simplify complex biodiversity–ecosystem service relationships (Kowarik, 2011; Schwarz et al., 2017).

Similarly, FVHB is a structural indicator based on crown density and foliage persistence. Denser and more persistent foliage can increase the structural availability of refuge, perching, and nesting resources, but actual habitat quality also depends on tree architecture, surrounding vegetation, landscape context, and the ecological requirements of fauna. FVHB should therefore be interpreted as a parsimonious indicator of habitat-support potential rather than a direct measure of habitat quality or connectivity.

Existence value adds a different conservation dimension. Unlike food or habitat provision, FVEX includes the conservation status and ecological characteristics of the tree species itself. In the original framework, this component was explicitly intended to recognize the intrinsic conservation importance of species independently of services directly provided to other organisms. Consequently, FVEX is partly a conservation-priority construct rather than an independently measured ecosystem process. Keeping the three biodiversity components separate, while also integrating them in FVBD, is therefore informative because it makes explicit the different reasons why a species can exhibit high biodiversity-related functional value.

Overall, the contrasting values across FVC, FVFD, FVHB, FVEX, and FVBD reinforce the argument that urban tree selection should not optimize a single trait or service. Núñez-Florez et al. (2019) similarly showed that functional characteristics can be used to match species to urban planting conditions and desired ecosystem services, while broader functional approaches emphasize matching plant traits, spatial context, and ecosystem-service demand (Tran et al., 2020). This suggests that urban-forest multifunctionality is more likely to result from complementary species assemblages than from repeatedly planting species that maximize one functional dimension.

4.3 Scaling functional potential from species to urban parks

An important contribution of this study is the extension of functional values beyond the species level. Species traits and ecological attributes describe potential associated with taxon identity, whereas park-level functional potential also depends on the size and abundance of individual trees. Marinidou et al. (2013) addressed this by weighting species functional values by tree dimensions and aggregating individual values to estimate tree-cover ecological value.

This scaling framework is consistent with the broader idea of assemblage-level functional properties, in which ecological effects emerge from species functional characteristics and their representation within an assemblage (Violle et al., 2007). The specific functional-value approach additionally incorporates individual-tree dimensions, which is particularly relevant in urban forests where management can produce large within-species differences in size, age, and crown development.

The pronounced variation among the 31 parks therefore reflects several interacting components: species composition, tree abundance, species-level functional values, and individual-tree size.

The importance of tree dimensions is also supported by the methodology's original development. Marinidou (2009) found that individual and site-level ecological values were strongly influenced by tree dimensions and that the relative importance of dimensional and species-functional components varied among services. Similarly, urban-tree studies emphasize that crown size, growing space, and structural development strongly influence the functions expressed by trees (Pretzsch et al., 2015). Thus, an approach based exclusively on species lists would overlook potentially important differences among sites with similar floristic composition but different tree structures.

However, interpreting the park-level values requires an important distinction. In this study, park values represent the aggregate functional value of the analyzed tree assemblage. Because they are calculated by summing individual contributions, they are influenced by tree abundance, species composition, and tree dimensions. High total values, therefore, should not automatically be interpreted as greater functional efficiency or greater service provision per unit area.

This issue differs among functions. Carbon stored in multiple trees is intrinsically additive, making summation conceptually straightforward. Biodiversity-related functions are more complex because ecological contributions can involve redundancy, complementarity, and interactions among species. The methodological framework itself recognizes that community-level integration may be straightforward for additive services such as carbon but may require more complex functions for biodiversity. Consequently, BD should be interpreted as an aggregate indicator of biodiversity-support potential rather than a direct measure of biodiversity or ecological integrity.

Despite these limitations, scaling from species to trees and parks offers an important applied advantage. Most urban-forest inventories contain information on identity and tree dimensions, but relatively little functionally explicit information. Linking inventory records to traits and ecological attributes, therefore, allows routinely collected management data to provide additional ecological information. This represents an extension of previous Colombian applications of functional approaches. Núñez-Florez et al. (2019), for example, demonstrated their usefulness for functional species selection in Ibagué; the present study shows how similar information can be propagated to existing tree assemblages and compared among urban green spaces.

4.4 Spatial structuring of functional value in Bogotá

The significant positive spatial autocorrelation found for all five park-level functional dimensions indicates that functional value was spatially structured rather than randomly distributed among the sampled parks. High–High clusters were repeatedly concentrated in northeastern Bogotá, suggesting that neighboring parks in this part of the city tended to contain tree assemblages with relatively high functional values.

Spatial structure is expected in urban vegetation because urban ecosystems are characterized by strong spatial heterogeneity generated by environmental conditions, land-use history, infrastructure and human decision-making (Pickett et al., 2017). Urban plant assemblages can consequently be understood as the result of nested filters operating from regional climate and biogeography to neighborhood-level environmental, socioeconomic and cultural conditions (Williams et al., 2009; Pataki et al., 2013; Aronson et al., 2016). The clustering observed here is consistent with the idea that nearby parks can share aspects of planting history, management, urban form or environmental context.

Previous studies in Bogotá provide additional context for this interpretation. Public urban forests and their ecosystem services have been shown to exhibit socio-ecological differences across the city (Escobedo et al., 2015), and spatial variation in green infrastructure and thermal-regulation capacity has also been documented (Rubiano, 2019). Similar inequalities in access to and distribution of urban vegetation have been reported in other cities (Kabisch & Haase, 2014; Schwarz et al., 2015; Nesbitt & Meitner, 2016).

However, the present analysis does not test these variables as causal drivers, and the observed northeastern clusters should therefore not be attributed directly to socioeconomic conditions, park size, management history or any single environmental factor. Rather, the spatial analysis identifies a pattern that motivates those hypotheses. Determining why functional values cluster spatially would require explicitly modelling park area, tree abundance and density, species richness and composition, tree-size structure, socioeconomic conditions, environmental context and potentially management history.

The LISA results may nevertheless be useful as a screening tool. High–High clusters identify spatial concentrations of high aggregate functional potential, whereas Low–High outliers identify individual parks with relatively low values embedded within higher-value neighborhoods. The latter could be particularly informative for management because they identify locations where local assemblage characteristics differ from their surrounding spatial context. These patterns should not by themselves prescribe intervention, but they can help prioritize sites for more detailed diagnosis.

This spatial perspective also highlights that optimizing urban ecosystem services involves both which species are planted and where functional capacity is located. Frameworks such as the Green Infrastructure Space and Traits model explicitly argue that multifunctionality depends jointly on plant traits and spatial arrangement (Tran et al., 2020). The current study provides an empirical basis for extending this logic in Bogotá by identifying spatial variation in functional potential across existing park assemblages.

4.5 Implications, limitations, and future applications

The study supports the use of trait-based functional indices as a complementary tool for urban-forest planning, but their scope should be clearly defined. The indices quantify potential functional value based on selected traits, ecological attributes, and tree dimensions; they do not constitute direct measurements of ecosystem-service delivery. Marinidou et al. (2013) themselves presented their methodology as a flexible basic approach that could be adapted to local conditions rather than as a universally applicable assessment tool. This flexibility is one of its strengths, but it also means that interpretations depend on the variables, weighting rules, and data sources used.

Several sources of uncertainty are particularly relevant. First, some functional information was obtained from global databases or taxonomic-level estimates when local observations were unavailable. Second, food-provision value depends on documented biotic interactions and, therefore, on the completeness of the available interaction data. Third, the 59 prioritized species represent most individuals in SIGAU but only a fraction of the total taxonomic richness. Rare species can have unique traits or interactions that are disproportionate to their abundance, so prioritizing dominant species captures the major contribution expected from a mass-ratio perspective but not the full functional diversity of urban flora.

The quality and completeness of the underlying urban-tree inventory are additional constraints. SIGAU provides valuable information for management and research, but DBH data were unavailable for most citywide records, preventing individual-level scaling across the entire urban inventory. Improving dendrometric completeness and taxonomic standardization would substantially expand opportunities for spatial and temporal assessments of urban-tree functional potential.

For management applications, functional benefits should also be considered together with potential ecosystem disservices. Trees can generate costs or undesirable effects related to infrastructure conflicts, allergenicity, maintenance, invasive potential or other attributes, and composite approaches that combine ecosystem services and disservices can provide more balanced guidance (Speak et al., 2018). Similarly, additional functional dimensions such as shade, thermal regulation, air-pollution mitigation or stormwater regulation could eventually be integrated to move from service-specific assessment toward urban-forest multifunctionality (Grote et al., 2016; Núñez-Florez et al., 2019; Tran et al., 2020).

Finally, the present analysis provides a spatial snapshot, not a temporal monitoring test. Nevertheless, the underlying structure of the method—species identity, functional attributes, individual dimensions and spatially explicit inventories—makes repeated assessment conceptually possible. Successive inventories could evaluate how growth, mortality, planting and replacement alter functional value over time. Such applications would require sufficiently complete and standardized inventory data, but could eventually turn operational urban-tree databases into tools not only for recording trees but also for tracking changes in functional potential.

5. Conclusions

This study shows that trait-based functional values can complement urban-tree inventories by linking species traits and ecological attributes with individual-tree structure and park-scale patterns. Bogotá's dominant urban tree species differed substantially in carbon-related and biodiversity-related functional potential, and these differences propagated to marked variation among park tree assemblages.

Park-level functional values were spatially structured, with recurrent high-value clusters in northeastern Bogotá. The framework is most appropriately interpreted as a comparative assessment of functional potential rather than a direct measurement of ecosystem-service delivery. Its main contribution is to move urban-tree assessment beyond species identity and abundance toward functionally explicit information that can support species selection, park diagnosis, and spatially informed urban-forest planning. Future applications would benefit from more complete dendrometric inventories, continued taxonomic standardization, and improved local trait and biotic-interaction data.

6. Data availability

The species-level functional value dataset generated in this study is publicly available through SiB Colombia and GBIF at https://doi.org/10.15472/hpbjwc (Rubiano, 2026). Additional data supporting the findings of this study are available from the corresponding author upon reasonable request.

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9. Competing interests

The author declares no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

10. Declaration of generative AI and AI-assisted technologies

During the preparation of this work, the author used ChatGPT (OpenAI) to assist with drafting, language editing, and code refinement. All outputs were critically reviewed and edited by the author, who takes full responsibility for the final content. Generative AI was not used to create or alter the underlying research data.

11. References

Álvarez Lucero, G. D., Tovar Corzo, G., & Rodríguez Garavito, D. A. (2010). *Manual de silvicultura urbana para Bogotá*. Jardín Botánico José Celestino Mutis.

Álvarez Lucero, G. D., Serrano Carranza, C. M., Duque-Osorio, R., Guzmán Lugo, D. M., Carvajal Guacaneme, L., Arteaga Morales, S. M., Rodríguez Sánchez, J. P., Madriñán Restrepo, S., González Rosas, C., Guzmán Ramírez, M., Cárdenas Toquica, M. E., Pineda Torres, Y. M., Rey

Guerra, C. V., Bautista Carrizosa, D. F., & Calderón Rodríguez, J. M. (2020). *Manual de coberturas vegetales de Bogotá, D.C.* Jardín Botánico de Bogotá José Celestino Mutis & Ediciones Uniandes.

Anselin, L. (1995). Local indicators of spatial association—LISA. *Geographical Analysis, 27*(2), 93–115. doi: 10.1111/j.1538-4632.1995.tb00338.x

Aronson, M. F. J., Nilon, C. H., Lepczyk, C. A., Parker, T. S., Warren, P. S., Cilliers, S. S., Goddard, M. A., Hahs, A. K., Herzog, C., Katti, M., La Sorte, F. A., Williams, N. S. G., & Zipperer, W. (2016). Hierarchical filters determine community assembly of urban species pools. *Ecology, 97*(11), 2952–2963. doi: 10.1002/ecy.1535

Bivand, R. S., Pebesma, E. J., & Gómez-Rubio, V. (2008). *Applied spatial data analysis with R*. Springer.

Bolund, P., & Hunhammar, S. (1999). Ecosystem services in urban areas. *Ecological Economics, 29*(2), 293–301. doi: 10.1016/S0921-8009(99)00013-0

Casanoves, F., Pla, L., & Di Rienzo, J. A. (2011). *Valoración y análisis de la diversidad funcional y su relación con los servicios ecosistémicos*. Centro Agronómico Tropical de Investigación y Enseñanza (CATIE).

Chave, J., Coomes, D., Jansen, S., Lewis, S. L., Swenson, N. G., & Zanne, A. E. (2009). Towards a worldwide wood economics spectrum. *Ecology Letters, 12*(4), 351–366. doi: 10.1111/j.1461-0248.2009.01285.x

de Bello, F., Lavorel, S., Díaz, S., Harrington, R., Cornelissen, J. H. C., Bardgett, R. D., Berg, M. P., Cipriotti, P., Feld, C. K., Hering, D., da Silva, P. M., Potts, S. G., Sandin, L., Sousa, J. P., Storkey, J., Wardle, D. A., & Harrison, P. A. (2010). Towards an assessment of multiple ecosystem processes and services via functional traits. *Biodiversity and Conservation, 19*, 2873–2893. doi: 10.1007/s10531-010-9850-9

Del Risco, A. A., Montoya, Á. M., García, V., Currea, S., Rivera, Y. A., Moreno, D., & Rodríguez, Á. T. (2022). Data synthesis and dynamic visualization converge into a comprehensive biotic interaction network: A case study of the urban and rural areas of Bogotá D.C. *Urban Ecosystems, 25*, 75–86. doi: 10.1007/s11252-021-01133-3

Díaz, S., Lavorel, S., de Bello, F., Quétier, F., Grigulis, K., & Robson, T. M. (2007). Incorporating plant functional diversity effects in ecosystem service assessments. *Proceedings of the National Academy of Sciences, 104*(52), 20684–20689. doi: 10.1073/pnas.0704716104

Díaz, S., Kattge, J., Cornelissen, J. H. C., Wright, I. J., Lavorel, S., Dray, S., Reu, B., Kleyer, M., Wirth, C., Prentice, I. C., Garnier, E., Bönisch, G., Westoby, M., Poorter, H., Reich, P. B., Moles, A. T., Dickie, J., Gillison, A. N., Zanne, A. E., … Gorné, L. D. (2016). The global spectrum of plant form and function. *Nature, 529*(7585), 167–171. doi: 10.1038/nature16489

Escobedo, F. J., Clerici, N., Staudhammer, C. L., & Corzo, G. T. (2015). Socio-ecological dynamics and inequality in Bogotá, Colombia's public urban forests and their ecosystem services. *Urban Forestry & Urban Greening, 14*(4), 1040–1053. doi: 10.1016/j.ufug.2015.09.011

Esperon-Rodriguez, M., Gallagher, R., Calfapietra, C., Cariñanos, P., Dobbs, C., Eleuterio, A. A., Esperon Rodriguez, D., Jahani, A., Litvak, E., Livesley, S. J., Manoli, G., Marchin, R. M., McPhearson, T., Messier, C., Östberg, J., Roman, L. A., Russo, A., Saffariha, M., Shackleton, C., … Tjoelker, M. G. (2025). Barriers and opportunities for resilient and sustainable urban forests. *Nature Cities*. doi: 10.1038/s44284-025-00212-2

Gómez-Baggethun, E., & Barton, D. N. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics, 86*, 235–245. doi: 10.1016/j.ecolecon.2012.08.019

Goodness, J., Andersson, E., Anderson, P. M. L., & Elmqvist, T. (2016). Exploring the links between functional traits and cultural ecosystem services to enhance urban ecosystem management. *Ecological Indicators, 70*, 597–605. doi: 10.1016/j.ecolind.2016.02.031

Grime, J. P. (1998). Benefits of plant diversity to ecosystems: Immediate, filter and founder effects. *Journal of Ecology, 86*(6), 902–910. doi: 10.1046/j.1365-2745.1998.00306.x

Grote, R., Samson, R., Alonso, R., Amorim, J. H., Cariñanos, P., Churkina, G., Fares, S., Le Thiec, D., Niinemets, Ü., Mikkelsen, T. N., Paoletti, E., Tiwary, A., & Calfapietra, C. (2016). Functional traits of urban trees: Air pollution mitigation potential. *Frontiers in Ecology and the Environment, 14*(10), 543–550. doi: 10.1002/fee.1426

Guedes, J. J. M., Moura, M. R., Jardim, L., & Diniz-Filho, J. A. F. (2025). Global patterns of taxonomic uncertainty and its impacts on biodiversity research. *Systematic Biology*, syaf010. doi: 10.1093/sysbio/syaf010

IUCN. (2025). *The IUCN Red List of Threatened Species*. International Union for Conservation of Nature.

Kabisch, N., & Haase, D. (2014). Green justice or just green? Provision of urban green spaces in Berlin, Germany. *Landscape and Urban Planning, 122*, 129–139. doi: 10.1016/j.landurbplan.2013.11.016

Kattge, J., Díaz, S., Lavorel, S., Prentice, I. C., Leadley, P., Bönisch, G., Garnier, E., Westoby, M., Reich, P. B., Wright, I. J., Cornelissen, J. H. C., Violle, C., Harrison, S. P., van Bodegom, P. M., Reichstein, M., Enquist, B. J., Soudzilovskaia, N. A., Ackerly, D. D., Anand, M., … Wirth, C. (2011). TRY—A global database of plant traits. *Global Change Biology, 17*(9), 2905–2935. doi: 10.1111/j.1365-2486.2011.02451.x

Kindt, R. (2020). WorldFlora: An R package for exact and fuzzy matching of plant names against the World Flora Online taxonomic backbone data. *Applications in Plant Sciences, 8*(9), e11388. doi: 10.1002/aps3.11388

Kowarik, I. (2011). Novel urban ecosystems, biodiversity, and conservation. *Environmental Pollution, 159*, 1974–1983. doi: 10.1016/j.envpol.2011.02.022

Lavorel, S., Grigulis, K., Lamarque, P., Colace, M.-P., Garden, D., Girel, J., Pellet, G., & Douzet, R. (2011). Using plant functional traits to understand the landscape distribution of multiple ecosystem services. *Journal of Ecology, 99*(1), 135–147. doi: 10.1111/j.1365-2745.2010.01753.x

Mahecha, G., Sánchez, F., Chaparro, J., Cadena, H., Tovar, G., Villota, L., Morales, G., Castro, J., Bocanegra, F., & Quintero, M. (2010). *Arbolado urbano de Bogotá: Identificación, descripción y bases para su manejo*. Secretaría Distrital de Ambiente.

Maitner, B. S., Boyle, B., Casler, N., Condit, R., Donoghue, J., Durán, S. M., Guaderrama, D., Hinchliff, C. E., Jørgensen, P. M., Kraft, N. J. B., McGill, B., Merow, C., Morueta-Holme, N., Peet, R. K., Sandel, B., Schildhauer, M., Smith, S. A., Svenning, J. C., Thiers, B., … Enquist, B. J. (2018). The BIEN R package: A tool to access the Botanical Information and Ecology Network (BIEN) database. *Methods in Ecology and Evolution, 9*(2), 373–379. doi: 10.1111/2041-210X.12861

Marinidou, E. (2009). *Estimación del aporte de la cobertura arbórea a la regulación climática y la conservación de la biodiversidad: Diseño y aplicación de una metodología en Chiapas, México* [Master's thesis, Centro Agronómico Tropical de Investigación y Enseñanza].

Marinidou, E., Finegan, B., Jiménez-Ferrer, G., Delgado, D., & Casanoves, F. (2013). Concepts and a methodology for evaluating environmental services from trees of small farms in Chiapas, México. *Journal of Environmental Management, 114*, 115–124. doi: 10.1016/j.jenvman.2012.10.046

Moreno Barreto, J. E. (2022). *Rasgos funcionales de especies del arbolado urbano presentes en las colecciones vivas del JBB* [Dataset]. Jardín Botánico de Bogotá José Celestino Mutis. doi: 10.15472/dfjela

Moreno Barreto, J. E., & Rubiano Calderón, K. D. (2020). Aproximación al uso de rasgos funcionales y gradientes ambientales para seis especies del arbolado urbano de Bogotá. *Revista Facultad de Ciencias Básicas, 15*(2), 17–33. doi: 10.18359/rfcb.3901

Nesbitt, L., & Meitner, M. J. (2016). Exploring relationships between socioeconomic background and urban greenery in Portland, OR. *Forests, 7*, 162. doi: 10.3390/f7080162

Nowak, D. J., Crane, D. E., Stevens, J. C., Hoehn, R. E., Walton, J. T., & Bond, J. (2008). A ground-based method of assessing urban forest structure and ecosystem services. *Arboriculture & Urban Forestry, 34*(6), 347–358.

Núñez-Florez, R., Pérez-Gómez, U., & Fernández-Méndez, F. (2019). Functional diversity criteria for selecting urban trees. *Urban Forestry & Urban Greening, 38*, 251–266. doi: 10.1016/j.ufug.2019.01.005

O'Brien, L. E., Urbanek, R. E., & Gregory, J. D. (2022). Ecological functions and human benefits of urban forests. *Urban Forestry & Urban Greening, 75*, 127707. doi: 10.1016/j.ufug.2022.127707

Pataki, D. E., McCarthy, H. R., Gillespie, T., Jenerette, G. D., & Pincetl, S. (2013). A trait-based ecology of the Los Angeles urban forest. *Ecosphere, 4*(6), 1–20. doi: 10.1890/ES13-00017.1

Pickett, S. T. A., Cadenasso, M. L., Rosi-Marshall, E. J., Belt, K. T., Groffman, P. M., Grove, J. M., Irwin, E. G., Kaushal, S. S., LaDeau, S. L., Nilon, C. H., Swan, C. M., & Warren, P. S. (2017). Dynamic heterogeneity: A framework to promote ecological integration and hypothesis generation in urban systems. *Urban Ecosystems, 20*, 1–14. doi: 10.1007/s11252-016-0574-9

Pretzsch, H., Biber, P., Uhl, E., Dahlhausen, J., Rötzer, T., Caldentey, J., Koike, T., van Con, T., Chavanne, A., Seifert, T., du Toit, B., Farnden, C., & Pauleit, S. (2015). Crown size and growing space requirement of common tree species in urban centres, parks, and forests. *Urban Forestry & Urban Greening, 14*, 466–479. doi: 10.1016/j.ufug.2015.04.006

Réjou-Méchain, M., Tanguy, A., Piponiot, C., Chave, J., & Hérault, B. (2017). biomass: An R package for estimating above-ground biomass and its uncertainty in tropical forests. *Methods in Ecology and Evolution, 8*(9), 1163–1167. doi: 10.1111/2041-210X.12753

Rodríguez-Alarcón, S., Pinzón-Pérez, L., López, J., & Cabrera-Amaya, D. (2019). *Rasgos funcionales de plantas leñosas nativas y exóticas en áreas verdes de Bogotá, Colombia* [Dataset]. Jardín Botánico de Bogotá José Celestino Mutis. doi: 10.15472/xmkibe

Rubiano, K. (2019). Distribución de la infraestructura verde y su capacidad de regulación térmica en Bogotá, Colombia. *Colombia Forestal, 22*(2), 83–100. doi: 10.14483/2256201X.14304

Rubiano K (2026). Índices de valor funcional de las especies dominantes del arbolado urbano de Bogotá - 2025. Version 2.0. Jardín Botánico de Bogotá "José Celestino Mutis". Checklist dataset. https://doi.org/10.15472/hpbjwc

Rubiano Calderón, K. D., & Moreno Barreto, J. E. (2020). Efecto del método de emplazamiento en la respuesta funcional de seis especies arbóreas de Bogotá. *Colombia Forestal, 23*(2), 5–19. doi: 10.14483/2256201X.15811

Rubiano Calderón, K. D., & Moreno Barreto, J. E. (2022). *Rasgos funcionales de especies del arbolado urbano presentes en Bogotá en relación con diferentes tipos de emplazamiento asociados a superficies impermeables* [Dataset]. Jardín Botánico de Bogotá José Celestino Mutis. doi: 10.15472/squgg6

Salamanca-Fonseca, M., Aldana, A. M., Vargas-Martinez, V., Acero-Gomez, S., Fonseca-Tellez, J., Gutierrez, S., Hoyos, Y. D., León, K. M., Márquez, C., Molina-R, L., Moreno-Abdelnur, A., Pineda, S., Pinzón, J. J., Trespalacios, M., Velasco, L., Sanchez-Tello, J. D., Alvarez-Garzón, C., Posada, J. M., & Sanchez, A. (2024). Effects of urban, peri-urban and rural land covers on plant functional traits around Bogotá, Colombia. *Urban Ecosystems, 27*, 251–260. doi: 10.1007/s11252-023-01429-6

Schwarz, K., Fragkias, M., Boone, C. G., Zhou, W., McHale, M., Grove, J. M., O'Neil-Dunne, J., McFadden, J. P., Buckley, G. L., Childers, D., Ogden, L., Pincetl, S., Pataki, D. E., Whitmer, A., & Cadenasso, M. L. (2015). Trees grow on money: Urban tree canopy cover and environmental justice. *PLoS ONE, 10*(4), e0122051. doi: 10.1371/journal.pone.0122051

Schwarz, N., Moretti, M., Bugalho, M. N., Davies, Z. G., Haase, D., Hack, J., Hof, A., Melero, Y., Pett, T. J., & Knapp, S. (2017). Understanding biodiversity–ecosystem service relationships in urban areas: A comprehensive literature review. *Ecosystem Services, 27*, 161–171. doi: 10.1016/j.ecoser.2017.08.014

Smith, M. D., Koerner, S. E., Knapp, A. K., Avolio, M. L., Chaves, F. A., Denton, E. M., Dietrich, J., Gibson, D. J., Gray, J., Hoffman, A. M., Hoover, D. L., Komatsu, K. J., Silletti, A., Wilcox, K. R., Yu, Q., & Blair, J. M. (2020). Mass ratio effects underlie ecosystem responses to environmental change. *Journal of Ecology, 108*(3), 855–864. doi: 10.1111/1365-2745.13330

Speak, A., Escobedo, F. J., Russo, A., & Zerbe, S. (2018). An ecosystem service-disservice ratio: Using composite indicators to assess the net benefits of urban trees. *Ecological Indicators, 95*, 544–553. doi: 10.1016/j.ecolind.2018.07.048

Tran, T. J., Helmus, M. R., & Behm, J. E. (2020). Green infrastructure space and traits (GIST) model: Integrating green infrastructure spatial placement and plant traits to maximize multifunctionality. *Urban Forestry & Urban Greening, 49*, 126635. doi: 10.1016/j.ufug.2020.126635

Violle, C., Navas, M.-L., Vile, D., Kazakou, E., Fortunel, C., Hummel, I., & Garnier, E. (2007). Let the concept of trait be functional! *Oikos, 116*, 882–892. doi: 10.1111/j.0030-1299.2007.15559.x

Williams, N. S. G., Schwartz, M. W., Vesk, P. A., McCarthy, M. A., Hahs, A. K., Clemants, S. E., Corlett, R. T., Duncan, R. P., Norton, B. A., Thompson, K., & McDonnell, M. J. (2009). A conceptual framework for predicting the effects of urban environments on floras. *Journal of Ecology, 97*(1), 4–9. doi: 10.1111/j.1365-2745.2008.01460.x

Williams, N. S. G., Hahs, A. K., & Vesk, P. A. (2015). Urbanisation, plant traits and the composition of urban floras. *Perspectives in Plant Ecology, Evolution and Systematics, 17*(1), 78–86. doi: 10.1016/j.ppees.2014.10.002

World Flora Online. (2025). *World Flora Online Plant List* [June 2025 release]. World Flora Online Consortium.

Zanne, A. E., Lopez-Gonzalez, G., Coomes, D. A., et al. (2009). *Data from: Towards a worldwide wood economics spectrum* [Dataset]. Dryad. doi: 10.5061/dryad.234

Supplementary material for "Trait-based functional indices reveal contrasting carbon-storage and biodiversity-support potential across urban tree species and parks in Bogotá"

Kristian Rubiano[1,2,*]

[1] Jardín Botánico de Bogotá José Celestino Mutis, Bogotá, Colombia

[2] School of Sciences and Engineering, Universidad del Rosario, Bogotá, Colombia

ORCID: https://orcid.org/0000-0002-8936-2037

[*] *Email address: kristian.rubianoc@gmail.com*; *kristian.rubiano@urosario.edu.co*

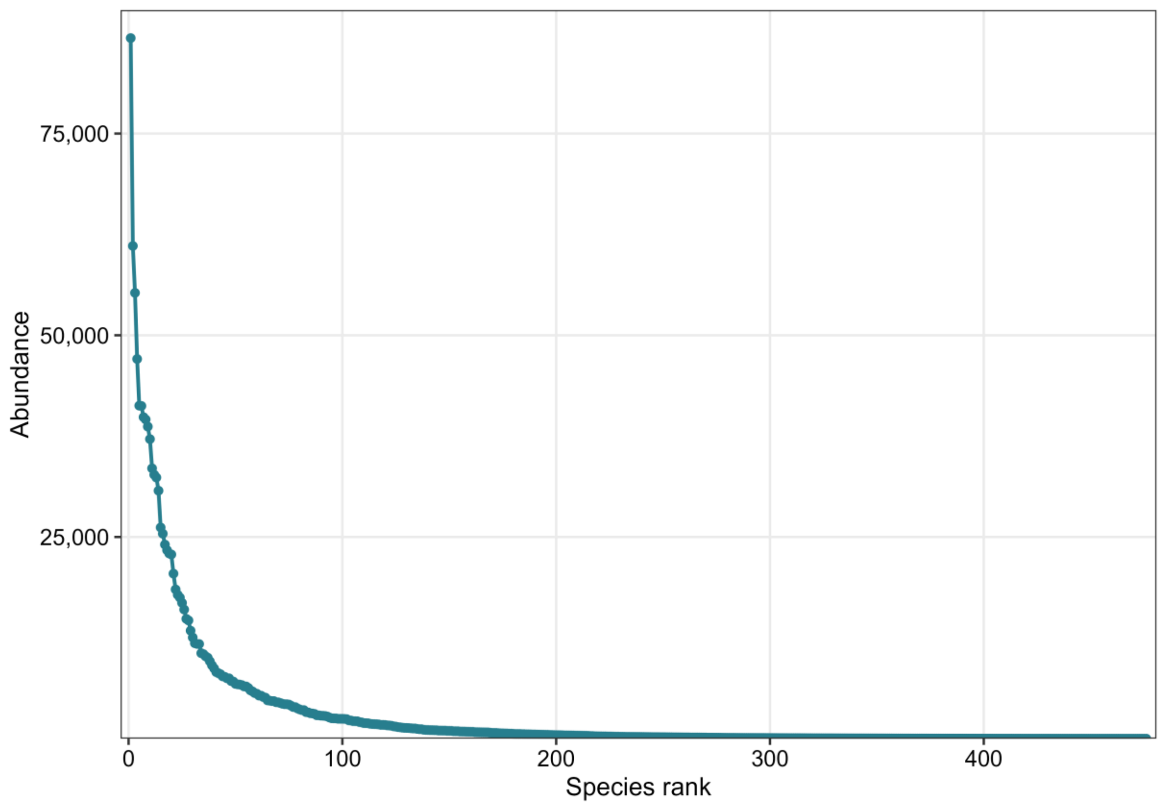

Figure S1. *Rank–abundance curve for Bogotá's urban-tree assemblage. Species are ordered from the most to the least abundant according to records in SIGAU.*

Table S1. *Most abundant urban-tree species in Bogotá according to SIGAU and prioritized for the present study ($n = 59$). Scientific names are reported as recorded in the SIGAU database.*

id	Common name	Scientific name	Origin	Abundance	Relative abundance (%)	Accumulated abundance (%)
1	Sauco	*Sambucus nigra*	Native	86838	5.99	5.99
2	Eugenia, jazmín australiano, jazmín del cabo, laurel huesito	*Pittosporum undulatum*	Introduced	61073	4.21	10.2
3	Acacia negra, gris	*Acacia decurrens*	Introduced	55257	3.81	14.01
4	Chicalá, chirlobirlo, flor amarillo	*Tecoma stans*	Native	47060	3.25	17.26
5	Urapán, Fresno	*Fraxinus chinensis*	Introduced	41277	2.85	20.11
6	Eugenia	*Syzygium australe*	Introduced	41240	2.85	22.96
7	Holly liso	*Cotoneaster multiflorus*	Introduced	39849	2.75	25.71
8	Acacia japonesa	*Acacia melanoxylon*	Introduced	39561	2.73	28.44
9	Ciprés, Pino ciprés, Pino	*Cupressus lusitanica*	Introduced	38678	2.67	31.11
10	Guayacán de Manizales	*Lafoensia acuminata*	Native	37130	2.56	33.67
11	Eucalipto común	*Eucalyptus globulus*	Introduced	33505	2.31	35.98
12	Cerezo, Cerezo, capulí	*Prunus serotina*	Native	32714	2.26	38.24
13	Hayuelo	*Dodonaea viscosa*	Native	32367	2.23	40.47
14	Acacia baracatinga, acacia sabanera, acacia nigra	*Paraserianthes lophantha*	Introduced	30737	2.12	42.59
15	jazmín de la china, Ligustrum	*Ligustrum lucidum*	Introduced	26174	1.81	44.4
16	Caucho sabanero	*Ficus soatensis*	Native	25408	1.75	46.15
17	Falso pimiento	*Schinus molle*	Introduced	24055	1.66	47.81
18	Palma yuca, palmiche	*Yucca gigantea*	Introduced	23358	1.61	49.42
19	Cayeno	*Hibiscus rosa-sinensis*	Introduced	22957	1.58	51
20	Arrayan blanco	*Myrcianthes leucoxyla*	Native	22831	1.58	52.58
21	Aliso, fresno, chaquiro	*Alnus acuminata*	Native	20455	1.41	53.99
22	Roble	*Quercus humboldtii*	Native	18497	1.28	55.27
23	Caucho benjamín	*Ficus benjamina*	Introduced	17829	1.23	56.5
24	Corono	*Xylosma spiculiferum*	Native	17486	1.21	57.71
25	Cucharo	*Myrsine guianensis*	Native	16832	1.16	58.87

26	Caballero de la noche, jazmín, Dama de noche	*Cestrum nocturnum*	Native	16005	1.1	59.97
27	Liquidambar, estoraque	*Liquidambar styraciflua*	Introduced	14851	1.02	60.99
28	Higuerillo	*Ricinus communis*	Introduced	14657	1.01	62
29	Tomatillo	*Solanum oblongifolium*	Native	13388	0.92	62.92
30	Sauce llorón	*Salix humboldtiana*	Native	12543	0.87	63.79
31	Tuno esmeraldo	*Miconia squamulosa*	Native	11828	0.82	64.61
32	Pino colombiano, pino de pacho, pino romerón, Pino romerón	*Retrophyllum rospigliosii*	Native	11744	0.81	65.42
33	Araucaria	*Araucaria excelsa*	Introduced	11731	0.81	66.23
34	Abutilon rojo y amarillo (Farolito)	*Abutilon megapotamicum*	Introduced	10595	0.73	66.96
35	Cajeto 1, Cajeto, garagay, urapo	*Citharexylum subflavescens*	Native	10481	0.72	67.68
36	Nogal, cedro nogal, cedro negro	*Juglans neotropica*	Native	10213	0.7	68.38
37	Acacia morada	*Acacia baileyana*	Introduced	10042	0.69	69.07
38	Pino pátula	*Pinus patula*	Introduced	9595	0.66	69.73
39	Arboloco	*Smallanthus pyramidalis*	Native	9092	0.63	70.36
40	Cordoncillo	*Piper bogotense*	Native	8708	0.6	70.96
41	Cedro, cedro andino, cedro clavel	*Cedrela montana*	Native	8251	0.57	71.53
42	Eucalipto de flor, eucalipto lavabotella	*Callistemon citrinus*	Introduced	8118	0.56	72.09
43	Calistemo llorón	*Callistemon viminalis*	Introduced	7987	0.55	72.64
44	Sangregado, Sangregao, drago, croto	*Croton bogotanus*	Native	7723	0.53	73.17
45	Fucsia boliviana	*Fuchsia boliviana*	Introduced	7662	0.53	73.7
46	Salvio negro	*Cordia cylindrostachya*	Native	7487	0.52	74.22
47	Tinto	*Cestrum mutisii*	Native	7478	0.52	74.74
48	Pino libro	*Platycladus orientalis*	Introduced	7135	0.49	75.23
49	Alcaparro enano	*Senna multiglandulosa*	Native	7079	0.49	75.72
50	Espino, Garbancillo, Garbancillo	*Duranta mutisii*	Native	6791	0.47	76.19
51	Alcaparro doble	*Senna viarum*	Native	6736	0.46	76.65
52	Mano de oso	*Oreopanax incisus*	Native	6706	0.46	77.11
53	Cucubo	*Solanum auctosepalun*	Native	6639	0.46	77.57
54	Chilco	*Bacharis floribunda*	Native	6473	0.45	78.02

55	Durazno común	*Prunus persica*	Introduced	6473	0.45	78.47
56	Mangle de tierra fría	*Escallonia pendula*	Native	6287	0.43	78.9
57	Sietecueros nazareno	*Tibouchina urvilleana*	Introduced	5985	0.41	79.31
58	Mortillo	*Hesperomeles goudotiana*	Native	5852	0.4	79.71
59	Duraznillo, velitas	*Abatia parviflora*	Native	5653	0.39	80.1

Table S2. *Summary of the taxonomic validation of the prioritized species. Rows highlighted in blue indicate taxa for which the accepted scientific name differed from that recorded in SIGAU. Species IDs correspond to those in Table S1.*

id	Scientific name in SIGAU	Scientific name	Autorithy	Family	Source
1	*Sambucus nigra*	*Sambucus nigra*	L.	Viburnaceae	WFO (2025)
2	*Pittosporum undulatum*	*Pittosporum undulatum*	Vent.	Pittosporaceae	WFO (2025)
3	*Acacia decurrens*	*Acacia decurrens*	(J.C.Wendl.) Willd.	Fabaceae	WFO (2025)
4	*Tecoma stans*	*Tecoma stans*	(L.) Juss. ex Kunth	Bignoniaceae	WFO (2025)
5	*Fraxinus chinensis*	*Fraxinus chinensis*	Roxb.	Oleaceae	WFO (2025
6	*Syzygium australe*	*Syzygium australe*	(J.C.Wendl. ex Link) B.Hyland	Myrtaceae	WFO (2025)
7	*Cotoneaster multiflorus*	*Cotoneaster multiflorus*	Bunge	Rosaceae	WFO (2025)
8	*Acacia melanoxylon*	*Acacia melanoxylon*	R.Br.	Fabaceae	WFO (2025)
9	*Cupressus lusitanica*	*Hesperocyparis lusitanica*	(Mill.) Bartel	Cupressaceae	WFO (2025)
10	*Lafoensia acuminata*	*Lafoensia acuminata*	(Ruiz & Pav.) DC.	Lythraceae	WFO (2025)
11	*Eucalyptus globulus*	*Eucalyptus globulus*	Labill.	Myrtaceae	WFO (2025)
12	*Prunus serotina*	*Prunus serotina*	Ehrh.	Rosaceae	WFO (2025)
13	*Dodonaea viscosa*	*Dodonaea viscosa*	Jacq.	Sapindaceae	WFO (2025)
14	*Paraserianthes lophantha*	*Paraserianthes lophantha*	(Vent.) I.C.Nielsen	Fabaceae	WFO (2025)
15	*Ligustrum lucidum*	*Ligustrum lucidum*	W.T.Aiton	Oleaceae	WFO (2025)
16	*Ficus soatensis*	*Ficus soatensis*	Dugand	Moraceae	WFO (2025)
17	*Schinus molle*	*Schinus molle*	L.	Anacardiaceae	WFO (2025)
18	*Yucca gigantea*	*Yucca gigantea*	Lem.	Asparagaceae	WFO (2025)
19	*Hibiscus rosa-sinensis*	*Hibiscus rosa-sinensis*	L.	Malvaceae	WFO (2025)
20	*Myrcianthes leucoxyla*	*Myrcianthes leucoxyla*	(Ortega) McVaugh	Myrtaceae	WFO (2025)
21	*Alnus acuminata*	*Alnus acuminata*	Kunth	Betulaceae	WFO (2025)
22	*Quercus humboldtii*	*Quercus humboldtii*	Bonpl.	Fagaceae	WFO (2025)
23	*Ficus benjamina*	*Ficus benjamina*	L.	Moraceae	WFO (2025)
24	*Xylosma spiculiferum*	*Xylosma spiculifera*	(Tul.) Triana & Planch.	Salicaceae	WFO (2025)
25	*Myrsine guianensis*	*Myrsine guianensis*	(Aubl.) Kuntze	Primulaceae	WFO (2025)
26	*Cestrum nocturnum*	*Cestrum nocturnum*	L.	Solanaceae	WFO (2025)

27	*Liquidambar styraciflua*	*Liquidambar styraciflua*	L.	Altingiaceae	WFO (2025)
28	*Ricinus communis*	*Ricinus communis*	L.	Euphorbiaceae	WFO (2025)
29	*Solanum oblongifolium*	*Solanum oblongifolium*	Dunal	Solanaceae	WFO (2025)
30	*Salix humboldtiana*	*Salix humboldtiana*	Willd.	Salicaceae	WFO (2025)
31	*Miconia squamulosa*	*Miconia squamulosa*	(Sm.) Triana	Melastomataceae	WFO (2025)
32	*Retrophyllum rospigliosii*	*Retrophyllum rospigliosii*	(Pilg.) C.N.Page	Podocarpaceae	WFO (2025)
33	*Araucaria excelsa*	*Araucaria columnaris*	(G.Forst.) Hook.	Araucariaceae	WFO (2025)
34	*Abutilon megapotamicum*	*Callianthe megapotamica*	(A.Spreng.) Dorr	Malvaceae	WFO (2025)
35	*Citharexylum subflavescens*	*Citharexylum subflavescens*	S.F.Blake	Verbenaceae	WFO (2025)
36	*Juglans neotropica*	*Juglans neotropica*	Diels	Juglandaceae	WFO (2025)
37	*Acacia baileyana*	*Acacia baileyana*	F.Muell.	Fabaceae	WFO (2025)
38	*Pinus patula*	*Pinus patula*	Schiede ex Schltdl. & Cham.	Pinaceae	WFO (2025)
39	*Smallanthus pyramidalis*	*Smallanthus pyramidalis*	(Triana) H.Rob.	Asteraceae	WFO (2025)
40	*Piper bogotense*	*Piper barbatum*	Kunth	Piperaceae	WFO (2025)
41	*Cedrela montana*	*Cedrela montana*	Turcz.	Meliaceae	WFO (2025)
42	*Callistemon citrinus*	*Melaleuca citrina*	(Curtis) Dum.Cours.	Myrtaceae	WFO (2025)
43	*Callistemon viminalis*	*Melaleuca viminalis*	(Sol. ex Gaertn.) Byrnes	Myrtaceae	WFO (2025)
44	*Croton bogotanus*	*Croton coriaceus*	Kunth	Euphorbiaceae	WFO (2025)
45	*Fuchsia boliviana*	*Fuchsia boliviana*	Carrière	Onagraceae	WFO (2025)
46	*Cordia cylindrostachya*	*Varronia cylindrostachya*	Ruiz & Pav.	Boraginaceae	WFO (2025)
47	*Cestrum mutisii*	*Cestrum mutisii*	Roem. & Schult.	Solanaceae	WFO (2025)
48	*Platycladus orientalis*	*Platycladus orientalis*	(L.) Franco	Cupressaceae	WFO (2025)
49	*Senna multiglandulosa*	*Senna multiglandulosa*	(Jacq.) H.S.Irwin & Barneby	Fabaceae	WFO (2025)
50	*Duranta mutisii*	*Duranta mutisii*	L.f.	Verbenaceae	WFO (2025)
51	*Senna viarum*	*Senna viarum*	(Little) H.S.Irwin & Barneby	Fabaceae	WFO (2025)
52	*Oreopanax incisus*	*Oreopanax incisus*	(Willd. ex Schult.) Decne. & Planch.	Araliaceae	WFO (2025)
53	*Solanum auctosepalun*	*Solanum stellatiglandulosum*	Bitter	Solanaceae	WFO (2025)
54	*Bacharis floribunda*	*Baccharis latifolia*	Pers.	Asteraceae	WFO (2025)
55	*Prunus persica*	*Prunus persica*	(L.) Batsch	Rosaceae	WFO (2025)

56	*Escallonia pendula*	*Escallonia pendula*	(Ruiz & Pav.) Pers.	Escalloniaceae	WFO (2025)
57	*Tibouchina urvilleana*	*Pleroma urvilleanum*	(DC.) P.J.F.Guim. & Michelang.	Melastomataceae	WFO (2025)
58	*Hesperomeles goudotiana*	*Hesperomeles goudotiana*	(Decne.) Killip	Rosaceae	WFO (2025)
59	*Abatia parviflora*	*Abatia parviflora*	Ruiz & Pav.	Salicaceae	WFO (2025)

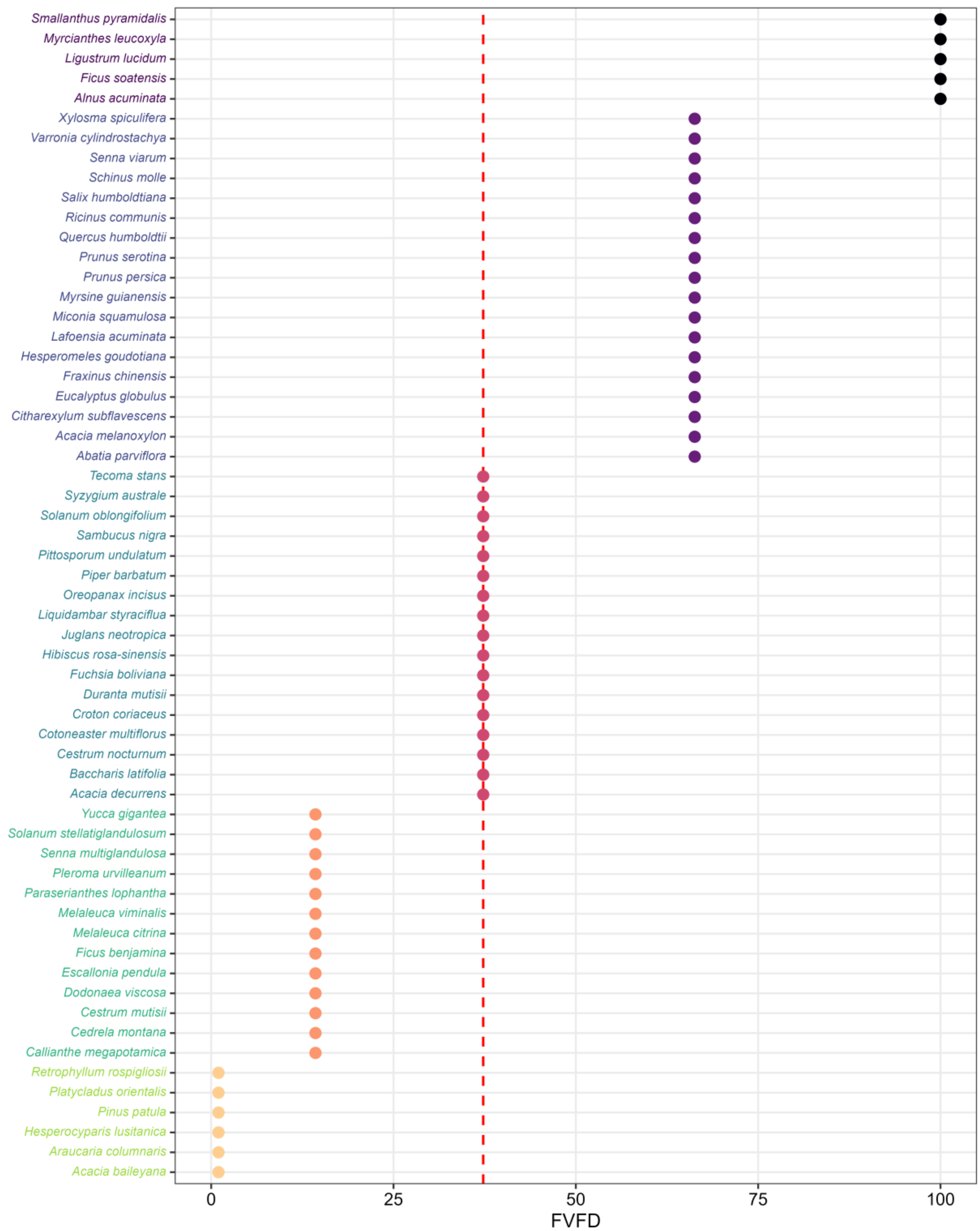

Figure S2. *Species functional value for food provision to urban fauna FVFD for the 59 prioritized urban-tree species in Bogotá. Species are ordered and their labels colored according to their FVFD value class. The red dashed line indicates the median value.*

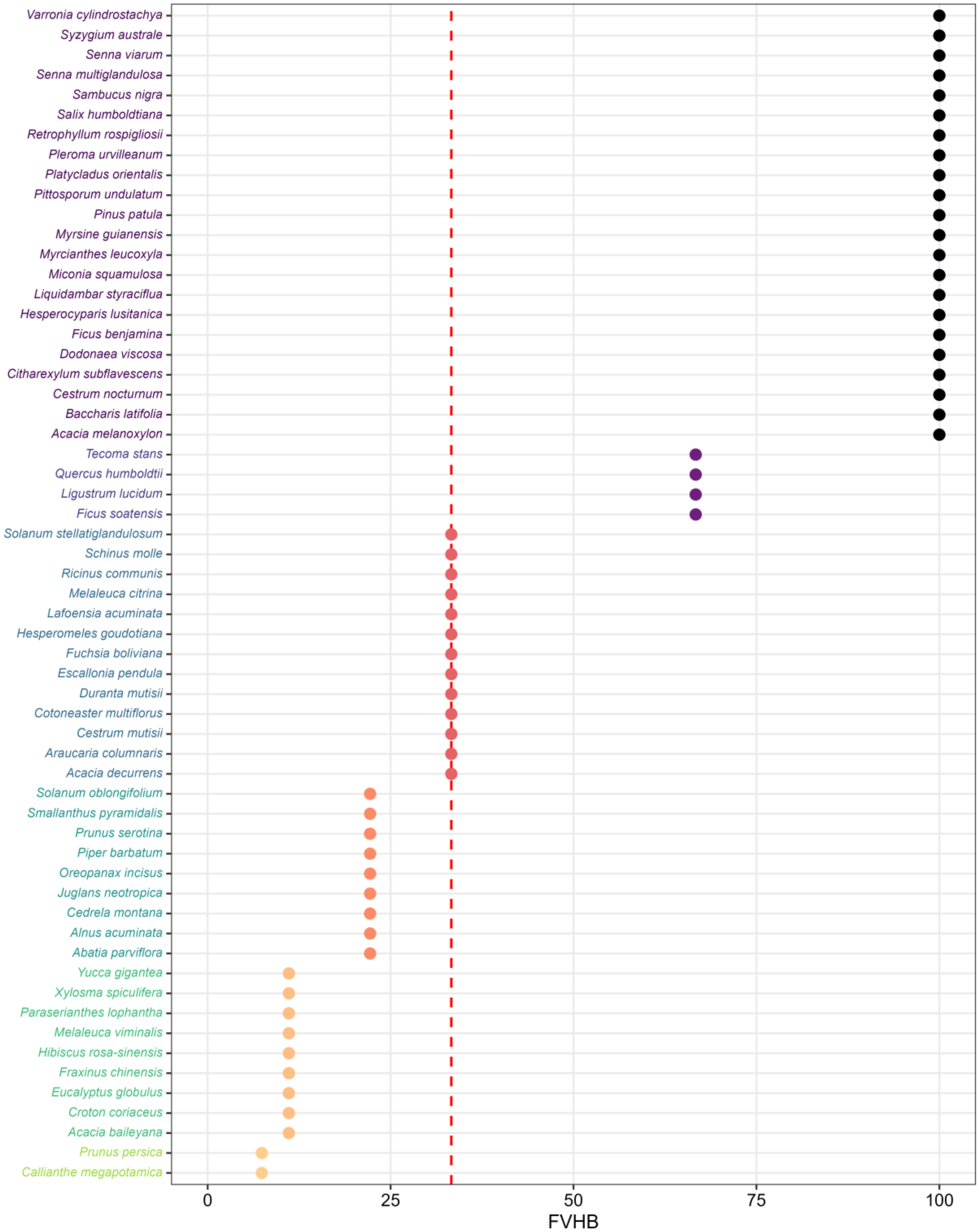

Figure S3. *Species functional value for habitat and connectivity provision FVHB for the 59 prioritized urban-tree species in Bogotá. Species are ordered and their labels colored according to their FVHB value class. The red dashed line indicates the median value.*

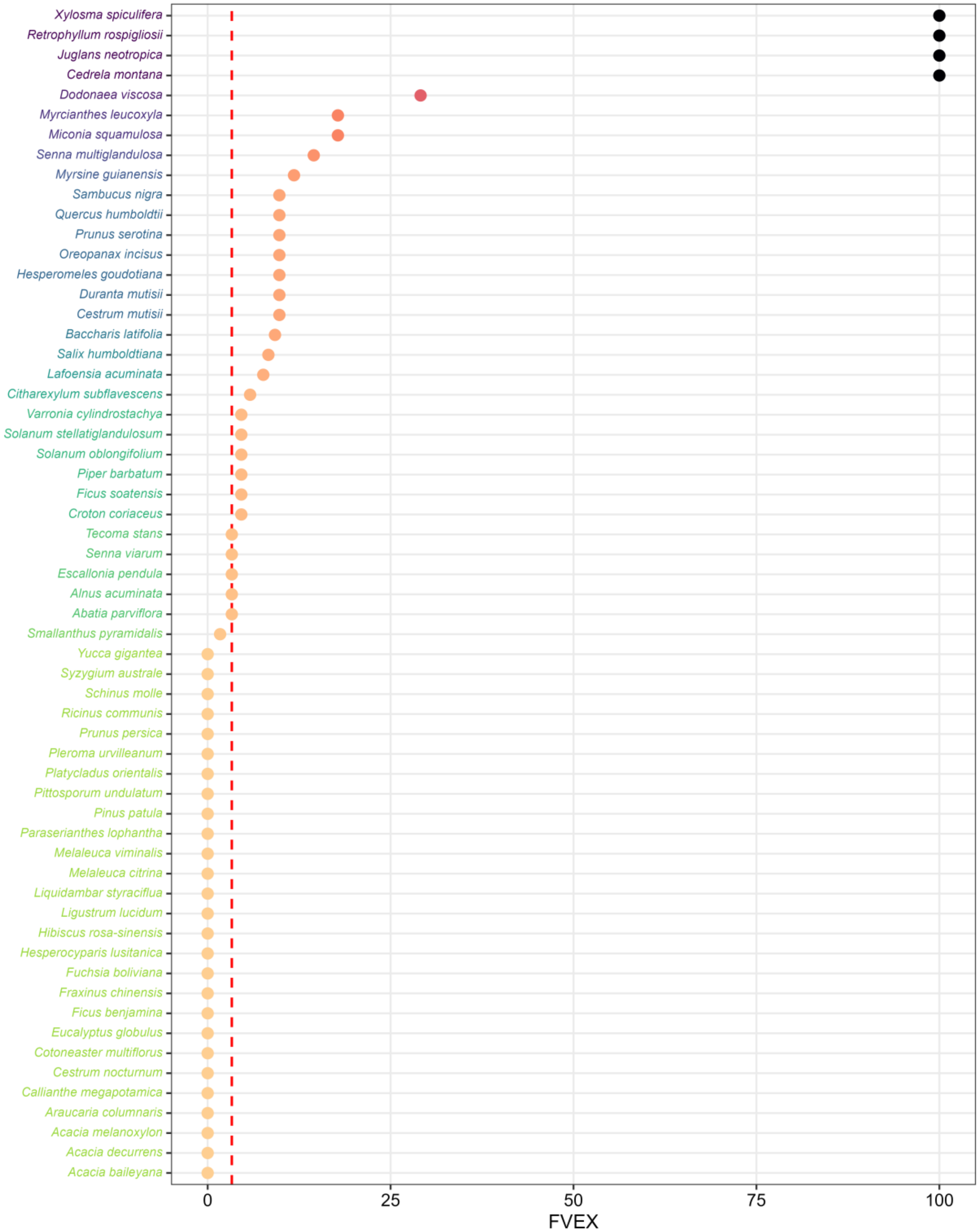

Figure S4. *Species existence value FVEX for the 59 prioritized urban-tree species in Bogotá. Species are ordered and their labels colored according to their FVEX value class. The red dashed line indicates the median value.*

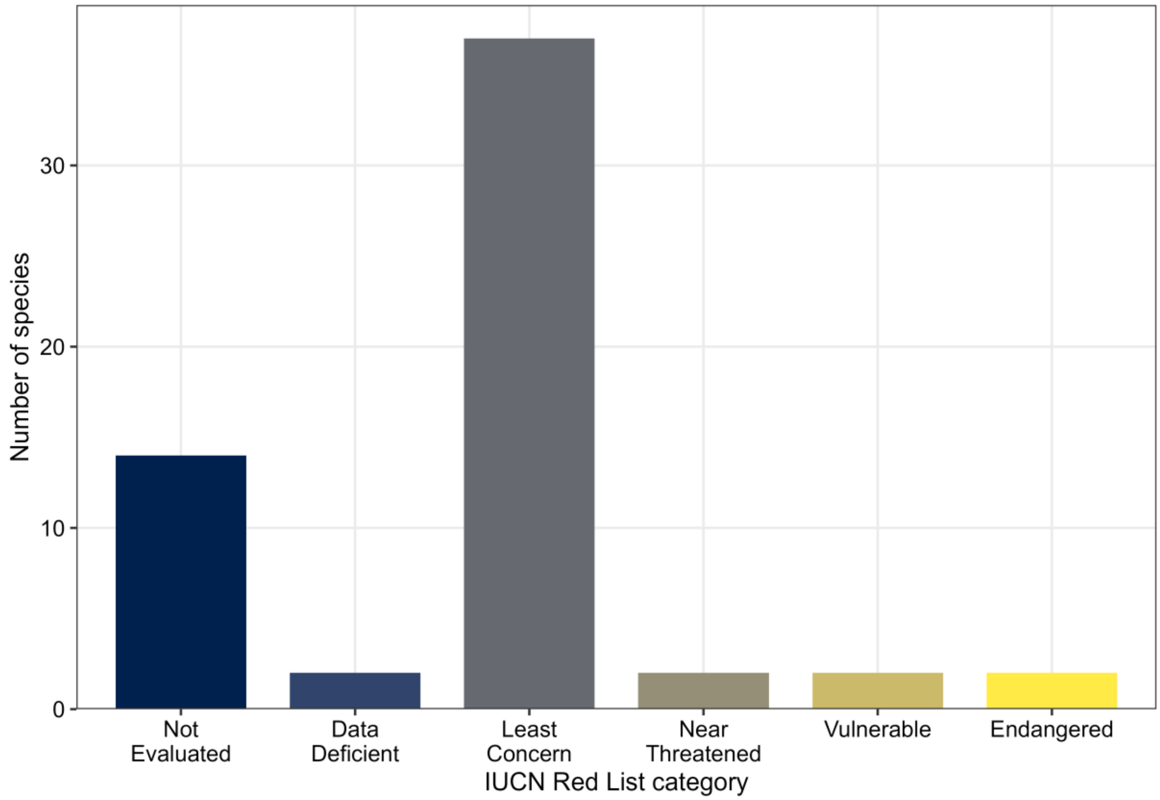

Figure S5. *Number of prioritized urban-tree species in Bogotá by IUCN Red List category.*