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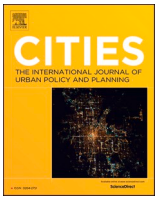

Exploring links between resident satisfaction and participation in an urban tree planting initiative

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ABSTRACT

Street-facing trees have been cited as providing a vast range of environmental benefits and also a contributing factor to community livability and quality of life. One measure of well-being that speaks directly to the livability of a city is residential satisfaction, which is represented by the social and physical environments of the particular places in which people live. Resident satisfaction can also demonstrate the degree of "fit" between one's ideal vision of a neighborhood and the actual, existing circumstances. Dimensions of resident satisfaction are less commonly studied as a variable to predict behavioral intentions or actions, and this study begins to fill that research gap by assessing resident willingness to participate in environmental restoration programs based on the streets where they live. Given the increased reliance on local residents as key actors to urban tree planting and management, this study was designed to understand the role of street-facing trees to different dimensions of resident satisfaction. We also assess the degree to which objective and subjective attributes of street trees influence resident satisfaction and explore the extent to which resident satisfaction can predict interest in a local urban tree planting initiative. Results indicate the unique role of urban trees to satisfaction and that subjectively held attitudes toward trees are important considerations when administering tree planting programs. This study also reinforces that urban tree planning and planting is a negotiation of priorities and visions between different stakeholder groups.

1. Introduction

In response to the rapid urbanization of the late 20th and early 21st centuries, cities across the world have committed to sustainability in order to balance environmental protection, economic development, and social equity for prosperous modern societies (Beatley, 2012; Wheeler & Beatley, 2014). Researchers and practitioners have identified green infrastructure, and urban tree planting initiatives specifically, as important means to accomplish sustainability goals (Young, 2011). Urban green infrastructure can be defined as a network of vegetation types and structures that collectively mitigate adverse environmental impacts while directly contributing to human well-being (Benedict & McMahon, 2006). Trees are one of the most common and consequential forms of urban green infrastructure, given their physical grandeur in the landscape and the emotional attachment shared by many city residents (Roeland, 2017). Street-facing trees, specifically, have been cited with a vast range of environmental benefits but also as a positive contributing factor in relation to community livability and quality of life (McAndrews & Marshall, 2018).

There are a range of values and approaches that inform street tree planting, maintenance, and its role in community livability. Not only are urban trees valued for their role in community beautification, they are also increasingly valued as multifunctional natural assets and nature-based solutions (Escobedo et al., 2019; McPherson et al., 1997; Seamans, 2013). As a result, urban tree planting initiatives (TPI) have been adopted as a tool to extend the reach of environmental benefits (e.g., shading, stormwater interception) and health benefits (e.g., stress recovery and reduction; increased physical activity) of green space (Doroski et al., 2020; Eisenman et al., 2021; Nguyen et al., 2017; Young, 2011; Young & McPherson, 2013). Taken together, this line of discourse promotes urban trees as an integral part of livable urban environments, where essential human needs - like health and well-being - are met through the institutional installation and management of the urban forest (Veenhoven, 2014), particularly on city streets. According to a

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nationwide U.S. survey of urban tree planting initiatives, over half of planted trees are along public streets while private residences constitute 15 % of planting sites (Eisenman et al., 2021).

One determinant of health and well-being that speaks directly to the livability of a city is residential satisfaction (Kweon et al., 2010). Residential satisfaction is defined as the relationship between a person and their residential environment (Amérigo & Aragonés, 1997), which is represented as social and physical environments by the people who live there (Kaplan, 1985). A place meeting the physical and social needs of a resident is expected to improve their quality of life, and overall sense of well-being is expected to improve (Ciorici & Dantzler, 2018). For example, McAndrews and Marshall (2018) find that arterial roadways perceived to be 'vibrant' are more strongly associated with residents' livability than those perceived as 'sketchy,' and that these two qualities commonly occurred along different sections of the same streets.

The objectives of this paper are to gauge resident satisfaction with landscape features during the outset of an urban tree planting initiative and to determine which subjective and physical measures, based on the streets where they live, may contribute to participation in the tree planting initiative. We compare several dimensions of resident satisfaction with the outdoor environment, including satisfaction with nearby nature, environmental order/disorder, and social cohesion. We then examine how objective attributes of existing street trees correlate to subjective interpretations of street tree attributes, if variation exists between mature trees and young trees, and how either objective or subjective attributes of street trees influence the dimensions of resident satisfaction. Lastly, we explore how resident satisfaction may influence residents' interest, willingness, and ability to participate in an upcoming urban tree planting initiative.

We believe that residential satisfaction can play an important role in TPIs. Expenditures on street trees are also the largest line-item for municipal tree management budgets in the United States (Hauer & Petersen, 2016), thus the impetus for increasing, and almost non-negotiable, reliance on resident participation in relation to the care for public trees. In turn, residential satisfaction is related to place attachment, whereby the visible scenery and immediate environment surrounding a home, including trees and landscaping, can play a role in influencing feelings toward a residential neighborhood and desire to improve it (Groffman et al., 2016; Kaplan, 1985). However, hesitation toward tree planting and care exist in light of known hazards and risks associated with, related to its maturity (i.e. falling limbs) or when coupled with community redevelopment (i.e. gentrification) (Roman et al., 2020).

2. Literature review

2.1. Context of resident satisfaction

Research about quality of life in a place of residence continually finds that objective measures of the environment - like street amenities (benches, trees) or local destinations (parks, bus stops) - are important yet inadequate in themselves to indicate life quality (Marans & Rodgers, 1975). As such, studies of resident satisfaction elicit overlapping information about the objectively real and perceptually subjective features of residential, physical, and social environments (Amérigo & Aragonés, 1997; Aragonés et al., 2017). Resident satisfaction reveals not only if physical attributes of a residential environment exist and are used, but also the ways in which they are perceived and evaluated by the people who experience them daily.

Resident satisfaction provides a generalized view into the well-being of residents (Kweon et al., 2010) and can demonstrate the degree of "fit" between one's ideal vision of a neighborhood and the actual, existing circumstances (Loo, 1986). Residential environments include the home and components of the nearby environment, like neighbors and the neighborhood as a whole (Amérigo & Aragonés, 1997; Aragonés et al., 2017). The home is the most immediate environment for a resident to organize activities, provide stability, and exert control; it is not only a place that provides shelter and security, it offers personal and interpersonal meaning and identity to structured social relationships (Aragonés et al., 2017; Pham et al., 2013). Studies of the home setting consider family needs and culture (Morris & Winter, 1975), as well as the quality of housing as a built structure (Amérigo & Aragonés, 1997; Hur & Morrow-Jones, 2008). Many of these themes are also present between home owners and home renters, where renters consider safety to be a key component of residential satisfaction (e.g. James III & Carswell, 2008) but not necessarily more than home owners (Ciorici & Dantzler, 2018).

Conversely, the neighborhood is the intermediate area adjacent to a home that provides access to civic centers and social ties for residents. Physical proximity to everyday destinations is expected to facilitate familiarity and meetings between neighbors, thus increasing the probability of friendly relationships (Aragonés et al., 2017). However, according to Sampson (2019), neighborhood structures directly mediate and are mediated by macro structures (e.g. political, economic, legal) and micro processes (e.g. perception and choice). On one hand, the neighborhood becomes a common setting in which residents are attached to people and place, which may strengthen the quality of life (Dassopoulos et al., 2012); without policy interventions, however, neighborhoods can also serve to perpetuate structural inequalities and concentrated disadvantage (Sampson, 2019). With this in mind, studies of resident satisfaction would, ideally, consider not only what it means for a resident to feel at home, but also how feelings of connection may vary based on different experiences with migration, mobility (social, economic, or physical) and housing (Blunt & Sheringham, 2019).

Most studies have found that satisfaction with housing and satisfaction with neighborhood context are iteratively correlated (Lovejoy et al., 2010) and defining the physical limits of each for research purposes is problematic, largely because of the blurred boundaries between semi-public and private spaces (Amérigo & Aragonés, 1997). The distinction, and lack thereof, between public and private spaces is significant in the context of urban forestry and planting street-facing trees, specifically. In a study from New York City, most residents surveyed saw the government as holding the responsibility for tree care and did not entirely see themselves as responsible for stewarding trees planted on public property such as streets (Moskell & Allred, 2013). Another study also found that mostly African American residents resisted participation in a new tree planting campaign because they were not included in the decision-making process and saw the needs of their neighborhood differently than the tree planting organizers (Carmichael & McDonough, 2018, 2019).

These examples demonstrate how it is possible to measure different resident satisfaction differently for the same place (Galster & Hesser, 1981). In combination, the socio-demographic and personality characteristics of the residents, when coupled with the physical environments in which they live, lead to different realities, lived experiences, and specific residential needs (Aragonés et al., 2017). What is known, however, is that vegetation and trees, specifically, do play an important role in resident satisfaction, and the next section will examine that literature in greater depth.

2.2. The role of urban forests and natural landscapes to resident satisfaction

While research suggests fairly uniform preferences for healthy, well-maintained urban trees across city residents (Rishbeth, 2004), these preferences have also shown to vary based on socio-demographic background (Fernandes et al., 2019; Williams, 2002), the specific characteristics of the tree (Williams, 2002), and the planting location of the tree (Camacho-Cervantes et al., 2014; Gorman, 2004; Gwedla & Shackleton, 2019). Previous research has related resident satisfaction to trees and vegetation viewed from a home window (e.g. Kearney, 2006) or different areas of a neighborhood (e.g. Ma et al., 2018), but none of

this research has specifically isolated street trees from trees planted on street-facing private property or other natural features more generally (Table 1).

The perceived appearance of a neighborhood is an often studied factor of resident satisfaction (e.g. Hadavi & Kaplan, 2016), as well as satisfaction with its maintenance, cleanliness and upkeep (e.g. Hur & Morrow-Jones, 2008). Neighborhood landscape components, such as trees or parks, have shown an overall positive effect on residential satisfaction. Residents with local parks or other open spaces have also reported higher resident satisfaction (e.g. Kearney, 2006); this is also true when a park or open space is close to home (e.g. Sugiyama et al., 2008). When studied as part of the macro-neighborhood environment, outdoor landscape components also enhanced pleasant neighborhood aesthetics in both urban (Kweon et al., 2010) and suburban areas (Lee et al., 2017). The views of nature provided by a home window can be especially accessible forms of resident satisfaction, especially trees and natural areas (Kaplan, 1985, 2001; Kearney, 2006). In addition, feelings of safety and aesthetic preference for the immediate surrounding environment have most significantly influenced residential satisfaction (e.g. Hur & Morrow-Jones, 2008).

In early scholarship, the importance of neighborhood nature was highlighted by Rachel Kaplan (1985, 125), who demonstrated that the, "…unspectacular, every day, small-scale aspect(s) of the natural environment," plays a significant role in the satisfaction of nearby residents. Extending this to human health and well-being writ large, Beatley (2016, 39) represents this temporal and scalar human-nature relationship as a "Nature Pyramid." For example, hinterlands at the top of the pyramid provide rich and valuable nature-based experiences but are logistically unrealistic to visit every day; in contrast, natureful neighborhood places at the base of the pyramid can provide convenient daily access and encourage more frequent exposure (Fig. 2). Extending this logic to proactive landscape planning practice, Eisenman (2016) has proposed "proximal greening" as an important strategy to improve the livability of cities, and this is especially noteworthy for tree planting efforts.

Neighborhood landscape components can, however, also be sources of resident dissatisfaction, for example, when trees and shrubs are overgrown or when parks harbor disruptive users (e.g. Grogan-Kaylor et al., 2006). There are other consequences of unkempt or disordered landscapes in a residential neighborhood. Early research investigated the association between dense, eye-level trees and vegetation with reported and subjective criminal activity by offering concealed space and a place to hide stolen items (Fisher & Nasar, 1992; Nasar et al., 1993). Additionally, if large areas appear abandoned, contain overgrowth, or are not actively used by residents, there is little indication that anyone cares for the property or is responsible for its upkeep. Such spaces have little community surveillance and can be considered "indefensible," or unclaimed places that may entice socially undesirable behaviors such as criminal activities (Newman, 1972). Recently, studies have actually shown a reduction in crime in cases of increased residential yard management activities and neighborhood crime (Troy et al., 2012, 2016) as well as cleaned and greened vacant lots and accounts of violence, crime, and fear of crime (Branas et al., 2011, 2018).

There have also been cases when urban trees are seen as a nuisance and financial liability by residents of poorer areas (e.g. Heynen et al., 2006); here, additional tree planting may not be seen as a community asset. These forms of resident dissatisfaction relate to a recurring finding that the quantity or amount of open space and vegetation may not be as important as its planting arrangement and quality, which may then inform how outdoor spaces are used (Kaplan, 1985; Kweon et al., 2010; Zhang et al., 2017). In a broader context, Zhang et al. (2017) report that the objectively-measured availability of open space helped predict residents' subjective perceptions of open space quality. Similarly, Kweon et al. (2010) found that trees influenced resident satisfaction when open space was present or distant, and suggested that the growth of trees in a neighborhood may have a stronger impact on residents than parks or other open spaces alone.

In summary, if every day places of nature are arguably some of the most important to sustain for resident quality of life, the role of "quality" natural environments cannot be left unexplored. Environmental quality

Table 1
Past literature reporting the impact of trees and natural spaces to resident satisfaction.

	Scope	Natural feature	Impact on resident satisfaction		
			Positive	Negative	None/negligible
Physical (objective) features	From home window	Trees	Kaplan, 1985		Vemuri et al., 2011; Kearney, 2006
		Parks		Kaplan, 2001	Kearney, 2006
		Farmland			Kaplan, 2001
		Forests and landscaped areas	Kearney, 2006; Kaplan, 1985, 2001		Kaplan, 2001
		Large mowed areas			Kaplan, 2001
		"Nature"/naturalistic	Kaplan, 1985		
		Wildlife sightings			Kaplan, 2001
	Presence/ amount	Density of tree canopy cover or vegetation patches	Abass & Tucker, 2018; Ellis et al., 2006; Hur et al., 2010; Jorgensen et al., 2007; Kweon et al., 2010; Vemuri et al., 2011	Lee & Moudon, 2008	
		Total area of tree canopy cover or vegetation patch	Lee & Moudon, 2008		
		Parks, green spaces, or other (non)forested open spaces	Abass & Tucker, 2018; Lee & Moudon, 2008		Abass & Tucker, 2018; Kweon et al., 2010
		Overgrowth (in neighborhood)			Hur & Nasar, 2014
	Proximity	Parks, green spaces, or other (non)forested open spaces	Abass & Tucker, 2018; Lee & Moudon, 2008		Abass & Tucker, 2018; Kweon et al., 2010
Perceived (subjective) features	Presence/ amount	Trees	Gandelman et al., 2012; Kaplan, 1985; Lee et al., 2017		
		Parks, green spaces, or other (non)forested open spaces	Lee et al., 2017; Kaplan, 1985		Hadavi, 2017
		Safe parks	Sugiyama et al., 2008		
		Pleasant parks	Sugiyama et al., 2008; Zhang et al., 2017		
		Nuisance parks			Sugiyama et al., 2008
		Naturalness/openness (general)	Hur et al., 2010		
		Overgrowth (in neighborhood)			Grogan-Kaylor et al., 2006
		Quality of walking paths			Sugiyama et al., 2008
	Proximity	Parks, green spaces, or other (non)forested open spaces	Hadavi, 2017; Lee et al., 2017; Wu et al., 2019		

can be assessed by the level of maintenance or upkeep attended to open space or vegetation as well as the overall health and vigor of plant assemblages (Nassauer, 2007). Based on this literature synthesis, we would expect that the objective attributes of street-facing trees would directly impact residents' subjective attitudes toward these trees, and that both sets of variables would affect levels of resident satisfaction; and, as result, we would expect that higher or lower levels of resident satisfaction would instigate participation in a TPI in order to sustain or to improve the conditions of their neighborhood streets and trees (Fig. 1).

3. Materials and methods

3.1. Study area

Urban tree planting in Massachusetts is led by the state Department of Conservation and Recreation (DCR) through the Greening the Gateway Cities program. Since 2014 the Greening the Gateway Cities Program has partnered with municipal governments and local NGOs in order to reduce heating and cooling costs for residents; as of 2020, over 20,000 trees have been planted in 14 cities (MA Urban Canopy Project 2020). The program has been renewed (Massachusetts Department of Conservation and Recreation, 2020) and accounted for in the 2022 capital investment plan (Hook, 2021) as it seeks to expand tree canopy cover by 5–10 % in state-designated environmental justice areas (Coop & Church, 2018).

A cousin initiative has modeled the Greening the Gateway Cities program to expand urban canopy cover in the rural northwestern part of Massachusetts, in much smaller "gateway" city areas. The Franklin Land Trust and DCR were recently awarded a U.S. Forest Service Landscape Scale Restoration Competitive Project grant to plant 1200 new trees in the Massachusetts town of Greenfield (Fig. 3). Between 2019 and 2022, the initiative aims to, "increase tree canopy in small, isolated cities… [and learn to] replicate [this approach] in other regions with small cities nested among large forested regions," and provide, "a measurable, positive impact on the lives of low-income residents of small cities listed as priorities for urban forestry in the MA Forest Action Plan that also serve as the gateway to the state's large forest landscapes." As project partner, the Franklin Land Trust is directly working with the municipal public works department to coordinate the tree plantings and provide maintenance for two seasons following the planting. In addition to planting strips in the public-right-of-way, trees are also being planted within 20-ft inside private property boundaries, as this area is still considered part of the town's front yard-tree planting program and permissible for public tree planting under current zoning (General Code of Greenfield §172-3.3) (Fig. 4).

3.2. Survey instrument

This paper used a mixed-methods approach, combining questionnaires with spatial data.

First, a self-reported questionnaire included environmental indicators of resident satisfaction rated as 5 point Likert scales (note that several items were re-scaled from high-to-low from low-to-high, see asterisks in Table 2 and the full questionnaire in Appendix 1) Questions were derived from the WHO's quality of life assessment (WHO, 1998), Hadavi and Kaplan (2016) and Hadavi (2017). ESRI's ArcGIS Pro (version 2.9.0) was used to extract spatial data, and the open-source program R and RStudio was used for statistical analyses (version 1.4.1717, R Core Team, 2020), including packages *Hmisc* (Harrell Jr., 2021), *nFactors* (Raiche & Magis, 2020), *performance* (Lüdecke et al., 2021), *psych* (Revelle, 2021), and *tidyverse* (Wickham et al., 2019).

Data for questionnaires was collected from residents *prior* to the start of the tree planting initiative in Greenfield. Using tax assessor information in the planting zones, a postcard and survey packet were mailed exclusively to 3600 single family and multi-family households, and the materials were received between April 29 and May 6, 2019. An introductory postcard was mailed one week prior to the hard-copy survey packet, and both materials announced that the survey was available in Spanish and through the Qualtrics website (Dillman et al., 2008). As compensation, participants were entered into a raffle for three chances to win a $100 Amazon gift card. This recruitment method yielded a 10.25 % response rate ($n = 242$ mail, $n = 127$ online, $n = 369$ total). To supplement household recruitment, participants were also screened and

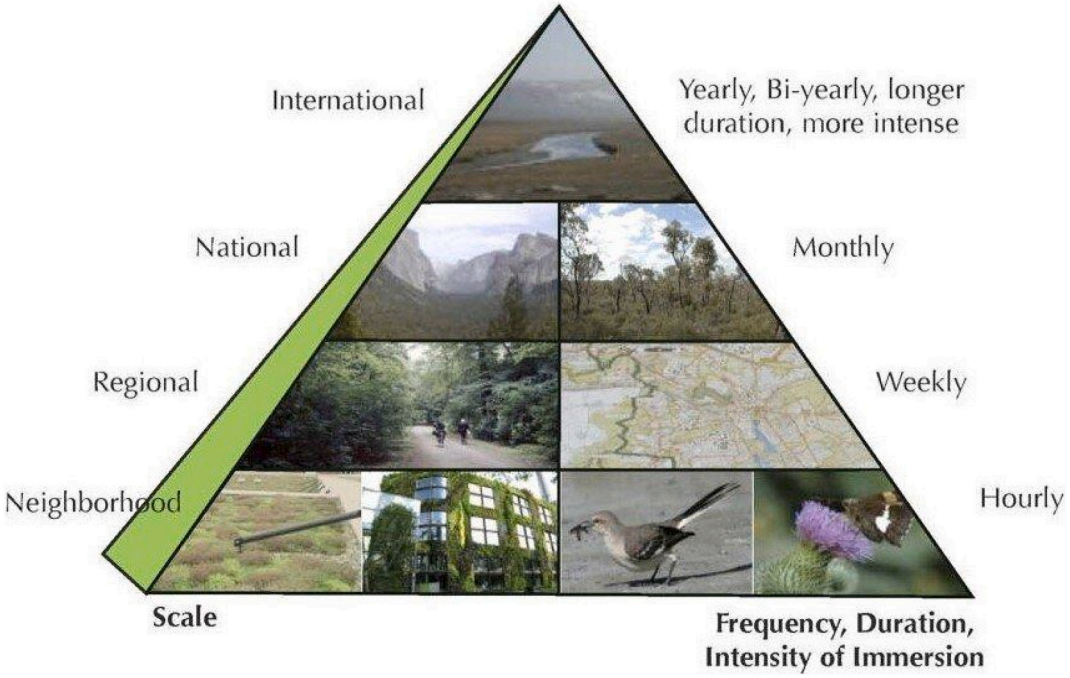


Fig. 1. Nature Pyramid.
Reproduced from Beatley (2016).

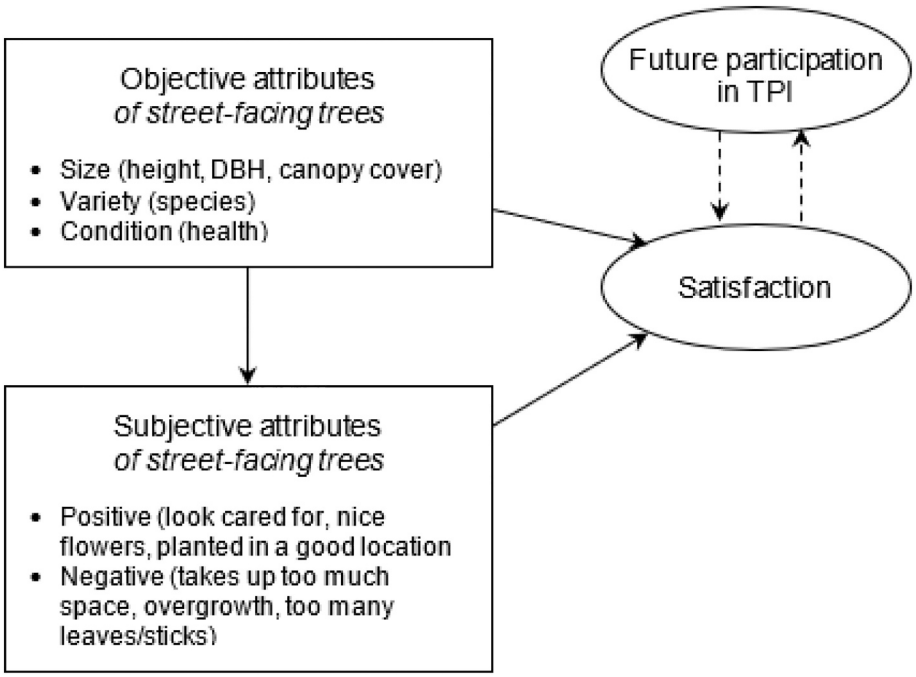


Fig. 2. Conceptual diagram of this study.

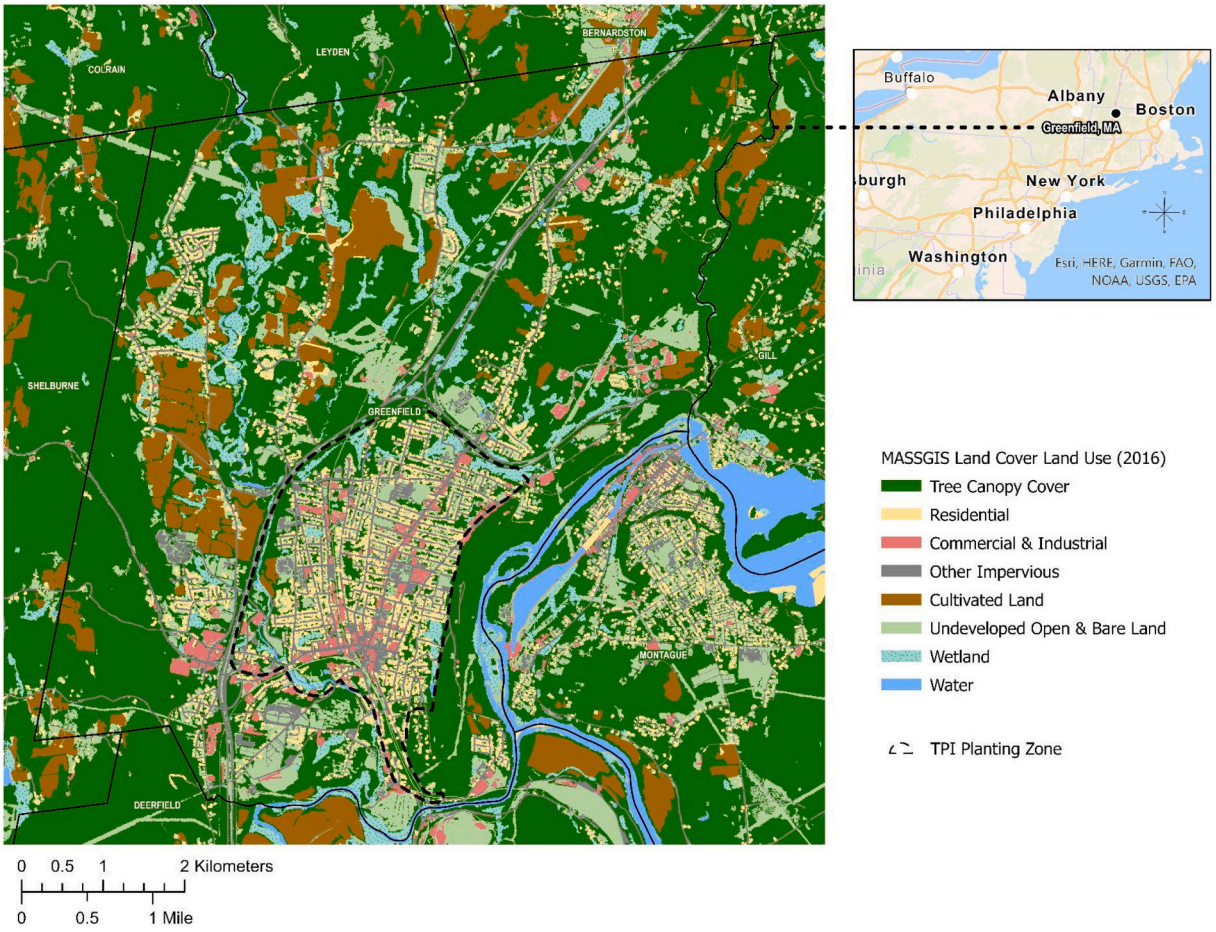
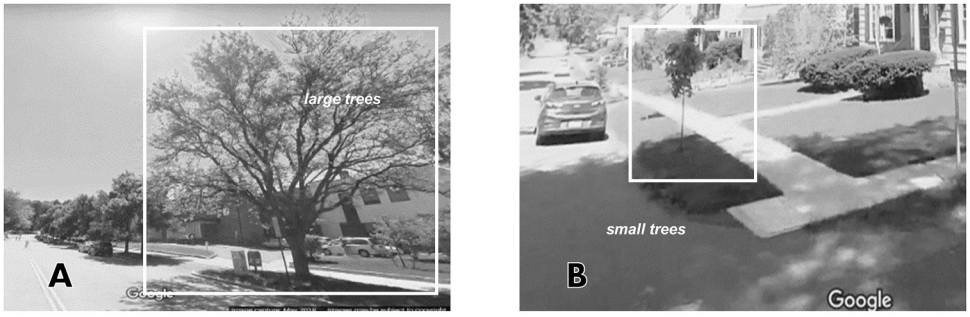


Fig. 3. Surrounding land use context of Greenfield tree planting initiative (TPI) planting zone.

Fig. 4. Examples of typical tree planting space among the built infrastructure of Greenfield, Massachusetts: (A) Residential street with new, small-statured trees planted underneath power lines in the right-of-way; (B) residential street without new trees in the right-of-way; (C) commercial corridor with trees planted in both sidewalk cut-outs and right-of-way planting strip; (D) commercial corridor without trees planted on public or private property (Google Earth, 2022).



sample (n)	mean	std. dev
272	1.23	1.36

sample (n)	mean	std. dev
171	0.96	0.33

Fig. 5. Descriptive statistics and Google Street View images of large, mature street trees (A) and small, young streets assessed as part of the resident satisfaction survey. NOTE Scale range = −3 (negative attitude toward tree) to +4 (positive attitude toward tree).

intercepted at public places in the planting zone. This included the library, farmer's market, post office, and sidewalk pedestrians over six field visits during different weekdays, weekend days, and times. This recruitment yielded 163 additional surveys, and after screening for duplicates, in total, 425 of 532 completed surveys (79.9 %) included home addresses inside the designated tree planting zone and were considered for further analysis.

3.3. Analytic strategy

3.3.1. Dimensions of resident satisfaction

Given the vast literatures relating the built and natural environments to resident satisfaction, initially a confirmatory factor analysis (CFA) was used for this study; however, due to the sample size and listwise deletion, the resident satisfaction items solicited in this survey did not create a strong confirmatory factor structure, and CFA could not be further pursued in this sample.

Instead, exploratory factor analysis (EFA) (oblim rotation and maximum likelihood factor method) was applied to several survey questions, asking about satisfaction with the amounts (13 items) and qualities (13 items) of neighborhood features, as well as neighborhood features that influence feelings of personal safety while outdoors (13 items). EFA was used to define how latent "factors" account for correlations among neighborhood features, or how similar neighborhood items may similarly influence resident satisfaction. The suitability of EFA was first verified using the KMO statistic (MSA = 0.89) and Bartlett's test of sphericity (c^2 (741, n = 425) = 9025.26, $p < 0.001$). Following the EFA, additional tests assessed the proposed factor structure, including Cronbach's alpha (Cronbach, 1951), Cattell's scree test (Cattell, 1966), Horn's parallel analysis (Horn, 1965), and Ruscio and Roche's data comparison method (Ruscio & Roche, 2012). Resultant factors were then converted to composite variables, calculated by

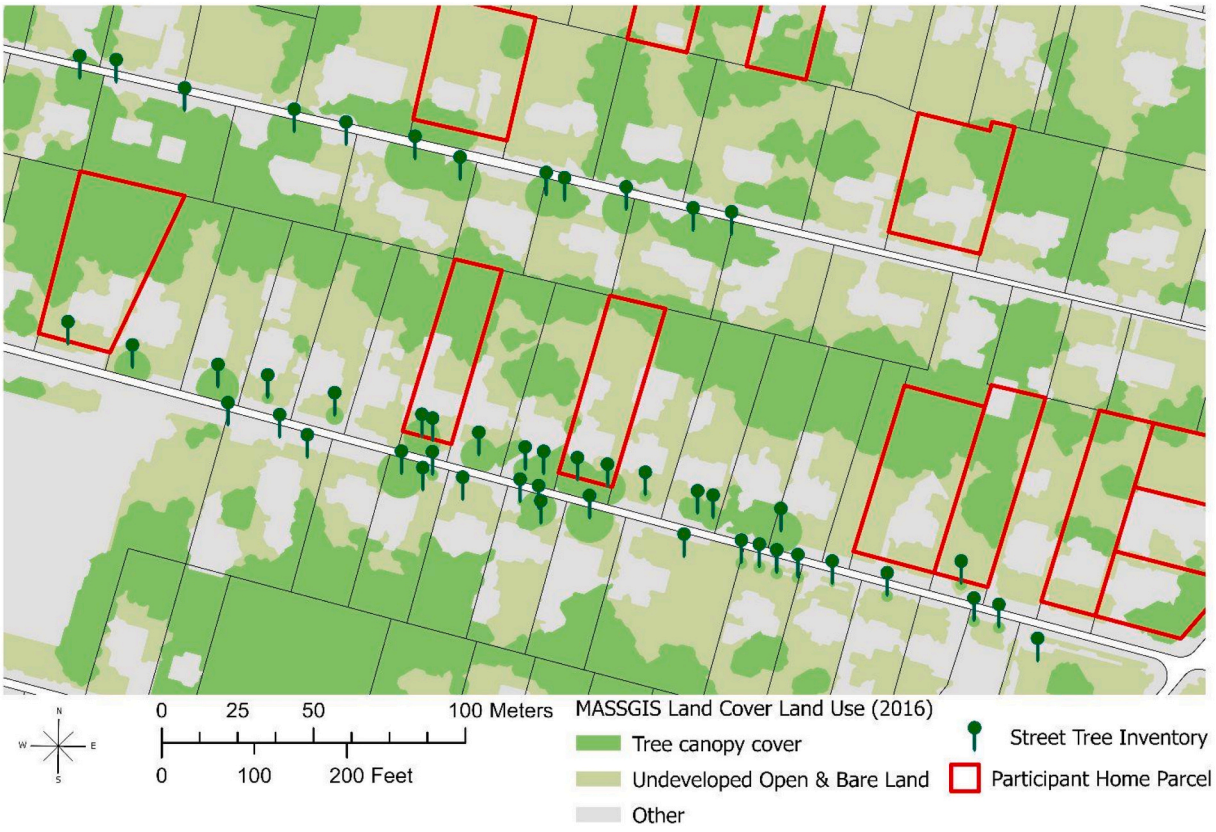


Fig. 6. An example of the spatial data used in this analysis, showing where street tree (dark pins) canopy cover was able to supplement the 2016 tree cover data (medium green) over presumed lawns (lightest green) on street segments where our participants live (red outline). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

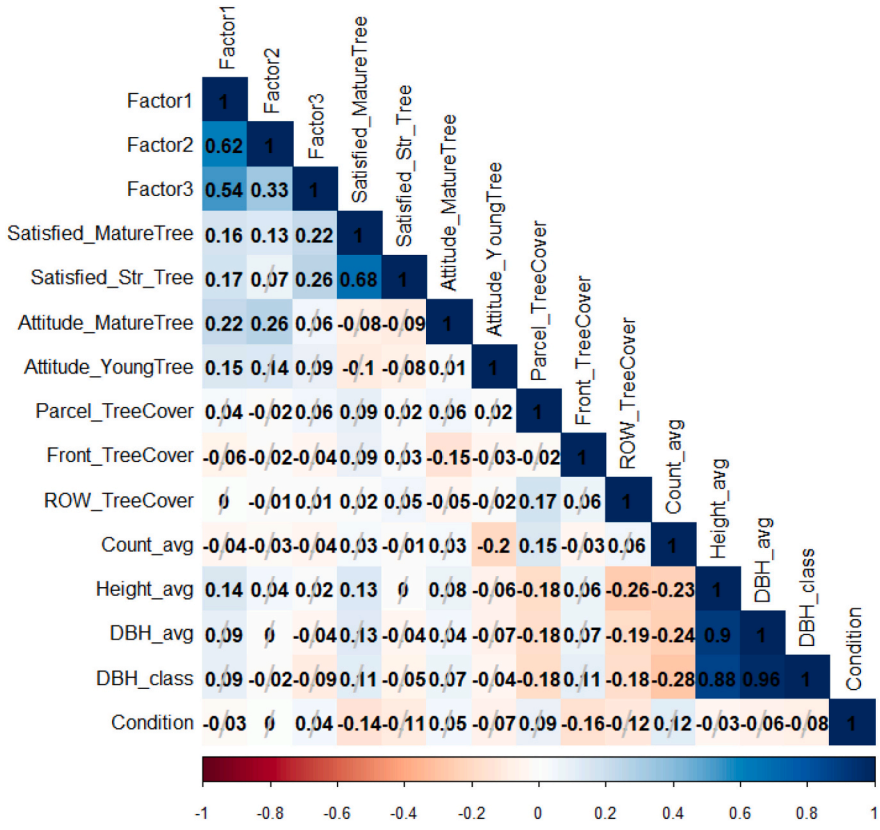


Fig. 7. Associations between subjective attitudes (Factor 1, Factor 2, Factor 3, Satisfied_MatureTree, Satisfied_Str_Tree, Attitude_MatureTree, Attitude_YoungTree) and objective measures (Parcel_TreeCover, Front_TreeCover, ROW_TreeCover, Count_avg, Height_avg, DBH_avg, DBH_class, Condition) of street-facing trees. NOTE: The numbers in the cells indicate the Pearson's correlation coefficient, where darker shading indicates a stronger negative (red) or positive (blue) relationship. Cells with an '/' are not statistically significant. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 2
Dimensions of resident satisfaction, 3-factor solution.

	Mean	S.D.	Loadings	Alpha**
Factor 1: satisfaction with amounts/ qualities of social realm (neighborliness, communicated care)	3.40	0.80		0.90
Loud noise(s)[c,*]	3.94	1.21	0.39	0.90
Pleasant interactions with neighbors[a]	2.67	0.61	0.52	0.90
The number of neighbors I like to speak with regularly[b]	3.38	1.26	0.80	0.89
Sense of community[b]	3.12	1.17	0.78	0.89
How my neighbors take care of their property[b]	3.38	1.14	0.66	0.89
Safety when walking at night[b]	3.49	1.27	0.45	0.89
How the local government takes care of the streets[b]	2.92	1.21	0.34	0.89
Street lights[a]	3.45	1.24	0.32	0.89
Peacefulness[b]	3.40	1.14	0.80	0.88
Overall appearance[b]	3.30	1.09	0.77	0.88
The trustworthiness of people living in my neighborhood[b]	3.63	1.14	0.70	0.88
Safety when walking during the day[b]	4.20	0.98	0.49	0.88
Factor 2: satisfaction with personal safety when outdoors (crime, mobility, infrastructure)	4.07	0.84		0.83
Unpleasant parks or natural areas[c,*]	3.78	1.38	0.33	0.89
Frightening shadows (between buildings, in a dark park)[c,*]	4.49	1.01	0.76	0.88
Indoor crime[c,*]	4.53	0.85	0.68	0.88
Trees and/or shrubs that block views when walking or biking[c,*]	4.34	1.08	0.48	0.88
Unmaintained or damaged sidewalks that make walking or biking difficult[c,*]	4.01	1.29	0.45	0.88
Signs, buildings, cars, etc. that block views when walking or biking[c,*]	4.30	1.08	0.44	0.88
Distracted or irresponsible driving[c,*]	3.45	1.32	0.41	0.88
Outdoor crime[c,*]	4.25	1.02	0.93	0.87
Other suspicious activity[c,*]	4.19	1.08	0.86	0.87
Too many places for dangerous people to hide[c,*]	4.34	1.09	0.84	0.87
Unkept weeds, litter, or other stray items[c,*]	3.92	1.23	0.36	0.87
Factor 3: satisfaction with amounts/ qualities of active outdoor places and civic amenities (involvement, activity)	2.51	0.51		0.82
Opportunities to be involved with my community (e.g. neighborhood watch, volunteer fire department)[a]	2.58	0.70	0.67	0.80
Places for outdoor parties or celebrations[b]	2.89	1.30	0.49	0.78
Vegetable gardens[a]	2.10	0.73	0.41	0.78
Sidewalks[a]	2.69	0.59	0.39	0.78
How natural areas or parks are maintained[b]	3.35	1.11	0.35	0.78
Children's playgrounds[a]	2.51	0.75	0.67	0.77
Natural areas or parks[a]	2.49	0.69	0.67	0.77
Places to sit[a]	1.99	0.68	0.59	0.77
Flower beds[a]	2.63	0.71	0.36	0.77
Picnic areas[a]	2.09	0.74	0.67	0.76
Unloaded items				
Nearby produce stands or farmers markets[a]	3.60	1.21		
Traffic speed[c,*]	3.33	1.34		
Lawns[a]	3.14	0.68		
Shrubs and bushes[a]	2.88	0.38		
Large trees[a]	2.52	0.78		
Street trees[a]	2.39	0.80		

[a] How satisfied are you with the amount of the following features in your neighborhood?, where 1 = much too few and 5 = way too much.
[b] How satisfied are you with the following qualities of your neighborhood?, where 1 = not at all and 5 = completely.
[c] How much do any of the items below discourage you from pursuing outdoor activities in your neighborhood?, where 1 = a little and 5 = very much.
[*] items re-scaled to low-high from high-to-low.
[**] the alpha measure in-line with each factor represents the overall alpha per factor, whereas the measure in-line with each item represents the raw alpha per item.

participants' average ratings per factor item, and the unloaded items remained in consideration as additional dependent variables.

Following the EFA, one-way between-subjects ANOVA was used to compare the mean of each factor across groups of self-reported socio-demographic variables, including participant age, gender, race/ethnicity, language spoken at home, income, education, housing status, housing tenure, and plans to move. ANOVA was used to determine if there is statistical evidence that the group means are significantly different and post hoc comparisons were further assessed using the Tukey HSD test.

3.3.2. *Influence of objective and subjective attributes of street trees to resident satisfaction*

Subjective and objective measures of street-facing trees were the primary independent variables of interest. Participants' subjective thoughts about street trees were measured with multiple-choice statements about different patterns of trees and landscaping on their residential street. Trees and landscaping were illustrated with two separate black and white photos of a mature street tree and a young street tree (captured from Google Street Views of the study area, Fig. 5). Participants could select up to four positive statements about the images (are planted in a good location, look cared for, look mostly healthy, have nice flowers), up to three negative statements (sheds too many leaves and sticks, have too many overgrown limbs, take up too much space), or 'not applicable' if they do not have those patterns of trees and landscaping on their residential street. The ratings for each photo were combined to a single ordinal scale ranging from −3 to +4, where one positive 'point' was added for every marked positive statement and one negative 'point' was subtracted for every marked negative statement; a resultant value of '0' was considered neutral. Those marked 'not applicable' were coded separately, and those left blank remained null.

Objective attributes of street trees were aggregated from two datasets. First, the open-source, high resolution 2016 land cover/land use shapefile (1-5 m resolution) was isolated to only the forest classes (deciduous, evergreen) that exist within the public right-of way (20-ft outside of a property boundary), the front yard right-of-way (20-ft inside a property boundary), and the remaining portion of the property (Fig. 6). Property boundaries and the type of housing were approximated using the assessor parcels, and all public spatial data was sourced from MassGIS (Bureau of Geographic Information), Commonwealth of Massachusetts EOTSS. Secondly, a city street tree inventory from the Greenfield Tree Committee was used to supplement the spatial dataset with the additional measures of number of trees (count); species diversity (count of unique species); tree canopy cover (areal spread of leafy foliage); DBH (diameter at breast height, as proxy of tree size and age); height (another proxy of tree size and age); and condition (categorical scale of tree health, where low is dead/dying to and high is 'good' health). All trees planted after the time of the survey (2019) were removed from this study. Since the survey questions were framed to address measures at the street-scale, all objective attributes were averaged to the area of a "block face," which is a length of street centerline segmented at roadway intersections and a useful geographic unit in environmental design research (Ewing et al., 2006).

3.3.3. *Interest in tree planting initiatives and resident satisfaction*

Lastly, each factor of resident satisfaction was tested as an independent variable to participant interest in tree planting initiatives. Interest in tree planting was measured separately through several indicators in the survey, including whether or not they knew about the city's tree planting initiative and a check-all that apply section was offered to mark if they would like to receive occasional emails about tree-related news in Greenfield; participate in volunteer tree planting events in Greenfield; join the Greenfield Tree Committee; and/or donate to the Greenfield Tree Committee. These five indicators were coded as binary dummy variables, where 1 = yes and 0 = no. Separate bivariate logistic regression models were used to see if factors of resident

satisfaction strengthen or boost interest in tree planting initiatives.

4. Results

4.1. Exploratory factor analysis and independent means tests/ANOVAs

Many of the 39 resident satisfaction items had strong positive associations and virtually all were significantly correlated. A 3-factor EFA solution was the most interpretable and reliable result following the adequacy tests and criteria (Table 2). A 4-factor solution was also considered, however, it identified the same instances of cross-loading and unloaded factors as the 3-factor solution; thus, the simpler factor solution was chosen for this analysis.

Factor 1 reflects '*satisfaction with amounts/qualities of social environment*' ($\alpha = 0.90$), where a general sense of community, neighborliness, and orderly environment communicate a high degree of sociality. It is notable that participants are satisfied with the item 'how neighbors take care of their property' ($m = 3.38$, $sd = 1.14$) significantly more than 'how the government cares for the streets' ($m = 2.92$, $sd = 1.21$) ($p < 0.001$). Across sociodemographic variables (Table 3), participant income showed the greatest variation to Factor 1 ($F = 3.06$, $p = 0.01$); post hoc comparisons using the Tukey HSD test indicated that the wealthiest income bracket (>$100,000, m = 3.68, sd = 0.63) has significantly higher 'satisfaction with amounts/qualities of social environment' than the poorest income bracket (<$25,000, m = 3.17, sd = 0.85), and the other income brackets did not significantly differ from the wealthiest or poorest groups. Significant variation also emerged for the variables of age, education, housing status, and plan to move, but the disproportionate group sample sizes may be undermining the statistically significant differences seen in these variables.

Factor 2 demonstrates '*satisfaction with personal safety when outdoors*' ($\alpha = 0.83$), and collates dimensions of safety, including safety from crime, blocked views, or the upkeep of public places (e.g. sidewalks, parks). The item 'trees/shrubs that block views while walking' ($m = 4.34$, $sd = 1.09$) is not significantly different from 'signs, buildings, cars, etc. that block views while walking' ($m = 4.30$, $sd = 1.03$) ($p = 0.32$).

Table 3
Results of one-way ANOVA, comparing the means of the factors across sociodemographic groups.

		Factor 1 'Satisfaction with amounts/qualities of social environment'				Factor 2 'Satisfaction with personal safety when outdoors'				Factor 3 'Satisfaction with amounts/qualities of active outdoor places and civic amenities'			
		M	*S.D.*	*N*	*F, p*	*M*	*S.D.*	*N*	*F, p*	*M*	*S.D.*	*N*	*F, p*
Age	18–24	2.54	1.03	4	4.43, <0.001	3.67	0.80	4	1.21, 0.30	2.10	0.58	4	1.44, 0.21
	25–34	**3.08**[a]	0.86	43		3.98	0.89	42		2.44	0.55	43	
	35–44	3.42[a,b]	0.71	76		4.17	0.68	75		2.45	0.48	76	
	45–54	3.49[a,b]	0.67	54		4.08	0.78	53		2.51	0.50	54	
	55–64	3.35[a,b]	0.79	92		3.97	0.90	92		2.52	0.51	92	
	65+	**3.61**[b]	0.78	123		4.19	0.82	119		2.59	0.52	123	
Gender	F	3.48	0.77	242	1.10, 0.34	4.14	0.81	236	1.46, 0.23	2.52	0.53	242	0.14 0.87
	M	3.36	0.78	126		4.01	0.84	125		2.52	0.47	126	
	other	3.31	0.82	8		4.36	0.86	8		2.43	0.50	8	
Race/ethnicity	White alone	3.42	0.79	353	0.93, 0.43	4.09	0.82	347	0.54, 0.66	2.53	0.05	353	1.57, 0.20
	Biracial (incl. white)	3.48	0.83	12		3.94	1.14	15		2.25	0.54	12	
	Non-white	3.21	0.59	15		3.99	0.71	15		2.47	0.64	15	
Language spoken at home	English only	3.41	0.77	321	0.98, 0.38	4.11	0.81	316	0.46, 0.53	2.52	0.49	321	0.34, 0.72
	English +	3.62	0.70	25		4.27	0.74	25		2.47	0.56	25	
	No English	2.80	–	1		2.60	–	1		2.86	–	1	
Income	<25k	**3.17**[c]	0.85	44	3.06, 0.01	**3.71**[e]	0.97	43	3.20, 0.01	**2.38**[i]	0.60	44	2.16, 0.05
	25-34k	3.48[c,d]	0.93	41		4.08[e,f,g,h]	0.89	40		2.53[i,j]	0.56	41	
	35-49k	3.27[c,d]	0.64	47		4.00[e,f,g,h]	0.81	47		2.47[i,j]	0.51	47	
	50-74k	3.48[c,d]	0.79	85		**4.21**[f,g,h]	0.73	84		2.50[i,j]	0.48	84	
	75-99k	3.35[c,d]	0.81	70		**4.18**[f,g,h]	0.75	70		2.51[i,j]	0.51	70	
	100k+	**3.68**[d]	0.63	68		**4.25**[f,g,h]	0.71	67		**2.68**[j]	0.45	68	
Education	<HS	3.38[k,l,m,n]	0.62	3	5.75, <0.001	3.81[o,p,q,r]	1.05	3	7.14, <0.001	2.57	1.00	3	2.39, 0.38
	HS only	3.29[k,l,m,n]	0.75	30		**3.74**[o,p,r]	0.98	30		2.32	0.62	30	
	Some college	**3.23**[k,l]	0.88	49		3.99[o,p,q,r]	0.78	48		2.43	0.56	49	
	Associate's	**3.03**[k,l]	0.93	47		**3.61**[o,p,r]	1.03	45		2.41	0.57	47	
	Bachelor's	**3.42**[m,n]	0.71	116		**4.13**[o,q]	0.75	116		2.58	0.48	116	
	Graduate degree	**3.65**[m,n]	0.71	146		**3.32**[q,r]	0.70	142		2.58	0.46	146	
Housing status	Owner	**3.48**[s]	0.78	331	7.18, <0.001	**4.14**[u]	0.81	320	4.79, 0.003	2.54	0.50	333	2.32, 0.07
	Renter	**3.07**[t]	0.78	79		**3.82**[v]	0.92	73		2.39	0.55	79	
	Lease-to-own	2.75[s,t]	0.33	5		3.19[u,v]	0.86	5		2.44	0.25	5	
	Other	3.00[s,t]	1.30	2		4.27[u,v]	0.13	2		2.15	0.78	2	
Housing tenure	0–5	3.28	0.82	122	2.14, 0.12	4.03	0.82	112	1.98, 0.14	**2.40**[w]	0.52	122	4.58, 0.01
	5–10	3.43	0.77	68		4.27	0.73	67		2.48[w,x]	0.48	68	
	10+	3.47	0.78	204		4.06	0.88	201		**2.57**[x]	0.51	206	
Plan to move	Yes	**2.80**[y]	0.82	22	17.44, <0.001	3.84[aa,bb]	0.81	22	7.05, <0.001	**2.18**[cc]	0.51	22	7.01, 0.001
	No	**3.50**[z]	0.74	329		**4.15**[aa]	0.80	317		**2.55**[dd]	0.49	331	
	Unsure	**3.03**[y]	0.86	66		**3.74**[bb]	1.01	61		2.41[cc,dd]	0.55	66	

Items in **bold** denote statistically significant difference using a 95 % confidence interval, indicated by a unique superscripted letter.

Overall, this factor has the highest mean rating ($m = 4.07$, $sd = 0.84$), indicating a high level of satisfaction with personal safety in this sample of residents. For Factor 2, participants across income brackets also reported significantly different responses ($F = 3.20$, $p = 0.01$); unlike, Factor 1, however, the Tukey HSD test showed that participants from three of the highest income brackets (>$50,000, m = 4.18–4.25, sd = 0.71–0.75) all have significantly higher 'satisfaction with personal safety when outdoors' than the lowest income bracket (<$25,000, m = 3.71, sd = 0.97). Significant variation also emerged for the variables of education, but the disproportionate group sample sizes may be undermining the statistically significant differences seen in these variables.

Factor 3 shows '*satisfaction with amounts/qualities of active outdoor places and civic amenities*' (α = 0.82). Given its overall low mean rating ($m = 2.51$, $sd = 0.51$), residents were dissatisfied with the amount of places with public activity (e.g. playgrounds), with overt human attention (e.g. flower beds), or with opportunities to gather with other residents (e.g. places for parties). Like Factor 1 and 2, Factor 3 also showed significantly different responses from participants of the lowest and highest income brackets ($F = 2.16$, $p = 0.05$). Using the Tukey HSD test, participants from the wealthiest income bracket (>$100,000, m = 2.68, sd = 0.45) reported significantly more 'satisfaction with amounts/qualities of active outdoor places and civic amenities' than participants from the poorest income bracket (<$25,000, m = 2.38, sd = 0.60), and the other income brackets did not significantly differ from the wealthiest

Table 4
Results of one-way ANOVA, comparing the means of the unloaded factor items across sociodemographic groups.

		Select unloaded items															
		Lawns				Shrubs and bushes				Large trees				Street trees			
		M	*S.D.*	*N*	*F, p*	*M*	*S.D.*	*N*	*F, p*	*M*	*S.D.*	*N*	*F, p*	*M*	*S.D.*	*N*	*F, p*
Age	18–24	3.25	1.26	4	0.46, 0.81	3.00	0.82	4	1.82, 0.11	2.75	0.50	4	0.62, 0.69	2.75	0.50	4	1.73, 0.13
	25–34	3.12	0.84	41		2.83	0.55	40		2.55	0.80	42		2.61	0.80	41	
	35–44	3.20	0.75	71		2.79	0.50	73		2.63	0.85	75		2.32	0.80	74	
	45–54	3.19	0.56	52		2.85	0.41	53		2.41	0.67	51		2.17	0.71	52	
	55–64	3.07	0.63	86		2.93	0.25	88		2.49	0.72	90		2.40	0.87	90	
	65+	3.18	0.53	118		2.93	0.25	118		2.55	0.78	116		2.41	0.73	118	
Gender	F	3.15	0.64	227	0.14, 0.86	2.89	0.38	229	0.61, 0.54	2.51	0.78	232	0.47, 0.62	2.35	0.76	232	1.23, 0.29
	M	3.08	0.60	122		2.85	0.42	124		2.55	0.74	123		2.43	0.86	123	
	Other	4.00	0.93	8		3.00	0.00	7		2.75	0.74	8		2.75	0.46	8	
Race/ ethnicity	White alone	3.14	0.63	338	0.03, 0.99	2.88	0.39	339	0.61, 0.61	2.54	0.75	343	2.36, 0.07	2.38	0.80	345	0.66, 0.58
	Biracial (incl. white)	3.14	1.03	14		2.90	0.32	10		2.09	0.83	11		2.38	0.74	8	
	Non-white	3.20	0.42	10		3.00	0.00	15		2.85	1.14	13		2.67	0.90	15	
Language spoken at home	English only	3.17	0.63	307	0.78, 0.46	2.87	0.38	307	0.62, 0.53	2.52	0.77	312	0.19, 0.83	2.37	0.79	312	0.83, 0.44
	English+	3.00	0.80	23		2.96	0.45	25		2.52	0.85	23		2.54	0.93	24	
	No English	3.00	–	1		3.00	–	1		3.00	–	1		3.00	–	1	
Income	<25k	3.14	0.86	43	0.59, 0.71	2.90	0.38	39	1.16, 0.33	2.62	1.01	42	1.36, 0.24	2.48	0.88	40	1.14, 0.34
	25-34k	3.21	0.62	38		2.82	0.45	39		2.78	0.77	40		2.51	0.68	39	
	35-49k	3.29	0.66	45		2.87	0.34	47		2.61	0.77	46		2.37	0.71	46	
	50-74k	3.09	0.56	80		2.96	0.36	83		2.47	0.70	83		2.32	0.73	85	
	75-99k	3.16	0.69	67		2.88	0.32	69		2.49	0.68	68		2.50	0.89	68	
	100k+	3.17	0.60	65		2.84	0.45	67		2.44	0.73	64		2.25	0.78	68	
Education	<HS	**4.33^{ee}**	1.15	3	4.84, 0.002	3.00^{jj,kk}	0.00	3	2.48, 0.03	3.33	1.53	3	2.13, 0.06	**3.67^{ll}**	1.53	3	2.79, 0.02
	HS only	**2.83^{ff}**	0.70	30		**3.03^{jj}**	0.19	29		2.79	0.99	28		2.66^{ll,mm}	0.97	29	
	Some college	**3.10^{ff,gg,hh,ii}**	0.63	48		**2.74^{kk}**	0.57	46		2.53	0.93	47		2.38^{ll,mm}	0.89	45	
	Associate's	3.00^{ee-ii}	0.58	43		2.91^{jj,kk}	0.29	45		2.48	0.84	46		2.37^{ll,mm}	0.86	41	
	Bachelor's	**3.15^{hh,ii}**	0.56	109		2.86^{jj,kk}	0.37	110		2.61	0.67	114		2.43^{ll,mm}	0.77	116	
	Graduate degree	**3.25^{hh,ii}**	0.68	138		2.90^{jj,kk}	0.36	142		2.42	0.69	139		**2.28^{mm}**	0.70	144	
Housing status	Owner	**3.17^{nn}**	0.65	314	2.95, 0.03	2.88	0.38	323	1.98, 0.12	2.51	0.75	323	0.56, 0.64	2.37	0.82	321	0.63, 0.60
	Renter	3.09^{nn,oo}	0.76	75		2.89	0.36	71		2.59	0.92	75		2.46	0.72	76	
	Lease-to-own	**2.40^{oo}**	0.89	5		3.00	0.00	5		2.75	0.96	4		2.40	0.55	5	
	Other	2.50^{nn,oo}	0.71	2		3.50	0.71	2		3.00	0.00	2		3.00	0.00	2	
Housing tenure	0–5	3.19	0.80	115	0.47, 0.63	2.89	0.43	115	0.742, 0.477	2.45	0.78	118	1.17, 0.31	2.39	0.80	116	0.79, 0.46
	5–10	3.09	0.73	64		2.83	0.42	63		2.62	0.82	65		2.31	0.72	68	
	10+	3.14	0.54	196		2.89	0.34	203		2.56	0.75	199		2.45	0.83	199	
Plan to move	Yes	2.90	0.62	21	2.13, 0.12	2.76	0.62	21	1.13, 0.32	2.71	0.72	21	2.09, 0.13	2.41	0.59	22	0.50, 0.61
	No	3.14	0.66	318		2.89	0.37	318		2.48	0.75	320		2.41	0.81	318	
	Unsure	3.25	0.78	59		2.89	0.32	62		2.67	0.95	63		2.30	0.81	64	

Items in **bold** denote statistically significant differences using a 95 % confidence interval, indicated by a unique superscripted letter.

or poorest groups. Significant variation also emerged for the variables of housing tenure and plan to move, but the disproportionate group sample sizes may be undermining the statistically significant differences seen in these variables.

In spite of factors with both negative and positive connotations about participants' streets and neighborhoods, several items did not load onto the factor structure and may be particularly noteworthy for this study. Of these items, there is low satisfaction with the amount of large trees ($m = 2.52$, $sd = 0.78$) and significantly less satisfaction with the amount of street trees ($m = 2.39$, $sd = 0.80$) on average across participants' residential streets ($p < 0.001$). Other nature-based amenities also did not load onto other factors and did not receive high ratings, including satisfaction with the amounts of shrubs and bushes ($m = 2.88$, $sd = 0.38$), lawns ($m = 3.14$, $sd = 0.68$) and local produce stands ($m = 3.60$, $sd = 1.21$) - all of which were considered more satisfactory than the amount of street trees on their home street ($p < 0.001$). Unlike the loaded factors, participants' income brackets did not show statistically significant differences across the unloaded factor items (Table 4). Some statistically significant variation consistently emerged based on participants' level of education but the small sample sizes from the group with less than a high school diploma is likely skewing the results. The only exception is for shrubs and bushes ($F = 2.48$, $p = 0.03$), where participants that have completed some college (m = 2.74, sd = 0.57) are significantly less satisfied with the amounts of shrubs and bushes than participants that earned a high school diploma (m = 3.03, sd = 0.19).

Overall, there were not statistically significant differences between residents of different gender, across all factors and the unloaded factor items; no differences were detected between race/ethnicity and language spoken at home, however, further inference cannot be made due to the highly disproportionate sample size across groups.

4.2. Associations between resident satisfaction and tree characteristics

Subjective attitudes and objective measures of street-facing trees were analyzed as explanatory variables for each factor and unloaded tree-related items using Pearson's correlation coefficient (Fig. 7).

Satisfaction with the unloaded factor items - including satisfaction with the amount of mature trees and satisfaction with the amount of street trees - were most strongly associated with the objective attributes of the trees and subjective attitudes. Overall, a greater amount of trees inside public right-of-way (on private property) is associated with significantly stronger negative attitudes toward mature street trees ($r = -0.15$, $p = 0.04$). Attitudes toward mature street trees did not significantly vary alongside objective attributes of the street trees such as tree health ($r = -0.11$, $p = 0.11$), tree size ($r = -0.05$, $p = 0.43$), tree height ($r = 0.00$, $p = 0.97$), or the average number of trees per street ($r = -0.01$, $p = 0.83$). Interestingly, satisfaction with the amount of large trees slightly decreased as street tree health decreased ($r = -0.14$, $p = 0.03$) but increased with taller average street tree height ($r = 0.13$, $p = 0.05$).

The loaded factors of resident satisfaction were influenced by subjective attitudes and objective measures of trees to a lesser degree. Higher '*satisfaction with amounts/qualities of social environment*' (Factor 1) and '*satisfaction with personal safety when outdoors*' (Factor 2) were significantly correlated to positive subjective attitudes toward both mature trees ($r = 0.22$, $p < 0.001$ and $r = 0.26$, $p < 0.001$, respectively) and to a lesser degree, young trees ($r = 0.15$, $p = 0.04$ and 0.14, $p = 0.06$, respectively). Overall, participants with more front yard trees on their street have more negative attitudes toward large street trees ($r = -0.15$, $p = 0.02$). However, objective measures of trees on participants' streets alone were not significantly associated with any factor of resident satisfaction.

4.3. Bivariate logistic regression relating resident satisfaction to interest in tree planting initiatives

Overall, the ratio of participants that either knew of or had interest in becoming more involved in the tree planting initiative was small, even though Factor 3 '*satisfaction with amounts/qualities of active outdoor places and civic amenities*' and satisfaction with both large trees and street trees was also comparatively low. Of those that did express interest in the city tree planting initiative, responses varied. For example, only 17 participants were interested in joining the Greenfield Tree Committee and only 12 participants indicated interest in donating money to the tree committee, while a greater number of participants had knowledge of the current tree planting initiative ($n = 93$), indicated interest in volunteering at a tree planting event ($n = 37$), or subscribing for occasional emails about tree news in town ($n = 105$). Of these, most participants that subscribed to the email list also expressed interest in volunteering ($n = 29$) and also knew of the current tree planting initiative ($n = 23$).

Although the relative sample sizes are small, several factors of resident satisfaction significantly contributed to participants' interest in the tree planting program (Table 5). On average, participants were less likely to subscribe to tree committee emails, express interest in volunteering, and have knowledge of the TPI when they had greater satisfaction with the amounts of street trees on their residential streets ($p < 0.04$). Also, participants were significantly less likely to volunteer at a tree planting event ($p = 0.01$) but more likely to know about the TPI ($p = 0.04$) when they had higher '*satisfaction with amounts/qualities of active outdoor places and civic amenities*' (Factor 3).

5. Discussion

Characteristics that influence residents' satisfaction with their neighborhoods have been commonly studied in previous research (Aragonés et al., 2017; Hur & Morrow-Jones, 2008). In this study, greater attention was paid to the role of street trees and large street-facing trees to resident satisfaction, and how satisfaction writ-large may contribute to participation in a local urban tree planting initiative (TPI).

5.1. The role of street-facing trees to resident satisfaction

In support of the first research objective, several measures from our results indicate that residents notice trees separately from other vegetation near their home. From the factor analysis, satisfaction with the amounts of street trees and large mature trees did not load onto the factor '*satisfaction with amounts/qualities of active outdoor places and civic amenities*' nor with other unloaded items like shrubs/bushes and lawns, and satisfaction with street trees and mature trees were rated significantly less than all other landscape features in the survey.

Related results showed that, in this sample, only the sociodemographic variable of income consistently contributed to statistically significant differences between all three factors (which, together, broadly relate to social settings and human-scale amenities), but income did not play a significant role in satisfaction with any landscape feature - including mature trees and street trees. Said another way, wealthier participants were, on average, more satisfied with their residential social settings and human-scale amenities than poorer participants, but participants from all social classes have similar levels of dissatisfaction with landscape features. This may be a worthwhile area of future research.

Another important finding was that satisfaction with street trees, overall, was significantly lower when participants held stronger negative attitudes toward mature street trees, and overall negative attitudes toward trees are significantly associated with greater tree canopy cover on residents' front yards. At the same time, satisfaction did not significantly vary alongside objective attributes of street trees such as tree health, tree size, tree height, or the average number of trees per street. This suggests that people's subjectively held attitudes toward trees are important considerations when developing and implementing TPIs, especially as it relates to tree stewardship and survival (Breger et al., 2019) or specific trees in specific situations (Roman et al., 2020). Additionally, past research shows that residents can exhibit close

Table 5
Model estimates and fit statistics relating resident satisfaction to interest in tree planting initiatives.

Parameter	Subscribe to tree committee emails						Interest to volunteer						Knowledge of TPI					
	OR	SE	*p*-Value	95 % CI	DF	Tjur's R^2	OR	SE	*p*-Value	95 % CI	DF	Tjur's R^2	OR	SE	*p*-Value	95 % CI	DF	Tjur's R^2
Intercept	0.26	0.13	0.01	0.09–0.68	405	6.13e−04	0.16	0.11	0.01	0.03–0.60	418	0.001	0.14	0.08	0.00	0.05–0.40	417	0.004
Factor1	1.08	0.15	0.61	0.82–1.43			0.87	0.18	0.51	0.58–1.33			1.22	0.19	0.20	0.90–1.66		
Intercept	0.13	0.08	0.00	0.04–0.42	400	0.01	0.11	0.10	0.01	0.02–0.54	401	5.99e−05	0.09	0.06	0.00	0.02–0.31	401	0.01
Factor2	1.27	0.18	0.10	0.96–1.70			0.97	0.20	0.88	0.66–1.47			1.32	0.20	0.07	0.98–1.81		
Intercept	0.81	0.44	0.69	0.27–2.35	420	0.01	0.62	0.48	0.54	0.13–2.75	420	0.01	0.08	0.05	0.00	0.02–0.27	420	0.01
Factor3	0.70	0.15	0.10	0.46–1.08			0.46	0.15	**0.02**[a]	0.25–0.88			1.63	0.39	**0.04**[a]	1.03–2.65		
Intercept	0.57	0.22	0.14	0.27–1.19	404	0.004	0.13	0.08	0.00	0.04–0.39	405	7.05e−04	0.23	0.09	0.00	0.10–0.51	405	6.37e−04
Satisfied_MatureTree	0.82	0.12	0.16	0.61–1.09			0.89	0.20	0.59	0.58–1.37			1.08	0.17	0.61	0.80–1.47		
Intercept	1.07	0.38	0.86	0.53–2.15	404	0.03	0.35	0.18	0.04	0.13–0.93	405	0.02	0.08	0.05	0.00	0.02–0.27	405	3.20e−04
Satisfied_Str_Tree	0.61	0.09	**0.00**[a]	0.45–0.82			0.57	0.13	**0.01**[a]	0.37–0.89			1.63	0.39	**0.04**[a]	1.03–2.65		

[a] Bold = statistically significant using the 95 % confidence interval.

connection to "their" trees and green spaces (Konijnendijk van den Bosch, 2016), which raises important questions about the role of place identity, place attachment, and resident satisfaction to specific landscape features and spillover effects on urban tree management and stewardship across public and private property. It would be interesting to continue this research by re-interviewing select residents with varying degrees of resident satisfaction and further question their feelings toward neighborhood trees beyond the composite rating used in this study that equalizes negative statements toward trees (sheds too many leaves and sticks, have too many overgrown limbs, takes up too much space) together as a single rating.

Residents that express indifference or distaste for city trees is another consideration. Responsibility for public tree management in the City of Greenfield has been shared by the Department of Public Works and the non-governmental Greenfield Tree Committee, who presently are working well together (Mary Chicoine, President of Greenfield Tree Committee, personal conversation July 2021). This does not trivialize the perspective of residents and businesses who want to remove trees in major public spaces, for example, in favor of commercial visibility on a downtown main street (Larabee, 2021). But findings reinforce the fact that urban tree planning and planting is a negotiation of priorities and visions between different stakeholder groups.

This study uncovered a similar, though not identical, factor structure to research that studied the role of nearby vegetation to resident satisfaction. For example, Hadavi and Kaplan (2016) surveyed a similar number of residents from a much larger U.S. city ($n = 434$ from Chicago, Illinois) and uncovered a factor (named "amount of green features") that included shrubs and bushes, lawns, large trees, and flower beds, while another factor ("amount of affordances") loaded public green spaces with specific places of social significance, like children's play areas or outdoor gathering/picnic areas. In the case of a mid-sized U.S. city, the present study also found the latter to be true (e.g. the item natural areas or parks loaded onto the factor "satisfaction with amounts/qualities of active outdoor places and civic amenities" along with places for outdoor parties or celebrations and children's playgrounds); however, unlike Hadavi and Kaplan (2016) the data from the present study did not load large trees and street trees, along with shrubs and bushes or lawns, onto any factor. From this research, it is not immediately clear why such nuances of resident satisfaction exist, but future research may benefit from comparing the ways that the spatial extent of a city or neighborhood (and its surrounding land covers) or densities of green features within the perceived neighborhood boundary affect resident satisfaction.

5.2. The role of resident satisfaction to tree stewardship and collective efficacy

Results from our study have important implications for research on collective efficacy and civic environmental stewardship. A sense of collective efficacy, defined as the social cohesion among neighbors combined with a willingness to intervene on behalf of a common good (Sampson, 1997) can motivate action in a place of residence through mutual trust and solidarity among neighbors, which ignites group membership, feelings of belonging, and shared connections between people (Aragonés et al., 2017). Understanding resident motivations to participate in urban forest management, specifically, is a longstanding topic of research (e.g. Burch & Grove, 1993), and contemporary urban forestry governance involves local residents in both the management and maintenance of new and existing urban trees (Konijnendijk van den Bosch, 2016). Strategically, this makes sense for urban tree managers: budgetary and staff constraints necessitate the engagement of external stakeholders to extend working capacity (Harper et al., 2017; Moskell & Allred, 2013); urban residential areas are existing locations of ecological services and biodiversity (Conway, 2016); and residential lands provide key spatial opportunities to expand urban tree cover, especially due to declining amounts of publicly owned planting space (Nguyen et al.,

2017). The dimensions of resident satisfaction are less commonly studied as a variable to predict behavioral intentions or actions (Amérigo and Aragonés, 1997, Aragonés et al., 2017), and this study begins to fill that research gap by assessing resident willingness to participate in environmental restoration programs based on the streets where they live.

In support of the second research objective of this study, in this sample, residents may be more likely to engage with an urban TPI when their satisfaction is both high and low, which supports previous theoretical work (Amérigo & Aragonés, 1997, Aragonés et al., 2017). If resident satisfaction is already high, residents are expected to sustain a degree of "fit" with their neighborhood and place of residence, and thus, take initiative to modify features of the environment and improve well-being and satisfaction. But if resident satisfaction is low residents are expected to improve the degree of "fit" and also initiate modification to improve well-being and satisfaction.

From our sample, residents were also more likely to subscribe to tree committee emails when they were less satisfied with street trees. While email subscription is a low-commitment form of participation, it may be a gateway to more engagement over time, depending on the content and delivery of the e-mails. Additionally, lower '*satisfaction with amounts/qualities of active outdoor places and civic amenities*' significantly influenced residents' desire to volunteer at a tree planting event. One's desire to volunteer is a higher form of commitment, and in the case of this research, may signal residents' concurrent desire for new community tree plantings and using trees as a design intervention to "activate" public space and build social infrastructure. This is also noteworthy in the face of urban forest governance and volunteer participation in TPIs, considering the limited staff capacity to plant and maintain new trees over time, especially in small, under-resourced post-industrial towns (Breger et al., 2019; Harper et al., 2017).

On the other hand, participants with higher '*satisfaction with amounts/qualities of active outdoor places and civic amenities*' were more likely to know about the current tree planting initiative. In this study, we assessed a self-reported measure of TPI knowledge, and not objective measures of TPI marketing or market research, but the apparent congruence between a resident's knowledge of the TPI and their satisfaction with outdoor places is shown in this study and, with further research, may be predictive of future urban TPI participation in Greenfield or elsewhere.

5.3. Limitations

This study is not without limitations. First, the purpose of this research was to assess the role of nearby vegetation to resident satisfaction and, while comprehensive, our survey inherently missed aspects of resident satisfaction. For example, the study area sits along a key illegal drug trafficking corridor from larger cities in the south (e.g. Philadelphia, New York City) into northern New England (Johnson, 2015), and the city government is actively part of a nationwide, $26 billion settlement with opioid manufacturers and distributors (City of Greenfield 2021; Levavi, 2022); yet the composition of lethal street drugs continues to evolve in this city and across the region (Bebinger, 2022). Specific instances of crime or fear of crime (and drug use) are critical contextual factors that affect perceptions of public space and resident satisfaction but were not overwhelmingly articulated in the design of this study.

Secondly, the characterization of residents was not intentionally designed to overlook other significant representations of social identity, group belonging, cultural orientations or lived experiences. We acknowledge that these factors inevitably influence the type of sample that was recruited for this survey, as well as overall resident satisfaction and other place-specific relationships different residents may have with different aspects of the outdoors and landscape features. More formal investigation is occurring relative to this major gap in the social sciences of urban forestry and urban greening (Ordóñez et al., 2022, Su et al., 2022), but the convenience sample approach undertaken as research for this study reflects the views of willing participants and probably not all of the residential communities of the study area as a whole. Several sociodemographic variables that were underrepresented in the sample of this study may begin to indicate interesting between-group differences of resident satisfaction, including those related age (between younger and older adults), education (between secondary and higher education), housing status (between owners and renters), and plans to move.

Lastly, it is important to note that because such a rich literature about resident satisfaction exists, our intention was to use a confirmatory factor analysis (CFA) and assess a known factor solution on the data; however after initial checks, the data could not reasonably support a CFA and an exploratory factor analysis (EFA) was used in its place. The inability to use a CFA may have been caused by the data, itself, and the extent of its variety within a confined factor solution, perhaps from the sample of recruited participants described above. It may have also been caused by the amount of data received in a smaller geographic area, whereby similar studies recruited similar participant sample sizes but those samples represented a broader geographic area across a larger city. Given the importance of understanding the dynamics of small and mid-sized cities, future research designs could consider recruiting a sample across several adjacent urban areas or explicitly recruit participants from a smaller pool of representative residents (for example, residents of similar age or racial and ethnic background).

6. Conclusions

This study assess the degree to which objective and subjective attributes of street trees influence resident satisfaction and explore the extent to which resident satisfaction can predict interest in a local urban tree planting initiative. Results show that urban trees play a significant role to resident satisfaction, explicitly from other landscape elements, and that subjectively held attitudes toward trees are important considerations when administering tree planting programs. This study also reinforces that urban tree planning and planting is a negotiation of priorities and visions between different stakeholder groups. In years to follow this TPI, it could be interesting to assess the ways in which social networks of residents and stakeholders evolve to negotiate priorities and visions of urban greening in their community.

CRediT authorship contribution statement

Alicia F. Coleman: Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization, Supervision, Project administration, Funding acquisition. **Theodore S. Eisenman:** Conceptualization, Methodology, Validation, Writing – review & editing, Supervision, Funding acquisition. **Dexter H. Locke:** Methodology, Validation, Writing – review & editing. **Richard W. Harper:** Writing – review & editing.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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