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Traits of a bloom: a nationwide survey of U.S. urban tree planting initiatives (TPIs)

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ABSTRACT

Municipal leaders worldwide are showing substantial interest in urban greening. This encompasses incentives, policies, and programs to vegetate urban landscapes, and it often includes urban tree planting initiatives (TPIs). Over the past decade there has been a seven-fold increase in scholarly use of terms denoting TPIs, and roughly two-thirds of associated studies address TPIs in the United States (U.S.). This reflects a bloom of scholarly interest in TPIs. Yet, there has been limited research on contemporary TPIs as historically situated cultural phenomena, and there has to the best of our knowledge been no nationwide survey of TPIs across municipal scales. Addressing these gaps, this article presents findings from a survey of 41 TPIs in the United States. We report on typical traits of U.S. TPIs across six themes: background, dates and goals, public awareness, funding and governance, planting, and stewardship. Respondents identified over 115 traits that distinguish TPIs from typical urban tree planting activity, suggesting that TPIs are a discrete form of urban forestry. Over two-thirds of TPIs are funded separate from traditional urban forestry, and lack of institutionalization raises questions about long-term viability. TPIs mobilize political and financial resources for program launch, tree purchasing, and planting, but there may be a need for greater investment in stewardship activities and the social infrastructure that undergirds green infrastructure. Large shade trees for ecosystem services and native trees are the principal factors informing TPI species lists. Beautification and regulating ecosystem functions are, in turn, the principal potential benefits animating tree planting goals, yet few TPIs have conducted research to assess the fulfillment of associated outcomes. This study provides a foundation for future interdisciplinary scholarship on TPIs across the humanities, natural sciences, and social sciences.

1. Introduction

Municipal leaders around the world are showing substantial interest in urban greening, defined as a social practice of organized or semi-organized efforts to introduce, conserve, or maintain outdoor vegetation in urban areas (Kuchelmeister, 1998; Eisenman, 2016; Feng and Puay Yok, 2017). Urban greening encompasses a range of incentives, policies, and initiatives to vegetate urban landscapes (Beatley, 2016; Tan and Jim, 2017; Boverket, 2019), and it often includes urban tree planting programs, also known as "large scale tree-planting initiatives" (Young, 2011, 365), "tree planting campaigns" (Pincetl et al., 2013, 475), "tree distribution programs" (Nguyen et al., 2017, 24), and "tree giveaway programs" (Turner and Mitchell, 2013, 1). For purposes of this paper, we use the term tree planting initiatives (TPIs) or the singular tree planting initiative (TPI) to describe this type of urban greening.

In the United States (U.S.), there is a strong historical tradition undergirding contemporary TPIs, including major urban street tree planting in the second half of the nineteenth century (Campanella, 2003; Lawrence, 2006). Following widespread loss of American elms *(Ulmus americana)* to Dutch elm disease (*Ophiostoma* spp.) starting in the early to mid-twentieth century, the nonprofit Arbor Day Foundation in 1976 launched Tree City USA, a network that now includes over 3,400

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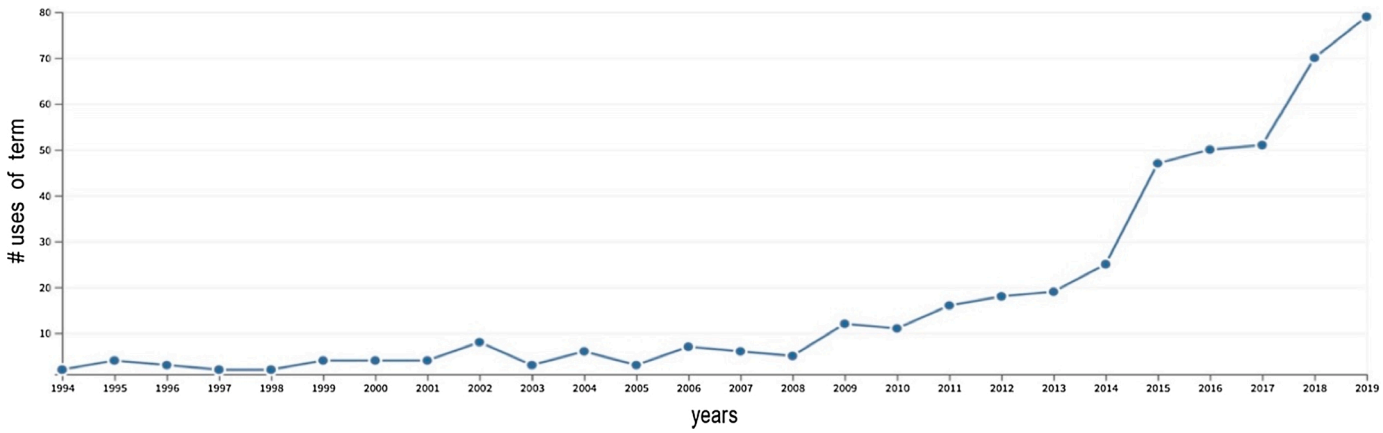

Fig. 1. Seven-fold increase in TPI scholarship over past decade. Results from December 27, 2019 Web of Science search for the term "urban tree planting initiative" OR "urban tree planting initiatives" OR "urban tree-planting initiative" OR "urban tree-planting initiatives" OR "urban tree planting program" OR "urban tree planting programs" OR "urban tree-planting program" OR "urban tree-planting programs" OR urban tree planting campaign" OR "urban tree planting campaigns" OR "urban tree-planting campaign" OR "urban tree-planting campaigns" in all fields 1900–2019.

communities which have made a formal commitment to increase and manage trees in public landscapes (Arbor Day Foundation, 2019). Expanding beyond the public realm, this group recently distributed over 135,000 free yard trees to over 76,000 homeowners in five years (Nguyen et al., 2017). In 1990, Texaco oil announced plans to provide $1 million in the first year of a Global Releaf campaign, organized by the American Forestry Association (now American Forests), to support tree planting programs in Denver, Houston, and New Orleans (PR Newswire, 1990). In 1991, President George H.W. Bush proposed a billion trees per year planting program as part of the America the Beautiful campaign, including a goal of 30 million trees per year for urban areas (Davis, 1991). And most recently, President Donald Trump announced plans to plant 1 trillion trees to combat climate change (Byrnes, 2020). A legislative bill was subsequently introduced in Congress that would commit the United States to planting some 3.3 billion trees annually over the next 30 years in rural and urban areas (H.R., 5859, 2020), and a coalition of public, corporate, nonprofit, and civil society actors has formed to advance the trillion tree goal in the United States with a strong focus on cities (Sisson, 2020; World Economic Forum, 2020).

Burgeoning interest in TPIs is also reflected in scholarship. A search on the Web of Science© database for terms that denote TPIs shows a seven-fold increase in usage over the past decade (see Fig. 1). It is noteworthy that roughly two-thirds (17 of 25) of the studies that emerged in this search focus on TPIs based in the United States.

Indeed, a growing body of scholarship is studying various aspects of U.S. TPIs. Young (2011) examined the planning strategies, setbacks, and successes of TPIs in eight major cities and one metropolitan county across different regions. More recently, scholars surveyed leaders in 52 Northeast cities to ascertain the number and species composition of trees planted on public land in their municipalities from 2012 to 2017 (Doroski et al., 2020). Scholars have assessed the politics and governance—efforts to coordinate human actions toward goals (Kjaer, 2004)—of large-scale TPIs in Los Angeles, California (Pincetl, 2010; Pincetl et al., 2013), and New York City (Campbell, 2014, 2017). These campaigns reflect at least half a dozen U.S. cities that have established goals to plant a million trees (Young and McPherson, 2013); New York City met this target in merely eight years (Turner, 2015). Some have assessed the missions, strategies, and challenges of five residential tree giveaway programs in the Northeast (Nguyen et al., 2017). Related studies have addressed factors that influence residents' participation in TPIs (Locke et al., 2015; Hand et al., 2019), and how such participation influences urban tree canopy patterns (Locke and Morgan Grove, 2014). Others have assessed links between TPIs, canopy cover, income, race, and ethnicity (Watkins et al., 2017), as well as links to residential energy use (Nelson et al., 2012; Ko et al., 2015b; Erker and Townsend, 2019), carbon sequestration and hydrology (Pincetl et al., 2013), carbon life cycle (McPherson and Kendall, 2014), and emission of biogenic volatile organic compounds (Curtis et al., 2014). Of note, numerous studies have assessed the tree survival rates of TPIs and associated links to biophysical and sociopolitical factors (Oldfield et al., 2013; Koeser et al., 2014; Mincey and Vogt, 2014; Roman et al., 2014; Ko et al., 2015a; Roman et al., 2015; Vogt et al., 2015a,b; Widney et al., 2016; Blair et al., 2019; Breger et al., 2019).

This literature also points to some noteworthy characteristics of TPIs in the United States. In large cities, TPIs are often promoted by mayors and support can change with shifting political leadership (Young, 2011; Pincetl et al., 2013; Campbell, 2017). Large cities also accounted for substantially more tree planting in the Northeast region even though smaller municipalities collectively comprise the larger population (Doroski et al., 2020). Survival of trees planted during TPIs may depend on engagement and coordination amongst a range of public, private, and nonprofit actors (Roman et al., 2015; Vogt et al., 2015a; Breger et al., 2019). A TPI can trigger reorganization of urban forestry governance (Campbell, 2014), and TPIs often include local nonprofit groups and volunteers for implementation and management (Summit and Sommer, 1998; Hauer et al., 2018), as well as scientists, municipal managers, and residents (Locke et al., 2015; Hand et al., 2019). This hybrid network of stakeholders co-produces knowledge, values, and beliefs through close collaboration between researchers and local community members (Pincetl, 2010; Campbell et al., 2016). Co-production may be especially true of residential tree giveaway programs, where laypeople are pivotal actors in efforts to increase trees on private lands that are outside the purview of traditional urban forestry, which generally focuses on public lands such as parks and streetscapes (Hauer and Petersen, 2016; Nguyen et al., 2017). Many TPIs are also characterized by ambitious canopy cover and planting goals (Young, 2011; Young and McPherson, 2013; Locke et al., 2017), and these quantitative metrics are often rooted in objectives to increase benefits characterized as ecosystem functions or services (e.g., Ko et al., 2015a; Nyelele et al., 2019). Some describe TPIs as a contemporary trend (Pincetl et al., 2013), or an urban forestry movement (Campbell, 2017), while others have documented local resistance to a TPI (Battaglia et al., 2014). This was recently exemplified in Detroit, Michigan, where many residents resisted tree planting due to a lack of engagement in the development and implementation of the program (i.e., procedural justice), and divergent experiences of their community's history and character, also known as heritage narratives (Carmichael and McDonough, 2018, 2019).

Combined with observations of practice, emerging scholarship also suggests that TPIs may reflect a discrete form of urban greening and urban forestry practice. Yet, there has been little research on

contemporary TPIs as an historically situated phenomenon (Pincetl et al., 2013), and this reflects a broader gap in historical scholarship in urban forestry (Dean, 2005; Roman et al., 2018). Likewise, the scholarly canon would benefit from a systematic survey of TPIs across municipal scales. This is important because many TPI studies focus on programs in large cities with populations of several hundred thousand (Young, 2011; Pincetl et al., 2013; Campbell, 2017). Yet, research shows that population size correlates with a range of variables associated with management of urban trees (Conway and Urbani, 2007; Ries et al., 2007; Rines et al., 2011; Koeser et al., 2016a,b; Harper et al., 2017; Hauer et al., 2018; Östberg et al., 2018; Ma et al., 2021). A systematic study of TPIs across municipal scales will help to assess the planting and management of urban trees and the landscapes in which they are located.

Additionally, as described above, TPI scholarship has gained significant traction in the United States; this is noteworthy because national context informs urban tree planting discourse and practice (Campanella, 2003; Konijnendijk et al., 2006; Lawrence, 2006; Rutkow, 2012), as well as urban environmental management writ large (Ernstson and Sörlin, 2019). A survey of U.S. TPIs will facilitate international comparative analysis (e.g., Keller and Konjijnnedijk, 2012), a mode of research that is increasingly important in a globalizing world that is characterized–among other things–by rapid and widespread diffusion of information, values, and norms (Castells, 1996; Ernstson and Sörlin, 2013).

With the aforementioned scholarship in mind, this study addresses the following overarching question: What are typical traits of urban TPIs in the United States? For purposes of this study, we define an urban TPI as a focused tree planting campaign that is distinct from a municipality's typical tree planting activity such as operational (e.g., park planting; replacement of dead trees or those removed during construction) or ceremonial (e.g., tree planting conducted in honor or in memory of people or events) planting. The study is also guided by the premise that contemporary TPIs and other forms of urban greening must be understood as historically situated phenomena that are developed and implemented by people. This derives its conceptual underpinning from the humanities, the branch of learning concerned with human culture (OED, 2020). Importantly, humanities scholarship is lacking in urban forestry and urban greening research (Bentsen et al., 2010), and calls have been issued for greater self-reflective inquiry and attention to the humanities in environmental discourse (e.g., Sörlin, 2012; Palsson et al., 2013; Heise et al., 2017). This is especially relevant in cities, which are most fundamentally built by and for people (Groffman et al., 2014). A descriptive survey of contemporary TPI traits is an important step in understanding TPIs as a cultural phenomenon. Findings of this study will, in turn, inform future research on TPIs across a range of environmental, historical, and sociopolitical points of inquiry.

2. Methods

We developed and distributed a survey to 1,132 U.S. urban forest managers, but we received no responses from Alaska or Hawaii, thus our survey sample is limited to the coterminous United States (see Fig. 3). This survey population was derived from a database of contact persons generated for the 2014 census of Municipal Tree Care and Management in the United States by Hauer and Petersen (2016). The survey instrument included the following instructions: "This survey is intended for the person (s) who can best respond to questions relating to the goals, public awareness, financing, planting, and stewardship activity of a TPI undertaken in your municipality." The survey population included urban forest managers in all U.S. cities over 50,000 people and a random selection of 51% of cities with a population 25,000–49,999, according to the U.S. 2010 decennial census. The survey was open from July 11, 2019 through October 13, 2019.

Survey recruitment followed several modes described by Dillman et al. (2014), including repeat mailings, cover letters, and reminder notifications. A first wave of survey recruitment was sent via email and produced a 34% email bounce rate (385 out of 1,132 cities). Roughly half of bounced email addresses (and mailing addresses) were then updated via internet search for an alternative municipal contact. In total, we distributed two emails to recruit participation in a digital Qualtrics® version of the survey, one hard copy version of the survey to all 1,132 cities via U.S. postal service that included a link to the digital Qualtrics® survey, and one postcard reminder to all 1,132 cities. Urban forest managers in 23 cities participated in the first round of electronic invitation, 48 to the second round of electronic invitation, and 27 cities responded to the mailed survey and postcard reminder. This yielded 98 survey participants, a 9% response rate that is slightly below the 10–15% average response rate for external surveys (SurveyGizmo, 2015). As noted by Dillman et al. (2014), low response rate is not an indicator of nonresponse error. We tested our survey sample of 98 respondents against variables in the 1,697 communities with 25,000 or more people in the USDA Forest Service Community Accomplishment Reporting System (CARS) Staff, Ordinance, Advisory, and Management Plan (NIC, 2019), and found no indication of nonresponse bias.

Survey design followed recommendations by Dillman et al. (2014) for phrasing of stem questions, unipolar ordinal close-ended questions, answer formatting, and use of open-ended questions. Prior to distributing the survey, we pre-tested it with six municipal arborists and urban forestry researchers and modified the survey based on feedback. The final survey instrument branched into short- and long-form after the opening question: "Since the year 1990, has a focused tree planting campaign/program/initiative (TPI) that was/is distinct from the municipality's typical tree planting activity been conducted in your community?" This was accompanied by an introductory statement describing urban tree planting initiatives as focused tree planting campaigns that are distinct from a municipality's typical tree planting activity such as operational or ceremonial planting.

Respondents who identified as having a TPI in their municipality since 1990 then answered questions that were structured under the following six themes: background, dates and goals, public awareness, funding and governance, planting, and stewardship. This structure and several questions were informed by related surveys (Young, 2011; Young and McPherson, 2013; Hauer and Petersen, 2016). For example, the existing literature notes that TPIs are often accompanied by ambitious canopy cover and planting goals; therefore, we asked survey respondents about the dates and goals of their TPIs to assess this trait across the municipalities included in the study. The Results section of this paper is, in turn, structured around the aforementioned six themes. The survey contained up to four close-ended questions for respondents who answered No or Do Not Know to the initial question. Of the 98 survey participants, 41 responded affirmatively to this opening question and completed the survey in approximately 30 min.

To present large amounts of data in a discernible way, we use descriptive statistics to report findings (Trochim, 2020). Due to limited space, we report on questions with at least a 70% response rate (n = 29). Questions that unintentionally overlapped with each other, and those where participants evidently did not understand the intent, were also removed. Please see Appendix 1 for reported survey questions, responses, and response rates. Percentages are rounded to the nearest whole number. In the survey, response options to unipolar, ordinal scale questions included the following stems: "Very _____," "Moderately _____," "Slightly _____," "Not _____." But due to space constraints in this manuscript, we report only consolidated "Very" and "Moderately" responses.

One open-ended question required a two-stage coding process (see Table 1). Drawing upon Meerow and Newell (2019), responses were first coded into five *a priori* deductive categories (who, what, where, why, how); the content of these categories was subsequently coded into inductively generated *a posteriori* themes. This combination of *a priori* and *a posteriori* methods increases coding reliability (Montgomery and Crittenden, 1977). To further strengthen reliability, three co-authors independently coded participant responses then met twice to generate a mutually agreed upon classification and set of terms for inductive themes (MacQueen et al., 2016; Church and Dunn, 2019).

Table 1
Characteristics that distinguish TPIs from a municipality's typical tree planting activity.

DEDUCTIVE CATEGORIES	WHO (28)	WHAT (19)	WHERE (25)	WHY (18)	HOW (27)
Inductive Themes *Topics*	**Private Sector (18)** *residents (9)* *volunteers (4)* *businesses (2)* *contractors (1)* *community (1)* *youth (1)*	**Quantity (11)** *additional trees (10)* *tree replacement (1)*	**Public Realm (11)** *right-of-way (5)* *public (2)* *schools (1)* *highway (1)* *greenway (1)* *park (1*	**Canopy Cover (7)** *increase tree canopy (4)* *mitigate canopy loss (3)*	**Funding (14)** *giveaway (4)* *grant (3)* *development mitigation funds (2)* *donation (2)* *individual purchase (1)* *trust (1)* *local match (1)*
	Public Sector (10) *municipality (4)* *mayor (2)* *conservation district (1)* *county (1)* *conservation corps (1)* *US Forest Service (1)*	**Species (8)** *species type (3)* *species diversity (1)* *drought tolerant (1)* *fruit (1)* *ash (1)* *shade trees (1)*	**Private Realm (8)** *private (2)* *private homes [incl. "yard" "residents" "homeowners" "college rental"] (5)* *commercial property (1)*	**Ecosystem Services (5)** *stormwater (3)* *shade (1)* *climate change mitigation/adaptation (1)*	**Governance (5)** *pub./priv. partnership (4)* *public partnership (1)*
			Distribution (6) *entire city (2)* *compact spaces (1)* *areas of need (1)* *select neighborhoods (1)* *high impervious cover (1)*	**Social (5)** *memorialization (2)* *socioeconomic status (2)* *beautification (1)*	**Public awareness (5)** *public awareness campaign (1)* *annual event (1)* *educational training (2)* *outreach to individuals (1)*
				Regulatory (1) *public mandate (1)*	**Duration (2)** *limited period of time (1)* *sustained (1)*
					Planting method (1) *bare root (1)*

3. Results

The distribution of municipalities by population size across the United States is largely reflected in the distribution of our participant sample consisting of 31% of municipalities with a population 25,000–49,999; 40% with a population 50,000–99,999; 12% with a population 100,000–149,999; 6% with a population 150,000–199,999; 9% with a population 200,000–999,999; and 2% with a population >1 million (see Fig. 2). Regional distribution of participants is illustrated in Fig. 3: 22% in the West, 29% in the Midwest, 33% in the South, and 16% in the Northeast.

3.1. Background

When asked if a TPI was/is distinct from the municipality's typical tree planting activity that has been conducted in the community since 1990, 42% of 98 respondents said yes, nearly half (46%) said no, and 12% responded that they do not know. Of those who responded yes (n = 41), two-thirds (68%) said that the TPI has a unique name, 37% said that the TPI has a website dedicated to the TPI, and 85% perceive TPIs as enhancing typical tree planting activity. Forty-four percent of respondents said that since 1990 their community has undertaken another TPI in addition to the one they are addressing in this survey.

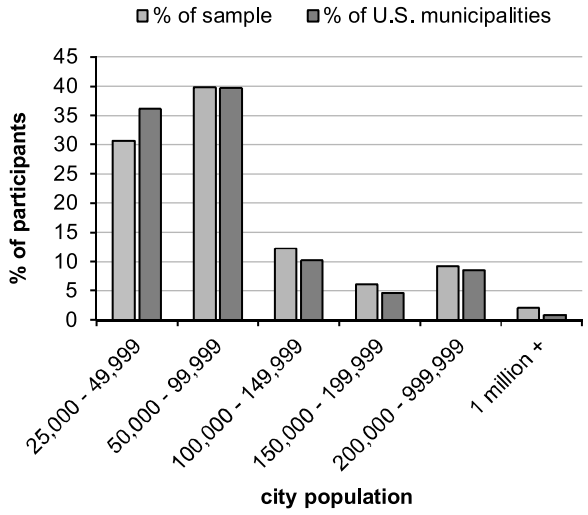

Fig. 2. Distribution of study participants and U.S. municipalities by population (2010 U.S. Census).

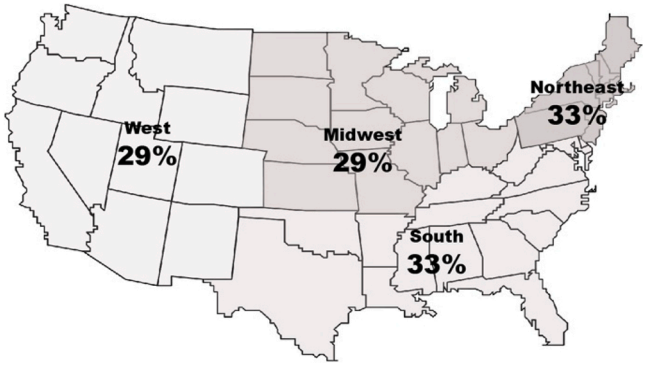

Fig. 3. Distribution of study participants by region. Regional classification scheme is based upon the U.S. Energy Information Administration: https://www.eia.gov/analysis/requests/powerplants/cleanplan/?src=home-b1.

When asked "What characteristics distinguish the TPI from the municipality's typical tree planting activity?", respondents identified 117 discrete topics (or traits). Participants identified the private sector, and residents in particular (n = 9), as actors that distinguish a TPI from typical tree planting activity. Respondents also identified the quantity and type of trees, and the location of planting sites, as distinguishing traits of TPIs: public realm locations seem to predominate in TPIs (n = 11), but respondents also identified eight types of private realm sites as well as targeted distribution goals (e.g., compact spaces, select neighborhoods and areas of need, and high imperviousness) as location-based traits that distinguish TPIs. Respondents identified four kinds of rationales–canopy cover increase/loss, ecosystem functions, social goals, and regulatory measures–as characteristics that distinguish TPIs from typical tree planting activity. Additionally, participants cited five management related traits that distinguish TPIs from typical tree planting. Of these, funding sources (n = 14) were the most common characteristics; public-private partnerships were cited four times; and public awareness efforts were cited five times as traits that distinguish TPIs from typical tree planting.

3.2. Dates & goals

Of the 41 municipalities with TPIs, the first TPI was planned and launched in 1980 and the average TPI launch date was 2008. Three quarters (73%) of these TPIs have not been completed. When asked about the percent canopy cover at the time of the TPI's launch, 58% of respondents did not know; of those who did know (43%), canopy cover averaged 23%. Participants were also asked to provide their target planting goal at the time of the TPI launch, either as canopy cover percentage or by number of trees. Responses provided as a percentage ranged from 20% to 55% canopy cover, with mean and median values of 33% and 31%, respectively. Responses providing number of new trees ranged from 52 to 30,000. Ten percent of respondents did not establish or did not know their TPI's canopy goal. Of the 11 TPIs that have been completed, nine (82%) report having met their tree planting goal.

When identifying important factors or sources for developing their TPI's canopy goal, 85% of respondents identified available budget as very or moderately important. State forestry guidance and process led by a mayor also factored highly (59% and 58% respectively), as did the potential maximum canopy cover in the community (50%). City council, tree commissions, public process, U.S. Forest Service, and American Forests guidance reportedly had less influence. Respondents identified beautification, improving air quality, reducing urban heat, shading microclimates, and enhancing stormwater management as the five most important potential benefits (in descending order) underlying the development of TPI goals (see Fig. 4).

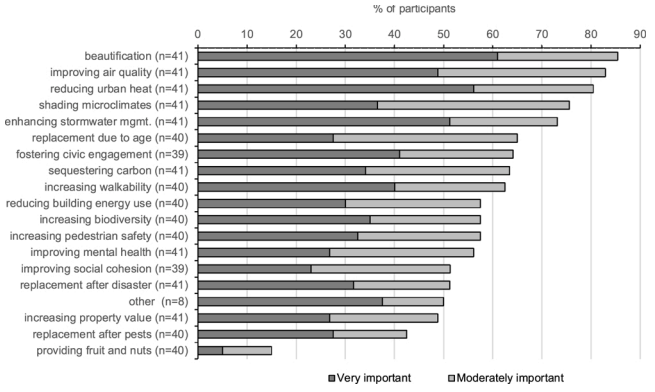

Fig. 4. Potential benefits informing the development of TPI's tree planting goal.

Table 2
Stakeholder engagement across types of TPI activity. Table includes actors identified as "very engaged" or "moderately engaged" by over 30% of respondents.

Public Awareness	Launch	Administration	Planting	Watering	Technical Tree Maintenance
forestry department [75%]	forestry department [75%]	forestry department [75%]	forestry department [67%]	forestry department [55%]	forestry department [66%]
private citizens [63%]	parks department [59%]	parks department [49%]	parks department [59%]	parks department [50%]	parks department [46%]
mayor/city manager [63%]	mayor/city manager [54%]	public works department [31%]	private citizen(s) [40%]	private citizen(s) [49%]	
local nonprofit(s) [53%]	local nonprofit(s) [36%]	local nonprofit(s) [31%]	local nonprofit(s) [33%]		
parks department [51%]	civic group(s) [36%]		neighborhood group(s) [33%]		
civic group(s) [42%]	local tree committee [35%]				
planning department [40%]	private citizen(s) [32%]				
state agency [38%]					
local tree committee [34%]					
corporations [34%]					
public works/transportation department [33%]					
neighborhood group(s) [32%]					

3.3. Public awareness

One third (34%) of respondents said that the TPI had a documented public awareness/outreach plan, but over half (51%) said there was no such plan. Social media and planting days or tree-related events (e.g., nationwide Arbor Day) tended to be the most common means for generating public awareness over an average eight years of sustained publicity. Over 30% of respondents identified 11 stakeholders as very/moderately engaged in public awareness, with the local forestry department (75%), local parks department (63%), local mayor/municipal manager's office (63%), and local nonprofits (53%) identified by a majority (see Table 2).

3.4. Funding & governance

When asked if the TPI had a funding and administration plan, one third (34%) did and over half (61%) did not. Over 30% of respondents identified seven stakeholders as very/moderately engaged in project launch, with the local forestry department (75%), local parks department (59%), and mayor/municipal manager's office (54%) identified by a majority (see Table 2). Also noted in Table 2, over 30% of respondents identified the local forestry department (75%), local parks department (49%), local public works department (31%), and local nonprofits (31%) as very/moderately engaged in TPI administration. Eighty percent of respondents reported that administration and implementation responsibility did not change after the launch of the TPI, but occasionally it did (12%), permanently shifting to the municipal forestry or parks department, or to a nonprofit. A small percentage of respondents (12%) also noted that a new organization was launched in conjunction with the TPI, including a local tree board, citizen groups, and nonprofits.

Nearly three-quarters (71%) of TPIs received funding that was separate from the municipality's typical urban forestry budget. As noted in Fig. 5, across the 29 municipalities who reported separate funding, 52% of TPI funds came from the municipal budget (of which 21% is

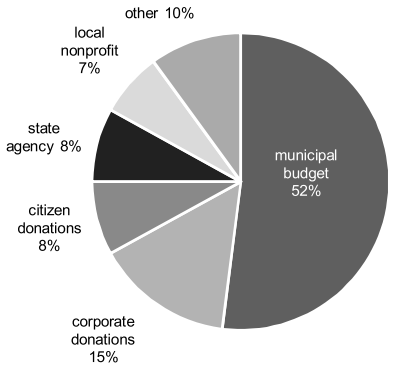

Fig. 5. Distribution of TPI funding sources.

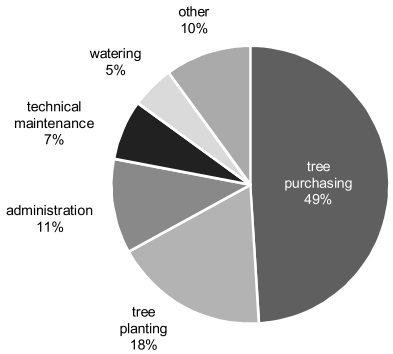

Fig. 6. Allocation of TPI funds.

from a dedicated tree fund), with smaller percentages from corporate donations (15%), private citizens (8%), a state agency (8%), local nonprofit organizations (7%), and others such as federal, county, and unspecified sources (10%). Nearly half (49%) of TPI funds were used for tree purchasing and 18% for planting. Administration accounted for 11% of TPI costs, leaving 12% of funding for long-term technical maintenance (7%) and watering (5%). The remaining 10% of funds went to "other" uses (see Fig. 6).

3.5. Planting

When asked if there was a documented planting plan for the TPI, one third (33%) responded yes but over half (57%) responded no. Half (50%) of the TPIs used a tree species list created expressly for the TPI, and approximately half (51%) also coordinated with a tree nursery to plan and provide for trees. When asked why it is necessary to coordinate with a tree nursery to meet planting goals, all respondents (n = 19) cited tree availability to meet the needs of the TPI; additional reasons included increased publicity, expertise, and quality control. In formulating tree species lists, 85% of respondents identified large trees for ecosystems services and native species, 75% identified nursery availability, and 55% identified flowering species as very/moderately important (see Fig. 7).

Almost all (93%) TPIs are limited to operations within their municipal boundary. Some 56% of participants said that particular neighborhoods were selected for planting; of these, areas with low canopy cover and low household income were respectively cited by 87% and 52% of respondents as very/moderately important criteria for planting location. Nearly three-quarters of TPI trees are planted along public streets (52%) and in parks (21%); private residences constitute 15% of TPI planting sites. When trees are distributed to residents and businesses, 52% of participants stated that trees are offered at no cost, and 12% responded that trees were available at a reduced cost. Over 30% of respondents identified the following as stakeholders who were very/moderately engaged in planting: 67% local forestry department, 59% local parks department, 40% private citizens, 33% local nonprofit(s), and 33% neighborhood groups (Table 2).

3.6. Stewardship

When asked if there was a documented planting plan for the TPI, 29% responded yes and over half (56%) responded no. Forty percent of participants reported having conducted an inventory of tree vigor and survival; on average, these inventories addressed virtually all trees planted as part of a TPI, and they showed a survival rate of 82% four years after planting. As noted in Table 2, over 30% of respondents identified the following stakeholders as very/moderately engaged in watering: the local forestry department (55%), local parks department (50%), and private citizens (49%). The same ratio of respondents identified the local forestry department (66%) and local parks department (46%) as very/moderately engaged in technical tree maintenance activities such as pruning, inspection, pest/disease control, and removal.

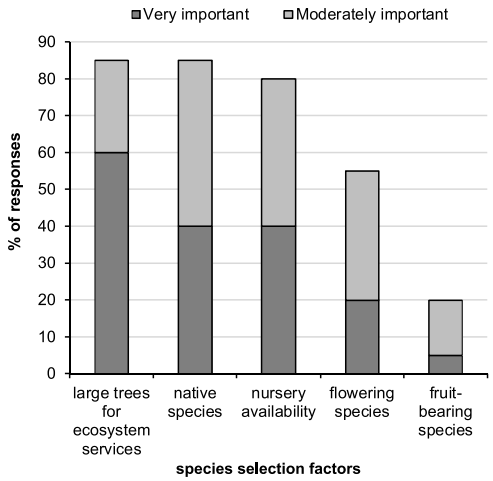

Fig. 7. Factors informing TPI species lists.

4. Discussion

Participants in this nationwide U.S. survey identified over 115 traits that distinguish their municipality's TPI from typical tree planting activity. TPIs rely upon a combination of private and public actors, with strong engagement of residents/volunteers; TPIs feature unique funding mechanisms, governance structures, and public awareness strategies; tree planting occurs on both public and private land, and in targeted areas; and TPIs seek to increase the quantity/canopy cover of urban trees to primarily beautify urban landscapes and increase ecosystem functions/services such as air quality improvement, urban and microclimate cooling, and enhanced stormwater management, all of which provide an opportunity to promote particular tree species (see Table 1 and Fig. 4). Moreover, 71% of TPIs have funding separate from the municipality's typical urban forestry activity, 68% have a unique name, and 70% of TPIs have an explicit planting goal. These findings illustrate that U.S. TPIs are distinct from typical urban tree planting and reflect a unique form of socioecological practice.

By contrast, tree planting only constitutes 14% of typical urban forestry budgets in the United States (Hauer and Petersen, 2016), so it is not surprising that 85% of respondents said that a local TPI enhances tree planting activity. But while TPIs are successful at mobilizing political and financial resources, nearly half (48%) of TPI funds are sourced outside of the municipal budget (see Fig. 5), and 61% of participants said that there was no documented funding and administration plan. Nearly three-quarters of traditional urban forestry funding, on the other hand, comes from the municipality's general fund (Hauer and Petersen, 2016). Combined with findings that TPIs having a unique brand, distinct funding, and strong ties to executive municipal leadership, survey results suggest that many TPIs are functioning as ad hoc initiatives. As noted by Young (2011), lack of institutionalization and traditional infrastructure funding raises concerns about the long-term viability of TPIs as green/living infrastructure. Additionally, our survey found that local mayors/municipal managers are very or moderately engaged in public awareness, launch, and administration of TPIs, but this is generally not the case in typical urban forestry (Hauer and Petersen, 2016). TPI support can, in turn, shift as political leadership changes (Young, 2011). So, while TPIs may in many regards support typical urban forestry practice, the long-term survival of the former may require greater integration with the latter. This can be advanced through formal policies, plans, and ordinances (Konijnendijk van den Bosch, 2014; Harper et al., 2018).

Local forestry and parks departments are the principal actors across all aspects of TPI governance. Local mayors/city managers are also important actors in public awareness, launch, and administration of TPIs, and over 30% of respondents identified 12 different stakeholders as very or moderately engaged in public awareness. These findings reinforce the high-profile nature of TPIs, as well as the diverse governance network of TPIs (see Table 2), which reflects a broader movement in urban forestry from "governance by government to governance with government" (Konijnendijk van den Bosch, 2014, 35). Table 2 also illustrates a noteworthy trajectory of stakeholder engagement across the life-cycle of TPIs. A range of civil society actors are engaged in public awareness and project launch, but only three stakeholder groups (forestry/parks departments and private citizens) and two stakeholders (forestry and parks departments) are very or moderately engaged in stewardship activities such as watering and technical tree maintenance, respectively. These distinctions are also reflected in the allocation of funds: some two-thirds of TPI financing is dedicated to upfront activities such tree purchasing (49%) and planting (18%), while stewardship activities such as watering and maintenance only account for 5% and 7%, respectively (see Fig. 6).

In traditional urban forestry, on the other hand, roughly half of budgets are dedicated to management activities such as tree pruning (24%), tree removal (23%), or stump removal (4%) (Hauer and Petersen, 2016). This type of work requires technical expertise and heavy equipment and is usually conducted by professional arborists (Rines et al., 2010; Koeser et al., 2016a,b). By contrast, engagement of non-technical actors and uncompensated residents/volunteers is a distinguishing trait of TPIs (see Table 1), and these stakeholders can be critical to the establishment and survival of recently planted trees (Roman et al., 2015; Vogt et al., 2015a; Hauer et al., 2018; Breger et al., 2019). Yet, our findings show that 5% of TPI funds are dedicated to watering newly planted trees. This is only slightly more than the 3.4% of typical urban forestry budgets allocated to watering (Hauer and Petersen, 2016), which is surprising, as TPIs are dedicated exclusively to planting and increasing the number/canopy cover of urban trees. Moreover, respondents in our survey reported a tree survival rate of 82% four years after planting, which is lower than the ~93% survival rate of tree cohorts within five years of planting identified in a review of literature on urban tree mortality (Hilbert et al., 2019).

This suggests that U.S. TPIs might direct more resources to stewardship and the social infrastructure that supports green infrastructure; related observations have been made elsewhere (Kronenberg, 2015). This is especially important as many urban greening programs and TPIs target post-industrial cities and underserved communities, and profess a commitment to social equity (e.g., McKendry, 2018; Sisson, 2020). Yet, lack of engagement with residents can engender resistance to TPIs (Battaglia et al., 2014; Carmichael and McDonough, 2018, 2019). Likewise, poor engagement with and investment in stakeholders such as departments of public works, who may inherit the long-term management responsibility of large-scale tree plantings, can lead to poor stewardship and survival of tree plantings (Breger et al., 2019). By contrast, a tree planting program with paid youth staff who conduct watering and maintenance can boost tree survival and growth while also providing job training (Roman et al., 2015).

It is also worth noting that municipal arborists may be so preoccupied dealing with the disservices (e.g., falling limbs, fruit, and leaves; buckling sidewalks) and management costs (e.g., pruning and removal of dead trees) of an aging tree population that there is insufficient labor to support the next generation of trees (Roman et al., 2020). This relates to the types of trees being promoted by TPIs: large trees for ecosystems services and native species were respectively identified by 85% of respondents as very/moderately important for determining planting lists, while 55% identified flowering species as very/moderately important. By contrast, studies show that many residents prefer flowering or fruiting trees (Kirkpatrick et al., 2014; Nguyen et al., 2017; Carmichael and McDonough, 2018) and that aesthetic factors are a priority for residents regarding tree species selection (Summit and Sommer, 1998; Locke et al., 2015; Conway, 2016; Gwedla and Shackleton, 2019). These trees tend to be smaller and present less risk from falling limbs than large shade trees, a concern expressed by residents from different socioeconomic and residential settings (Conway, 2016; Carmichael and McDonough, 2018). This suggests that TPIs may benefit from prioritizing ornamental plantings in addition to, or instead of, large shade trees: not only may this improve residents' participation in TPIs and their stewardship of newly planted trees, it may also reduce the long-term management burden on professional arborists and understaffed municipal departments while reducing risks associated with large trees in close proximity to property and utilities. These decisions will be abetted by greater consideration of tradeoffs associated with tree selection and siting (Roman et al., 2020).

4.1. Future research

An underlying goal of this study is to lay a foundation for future scholarship on TPIs across various points of inquiry. On that note, we propose a few research domains that may be of interest going forward, understanding that there are likely many more.

- *Population Size:* Various studies have identified and discussed the relationship between greater municipal population size and availability of funds for urban forest management (Harper et al., 2017; Rines et al., 2011), including an increased tax base (Miller and Bates, 1978), increased awareness by residents of the practice of urban forestry and affiliated benefits of urban trees (Grado et al., 2013), and greater demand of services and the level at which they are delivered (Treiman and Gartner, 2005; Ries et al., 2007). Importantly, TPI studies tend to focus on large municipalities with populations in the hundreds of thousands or over a million (e.g., Young, 2011; Pincetl et al., 2013; Young and McPherson, 2013; Campbell, 2014; Locke and Morgan Grove, 2014). But over 80% of TPIs addressed in this study are in cities with populations under 150,000, and this generally reflects the distribution of U.S. municipalities by population. This illuminates a need for greater scholarly attention to cities with mid- and small-size populations, an observation noted by others (Doroski et al., 2020). Such attention will enable comparative analysis of TPIs across municipal scales where governance structures and institutional capacity may vary.

- *Planting Norms:* The composition and structure of urban forests is strongly influenced by the human and biophysical legacies of a place (Roman et al., 2018). For example, TPIs in the Midwest plains and the West are located in areas that have significantly less rainfall and underlying canopy cover than the Southeast and Northeast (Kottek et al., 2006; Nowak and Greenfield, 2012). Likewise, native flora and plant hardiness can vary substantially across regions (USDA, 2012), as can cultural associations of trees and landscapes (Jackson, 1986; Roman et al., 2018). Within a region, the size of a city can also influence the species composition of tree planting (Doroski et al., 2020). Relationships between actors at the metropolitan or regional scale can, in turn, influence municipal governance of green infrastructure (Bixler et al., 2020). Plant nurseries, for example, have been shown to significantly influence urban tree species composition and proliferation of non-native species (Conway and Vander Vecht, 2015; Pincetl et al., 2014; Roman et al., 2018). This is noteworthy, as nursery availability is a major factor informing TPI species lists (see Fig. 7). In addition to *intra*-national context, it is also important to consider *inter*-national distinctions that may inform TPIs. The density and distribution of street trees, for example, can differ substantially among capital cities in different countries and continents, even when controlling for climate (Smart et al., 2020). This reinforces that places may have distinct cultural legacies and expectations related to governance and management of urban trees (Keller and Konjijnnedijk, 2012) and urban flora (Lachmund, 2013; Ernstson and Sörlin, 2019), as well as diverse perceptions about trees in urban landscapes (Kostof, 1991; Dean, 2005; Lawrence, 2006; Konijnendijk, 2008). Moreover, landscape planting and design can affect people's stewardship practices, perceptions of safety, and social cohesion (Nassauer, 2011; Nassauer and Raskin, 2014). These issues open up questions about the rationales and associated planting norms that undergird TPIs and related urban greening programs, as well as the heritage narratives informing such norms (Carmichael and McDonough, 2019). For example, should TPIs in all places adopt universal norms that privilege large shade trees and numeric urban tree canopy (UTC) goals predicated on quantifiable and monetizable ecosystem functions? Or should TPIs adopt place-based norms that foreground cultural and experiential dimensions of trees and the landscapes in which they are situated?

- *Procedural Justice:* Over half of participants in this study said that their TPI targets particular neighborhoods, and of these respondents,

87% and 52% respectively cited areas with low canopy cover and low household income as very/moderately important criteria. This suggests that many TPIs are prioritizing distributive justice when determining planting locations. But as TPI leaders grapple with complex questions related to planting norms noted earlier, they should also seek equitable involvement in the decision-making process, also known as procedural justice (Carmichael and McDonough, 2019). This is especially true as there has been little research on the procedural dimensions of TPIs, and TPIs are becoming an increasingly mainstream form of public work with material, social, and environmental effects that may extend several decades into the future. In this vein, TPI practice and scholarship would benefit from adopting precedents in urban planning, where participatory process has been a normative ideal for half a century (Arnstein, 1969; Forester, 1980; Innes, 1995; Healey, 1996; Portney and Berry, 2010). Also known as communicative or collaborative rationality, participatory planning is a decentralized decision-making process that actively engages a range of stakeholders–especially local residents–in formulating the goals, means, and outcomes of local public works and policy. In the case of TPIs, key stakeholders may include arborists, civil engineers, foresters, landscape architects, residents, and urban planners. It is worth noting that contemporary TPIs do engage a broad network of actors in public awareness and implementation (see Table 2), and collaborative decision-making is now an important characteristic of urban forestry governance (Konijnendijk van den Bosch, 2014; Ordóñez et al., 2020). What is less clear, is if and how diverse stakeholders are engaged in the upfront TPI goal-setting process that informs planting norms and management practices.

- *Empirical Outcomes:* Only 17% of survey respondents said that research has been conducted to assess whether stated benefits of the TPI have been realized. This illuminates an important research gap in urban greening scholarship, especially in light of studies that raise questions about the capacity of urban trees to meet various ecosystem function/service goals (e.g., Pataki et al., 2011; Nelson et al., 2012; Pincetl et al., 2013; Petri et al., 2017; Eisenman et al., 2019; Erker and Townsend, 2019; Xing and Brimblecombe, 2019). Yet the rise of urban TPIs over the past decade also points to compelling opportunities for empirical research and natural experiments on a range of environmental outcomes including air quality, local and citywide temperature, atmospheric carbon, hydrology, and wildlife; human health outcomes based on epidemiological methods; and psychosocial metrics related to stress, mental health, social cohesion, and crime. Reflecting the complex, contested nature of urban space (Low, 2017), this research should seek interdisciplinary partnerships, promote epistemological pluralism, and acknowledge the positionality of scholars (Takacs, 2003; Eisenman et al., 2019; Roman et al., 2020).

- *Historical Context:* Combined with a seven-fold increase in associated scholarship over the past decade (see Fig. 1), the contemporary rise of TPIs may represent a noteworthy chapter in the historical arc of urban greening. The timing of this emergence is particularly noteworthy: both the rise of TPI research and the average TPI launch year coincide with the 2008 threshold when, for the first time, humans became more urban than rural in settlement type, sparking popular and scholarly interest in "global urbanization" (e.g., United Nations, 2008; Birch and Wachter, 2011; Angel, 2012; Wigginton et al., 2016). These co-arising phenomena are, in turn, situated within growing awareness that we are living in an anthropogenic biosphere, where humans are a great force of nature in the historical record of planet Earth (Crutzen, 2002; Ellis, 2015). Scholarship spanning the humanities, natural sciences, and social sciences would benefit from situating TPIs in this unprecedented temporal context, especially as historical research is lacking in urban forestry literature (Dean, 2005; Pincetl et al., 2013; Roman et al., 2018). The environmental humanities are especially well situated to take up this charge and direct a scholarly lens on TPIs as a cultural phenomenon. Why, for example, and through what discourses and sociopolitical pathways, has there been such a bloom of TPIs at this historical moment? To what extent, and through which actor networks, have TPIs and related greening initiatives been co-produced through close collaboration between communities of research and practice (e.g., Lachmund, 2013; Campbell et al., 2016)? This type of self-reflective inquiry is lacking in urban forestry science (Bentsen et al., 2010), and it represents an opportunity to expand the discursive and epistemological aperature in urban environmental scholarship writ large.

5. Conclusion

This article presents findings from a survey of 41 urban tree planting initiatives (TPIs) across municipal scales in the United States. Survey participants identified over 115 traits that distinguish TPIs from typical urban forestry activity. Over two-thirds of TPIs have funding separate from traditional urban forestry, and nearly half of TPIs funds are sourced outside of the municipal budget. This suggests that TPIs are successful at raising money to enhance urban tree planting, but lack of institutionalization and traditional infrastructure financing raises questions about long-term viability. Likewise, TPIs are good at mobilizing political and financial resources for program launch, tree purchasing, and planting, but findings suggest underinvestment in stewardship activities such as watering and long-term maintenance, and a need for greater investment in the social infrastructure that undergirds green infrastructure. Large shade trees for ecosystem services and native trees are the principal factors informing TPI species lists. Beautification and regulating ecosystem functions are, in turn, the principal potential benefits animating tree planting goals, yet few TPIs have conducted research to assess the fulfillment of associated outcomes. This study calls attention to contemporary TPIs as an historically situated cultural phenomenon, and it provides a foundation for future interdisciplinary scholarship on TPIs across the humanities, natural sciences, and social sciences.

CRediT authorship contribution statement

Theodore S. Eisenman: Conceptualization, Data curation, Formal analysis, Funding acquisition, Project administration, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing. **Tamsin Flanders:** Conceptualization, Data curation, Formal analysis, Project administration, Software, Validation, Visualization, Writing - original draft, Writing - review & editing. **Richard W. Harper:** Conceptualization, Formal analysis, Funding acquisition, Project administration, Supervision, Validation, Writing - original draft, Writing - review & editing. **Richard J. Hauer:** Data curation, Formal analysis, Validation, Visualization, Writing - original draft, Writing - review & editing. **Katherine Lieberknecht:** Formal analysis, Funding acquisition, Validation, Writing - original draft, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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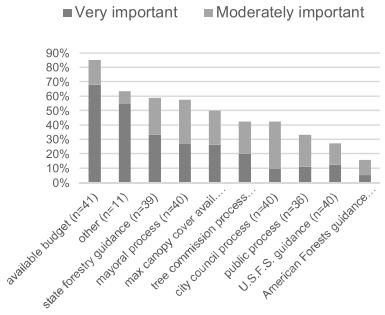
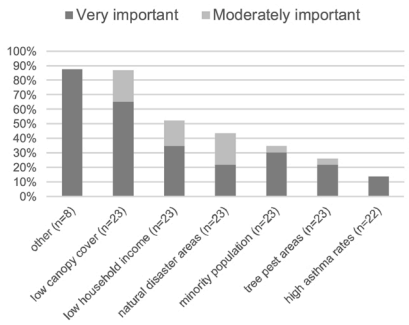
Appendix 1. Survey Questions & Responses

*Graphics included here are not incorporated in the manuscript.

QUESTION	RESPONSE
Background	
Q1: Since the year 1990, has a focused tree planting campaign/program/initiative (TPI) that was/is distinct from the municipality's typical tree planting activity, been conducted in your community?	Yes=42% No=46% Do not know=12% *(n=98)*
Q2: Does the TPI have a name?	Yes=68% No=32% Do not know=0 *(n=41)*
Q3: Did/Does the TPI have a website?	Yes=37% No=61% Do not know=2% *(n=41)*
Q4: What characteristics distinguish the TPI from the municipality's typical tree planting activity?	Table 1 *(n=41)*
Q5: In your opinion, is the TPI enhancing, not impacting, or detracting from typical tree planting activity in the municipality?	Enhancing=85% Not impacting=7% Detracting=5% Do not know= 3% *(n=41)*
Q6: Since 1990, have other TPIs in addition to the one you are describing been conducted in your community?	Yes=44% No=51% Do not know=5% *(n=41)*
Dates and Goals	
Q7: In what year was the TPI launched?	Earliest=1980 Most Recent=2019 Mean=2008 *(n=41)*
Q8: What was the % canopy cover at the time of the TPI's launch?	In response to this question, 43% of participants provided answers while 58% responded "Do not know." Two respondents provided a percent range. Discounting these two, the average and median % canopy cover at time of TPI launch was 25% and 24%, respectively. *(n=40)*
Q9: What was/is the TPI's new tree planting and/or total canopy cover goal?	In response to this question, 44% participants provided data on # of new trees planted, 26% provided data on % canopy cover, 10% responded "other," and 20% said that they do not know. Data on # of new trees planted ranged from 52 to over 30,000. Data on % canopy cover goal ranged from 20% to 55%, with average and median values of 33% and 31%, respectively. *(n=39)*
Q10: How important, if at all, were the following sources for developing the tree planting or canopy goal?	

Q11: Has the TPI been completed?	Yes=27% No=73% Do not know=0% *(n=41)*
Q12: How important, if at all, were the following potential benefits to the development of planting goals?	Figure 4 *(n=variable, 39-41)* Other *(n=8)*
Q13: Has an evaluation been conducted (or is there research in process) to assess whether the TPI's intended benefits are being realized?	Yes=17% No=78% Do not know=5% *(n=41)*
Public Awareness	
Q14: Did/does the TPI have a documented public awareness/outreach plan?	Yes=34% No=51% Do not know=15% *(n=41)*
Q15: How did/does the TPI generate public awareness?	Social media=23% Local media (newspaper, television, radio)=13% Grassroots campaigning (door-to-door, civic meetings)=15% Community meetings=11% Planting days or tree-related events=21% Other=17% *(n=41)*
Funding and Governance	
Q16: How engaged, if at all, were/are stakeholders in different activities related to the TPI?	Table 2 *(n=36-41)*
Q17: Did/does the TPI have a documented funding and administration plan (related to fundraising, budgeting, personnel, and purchasing activities)?	Yes=34% No=61% Do not know=5% *(n=41)*
Q18: Was a new organization launched in conjunction with the TPI?	Yes=12% No=88% Do not know=0% *(n=41)*
Q19: Did/does the TPI have funding that is separate from the municipality's typical urban forestry activity?	Yes=71% No=24% Do not know=5% *(n=41)*
Q20: Please provide a percent estimate of the sources of funding for the TPI	Figure 5 *(n=29)*
Q21: Please provide an estimate of the distribution of TPI funds across the following activities.	Figure 6 *(n=29)*
Planting	
Q22: Did/does the TPI have a documented planting plan?	Yes=33% No=57% Do not know=10% *(n=40)*
Q23: Did/does the TPI have a tree species list that was established as distinct from typical tree planting activity in your municipality?	Yes=50% No=48% Do not know=2% *(n=40)*
Q23a: How important were/are the following factors to the creation of this tree species list?	Figure 7 *(n=20)*
Q24: Did/does the TPI coordinate with a tree nursery(s) to plan for and provide trees to meet planting goals?	Yes=51% No=49% Do not know=0 *(n=41)*
Q25: What was/is the extent of tree planting?	Within city limits (i.e. municipal boundary)=93% Beyond city limits (i.e. municipal boundary)=5% Do not know=2% *(n=41)*

Q26: Within the planting extent, were/are particular neighborhoods selected?	Yes=56% No=44% Do not know=0 *(n=41)*
Q27: How important, if it all, were the following criteria for selecting neighborhoods?	
Q27a: What sites were/are the primary focus of the TPI?	Streets and rights of way=52% Parking lots=3% Public parks (maintained)=21% Public parks/conservation areas (unmaintained)=2% Public non-park properties (e.g. schools, civic space)=4% Private residences=15% Private, publicly accessible areas (e.g. campuses, industrial parks)=1% Other=2% *(n=41)*
Q28: Which of the following statements best described/describes your TPI's distribution of trees to residents and businesses?	Trees are free to residents/businesses=52.5% Trees are available at a reduced cost to residents/businesses=12.5% Residents/businesses paid the full cost for their trees=2.5% Residents/businesses are paid to plant their trees=5% Other=25% Do not know=2.5% *(n=40)*

Stewardship

Q29: Did/does the TPI have a documented stewardship/maintenance plan?	Yes=29% No=56% Do not know=15% *(n=41)*
Q30: Did/do volunteers receive training prior to carrying out planting and watering activities, respectively?	Planting: Yes=70% No=27% Do not know=3% *(n=37)* Watering: Yes=42% No=55% Do not know=3% *(n=33)*
Q31: Has there been an inventory of vigor and survival of trees planted in the TPI?	Yes=40% No=33% Planned but not conducted=22% Do not know=5% *(n=40)*
Q32: What percent (%) of trees planted as part of the TPI were inventoried?	Min=75% Max=100% Mean=98% *(n=16)*
Q32a: What percent (%) of trees planted as part of the TPI survived?	Min=15% Max=95% Mean=82% Median=88% *(n=15)*
Q32b: About how many years after TPI launch was the inventory conducted?	Min=1 Max=11 Mean=4 *(n=15)*

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