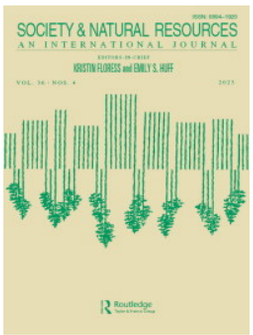

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Urban Forest Management Motivations and Practices in Relation to a Large-Scale Tree Planting Initiative

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ABSTRACT

The success of public trees planted in urban areas by tree planting initiatives (TPIs) depends on how well the new trees fit into existing municipal structures and capacities. We sought to understand municipal management of trees in mid-sized towns through a case study in Massachusetts (US) involving a state-funded and state-managed TPI. Data was collected through structured interviews with tree wardens (municipal urban forest managers) to understand the various impacts that maintenance practices, municipal support and funding, and departmental structure may have on recently planted trees. In this Massachusetts program, municipal structure influenced the number of proactive management practices as well as the size of the tree activity budget. Consideration of municipal department roles and structure by TPIs may allow for more effective implementation of these initiatives. Our study begins to fill a research gap regarding small to mid-size municipalities and their role in tree planting and maintenance.

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Arboriculture; environmental governance; institutional capacity; municipal forest; proactive tree management; reactive tree management; street tree; tree maintenance; urban environmental management; urban environmental stewardship

Introduction

Tree planting initiatives (TPIs) have become an important means for local urban forestry organizations to pursue goals of creating more sustainable and equitable urban environments (Eisenman et al. 2021). Some initiatives led by municipalities and nonprofits have focused on tree giveaways for residential yards, with residents obtaining free trees and assuming responsibility for their planting and maintenance (Nguyen et al. 2017). Other initiatives employ professional arborists to oversee and train volunteers or seasonal staff for street and park tree planting (Fisher, Svendsen, and Connolly 2015; Roman et al. 2015; Hauer et al. 2018). TPIs are often touted as a sound public investment that will generate a return-on-investment from the bevy of increasing environmental benefits that trees are expected to generate over time (Pincetl et al. 2013; McDonald et al. 2016; Breger et al. 2019). However, TPIs often do not support costs such as labor and maintenance (Koeser et al. 2016b), nor do they typically address the disservices that trees may produce (Conway and Yip 2016; Roman et al. 2021).

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TPIs could leave municipalities or residents on the hook for these costs, and it is unknown if residents and/or municipalities have the individual or institutional capacity to manage future costs and disservices (Breger et al. 2019).

For TPIs to deliver promised urban tree benefits, trees must be able to reach maturity amid a complex web of governance and stewardship that involves numerous actors, including residents; personnel working in municipal parks, forestry, or public works departments; staff at nonprofit organizations; and other stakeholders (Foo 2018; Roman et al. 2021). When ownership, stewardship and maintenance responsibilities are clearly defined, well-funded, and supported by arboricultural expertise, juvenile trees may be expected to have high rates of survival (Roman et al. 2015; Geron et al. 2023). In cities and towns in the United States (US), municipal agencies and staff are critical for providing stewardship and maintenance of newly planted trees within their boundaries—including street trees and other trees in the public right-of-way as well as trees in municipal parks—where these agencies typically have formal jurisdiction over tree management (Braverman 2008; Eisenman 2016; Hauer and Peterson 2016; Roman et al. 2018). As trees age they require different kinds of maintenance, that if not routinely completed, may lead to nuisance complaints (e.g., messy fruit droppings), public safety risk (e.g., falling limbs or trees), and foster negative opinions toward trees (Shatz et al. 2013; Conway and Yip 2016; Carmichael and McDonough 2018). Thus, the long-term success of TPIs remains conditioned by existing frameworks of municipal capacity for tree management and governance (Pincetl et al. 2013; Hauer and Peterson 2016; Ordóñez et al. 2019; Geron et al. 2023).

Relating Urban Forest Plans and Policies to Municipal Capacity

To aid in coordination of governance and maintenance of urban trees, urban forest management plans are a key policy tool for assessing the current state of an urban forest system, and planning ahead for planting, maintenance, and monitoring. Urban forest management plans also enable municipalities to justify program expenditures (Ordóñez and Duinker 2013). Researchers assessing Scottish urban forest management found that policy frameworks, such as urban forest management plans, were important in promoting preventative tree care, creating consistency in communication, and aiding in the allocation of resources (van der Jagt and Lawrence 2019). In the US, a study of Massachusetts tree wardens (equivalent to municipal arborists or foresters with unique legal responsibilities; see Harper et al. 2017) found "lackluster support" (32%) for management plans as an important performance parameter (Rines et al. 2010, 299). This lack of support could be based on tree wardens' past experiences with urban forest management plans being created but failing to be implemented, possibly due to budget constraints (Rines et al. 2010).

Municipal tree ordinances and by-laws are another widely recognized policy tool that outline standards for the protection and regulation of both municipally managed trees and trees on private property (Hill, Dorfman, and Kramer 2010; Conway and Lue 2018). In Florida, municipalities with heritage tree ordinances (i.e., protections for trees above a certain size or in certain taxonomic groups) have significantly higher canopy cover (Hilbert et al. 2019), and municipal officials across Pennsylvania recognized the

importance of ordinances as sound urban tree management (Stevenson, Gerhold, and Elmendorf 2008). In Atlanta, Georgia, urban tree land-use ordinances were associated with an increase in urban tree canopy over ten years (Hill, Dorfman, and Kramer 2010). A municipality without an urban forest management plan and/or tree ordinance may not have the ability to plan for tree care, and this lack of formal policy and planning may be compounded by lack of financial resources to maintain trees, which in turn can impact the survivorship of recently planted trees (Roman et al. 2015; Vogt, Hauer, and Fischer 2015; Widney, Fischer, and Vogt 2016; Breger et al. 2019).

Management and maintenance practices can impact the growth and health of the urban forest and can be broadly categorized into two approaches: proactive and reactive (Ryder and Moore 2013; Hauer, Vogt, and Fischer 2015; Hauer and Peterson 2016; van der Jagt and Lawrence 2019; Roman et al. 2022). These terms are also used in wildland forest management (Ogden and Innes 2008; Hessburg et al. 2021) to contrast forward-thinking practices that endeavor to anticipate and prepare for future challenges and conditions (proactive) from practices that "wait for something to happen before any action is taken" (reactive; Ogden and Innes 2008). Drawing on the aforementioned urban and wildland forestry literature, we define *proactive* urban forest management as a planned, systematic, and preventative approach, with tree care practices that anticipate and preempt threats to trees and tree-related disservices while promoting sustained tree benefits, and *reactive* management as an approach that responds to an unplanned event, crisis, or emergency, with tree care practices occurring ad hoc in an attempt to deal with threats and hazards. Proactive urban forestry practices include regularly scheduled maintenance (such as inspection and pruning cycles for mature trees, and establishment care for young trees), comprehensive strategies for pests and diseases, up-to-date inventories and management plans, strategies for public engagement and interdepartmental coordination, investing in replacement plantings, and tree preservation and protection ordinances (Ryder and Moore 2013; Vogt, Hauer, and Fischer 2015; Galenieks 2017; van der Jagt and Lawrence 2019; Clark, Ordóñez, and Livesley 2020; Ordóñez et al. 2020; Roman et al. 2022). Indeed, a central premise of tree risk management in urban forestry (Klein et al. 2019) is that risks from tree failures (e.g., falling trees causing utility outages, injuries, or building damage) can be reduced through proactive practices. Reactive practices include activities that occur in the absence of proactive practices, such as emergency response to limb or tree failure due to neglect of regular inspections, pruning, or removal. While the term "reactive practice" implies action, what is actually observed is typically negligible and insubstantial routine practices, with tree care activities typically occurring in emergencies (Hauer, Vogt, and Fischer 2015; Davies et al. 2017).

Urban forest management varies by municipality based on factors including community size (Treiman and Gartner 2004; Grado, Measells, and Grebner 2013), resource availability (Stobbart and Johnston 2012; Miller and Bate 1978), residents' priorities (Treiman and Gartner 2005), and municipal department structure (Hauer and Peterson 2016). These factors individually or collectively impact municipal tree care practices and residential stewardship. Urban forest management also varies based on population, with larger municipalities (>50,000) having more forestry-focused departments (e.g., parks and recreation, forestry) than smaller communities (Hauer and Peterson 2016). Urban

forest managers themselves may be housed within differing municipal departments such as parks and recreation, public works, planning, transportation, and forestry (Grey 1995; Hauer and Peterson 2016). The mismatch in departmental focus may lead to differing and even competing priorities and challenges across departments and may impact tree care practices and management. For instance, municipal tree staff working in public works or utility departments may be more focused on managing tree risks and conflicts with grey infrastructure (e.g., power lines, sidewalks) than on cultivating new plantings (Breger et al. 2019). Indeed, municipal tree staff may be preoccupied reactively managing a recent crisis, like a storm or a pest outbreak, diminishing the time and financial resources available for proactive urban forest management, including the planning and operation of an urban tree planting program (Roman et al. 2021). A systematic review of the municipal urban forest management literature found that lack of planning and proactive management was one of the most common challenges to managers, second only to budgetary constraints (Ordóñez et al. 2019). Additionally, in a comprehensive survey of municipal tree care practices in the US, only 55% of communities reported having proactive management (Hauer and Peterson 2016).

Linking Urban Forest Governance and TPIs

There is a growing body of literature regarding urban forest governance (Ordóñez et al. 2019), but it is unknown how TPIs impact municipal-level governance, especially in the context of differing municipal departmental organizational structures and capacities. Past research about local urban forestry organizations has examined governance of TPIs (Young and McPherson 2013), the role of local urban forestry nonprofit organizations (Foo 2018), relationships among urban environmental stewardship groups (Svendsen and Campbell 2008; Jasny et al. 2019), and reactive management and budgetary considerations (Hauer and Peterson 2016; Davies et al. 2017; van der Jagt and Lawrence 2019). It is important to examine the role of TPIs in urban forest management because of the growing interest in and funding for such initiatives (Eisenman et al. 2021).

Most recently the US Congress passed H.R.5859. 5859 (2020) and H.R.5376. 5376 (2022) which allocate billions of dollars for tree planting in both in rural and urban areas. Therefore, understanding TPIs and municipal urban forest governance jointly can provide an important lens into the long-term efficacy of current and future programs or initiatives. For example, research in Ontario, Canada found that small municipalities featured ineffective urban forestry programs because there was not a centralized support system from upper-level government agencies (Barker and Kenney 2012) while another study of small, southern US towns found that centralized support (state and federal resources) predicted increased local tree maintenance (Lewis and Boulahanis 2008). Studies analyzing urban forestry governance are needed across different municipal scales, and in different regional contexts, to comparatively understand their variability of structure and capacity.

Crucially, although past research on urban forest governance has often focused on large cities (e.g., Young and McPherson 2013; Foo 2018; Jasny et al. 2019), small to mid-sized municipalities are often overlooked. In the northeast US (where our study takes place) these small to mid-sized towns collectively comprise the larger human

population (Doroski, Ashton, and Duguid 2020). Furthermore, whereas large cities may have park departments or other agencies with numerous staff, the municipal tree staff in small- to mid-sized cities may be a small team or a single individual. Indeed, their roles and responsibilities may extend beyond trees, to include a multitude of duties such as street and utility maintenance. The aforementioned mismatch of departmental focus may also occur, resulting in a multi-hat (MH) position, which is a common occurrence across many fields and professions (Fatien and Otter 2015; Mathias and Williams 2018; Lotts 2020).

Conceptual Framework

Building on the aforementioned literature on urban forest management, governance, and TPIs, especially Hauer and Peterson (2016), Breger et al. (2019), and Eisenman et al. (2021), we present a conceptual framework for local urban tree planting initiatives in the context of municipal urban forestry (Figure 1). Specifically, this framework was designed around the kinds of small to mid-sized municipalities that we studied: municipalities in which the urban tree manager may "wear multiple hats" (MH position) and have a variety of duties and responsibilities other than tree care, or the urban tree manager focuses solely on tree care activities, which we refer to as a tree-focused position (TF). The organizational structure and capacity of municipal urban forestry influences, and is influenced by, public perception of trees (Coleman et al. 2021, 2023), TPIs (Young 2011), and non-municipal institutions (Elton et al. 2022a). Our simplified figure does not include factors which, while important to municipal forestry writ large, are not

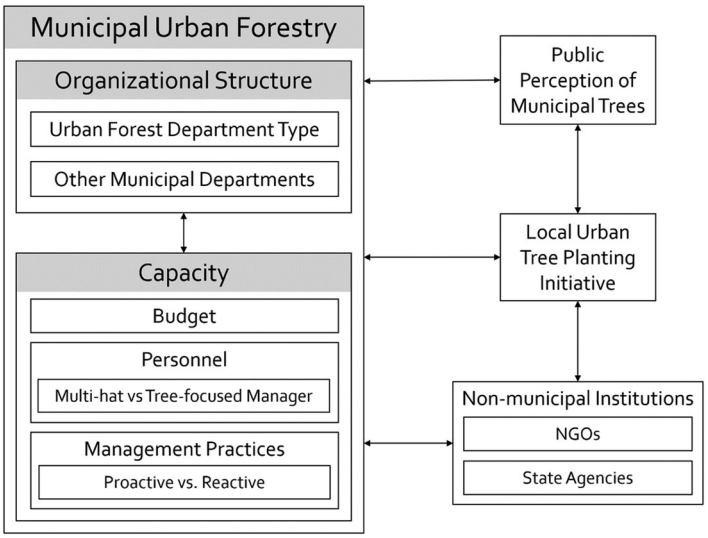

Figure 1. Conceptual framework regarding local tree planting initiatives in the context of municipal urban forestry in small to mid-sized towns. Municipal urban forestry influences, and is influenced by, public perception, local planting initiatives, and non-municipal institutions. Key components of municipal urban forestry include organizational structure (particularly department type), as well as capacity issues including budget, personnel, and management practices.

covered by our study, such as local urban forest governance history and the roles of volunteers (Carmichael and McDonough 2018).

In this paper, we present a case study about urban forest management motivations and practices of municipalities taking part in a state-funded TPI in Massachusetts, and we explicitly examine municipal capacities and structures for engaging the TPI. We characterize the variation of urban forestry practices (proactive and reactive) and resources used for tree maintenance to demonstrate how a given municipality's existing capacity may impact outcomes for recently planted public trees. We also analyze municipal structure and support to understand how urban forestry operations are organized within each municipality and to ascertain if there are ramifications for newly planted public trees relative to municipal funding and management strategies. Our overarching goal is to explain how municipal objectives, motivations, and resources are used to care for and manage urban trees installed as part of a TPI. We then close with insights about municipal tree management in relation to TPIs in Massachusetts, and suggested avenues for further research about urban forest management in other places.

Methods

Study Area

This study focuses on a state-funded and state-managed TPI in Massachusetts titled Greening the Gateway Cities (GGC). A "Gateway City" is defined as a mid-sized, regional economic center that historically provided manufacturing jobs; today, these urban centers face a range of socio-economic challenges in the post-industrial economy (MassINC 2015), including chronically low urban tree canopy cover (Cahill 2018). The Commonwealth of Massachusetts (2010) defines a Gateway City using three metrics: (1) population between 35,000 and 250,000; (2) median household income below the state average [US$70,954]; and (3) average educational attainment level (Bachelor's degree or above) below the state average [41.3%] (U.S. Census Bureau 2016).

The GGC is administered by the Massachusetts Department of Conservation and Recreation and is similar to other TPIs across the US as it involves tree planting on a variety of urban landscape types (e.g., residential yards, sidewalks, and institutional grounds spanning both public and private lands). The Massachusetts Department of Conservation plants all GGC trees using professional arborists and seasonal staff with an expressed focus on planting trees for their affiliated ecosystem services in zones that have been designated by the state in need of environmental justice (Breger et al. 2019). The GGC uses an 80:20 planting ratio of private residential versus public sites, and works with landowners, municipal agencies and local nonprofits for watering and maintenance (Breger et al. 2019). The GGC aims to increase neighborhood urban tree canopy by 5–10% points to reduce residential winter-heating and summer-cooling costs (Commonwealth of Massachusetts 2015). The GGC is also expected to provide co-benefits such as reduced stormwater runoff, improved air quality, increased property values and tax receipts, and a safer, healthier environment for residents (Commonwealth of Massachusetts 2015). Between 2014 and 2021, the GGC has planted over 20,000 trees across an initial 14 cities and towns in Massachusetts, and since 2020

Figure 2. Fourteen original Greening the Gateway cities in Massachusetts, US.

has expanded to include eight more. This study focuses on the original 14 cities and towns in the GGC (Figure 2).

Data Collection and Analysis Methods

We conducted qualitative interviews with Massachusetts tree wardens and/or other related tree management personnel (see Table 1) following similar methodological guidelines from Harper et al. (2020). Massachusetts tree wardens are a legally mandated position for every municipality in the Commonwealth but are typically not a full-time paid position (Rines et al. 2010). Tree wardens are commissioned to preserve and steward a municipality's public trees and have legal authority over their management (Steiner 2016). Because Massachusetts state law mandates the tree warden role in all of its 351 municipalities, and because the state also has an active TPI, it provides an excellent case study for exploration into the integration of TPIs into municipal forestry

Table 1. Municipal positions for tree wardens in this study. Multi-hat (MH) and tree-focused (TF) signify if urban forestry is the focus of the tree warden.

Municipality	Position title[a]	Department	MH or TF	Number of proactive practices	Number of reactive practices	Tree activity budget
1	Assistant Director of Public Works	Department of Public Works	MH	2	8	$50,000
2	Tree Warden	Department of Natural Resources	TF	11	4	$360,000
3[b]	Parks Department Supervisor	Department of Public Works	MH	10	5	$500,000[c]
4	City Forester	Parks, Buildings and Recreation Management Department	TF	8	5	$90,000
5	Commissioner of Public Works	Department of Public Works	MH	4	4	$50,000
6	Cemetery and Tree Division Manager	Department of Community Maintenance	MH	6	7	$65,000
7[b]	Tree Warden	Department of Public Works	TF	12	2	$120,000

[a]All position titles include the role and responsibilities of tree warden.
[b]Interviews conducted with associated representatives (i.e., not the tree warden).
[c]Temporary funding increase that was paid to a contractor to prune and remove hazardous trees.
The number of proactive and reactive practices were derived from the interviews about the practices (see Tables 2 and 3). Tree activity budgets, excluding salaries, are shown for each municipality.

operations. In this research, we focused specifically on tree wardens as they represent a standardized role across Massachusetts municipalities that exert influence over how a municipality manages the urban forest, but with differences across municipalities in forestry operations. Although our case study is focused on the Massachusetts context with tree wardens and a specific state TPI, similar staff and initiatives exist across the US and globally, with their management decisions shaping the growth, abundance and health of trees in the public realm (Harper et al. 2017; Roman et al. 2018; Threlfall and Kendal 2018). The size of the municipalities in this case study will also add to the recent request for more urban forestry research involving TPIs in small- to mid-size cities, as the current literature has been primarily focused on large cities (Doroski, Ashton, and Duguid 2020; Eisenman et al. 2021).

The interviews focused on both the role of the urban forest manager and the municipalities as a whole. First, we sought to understand how the urban forest manager fits within the municipal department structure and exerts influence over municipal capacity and urban tree management practices in the context of the GGC. Second, we examined the municipality's urban forestry organizational structure (referred to as departmental structure hereafter), tree management practices and goals, and municipal budget in relation to the municipality and the GGC.

After completion of the interviews, we used an inductive approach based on our qualitative data to explore themes related to urban tree management and departmental structure across the GGC participating municipalities (Boyatzis 1998). Specifically, we aimed to characterize tree management practices, municipal structure, and municipal capacity (including budget and personnel) for tree care and management amid the GGC initiative. The insights were then linked to other data gathered from the interviews

(i.e., budgets, management practices, number of tree plantings and removals) to illustrate the impacts of TPIs on municipalities.

Tree management practices identified through interview responses were each labeled as either proactive or reactive and encompass approaches for increasing tree canopy as well as tree care and maintenance. The classification of a given tree management practice as reactive or proactive was based on prior literature in urban forestry (Ryder and Moore 2013; Vogt, Hauer, and Fischer 2015; Galenieks 2017; van der Jagt and Lawrence 2019; Clark, Ordóñez, and Livesley 2020; Ordóñez et al. 2020; Roman et al. 2022). The number of each type of practice was quantified to determine: (1) how reactive/proactive each municipality is; (2) the most commonly implemented reactive/proactive practices; and (3) if the number of reactive/proactive practices are influenced by their departmental structure.

In describing the departmental structure, we categorized municipalities as either having multi-hat (MH) or tree-focused (TF) urban forestry staff (see Section "Conceptual Framework"), a distinction developed during the coding process based on the range of a tree warden's job responsibilities. The categorization of municipalities as either MH or TF was used to compare the goals, capacities and practices of urban forestry departments across departmental structures.

To identify municipal capacity, specifically resource allocations, that coincided with the GGC, we also quantified the pace of tree planting and tree removal, as well as fiscal budgets. Approximate budgetary information for each municipality was collected from the interviews using the Tree Activity Budget format from Hauer and Peterson (2016) which includes all tree activity expenses such as personnel (salary), overhead, equipment, supplies, tree care and contract payments. Personnel (salary) costs were removed from the initial budget data to denote monetary variation for tree care activities only.

Interview questions (see Supplemental Appendix) were structured using both close-ended and open-ended questions to find specific tree-related municipal characteristics and to allow tree wardens to share the depth and meaning of their management experience and interactions with the GGC. The interview questions were first trialed with tree wardens in two cities that did not participate in the GGC and were refined based on feedback from the trial (Dampier et al. 2015; Harper et al. 2017). Tree wardens from the 14 original communities participating in the GGC initiative were contacted by phone and email, with the latter containing a cover letter explaining the research project and a consent form. Interviews typically took 30–60 min to complete. All interviews took place between April and June 2021. Interviews with the first author were conducted in an online, video format due to COVID-19 restrictions, and were recorded.

Interviews were transcribed and coded using NVivo (QSR International Pty Ltd 2020) qualitative analysis software by the first author. Interviews were first coded based on the section themes of the interview questions (see Supplemental Appendix) which related to urban tree management practices and departmental structure across the GGC participating municipalities and then discussed with and reviewed by the second author. Sub-themes were either predetermined by the interview questions or were identified through the coding process based on the responses from the interviews. Sub-themes that were identified in the coding process were discussed and reviewed with the second author. Coded sub-themes provided a way to define the range of responsibilities of tree

wardens, their job categorization (MH or TF), municipal tree management practices and capacity for tree care amid the GGC initiative. Once the initial coding of the interviews was completed by the first author, transcripts were reviewed again by the first and second author jointly to confirm or further refine the existing themes. The same process was repeated for coding and refining the sub-themes.

Results

Tree wardens and other related tree management personnel from seven of the 14 original GGC municipalities (50% response rate) agreed to be interviewed. Five interviews were with tree wardens and two interviews were based on referrals (through phone calls from the tree warden themself or the department in which they work), with (1) a forester working at a nonprofit organization that contractually maintains city parks and green spaces; (2) the Director of Planning and Development who spoke on behalf of the tree warden.

Of the seven municipalities in this study, three had TF tree wardens whose full-time job was focused on tree management while the other four were MH and had to divide their time as a tree warden with other responsibilities (Table 1). The three TF tree wardens led their department or division and each reported that they were 100% focused on tree management in their municipality. The MH tree wardens typically had a higher administrative role (i.e., Director of Public Works) and managed multiple divisions, each with different municipal responsibilities (i.e., Parks, Sewers, Roads, Cemeteries), but with the added responsibilities of being tree warden. These MH interviewees reported that 10–40% of their time was spent on tree management.

Tree wardens from both MH and TF municipalities indicated that their urban forest management goals included wanting to create cyclical tree pruning programs, updating tree inventories, and planting more trees. MH tree wardens also prioritized hiring a city forester, creating a local tree ordinance, and stump removal while TF tree wardens prioritized creating urban forest management plans and increasing community education.

The number of reactive and proactive tree management practices was recorded and listed for each municipality in Table 1. Tables 2 and 3 include the list of practices in

Table 2. Proactive urban forestry practices identified from the interviews and the number of municipalities that mentioned a given practice.

Proactive practices	Number of municipalities
Local tree ordinances	6
Community engagement	6
Community education	5
Information shared with residents	5
Right Tree Right Place philosophy	5
Watering for newly planted trees	4
Resident/volunteer stewardship	4
Proactive hazardous tree removal	4
Current management plan (<10 years old)	4
Current or updated tree inventory	4
Planting more trees than removing per year	3
Building resident trust	2
Stumps removal tied to cutting process	1
Pruning cycles—building up or currently have	1

Table 3. Reactive urban forestry practices identified from the interviews, including responses of absent proactive practices, and the number of municipalities that mentioned a given practice.

Reactive practices	Number of municipalities
Stump removal tied to planting or other process	6
Little or no dedicated tree planting funding	6
Reactive pruning	5
Reliance on outside contractors	4
Old or no tree management plan (>10 years old)	3
Old or no tree inventory	3
Reactive hazardous tree removal	2
No community education	1
No information shared with residents	1
No community engagement	1
No local tree ordinances	1
Removing more trees than planting per year	1

their entirety. The average number of proactive and reactive practices for MH municipalities was 5.5 and 6.0, respectively. For TF municipalities those average values were 10.3 and 3.7, indicating that TF municipalities had more proactive and fewer reactive tree management practices than MH municipalities (Table 5). Four of the municipalities featured a majority of proactive practices, while two had a majority of reactive practices, with one having an equal number of reactive and proactive practices.

The list of proactive and reactive practices (Tables 2 and 3) provides a snapshot of current urban tree management and the practices that municipalities are able to accomplish. The most common practices enacted across nearly all municipalities include local tree ordinances, community engagement (i.e., tree related activities for residents such as tree planting or pruning), and stump removal tied to planting or other process. The most common practices shared solely by municipalities with a majority of proactive practices were community education events (i.e., Earth/Arbor Day at public schools, tree care classes, tree hearings, community forums), watering for newly planted trees, planting more trees than removing per year, current or updated tree inventory, and proactively managing hazardous tree removal. Tree wardens from majority proactive practice municipalities expressed how important a tree inventory and management plan were relative to forming proactive practices, with one individual stating:

> Before we did the management plan, the Forestry Department was staffed with four people. It's now staffed with eight … We also have a dedicated tree warden now, which our tree warden before 2014 was the Superintendent of the Department of Public Works who was wearing about four or five different hats. So, being the tree warden wasn't the top priority … The city has invested substantially in [our] infrastructure and equipment so that [we] can do more work in-house, which I think has worked in our favor.

The most common practice shared solely by municipalities with a majority of reactive practices is reactive hazardous tree removal. One tree warden explained,

> For the prior 20 years, the city just wasn't spending money on trees unless it was an emergency. That neglect led to a lot of stuff that had to be cleaned up …

While most municipalities interviewed used the Right Tree Right Place philosophy (i.e., appropriate tree species are matched to suitable planting sites, see Ko et al. [2015] and Vogt, Hauer, and Fischer [2015]) for tree planting, almost all of them mentioned having little to no funding dedicated primarily to tree planting. Outside of the GGC

Table 4. Average annual number of trees planted (TP) based on three phases: (1) before GGC; (2) during GGC, and (3) after GGC; and yearly average of tree removal.

Municipality	Yearly avg. TP before GGC	Yearly avg. TP during GGC	Yearly avg. TP after GGC	Yearly avg. tree removal
1	60	0	60	70
2	150	150	350	250
3	125	700	450	200
4	160	160	160	600
5	200	200	200	NA
6	NA	NA	NA	60
7	15	125	125	75

initiative, tree planting typically occurred as part of road and sidewalk infrastructure projects, federal, state, or local grants, or through volunteer initiatives. The yearly average number of tree plantings for each municipality for three separate time periods: before the GGC, during the GGC, and after the GGC, is shown in Table 4. Municipality 1 was the only municipality to see a decline in tree planting while the GGC was active, and it dropped to zero. The tree warden mentioned the reason for the drop was that since the GGC was already engaged in tree planting, the municipal staff would be focusing their efforts elsewhere. This respondent also indicated, however that after the GGC initiative concluded, the municipality would likely resume tree planting efforts, depending on funding:

> It depends on funding right now and the funding's not much … I'd like to do more, but we don't have the money.

Municipality 2 noted an increase in tree planting after the GGC because of city government restructuring which led to the hiring of a tree warden and increased funds for tree planting, removal, and maintenance. While the municipality increased the number of tree plantings, it also increased the number of tree removals as it endeavored to clear a backlog of hazardous trees.

Tree planting in Municipality 3 was managed by a nonprofit, who also happens to run the GGC in their municipality. Before the GGC, the nonprofit planted about 125 trees per year, while the municipality planted zero. However, due to their participation in the GGC initiative, the nonprofit planted 700 trees a year. The nonprofit plans to continue a substantially higher rate of tree planting after the GGC has wrapped up, as long as they can obtain the necessary funding (e.g., from local, state and federal grants). Municipalities 4 and 5 had a steady rate of tree planting across all three periods. Comments from the tree warden at Municipality 5 suggested there was higher variability from year to year, depending on capital projects, grant funding—and more recently, restrictions due to COVID-19—but that tree planting probably averaged around 200 installations per year. At the time of the interview, the tree warden at Municipality 6 did not have tree planting information on hand, but commented that they heavily rely upon a local nonprofit for tree planting in the city. Municipality 7 saw a large increase in average tree planting for the periods during and after the GGC. This increase was due to a completed management plan which coincidentally started at the same time as the GGC and led to a steady stream of tree planting, with plans continuing into the future.

Removal rates for the municipalities varied, but this was dependent on several factors like hazardous tree backlogs, personnel, and funding. Tree removals in relation to Municipality 4 seemed abnormally high but there was nothing emergent in the interview data that explained this occurrence.

Some tree wardens mentioned how they are more attentive to the newly planted trees in their municipality: they see the trees frequently and take note of their condition, and residents ask them questions about the trees. As for long-term maintenance, nearly all tree wardens responded that they anticipate having the capacity necessary to maintain the GGC trees that were planted on public property after the program ends. Two tree wardens mentioned that they may request future funding or engage a local volunteer group for maintenance. The tree warden from Municipality 3 (where the nonprofit works to maintain city parks and trees) initially expressed some reservations, but ultimately concluded that maintenance was possible:

> In my organization I think we do have some capacity because we do park cleanups and park improvement projects… The city does not have the capacity or the wherewithal. They know it's important and they agree, but they just don't have the resources. They have to choose: can I water a tree or can I fill a pothole?

The tree warden from Municipality 5 was the only one who expressed serious doubts about being able to maintain public GGC trees. As with Municipality 3, the tree warden indicated that difficult decisions would need to be made by the municipality regarding funding priorities, making the externally-funded GGC initiative critical:

> If the Greening the Gateway Communities program leaves, we're going to be in dire straits. It's going to be hard to sustain it… I feel like we've gained a lot of momentum and if they leave, that momentum will come to a grinding halt.

Tree activity budgets (excluding salary for personnel) for each municipality are shown in Table 1. According to the interview, the budget for Municipality 3 was unique because this level of funding was approved only for three years (2019–2021) and was paid to a contractor for the pruning and removal of hazardous trees. Previously, the tree activity budget was $0, and will revert back to $0 for fiscal year 2022—the end of the temporary funding period. Average tree activity budgets were compared across MH and TF municipalities (Table 5) with the budget of Municipality 3 being removed from the average calculation due to its temporary status. There is a drastic difference between tree activity budgets of MH and TF municipalities with TF municipalities having a tree activity budget 3.4 times larger than MH municipalities.

When tree wardens were asked about what they would do with a budget increase, the most common response was to plant more trees (5 out of 7), regardless of being a MH or TF municipality. The next most common response (4 out of 7) was to increase the

Table 5. Average number of proactive and reactive practices as well as average tree activity budget compared between multi-hat (MH) and tree-focused (TF) municipalities.

	Average proactive practices	Average reactive practices	Average tree activity budget
MH municipality	5.5	6.0	$55,000[a]
TF municipality	10.3	3.7	$190,000

[a]The tree activity budget for Municipality 3 was removed from this calculation because the funding increase was temporary.

capacity of their in-house crews by hiring more arborists and tree care professionals—with all 3 TF municipalities responding and 1 MH municipality. One tree warden explained why hiring in-house tree crews was important:

> It's too expensive to have outside vendors trimming, so that's why we've moved to more in-house crews and over the years we've sacrificed contractual money from our contractual line to be able to hire more in-house personnel and that has proved hugely beneficial to us.

Only MH municipalities indicated that they wanted funds used for hazardous tree removal, while both MH and TF municipalities wanted funds to be used for pruning.

Finally, all tree wardens responded positively when asked if city officials view urban forestry as a priority and if they support the role of tree warden. Some expressed this sentiment by explaining that the city has increased their budget or staffing levels, while others expressed that since their budget had not been cut, this was a sign of support. One tree warden talked about the need for "proving" the departments "worth" because of recent restructuring that made the respondents' position possible:

> I feel that because I'm here, because this position is here, that's step one for the amount of support we're getting. Now what we need to do is show him [mayor] and the City Council what we can bring.

One tree warden commended local government officials for their awareness of the importance of trees and maintenance, but indicated concern that it may get lost among other priorities:

> We love trees, we're very supportive of trees. But again, if you got the pie and you keep carving out of the pie for trees… And it's not just trees. There's a slew of important things that we gotta prioritize.

When asked about community support for urban forestry from residents, all tree wardens expressed that there is support but that it varied by local context. One tree warden shared how it took several years for residents to overcome a negative perception of trees after a severe ice storm damaged many trees and buildings. Another tree warden expressed how local volunteering for tree stewardship and advocacy has become a higher priority for residents in the municipality, but that conflict ensued when the volunteers tried to formalize their group as a nonprofit. Other municipalities with established tree-focused advocacy groups or nonprofits expressed how their support is critical for helping to maintain and plant new trees. One tree warden said that issues around environmental justice, the urban heat island, and air quality are what connect residents to trees—that they act as an intersection to discussing these issues. Tree wardens in this study expressed concerns about climate change, specifically around the urban heat island, effects on certain species and street trees, increased pests, and changing weather patterns.

Discussion

In this case study, we sought to understand municipal management of trees in mid-sized towns in Massachusetts involving a state-funded and state-managed TPI. This was accomplished through structured interviews with tree wardens to comprehend the

various impacts that maintenance practices, municipal support and funding, and departmental structure have on recently planted trees as part of the GGC program. We found variation in how municipal personnel interact with and perceive the GGC. Specifically, we developed the coding categorization of TF and MH municipal urban forestry staff based on the observed differences in funding and urban forest management practices between municipalities. The GGC has inspired forms of proactive urban forest management among all the municipalities and tree wardens who participated in our study, similar to other research that determined that available state and federal resources predicted increased local tree maintenance in small cities (Lewis and Boulahanis 2008). While our research is exploratory, this suggests that centralized support mechanisms for TPIs improve tree management for small- to mid-sized cities.

Our analysis also illustrates how the burden of public trees planted by the GGC is perceived to be minimal by a majority of the municipalities we interviewed. This may be due to inherent factors associated with the GGC: it is externally funded and managed by the Massachusetts Department of Conservation and Recreation, and it plants trees with professional foresters and seasonal staff and maintains them for up to three years, with help from community partners. While some municipalities choose to assist and work in cooperation with the GGC, this arrangement is not mandated, and so the municipalities do not bear the initial financial and staffing burdens associated with the new installations. This arrangement is quite different from other TPIs, where residents or volunteer groups plant and maintain trees (Nguyen et al. 2017; Breger et al. 2019; Riedman et al. 2022; Elton et al. 2022b). In the Massachusetts towns we studied, the maintenance burden of the trees is perceived to be low because, in the view of the tree wardens, most of the required maintenance will take place in the future, therefore relinquishing responsibility in the present. This perspective is concerning because of the possibility that GGC trees will be insufficiently cared for once the state foresters' labor and maintenance commitment comes to an end, which can result in higher costs in relation to future maintenance (Vogt, Hauer, and Fischer 2015), and may contribute to residents' negative experiences and perceptions of trees (Carmichael and McDonough 2018; Roman et al. 2021). It is especially concerning for MH tree wardens to have a perceived low-maintenance burden of the GGC because they typically have smaller urban tree-related budgets and manage forests on more of a reactive basis than their TF counterparts.

Concerns surrounding municipal funding for tree planting and maintenance in the US have been a consistent theme in urban forestry literature (Pincetl 2010; Danford et al. 2014; Hauer and Peterson 2016; Breger et al. 2019) and were also evident in this research as budget issues impacted tree wardens' desires for more tree planting. Five of the seven tree wardens in this study would plant more trees if they had the funding, a sentiment shared by other staff from municipalities and TPIs (Young 2011; Eisenman et al. 2021). Taking into consideration the financial context for each municipality is extremely important, especially for those with limited tree activity budgets. In a few municipalities, tree planting and maintenance is competing with built infrastructure needs (e.g., road repairs), especially if the tree warden is in a MH role. The lack of municipal funding for tree planting and maintenance may foster a value and appreciation for the state-funded GGC initiative in each municipality, but many other TPIs in

the US have sourced their funds from a diverse array of sources (e.g., citizens, corporation, nonprofits, municipal, state and federal agencies) which may affect their long-term feasibility (Young 2011; Eisenman et al. 2021). The size of the municipality has also been found to effect the funds for urban tree management due to the size of the tax base (Miller and Bate 1978), resident knowledge of urban tree benefits (Grado, Measells, and Grebner 2013), and the demand for tree-related services (Ries, Reed, and Kresse 2007) which may explain some of the context surrounding the municipalities in this study as they are all small- to mid-sized municipalities (<160,000 residents). In accordance with other research findings (Vogt, Hauer, and Fischer 2015), tree wardens also raised concerns about costs and quality of tree maintenance when comparing in-house staff to contracted labor. Tree wardens generally believed that in-house staff was cheaper and better overall for the quality of tree care in their municipality. This case study shows that the motivations of a municipality to hire more in-house tree maintenance staff is related to factors like departmental structure, municipal capacity, and level of proactive practices; more research is needed, however, to understand the advantages and disadvantages of in-house municipal tree maintenance staff across a variety of urban contexts.

Tree wardens felt supported by departmental or tree activity-related budget increases, but they also felt supported by not having their budget cut when other municipal departments faced cuts. The tree wardens we interviewed portrayed their budgets as being constantly stretched, but on average, TF tree wardens have much larger tree activity budgets than their MH counterparts. This may have governance implications for MH municipalities as there is potential for them to increase tree activity budgets if they are able to restructure their departments to be TF instead of MH.

Management practices can be greatly influenced by the structure of the municipal department, as shown with TF municipalities having double the proactive practices as MH municipalities. Rines et al. (2010) surveyed 143 Massachusetts' tree wardens in 2006 about urban tree management priorities and found nearly unanimous support for hazard tree removal as a priority for urban tree management policy, while just below half of tree wardens supported preventative tree maintenance and tree planting as priorities for management policy. This difference was due to part-time and volunteer tree wardens not prioritizing preventative tree maintenance and tree planting relative to full-time tree wardens. Therefore, our findings corroborate Rines et al. (2010): TF tree wardens employ more proactive practices than MH counterparts. Urban forest managers in Scotland were found to mostly employ reactive practices and this was influenced by limited funding, resources, knowledge, poor management structures, and their perception of trees as a liability (van der Jagt and Lawrence 2019). There is a research gap concerning urban forest management regimes and their impacts on costs as well as tree-related outcomes and benefits (Vogt, Hauer, and Fischer 2015). Our study begins to address this gap by identifying that TF municipalities also had much higher budgets than MH counterparts. However, the top practices that TF tree wardens engaged with, such as creating/enforcing local tree ordinances, community engagement activities, and maintaining a tree inventory, do not require expensive equipment or the purchasing of new trees, but rather, personnel time. It would appear that a TF tree warden has the time to prepare and execute a plan that engages the municipality, residents, and the existing

trees. Consequently, proactive tree management benefits from both having a TF tree warden and giving that tree warden sufficient program budget.

Urban forestry governance literature demonstrates that proactive management can lead to increased tree canopy cover over many decades through the typical channels like a large budget and proactive tree planting practices (Roman et al. 2017; 2022); what often goes undiscussed or disclosed, however, are the detailed management processes needed for success (Ordóñez et al. 2019). Detailed management processes occur at the municipal level and also include additional actors who liaise with both the urban forest and the municipality (i.e., residents, NGOs, TPIs, etc.), which produces a co-governance model (Ordóñez et al. 2019; Geron et al. 2023). TPIs can facilitate, or be part of, an existing co-governance model, but the role of the municipality may change depending on its structure (MH vs TF) and the involvement of other stakeholders and groups that participate in urban tree stewardship and planting. For instance, the tree wardens in our study acknowledged how important outside groups and resident tree stewardship were in accomplishing their work. Further research is needed to better understand the complexities of TPIs in small to medium cities by examining a co-governance model that includes staff at municipal and state levels, as well as nonprofit tree groups and consulting arboriculture professions. The development and enforcement of local tree ordinances are another detailed management component (Hill, Dorfman, and Kramer 2010; Conway and Lue 2018; Hilbert et al. 2019). Our research labels local tree ordinances as a proactive practice, but it does not assess the local ordinances themselves. The efficacy of local tree ordinances is highly dependent on how well they describe their requirements or protections, as well as the enforcement mechanisms. More research is needed to understand the varying levels of implementation and enforcement of local tree ordinances, as well as their sociopolitical origins (e.g., whether proactive practices codified through ordinances arose out of challenges from reactive management, Koeser et al. 2016a).

The lack of proactive urban tree management, particularly in conducting routine maintenance, can also impact municipalities. Deferred tree maintenance can result in increased costs for future urban forest managers and municipal residents (Vogt, Hauer, and Fischer 2015). In our study, deferred maintenance typically revolved around tree pruning and hazardous tree removal. Without regular maintenance, urban trees may pose an excessive risk to both people and property, leading to high removal costs and ramifications for the municipal budget (Ryan 1985). This has played out in two municipalities in our study that have endeavored to clear large backlogs of hazardous trees after years of deferred maintenance. The short-term budget for Municipality 3, above the average tree activity budget (including salary), was used entirely for contractual hazardous tree removal, and was renewed for two additional years to complete the work. After years of neglect, Municipality 2 found that an increased tree activity budget led to both increases in tree removals and tree planting. These examples demonstrate that inconsistent maintenance regimes can affect the municipal budget, but that they are also subject to municipal administration priorities, which may change due new administrations or disturbance events (Harper et al. 2018; Konijnendijk, Nesbitt, and Wirtz 2021). Climate change may further exacerbate inadequate maintenance practices and increase municipal costs as urban trees may have increased stressors and become more

vulnerable to pests and disease (Tubby and Webber 2010; Khan and Conway 2020). More research is needed to fully understand municipal urban forestry practices and policies and how they intersect with climate change impacts (e.g., proactive and reactive management).

Our case study focused on small to mid-size municipalities in one US state which may represent different dynamics than may be uncovered in large municipalities, in other regions of the US or other countries. Since many TPI studies focus on larger cities (e.g., Young 2011; Pincetl et al. 2013, Campbell 2014; Locke and Grove 2016), our study begins to fill a research gap regarding small- to mid-sized municipalities, the roles and responsibilities of their urban forest managers, and their role in tree planting and maintenance. More research is needed, however, to understand the role of urban forest managers, and the deficit of tree planting, between larger and smaller municipalities and its application to other regions nationwide, and internationally.

This research sought to explore and identify themes and trends from a small statewide sample (seven interviews) and may not fully reflect the themes and trends from a larger, more representative sample. Although the number of interviews is small, our response rate was high (50%) and other urban forestry research has used small numbers of interviews to identify developments in practice and management, on topics such as collective action, yard tree giveaways, and local tree committees (Nguyen et al. 2017; Harper et al. 2018; Vogt and Abood 2021). Our study was explorative and only had 14 eligible municipalities of similar sociodemographics to interview from, therefore the sample size would not have been large, even with a 100% response rate. Non-response to our outreach efforts may be due to disinterest, inability, or other personal bias, and may affect the outcomes and trends reported in this research. However, we stress that we were seeking qualitative insights in a case study, that our findings broadly align with prior studies, and that nonresponse bias and other forms of bias can exist even in survey research with much larger samples (Elston 2021).

Our research suggests that the management of urban forests is influenced by departmental structure and municipal capacity, particularly through the role of the urban forest manager (such as tree wardens in Massachusetts). This has implications for the success of TPIs as departmental structure and municipal capacity may affect the long-term survival and health of publicly planted trees (Breger et al. 2019). A deeper understanding of urban forest management at the municipal level is needed so that more proactive practices may be employed in the service of municipal trees and urban communities.

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Ethical statement

This research involved structured interviews and IRB approval was obtained through Clark University for research involving human subjects. All interviewees provided informed, verbal or written, consent as outlined in the Human Subject application and all responses and names were properly anonymized as stipulated by the approved IRB proposal.

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