Urban Forestry & Urban Greening 114 (2025) 129112

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Original article

The 10/20/30 planting rule aligns with traditional plant diversity metrics across spatial scales

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ARTICLE INFO

Keywords:
Urban forestry
Biodiversity
Spatial
Shannon diversity
Taxonomic distance
10/20/30 rule

ABSTRACT

The 10/20/30 rule is a common rule of thumb for planting trees in urban areas, but its connection to ecological theory and traditional biodiversity is unclear. The rule states that no more than 10%, 20%, or 30% of trees in a city should belong to the same species, genus, or family, respectively. We compared two accepted biological diversity metrics (Shannon diversity and taxonomic distance) with the logic of the 10/20/30 rule. We utilized tree planting data for New Haven, Connecticut, USA and evaluated these data at three municipal scales: city, neighborhood, and census block as well as 86 grids of increasing cell sizes (from 10 × 10 m to 11.5 × 11.5 km). To determine whether the 10/20/30 rule aligns with diversity metrics, we created a function that follows the logic of the rule and quantifies the relative pass or failure of a site. Our "rule index" was significantly correlated with the two diversity metrics irrespective of spatial scale, leading us to conclude that it is a useful guide for planting. We suggest that consideration of the 10/20/30 rule at smaller spatial scales such as census blocks in larger cities could yield benefits for both biodiversity and social equity.

1. Introduction

Trees in urban areas provide many social, economic, and ecological benefits. They promote stormwater mitigation (Kirnbauer et al., 2013; Sanders, 1986), improve air quality (Escobedo et al., 2011; Escobedo and Nowak, 2009; Nowak, 2006), reduce urban heat stress (McPherson and Simpson, 2003; Soares et al., 2011), improve mental health (Dallimer et al., 2012; Marselle et al., 2020; Tyrväinen et al., 2005), and provide habitat for wildlife (Costanza et al., 1997; Liu and Slik, 2022). However, urban trees are often subject to greater stress than their rural counterparts. Many cities therefore struggle to maintain a healthy and diverse urban forest due to an overreliance on "urban-adapted" species such as Norway maple (*Acer platanoides* L.) or pin oak (*Quercus palustris* L.) as well as aesthetic preferences (Bourne and Conway, 2014; Ma et al., 2020).

The factors that influence species composition in urban forests and particularly of street trees are therefore different from the factors that determine tree composition in naturally forested ecosystems. In natural forests, communities tend to be more complex as they are shaped over time by many processes including dispersal limitation, environmental filtering, and intra- and interspecific interactions (Ashton and Kelty, 2017). This complexity gives a certain resilience to natural ecosystems, allowing them to better withstand and recover from environmental changes (Elmqvist et al., 2003; Jactel et al., 2017). This is not a luxury that urban forests enjoy.

Urban forests therefore tend to be less diverse and more homogeneous than natural forests (Hamberg et al., 2015; Ma et al., 2020; Cowett and Bassuk, 2017). There have been several guidelines proposed to combat this lack of urban tree diversity, of which perhaps the most widely used is the 10/20/30 rule, proposed by Santamour (1990). The 10/20/30 rule states that trees in a city should be made up of no more than 10%, 20%, or 30% of any single species, genus, or family, respectively. While this is a simple rule of thumb to manage diversity at the city scale, it is not directly rooted in ecological theory nor is there any empirical evidence that suggests its effectiveness in protecting against pests or disease (Laćan and McBride, 2008; Kendal et al., 2014). Here we question whether following the rule aligns with biological diversity. Our goal is to increase our understanding of the 10/20/30 rule planting rule within the framework of ecological concepts of diversity and determine how the result plays out across multiple spatial scales.

We evaluated street tree diversity using a comprehensive street tree dataset for the city of New Haven, Connecticut, USA. This dataset

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https://doi.org/10.1016/j.ufug.2025.129112
Received 15 April 2025; Received in revised form 6 October 2025; Accepted 7 October 2025
Available online 18 October 2025
1618-8667/© 2025 Published by Elsevier GmbH.

included a spatially explicit record of all trees by species and a record of planting year since 2007. We developed an index that estimates relative passing and failure of the rule at a given site, thereby representing the rule as a continuous metric rather than a binary pass-fail score. Using this approach, we can closely compare the logic of the 10/20/30 rule to more common metrics like Shannon diversity (Shannon, 1948; Cowett and Bassuk, 2017) and taxonomic distance (Clarke and Warwick, 1998), a metric that uses taxonomic relatedness to summarize the phylogenetic diversity of taxa at a site. Importantly, we clarify here that it was not our intention to invent a new metric for others to evaluate diversity. Rather, this index was devised to compare the logic of the 10/20/30 rule to common biodiversity metrics. We evaluated the relationship between each metric at three municipal scales (city, neighborhood, and block) and across 86 grids with cell sizes ranging from 10 × 10 m to 11.5 × 11.5 kilometers. We hypothesized that our "rule index" would be positively correlated with biodiversity metrics, which would theoretically lead practitioners or scientists to draw the same conclusion regardless of which metric is used. If true, this would indicate that following the 10/20/30 rule at the city scale (assuming good intentions and at least some consideration of local scales) is useful in managing for increased biodiversity of urban landscapes.

2. Methods

2.1. Site description

Our study was conducted in New Haven, Connecticut, USA (Fig. 1). This New England city features residential areas, commercial zones, industrial infrastructure, and an abundance of green space, offering an ideal landscape to study urban tree diversity. Furthermore, the city's tree canopy has developed over centuries since the planting of the first elms in 1686. As of 2021, New Haven was the second-largest city in the state of Connecticut with a total area of 52.1 square kilometers and an estimated population of 135,081 people (U.S. Census Bureau, 2020). New Haven's climate is representative of the broader northeastern US region: humid continental with warm summers and cold winters (Thrasher et al., 2022; Dinerstein et al., 2017). Between 2015 and 2025, the average temperature in New Haven was −1.2 degrees Celsius in January and 23.7 degrees Celsius in July (for Environmental Information, 2025). The city received an average 121 centimeters of precipitation per year over the previous decade (for Environmental Information, 2025).

2.2. Dataset

We utilized a dataset provided to us by the Urban Resources Initiative (URI), a non-profit organization affiliated with The Forest School at the Yale School of Environment, has been planting trees in New Haven since its establishment in 1991. Since 2007, URI has been the sole street tree manager and planting authority in New Haven, when they launched their GreenSkills program and began following the 10/20/30 or similar planting rules (Scanlan et al., 2021). Through this program, URI supplies and plants trees for New Haven residents at no cost, under the requestor's commitment to water the tree for three years (Scanlan et al., 2021). As of May 2025, New Haven has 31,844 documented trees. All trees have been identified, measured, and geotagged, with a total of 8,247 planted since 2007 by URI. A simplified version of this dataset can be accessed on URI's treekeeper website (Urban Resources Initiative, 2025). More detailed datasets with planting date records can be obtained by contacting URI directly.

We used data on living trees within the New Haven city boundary that were planted within 20 m of the roadway and removed any records that were missing location or taxonomy information. We grouped cultivars of the same species (e.g., Elm, American "Colonial Spirit"; Elm, American "Homestead"; Elm, American "Jefferson"; Elm, American "Princeton"; and Elm, American "Valley Forge" were considered *Ulmus americana*). We removed all records that were recorded as stumps (1,749) or lacked species identification (346). After limiting to living trees within 20 m of the roadway, we were left with a dataset of 24,880 street trees. However, many of these trees do not contain specific planting dates nor is this a temporally explicit census dataset. We therefore did not attempt a longitudinal analysis of tree diversity and instead focus on the state of street tree diversity in New Haven as of 2025.

2.3. Defining scale, measurements, and mode of analysis

We defined sites relative to each spatial scale (city, neighborhood, city block, or grid cell). At each site, we calculated Shannon diversity at the species level, in addition to taxonomic distance, which is a metric that uses information from family, genus, and species taxonomic levels to calculate phylogenetic distances between taxa present in each sample (in our case, we used the log-transformed sum of all pairwise distances). We first used the `name_backbone` function from the rgbif R package to obtain taxonomic information, the `phylo.maker` function from the V.PhyloMaker package to create a matrix of phylogenetic distances, and the package metacoder to create a cladogram (phylogenetic tree) for all species present in our dataset (Foster et al., 2017; Chamberlain et al., 2024; Jin and Qian, 2022) (Supplemental Figure S2). This measure of taxonomic distance gets directly at the core underlying driver of negative density dependence, the principal diversity theory that drives the rationale for the 10/20/30 rule. We also used the Vegan package in R to calculate Shannon diversity (Oksanen et al., 2008). For visual comparisons, we mapped each metric at the neighborhood and block scales using the R packages ggplot2, terra, and viridis (Hijmans, 2024; Garnier et al., 2024; Wickham, 2016). We made no transformations or adjustments to Shannon diversity values, but we summarized taxonomic distance as the log of the sum of the branch lengths between each pair of taxa present at a site. We additionally calculated our rule index that estimates the relative passing and failure of the 10/20/30 rule.

We calculated the rule index for each site by comparing species composition to the recommended relative abundance (i.e., thresholds) of the rule (10% for any single tree species, 20% for any given genus, and 30% for any family). When conditions for failure are met at a site (i.e., more than 30% of individuals at a site belong to the same family, or more than 10% belong to the same species), we computed an index equal to the sum of proportions of rule-breaking taxa relative to the threshold for failure at that taxonomic level multiplied by −1. For example, Species A at site Z comprising 15% of all individuals yields a score of −1.5, whereas Species A and B each comprising 15% of all individuals yields an overall score of −3.0. For instances of passing, we similarly computed — for the top five most abundant taxa — the sum of the proportions relative to the threshold for failure at that taxonomic level, and did not multiply by −1. We repeated these calculations for each taxonomic level and obtained the average score for the rule index for that site. This effectively makes zero the threshold between average pass or failure at a given taxonomic level. Note that, since the rule index considers all taxonomic levels equally, it is possible to have a "passing" score for a site even if that site failed to pass the rule at a taxonomic level. Finally, we emphasize again here that we are not proposing a new metric, but rather a method of quantifying the logic of the 10/20/30 rule in a way that can be compared to other metrics of diversity. We refer more technically-inclined readers to our supplemental materials where they can find an R script with functions used here.

To determine whether these metrics are different from one another, we standardized all three metrics so they had a mean of zero with a standard deviation of 1 prior to statistical comparisons. This standardization ensures that metrics are comparable, allowing for more straightforward analysis. All analyses that were performed were done to understand whether these three metrics (Shannon diversity, taxonomic distance, and our rule index) provide the same information. We

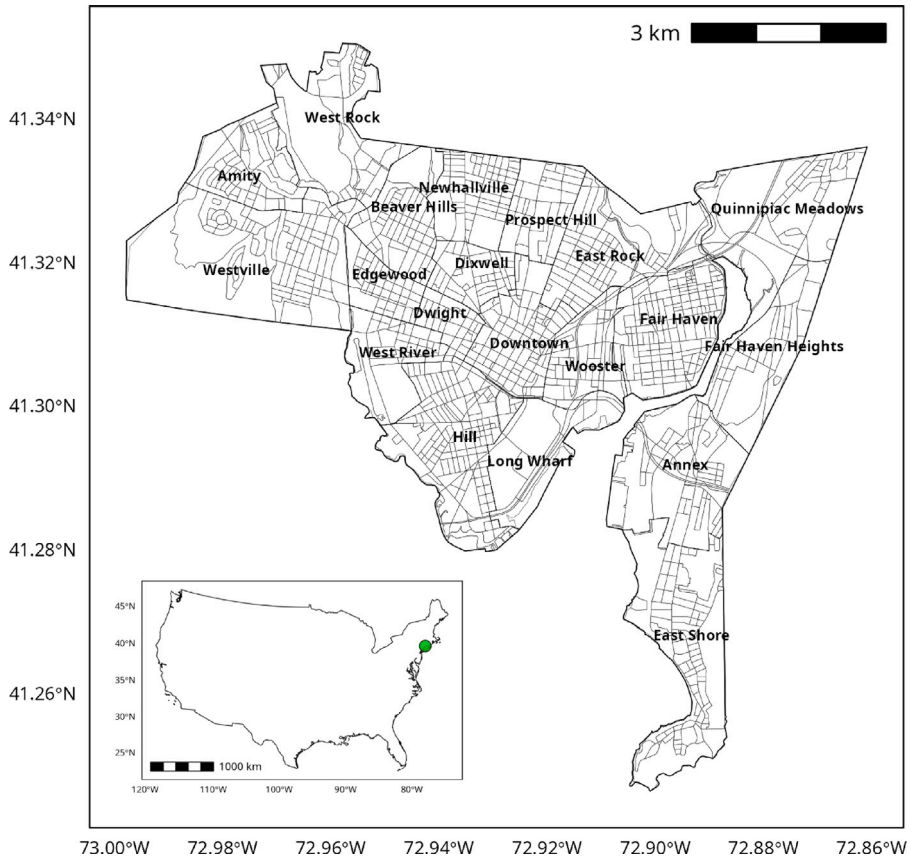

Fig. 1. New Haven, Connecticut, with city blocks and neighborhoods. Inset map shows the location of New Haven in the northeastern USA.

used second-order polynomial regressions, Kruskal–Wallis tests (a non-parametric version of the common t-test), and Principal Component Analysis (PCA) to compare metrics to one another. Specifically, PCA is a dimensionality reduction technique that attempts to simplify complex datasets into fewer variables termed "principal components". In our case, we are using it primarily as a visual aid to assess whether these three metrics are correlated. PCA helps us visualize whether these metrics provide different explanations of the variance in our dataset. This approach allows us to quantify relationships between metrics and to gauge whether they would lead to different conclusions about biological diversity at a site.

To further compare these metrics across increasing spatial scales, we situated 86 grids over the city with cell sizes ranging from 10 to 11,525 m in size. Cell sizes were selected by creating a sequence from 10 to the square root of the expanse of the city (7,030) in increments of 10 (yielding 703 possible cell sizes), plus the total area of the city (effectively 1 large grid cell that covers the entire city). Using the R package terra (Hijmans (2024)) we created grids for each cell size where possible: although we had many potential cell sizes in our list, the cell sizes used must fit the extent of the city while consisting of cells that were equal in size (i.e., no half cells on the end to force the grid to fit exactly over the extent of the city). We created them this way so they share the same origin (the four grid corners are all in the same place i.e., all grids share the exact same extent). This was done in R using the package terra (Hijmans, 2024). See supplemental code for details. We then plotted the relationship between cell size and each metric. We compared the shape of these plots visually to determine if they suggest similar conclusions about diversity. Finally, we used these metrics to create spatially explicit maps to visualize Shannon diversity, taxonomic distance, and our rule index at several spatial scales. These maps can be similarly used to draw conclusions of street tree diversity in New Haven and to discuss whether following the 10/20/30 rule might lead practitioners to the same conclusions as other metrics.

3. Results

New Haven has an urban forest with approximately 24,880 street trees as of May 2025—with 163 species, 75 genera, 33 families, and 17 orders. On average, New Haven has 502 street trees per square kilometer. Currently, the most common tree species is pin oak (*Quercus palustris*), with 2,737 individuals, making up around 11% of street trees in the city (Table 1, Supplemental Figure S1). According to the thresholds of the 10/20/30 rule, pin oak represents 11% of tree species and therefore causes New Haven to fail the 10/20/30 rule at the species level (Table 1). Pin oak is followed by *Acer platanoides* and *Platanus x acerifolia* both representing 8%. New Haven passes the 10/20/30 rule at the genus level, with *Quercus* spp. comprising 18% of individuals, and also passes at the family level, with the most abundant family (Sapindaceae) comprising 19% of individuals. No neighborhoods passed the 10/20/30 rule at all levels. Out of 20 neighborhoods, three pass at the species level, seven pass at the genus level, and 15 pass at the family level. Out of 1,618 city blocks (of which 1,414 had at least one street tree), 16 pass at the species level, 102 pass at the genus level, and 293 pass at the family level.

As of May 2025 the Shannon diversity, taxonomic distance, and our rule index for the city was 3.76, 15.99, and 1.36, respectively (Table 2). Metrics varied across the city, irrespective of spatial scale (Fig. 2, Fig. 3). Each metric differed from the others in terms of median values when standardized, at both the neighborhood and city block scale (Table 2, Fig. 4, Supplemental Figure S3). Visually, these maps align with other results that we have mentioned here (Fig. 2, Fig. 3).

At the block scale, we found that the three metrics are correlated (Fig. 4), with the strongest correlations between Shannon diversity and taxonomic distance (0.91). The correlation scores between the rule index and Shannon diversity and taxonomic distance was relatively weaker, but was still a positive correlation (0.85 and 0.69,

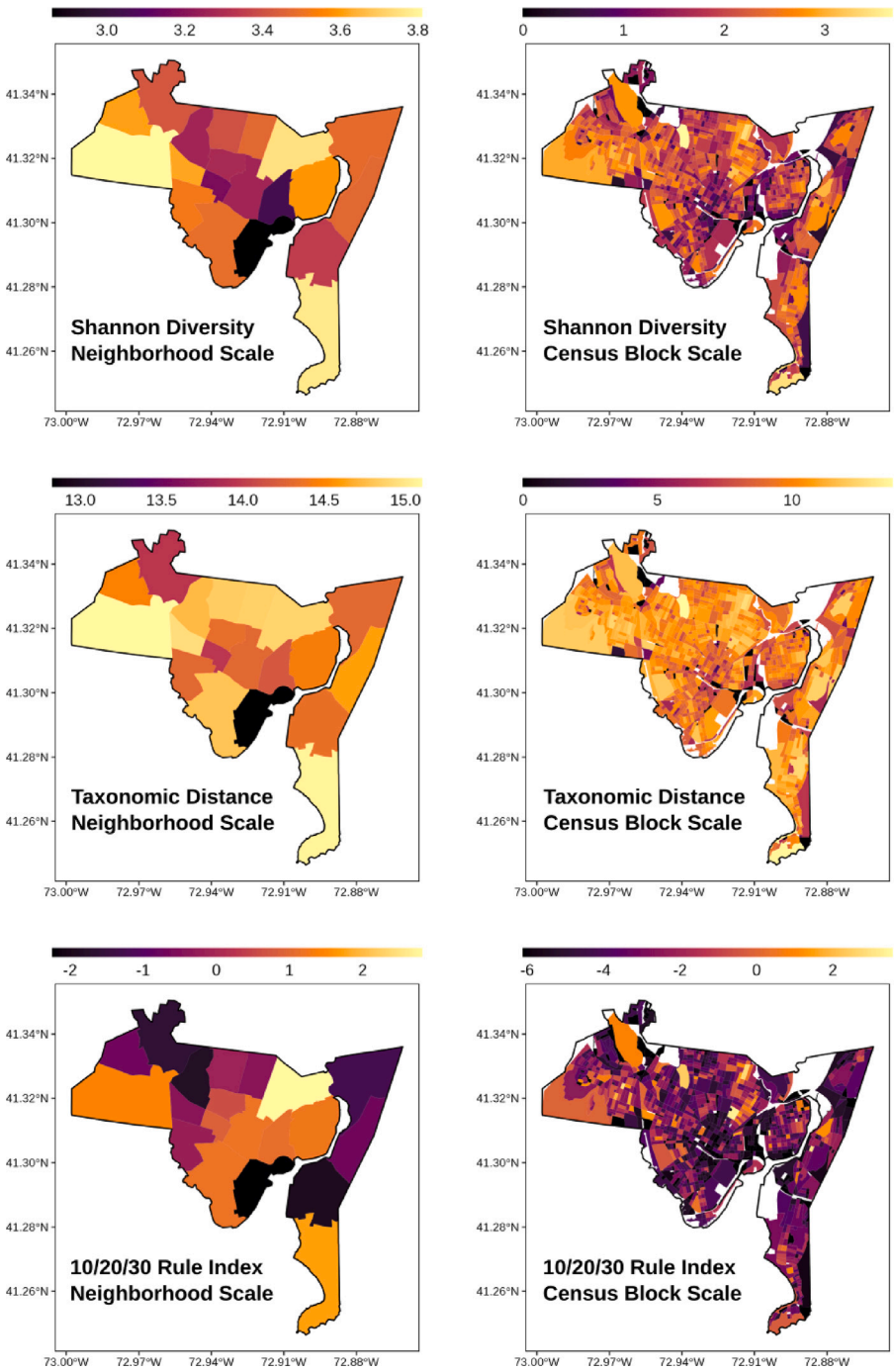

Fig. 2. Diversity metrics for street trees in New Haven, Connecticut, USA at two spatial scales. Left: Neighborhood scale. Right: City block scale. Top: Shannon diversity. Middle: Taxonomic distance. Bottom: Rule index. The color scale used here is the inferno theme from the R package viridis.

respectively). At the neighborhood scale, we observed a similar correlation between Shannon diversity and taxonomic distance (0.79), but the correlations between the rule index and Shannon diversity and taxonomic distance was weaker (0.44 and 0.47, respectively). These correlation results are also supported by Kruskal–Wallis tests, where we found no significant difference between standardized metrics at the neighborhood scale ($p > 0.05$). However, we did detect a significant difference between the metrics at the block scale ($p < 0.05$), suggesting that there may be more variation or noise at this smaller and variable scale (Fig. 2).

We also performed a principal component analysis (PCA), and observed that the three metrics generally provide similar information at both neighborhood and block scales, but similarities with the rule index seem to lessen at the neighborhood scale (Fig. 5). At the neighborhood scale, the first principal component explains 71.7% of the total variance, the second explains 21.4%, and there is a distinguishable separation between the metrics. At the block scale, the first principal component explained 88.0% of the total variance, with the second explaining 10.3%. We do not see a strong separation of the metrics at the block scale, suggesting that they do not provide significantly dissimilar information at this scale.

When comparing metrics versus spatial scale in more detail via our set of 86 grids, we found that metrics increased at similar rates with respect to cell size (Fig. 6). The metrics show similar saturating

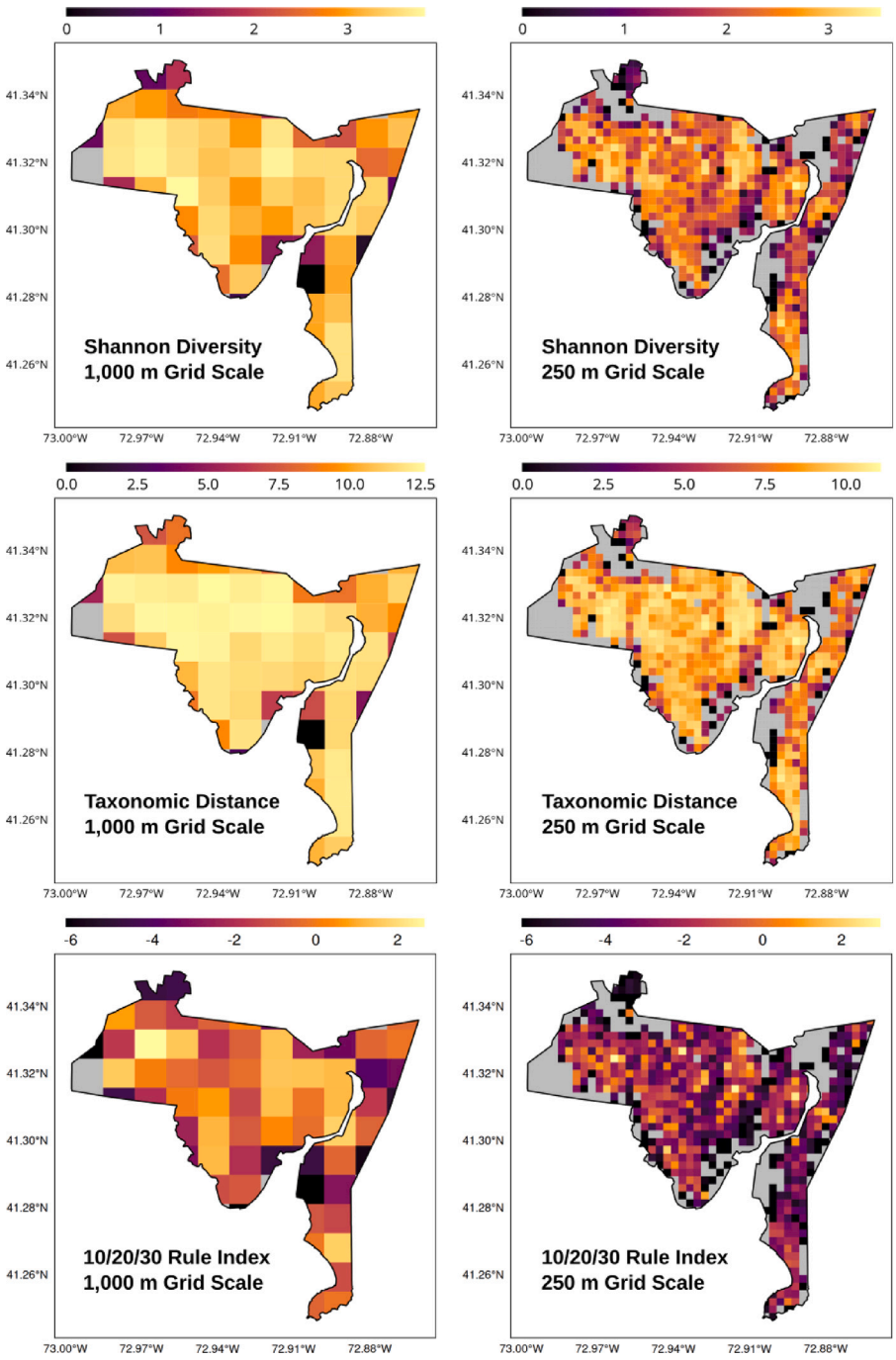

Fig. 3. Diversity metrics for street trees in New Haven, Connecticut, USA at two selected grid scales. Left: gridded metrics at 1,000 m scale. Right: gridded metrics at 250 m scale. Top: Shannon diversity. Middle: Taxonomic distance. Bottom: Rule index. Gray colors represent areas with no data. The color scale used here is the inferno theme from the R package viridis.

responses to increasing cell sizes, reaching plateaus around 2–3 km. However, our rule index appears to be slightly more sensitive to scale evidenced by higher standard errors and by the shape of the fitted line (Fig. 6). To illustrate these differences spatially, we also mapped Shannon diversity from four selected scales, with grid cell sizes of 100 m, 250 m, 500 m, and 1000 m (Supplemental Figures S4, S5, S6).

4. Discussion

We evaluated street tree diversity in New Haven, Connecticut, USA, across three municipal scales (city, neighborhood, and block) and across 86 grids of increasing cell sizes using two known ecologically recognized metrics (Shannon diversity and taxonomic distance) and a novel metric (referred to herein as our "rule index") that is based on the logic of the 10/20/30 rule—a recommended rule of thumb for tree planting in urban areas. Overall, New Haven hosts a diverse urban forest, with 163 species from 75 genera and 33 families represented among its thousands of street trees. While street tree diversity has likely increased or become more even under URI's tenure, our evaluation demonstrates that some parts of the city could likely benefit from special attention at smaller scales for a more connected, diverse, and resilient urban forest to be fully realized (Fig. 2, Fig. 3). Notably, Norway maple is the second-most dominant species in the city and represents the most abundant family (Sapindaceae) in the city, despite

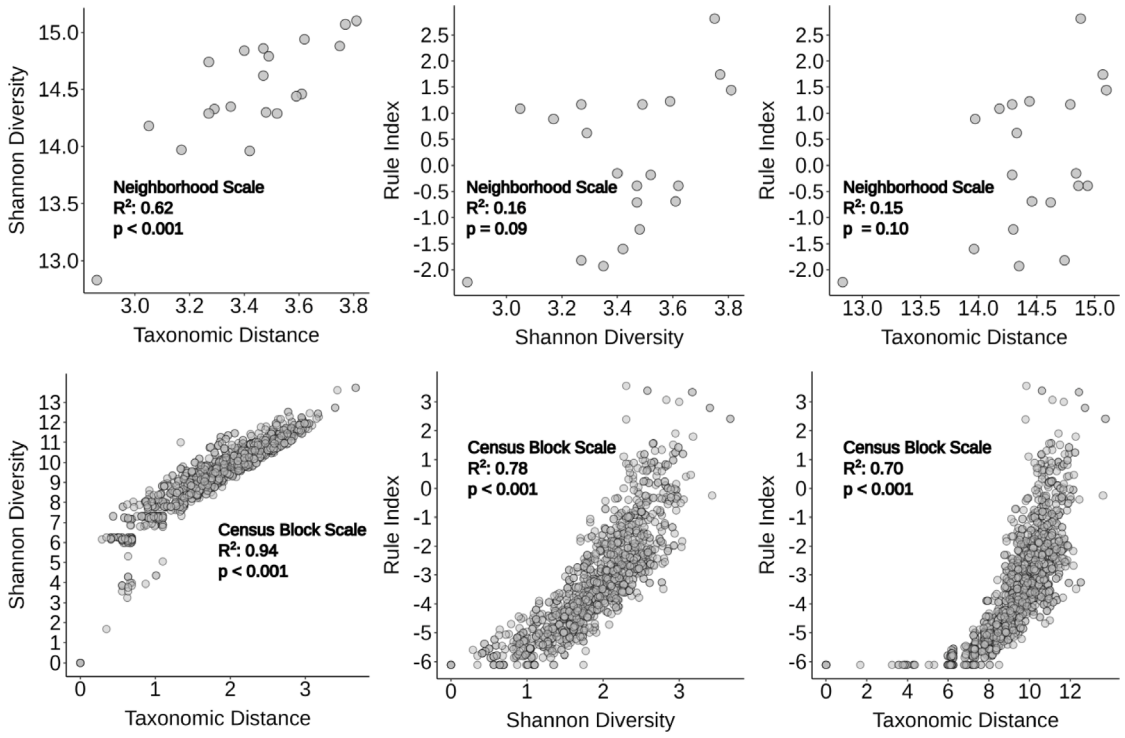

Fig. 4. Scatterplots showing relationships between diversity metrics at the neighborhood (top) and city block (bottom) scales. The adjusted R^2 (from second-order polynomial regression) and p-values are shown in each plot.

Table 1
Top ten most frequently planted species of street trees in the city of New Haven, Connecticut, USA as of May 2025. Abundance and relative proportion shown, with taxonomic levels up to family. Species richness as of May 2025 was 163 with a total of 24,880 street trees.

Species	Genus	Family	N	Proportion
Quercus palustris	Quercus	Fagaceae	2737	0.11
Acer platanoides	Acer	Sapindaceae	1973	0.08
Platanus x acerifolia	Platanus	Platanaceae	1923	0.08
Quercus rubra	Quercus	Fagaceae	1362	0.05
Gleditsia triacanthos	Gleditsia	Fabaceae	1225	0.05
Acer rubrum	Acer	Sapindaceae	1078	0.04
Tilia cordata	Tilia	Malvaceae	1051	0.04
Zelkova serrata	Zelkova	Ulmaceae	990	0.04
Pyrus calleryana 'bradford'	Pyrus	Rosaceae	769	0.03
Malus tschonoskii	Malus	Rosaceae	686	0.03

Table 2
Median values for Shannon diversity, taxonomic distance, and rule index at the neighborhood and block scales in New Haven as of May 2025.

Scale	Shannon diversity	Taxonomic distance	Rule index
City	3.76	15.99	1.36
Neighborhood	3.47	14.45	−0.16
Block	1.83	9.52	−3.76

not having been planted in the city since 2007. This dominance of Sapindaceae, which represents 19% of trees in the city, could have implications for managing pests such as Asian Longhorn Beatle (Meng et al., 2015). Overall these results are not very surprising as Norway maple is known to be one of the more common street trees in the northeastern United States (Cowett and Bassuk, 2017) and temperate cities worldwide (Hamberg et al., 2015). Nevertheless, the prominence of Norway maple is something that New Haven, in addition to other cities, is working to address (Cowett and Bassuk, 2021).

Regarding the metrics used to evaluate New Haven's street tree diversity, it does not matter. The three metrics that we tested here (Shannon diversity, taxonomic distance, and our rule index) are positively correlated with one another, as evidenced by polynomial regressions, PCA, and qualitative comparisons of metrics in relation to grid cell sizes (Fig. 6). We therefore suggest that the logic of the 10/20/30 rule or other similar rules can be used to guide tree planting efforts in urban areas. However, we note again that we did not strictly test whether the 10/20/30 rule leads to increased resilience to pests and disease, nor did we attempt to decipher the thresholds at which increased biodiversity per other metrics translates to resilience, as this is beyond the scope of our study. Finally, while this rule index was useful for evaluating street tree diversity in the context of our specific question, we emphasize that we are not advertising a new biodiversity metric—Shannon diversity and taxonomic distance are simpler metrics with more research and software packages behind them and should be used (Cowett and Bassuk, 2017; Oksanen et al., 2008; Jin and Qian, 2022).

To our knowledge, we are the first to test increasing spatial scale versus multiple diversity metrics in the context of urban forests. These metrics change strongly with increasing scale (especially at small scales). Although the shape of these curves are similar (Fig. 6), there are some slight differences that can be observed. Most notably, the rule index appears to be less consistent in relation to scale (particularly at scales ranging from 1 to 4 km) than the other two metrics—indicating that either (1) the rule index could potentially distinguish between sites better than the other metrics at larger scales or (2) it is noisier at smaller scales. We suspect that managing for species diversity across multiple spatial scales may be the best strategy (Elmqvist et al., 2003). However, we consider that many studies regarding urban tree diversity or resilience — if they specify a spatial scale — do so at varied scales (e.g., comparing cities or neighborhoods to one another). This may not be the most appropriate for such analyses or comparisons (Esperon-Rodriguez et al., 2022; Smart et al., 2020; Ma et al., 2020). The relationship between sample size and diversity metrics has been discussed in the literature (e.g., Galle et al. (2021)) and, on a grander scale, spatial resolution is known to change predictions of biodiversity

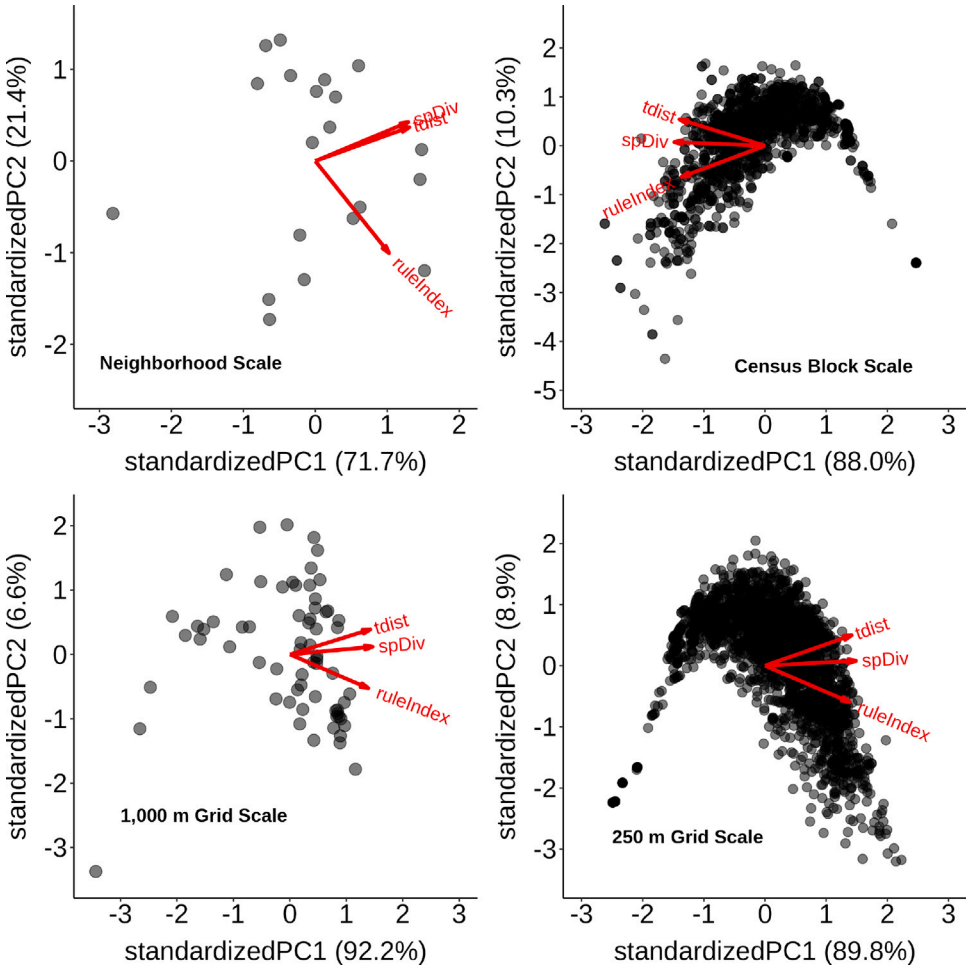

Fig. 5. Biplots from Principal Component Analyses on standardized metrics for the neighborhood scale (top left) the city block scale (top right), as well as for two grid scales 1,000 m (bottom left) and 250 m (bottom right). Each point on these figures represents a site at their respective scales i.e., a neighborhood, block, or grid cell. Axes represent the first two principal components, with the percentage of variance explained by each component shown in parentheses. spDiv = Shannon diversity, tdist = Taxonomic distance, ruleIndex = Rule index.

patterns (Cohen and Jetz, 2025). This provides a nuanced look at how biodiversity assessments can change with scale, with relevance for city planners and urban forestry practitioners. The results align with what is known regarding negative density dependence, where monodominant stands are more susceptible to pest and disease outbreaks (Ma et al., 2020; Hauer et al., 2020).

We also suggest caution when considering the scale of diversity analyses for planting efforts. Reporting a singular result for an entire city may not accurately represent the diversity of trees at more ecologically- and socially-relevant scales. Very small scales are also not practical, and we do not suggest that practitioners or researchers attempt to use a 10 m cell size for planning or evaluation. Rather, we hypothesize that a grid cell size somewhere between 500–2000 m may be more useful for urban tree diversity analysis—but we do not test this here and therefore cannot provide a specific recommendation. Anecdotally, it appears to us that scales smaller than 250 m becomes difficult to interpret on a map, and scales larger than 1 km highlight coarse patterns but might lose the nuance of smaller scale diversity patterns (Fig. 3, Supplemental Figures S4, S5, S6). Defining the most appropriate scale for evaluating street tree diversity is an important next step. In the event that creating grids is not feasible, we hypothesize that census blocks (rather than neighborhoods) are likely an appropriate municipal spatial scale for evaluating and managing for street tree diversity in mid-size or larger cities, so long as equity across these sites is considered.

Regarding equity—although it is not our main focus for this study, street tree diversity in New Haven appears to be correlated with income ((U.S. Census Bureau, 2020), personal observation; Fig. 2). For example, the neighborhoods of Dwight and Dixwell have lower median annual incomes (<$50,000) and lower street tree diversity (3.17 and 3.29, respectively) relative to wealthier neighborhoods such as Amity or East Rock where the median household income is around $67,500 and Shannon diversity scores are 3.61 and 3.75, respectively ((U.S. Census Bureau, 2020); Fig. 2). This is a known issue in many cities (Anderson et al., 2023; Takakura and Massi, 2022; Suel et al., 2023). We acknowledge, however, that the city of New Haven is working to address issues of street tree inequity, and we hypothesize that the street tree diversity of these neighborhoods has improved under URI's management (unpublished data). Research on this topic is ongoing. Further, although it may be easier to use neighborhoods or city blocks as the spatial unit for planning street tree planting, we hypothesize that using a grid could be less biased. Using a random sampling of grid cells, although ambitious, could allow for more objective and therefore equitable tree planting across a city since it would theoretically remove any historical bias from the drawing of neighborhood boundaries or in selecting neighborhoods for planting efforts. This kind of approach could be particularly helpful in mid-sized and larger cities where redlining has occurred (Babcock, 1932; Federal Housing Administration, 1938). With this publication we share an R script that can be used to create these grids and demonstrate how to

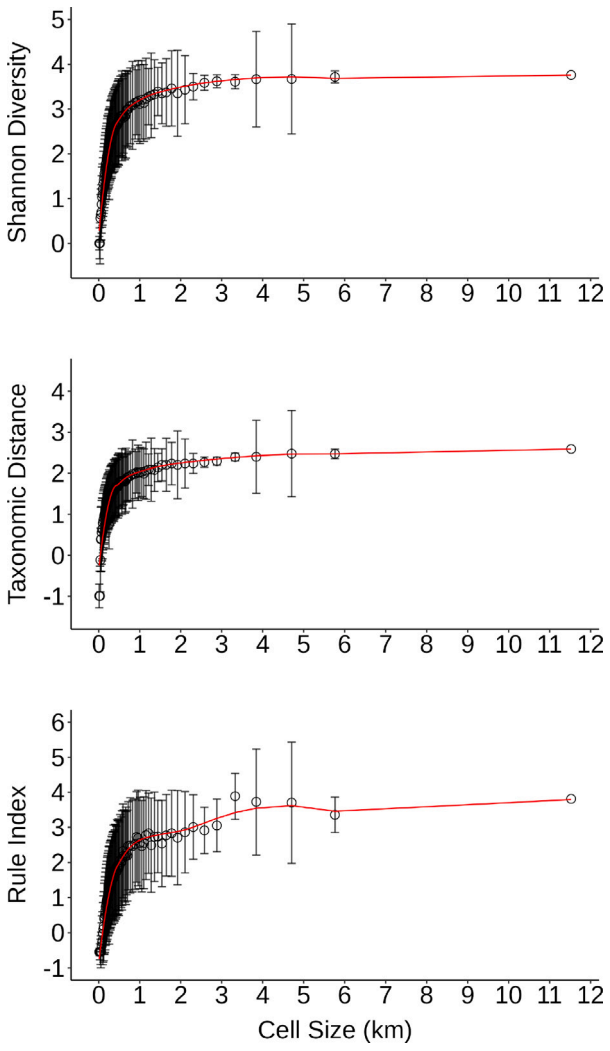

Fig. 6. Scatterplots showing relationships between diversity metrics and spatial scale. Line represents a fitted LOESS curve.

calculate the metrics we have used herein, so that others can test these methods in their own cities or neighborhoods.

Finally, we acknowledge that our study has limitations. First, the rule index metric that we created was purely a means to investigate our hypothesis and is not a new metric that we propose to be used in practice. This has some drawbacks in that this metric has not been tested in other settings, and while we did our best to create a logical function for evaluating relative success or failure for the 10/20/30 rule, it could certainly be improved upon. This function could be refined into an equation or program that could be used by practitioners if they wished, but in its current form it is not a practical tool for everyday street tree planning. The 10/20/30 rule should continue to be used as it has been, since practitioners can easily calculate relative abundance of species, genera, and families. Second, we did not test the effectiveness of the 10/20/30 rule in protecting against pests and disease, nor did we attempt to decipher the thresholds at which increased biodiversity per other metrics translates to resilience, as this is beyond the scope of this study. Third, we were unable to perform a longitudinal analysis of street tree diversity since this dataset does not have temporally explicit censuses (it only has planting dates, which are lacking prior to 2010). Finally, we acknowledge that our study is limited to a single mid-sized city, and therefore our results may not be generalizable to every city. However, New Haven is a mid-sized city with limited resources and as such it is representative of a city in the United States and potentially other countries.

In conclusion, none of these metrics appear better than another. Rather, the three metrics that we tested herein provide similar enough information that the relative conclusions that one might draw regarding tree diversity in New Haven would be the same regardless of which metric was used. It is likely, however, that using more than one metric (i.e., Shannon, taxonomic distance, or others such as Simpson's diversity (Simpson, 1949)) could be useful to corroborate one's evaluation. The scale at which diversity is evaluated is also important, and we suggest that evaluating biodiversity across a consistent spatial scale, such as a grid or census blocks, might be useful for researchers and practitioners. Our results suggest that adherence to the 10/20/30 rule appears to be a worthwhile rule of thumb for planting efforts to maintain street tree diversity in large or mid-sized cities.

CRediT authorship contribution statement

Michael R. Freiburger: Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Colleen Murphy-Dunning:** Resources, Methodology, Data curation. **Danica A. Doroski:** Writing – review & editing, Supervision. **P. Mark Ashton:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization. **Jacob D.J. Peters:** Writing – review & editing, Visualization, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

Authors, the undersigned authors of the manuscript entitled confirm that we have no financial or personal relationships with other people or organizations that could have inappropriately influenced or biased our work. They have nothing to declare

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.ufug.2025.129112.

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