Assessing Community Involvement and Co-creation in NYC's Urban Forestry Programs to Address Street Tree Inequalities

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Abstract

Caring for and expanding the urban forest is a popular urban adaptation and mitigation strategy to address climate risks and long-standing environmental justice issues. However, simply planting trees in areas of low-canopy does not automatically solve inequalities. Citizen participation, community buy-in, and the co-creation of solutions can be integral to making sure the benefits of a healthy urban forest are shared equitably. This thesis is a case study on how NYC has centered equity and involved residents in its tree planting and stewardship programs as a way to strengthen future program design to advance the urban forest. NYC Parks is a leader in urban forest management, overseeing about 5.7 million trees, including over 660,000 street trees. The agency completed its ambitious MillionTreesNYC campaign in 2015, launched several stewardship programs afterward to care for the new plantings, and has collaborated with private entities to implement community forestry projects. With NYC Parks planting record numbers of street trees annually and prioritizing their placement in heat vulnerable communities, it is important to assess how current and future stewardship programs can be designed and improved so that communities in greatest need benefit from a growing urban canopy. Interviews with municipal, nonprofit, and community stakeholders revealed robust collaborative governance between the city and urban environmental stewards, countless opportunities to become involved in caring for the urban forest, effective community leadership, and innovative programmatic strengths for effective participation and engagement. Stakeholders also shared there are logistical hurdles to street tree care, lack of agency and volunteer capacity, need for funding and technical assistance, and a need to increase knowledge and engagement around tree stewardship. Key findings and recommendations looked at opportunities to improve programmatic funding and design that sustains and advances the urban forest in an equitable way.

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To baby Sylvia…may I do all that I can to leave this planet in a better place for you, including planting, and stewarding, a few trees along the way.

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Glossary

Collaborative governance: A governing arrangement where public and private stakeholders work together to solve problems and make decisions to address public issues.

Environmental justice: Equal distribution of environmental risks, hazards, investments, and benefits, without direct or indirect discrimination. It also implies equal access to environmental benefits, information, and participation in decision-making (Treglia et al, 2021).

Equity: Fairness and justice in the treatment of people as well as in processes and results.

Street tree: A publicly-owned urban tree located in the public right of way, usually along the curbside or sidewalk.

Tree canopy: The parts of a tree including leaves, branches, and stems that shade the ground.

Tree Stewardship: Specific activities that support the care and protection of a tree, including pruning, watering, removing weeds and litter, and mulching.

Urban forest: Individual trees and groups of trees in parks and forested natural areas on public and private land ranging across cities, towns, and suburbs.

Abbreviations and Acronyms

EJ	environmental justice
GTC	Greenpoint Tree Corps
GWQ	Greening Western Queens
HVI	heat vulnerability index
IPCC	Intergovernmental Panel on Climate Change
MOCEJ	New York City Mayor's Office of Climate and Environmental Justice
MTNYC	MillionTreesNYC
NbS	nature-based solutions
NYC	New York City
NYC Parks	New York City Department of Parks and Recreation
NYRP	New York Restoration Project
OC	outreach coordinator
PfP	Partnerships for Parks
STEW-MAP	Stewardship Mapping and Assessment Project
TPH	Trees for Public Health
TPI	tree planting initiative
Trees NY	Trees New York
UHI	urban heat island

Chapter 1: Introduction and Methodology

Introduction

We live in an era of extreme heat and climate risk. High temperature records are being shattered, and the number of high-heat days over 90 degrees are slated to rise. Warmer weather exacerbates the urban heat island effect and health risks – including acute asthma attacks, heat exhaustion, stroke, and mortality. Heat is also intensifying poor air quality and the effects of diseases. The climate crisis is also a public health crisis, and it is affecting communities disproportionately. It is well documented that low-income communities and communities of color are feeling the brunt of extreme heat. Neighborhoods that were segregated and starved of investment due to racist and discriminatory housing and lending policies have less urban tree canopy cover and green space. Large scale municipal tree planting campaigns, also known as tree planting initiatives, are one solution to addressing this disparity. While many cities like Los Angeles, Denver, and Boston launched formal tree planting initiatives to mixed success, New York City's MillionTreesNYC (MTNYC) stands as a model having planted one million trees while finishing two years early. The program, which ran from 2007-2015, built innovative partnerships, developed a robust volunteer network, transformed its planting strategy, and prioritized equity in its tree distribution to combat poor air quality and a lack of trees in specific communities.

The MTNYC program is a product of New York City's leadership on sustainability and climate action that spans nearly two decades dating back to the release of PlaNYC in 2007. Facing the ongoing impacts of climate change, NYC updated its sustainability plan in 2023 to continue building a more equitable, healthy, and resilient city. One of those commitments is to

expand urban tree canopy cover from 22% to 30% by 2030 by preserving and maintaining the city's approximately 7 million trees and planting new trees. Local elected officials have also recently called to plant and restore one million more trees (Rubinstein, 2022). With tree and canopy expansion front of mind, planners, policymakers, and stakeholders are advocating that this work continues to prioritize the most vulnerable to climate impacts and environmental burdens by planting trees where they are needed most. Recent research in NYC has shown that as of 2017, communities with lower per capita income and higher proportions of people of color tend to have lower tree canopy than higher income communities (Treglia et al, 2021). Resident participation, community buy-in, and the co-creation of solutions can be integral to making sure the benefits of a healthy urban forest are shared equitably. Skepticism and distrust of government can impact climate and greening goals when people are not a part of the process.

To meet NYC's commitment to expand the urban tree canopy and address historic inequities, the city cannot simply plant trees in areas of low-canopy. The stewardship and maintenance of new and young street trees - the trees located curbside in the public right-of-way - is critical to ensuring they survive and thrive. NYC has a robust urban environmental stewardship network made up of volunteers and organizational partners, but an increase in the active citizenry is needed to help steward more trees, especially in low-income and environmental justice (EJ) communities. NYC Parks is a leader in urban forest management - overseeing 54% of the city's urban tree canopy across street trees in public right-of-ways and trees on city parkland (Treglia et al, 2021) - but limits in funding and staff capacity hinder program effectiveness and reach, making it impossible for the NYC Department of Parks and Recreation (NYC Parks) to steward all of the trees within their jurisdiction.

This thesis aims to identify ways to grow participation and sustain community involvement in street tree stewardship by using New York City as a case study to explore the ways the city's urban forestry initiatives and stewardship models have centered communities, equity, and co-creation. A primary objective is to look at how those practices and programs can be strengthened to develop long-term tree stewardship and advance the urban forest, especially in EJ communities. More specifically, the research will assess the MillionTreesNYC citywide planting program, neighborhood tree planting initiatives, and various city stewardship programs created to provide care and maintenance of newly planted trees. Through research and conducting interviews with municipal, organizational, and community stakeholders, this work will identify best practices, barriers to overcome, and attitudes towards trees that can be incorporated into future program design that increases and sustains community involvement and urban forest cover, with a focus on low income and low tree canopy neighborhoods. By improving and expanding community engagement and education, addressing barriers to stewardship participation, providing physical and financial resources, and co-creating solutions, communities can help grow the urban forest.

The motivation for this project stems from personal interest and involvement in NYC's urban environmental stewardship community. Starting in late 2012, I spent nearly 10 years working for and around NYC Parks, including park restoration in the Rockaways caused by Superstorm Sandy, helping plant and care for trees in the MTNYC initiative, and providing technical assistance to grassroots community groups caring for their local parks, gardens, and urban forest. I helped provide small grant funding and connect other capacity building resources to dedicated volunteers and organizational partners to advance their stewardship efforts, including installing tree guards, beautifying tree pits, and taking citizen pruner courses. As a

former NYC resident, I saw first-hand both the many challenges street trees face to survive in a dense, urban environment, as well as many people's inspiring work to care and protect the trees on their blocks. As my own learning around environmental justice issues grew, I became more interested in the distribution of green space, access, and ecosystem benefits in NYC. After celebrating the city's MTNYC completion, my curiosity eventually transitioned from "how" the city can plant one million trees to "who" will steward them. Given the extent NYC Parks engages and supports community volunteers, and my own role in supporting collaborative governance, it made me wonder how civic stewards interact with the city, utilize the available resources, and contribute to creating a healthier, more sustainable environment. My thesis is as much rooted in better understanding how NYC plants and cares for trees, as it is checking in with community leaders to see how programs, policies, and processes are working.

Methodology

Research Questions

I developed a primary research question and included several other sub-questions to help tease out additional context related to the overarching theme of my project.

Primary question:

- In what ways have NYC's urban forestry initiatives centered communities, equity, and co-creation, and how might those efforts be strengthened to grow the urban canopy?

Sub-questions:

- How can community stakeholders play a larger role in NYC's urban forest? What kind of resources and support would they need?
- What barriers exist to partaking in forestry programs?
- Rumors circulated in 2022 about some future Million More Trees initiative proposed to increase the canopy by 2030. If there was such a campaign, how do stakeholders recommend approaching it differently?

Literature Review

This thesis is a mixture of qualitative methods. The literature review focused on a range of topics touching on climate change, environmental justice, urban tree planting and stewardship initiatives, collaborative governance, and community involvement in urban forestry programs.

First, I highlighted the current impacts of climate change and the need for adaptation strategies to build resilience. The benefits of trees, the ecosystem services they provide, and the role of trees in the urban environment follow after. I then move into how these benefits are not shared equally, as historically redlined and disadvantaged cities typically suffer from environmental injustices such as less green space and lower tree canopy cover. This makes these areas more susceptible and vulnerable to climate impacts, such as extreme heat and the urban heat island effect. The next section focuses on cities and their attempts over the last couple of decades to address climate impacts through massive urban tree planting initiatives, like committing to plant one million trees. Tree planting should be paired with stewardship and maintenance, so I start to touch on the importance of caring for trees. Many tree planting commitments are carried out by a mixture of government, businesses and nonprofit organizations, and civic groups that represent innovative and evolving forms of environmental and collaborative governance that are important to cover. Despite the potential of large tree planting projects, some literature has shown how these projects might not deliver their desired benefits, could pose numerous programmatic challenges, and exacerbate inequality such as green gentrification. Finally, I will dedicate a section on the co-creation of urban green infrastructure through the lens of civic participation. Understanding residents' involvement, motivations, perceptions, and opportunities to participate in greening initiatives and environmental stewardship programs can help cities develop a robust volunteer network and increase recruitment and retention. These areas will help provide important context to set up my research question on how NYC's urban forestry initiatives center communities, equity and co-creation, and how might those efforts be strengthened.

NYC Case Study: Document Analysis

I briefly explored how NYC has prioritized equity and community involvement in green infrastructure and climate planning through the analysis of several New York City planning, sustainability, and urban forestry initiatives and reports. These documents span three mayoral administrations dating back to 2006, including the MillionTreesNYC campaign, the Cool Neighborhoods plan to address heat vulnerability, and several evaluative reports on the state of NYC's urban forest. Reviewing these systematically complemented my interviews by focusing on similar topics of equity and community involvement. There were reports documenting tree planting initiatives and management strategies over the course of 18 years. I reviewed reports written by NYC Parks, the Mayor's Office, and the U.S. Forest Service that all might have different perspectives and language around equity and community involvement. I searched for how these elements were discussed, the level of focus and attention on equity in the urban forest, and any best practices that can be carried forward. This background helped to establish additional context leading up to my interviews.

NYC Case Study: Interviews

I conducted a case study of NYC's urban forestry initiatives over nearly two decades. The project primarily consisted of interviews with municipal, organizational, and community stakeholders to understand how NYC involves communities and centers equity in its forestry initiatives. I spoke with NYC Parks forestry officials, parks and urban forestry organizational partners, grassroots community stewardship groups, and representatives from the recently created Urban Forest Task Force. I identified and prioritized people who either had a background in leading or supporting urban forestry programs, working closely with NYC Parks,

collaborating with organizational and grassroots greening partners, or navigating public space stewardship. I conducted convenience sampling where I started with people I knew or knew about their work, followed by snowball sampling to cast a wider net around my topic. Though I was not trying to build a representative sample, I did want to capture the breadth of interviewee involvement in an array of forestry initiatives - both citywide and neighborhood-specific. Three interview instruments were created and can be found in the appendices.

Five NYC Parks representatives (i.e. municipal stakeholders or NYC Parks employee) spanning different municipal urban forestry programs dating back to 2007 spoke about their tree planting and maintenance operations, street tree planting process, stewardship programs, working with residents, the evolution of tree planting from MTNYC to annual tree planting throughout the boroughs today, the shift to massive stewardship programs and activities over the last six years, and the city's focus on equity. I was interested to learn how NYC Parks prioritizes equity and community involvement, and how this thinking evolved. Interviewees hailed from the MTNYC program, street tree planting division, stewardship team, a borough forester, and someone formerly of the urban forestry workforce development program.

I contrast these municipal perspectives with those of community leaders and grassroots groups who are participating in these programs. I interviewed six people representing five nonprofit organizations (i.e. organizational stakeholders), which all have strong working relationships with NYC Parks and extensive experience conducting community outreach and engagement, running volunteer stewardship programs, and conducting tree maintenance. All organizations are affiliated with the Forest for All NYC coalition, while three were from the Urban Forest Task Force, a coalition that developed the NYC Urban Forest Agenda that focused on how to improve and enhance NYC's urban forest through planning, stewardship and policy.

Others represented community forestry projects like Greening Western Queens (GWQ) and Greening Greenpoint. Interview questions were geared towards the roles organizational partners play in urban forestry management and initiatives, their perspectives on NYC's urban forestry leadership, how they work with communities and NYC Parks, barriers to community engagement and participation, and how they prioritize equity in their work.

Finally, six people were interviewed from five grassroots community groups (i.e. community stakeholders or community leaders) that represented four of the five boroughs. These community groups are all established, have been operating for at least several years, and bring extensive experience stewarding parks, trees and public open spaces. These people are community leaders and dedicated tree stewards who spoke about their passion for the work, their working relationship with NYC Parks, and their hopes and goals for NYC's urban forest. They also provided insight into their participation (or non-participation) in stewardship programs, trees in under-resourced areas, and other thoughts on program design. I was curious to learn of their experience working within city programs, how they see their level of involvement working with NYC Parks and if they think they are co-creating policy and strategy, and what drove them to get involved with urban forestry projects. Questions focused on their civic background, motivations to get involved, how they are involved with the urban forest, resources they utilize, barriers to participation, and collaboration with NYC government.

There are some limitations to the set of interviewees. I spoke with citizens and volunteers I knew who were long-standing, experienced community leaders in urban environmental stewardship having cared for parks, trails, trees, and other spaces. One group spent roughly 25% of their work supporting their local park and surrounding trails. Another group cares for a playground, plaza and a couple other parks in addition to 175 street trees, while a third group is

responsible for 16 parks and ballfields. These people have worked with NYC Parks for a while and know how to navigate city government. My connections and relationships with community stakeholders – which includes awarding small monetary grants to their community groups – could have influenced our interactions and responses. I did not speak with any residents who were unfamiliar or had limited experience with the urban forest, which might have influenced the data. This is different to Riedman's study who interviewed 10 people affiliated and 10 people unaffiliated in Philadelphia's TreeTender program (Riedman et al 2022). While the goal was to speak with an informed audience to identify programmatic weaknesses and gaps, people with limited to no knowledge on the urban forest could have revealed valuable information on their perspectives working with city government and interest in engaging with the environment - people the urban forestry movement is looking to target. A representative from Staten Island is also a glaring omission from my community stakeholder list. The borough's population density is less compared to other boroughs but tree density is greater, meaning there could have been valuable insight into what tree stewardship looks like for residents there.

Regarding NYC Parks, my study only dated back to about 2007, leaving out decades of programs and experiences with the urban forest. There are a significant number of agency employees who worked on urban forestry initiatives, yet I only interviewed five people. I also could have interviewed residents who were a part of the MTNYC or community forestry programs, instead of just focusing on program managers.

The interviews were semi-structured, open-ended interviews lasting between forty-five minutes to one and a half hours. Interviewees brought in personal experiences and thoughts on program design. Seventeen interviews were held remotely on Zoom, recorded digitally with consent, and I performed verbatim transcription. The final interview list was whittled down from

nearly 30 stakeholders, 24 of which were invited. A full list of the people interviewed can be found in Table 1. Interviews were conducted between August and September 2022. All interviewees were recruited via email. An interview script was developed for each stakeholder group following review of relevant literature (see Appendices). Interview data was coded for common themes.

Practitioner knowledge

I spent nearly a decade of my professional background working in and around NYC Parks programs - with eight years at Partnerships for Parks providing technical assistance to grassroots volunteers. Some of the experiences include serving as a volunteer tree planting captain for MTNYC events; stewarding park and street trees in the Rockaways during the MTNYC initiative; providing capacity building support to community groups; connecting volunteers who were interested in caring for the urban forest with agency staff and resources; and administering a $260,000 grant to an organization for tree planting and stewardship project in North Brooklyn. These experiences informed my research focus and provided a foundation of what projects to review, who to contact, and some of the key questions to ask.

Table 1: List of interviewees broken down into different affiliations

Interviewee	Group/Org/Agency	Division/Program	Type
Brian Aucoin	NYC Parks Department	MillionTreesNYC Training Program	Municipal
Shalini Beath	NYC Parks Department	MillionTreesNYC	Municipal
Jason Stein	NYC Parks Department	Natural Resources Group - Stewardship Team	Municipal
Nave Strauss	NYC Parks Department	Natural Resources Group - Street Tree Planting	Municipal
Sophia Wohl	NYC Parks Department	Brooklyn Borough Forestry	Municipal
Anna Bakis	Brooklyn Greenway Initiative	Greenpoint Tree Planting and Stewardship Project	Organizational
Sam Bishop	Trees New York	Citizen Pruner	Organizational
Ted Enoch	Partnerships for Parks	Catalyst Program	Organizational
Amy Motzny	Gowanus Canal Conservancy	Gowanus Tree Network	Organizational
Julia Raskin	Natural Areas Conservancy	Trail Maintainer Program	Organizational
Julie Welch	Partnerships for Parks	Greening Western Queens	Organizational
Sarah Balisteri	Greenpoint Tree Corps	Greening Greenpoint	Community
Leona Chin	Kissena Synergy	Other	Community
Chris Johnson	Hamilton Grange Neighborhood Association	Other	Community
Marlene Pantin	Red Hook Conservancy	Other	Community
Elizabeth Quaranta	Friends of Mosholu Parkland	Other	Community
Acacia Thompson	Greenpoint Tree Corps	Greening Greenpoint	Community

Chapter 2: Literature Review

Impacts of Climate Change

The planet's weather and climate are changing rapidly due to human influence (IPCC, 2021). Burning fossil fuels emits greenhouse gases, which have steadily accumulated over the last 150 years, warming the ocean, land and atmosphere (IPCC, 2021). The Intergovernmental Panel on Climate Change (IPCC) noted in its Sixth Assessment Report that rising temperatures will increase the frequency and intensity of heat waves, heavy precipitation, droughts, tropical cyclones, and sea levels (IPCC, 2021). Communities are already feeling the impacts caused by climate change. This comes at a time when populations around the world are becoming increasingly urban and coastal (Hugo, 2011).

Increased urbanization brings a variety of climate and health risks. Temperatures in urban environments are higher than in suburban and rural areas (Oke, 1982) and are a significant threat to human health that can lead to morbidity and mortality (McGeehin and Mirabelli, 2001; Weinberger et. al, 2020). The effects of this "urban heat island" (UHI) - caused by the lack of vegetation and high cover of impervious surfaces like asphalt roads and dark building rooftops - are becoming more extreme. Global surface temperatures have increased 1.8 degrees Fahrenheit since 1850 and will increase significantly throughout the 21st century (IPCC, 2021). In the contiguous United States, the annual average temperatures have risen nearly two degrees Fahrenheit in a century (U.S. Environmental Protection Agency, n.d.-a), while heat waves are occurring more often in major U.S. cities, increasing from an average of two heat waves per year during the 1960s to six per year during the 2010s and 2020s (U.S. Environmental Protection Agency, n.d.-b). One study that looked at heat exposure in four U.S. cities showed that by 2050,

climate change will increase the number of high heat stress days and nights (Oleson et al, 2015). Another study showed that by mid-century, annual heat-related mortality could increase by 3,500-27,000 deaths annually (Voorhees et al., 2011).

It is also important to note that extreme heat and other climate hazards do not affect everyone equally. People over 60 years old who suffer from certain diseases and serious medical conditions like obesity, hypertension and long-standing diabetes are at increased risk of heat-related illness (Kenny et al, 2010). The urban heat island also has a greater intensity in central parts of the city where there may be more socially disadvantaged people (Heaviside et al, 2017). These vulnerable groups and other marginalized communities also tend to lack sufficient resources to withstand these extreme conditions (Benevolenza and DeRigne, 2019), showing there is a need to invest in climate resilience/adaptation and mitigation.

The Need for Climate Adaptation to Build Resilience

Climate mitigation strategies that reduce greenhouse gas emissions have been the primary policy to combat future risks and vulnerabilities (Pielke et al, 2007; Preston et al, 2011). International agreements like the Kyoto Protocol and Paris Climate Accords, and U.S. national policies like the Inflation Reduction Act, have emphasized mitigation to limit global warming. However, adaptation planning is becoming increasingly important to address the uptick in extreme weather and other climate hazards (Preston et al, 2011; Measham et al, 2011). Piekel et al. (2007) explained this is due to the growing realization of the "timescale mismatch" - that a certain level of warming is guaranteed due to the accumulation of past emissions, and current decarbonization efforts and policies will not have any effect on the climate for decades. National policies are limited in their ability to address local needs, given the variation of climate change

impacts, demographics, and geography across the U.S. This is causing cities and municipalities to develop and implement place-based adaptation strategies that are creating more livable, healthy, and sustainable cities (Measham et al, 2011; Rauken et al, 2014).

Advancing climate adaptation policies and investing in technologies and engineering solutions helps protect people and places by reducing climate risks and building resilience. Adaptation strategies are developed for various measures including preventing flood damage, ensuring safe drinking water, withstanding extreme heat, and building capacity to deal with future disasters (United Nations, n.d.). These strategies have traditionally been through 'hard' engineering approaches such as constructing seawalls and levees to protect coastlines, irrigation to help manage limited water availability, and dams (Jones et al, 2012). A more flexible, adaptable, and cost-effective alternative to these rigid and expensive measures is nature-based solutions (NbS) - an increasingly popular concept that utilizes nature to address climate change impacts (Jones et al, 2012; Nesshöver et al, 2017; Hobbie and Grimm, 2020). One consistently important aspect across the literature is the creation, development, and management of nature-based solutions that can encourage the involvement of stakeholders (Nessöver et al, 2017; Pauleit, 2017). Nessöver et al, (2017) notes that a participatory process that involves and empowers others can lead to ownership and stewardship of this infrastructure, while also connecting people to their local natural resources.

Urban nature-based solutions like parks, forests, and other green areas can combat extreme heat, manage stormwater and flooding, and improve air quality. Studies show that adding more urban green spaces, rain gardens, and porous pavements reduced surface runoff reduction (Zhang et al, 2015; Rosenberger et. al, 2021). Areas with parks and other urban green spaces reduce temperatures and provide cooling (Hobbie and Grimm, 2020; Aram et al., 2019),

while providing a variety of physical and mental health benefits. Urban greenness can reduce mortality (Crouse et al, 2017), stress, noise, and exposure to air pollutants and increase physical activity and social cohesion (Braubach et al., 2017). Braubach et al. (2017) also notes the significant barriers to green space for under-served and socioeconomically disadvantaged groups. By improving access and availability to these types of spaces, cities can reduce health inequalities. In addition to the positive ecological, social, and health impacts provided by green spaces, they can have a variety of economic advantages such as rainwater runoff reduction, reduced energy usage due to cooling effects, enhanced insurance and property values, and decreasing adaptation costs to climate change (Zhang et al, 2015; Green et al, 2016; Elmqvist et al., 2015).

Trees and the Urban Forest

Cities are using trees as an urban greening tool to build resilience, increase sustainability, and provide significant health and ecosystem co-benefits (Stone et al, 2012; Pincetl, 2010; Wolf et al, 2020). An urban tree is a "woody perennial plant growing in towns and cities" (Roy et al, 2012, p. 352) while the urban forest includes individual trees and groups of trees in parks and forested natural areas on public and private land ranging across cities, towns, and suburbs (Wolf et al, 2020). Urban forestry is the "transdisciplinary science of the planting, preservation, and restoration of trees, forests, and other natural areas in cities" (Watkins et al, 2018, p. 84). Incorporating trees into urban environments is not a new phenomenon. Over the last several centuries, tree planting was driven by a number of factors, including political power, national tradition, urban design function (Eisenman, 2016), and more recently, civic beautification (Roman et al, 2021; Koch, 2000). The concept of trees as ornamentation started to shift during

the Industrial Revolution when mass migration to cities, increasing pollution, and inadequate housing and civic infrastructure created unsanitary conditions (Pincetl, 2010; Koch, 2000; Eisenman, 2016) that helped spawn movements to improve the health of cities, including increasing the amount of street trees (i.e. curbside or sidewalk tree), parks, parkways, park systems, and other vegetation (Koch, 2000; Eisenman, 2016).

In the U.S., trees were included on city streets and squares as early as the 1800s while city beautification efforts helped green industrial cities (Koch, 2000). The establishment of Arbor Day in 1872 brought increased attention to trees, helping create shade tree commissions, commissioners, and tree wardens that advanced the professional management of the urban forest (Konijnendijk et al, 2006; Fisher et al, 2015). These commissions, composed of urban planning professionals and citizens, sought to beautify cities through street tree and park plantings (Fisher et al, 2015). Tree ordinances also established tree planting and maintenance in public-right of ways, parks, and other spaces (Johnston, 1996). Increasing federal government and nonprofit organizational support helped advance the urban forestry movement (Pincetl et al, 2013). While trees became increasingly seen as a tool to improve urban environments (Sklar and Ames, 1985), municipalities had to navigate severe budget cuts and inconsistent funding to sustain their efforts. Austerity measures in the 1970s and 1980s saw an increased role for civic, improvement and non-governmental associations in advancing the urban forest (Seamans, 2013; Fisher et al, 2015). Municipalities are now investing more in urban forestry departments to manage all aspects of planting and maintenance (Braverman, 2008). With nearly 80 percent of the U.S. population living in urban areas, a significant amount of people depend on the many economic, social and environmental benefits and services they provide (Nowak et al, 2010).

Tree Benefits

Urban trees provide a multitude of benefits and services to humans and the environment (Dwyer et al., 1992; Roy et al, 2012; Mullaney et al, 2015). Trees have a variety of social, economic, and health benefits. Tree planting has been shown to enhance a community's social identity and self esteem (Dwyer et al, 1992). Increasing tree canopy cover has also been associated with lower rates of crime, regardless of socio-economic factors (Gilstad-Hayden et al, 2015), though other research has found tree species and planting location may have a greater influence (Donovan and Prestemon, 2012). Urban and community forestry programs can also empower individuals, organizations, and communities (Westphal, 2003). Fisher et al (2015) notes that urban greening allows residents and grassroots volunteers to play an active role in their communities and cities, increase connectivity, and strengthen social relationships.

Economic benefits of urban trees include influencing energy use and air quality, increasing property value, and quantifying ecosystem services. Trees reduce building energy consumption by providing shade and evaporative cooling that requires less air-conditioning during warmer temperatures (Kovacs et al, 2013; Akbari, 2002). Akbari (2002) measured that savings associated with benefits from using less air-conditioning and improving urban air quality can be up to $200 per tree, depending on a region's climate. Ecosystem services like pollutant removal, stormwater runoff reduction, air temperature reduction, and carbon storage, have shown to provide greater benefits as trees reach maturity (Nyelele et al, 2019). Nowak et al (2006) estimated that air pollution removal (O3, PM10, NO2, SO2, and CO) by US urban trees was estimated at 711,00 metric tons and had the equivalent value of $3.8 billion. The impacts of urban trees on human health tend to be greatest in areas with significantly higher population density (Nowak et al, 2014). Research has also shown that trees increase property value in cities

across the U.S. In Portland, Oregon, street trees added nearly $9,000 to the sales price and reduced a house' time on the market by almost 2 days (Donovan and Butry, 2010), while in Athens, Georgia and Tampa, Florida, homes with trees onsite or in close proximity had higher sales prices (Anderson and Cordell, 1988; Donovan et al, 2019). Local communities can benefit from additional tax revenue that higher property values can provide (Dwyer et al, 1992; Donovan and Butry, 2010). Finally, trees can also provide indirect economic benefits to people by helping reduce costs to heating and cooling, stormwater management, damage from flooding and erosion, and health care (Dwyer et al, 1992).

Urban tree cover can play a significant role in improving people's mental and physical health, reducing mortality, and advancing equity. Exposure to nature has significant benefits and has shown to increase perceptions of social cohesion and improve mental health (Cox et al, 2017). Close proximity to, and higher density of, trees have shown to lower antidepressant prescription rates and lower mental mental distress (Taylor et al, 2015; Tsai et al, 2018). Trees play a key role in increasing physical health outcomes too. McDonald et al (2020) quantified the effect of urban tree canopy cover in US cities on summer daily mean air temperatures and found trees can reduce heat-related morbidity and mortality by avoiding nearly 350 deaths and 50,000 doctor's visits due to heat annually (McDonald et al, 2020). Heat does not affect all populations equally. Graham et al (2016) noted that heat-related morbidity occurs more frequently in areas with the lowest canopy cover and highest proportion of impervious surfaces. Assessing the relationship between neighborhood tree canopy cover and heat-related ambulance calls during extreme heat events in Toronto, Canada, they measured that as tree canopy cover increases by 5%, heat-related morbidity is reduced by 80%. In addition to combating heat, the ability of trees to improve air quality has been shown to reduce respiratory issues. Lovasi et al (2008) found that

street trees were associated with lowering the prevalence of early childhood asthma, while the loss of ash trees due to the emerald ash borer led to an increase in mortality due to cardiovascular and lower-respiratory-tract illness (Donovan et al, 2013). Similar to heat, the distribution of trees can also have health implications. Higher tree density and median income were significantly correlated with reduced incidence of respiratory and cardiovascular cases, with African Americans having a greater chance of having respiratory issues above the median rate (Jennings et al, 2019).

Ecosystem Services

Research is increasingly focused on highlighting the ecosystem services - also known as the ecological functions that are linked to human well being - that trees provide (Salmond et al, 2016). These environmental benefits include improving air quality, and managing carbon emissions, influencing micro-climates like the urban heat island, and stormwater management. Urban trees play an important climate mitigating role by sequestering carbon dioxide emissions from anthropogenic sources during photosynthesis (Akbari, 2002; Akbari et al, 2001; Nowak and Crane, 2002). More importantly, according to Akbari (2002), as trees age, the rate of sequestration increases (Akbari, 2002).

Tree growth is also integral to more effectively removing air pollution, as trees absorb pollutant gases (CO, NOx, O3, SO2) through the leaf stomata and intercept particles on plant surfaces (Nowak et al, 2014; Akbari, 2002). By also lowering ambient air temperature through shading and land cover changes that help prevent penetration by incoming thermal radiation, trees help reduce the formation of urban smog and combat the urban heat island effect (Akbari, 2002; Ziter et al, 2019). As noted earlier, temperatures in cities are increasing due to climate

change creating a vicious cycle of energy usage and carbon emissions to try and lower temperatures. Urban forests provide additional cooling through evapotranspiration - the process where water moves from the soil to the atmosphere via plants (Ziter et al, 2019; U.S. Geological Survey, 2018). These cooling functions play a critical role in regulating daytime temperature. For example, Schwaab et al (2021) looked at data across 293 European cities and found that the land surface temperatures for areas with urban trees were on average lower in regions across Southern and Central Europe compared to urban areas without. They also found trees to be more effective at cooling than treeless urban green spaces.

Another key ecological function trees play is managing stormwater. As climate change exacerbates weather events and increases precipitation, trees will be integral to help divert water to reduce impact on the sewer system and prevent flooding. Trees reduce stormwater by "canopy interception loss" (i.e. leaves and branches hold rainwater), transpiration, infiltration (i.e. water absorbed through the tree pit soil surface), and coupling with other green infrastructure (Berland et al, 2017; Elliot et al, 2018). Research has shown that tree pit design and management can play an important role in stormwater infiltration. Elliot et al (2018) demonstrated that installing a guard around the tree pit resulted in higher infiltration rates compared to unguarded pits, which likely could be due to reduced soil compaction caused by foot traffic.

For all of the benefits that trees provide, there is also a significant amount of literature documenting their ecosystem 'disservices', or negative externalities. Urban trees can impact air quality and exacerbate asthma by emitting volatile organic compounds that contribute to the formation of ozone, releasing allergenic pollen, and preventing air pollution dispersion in dense cities (Novak, 2006; Novak, 2014; Eisenman et al, 2019). Nowak (2006) even noted that local tree cover has been associated with possible increases in asthma prevalence and increases in

allergic reaction to tree pollen. Carbon sequestration by urban trees makes them valuable infrastructure to mitigate climate change, but life cycle assessments have shown nursery production, planting, pruning, removal and disposal can make them carbon emitters early in their development (Petri et al; 2016). The costs of maintenance over the life of an urban tree can be significant as tree roots can damage sidewalks, sewer lines, block signs, and cause power outages (Akbari 2002; Mullaney et al, 2015; Vogt et al 2015). Direct costs of regular maintenance of trees like pruning and watering must also be considered (Vogt et al 2015). Finally, trees and other urban greenery can result in increased property values and resources, leading to gentrification that displaces local residents (Roman et al, 2021). Tree benefits and disamenities are experienced disproportionately along racial and socio-economic lines and have been shown as part of a larger pattern of injustice (Landry and Chakraborty, 2009).

Environmental Justice

In the U.S., low-income communities and communities of color have historically faced the brunt of environmental impacts and disparities. A burgeoning grassroots movement starting in the 1970s and 1980s formed in response to environmental injustices that focused on the unequal distribution of toxic facilities, environmental risks and hazards, and other undesirable land uses in disadvantaged communities and communities of color (Cole and Foster, 2001; Miranda et al, 2011).Dr. Robert Bullard and others examined the relationship between race, class, and the siting of hazardous facilities and found that toxic waste dumps, landfills, garbage incinerators and other facilities were often located in communities with a larger percentage of poor, elderly, young, and minority residents (Bullard, 1993), demonstrating that race - regardless

of class - was the most significant factor in the siting process (Taylor, 2014; Loh and Sugerman-Brozan, 2002; Miranda et al, 2011).

Environmental injustice also means political and social disenfranchisement. Disparities in siting hazardous facilities and public health impacts across communities of color - compared to poor or affluent white neighborhoods - have been attributed to a lack of access to political power and decision-making processes (Agyeman et al, 2002). This is a product of decades of racist plans, policies, and actions in the U.S. starting during the New Deal era that further segregated minorities and communities of color, drained them of resources and created barriers to public participation and social mobility (Massey and Denton, 1993). This racial residential segregation was typified by redlining - an insidious practice institutionalized by the federal government in the 1930s that systematically denied home loans to urban neighborhoods based on lending risk that was heavily driven by race, ethnicity and immigration status (Aaronson et al, 2021). The most risky neighborhoods were outlined in red and given a “D” grade, which resulted in significant disinvestment and had lasting impacts on homeownership, house values, and vacancy rates (Aaronson et al, 2021). For example, highly segregated white neighborhoods today have greater home ownership rates, higher incomes, and higher home values, and longer life expectancies than segregated communities of color (Menendian et al, 2021). Menendian et al (2021) also found that as of 2010, 83 percent of redlined neighborhoods were still considered highly segregated communities of color, while 81 percent of metropolitan regions in the U.S. with more than 200,000 people were more segregated in 2019 than they were in 1990, showing the lingering effects of redlining.

Segregation has created significant environmental health disparities across race and class (Loh and Sugerman-Brozan, 2002). Communities of color are exposed to disproportionately high

levels of ambient air pollution (Lane et al, 2022; Tessum et al, 2021). Research has shown that metropolitan areas that are more segregated tend to have worse air quality compared to areas with low segregation (Morello-Frosch et al, 2006). This uneven distribution of air quality also stretches across demographic groups with age, income, and race (Miranda et al, 2011). Racial residential segregation is strongly associated with the emission of particulate matter (PM2.5), which is a large contributor to human mortality (Tessum et al, 2021). Tessum et al (2021) looked at racial-ethnic exposure disparities across the country and found higher-than-average exposures for communities of color and lower-than-average exposures for white communities. Communities of color are disproportionately exposed to emission sources at all levels of income (Tessum et al, 2021). Research found that exposure to poor and toxic air quality is associated with elevated risks of cancer with disparities in segregated metropolitan areas, with the risk burden widening with increasing levels of segregation (Morello-Frosch and Jesdale, 2005). The health disparities, however, are not limited to air quality. The impact of the COVID-19 pandemic was similar. The more racially segregated counties had higher mortality and infection rates, with communities of color with greater infection, hospitalization, and death rates (Torrats-Espinosa, 2021).

Low-income communities and communities of color bear the brunt of climate impacts like extreme heat (Hsu et al, 2021; Chakraborty et al, 2019). Historical housing policies and practices, like redlining, have played a significant role. Spatial analysis of 108 urban areas in the US showed that 94% had higher land surface temperatures in formerly redlined areas by as much as 7 degrees Celsius, while also facing greater financial and health costs (Hoffman et al, 2020). Racial discrimination and disinvestment resulted in environmental inequalities like unequal access to green space and distribution of urban tree cover (McDonald et al, 2021; Watkins et al,

2018, Landry and Chakraborty, 2009). These same neighborhoods tend to have lower street tree diversity and are less likely to have older trees, leaving communities hotter, less resilient to climate impacts, making them more vulnerable (Burghardt et al, 2023). Urban green space inequities like tree cover are often associated with socioeconomic status like income and education (Nesbitt et al, 2019; Yang et al, 2022). Locke et al (2021) studied the distribution of trees in redlined areas and found that residents in A-graded areas had greater access to wealth that were invested in tree planting and green space creation, while D-graded areas had smaller lots, more industrial land uses, and fewer resources for tree maintenance that culminated in lower tree canopy. In Baltimore, wealthier urban neighborhoods have greater street tree abundance, canopy cover, and species diversity (Anderson et al, 2023), while in Miami-Dade County white communities had greater tree density, tree cover, tree diversity, and energy savings, and African Americans had the lowest (Flocks et al, 2011). McDonald et al (2021) found that 92% of urbanized areas surveyed, low-income blocks had 15.2% less tree cover and were 1.5 degrees Celsius hotter than high-income blocks (McDonald et al, 2021). Some research, however, shows that race is not as strongly correlated with tree cover as income. Schwarz et al (2015) looked at the distributional equity of urban tree canopy (UTC) cover across seven large U.S. cities and found there is a positive correlation between UTC cover and median household income, but did not find a high percentage of racial and ethnic minorities in low tree canopy cover.

U.S. Urban Tree Planting Initiatives

Some cities are attempting to use large-scale tree planting initiatives (TPIs) to address these urban forest inequities (Pincetl, 2010; Eisenman et al, 2021; Burghardt et al 2023), while also advancing sustainability and delivering public benefits (Young, 2011; Coleman et al, 2022).

This comes at a time when tree canopy cover in urban areas across the United States is declining and impervious surfaces are on the rise (Nowak and Greenfield, 2018). While there has been a notable increase in TPIs over the last two decades (Sousa-Silva et al, 2023) in cities like New York, Denver, Houston, Boston, and Los Angeles, massive tree planting programs are not new. Before Los Angeles launched its MillionTrees LA program in 2006, a local nonprofit organization TreePeople started a million tree campaign in 1981 that took three years to complete (Johnston, 1996; TreePeople, n.d.).

Urban TPIs are "any planned activity carried out by local, regional, or national governments or non-government stakeholders, such as large landowners or environmental organizations, aimed at increasing or maintaining the overall number of trees in a city" (Sousa-Silva, 2023). They can be high-profile programs with ambitious tree targets and goals that are spearheaded by mayors of populous cities used to enhance tree-planting activities (Eisenman et al, 2021; Pincetl, 2010; Young and McPherson, 2013). They are separate from regular municipal tree planting operations and have their own funding sources, governance structures, engagement strategies and planting goals (Eisenman et al, 2021; Sousa-Silva et al, 2023; Young, 2011). TPIs are made up of diverse funding portfolios that include public, corporate, foundation, and federal government support (Young and McPherson, 2013). These initiatives are often led by the public sector that coordinate and collaborate across a diverse group of grassroots, municipal, and corporate entities to fundraise, conduct outreach, and plant trees (Eisenman et al, 2021; Young and McPherson, 2013). Local governments - such as forestry and parks and recreation departments - take on the bulk of managing and advancing the urban forest (Fisher et al, 2012; Wolf et al, 2021). They are responsible for the tree planting, maintenance, and removal costs along streets, public right-of-ways, and in public parks (Landry

and Chakraborty, 2009, Wolf et al, 2021; Vogt and Hauer et al, 2015; Fisher et al, 2012). While trees tend to be planted predominantly on public property (Eisenman et al, 2021), homeowners and private property are also critical to achieving program and city goals (Pincetl, 2010). In some cities like New York and Los Angeles, nonprofits played an outsized role (Pincetl, 2010; Young and McPherson, 2013). Regardless where trees are placed, community engagement and government collaboration with residents and volunteers are integral to planting initiatives and tree survival, particularly related to tree stewardship (Eisenman et al, 2021; Sousa-Silva, 2023). TPIs allow cities to develop and implement tree stewardship plans where they might not have existed previously (Young and McPherson, 2013). This network of stakeholders to implement TPIs demonstrates the movement towards co-production with the government (Pincetl, 2010).

The addition of young, new trees to dense urban environments requires active and ongoing maintenance to ensure they grow, thrive, and deliver maximum public benefits (Summit and McPherson, 1998; Lu et al, 2010; Breger et al, 2019). The highest tree mortality rates occur within the first several years after planting, so post-planting tree stewardship - specific tree care activities and program processes (Roman et al 2015) - is vital for tree survival (Lu et al, 2010; Roman et al, 2015; Vogt and Hauer et al, 2015; Breger et al 2019; Goncalves, 2019). Many factors affect young street tree survival, such as compacted, contaminated, and nutrient-deficient soil, construction damage, higher temperatures, vandalism, restricted water, and lack of community involvement (Roman et al 2015; Vogt et al, 2024). Boyce (2011) studied one New York City neighborhood's efforts to increase their urban forest canopy and found that street trees lacking dedicated stewards had mortality rates three times greater than trees with stewards. Stewards are designated groups or individuals assigned to provide maintenance for a tree, including watering and tree pit care (Widney et al, 2016). Trees provide greater benefits and

ecosystem services like shade, cooling, stormwater absorption and carbon sequestration as they mature, so supporting their growth and development are critical (Widney et al, 2016; Ko et al, 2015; Nowak and Greenfield, 2018; Coleman et al, 2022). Therefore, minimizing the loss of existing trees is equally important as planting, if not more, making post-planting care and maintenance imperative (Sousa-Silva 2023; Nowak and Greenfield 2018).

Evidence of active, direct stewardship - such as pruning, weeding, pest management, mulching, installing tree guards, watering, and other site maintenance - was a positive indicator for street tree survival (Lu et al, 2010). Pruning helps maintain tree health, prevents branches from impacting utility wires, and increases aesthetics (Summit and McPherson, 1998). Tree guards provide protection in the public right-of-way by preventing soil compaction and animal waste, and have been shown to increase water infiltration rates (Elliot et al, 2018). Adding mulch to the base of the tree is typically implemented at the time of planting and done routinely to improve its health (Vogt and Hauer et al, 2015). Watering newly planted trees consistently for the first several years is critical to their establishment and survival (Mincey and Vogt, 2014; Vogt and Hauer et al, 2015; Roman et al, 2015, Vogt and Watkins et al, 2015; Anderson et al, 2023). However, trees may be scattered throughout a geographic area, making delivering water time and resource intensive (de Guzman et al, 2018; Jack-Scott et al, 2013). Dedicated funding and staffing are critical for tree survival, yet municipal tree care budgets are often not prioritized (Vogt and Hauer et al, 2015). For example, in Eiseman's assessment of city TPIs, the allocation of funds were dedicated predominantly to 'upfront activities' such as tree purchasing and planting (67%), while stewardship activities like watering and maintenance were underinvested (5% and 7%, respectively) (Eisenman et al, 2021). Stewardship activities are receiving less funding in an economic environment with many competing priorities and limited available

resources (Roman et al, 2021, Vogt and Hauer et al, 2015). This has required municipal urban forest management - and environmental stewardship at large - to increasingly explore collaborative solutions with nonprofit organizations and civic groups to help with maintenance (Wolf et al, 2021; Campbell et al, 2021; Pincetl 2010; Fisher et al, 2012).

Collaborative Governance

Government, private businesses and organizations, and civic groups work collaboratively to co-produce urban tree planting and stewardship in TPIs (Breger et al, 2019; Campbell et al, 2021; Eisenman et al, 2021; Pincetl, 2010). The involvement of a diverse network of partners have made TPIs a model of hybrid or collaborative governance arrangements where public and private stakeholders and government work together to engage in consensus-oriented decision-making to address complex public problems (Fisher et al, 2015; Ansell and Gash, 2008). Engaging in collaborative governance helps to address social, economic, and environmental challenges like climate change that cannot be solved by single organizations and requires new creative, flexible, and adaptive approaches (Mitchell et al, 2015; McGuire, 2006). Collaborative governance is also a strategy known to improve public program effectiveness, providing additional avenues for citizens to participate in decision-making and help advance solutions (Mitchell et al, 2015; Kalesnikaite, 2019).

Collaboration with nongovernmental entities can be traced back to the 1970s and 1980s when neoliberal policies drastically reduced municipal budgets and increased the devolution of government responsibilities, contributing to a gap in social service provision filled by nonprofit organizations (Seamans, 2013). The inclusion of nonprofit organizations in policymaking was not an isolated event, but rather they have been playing an increasingly important role in

American society, taking different forms in voluntary associations, interest groups, and social-service agencies (Leroux, 2007). Community members who make up these voluntary associations and grassroots groups donate their time and energy and may be responding to hyper-local concerns and problems, whereas professional organizations have paid staff, are more resourced, and may tackle larger policy issues (Carmin, 1999).

The shift in public service provision is also well documented across the environmental field, as attention and concern grew for urban green infrastructure and environmental problems, with particular emphasis on parks and open space (Pincetl, 2003; Perkins, 2009; Caggiano et al, 2022). The loss of public funding resulted in local governments trimming urban parks department budgets, forcing agencies to rely on nonprofits and volunteer labor (Holifield and Williams, 2014; Perkins, 2009). Establishing public-private partnership was one response to achieve policy goals and help deliver amenities to open spaces (Portney and Berry, 2014; Pincetl, 2003). Though collaborative governance and public-private partnerships have been defined as similar in nature (Ansell and Gash, 2008; Scott and Thomas, 2017), Ansell and Gash (2008) note that public-private partnerships distinctly aim to primarily achieve *coordination* to deliver services or perform tasks, whereas collaborative governance institutionalizes a collective decision-making process.

Environmental governance literature finds that collaboration improves and strengthens policy and program outputs and outcomes (Kalesnikaite, 2019; Scott, 2015; Portney and Berry, 2014). An essential partner in urban environmental governance efforts are civic environmental stewards, who work in public parks, community gardens, wetlands and various other land types, engaging in conservation, natural resource management, education, sustainability and advocacy (Caggiano et al, 2022; Goncalves, 2019; Fisher et al, 2012; Skylar and Ames, 1985). By working

with, and outside of the public and private sectors, these groups exhibit collaborative governance by taking on greater maintenance responsibility of green spaces, assessing local community needs and priorities, advocating for funding, testing innovative approaches, and helping shape urban environmental plans, policies, and programs (Sousa-Silva, 2023; Fisher et al, 2012; Campbell et al 2021; Caggiano et al 2022). These community-based groups range from city residents to more formal academic, athletic, religious, rotary, or other civic entities and operate under various budgets and structures (Campbell et al, 2021) and involve themselves in a number of ways, including the creation of public programming, building peer networks and social cohesion, growing the capacity of other stewards, and physically managing green spaces like the urban forest (Campbell et al, 2021; Fisher et al, 2012; Fisher et al, 2015).

Citizen involvement in environmental and urban forest governance has developed from a narrow focus on public participation in government policies and formalized planning practices towards increased active citizenship in a 'mosaic governance' approach that is sensitive to, and inclusive of, citizen group expertise and place-based ecological, social, and cultural context (Bujis et al, 2016). Top-down, one-size-fits-all management that ignores the roles of communities are being replaced by governance approaches that evolve to meet citizens' needs (Campbell et al, 2016; Bujis et al, 2016). For example, the city of Melbourne, Australia, has utilized forms of mosaic governance to engage citizens in developing urban forest precinct plans, tracking plan implementation, and sharing personal knowledge on urban trees (Gulsrud et al, 2018; Nesbitt et al, 2018). Melbourne's community-based planning moves beyond conventional participatory practices towards co-production of program and policy solutions (Gulsrud et al, 2018) - a specific mode of collaborative governance that emphasizes the active engagement and involvement of diverse stakeholders (Hölscher et al, 2024; Satorras et al, 2020). Ensuring local

community urban forest preferences are integrated into urban forest planning also advances equitable and inclusive solutions (Sax et al, 2020; Goncalves, 2019). These practices are part of a larger trend of 'governance with government' as opposed to 'governance by government' (Lawrence et al, 2013).

Researchers highlight numerous challenges local governments and an active citizenry face when working and sharing decision-making authority. Collaborative governance can be time-consuming and stressful, which could impact productivity and even fail to yield results (Mitchell et al, 2015). Participants may struggle to agree on common goals, power may be shared unequally, volunteers might be hindered by government reluctance to partner, there can be a lack of trust, or too many actors may complicate communication and decision-making processes (McGuire 2006; Satorras et al, 2020). Collaborative governance may be reliant on staff, funding, and political and institutional support where any loss of resources or deprioritization can hamper the partnership (Mitchell et al, 2015). Successful inclusion and mobilization of civil society groups could create an overreliance on volunteers that diminishes the importance of paid government staff and leads to further public disinvestment (Perkins 2009; Young and McPherson 2013). Nonprofit organizations taking on programmatic leadership roles and serving as intermediaries may exhibit sole decision-making authority, be ineffective in promoting community and marginalized group participation, and limit shared-decision-making (Carmichael and McDonough, 2018). Research also highlights the strength of the public sector and its primary role in implementing TPIs, which opposes the argument that government is ineffective, is reliant on the private sector, and TPIs are an 'evolution of governance strategy' (Young and McPherson, 2013). Finally, operational and logistical challenges can limit the effectiveness of collaborative governance. There are equity concerns that the use of information and

communication technology may inadequately engage communities, especially when cities already struggle to reach a diverse representation of citizens, including immigrant and low-income groups (Sorrentino et al, 2018; Hölscher et al, 2024). A lack of financial resources and insufficient outreach and education could also limit organizational and stewardship capacity to develop long-term stewardship of trees and other natural resources (Young, 2011; Goncalves, 2019).

TPIs and Equity

Tree planting initiatives utilize a unique governance structure to advance the urban forest on public and private land. While TPIs and urban forestry programs often prioritize urban sustainability and environmental justice, research has shown they might not deliver these desired benefits, could pose numerous programmatic challenges, and exacerbate inequality (Sousa-Silva, 2023; Landry and Chakraborty al, 2009).

One concern is that trees and canopy cover are not equitably distributed in urban environments. As touched on earlier, wealthier urban neighborhoods tend to have greater tree abundance and canopy cover, while low income neighborhoods are associated with lower levels of tree canopy (Anderson et al, 2023; Danford et al, 2014). TPIs try to bridge these distributional and equity gaps by planting in those neighborhoods of need (Burghardt et al, 2022) but research shows this is not always successful. One study of four nonprofit-led planting programs found the probability of tree planting was higher in more highly educated neighborhoods while planting was less likely to occur as neighborhood minority composition increased (Watkins et al, 2017). There is also a lack of follow-up on tree survival and growth and the implementation of environmental justice goals (Sousa-Silva, 2023; Eisenman et al, 2021, Widney et al 2016;

Garrison, 2018). City resource constraints have impacted monitoring tree establishment, survival rates, and canopy cover change (Sousa-Silva, 2023), while some TPIs lacked sufficient measures to track progress and determine whether planting was equitable (Garrison, 2018). Garrison (2018) analyzed recent tree planting initiatives by New York City and Los Angeles and found that despite commitment to improving distributive equity, NYC planted more trees in areas with existing higher tree densities than those associated with poverty or race (Garrison, 2018). Danford et al (2014) also found that well-intentioned initiatives can hinder equity goals due to site constraints. The Grow Boston Greener's program found public tree planting sites are often not available in environmental justice communities due to industrial, transportation, or utility land uses (Danford et al, 2014).

Housing tenure - whether one rents or owns property - influences urban canopy cover distribution and maintenance. Tree canopy cover is typically greater in single-family, affluent areas where there is more space to plant trees compared to more densely populated areas containing multi-family homes and fewer public tree parcels (Pincetl, 2010; Anderson et al, 2023). Since private property can predominantly make up total urban land use (Perkins et al, 2004), neighborhood investment can exacerbate existing structural inequities based on income and housing tenure (Burghardt et al, 2023). Donovan et al (2014) found that census block groups associated with less education and lower incomes correlated with more renters. Renters (higher rentership rates) have correlated with lower overall residential tree canopy cover and higher African American population (Perkins et al, 2004). Since larger trees provide greater health and ecosystem benefits and tend to increase property values, homeowners and higher-income populations benefit more due to their proximity to trees on their property than marginalized communities that have more renters and fewer trees (Perkins et al, 2004; Heynen et al, 2006).

Increased property values and housing prices due to local tree planting and neighborhood investment can lead to gentrification by displacing residents in disadvantaged communities (Riedman et al, 2022). For renters, lacking a sense of ownership over trees prevents decision-making authority where they live (Jennings et al, 2019) while impacting motivation to care and protect newly planted trees (Skylar and Ames, 1985).

The dynamic between housing tenure and trees shows that tree planting in low-income and racially diverse communities does not automatically advance environmental justice and solve distributional inequities. Research on the tree planting program in Portland, Oregon found that people with existing trees were increasingly likely to plant more (Donovan and Mills, 2014). Donovan and Mills (2014) noted that if the City decided to focus planting in areas of higher need, then fewer residents might plant trees (Donovan and Mills, 2014). There are several strategies to prevent TPIs from exacerbating inequities: greater attention to tree planting strategy, addressing social infrastructure/sociodemographic factors, and evaluating historical inequalities in tree distribution (Campbell et al, 2021; Sousa-Silva, 2023; Donovan and Mills, 2014; Anderson et al, 2023). Understanding citizens' motivations for civic engagement, perceptions of trees, and how they are involved in TPIs can help inform solutions that focus on engaging marginalized communities from the start on TPIs, reduce barriers to participation, and expand education can help bring more people into the fold.

Community Involvement and Public Participation in Urban Forestry

Community involvement is integral to tree planting and stewardship programs (Moskell et al, 2011; Locke and Grove, 2016; Hand et al, 2019; McNamara et al, 2022). Many cities cannot rely solely on public lands to achieve their urban tree canopy goals and need to plant trees

on private property (Locke and Grove, 2016; Battaglia et al, 2014). Meanwhile, limited staff, contractor support, and budgets hinder municipalities from caring for all new and mature trees (Moskell et al 2011; Moskell and Allred, 2013). Public involvement in urban environmental stewardship has many benefits, including supporting physical infrastructure and advancing participation processes (Fors et al, 2015). Caring for trees increases appearance, reduces costs, enhances technical skills, and enhances tree growth and survival (Fors et al, 2015; Moskell et al, 2016). Participation can also increase public trust, build consensus, improve governance processes and quality decision-making, ensure local needs and priorities are met, and promote active citizenship (Reed, 2008).

However, the need for an active, engaged citizenry is an ongoing challenge to address. The public, not just urban forestry volunteers, feel positively towards trees and generally understand the importance they play in cities (Lohr, 2004; Conway and Bang, 2014; Kirkpatrick et al, 2013). There is also a desire for residents to improve and be involved in their communities (Fisher et al, 2015; Moskell et al, 2011). Environmental stewardship and urban greening can serve as a gateway to becoming more civically engaged, while also strengthening social capital (Fisher et al, 2015; Ryan, 2015). On the other hand, some people have mixed attitudes towards trees (Battaglia et al, 2014). They believe the government should be responsible for tree stewardship (Moskell and Allred, 2013), that civic participation is correlated with socioeconomic status (Portney and Berry, 2010), and that citizen engagement can hinder sustainable outcomes (Wamsler et al, 2020). Understanding residents' involvement, motivations, perceptions, and opportunities to participate in TPIs and environmental stewardship programs can help cities develop a robust volunteer network by engaging more people, improving their overall

experience, and increasing recruitment and retention (Moskell and Allred 2013; Vogt et al, 2024).

Learning more about who typically volunteers with TPIs and urban environmental stewardship can provide a better understanding of people's involvement. Individual citizens, neighborhood associations, community groups, and business improvement districts are all stewards (Fisher et al, 2015; Campbell et al, 2021; Conway et al, 2011; Butt et al, 2021). Stewards can be novices who engage only once and lack sufficient knowledge about the urban forest, or they can be regular, committed volunteers with significant experience that dedicate substantial amounts of time to the ongoing care and maintenance (Fisher et al, 2015). Stewardship groups play an important role in organizing and engaging their communities, leading by example, and building the capacity of stewards through education and public programming (Campbell et al, 2021). Volunteer demographics in urban greening projects predominantly tend to be people who identify as white, female, older, more affluent, and college-educated (Ryan, 2015; Fisher et al, 2015; Conway et al, 2021; Wolf et al, 2021). This trend stretches also to tasks and responsibilities outside of hands-on work. One study looked at the average tree board member in a Tree City USA community and found they are mostly male, well-educated, nearly one-third were retired, and half were over the age of 60 (Greenleaf and Ries, 2019). There is a clear need to increase representation across race, age, and class in environmental participation and decision-making (Wolf et al, 2021; Greenleaf and Ries, 2019), especially since varied volunteer participation – such as greater activity by people in wealthier neighborhoods with more single-family homes – has exacerbated existing urban forest inequities (Riedman et al, 2022; Conway et al, 2011). The racial composition of community and neighborhood groups can also impact where people choose to volunteer (Jo et al, 2023).

There are different types and levels of participation in public programs and policy debate based on citizens' power and influence, from non-participation to full control of decision-making (Arnstein, 1969). For simplicity, this paper uses participation interchangeably with public participation, citizen participation, citizen involvement, stakeholder engagement, community engagement, or civic engagement (Sarzynski, 2015). The degree of citizen participation, influence and control through co-production and inclusive planning is becoming a mainstay in urban climate governance (Sarzynski, 2015). For example, one formalized public participation method that has taken root is forming climate action committees, which target and engage stakeholder groups and residents for extended periods of time to make decisions and support planning processes (Anguelovski and Carmin, 2011; Rowe and Frewer, 2000). When it comes to green infrastructure projects, stakeholders want to be involved in the planning to a greater extent (Wilker et al, 2016). Fors et al (2015) notes that this involvement in green spaces can be physical (directly affecting the environment through tree planting, tree assessment, maintaining vegetation, or construction) or civic (input into master plan decisions, management decisions, fundraising, and lobbying). Residents and community groups can support the urban forest through leading or participating in independent stewardship efforts or attending formal nonprofit and governmental volunteer programs (Moskell et al, 2016). The opportunities for citizen involvement can range from one-off tree planting and stewardship events to longer-term skill development training, advocacy, and routine tree stewardship events or programs that include pruning, mulching, and watering (Moskell et al, 2011; Vogt et al, 2024). Other non-physical opportunities include serving on urban forestry citizen advisory boards (Greenleaf and Ries 2019), online methods like contributing to newsletters, writing emails, managing social media accounts, and conducting outreach, and through giving money (Vogt et al, 2024).

People's feelings, perceptions, and attitudes about trees impact their participation and involvement in urban forestry. Volunteers engaging in the urban forest are motivated by a number of factors, including gaining career-related experience (Vogt et al, 2024; Greenleaf and Ries, 2019) and knowledge about trees (Vogt et al, 2024), helping the environment and mitigating climate change (Vogt et al, 2024; Moskell et al, 2011; Battaglia et al, 2014; Goncalves 2019), addressing the lack of government resources (Moskell et al, 2016), and having a positive impact on their local community (Moskell et al, 2011; Vogt et al, 2024). Improving one's community yields positive social experiences and interactions, helping build local relationships that creates a sense of belonging and attachment to place (Fisher et al, 2015; Wolf et al, 2021; Ryan, 2015). Social benefits of volunteering, along with programs designed to allow for greater volunteer input are strong motivators for volunteers to return and remain involved (Vogt et al, 2024). Participation in community environmental stewardship projects also has been found to increase resident empowerment by equipping them with the knowledge, skills, and experience to care for trees within one's own neighborhood and yard and even participate in other civic groups (Ryan, 2015; Moskell et al, 2016).

Negative perceptions of trees can hinder resident tree planting and stewardship participation. People are concerned about tree disservices such as attracting wildlife and insects, releasing pollen, and causing property damage (Battaglia et al, 2014). With tree planting, residents can be protective of the public right-of-way and exhibit feelings of personal ownership (Rae et al, 2010), while they are also worried by the threat of neighborhood development and gentrification (Riedman et al, 2022; Battaglia et al, 2014). Others are disillusioned with understaffed and underfunded city services that have not exhibited proactive tree management, making citizens who have experienced historical tree disservices and disinvestment believe the

financial, safety, and aesthetic burden will fall onto them (Riedman et al, 2022; Carmichael and McDonough, 2018). Numerous barriers to participation also make it challenging for people to support tree planting initiatives, especially in low-income and minority communities (Riedman et al, 2022). Many communities lack the available space in neighborhoods to plant trees, which could exacerbate inequalities (Riedman et al, 2022). Community leaders and organizations are overburdened, facing limited time, resources, and capacity Riedman et al, 2022; Perkins et al, 2004. Tree planting initiatives may not always align with other community priorities (Perkins et al, 2004). Residents may not also be equipped with the knowledge, skills, and experience to care for a tree into maturity. For example, Lohr (2004) found that urban residents who did not believe trees were important to their quality of life were more likely to be male, young, poorly educated, or low-income and be either African American or Asian American (Lohr, 2004). A lack of demographic representation, older residents, and language barriers also pose additional communication hurdles (Riedman et al, 2022). Cities and organizations can better understand and incorporate these motivations, concerns, and feelings into their outreach and engagement to help recruit more volunteers and design better stewardship programs (Wolf et al, 2021; Conway et al, 2021).

The urban environmental stewardship and forestry literature covers extensively how program managers, organizations and other stakeholders/practitioners can leverage resident and volunteer needs and motivations to increase program participation. Given one of the most significant challenges for engagement is a lack of urban forestry knowledge among stakeholders (Moskell et al, 2011; Conway et al, 2021; Butt et al, 2021), entities can provide public education about topics such as the benefits of trees (Moskell et al, 2011; Goncalves et al, 2019; Rae et al, 2010), tree stewardship (Moskell and Allred, 2013), and tree planting processes (Rae et al, 2010)

to help residents gain skills and confidence that will motivate them to continue their involvement (Butt et al, 2021). This information should reach diverse populations (Conway et al, 2021) and be tailored to address local interests, conditions, and concerns (Barron et al, 2021; Battaglia et al, 2014; Goncalves, 2019). In Detroit, the nonprofit organization leading tree planting efforts focused solely on educating residents about tree benefits despite the community already being well-versed (Carmichael and McDonough, 2018). Ignoring their past negative tree experiences and providing minimal opportunities to influence decision-making were primary reasons why fewer people participated in the program (Carmichael and McDonough, 2018).

Research has also explored other strategies to encourage participation. In-person and door-to-door outreach increased engagement, stewardship, and improved tree health through (McNamara, 2022; de Guzman, 2018). Sending weekly postcards to encourage residents to water newly planted trees had a positive impact on their watering behavior (Moskell et al, 2016), while phone call reminders increased attendance at tree giveaway events (Hand et al, 2019). Increased municipal and organizational staff capacity are critical to conducting this sustained engagement (Walmsler et al, 2019) and providing technical assistance opportunities to help residents with valuable time-intensive tree maintenance and support throughout the full life cycle of a tree (Riedman et al, 2022; Carmichael and McDonough, 2018). Finally, allowing citizens to influence and meaningfully engage in the planting and stewardship process can drive participation (Carmichael and McDonough, 2019; Reed, 2008) while ensuring local knowledge, community perspectives, and concerns are included (Riedman et al 2022; Barron et al 2021). Broadening outreach and engagement to unwilling partners and renters (Conway and Bang, 2014; Perkins et al, 2004), networking with non-greening groups (Westphal, 2003), and making sure engagement

staff are representative of the communities they serve are additional recommendations to improve participation (Donovan and Mills, 2014).

Chapter 3: New York City's Urban Forest

NYC Geography and Demographics

New York City (NYC) is the country's most populous city at roughly 8.48 million (NYC Department of City Planning, 2025), spread out across 59 community districts. Brooklyn and Queens have the highest populations of the five boroughs, with Staten Island being the smallest. At roughly 300 square miles, NYC has 29,303 people per square mile (U.S. Census Bureau, 2023) making it the most dense city in the country. The city is a racial and ethnic melting pot, including white alone (35.9%), Black alone (22.7%), and Asian alone (14.6%), while 28% are Hispanic or Latino (U.S. Census Bureau, 2023). Approximately 48% of the population speaks a language other than English at home, while 52% speak English only. The median household income is $79,713, with 17.4% of the population living in poverty. NYC was considered a temperate climate until 2020 when the U.S. National Climate Assessment reclassified the city as a humid subtropical climate zone (Collins, 2020; City of New York, 2023), meaning on average the summers and winters will be increasingly warmer.

NYC Climate Hazards

Climate change is impacting NYC right now, with significant threats from rising sea levels, more frequent extreme weather events, and increasing temperatures (McPhearson et al, 2024). Superstorm Sandy and Hurricane Ida are two recent examples of how vulnerable the city is to extreme weather. Climate impacts have significant health-related economic costs too, with NYC deaths, hospital visits, and emergency room visits from climate-sensitive events resulting in annual costs of $4.17 billion and $83.45 billion over two decades (McPhearson et al, 2024).

The city's primary climate hazards are extreme heat, coastal storm surge, inland and coastal flooding, and extreme precipitation (City of New York 2023; Braneon et al, 2024). Summer temperatures over 90 F have increased over the last decade, while the number of days with minimum temperatures below freezing have declined since 1900 (Braneon et al, 2024). The year 2023 was one of the hottest on record across the five boroughs (NOAA, n.d.; Spectrum News, 2024), with higher temperatures extremely likely for the New York metropolitan region in the coming decades (Braneon et al, 2024). It is projected in the 2030s there will be up to three times as many days above 90 F and up to four times as many heat waves (City of New York 2023; Mayor's Office of Climate and Environmental Justice, 2024). The New York City Panel on Climate Change projects up to a 5.7 F increase (City of New York, 2017), while average annual temperatures will also increase by the 2100s (City of New York, 2023). This heat is creating a public health crisis, with extreme heat the leading weather-related cause of death in NYC (Mayor's Office of Climate and Environmental Justice, 2024). More than 500 New Yorkers die prematurely each summer due to the hot weather (2025 Heat Mortality Report, n.d.). The heat is also impacting air quality. Ground-level ozone (O3) is produced by pollutants and heat, and had higher levels in 2023 than any previous year dating back to 2009 (NYC Community Air Survey Annual Report, n.d.). This could become worse as temperatures continue to rise.

New York City's coasts are susceptible to coastal flooding by storm events and tidal flooding, which are projected to increase (City of New York 2023). New York City sea levels have risen a foot since 1900 and could increase by almost 5.5 feet by 2100, inundating low lying areas more often and exacerbating coastal flooding during storm surges (City of New York 2023; McPhearson et al, 2024; Braneon et al, 2024). Warming ocean temperatures are slated to increase intensity and frequency of tropical storms in the Northeast making the coastal communities more

vulnerable to coastal storm surge (Mayor's Office of Climate and Environmental Justice, 2024). According to a 2015 Federal Emergency Management Agency flood assessment, nearly a sixth of NYC's land area and over 400,000 residents sit in the 100-year floodplain, which is slated to increase with rising sea levels (City of New York, 2023). The frequency of tidal flooding, also known as sunny-day flooding that occurs naturally in low-lying areas with no rain or storm event, has nearly doubled and could increase to an average of every other week by 2080s (Mayor's Office of Climate and Environmental Justice, 2024). These flood events can damage the sewer system through saltwater exposure and erosion (Mayor's Office of Climate and Environmental Justice, 2024).

Climate change is also causing more frequent and intense extreme precipitation events in the northeast U.S. (Braneon et al, 2024). Short-term rain events, also known as cloudbursts, can cause severe flooding, especially in low-lying areas that have less green space (Mayor's Office of Resiliency, 2021). Nearly 60 percent of NYC's sewer system is 'combined', meaning one pipe carries both stormwater runoff and sewage from buildings. When intense rain events inundate the sewer system, it can overflow and send waste and pollutants into local waterways (Mayor's Office of Climate and Environmental Justice, 2024; Mayor's Office of Resiliency, 2021). More rainfall is on the horizon. The city is projected to experience more extreme precipitation in the mid-to-late century, while by the end of the century, there could be 1.5 times as many days as today with more than one inch of rain and annual rainfall could increase more than 30 percent (Mayor's Office of Climate and Environmental Justice, 2024; Mayor's Office of Resiliency, 2021). A greater probability in high-intensity precipitation events could result in more urban flooding (Mayor's Office of Climate and Environmental Justice, 2022). In 2021, Category 4 Atlantic Hurricane Ida typified the extreme rainfall and stormwater flood events that can be

expected in the future. The storm sustained 150 mph winds and broke the city's hourly rainfall record, inundating sewers and flooding inland communities. Eleven of the 13 people who died from the storm were living in unregulated basement apartments - informal housing arrangements that pose hazardous conditions (City of New York, 2023; Leitch and MacLean, 2022). Not only did Hurricane Ida shine light on an emerging policy issue around housing and wastewater infrastructure, but it was a reminder, just as Superstorm Sandy before it, that climate change disproportionately impacts low-income and marginalized communities.

Climate Change and Environmental Injustice

In 2024, New York City's Mayor's Office of Climate and Environmental Justice released a report that studied the cumulative impacts of environmental burdens and the disparities in environmental benefits affecting low-income communities and communities of color. One of the report's key findings was that these New York City communities "bore the disproportionate burden of polluting infrastructure while simultaneously experiencing disinvestment in environmental benefits such as parks and natural resources, and solid waste pickup" (Mayor's Office of Climate and Environmental Justice, 2024, p. 7). This reiterated how systemic racism and disinvestment segregated communities across the country and subjected them to years of environmental, social, and economic injustices. The impact of redlining and other racist policies persist in New York City and can be seen in how climate change hazards and risks impact communities today. Flooding due to coastal storm surge, chronic tidal flooding, and extreme rainfall are more likely to affect NYC environmental justice communities this decade and could persist into the future (Braneon et al, 2024; Mayor's Office of Climate and Environmental

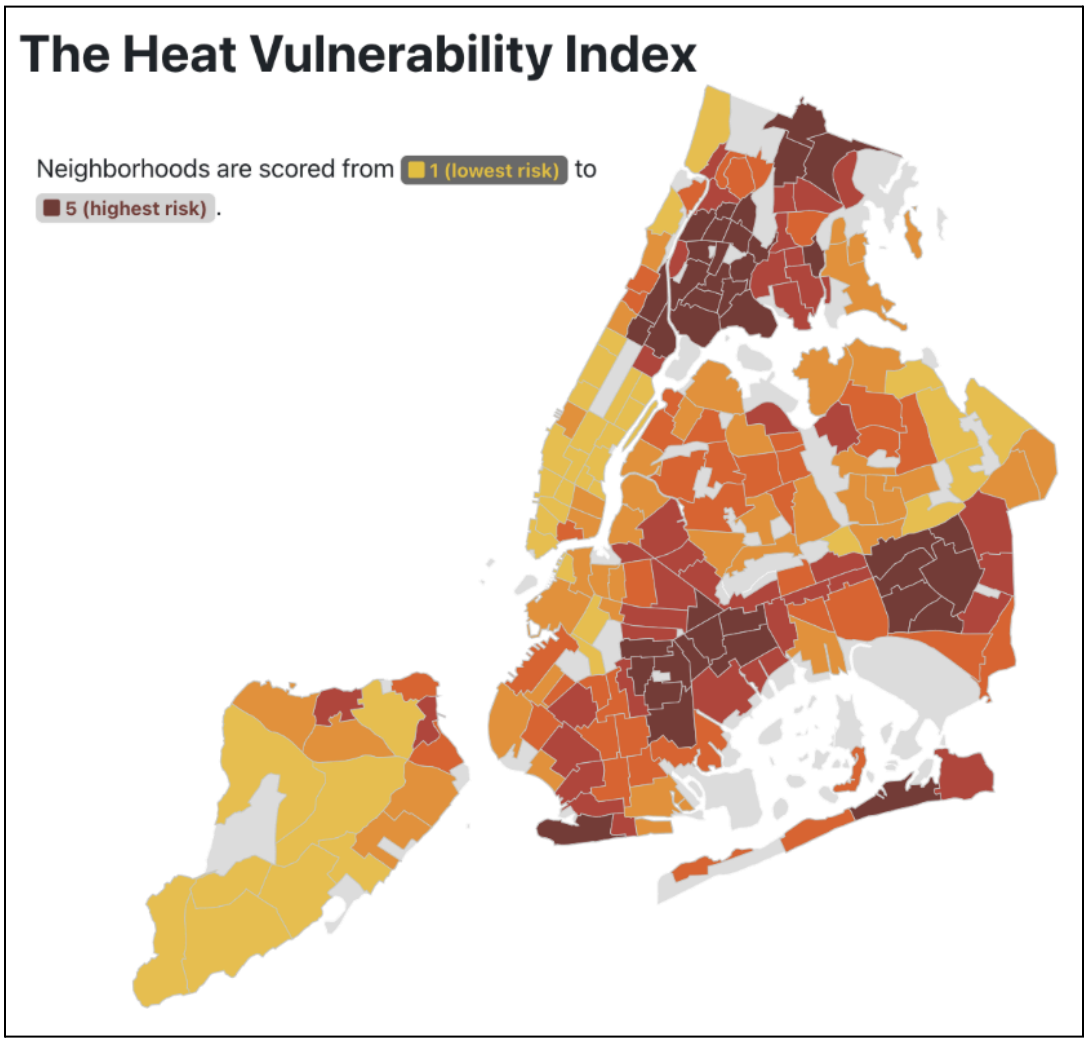
Justice, 2024). Hurricane Ida impacted low-income and immigrant communities disproportionately (City of New York, 2021).

Heat has a similar impact and reach. Nearly half of all NYC heat-related deaths occurred in neighborhoods with high or very high poverty levels (Braneon et al, 2024). Black New Yorkers are more than twice as likely to die from heat stress than White residents, and have a higher likelihood of heat-exacerbated death compared to other New Yorkers (Braneon et al, 2024; 2025 Heat Mortality Report, n.d.), as they typically have higher rates of poverty, lower access to air conditioning, green space, and neighborhood cooling resources (Interactive Heat Vulnerability Index, n.d.). Access to air conditioning varies across race and class and is considered by some the most important health risk factor as heat exacerbated deaths at home are more likely to occur (2025 Heat Mortality Report, n.d.; City of New York, 2023). Environmental justice communities are most vulnerable to heat and have the lowest rates of air conditioning at home (Mayor's Office of Climate and Environmental Justice, 2024). One study found that financial barriers play a critical role in determining whether Black and low-income New Yorkers own or use air conditioning in hot weather (Mayor's Office of Climate and Environmental Justice, 2024). Given the severity of extreme heat, the City's Department of Health and Mental Hygiene and Columbia University developed the heat vulnerability index (Figure 1). This tool combined environmental and social factors - average surface temperature, percentage of green space, access to home air conditioning, median income, and the percentage of residents who are non-Latinx Black (Mayor's Office of Climate and Environmental Justice, 2024) - to identify the most heat vulnerable neighborhoods (City of New York, 2023; City of New York, 2017). The areas in NYC with the highest vulnerability of heat (HVI-5 and HVI-4) also happen to be in historically redlined neighborhoods, including Central and South Bronx, Upper Manhattan,

Central and East Brooklyn, and Southeast Queens (Mayor's Office of Climate and Environmental Justice, 2024). Communities of color face an uneven distribution of urban green infrastructure in NYC compared to predominantly white areas, depriving them of access to critical ecosystem benefits (Herreros-Cantis and McPhearson, 2021). Environmental justice areas have a 19% deficiency of accessible park space in NYC compared to non-environmental justice areas (Mayor's Office of Climate and Environmental Justice, 2024). Urban tree canopy is lower in communities with lower household income and higher proportions of people of color (Forest for All NYC, 2021; Treglia et al, 2021)

New York City is using trees as one way to advance environmental justice, mitigate extreme heat, and increase resilience. The city is building on years of urban forest leadership by planting new and maintaining existing trees to equitably expand the urban tree canopy from 22% to 30% (Office of the Mayor, 2023). This commitment was cemented by the passing of Local Law 148, which required developing an Urban Forest Plan to meet the new urban forestry goal (Local Law 148, 2023). This followed recent investments in heat vulnerable communities through Cool Neighborhoods NYC, the city's first heat resiliency plan in 2017. As of June 2023, over 15,600 street and park trees were planted in HVI-5 neighborhoods with the goal to plant trees "in every viable place in HVI-4 and HVI-5 neighborhoods by 2027" (NYC Parks, 2024a). New York City has a long history of prioritizing equity and community involvement in their urban forestry initiatives that it can draw from as the city works to address climate change.

Figure 1: NYC Heat Vulnerability Index



Source: NYC Environment and Health Data Portal (*Interactive Heat Vulnerability Index.* (n.d.))

Trees in NYC

Over 7 million trees make up the New York City urban forest, including 200 species (NYC Parks, n.d.-a). The urban tree canopy - the parts of a tree including leaves, branches, and stems that shade the ground - covers 22%, or 42,654 acres, of NYC's land area (NYC Parks,

n.d.-b). Approximately 57% of the total tree canopy is on city land, followed by 35% on private land, and nearly 8% on state and federal jurisdiction (Treglia et al, 2021). Urban tree canopy distribution varies across the five boroughs, with Queens and Staten Island containing nearly one-third and one-quarter, respectively, of the city's tree canopy (story map). The canopy is in constant flux, with increases due to tree growth and new plantings and losses caused by storms, pests and diseases, decay, and vandalism. Land use and ownership patterns impact tree canopy dynamics on lands not under the jurisdiction of NYC Parks (NYC Parks, n.d.-b). Recent analysis of tree canopy change showed that from 2010 to 2017, the canopy generally increased across the city by 1.7%, with the majority in the rights-of-way. These canopy increases tended to be in areas with higher poverty rates and heat vulnerability, likely due to new plantings from tree planting initiatives and growth from existing trees (Treglia et al, 2021).

NYC's urban forest provides significant benefits. According to the New York City Department of Parks and Recreation (NYC Parks), the city's street trees intercept 1.2 billion gallons of water, conserve 770,000 kilowatt hours, and remove 1.4 million pounds of air pollutants each year at an economic value of over $122 million annually (NYC Parks, n.d.-b). Street trees and parkland trees combine to store about 1.2 million tons of carbon (Nowak et al, 2018). The U.S. Forest Service estimated that the compensatory value of the city's forest - the estimated costs to replace the trees based on their size, condition, and location - is about $5.7 billion (Nowak et al, 2018). As the impacts of climate change worsen and become more frequent, the urban forest will become more susceptible to immediate and long-term damage caused by intense storms, flooding, and saltwater inundation (NYC Parks, n.d.-b). Proper management of the city's urban forest is needed to ensure ecological and economic benefits.

Management of NYC's Urban Forest

NYC Parks is responsible for planting and caring for all trees growing in parks and in the public right of way - the area between the curb and private property line (Chapter 21, Department of Parks and Recreation, NYC Charter, Section 533, n.d.). The agency, which stewards more than 30,000 acres of land across NYC, oversees the largest share of the total urban forest at roughly 81% (about 5.7 million trees), with over five million in landscaped parks and natural forests and over 660,000 trees spanning city streets (NYC Parks, n.d.-c). More than half of the city's tree canopy (53%) falls within NYC Parks jurisdiction, with 28% concentrated in natural and developed parkland and 25% in the public right-of-way, such as trees lining sidewalks, in medians and malls, along parkways and road edges, and other transportation corridors (Treglia et al, 2021; NYC Parks, n.d.-c). Trees under NYC Parks jurisdiction are protected through various laws, rules, and regulations. Working on or around street or park trees requires a Tree Work Permit; the failure to obtain adequate approval can lead to arrest and prosecution. For example, removing a tree without a permit is illegal and punishable by law with a fine "up to $15,000 and/or imprisonment for up to one year" (NYC Parks, n.d.-d). There are also requirements for trees that are permitted to be removed, such as planting a replacement or paying a fee to NYC Parks to cover the replacement cost (Treglia et al, 2021). The city government has also taken steps to strengthen tree regulations to help expand the urban forest. In 2008, the City Council adopted a zoning amendment that mandates street tree planting in all zoning districts, except industrial areas. The regulation requires that for any new developments or significant building renovations, "one street tree would be required for every 25 feet of street frontage of the zoning lot", or plant off-site where there are space limitations (NYC Department of City Planning, 2008). NYC Parks chooses the species, size, and location of street trees in

accordance with their own planting standards (Treglia et al, 2021). Since street trees are critical city infrastructure and are planted in the public right-of-way, nearby homeowners and businesses are not able to refuse plantings (NYC Parks, n.d.-d).

NYC Parks manages and oversees all maintenance of over 660,000 street trees and 156,000 trees in landscaped parks to ensure public safety and promote tree health, including planting, inspection, pruning, and removal and disposal of dead trees. Forest trees are managed at the ecosystem level (NYC Parks, n.d.-b). Street tree planting occurs on a cyclical basis where NYC Parks surveys, inspects, and plants trees one neighborhood at a time through its Neighborhood Tree Planting Program. Launched in the fall of 2024, NYC Parks is surveying public right-of-ways based on a planting cycle, prioritizing neighborhood blocks that are the most heat-vulnerable neighborhoods with minimal existing tree cover based on the NYC Department of Health and Mental Hygiene's Heat Vulnerability Index (NYC Parks, n.d.-e). The agency is committing to planting neighborhoods sequentially over the course of nine years to reach the entire city by 2035. Thanks to a recent $136 million capital investment, the agency also expects to plant all neighborhoods most at risk of excessive heat in the next two years (NYC Parks, 2024a). This block planting strategy has evolved significantly from NYC Parks' previous approach that prioritized citizen requests for new street trees, which "resulted in inconsistent and unpredictable service with a backlog of 42,000+ requests for trees and a wait time for the public of 2 to 7 years" (NYC Parks, 2024b). Street trees are planted from October through May and currently cost about $3,110 each on average to plant (Duggan, 2025).

The tree planting process is a delicate balance that considers many factors to identify the ideal tree species for each site condition, including tree bed type and sidewalk width, soil volume and pH, soil compaction, exposure to road salt, surrounding tree canopy, flood and drought

conditions, and nearby infrastructure (NYC Parks, n.d.-f; NYC Parks, n.d.-d). Infrastructure constraints pose barriers to street tree planting. Even though there may be physical spaces above ground, foresters must assess how the tree's size and height will affect buildings, utility lines, sewers, and sidewalks (Boyce, 2011). Despite these challenges, there is still plenty of space citywide to plant about 250,000 additional street trees (Treglia et al, 2021). After planting nearly 18,000 trees last year, the most in the last six fiscal years, the neighborhood tree planting program will enable the city to plant consistently high amounts of trees per year while supporting the city's critical goal of 30% canopy coverage (City of New York, 2023; NYC Parks, 2024a). This is critical as people continue to call for more trees to be planted (Donovan, 2022).

NYC Parks has centered equity in its tree planting program since before MillionTreesNYC, dating back to at least 2005 when low street tree quantity and high asthma rates were key drivers. Currently, through the Neighborhood Tree Planting Program, NYC is prioritizing street and park tree planting in the most heat-vulnerable neighborhoods based on the NYC Department of Health and Mental Hygiene's Heat Vulnerability Index (NYC Parks, n.d.-e). The focus on health impacts of extreme heat has been integral to NYC's post-MTNYC approach since Mayor Bill de Blasio launched Cool Neighborhoods NYC. This initiative aimed to reduce the urban heat island effect through various climate mitigation and adaptation strategies, including planting street and park trees in areas of high need - those with a Heat Vulnerability Index score of 4 and 5 - like the South Bronx, Northern Manhattan, and Central Brooklyn (Treglia et al, 2021). The initiative committed $106 million over three fiscal years (FY18-20) for tree planting, with $82 million directed to street tree plantings, $16 million for park plantings, and $7 million to support forest restoration (Treglia et al, 2021). The Adams administration has been supportive of continuing this approach, recently providing a $136 million capital

investment in the fall of 2022 to help NYC Parks "plant every viable spot in neighborhoods most at risk of excessive heat by 2027" (NYC Parks, 2024a).

In New York City, street trees are planted by contractors that work under the supervision of NYC Parks. Once trees are in the ground, planting contractors are responsible for all regular tree maintenance for one to two years, depending on their contract (NYC Parks, n.d.-e). These basic tree care services include watering at least once every two weeks from May through October, weeding, minor pruning, replacing missing soil, and entire tree replacement if it dies during the guarantee period. Once this maintenance contract ends, street tree care is transferred to NYC Parks' borough forestry offices where trees are incorporated into a programmed pruning cycle of seven years (NYC Parks, n.d.d). From there, general tree maintenance is prioritized based on NYC Parks' new Tree Risk Management program, which addresses the highest risk conditions first. NYC Parks forestry staff are trained arborists who perform routine tree risk assessments like tree hazards, dead or poor condition trees, illegal tree damage, pest and disease, sidewalk or infrastructure conflicts, and tree work permit requests. They also conduct tree failure, tree planting, and stump removal inspections. The most routine tree work is block pruning, where foresters will address all or most trees in one geographic area as part of a routine cycle every seven years, depending on funding (NYC Parks, n.d.-b).

NYC Parks manages the urban forest primarily using public funding, though historically small allocations have the agency stretched to manage trees, parks, playgrounds, recreation centers, trails, and innumerable other assets. In 2024, $618 million was allocated to the agency out of $112.4 billion, or about .5% of the entire budget (Honan and Hogan, 2024). NYC Parks receives expense (personnel and Other Than Personal Service (OTPS) or non-personnel related expenditures) and capital funding through the city's budgeting process. Analysis from The

Nature Conservancy on OTPS showed that from fiscal years 2018-2022, an average of $23 million per year went towards planting street trees, landscape park trees, and restoration efforts in forested natural areas (Treglia et al, 2021). Amounts ranged from roughly $13 million to $88 million per year. This high variability is due to the fact that a significant portion of NYC Parks' budget is not guaranteed funding (i.e baselined) and can be subject to adjustments and removals during budget cuts, as was the case when the urban forestry budget was reduced 85% during the pandemic in fiscal year 2020 (Treglia et al, 2021). Capital funding, which primarily goes to planting street trees, has seen large increases due to time-bound government initiatives like the MillionTreesNYC and Cool Neighborhoods NYC initiatives. However, baseline funding has remained minimal and stagnant, with roughly $7.3 million per year from FY 2006-2020 and $10 million annually for FY 2021 and FY 2022 (Treglia et al, 2021; Bigelman, 2024). With nearly 80% of tree-related capital funding going to street tree planting (Treglia et al, 2021), very little is directed towards maintenance. This has caused forestry professionals to express a desire to 'institutionalize' stewardship by allocating funds in the capital budget, which would sustain maintenance investments and advance the health and safety of the urban forest (Young, 2011).

Additional funding outside of the city budget process can come from the Mayor's Office, New York City Council members, and participatory budgeting to support the urban forest. TNC noted that from fiscal year 2006-2021, mayoral funds have made up about 80% of tree-related funding, while the City Council has used its own resources to fund about 2.7% of NYC Parks' tree-related budget. Participatory budgeting is a process that allows citizens to decide how to spend public funds by proposing and voting on capital improvement projects in their city council district. Started in 2011, funding for tree-related projects, such as tree planting and installing tree guards to increase protection, have been steadily increasing (Treglia et al, 2021). NYC launched

a citywide participatory budgeting initiative in 2022 called the People's Money that can also support tree projects. Despite the different funding mechanisms, a variable and inconsistent budget jeopardizes the urban forest. Navigating the annual dance of budget cuts and advocacy has an impact on long-term forest planning and management. A citywide coalition called Play Fair has recently formed and advocates to increase the municipal budget for NYC Parks to at least 1% - something Mayor Eric Adams had previously committed - to restore personnel cuts and increase the number of seasonal workers, and make sure the agency is equipped to handle the city's large maintenance backlog (New Yorkers For Parks, n.d.). To help fill budget and personnel shortfalls, NYC Parks relies heavily on a network of community volunteers and civic stewardship groups to help maintain and promote the urban forest.

NYC Tree Stewardship

New York City has an extensive and robust urban environmental stewardship network caring for a variety of physical site types including parks, trees, wetlands, rivers, forests, gardens, and trails, as well as educating the public, fundraising, and advocating. Research has shown that there have been more than 1,000 active park-based stewardship groups in NYC (Treglia et al, 2021) and nearly 2,800 civic stewardship groups citywide (Campbell, 2014). In a 2017 survey conducted by the U.S. Forest Service New York City Urban Field Station for the Stewardship Mapping and Assessment Project (STEW-MAP) - a method to understand and map civic groups who care for the environment across New York City - over 800 groups responded representing an estimated 540,000 members and staff with budgets totaling roughly $800 million covering over 205,000 acres (Landau et al, 2019). These groups run the gamut in size structure, ranging from "multimillion-dollar environmental nonprofits to completely grassroots, non-501(c)(3)

community gardens, clubs, and block associations" (Campbell, 2017, p. 32). Groups tend to be smaller, with the majority having zero or one staff member and having a budget of less than $10,000 (Campbell, 2017). While they work citywide, there have been higher concentrations of groups in Central Brooklyn, the south Bronx, and parts of Manhattan (Treglia et al, 2021).

Citizens and stewardship groups have been caring for New York City street trees for decades (Municipal stakeholder, personal communication). Trees New York has been around since the 1970s and it was noted they were likely the de facto organizational experts caring for the urban forest. One NYC Parks employee recalled working as an Outreach Coordinator in the late 1990s supporting groups in southeast Queens that were accessing fire hydrants, carrying buckets and containers to water street trees, and weeding and planting in tree pits. There are a number of ways people can immerse in hands-on stewardship. Basic street tree care activities include watering trees, picking up waste, installing signage, removing weeds, planting vegetation to beautify the tree pit, and adding mulch. 'Advanced' street tree care activities such as installing tree guards or pruning a tree require a Tree Work Permit. Since NYC provides tree guards in only limited circumstances, if citizens want them they can purchase or build their own tree guards, hire a contractor, or donate to New York Tree Time to have a guard installed. Securing a permit to prune can be bypassed if volunteers become certified Citizen Pruners - a 4-week training program led Trees New York that lets citizens legally prune young street trees to promote healthy tree structure and provide critical support at early stages of its development.

Stewards can work directly with the NYC Parks Stewardship program to receive support for their tree care work. Created in 2015 following the conclusion of MillionTreesNYC, the program provides avenues for people to get involved in different site types, including street trees. Citizens can attend large public volunteer events throughout the city all year long, they can

request a project for their community group, or they can become Super Stewards who work independently to make an impact on their neighborhoods. Through the Super Steward program, NYC Parks provides training, access to tools and resources, and empowers individuals to conduct stewardship work on their own, as well as recruit friends and neighbors. Super Stewards who care for street trees are called Care Captains - a tribute to the program started during MTNYC. They can work citywide or in specific, defined neighborhoods called Green Neighborhoods - a specific initiative through NYC Parks Stewardship to encourage local volunteerism by engaging communities in the care of street trees, forests, wetlands, gardens and other natural resources in their neighborhood (NYC Parks, n.d.-g). Once people become Super Stewards, they have access to request the TreeLC truck at one of their volunteer tree care events for up to 3 hours, which can bring supplies (handtools, gloves, garbage bags, and give-away items), a NYC Parks staff member, and a full truck of mulch to cover about 20 trees. Volunteers can request up to 3 dates, but NYC Parks can only grant one TreeLC truck per person during each 6-month registration period since the truck only comes out twice a month (on the first Saturday and second Friday of each month). The NYC Tree Map provides an engaging, interactive outlet for anyone to log their stewardship activity down to the level of individual trees. People can explore the species, trunk diameter, and ecological benefits. Since its launch in November 2016, people have logged over 72,000 stewardship activities, though this number might be understated due to lack of use or awareness (Treglia et al, 2021). If caring for city street trees was not enough, people who are able to receive a free tree through New York Restoration Project's community tree giveaways to plant on private properties within the five boroughs.

There are numerous ways for New Yorkers to advance the urban forest beyond digging around in tree pits. Citizen science is a growing area of interest, with more people developing a

useful skill set for tracking and reporting data. NYC Parks is hosting its fourth street tree census in 2025 where volunteers can help record the location, size, species, and condition of trees to "promote increased awareness of the importance of the urban forest and support municipal urban forest management" (NYC Parks, 2017). In the last inventory in 2015, over 2,200 volunteers spent nearly 12,000 hours inventorying 225,595 street trees (NYC Parks, 2017; Treglia et al, 2021). This provides valuable data for the city while adding capacity to NYC Parks. Citizens can affect public policy by engaging elected officials on the importance of the urban forest, attend public hearings and submit testimony on proposed plans or legislation, attend or organize rallies and demonstrations, and attend local community and borough board meetings (Treglia et al, 2021). People can also help secure more funding for trees in the city budget. The Mayor can increase the allocation to NYC Parks, distribute expense funds through the Mayor's Office, and city council members can award additional money from their own pots for things like tree guards. Participatory budgeting is another avenue for people to submit and vote on tree planting and guards. Finally, there are several grants available in NYC that provide seed funding to grassroots community groups that encourage greater participation, build capacity, and empower volunteers. Groups can apply for grant funding that covers tree maintenance from entities like Partnership for Parks, a joint program of NYC Parks and City Parks Foundation that supports community volunteers and grassroots groups who want to care for their local parks through intensive staff support and capacity building resources.

Citizens can engage with trees and play an important role serving as the eyes and ears for NYC Parks by submitting street tree service requests to the city's 311 system. Started in 2003, the telephone and electronic request 311 was created as a way for New Yorkers to easily connect with the government for non-emergency services, while also measuring and improving resource delivery (City of New York, n.d.). There are nearly 300 different complaint types, with

tree-related requests and complaints a popular item. NYC Parks encourages citizens to report non-emergency issues if a tree needs attention, including damaged trees, overgrown trees or branches, root, sewer and sidewalk conditions, dead trees, dead or dying trees, hazardous conditions, and illegal tree damage (NYC Parks, n.d.-f). According to data pulled from the Nature Conservancy's *State of the Urban Forest* report, from January 2010 to April 2020, there were over 931,000 tree-related 311 service requests out of 22,551,199 total (Treglia et al, 2021). The most common tree-related request was to report a damaged tree, followed by a request for a new tree (before it was discontinued) (Treglia et al, 2021). While there is a high level of engagement around trees, who uses 311 and why varies significantly. Some neighborhoods might have better or worse conditions, people might have different levels of expectations and trust in government, sense of agency, or socio-cultural traits that make them likely to report a problem (Mullin et al, 2019; Kontokosta and Hong, 2018). These 311 requests, in other words, are not unbiased, are dependent on a number of important factors and might not be fully reflective of the city. The creation of 311 was a Mayor Mike Bloomberg development that enhanced MillionTreesNYC, increasing citizen tree engagement by reducing barriers and making interaction more efficient.

NYC Tree Planting Initiatives

NYC Parks is a leader in urban forest management and has positioned itself as an innovator around tree planting, equity, stewardship, and research. The scale and extent of the agency's urban forest operational responsibilities stands apart from other cities. "NYC Parks has street and park trees and they bear the responsibility and do all of the care and maintenance,

which gives them more integration and control in the life of the tree compared to other places" (Organizational stakeholder, personal communication). Urban forest policies, programs, processes, and priorities today are a product of NYC Parks' success designing, implementing, and completing tree planting initiatives over the last two decades. A list of the projects this thesis looked at can be found in Table 2 at the end of this chapter. The completion of the MTNYC initiative (2007-2015) is a crowning achievement and demonstrated the agency's success to implement a massive planting and stewardship operation and prioritize distributional equity, while also showing the city's willingness to be progressive and try new practices. The Cool Neighborhoods NYC initiative is building off MTNYC by directing critical tree investments to the most heat-vulnerable communities. NYC Parks is using its vast experience to execute large, highly collaborative, innovative, time-bound, government-led initiatives that are advancing the city's urban forest and laying a foundation for engagement with urban environmental stewards.

Citywide Case Study: MillionTreesNYC

MillionTreesNYC (MTNYC) was launched in 2007 as part of the city's PlaNYC 2030: A Greener, Greater New York (PlaNYC) - former Mayor Mike Bloomberg's long-term sustainability vision comprising 127 initiatives to combat climate change and reduce the city's greenhouse gas emissions by 30% (City of New York, 2007). The ambitious goal of MTNYC was to plant and care for one million new trees citywide over the next decade to help increase the urban forest and bring critical 'quality-of-life' benefits, especially to low-income communities with few trees. The project achieved this milestone two years early in 2015, thanks to

unprecedented engagement with thousands of volunteers, a $400 million dollar capital budget for urban forestry (Campbell, 2014), and an effective governance structure.

MTNYC was a public-private program between NYC Parks and the nonprofit New York Restoration Project (NYRP) that sought to "enhance the entire 'green matrix' of the urban forest" by planting across property jurisdictions and physical sites, including streets, parks, natural areas, schools, public housing campuses, and private yards (Campbell et al, 2014). NYC Parks was responsible for planting 70% of the total tree count on public right-of-ways and reforesting city parkland, while NYRP was assigned 30% of the total planting amount on public and private properties outside of the jurisdiction of NYC Parks, including housing developments, schoolyards, cemeteries, community centers, and hospital grounds (Campbell et al 2014; Campbell, 2014). NYRP started hosting tree giveaways for residents to plant in their yards within the five boroughs. The two entities shared decision-making and complemented each other with their various skillsets and expertise, with NYC Parks bringing its urban forestry operations and experience and NYRP able to raise private dollars through corporate and individual funders and perform 'savvy' marketing and outreach campaigns (Campbell, 2014; Campbell, 2017). The establishment of a MTNYC Advisory Committee was also used for outside experts to help advise NYC Parks and NYRP on tree planting, education, stewardship, public policy, research and evaluation, and marketing (Fisher et al, 2015). This was a group of approximately 400 individual members from 109 organizations including representatives from government agencies, non-profit organizations, businesses, educators, researchers, and long time community stakeholders (Campbell, 2014; Campbell et al, 2014). The effectiveness of the advisory committee was mixed. Some of the subcommittees gave rise to formalized programs, while some

participants felt underutilized and that the committee lacked influence and decision-making authority in a very top-down, hierarchical system (Campbell, 2014; Campbell, 2017).

MTNYC changed how NYC Parks operated in multiple ways. First, it transformed how NYC Parks planted trees. The city used the 2005 Street Tree Census to inform the initiative's street tree planting strategy, finding that roughly 220,000 street trees could be planted in the public right of way (Campbell et al, 2014; Campbell, 2017). NYC transitioned from responding to resident requests to plant single trees to planting entire blocks at a time based on low tree stocking levels - a quantitative measure of an area occupied by trees. At the time, current tree plantings filled 74% of the existing space. Mayor Bloomberg wanted to aggressively increase that level to 100% by fully lining each street with trees, which meant planting 23,000 additional street trees annually - almost tripling the number planted each year (City of New York, 2007). To help meet this goal, the City revised the zoning code that required new construction and redevelopment projects to plant one street tree for every 25 feet (City of New York, 2007). Tree pit designs were also expanded from 4x4 feet plots to 5x10 feet to improve tree establishment by absorbing more oxygen, nutrients, and stormwater, and containing tree roots better so the trees do not die or damage the sidewalk (City of New York, 2007; Municipal stakeholder, personal communication).

Caring for trees to ensure survival and realize environmental benefits became a priority part way through MTNYC. A massive tree planting campaign made obvious the need to engage volunteers to increase the city's labor force (Fisher et al, 2015). Initially the campaign focused attention on large citywide (and wildly popular) volunteer tree planting events in parks to engage and build a large constituency. Some people believe tree stewardship was not prioritized (Campbell, 2017). MTNYC soon added volunteer maintenance and stewardship days to cultivate

interest and engage more people in tree care). The initiative transformed the way people had cared for trees in NYC. Previously, TreesNY was the primary go-to organization focusing on street tree stewardship while NYC Parks worked in natural areas. MTNYC sought to partner with community groups to steward newly planted trees and relied heavily on public outreach, training, and education to support their long-term care (Fisher et al, 2015; Campbell et al, 2014). This was also enhanced by technical assistance in mini-grant funding and the distribution of tree care tools to community stewardship groups (NYC Global Partners, 2013). Increased attention and unprecedented financial backing for volunteer support, recognition, and education helped with volunteer engagement as it showed volunteers were valued. "[Before MTNYC] there was no capacity or funding for an enormous amount of citizen education, stewardship, and volunteer recruitment. If it did exist, it was extremely minimal. MTNYC is what brought that whole volunteer component in" (Municipal stakeholder; personal communication).

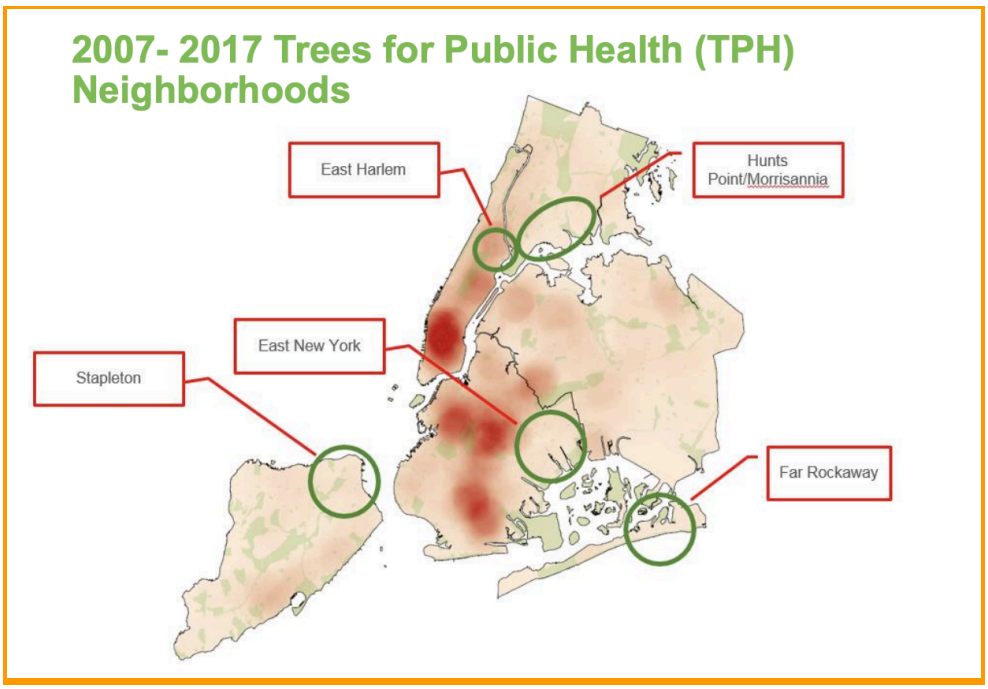
MTNYC developed stewardship programs that helped grow engagement in tree stewardship and equipped and empowered individuals to become 'tree care captains', lead stewardship events in their own communities, and play a larger, sustained role in the decision-making and advancement of the urban forest (Fisher et al, 2015). In 2009, a Stewardship Corps (or StewCorps) was created that offered formal tree-care training and certification. This was a partnership between MTNYC and greening entities - NYC Parks GreenThumb (community gardening program), TreesNY, and New York Botanical Garden, Brooklyn Botanical Garden, and Queens Botanical Garden - that resulted in partners receiving grants to educate and cultivate citizen tree stewards (Campbell, 2017). This program transitioned to the TreeLC program that offered hands-on workshops, tree care toolkits, and mini-grants to stewardship groups (Campbell et al, 2016). By 2014, this had resulted in 1000 tree care

workshops, thousands of tree adoptions, and working with over 12,000 volunteers (13,000 volunteers by the end of the initiative in 2015) (Fisher et al, 2015). NYC Parks' creation of a director of stewardship in 2014 concluded the program evolution and solidified the importance it would have moving forward (Campbell, 2017).

Another important way that MTNYC served as a model was how NYC Parks prioritized equity and environmental justice. The equity-driven part of the MTNYC program was based on planting trees in Trees for Public Health (TPH) areas that were tree deserts. The TPH program preceded PlaNYC and focused on street tree planting in six neighborhoods across all five boroughs - Hunts Point and Morrisania in the Bronx, East New York in Brooklyn, East Harlem in Manhattan, the Rockaways in Queens, and Stapleton in Staten Island. These places, as seen in Figure 2, had "fewer than average trees and higher than average public health burdens" (Loquine and Greenfeld, 2008) as well as "high correlation of poverty, lack of services, low air quality, and incidences of childhood diseases" (Campbell et al, 2014, p. 37). These neighborhoods were initially selected based on low tree canopy, high poverty, street tree stocking levels and asthma hospitalization rates for children ages 0-14 (Loquine and Greenfeld, 2008; Municipal stakeholder, personal communication). Decades of uneven forest development due to the previous citizen tree request system left the urban forest unbalanced, creating a "massive disparity because the concentration of those service requests would be in what we know as white, wealthy neighborhoods (Municipal stakeholder, personal communication). Overarching program goals included creating "community informed plans to green neighborhoods" and "mobilize community groups to work collaboratively with Parks and other agencies to establish and realize their greening goals" (Loquine and Greenfeld, 2008, p. 34), showing that NYC Parks has been centering communities, encouraging collaborative governance, and supporting

neighborhood-specific forestry management plans for two decades. In the case of the Far Rockaway Community Forestry Management Plan, NYC Parks sought to meet PlaNYC's goals to increase tree stocking levels from 41% to 100% by the end of MTNYC, and establish a "Friends of Trees" group that will be "critical to realizing the goals of this project and to moving the program forward where action items are beyond Parks' resources" (Loquine and Greenfeld,2008, p. 19). Not only were TPH areas prioritized for planting trees, but they were considered for technical assistance support like small grant funding (Municipal stakeholder, personal communication).

Figure 2: Trees for Public Health Neighborhoods



Source: Strauss, N., and Henderson-Roy, N. Overview of NYC Parks Tree Planting and Stewardship Programs Presentation (n.d.)

A workforce development component of MTNYC - MillionTreesNYC Training Program (MTTP) - also centered equity in its program design and implementation to "strengthen and

diversify the workforce" to help maintain trees in the long-term (Campbell et al, 2014, p. 37). Started in 2008, this 7-month green collar jobs training program between NYC Parks and NYRP gave unemployed minority young adults, primarily from marginalized neighborhoods, between the ages of 18-24 the skills, experience, and education to pursue work in the fields of urban forestry management, ecological restoration and urban landscaping (NYC Parks, 2009). The program was part of a larger citywide initiative led by the Mayor's Center for Economic Opportunity (CEO) to combat poverty that aimed to increase awareness of the environment and equip young adults with employment and life skills (Campbell et al, 2014; Municipal stakeholder, personal communication). MTNYC had success collaborating with trusted community partners like with New York City Housing Authority campuses, the Department of Youth and Community Development's CEO programs and from local community-based organizations to conduct outreach and recruitment (Municipal stakeholder, personal communication; NYC Parks, 2009).

Participants were able to receive drivers licenses and GEDs, learn how to operate equipment and vehicles, pursue numerous certifications including pesticide/herbicide application, chainsaw training, compost training, and continuing education credits from the New York Botanical Garden, and work with a job readiness coach to develop a variety of professional skills (Municipal stakeholder, personal communication); Falxa-Raymond et al, 2013). NYC Parks leveraged its partnerships and professional expertise to enhance the program. For example, they worked with private tree companies to bring staff to train participants in tree identification and chainsaw operation for an intense two-week training. They also collaborated with the Parks Opportunity Program - one of the largest workforce development programs in the nation - to glean some of their best practices and utilize their knowledge and skillset. MTTP was modeled

off a training program that occurred in the 1980s, where NYC Parks was able to utilize federal funding to train tree climbers and pruners to build out the workforce following the economic downturn of the 1970s (Municipal stakeholder, personal communication). A $2 million federal grant came for MTTP to help create 20 new jobs in horticulture and forestry for two years through which program graduates could transition to help restore urban forests in NYC (NYC Parks, 2009). Unfortunately, the great recession impacted the program, reducing staff and money that ultimately led to its demise. There were a total of 104 people in five years of the MTTP program (Municipal stakeholder, personal communication).

Despite MTNYC's commitment to equity and environmental justice, some research has questioned the program's distributive impact of its tree planting efforts and whether under-resourced neighborhoods are actually benefiting from the investments. Garrison believed that MTNYC did not do as great of a job prioritizing low-income communities of color as more trees were planted in higher densities in areas that already had greater tree canopy, further perpetuating pre-existing inequalities (Garrison, 2018; Garrison, 2017). TPH neighborhoods received 62,081 new trees - 6% of the total million trees planted in 5% of the city's total area (Garrison, 2017). Though areas like TPH were prioritized, there were insufficient guidelines around quantity or what proportion of trees would be planted in these areas. MTNYC focused on the larger goal of planting one million trees opposed to adopting "specific statistical measures of distributional equity" for specific neighborhoods (Garrison, 2018, p. 11). An impediment to MTNYC's equity goals could have been due to planting an outsized number of trees in parks (83%), which are already distributed inequitably across the city due to historical disinvestment and racist plans and policies (Garrison, 2017). Additional research found mixed results from the impact of MTNYC based on different tree attributes, noting that not enough time has passed to

evaluate the full effects (Lin et al, 2021). In addition, improving the environmental quality of neighborhoods could have influenced gentrification (Bratspies, 2021). These concerns have been exacerbated by what some have seen as MTNYC's procedural inequity. Despite the creation of an advisory board, MTNYC's top-down approach "failed to include residents in the decision-making process" and left them out of influencing the goals and priorities of the tree planting program (Bratspies, 2021). Rather than "selecting goals and priorities through technocratic expertise and then selling them to the public" (Bratspies, 2021), local-decision making at the neighborhood level is critical, especially for low-income and minority voices (Bratspies, 2021; Lin et al, 2021). Lin et al (2021) suggest that a bottom-up, resident-oriented approach could bring co-benefits such as increasing volunteer stewardship. While incorporating this may be difficult with citywide planting programs like MTNYC, NYC does have experience over the last two decades with smaller-scale neighborhood planting and stewardship initiatives that have engaged communities in a deep, sustained way.

Community Forestry Case Studies

MTNYC was a citywide, top-down initiative that relied heavily on volunteers. Though the program had a diverse advisory committee that included non-profit organizations and community representatives who advised NYC Parks and NYRP staff, there were limits to their influence. Some community forestry projects have occurred in the neighborhoods of Gowanus, Greenpoint, and across Western Queens that have involved communities differently compared to MTNYC. These examples enhance NYC's urban forestry expertise and demonstrate different

approaches to engaging and sustaining community involvement around tree planting and stewardship.

Community Forestry Project #1: Greening Western Queens

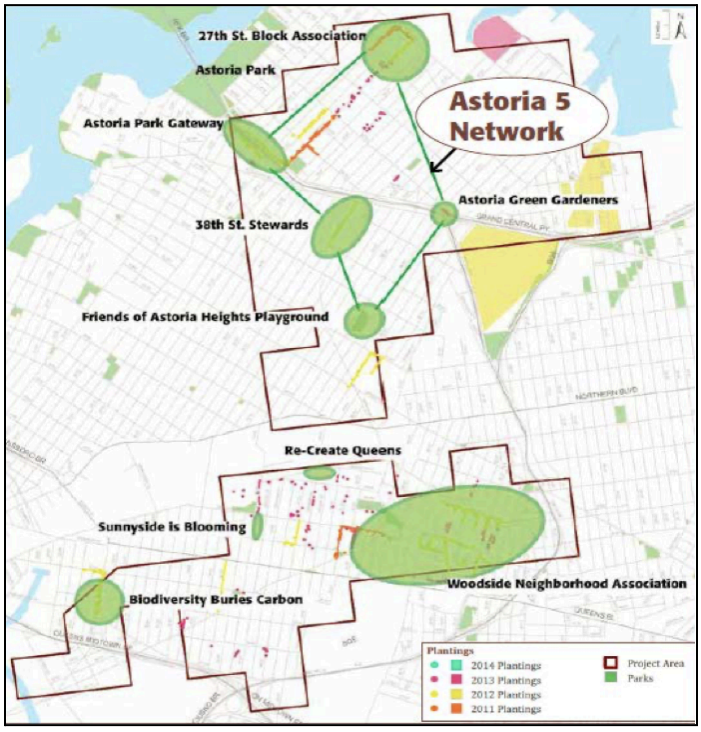
The Greening Western Queens Community Forestry Project (GWQ) was an urban reforestation and community stewardship initiative in the neighborhoods of Astoria, Long Island City, Sunnywide, and Woodside that occurred from 2011-2014. The roughly $2.5 million for the project were awarded as part of the $7.9 million settlement between the citizen action group, Power for the People, and the utility Con Edison, for damages incurred as a result of a 10-day power outage in 2006 in Western Queens (Castro-Cosio, 2016). Power for the People decided to apply the settlement funds on energy efficiency and environmental projects in the community, with trees becoming a priority after people realized an increase in the number of trees and green space would have combatted extreme heat during the power outage (Castro-Cosio, 2016). Therefore the goal of GWQ was to raise the awareness of the benefits of trees and plant new trees in areas of low quantity. The program was implemented by the City Parks Foundation through Partnerships for Parks (PfP), in collaboration with NYC Parks, Trees New York, and NYRP. This highly collaborative dynamic – instead of having one entity lead the project alone – was valuable and effective, particularly for the local community stewards. PfP hired a Community Coordinator and a Visioning Coordinator to serve as primary points-of-contact for community members during the project. The Visioning Coordinator provided technical support to stewards, helped convene stewardship groups with each other to share knowledge and best practices, and maintain connectivity throughout the project (Organizational partner, personal

communication). “The focus was bringing stewardship groups together and equipping them with the structure they would need to sustain themselves overtime after the program came to a close, give them the means to form a 501(c)(3) if they needed to, and begin starting to raise money to support their efforts over time. [I would] make sure they had each other’s contact information, form master communication lists, and provide suggestions on keeping an ongoing calendar of events for tree care” (Organizational stakeholder, personal communication). NYC Parks’ Forestry Department was also seen as a highly important resource throughout the project by working with stewards when the trees were planted and participating in tree care projects (Organizational stakeholder, personal communication).

The GWQ program was designed based on PfP’s organizing model called ‘Catalyst’, which is a long-term community engagement program working in historically under-served parks or green spaces through a multi-year process that allows communities to coalesce and come together (Organizational stakeholder, personal communication). In this instance, the model was used for “a) building community engagement and prioritizing community-based tree plantings, b) connecting people, ideas, and efforts to identify common goals, and c) sustaining local leadership and stewardship of green spaces” (Castro-Cosio, 2016, p. 118). Tree plantings occurred where at least one resident within the designated outage area committed to caring for it. “The areas [were prioritized] where a citizen signed a pledge and said, ‘If you plant a tree on my block, I will take care of them and organize my block to care for them’” (Organizational stakeholder, personal communication). GWQ also consisted of other urban forestry activities, including citizen tree-mapping and community visioning, as well as training workshops and tools to build local stewardship capacities and skills. Creating a detailed tree inventory by mapping existing and potential street trees provided an important foundation and opportunity for

community input on where future trees needed to go, where the main thoroughfares were, and where they would have the greatest impact (Organizational stakeholder, personal communication). By the end of the project, 1,128 trees were planted - 600 street trees and 528 on publicly accessible private land - nine stewardship community groups had formed, 81 residents received citizen pruner certifications, and 300 people participated in 22 free tree care training workshops (Castro-Cosio, 2016). Roughly 400 custom-made tree guards were also installed, as the program budget had incorporated tree guards from the outset (Organizational stakeholder, personal communication). While there was not an explicit equity angle to GWQ, one organizational partner noted the program looked at heat maps, asthma rates and overall high heat index to align with the ongoing citywide MTNYC initiative.

Figure 3: Map of stewardship hubs in Greening Western Queens



Source: Castro-Cosio (2016). *Dealing with Uncertainty: Infrastructures for Resilience in Urban Communities.* pp. 124

Community Forestry Project #2: Greening Greenpoint

Another neighborhood tree planting project took place in Greenpoint, Brooklyn as part of the $68.6 million Greenpoint Community Environmental Fund (GCEF). The community-led grant program was established in 2010 from settlement funds with ExxonMobil who was responsible for contaminating Greenpoint land and groundwater with millions of gallons of oil for more than five decades - one of the largest recorded spills in U.S. history (New York State Office of the Attorney General, 2024). Greening Greenpoint, one of the 77 grants awarded, was a four-year project to implement a comprehensive urban forestry plan. Activities included planting new street and park trees, installing tree guards, expanding existing tree pits, and mobilizing community members to steward local trees. All work had to occur in the 11222 zip code. The goals were to "create new tree canopy cover, promote healthy, long-lived trees, add new green space, capture and treat stormwater runoff, and reduce local air pollution in the community (New York State Office of Attorney General and New York State Department of Environmental Conservation, 2024, p. 101). The program, launched in 2014 with a $1.95 million grant and $1.96 million in matching funds, was a partnership between City Parks Foundation, Trees New York, and NYC Parks, and NYC Tree Time. The project would go on to receive a total investment of $4.86 million (New York State Office of Attorney General and New York State Department of Environmental Conservation, 2024). There was a long list of project accomplishments, including planting 634 street trees, installing 575 tree guards, expanding over 1,000 tree beds, distributed 565 trees for planting on private property in Greenpoint, engaged

nearly 3,000 volunteers in street and park tree stewardship, trained 135 new Citizen Pruners, and hosted 33 Young Urban Forester Interns in the summers of 2015-2018 (New York State Office of Attorney General and New York State Department of Environmental Conservation, 2024).

Similar to Greening Western Queens, in addition to the typical volunteer stewardship roles, community members were involved in various levels of program administration, including grant development, project selection, and program design. In the beginning, the GCEF program convened 70 community meetings, engaged over 2,600 people, and educated residents on the funding priorities to help assist them in developing projects for funding. The largest investments were determined by community vote - tallying more than 1,000 neighborhood residents (New York State Office of the Attorney General, 2024). Greenpoint residents also had the chance to serve on the steering committee to guide the program's development and implementation. The Greening Greenpoint Stewardship Coordinator helped run meetings with the steering committee, who were made up of 6-8 long-term members of the community. "[The steering committee] had representatives from different block associations all in one group. They represented different parts of the neighborhood and met quarterly in an official steering committee meeting. They were there to give input on the project and where focus should be shifted" (Municipal stakeholder, personal communication). A survey was passed around by the steering committee that people could request specific addresses to be surveyed for tree planting, which was like a "prioritized 311 just for Greenpoint because there was funding for tree planting in the 11222 zip code" (Municipal stakeholder, personal communication). The project had two full-time staff members for one neighborhood, which was a significant investment given that, as of 2022, all of Brooklyn only had 4 borough foresters (Municipal stakeholder, personal communication). Program awareness was high. Outreach was heavily aided by an active citizenry who were

engaging in dozens of other environment-related projects throughout the neighborhood, on top of an influx of resources to allow people to get involved (Municipal stakeholder, personal communication).

Greening Greenpoint supported the development and growth of community groups like Greenpoint Tree Corps (GTC). The program equipped volunteers with the skills and training to continue the work into the future at the project's conclusion. In addition to becoming Citizen Pruners, the GTC's group leaders were able to take advantage of advanced training from Partnerships for Parks' Partnerships Academy Fellowship - a convening of green space advocates and stewards looking to develop their leadership around their local spaces. They started the community volunteer group in 2017 with the goal to work with neighbors to improve the urban forest through street tree stewardship, beautification, and educational events. "The reason why we wanted to start the group was knowing that the trees were coming to the neighborhood, and learning more about Parks Department and contractors and how trees are actually treated afterwards, I was like, 'who is going to take care of these trees?' GCEF was going to be over. If there is no money to pay people to do certain things they are not going to be around. So, that is why we wanted to try and rally a group of people to be interested and be keeping an eye on the new trees especially" (Community stakeholder, personal communication).

GTC is a community volunteer group that works with neighbors to improve the urban forest through street tree stewardship, beautification, and educational events (Greenpoint Tree Corps, n.d.). GTC quickly became a force in the community, even securing a $5000 participatory budgeting grant in the summer of 2021 to run their own Adopt-a-Tree watering program to provide free tools, watering equipment, and training to help young street trees reach maturity (Greenpoint Tree Corps, n.d.). "We had a requirement that the diameter of the tree be 6 inches or

smaller, so those would have been trees planted in the last several years. We targeted those because those trees needed the most watering support, and that was the main focus of our adopt-a-tree program was to try to provide the 15-20 gallons per week to those baby trees" (Community stakeholder, personal communication). NYC Parks noticed the great work the group was doing to continue the Greening Greenpoint legacy. "They basically continued the role of Greening Greenpoint past when it could exist. By forming their own group Greenpoint Tree Corps, they basically continued the work past when it was possible for Tree Time and NYC Parks to do that work" (Municipal stakeholder, personal communication).

Community Forestry Project #3: Gowanus Neighborhood Urban Forestry Initiatives

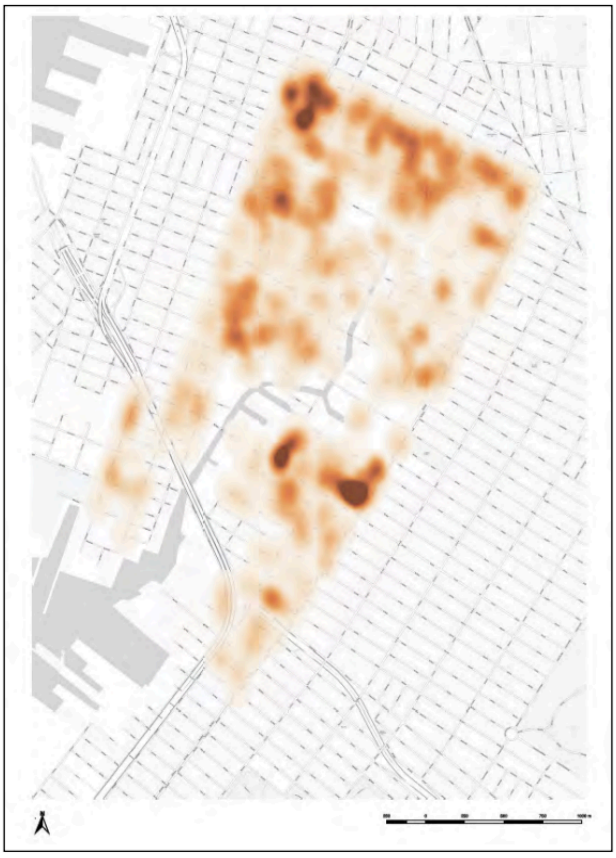
Unlike the previous two time-bound, settlement-funded neighborhood tree planting projects, Gowanus is primarily an example of building a sustained volunteer tree stewardship base through grassroots organizational leadership and programming. The Gowanus Canal Conservancy (GCC) is a nonprofit organization that was formed in 2006 as a grassroots effort to improve the environment in and around the Gowanus Canal – a 100-foot wide, 1.8-mile-long heavily polluted shipping channel that passes through a predominantly industrial area (Cleaning Up Gowanus Canal, n.d.). Years of industrialization, illegal dumping, and combined sewage overflows contributed to the canal becoming a Superfund site in 2010. GCC's mission is to "build an equitable, thriving, and resilient urban ecosystem in Gowanus through education, stewardship, and advocacy that empower our community" (Gowanus Canal Conservancy, n.d.-a). Tree stewardship is one of the organization's pillar activities, where the organization

leads initiatives to expand the size of tree pits, install tree guards, and engage volunteers in tree care that help improve green infrastructure stormwater capture and water quality. In 2024, GCC had 585 total volunteers contribute 1,510 hours, stewarding 245 trees (Gowanus Canal Conservancy, 2024). GCC evaluated the state of its urban forest in 2018 and found that they have a robust volunteer network, there is a large young tree population with 35% of the trees in the neighborhood under 6" in diameter, the area has many tiny tree beds that stifle roots, and 80 blocks could be converted from industrial manufacturing to mixed-use residential development due to the recent neighborhood rezoning, meaning new street trees are on the horizon (Gowanus Canal Conservancy, 2018; Organizational stakeholder, personal communication). A decade ago, the organization found approximately 3,000 street trees populated a 100-block area surrounding the canal (Gowanus Canal Conservancy, 2017). Two neighborhood-specific street tree inventories in 2012 and 2016 provided current conditions and trends for street trees that have been instrumental to formulating the Gowanus Urban Forest Management Plan - a five-year plan to expand, improve, and maintain the street trees immediately surrounding the canal (Gowanus Canal Conservancy, 2017). This plan has been instrumental in assessing how to expand the urban canopy, and how to improve trees that need more maintenance or care (Gowanus Canal Conservancy, n.d.-a). GCC's stewardship programs are having a positive impact. In the 2015 NYC street tree census, 51% of trees in the Gowanus area had at least one sign of tree stewardship activity, compared to 30% of trees in Brooklyn and 24% of trees citywide (Gowanus Canal Conservancy, 2017). Figure 4 highlights tree stewardship intensity in the area, one example of GCC's in-depth neighborhood analysis and hyper-local management plan.

The organization's primary tree stewardship program is the Gowanus Tree Network - a block-based approach that recruits neighbors on specific blocks to become part of the program,

work together, and build a healthy urban forest. GCC works with 16 blocks across the Gowanus Tree Management Area, with 33 Tree Ambassadors, and has completed 33 tree bed expansions and installed 75 tree guards since 2018 (Gowanus Canal Conservancy, n.d.-a). GCC equips volunteers with resources and guidance to improve the urban tree canopy, such as partnering with Trees New York to provide free Citizen Pruner training. The program's success is rooted in its neighbor-to-neighbor engagement and accountability, says one organizational stakeholder. "Now you have a neighbor dependent on you or you are dependent on your neighbor. You have a sense of accountability forming in these little networks that increases people's willingness to participate. Having that sense of being a part of something is more likely to get you to come out" (Organizational stakeholder, personal communication).

Figure 4: Tree Stewardship Intensity in the Gowanus Neighborhood



Source: Gowanus Street Tree Management Plan (Gowanus Canal Conservancy, 2017, p. 39)

GCC is incorporating green infrastructure maintenance into the fabric of the community through innovative strategies and partnerships to advance the urban forest. During the neighborhood rezoning process, one of the agreements of the rezoning proposal would create a Business Improvement District (BID) that prioritizes tree and open space stewardship in the public realm (Gowanus Canal Conservancy, n.d.-b). GCC is helping lead this BID formation and sees its maintenance of public realm assets like trees, rain gardens, parks and privately owned public spaces as a way to fill in gaps where NYC Parks does not have resources. Also during the neighborhood rezoning process, the organization successfully advocated for multi-stemmed tree planting that allows the creation of larger tree beds to plant multiple trees in one, if the customary tree pit every 25 feet is not able to be met. In 2019, Gowanus Tree Network volunteers partnered with a company to install 6 soil moisture sensors in tree beds that track real-time data on stormwater performance and the impact of stewardship on tree health (Gowanus Canal Conservancy, n.d.a). GCC is also part of the RAIN Coalition - a partnership formed in 2021 between four watershed organizations - Bronx River Alliance, GCC, Newtown Creek Alliance, and Guardians of Flushing Bay - and two workforce development groups - the Hope Program and Green City Force. This group provides critical tree care and rain garden maintenance to municipal green infrastructure investments, helps fill gaps in the city budget for stewardship, while creating pathways to permanent, good-paying jobs. These partnerships and strategies further cement GCC's commitment to steward young trees.

Conclusion

The four case studies - MillionTreesNYC, Greening Western Queens, Greening Greenpoint, and Gowanus Tree Network - provide a diverse set of approaches to designing and implementing citywide and neighborhood urban forestry projects.

Table 2: List of New York City Tree Planting and Stewardship Programs Analyzed During Study

Initiative	Description	Duration	Project Lead	Type	Prioritized Equity
Trees for Public Health	Established six target neighborhoods based on asthma and low-tree quantity.	2005-2015	NYC Parks	Planting	Yes
MillionTreesNYC	Planted and cared for 1 million trees	2007-2015	NYC Parks; New York Restoration Project	Planting and Stewardship	Yes
Greening Western Queens	Planted and stewarded 1,128 trees, leveraging funds through a local utility lawsuit	2011-2014	Partnerships for Parks; Trees NY; City Parks Foundation	Community Forestry Project	No
Greening Greenpoint	Implemented a comprehensive urban forestry plan, including planting 634 trees. Funds came from a lawsuit with an oil company.	2014-2019	Tree Time; Trees NY; NYC Parks; City Parks Foundation	Community Forestry Project	No
Gowanus Tree Network	Block-based stewardship model that recruits residents on specific blocks in the neighborhood	2016 - Present	Gowanus Canal Conservancy; Trees NY	Community Forestry Project	No
NYC Cool Neighborhoods	City-wide tree plantings prioritizing heat-vulnerable communities.	2017 - Present	NYC Parks	Planting	Yes
Super Stewards	Stewards care for neighborhood trees and other natural areas by hosting projects, applying for mini-grants, and networking.	2017 - Present	NYC Parks	Stewardship	No
Green Neighborhoods	Promotes local community in the care of street trees, forests, wetlands, gardens, and other natural resources in around the city	2018 - Present	NYC Parks	Stewardship	Varies

Source: Michael Mullaley

Chapter 4: Findings

Municipal, organizational and community stakeholders were interviewed to understand how NYC involves communities and centers equity in its urban forest initiatives. People were identified and prioritized based on their background in leading or supporting urban forestry programs, working for or closely with NYC Parks, collaborating with organizational and grassroots greening partners, or navigating public space stewardship. Interviewees covered a range of themes related to New York City's urban forest, including how communities are involved, the benefits of trees and how they build resilience to climate change, strong collaborations and partnerships, community engagement best practices, and barriers to increasing tree maintenance. Seven key takeaways emerged that helped inform my recommendations. These synthesized findings summarize my conversations.

Finding #1: Community leaders are seen as experts and a source of information and critical connections to resources and city staff

Community leaders and nonprofit organizations are high functioning entities that develop their own innovative and creative programs to support green spaces and the urban forest. They are seen as a valuable resource in their neighborhoods, forged by their experiences supporting the urban forest. They are a key source of information, helping inform residents how they can acquire materials like mulch and tools, providing advice on how to conduct urban environmental stewardship, and handling difficult personalities. They also are highly collaborative and develop strong networks to access resources. These groups see themselves as an extension of municipal

services, helping fill roles, address gaps, and build agency capacity. "I have become the Parks Department. I am getting the complaints" (Community stakeholder, personal communication). Leaders have developed technical knowledge and expertise through formal training with NYC Parks on street tree care and opening fire hydrants, and Trees NY to become certified citizen pruners. "People need to hear that I know what I'm talking about, or need to feel comfortable that there is someone who is complying with the rules, or that when we open up fire hydrants, we are permitted to open up fire hydrants" (Community stakeholder, personal communication).

Groups build their capacity by leveraging their local and citywide partnerships to overcome funding, material, and staffing needs. Mulch is one example of a critical resource for tree stewardship that is in demand. One leader knows to reach out to a local urban farm for mulch if they are not able to secure any from their primary source. Another community leader had developed their own network of people to contact if they needed mulch, such as their Partnerships for Parks (PfP) Outreach Coordinator, the local Park Manager, and a local NYC Parks forester. A third leader is equally resourceful about compost, explaining that theirs "doesn't come from [NYC] Parks, but is donated from a developer who is invested in the community and has given us tons of it to use on the parkland for trees and landscaping" (Community stakeholder, personal communication). These are all examples of important connections that were critical to their stewardship work, while saving them time, money and energy. "If we can't get mulch from [NYC] Parks in some way, and if it wasn't for the farm helping us figure it out, we wouldn't be able to do our street tree care events" (Community stakeholder, personal communication). Community groups noted that partnering with local and citywide nonprofit organizations was particularly instrumental to building their capacity as a nascent stewardship group. Greening Greenpoint, Open Space Alliance (now North Brooklyn

Parks Alliance) and Trees New York all provided technical and outreach support and stewardship supplies to one Brooklyn-based group. This support helped fill their funding gap as the group began their work.

Stakeholders noted that residents typically find navigating city government to be difficult and confusing, and are not always aware of resources and programs available to them. Community leaders see themselves as educating the public on important city processes and the urban forest, helping inform and empower residents. “One of the things I try my best to limit is people assume it is our job to take care of trees for them. I always want to convey to them, ‘No. That is not how this works.’ I want people to take action rather than us doing it for them” (Community stakeholder, personal communication). Stakeholders also see themselves providing a valuable resource for the Parks Department, who are limited in conducting outreach. “Being able to respond to the many, many [tree] inquiries we were getting from social media and making people feel like ‘Ok, this is going to be ok’, I do think that is providing a service to the Parks Department and 311. There was a place people could go to get answers” (Community stakeholder, personal communication).

The strong collaborative partnerships, deep community relationships, and extensive networks community groups built with the City and other nonprofit organizations allowed community leaders to become more informed, effective and autonomous leaders. “Now we have a strong sense of independence. In my rolodex, I know if there is a certain issue, I can reach out to Jason. If it is a material, I know how to reach Parks and say, ‘We can take an order of mulch’. Or if it is something else, we can reach NYRP potentially.” Local stewardship is critical because maintenance budgets for trees and green infrastructure are underfunded and these assets are undermaintained.

Finding #2: Community leaders have a close, collaborative working relationship with NYC Parks to co-assess, organize and execute tree stewardship and park maintenance projects. Stakeholders see their work as providing a valuable service to the Parks Department.

All five community groups interviewed shared that they have a close, collaborative working relationship with NYC Parks. The trust these leaders have built with NYC Parks from their extensive history working together has allowed them to play an active role in helping execute stewardship projects and influence decisions. One community stakeholder believed it is imperative grassroots groups work closely with NYC Parks. “You have to be colleagues with each other. There are rules and you have to play by those rules. It is very important you work with [NYC] Parks. We need to know the regulations and rules for some of the projects.” Another community stakeholder acknowledged their relationship goes deeper than typical stewards. “I am in there all of the time, we have storage space at the facility and a container outside, so therefore we have this daily interaction with [NYC Parks], which I think many folks don’t do because of where their parks are [located]. So for me, I can go to [Maintenance and Operations] and say 'Hey, we are doing this [project], can you support us to get this to the site?’. Even with mulch, I can say to them, ‘We are doing this street tree care and I need some mulch. A lot of times M&O will say ‘ok, we think we can do that’.” The stakeholder explained that their direct access to NYC Parks staff has helped build relationships and trust, as the agency sees them willing to help out and publicly advocating for more funding for NYC Parks.

A third community stakeholder shared how their group discussed and prioritized projects and needs with their NYC Parks District Manager. “It is a symbiotic relationship. [My Park

Manager] will ask, 'What do you want to do in the park?' I think the trick with the Parks Department is about forming relationships that are considered positive and not adversarial." They also reiterated the importance of understanding how to work with NYC Parks. "First you get training – the training is critical – with the training, you get that sense of what does the City want or expect and the sense of the rules and guidelines, so [you can] work within them and don't work outside them." Another community stakeholder acknowledged that people who did not have a close working relationship with NYC Parks often saw the agency as byzantine and inefficiently run because they tried to make change outside of a process. Despite being a newer group, a fourth community stakeholder is working closely with NYC Parks to onboard more volunteers to help steward trails and trees by organizing and coordinating with NYC Parks and Natural Areas Conservancy to hold trainings in their park. The group feels there is a level of collaboration, especially since both groups have been very responsive and communicative. "In the future we will have more input or say. At this time, Parks is guiding our efforts because we didn't know where to start.".

Working jointly with NYC Parks builds trust and allows greater autonomy and support, allowing groups to collaborate more with the City. "Because of those relationships [with the City], we get to see what is behind the curtain. We see how the problem is because I am so steeped in the parks advocacy world. I know sometimes more of what is happening than maybe someone who is just coming to take care of parks. They are not deeply engaged" (Community stakeholder, personal communication). Community stakeholders see their presence and work relieving a taxed, overworked, and already limited municipal staff so doing anything to reduce their workload is a huge help. One community stakeholder focused on keeping their local park clean so it "wouldn't overburden [NYC] Parks" because they are short staff, while another leader

explained that their NYC Parks borough staff are "actually relieved that they don't have to be out here all of the time looking at stuff, because we just report things as they come." These community groups function as additional monitors for NYC Parks. One group takes photos and submits work order requests to the agency. When there was no rain in the summer of 2022, they contacted NYC Parks and the associated contractor notifying them that the young trees in the area needed watering.

Finding #3: There is a need to increase knowledge and awareness of tree stewardship and the urban forest to better inform, educate, and mobilize residents.

Stakeholders feel that a lack of knowledge about NYC's urban forest influences how residents feel about and perceive trees. Some residents and businesses see them as hazardous and a nuisance instead of critical infrastructure. Others, as one community stakeholder shared, are not aware of how they can care for trees, seek assistance if they have questions, or understand the tree planting process. "People don't know they can take care of a street tree bed, they don't know how to ask for [a tree], they don't understand the process of how long it takes. People are a little bit lost when it comes to both street trees and their private property trees, like 'What do I do? Where do I find help?' It is not something that people just know immediately."

Other community leaders interviewed admitted it can be difficult to understand what opportunities are available to support the urban forest. One leader noted it took her a while to learn there was a formal tree stewardship program. "We ended up doing street tree care – that didn't come about right away, but a few years after because we didn't really know there was an actual street tree care program." A lack of awareness of urban forestry processes and programs is

also a product of struggling to navigate city government and not knowing how NYC Parks is structured. Those people who are already connected to groups like a community garden or school might have a better sense of how government works, or have advocated to their elected officials. For those unfamiliar, it can be a daunting process, especially for immigrant and marginalized communities who often live in tree deserts and already face barriers to participation. “A lot of people, especially immigrant communities, don’t understand that these are things they have access to in this city and they can request them. It is all about them knowing about it, and having the right to request these things and have access to them” (Community stakeholder, personal communication).

A popular solution to address a lack of knowledge and awareness about urban forestry programs is to increase community outreach and engagement. This is important because even engaged volunteers have limited knowledge of the urban forest (Moskell et al, 2011). Community leaders shared how difficult it was to mobilize people in their neighborhood to take ownership of tree beds and urban spaces, yet were optimistic that it could be addressed by better education. “A lot of it is really education and that is just a challenge, educating people on the importance of street trees, how to care for them, educating business owners,” said one leader. “It’s on [NYC] Parks to do a better job of promoting the importance of caring for street trees, particularly as a bulwark against the effects of climate change, and provide better guidelines for businesses on protecting street trees. That can go a long way in supporting the street tree care work groups do.” In an attempt to improve outreach, one community leader noted how NYC Parks has increased transparency of its tree planting through its website. However, they believe there are very few people who actually use or know about it. The agency cannot just rely on information being available online or through any one program like MTNYC. “It is an ongoing

effort to educate New Yorkers about why trees are important and why they are not just here to look nice and that they should really be valued and cared for as part of our infrastructure. You can't convince people of that with one program, it has to be an ongoing educational effort." (Community stakeholder, personal communication).

Finding #4: Technical assistance and capacity building resources are critical to advancing tree stewardship and empowering volunteers to become long-term stewards.

Supporting and developing long-term tree stewards is critical to help NYC Parks manage hundreds of thousands of street trees across the city. Capacity building was shared as a constant challenge for volunteer groups and leaders, demonstrating a need for technical assistance to equip volunteers with the proper tools, skills, and knowledge. Organizational and governmental greening partners have provided this type of support previously through the MTNYC initiative, such as holding periodic workshops and administering seed funding to help build a volunteer group's capacity, develop their organizational structure, and empower them to sustain and expand their tree stewardship work beyond the program's conclusion. One municipal stakeholder shared that the mini grant program was their favorite resource the program administered. "Groups received $1000 and then we would also give them additional support. If they wanted to host a number of events throughout the year, we would help them promote it by making flyers and posting it on social media, drop off mulch or compost for their tree beds, and hook up water supply for them. They could use funds for anything related to tree stewardship and caring for their trees. It was a way to invest in the people in the community, help them value their trees and expand their capacity to care for trees."

PfP also provides technical assistance through one-on-one staff support, public workshops, and small grants. Community stakeholders mentioned the value and importance of seed funding, such as PfP's Capacity Fund Grant. They also appreciated how NYC Parks' Super Steward program supports volunteers to become long-term stewards of street trees and natural areas through the staff's guidance on caring for trees and hosting volunteer events. The program delivers monthly training on how to become a Super Steward, holds on-site workshops to help certify new volunteers, provides material support through the TreeLC truck - providing tools, mulch and water to help community leaders run their events, and grants permits to access fire hydrants to water trees.

Technical assistance and capacity building is needed at both the citywide and neighborhood scale. The Greening Western Queens project had several dedicated staff members from NYC Parks, Partnerships for Parks, and New York Restoration Project providing on-the-ground support to volunteers who adopted newly planted trees. The project had a Community Visioning Coordinator whose primary role was to evaluate tree stewards to determine how much help they needed to continue their work beyond the grant project. This involved convening community groups and providing them the structure and guidance to help organize, fundraise, communicate, and if desired, form a nonprofit. The Gowanus Tree Network was highlighted as another, albeit different, example of providing hyper-local assistance to volunteers. GCC plays a convening role through the program and helps residents get to know each other. The organization provides their own set of resources and guidance to improve the urban tree canopy, including training residents to become Citizen Pruners. Investing in volunteers and providing them the tools and knowledge to do the work is exactly what is needed, according to one community stakeholder. "You have to give skills and ability and empowerment

to a group within the community. If you talk about one million trees, or a higher number, and you think where these trees are located, there just is not enough Parks resources."

Finding #5: NYC Parks has staff and budget limitations that place a greater maintenance onus on community volunteers and organizations.

NYC Parks currently plants about 18,000 trees each year, but has limited staffing and funding to care for the increasing number of young and newly planted trees. One example of staffing challenges is with the Super Steward program, which, as of late 2022, relied on one staff member to work with 600 volunteers and manage the field work, outreach, and data collection. The Super Steward program's ability to train and empower environmental stewards to maintain street trees and natural areas is hindered due to its inability to hire permanent staff lines and its reliance on a rotating cast of seasonal AmeriCorps service members. While AmeriCorps service members have played an important role in advancing the urban forest by running workshops and leading public stewardship events, their cumulative impact is dependent on how many service members NYC Parks can secure that season. The team is always changing since these positions term out after 10 months. "Lack of capacity is the biggest hindrance [to supporting the urban forest]. There is constant turnover. I've been the coordinator of the [Super Steward] program since its inception in 2016. I have only had a crew for a couple of years and they are seasonal, so by the time they get trained they have finished their term" (Municipal stakeholder, personal communication). An expanded staff with full-time, year-round employees would not only increase capacity to hold more workshops, support more volunteers and attend more events, but permanent staff lines would help empower community volunteers by developing stronger

personal connections. Seasonal staff develop temporary relationships with super stewards, disrupting opportunities to build trust. By the time a community leader and Super Steward staff member develop a bond and get to know each other, the service member's term is over. "The greatest issue is a lack of investment in staff. One of the most important things for empowering community volunteers, especially in underserved communities, is developing personal connections. And what we do is we throw seasonal staff at them and so by the time they have gotten to know or trust someone, their term of service is done" (Municipal stakeholder, personal communication). The Stewardship team is a niche group, so if they are overstretched and unable to work with volunteers, there is no other NYC Parks division they can really pass people or work off to.

Community leaders voiced challenges working with the Super Steward program. For example, NYC Parks requires volunteers to attend training as part of the Super Steward certification. They hold these events each month throughout the city, but it might not always be geographically convenient or accessible. This forces people to either travel longer distances outside of their borough to get trained immediately, or wait until an unknown date in the future for an opportunity closer to where they live. This delay might result in people losing interest. One community stakeholder shared the difficulty in navigating this dynamic. "If there is a training in the month you want to join the stewardship program, it might not be in Queens, so you might have to go to Staten Island, Bronx, Brooklyn or Manhattan. Most volunteers want to make it as convenient as possible for themselves. People lose interest if they can't get to the training. Then we would have to find them again to let them know a training is coming up in Queens." Some volunteer groups are heavily reliant on the Stewardship team, and since this program is a train-the-trainer model, limited staff means a group's efforts to develop additional

stewards are stymied if they cannot equip and certify new volunteers. “With [the Parks Super Steward trainer], at the end of June [2022], it was uncertain if he would be picked up again due to the budget. We were totally petrified because he had trained us. If July comes around and there is no budget for trainers, how would we continue?” (Community stakeholder, personal communication). There is a feeling that while the Stewardship team does a lot for volunteers and the urban forest, there is so much more that could be done if the program was adequately supported.

NYC urban forest program budgets and funding allocations are primarily dedicated to tree planting and not investing in maintenance. Capital contracts are used solely to plant trees and cannot be applied to tree maintenance. The City recently received $140 million from Mayor Adams to plant more trees over the next several years, but that is for capital contracts, not staffing (Municipal stakeholder, personal communication). Due to the quantity of trees planted every year, one NYC Parks employee noted that each individual tree does not receive the care and attention it should. Community leaders are increasingly aware that more responsibility for tree maintenance will fall to them, unless allocations with the city budget change. Once funding ran out for Greening Greenpoint, NYC Parks and organizational partners had to pull back and reduce their involvement, which sparked the creation of a community group to help steward the newly planted trees. In addition, organizational partners already see themselves as helping address the financial gaps by caring for young trees through pruning, mulching, and watering.

Community groups and nonprofit organizations play a large role in advancing the urban forest, but they also have capacity limits that need to be considered. Some community stakeholders highlighted how it is not sustainable for them to be relied on in the long-term. While the groups interviewed are having success in growing their work and increasing

engagement, they do not have the people, time and resources to hold more events or expand their stewardship scope. Lack of time was a common concern and one of the largest barriers to community group participation, especially given the energy needed to plan a one-day event and coordinate all of the logistics with NYC Parks, including delivering mulch, compost, and tools. "It is challenging to coordinate tree care as a regular person in a big city," said one municipal stakeholder. "You need someone who has identified a spot to drop it and then go through it - mulch and compost just can't stay out there for weeks. You have to have a plan." Most volunteers rely on NYC Parks to drop off tools and materials because residents have no way of transporting it themselves. "The one thing that limits our organization is that we don't have any kind of vehicles. We work with [NYC Parks Maintenance and Operations] a lot on street tree care because we need their help transporting things," explained one community leader. The physicality of stewardship work in all weather conditions might be more than many can handle, especially for people who are older. Finally, once a grant-funded project is complete, NYC Parks, nonprofit partners and grantmaking organizations often require reporting on the outcomes. This is a struggle even for the most experienced volunteers. "Like anything else with grants, there is grants management and reporting. Everyone hates it, I know, but it has to be done. But I could see any group say, 'Hey, this is just not worth it…all of the paperwork.'"At the organizational level, nonprofits who have a bit more funding and structure than community groups have developed a robust volunteer network and are stewarding a significant amount of trees, but they need funding and resources to support their activities too.

Finding #6: Watering young street trees is seen as the most important stewardship activity, yet lack of proper equipment and inability to access hydrants threatens the growth of the urban forest.

Many young street trees struggle to receive the necessary 15-20 gallons of water per week to grow properly. Not watering trees could permanently damage or even kill them, which would delay valuable tree canopy benefits for communities. While most street trees are under the jurisdiction of NYC Parks, the agency is not able to water them because of their lack of equipment, limited staff capacity, and the sheer quantity and geographic distribution. If a new tree dies during the first two years under a maintenance contract, the contractor is required to replace it and provide care for another two years. However, once that two-year commitment expires, trees remain vulnerable and need other people to monitor and steward.In addition to planting, borough offices are focused on pruning mature trees, so there is a gap in watering support for trees between 2 and 10 years of age - which is a pretty crucial time (Rose, 2018).

Tree stewards do their best to address this critical need, but they face multiple barriers. People who live in an apartment building have to locate their water source, which could involve dealing with difficult landlords who may limit access. Carrying heavy buckets of water down multiple flights of stairs is a difficult task for one tree, let alone trying to steward multiple on a block or in an area. Increasing temperatures and more frequent droughts due to climate change are further exacerbating tree stress and urgency to water. Fire hydrants provide an accessible option given their ubiquity and proximity, but these come with their own challenges. Any resident could request their local fire department to open a hydrant, but opening and closing it for each event is not realistic or sustainable. There are also different types of hydrants; old fashioned

ones that are easier to open and new hydrants with magnetic spin-tops that are difficult to maneuver. Old fashioned hydrant tools are not applicable to the new hydrants with magnetic caps. Navigating these watering logistics is a serious challenge that can be too difficult for some stewards to overcome. “I do think access to the resources and tools you need can be a little more than people are able to do. Watering is not always easy. Even when we do street tree care now, we do not water the trees, because more often than not, we can’t open the hydrants. This is a huge issue we haven’t addressed” (Community stakeholder, personal communication).

Attempts to address hydrant access have yielded some benefits. Tree stewards can receive a permit to open hydrants from the Super Steward program after completing training. Once secured, people are empowered to open hydrants either in their neighborhood or citywide, giving them more flexibility to cover a wider stewardship area. Organizational stakeholders can also benefit by partnering with the NYC Parks Stewardship team. The Brooklyn Greenway Initiative expanded their tree stewardship work along areas of the Greenway and secured a grant to lead another community forestry project in Greenpoint in 2021. Possessing a hydrant permit allowed them to run their own stewardship events and provide water to 43 newly planted trees. Despite some success,, organizational and community stewards are becoming increasingly frustrated dealing with the new spin-top hydrants. Although NYC Parks provides a tool for old hydrants, it is less effective because of the greater number of new hydrants, further complicating logistics and limiting stewardship activities. “I don’t understand why we don’t have access to open those [hydrants],” said one community leader. “You are giving me a permit to open a hydrant, but somehow you are telling me it is only for [one type] and not for that [other one]. Is it that we can't open it at all? You can't find the tool to open the fire hydrant. My thing was, if you want us to take care of street trees and water those trees, you have to provide us with the tool, or at least

allow us to access it somewhere." Not only does it take time and energy to search for a suitable hydrant without a magnetic cap, but the tool to open a magnetic cap is close to $1000. Groups and organizations are trying to address these issues locally, but when trees are planted far from each other throughout a neighborhood, an organization's already limited resources become stretched. "Especially in these blocks where new trees are being planted and they are not close to each other, it is hard to get to them," said one organizational partner. "[We] can't take our water cart to water every new tree, so [we are] limited in [our] own resources."

Finding #7: Partnerships for Parks' serves as a bridge between community and government, while its Catalyst program provides deep, sustained community engagement, allowing people to coalesce around a project, build trust, and collaboration.

Some community stakeholders mentioned the important role Partnerships for Parks (PfP) played in connecting them with NYC Parks and helping navigate City government. This allowed them to turn their stewardship interests and community concerns into concrete action. As a public-private partnership with NYC Parks and City Parks Foundation, PfP's outreach Coordinators (OCs) are embedded within the agency across all five borough offices, designated to a set of neighborhoods and serving as a community liaison. OCs are also often the first person community members are directed to when wanting to work with NYC Parks, helping provide an opportunity for people to build relations with the agency. One community leader recalled that after completing a project in their park, connecting with their OC provided a gateway into working with NYC Parks. "Then eventually we sort of branched out from [the park] once we realized there was more support. At this point we have an OC from PfP - thank god for

Partnerships for Parks - and I think just having conversations with that coordinator and learning more and just really being interested in taking care of trees" (Community stakeholder, personal communication). Outreach Coordinators can also field a wide array of community concerns. "I will contact the OC if there is anything going on," said another community stakeholder. "There was a trailer parked in the parking lot for a couple of months and we saw it didn't move, so we contacted the OC right away and were speaking to them daily." According to one organizational stakeholder, PfP's "network is nearly unparalleled in neighborhood reach in NYC" as they are connected to a really strong grassroots network. "Whether it is information sharing, [providing] grant opportunities, or directing targeted environmental interventions, I think we have the infrastructure to do a lot." Building capacity and skills is something community leaders noted as an important facet to PfP's work, and an invaluable element to their own growth. "It is somehow easier for city agencies and grantmaking organizations to fund equipment and not fund the difficult ongoing work of human to human contact and behavior change," said another community stakeholder. "That is one of the things I love about PfP. They are one of the few orgs that does capacity building and makes a strong effort in supporting parks groups and doing that messy human behavior work."

PfP also has the capability to immerse itself in communities through its Catalyst program. Anchored by its "Build, Connect, Sustain" philosophy, Catalyst has been an opportunity for one employee to work intimately in a community for 4-6 years, providing the time and space for quality convenings where local community members feel they are heard, can develop their leadership skills, build strong collaborative relationships, and make an impact on their neighborhood through their local park or green space. According to one organizational stakeholder, what distinguishes Catalyst is its ability to work intimately with communities for

long periods of time, becoming a confidant for the burgeoning community group and operating at a breadth and depth other agency staff are not able to. “The focus that Catalyst has lets us be in the committee meetings every month; we are at a really in-depth conversation that not many people at [NYC] Parks ever get to do. They are not privy to the ongoing, evolving conversations and watching people blossom” (Organizational stakeholder, personal communication). The program’s ability to be strong network weavers helped build bridges to other organizational and agency partners that fostered collaboration. Local park groups working with Catalyst are having tremendous success with “strong, robust relationships with their community board, community board district manager, council members, and they have stature and they speak in local civic situations knowing that their group matters and their elected officials will listen. These successful park groups have a real platform by which they can call out attention to many matters” (Organizational stakeholder, personal communication). The program builds authentic relationships and trust with the community group, helping provide structured community visioning activities and support to help communities envision success and take action that empowers and emboldens residents. “A big part of being an effective organizer is having authentic relationships that aren't transactional – that you have consistently demonstrated care and investment, not when everything is on the line, but you have demonstrated it” (Organizational stakeholder, personal communication).

While Catalyst has mostly supported parks in underserved communities, other programs have adopted its model to support tree stewardship. The Greening Western Queens program was based on Catalyst, providing ample time and opportunity for the community to coalesce around the tree planting and stewardship project. A timeline of five years helped form a highly functioning group of stewards that could continue the work on their own (Organizational

stakeholder, personal communication). NYC Parks also loosely based its Green Neighborhoods stewardship program on Catalyst, where the Stewardship team focuses on one geographic area for an extended period of time. One organizational stakeholder noted that the program had been directly involved in the formation of several very active Friends-of groups. Both GWQ and Green Neighborhoods programs demonstrated commitment to a community, patience to conduct outreach, organize residents, and empower leaders, while building authentic, supportive relationships that enabled groups to succeed. The ability for the program to be applied to different stewardship contexts also is a testament to its structure and approach working with communities.

Chapter 5: Discussion

This thesis used New York City as a case study to assess how the City has centered community involvement, equity, and co-creation in its urban forestry initiatives over the last two decades. The goal was to look at how these projects and programs might be strengthened to help sustain community involvement in street tree stewardship in environmental justice communities, since these areas typically have lower canopy cover (Landry and Chakraborty, 2009). As NYC continues to equitably plant thousands of street trees every year to expand the tree canopy to 30%, there is hope that residents will proactively step up and steward these new trees. However, tree planting alone cannot be the sole strategy for engagement. Targeting low-canopy, heat-vulnerable areas with the assumption people will automatically participate ignores the important procedural elements of engaging and involving communities early and often in urban forestry processes (Sousa-Silva, 2023). Stewardship programs that prioritize both new and existing trees and that seek equitable involvement in the decision-making process will be critical to sustaining the urban forest and reaching the city's canopy goal (Novak and Greenfield, 2018; Eisenman, 2021). Researching current and past urban forestry programs showed that NYC has the ingredients to advance participation in tree stewardship - diverse and innovative forestry engagement practices, robust volunteer stewardship network, and strong collaborative governance. However, staff and budget limitations hinder the City's ability to grow the volunteer base and meet the stewardship demand.

Community and organizational stakeholders have been instrumental in helping execute urban forestry projects, while in the process developing a close working, highly collaborative relationship with city government. Residents sat on advisory committees for MTNYC and

Greening Greenpoint, conducted tree census mapping to inform planting and stewardship efforts, secured settlement funding for greening efforts, and formed groups to drive change. Public participation is not limited to top-down government programs, but rather grassroots volunteers have become high functioning entities representative of an active citizenry that create their own innovative and creative programs to support urban environmental stewardship. They leverage government resources to grow their capacity and expertise - becoming a Super Steward, a hydrant captain, and a Citizen Pruner. Groups build relationships and trust with NYC Parks, enhancing their effectiveness and developing greater autonomy. They engage in collective stewardship activities that build social capital (Mincey and Vogt, 2014). Tools like 311 are used to advocate for trees and participate in the urban forest, serving as an additional monitoring for NYC Parks. Though 311 tends to be used disproportionately by some groups of people than others, it remains an empowerment tool for groups - drawing the City's attention about needs in their neighborhoods. This level of civic involvement denotes strong collaborative governance and that community and organizational stakeholders are already engaging in hyper-local decision making and co-creation of solutions related to stewardship efforts.

Despite significant existing citizen involvement, this study identified some logistical and administrative barriers to participating in stewardship activities and advancing the urban forest. For example, watering trees is one of the most significant barriers community leaders face in their volunteer efforts, leaving many trees untouched once maintenance contracts run out. As the City plants thousands of trees every year, there will be an equal amount that are cycled off of contracts in a couple of years. With impacts of climate change and the urban environment already making life difficult for trees to survive, not watering exacerbates the threat to the urban forest. In addition to watering, community stakeholders were upfront about the time and energy

it requires to host and secure supplies for their events. The logistics of picking up and returning tools is difficult, especially since groups typically must complete the work in the same day. The physicality of stewardship work in all weather conditions might be more than many can handle, especially for people who are older.

For all of the dedicated volunteers caring for their city's urban forest and open spaces, there are countless others who are unable to participate because of numerous obstacles that make it inaccessible. Residents also often feel they do not possess the knowledge and ability to care for trees, which can hinder involvement (Riedman et al, 2022). Socio-economic barriers prohibit people from coming out on a Saturday morning to participate in an event. For many, volunteering connotes that people have time and the means to dedicate. Even if people do find the time to dedicate, people might hit a number of road blocks trying to participate. The pandemic exacerbated a world that requires internet access, strong internet connection, and people who are computer savvy. Many of the stewardship trainings, workshops and funding opportunities over the last couple of years have been completed online. Not to mention that all funding and material support, and general outreach and engagement, are predominantly offered in English. Language access can be prohibitive and require additional support.

City funding is a critical component that can advance community participation, sustained engagement, and equity. NYC Park's annual budget is small, insufficient, and does not prioritize tree maintenance. However, the fact that NYC is currently investing hundreds of millions of dollars to address distributional inequities by planting trees in low tree canopy cover demonstrates the need to simultaneously invest in street tree maintenance to ensure trees have a better chance of survival (Lu et al, 2010). NYC has shown over the last two decades it has the political will to advance the urban forest, but more needs to be done to make sure trees survive in

the early years (2-10 years of age) to ensure communities benefit from canopy cover. There is concern that any citywide tree planting initiatives will disregard tree maintenance at a time when the majority of canopy gains are from the growth of existing trees, not planting new trees (Treglia et al, 2021).

Another aspect of tree maintenance that needs funding support is to increase NYC Parks staffing. Some volunteers expressed that they are maxed out and cannot take on more work. There is a need to increase outreach and engagement about tree stewardship to cultivate more volunteers, but the primary vehicle in NYC Parks to do so - the Stewardship division's Super Steward program - operates with a small staff with many positions filled by seasonal employees. From 2012-2022, staff numbers fluctuated every single year, having somewhere between 2-4 people that face turnover every 10 months. Program impact is dependent on the number of service members NYC Parks can secure each year, making long-term planning highly unpredictable. Staff turnover can also alter dynamics of existing relationships with community stewards (Butt et al, 2021). The Super Steward program provides expertise and guidance that is valuable to supporting volunteers caring for street trees, wetlands, forests, and trails. With a smaller staff, the team holds fewer trainings and events and has less opportunity to engage volunteers since they are trying to sustain their current work.

In addition to addressing opportunities and barriers to increase tree stewardship, this thesis also uniquely analyzed together citywide and neighborhood forestry projects to identify best practices. MTNYC is celebrated as a monumental achievement but there is also much to learn from the other community forestry projects. The literature supports this research gap. Many studies have typically looked at MTNYC as a standalone case study, while there was only one study found on Greening Western Queens related to social-ecological resilience and none related

to Greening Greenpoint or the Gowanus Tree Network. While my research did not conduct a side-by-side comparison and evaluation of each, there were some high level takeaways that are worth elevating. First, PfP is well placed to serve as a network weaver among city government and community and organizational stakeholders (Landau et al, 2019). PfP's Catalyst program served as a model for community organizing and engagement in the Greening Western Queens and Green Neighborhoods stewardship program. Not only does it have a proven track record to engage communities around the urban forest, but having an entity embedded within city government that commits itself to deep engagement and forging authentic relationships is effective. Another best practice was placing NYC Parks Forestry staff in each neighborhood project to help play an organizing role. These staff members could connect with neighborhood institutions, conduct asset mapping, identify interested residents, convene groups and individuals, and increase communication and transparency into city forestry processes. This presence helps build trust with communities, providing a stable point of contact and knowing residents can turn to. A third practice was the incorporation of workforce development programs to help reach tree planting and stewardship goals while providing critical skill building and pathways to employment. Given NYC Parks' capacity issues, if funding can be found, these programs could be a useful supplement. These programs showed up in various instances through the MillionTrees Training Program (a partnership between NYRP and NYC Parks) and Greening Greenpoint (Trees New York's Young Urban Forest interns). A fourth practice was that public-private partnerships helped execute tree planting and stewardship projects by bringing in additional funding, expertise, and capacity. Citywide and smaller-scale community forestry projects demonstrate that leveraging public and private entities are critical to maximize funding opportunities, incorporate expertise, and build organizational and programmatic capacity. Finally,

the “adopt-a-tree” maintenance strategy was used to engage New Yorkers, develop accountability, and create program buy-in for MTNYC, GWQ, Greening Greenpoint, and the Gowanus Tree Network.

This thesis assessed how equity was prioritized in NYC’s recent forestry initiatives, but there are larger implications to consider due to urban greening that go beyond program design. One perspective lightly touched on in the literature and in interviews was the role of private resources stewarding public infrastructure. An assumption was made in this study that volunteers and grassroots community groups want to participate in urban environmental stewardship. NYC has relied heavily on volunteers to support its work dating back to MTNYC and beyond. Decreases in public funding for green spaces and an over-reliance on civic stewardship groups are not new phenomena (Holifield and Williams, 2014; Campbell et al, 2021), but determining what is the city’s responsibility, and if volunteers should be taking on the work at all, is a deeper governance discussion. A second implication is the potential displacement of residents due to green gentrification. This thesis focuses primarily on increasing the urban tree canopy in environmental justice communities to deliver tree benefits to people who are disproportionately experiencing the impacts of climate change, yet these are the same places that are most vulnerable to gentrification. Research has shown that tree planting increases housing prices and property values (Li, 2019), and has been associated with gentrification (Donovan et al, 2021). Whatever neighborhood or citywide organizing that happens to foster greater stewardship, it is important to acknowledge fears around displacement are real, valid, and could heavily influence engagement. Program managers, policy makers, organizational leaders, and engagement staff should start thinking about strategies now - fostering dialogue with communities to understand gentrification concerns, supporting their construction of alternative visions of their neighborhood

that maintains its character, helping develop approaches to avoid displacement that centers community residents in the process, engaging with housing advocates, and being transparent about urban greening programs and policies. Building trust with a community will likely be heavily dependent on it.

Chapter 6: Recommendations and Conclusion

Recommendations

The following recommendations seek to advance an agenda of equitable, people-centered street tree stewardship in New York City. They stem from the analysis and research conducted from a comprehensive literature review and stakeholder interviews.

Funding

Recommendation #1: Increase municipal budget allocation to NYC Parks and earmark funds to support street tree maintenance

Proposed Lead: Forest for All NYC coalition, in partnership with the organization New Yorkers For Parks

In 2024, $618 million was allocated to the agency out of $112.4 billion, or about .5% of the entire budget (Honan and Hogan, 2024), with very little directed to street tree maintenance. Any new funds that come through, such as through the Cool Neighborhoods NYC initiative from Mayor Adams, is earmarked only for tree planting. Baselining stewardship funding in the Parks Maintenance and Operations budget would be an important step. There is a need to increase the amount of funds directed to street tree stewardship, with the primary focus to hire more full-time NYC Parks Stewardship Team staff to engage more volunteers. Additional maintenance funding could also be directed to expand the TreeLC truck program (such as the number of trucks or with more staffing, the amount of times they can offer the service throughout the year), or to purchase

tree guards to include with the new tree plantings since they are not currently mandatory. These investments can help direct more resources to heat vulnerable communities. With the Play Fair Campaign, led by New Yorkers For Parks, already annually advocating for 1% of the city budget and yet to reach that target, the Forest for All NYC coalition should assess whether there is an opportunity to collaborate and advocate for additional funding through this channel.

Recommendation #2: Enhance capacity-building and leadership development support to street tree stewards

Proposed Lead: Forest for All NYC coalition members

One of the key findings from my interviews was that technical assistance and capacity building are critical to advancing street tree stewardship and empowering volunteers to become long-term stewards. The NYC Mayor's Office of Climate and Environmental Justice echoed this sentiment in their EJNYC 2024 report, noting that capacity-building and leadership development were also deemed the most effective means of advancing environmental justice. "Resources like grants and political trainings empower communities to self-organize and participate in decision-making, enabling them to advocate for neighborhood improvements more effectively" (Mayor's Office of Climate and Environmental Justice, (2024).

In addition to seeking additional municipal funding to support NYC Parks, private dollars are equally critical to expanding technical assistance offerings. Partnerships for Parks - a joint program of City Parks Foundation and NYC Parks - currently offers small grant funding, public workshops, and other leadership development support. Around $5 million was secured in 2024

from the federal government through the Inflation Reduction Act to support the Greening Central Queens effort, but with the IRA being rescinded and federal dollars becoming more insecure, it is important to seek more philanthropic support. Projects and programs should have an environmental justice focus to align with NYC Parks' heat vulnerability agenda. Forest for All NYC coalition members, such as City Parks Foundation, New York Restoration Project, or Trees New York should strategically pursue philanthropic funding to support this work given their experience and background.

Stewardship

Recommendation #3: Increase collaboration between NYC Parks Stewardship and Partnerships for Parks Catalyst programs to explore targeted stewardship efforts in heat vulnerable communities

Proposed Lead: Partnerships for Parks or NYC Parks Stewardship Team

Both the Catalyst program and NYC Parks Stewardship's Green Neighborhoods programs engage in sustained community building for extended periods of time. The Green Neighborhoods program works with local communities in the care of street trees, forests, wetlands, gardens, and other natural resources in specific neighborhoods around the city. Green Neighborhoods, which has been around for several years, is based loosely on Catalyst's organizing model. Green Neighborhoods is currently working in Kissena Park, Queens, Inwood, Manhattan, and North Shore, Staten Island.

Catalyst is a long-term community engagement program, working in historically under-served NYC parks, connecting people to NYC green spaces and increasing their capacity to sustain parks. Catalyst has been supporting historically underserved green spaces for over two decades and is currently supporting 12 parks across the five boroughs. Catalyst embeds itself into the fabric of neighborhoods and elevates leaders who are passionate about improving their communities. They take an incremental approach in affecting change, working to build trust and develop strong relationships that are not transactional. The amount of time dedicated and meticulous, careful planning, coaching and supporting of community leaders is uncharacteristic of other agency engagement. Catalyst's focus is to develop community groups that will become sustainable entities. Leaving this legacy of a group helps make sure the work continues long after the program leaves. The program is also building out an urban forestry team to support the development of NYC's first Urban Forest Master Plan.

Given the overlap in work scope and respective expertise of each entity, pairing them together to engage in street tree stewardship community building seems like an important first step towards exploring more neighborhood-specific work. They could also align future work with any communities that have contractors transitioning out of their routine maintenance. Coordination within and across programs and agencies focused on street tree stewardship efforts could streamline engagement opportunities for residents and community leaders. This could also be a good step for continuing to build out an explicit urban forestry team in Catalyst. This neighborhood focus also aligns with the NYC Urban Forest For All Agenda's recommendation to "support development of community-scale urban forest plans and goals", which wants to "integrate community forestry into local planning processes and establish urban forest extent and

quality goals for each of the 59 Community Districts and five boroughs" (Forest for All NYC, p. 48).

Outreach and Engagement

Recommendation #4: Launch an urban forest educational campaign, with a focus on tree stewardship, targeting outreach strategies for residents with different socioeconomic characteristics**.**

Proposed Lead: A joint effort between NYC Parks (Forestry division and Stewardship team) and organizational partners like Partnerships for Parks who have outreach and community engagement experience, bandwidth, and a history of supporting urban forestry efforts. They could explore a train-the-trainer model where they educate and empower grassroots community groups and community based organizations who may be a trusted source in the community. Private funding, if secured, could also be used to hire an increased outreach and engagement presence.

New York City plans to plant 18,000 trees each year for the next several years. Embarking on an outreach and engagement campaign to better educate people on the urban forest, starting with those targeted neighborhoods, could provide a valuable window to engage volunteers in new ways. People often do not understand the basics around tree planting and stewardship. Others may have strong, negative or skeptical feelings towards trees and see them as a nuisance or hazard. Additional targeted education on street tree stewardship, particularly in advance of the targeted block planting areas, could help increase acceptance. Proactive engagement early and often prior to planting trees is important, as trust must first be built with communities to bridge

different feelings and opinions about trees. This is especially the case with marginalized communities, who might have felt their trees have been neglected.Community engagement is critical to bringing in more people to care and advocate for trees, and could be used to assess local needs and priorities (Sousa-Silva, 2023)**.** Having more bi-lingual or multi-lingual staff members, tailored to the neighborhood demographics, could help to increase the engagement process.

Future research

Focusing on tree stewardship in NYC's urban forestry programs and initiatives over a two-decade stretch revealed some areas for further research. Some of those ideas, ranging from spatial analysis to wider diversity of interviewee experiences, are listed below.

1) **Conduct spatial analysis using NYC Open Data on where tree stewardship is taking place across the city, as a way to target areas of weak engagement and prioritize education and outreach.** Researchers can pull 311 stewardship requests, activities from the NYC Tree Map, and volunteer data of active groups and people to generate a clearer picture of what neighborhoods are the most active and involved. NYC Parks has devised its own infrastructure investment webpages to highlight where tree plantings are taking place, when to expect work, and what stage each project is in. This could be overlaid with heat vulnerability and other socio-economic metrics to showcase city investments and used to direct where outreach and engagement could occur. This project can start to address the questions related to where stewardship is occurring and who is performing the work.

2) **Engage a broader citizenry with varied participation in NYC urban stewardship programs to understand areas to improve program development and engagement, with a focus on EJ communities.** This thesis interviewed community members and organizational partners who are heavily involved in urban environmental stewardship. Given my own practitioner experience, I went into this project with a lot of existing knowledge that shaped the direction of the project. While some key findings were

discovered about citizen's involvement in NYC's urban forestry history and ways that could be strengthened, it would be even more valuable surveying an audience that is not familiar with NYC Parks.

3) **Evaluate the impacts of communication and outreach strategies on resident behavior in tree planting and distribution programs.** The citywide and community forestry project case studies revealed numerous strategies to engage people with a spectrum of interests - from one-off volunteer to community leader. More work can be done to see the impacts of applying some of these practices in heat vulnerable neighborhoods that have less urban green infrastructure. More evidence is needed on the role of resident behavior in program outcomes and the effectiveness of different strategies to encourage street tree stewardship.

Conclusion

New York City has consistently prioritized equity and community involvement over the last two decades in its urban forestry projects. Addressing past harm and working to build a more just and sustainable city is even more critical given the environmental and social programmatic and funding rollbacks happening at the federal level. Last year, a collaborative partnership between NYC Parks, City Parks Foundation, and Trees New York launched the Greening Central Queens project to increase urban tree canopy coverage and provide work force development skills through 2029. The project received a $5 million grant from the Inflation Reduction Act

(IRA), but with the future of the IRA in doubt, so too may this project. While it is great to see another neighborhood forestry project take off that is rooted in elements identified in this thesis, there is more urgency now to advocate for funding to NYC Parks to ensure the agency's urban forestry work is maintained and thrives. Street tree stewardship has never been more critical, yet long-term maintenance is often put on the backburner for new, flashier tree planting projects. One community stakeholder wants to make sure maintenance is prioritized in future programs. "I worry [a new tree planting program] really ignores a better strategy to increase canopy cover, which is maintaining the health of the trees we already have and making sure the young trees that have been planted in the past several years make it to maturity. The majority of canopy gains from 2010-2017 are from the growth of existing trees, not planting new trees" (Community stakeholder, personal communication). Many wonderful volunteers, organizational partners, and agency staff are working tirelessly to realize a more equitable future, but financial and technical support is desperately needed. The future of NYC environmental justice communities depend on it.

Appendices

Figure 4: Community Stakeholder Interview Example Guide

Focus Area/Guiding Question	**Potential Questions**
Introductory Background	● Where do you live in NYC? ● How long have you lived in NYC?
Civic involvement How are communities civically engaged in NYC? Please tell me about your background and motivation for participating in NYC's public realm. How are they involved in NYC's urban forestry projects and initiatives?	● Are you associated with/a part of any community, civic or other types of groups? For how long? ● What position(s) do you hold in these groups? ● Briefly tell me about your local group and your involvement.* ○ When was your group formed? Why was it formed? How many members are a part of it? ● Briefly outline your background and motivations for starting/participating in your group.* ● What are key programs or initiatives your group carries out/has participated in?* ● What are you most proud of?
Caring for the urban forest How are communities involved in NYC's urban forestry projects and initiatives?	● What does it mean to you to care for your city's urban forest? ● Why do you choose to support trees? Why do you engage in caring for the NYC urban forest? What drove you to get involved in this particular issue/area? What motivates you? ● What are the field-based tree stewardship activities you lead/participate in? ○ What resources do you typically need to accomplish your tasks? ○ Briefly describe any other stewardship programs you participate in across the city. ● Do you work with the NYC Parks Stewardship division? ○ If so, what is your group's level of involvement with them? ○ Are you a NYC Parks Super Steward? If so, for how long?

Exploring partnerships and collaborations What is it like partnering with the City?	● Identify some key collaborating groups in your tree care work. Why have these partnerships been successful?* ● Please describe the nature of your relationship/interaction/collaboration with the NYC Parks Department?* ○ How do you work with NYC Parks on urban forestry projects? ○ What are the strengths of the partnership? ○ What are areas for improvement of the partnership? ○ What resources do they provide you to do your work? ● How can agencies like NYC Parks better support you/community groups?
Co-creation Briefly describe the level of control you/your group has on urban forestry projects, policies and initiatives.	● Briefly describe how you could play a larger role in NYC's urban forest? What would you/your group need? ● What barriers exist to partaking in forestry programs? ● In your ideal world, what role would you prefer to have with NYC's urban forest? (i.e. fully managed by city, playing a leadership role like you are, etc.) ● Do you feel your group has developed, shaped, or implemented environmental policy in your community? If so, how?
Equity	● What does tree equity mean to you? ● Briefly describe how NYC can advance equity in urban forestry initiatives.
Final thoughts	● Is there anything else you would like to share with me?

* = Questions influenced by Harper et al, 2018, "Exploring the characteristics of successful volunteer-led urban forest tree committees in Massachusetts"

Figure 5: Government Stakeholder Interview Example Guide

Focus Area/Guiding Question	**Potential Questions**
Introductory	● Name/title/position/years with NYC Parks ● What drew you to NYC Parks and supporting the urban forest?
Operational overview	● What does your division/program do? What do you do in your role? ○ [if not clear] How does your program/division support NYC's urban forest? ● What is the most difficult part of your job? ● What does it take to plant and maintain a tree in an urban environment?
Leaning into NYC Parks' Experience What has NYC Parks learned about urban forest management over the years?	● What makes NYC a leader in urban forest management? ● What are the strengths of NYC's process/management? ○ What are areas for improvement? ● NYC is regarded for its completion of the MillionTreesNYC campaign. What were its strengths? What were areas for improvement? ● With a Million More Trees Initiative proposed by 2030, how would you approach it differently?
Working collaboratively with communities In what ways are communities involved in NYC's urban forestry projects and initiatives?	● How does your division/program work with, involve or engage communities? ● What role do communities/residents/volunteers play in NYC's urban forest? ● Resources ○ What resources does your division provide community groups? ○ What resources do communities need to play a greater role? What resources do you/your division need to support communities in a larger way? ● What barriers do communities face in engaging in tree stewardship/NYC's urban forest? ● What are opportunities to engage residents further in urban forestry work? ● What would it look like if communities had greater control in NYC's urban forestry initiatives? ● What are the other resources or organizations that you would direct people to related to forest management in

	NYC?
Equity and Parks How does NYC Parks prioritize equity? (maybe preface what equity is/how it is being defined)	● What do you think equity means to NYC Parks? ● How has NYC Parks's prioritization of equity in urban forestry changed over the years? ○ How has the 2014 Community Parks Initiative and NYC Parks' *Framework for an Equitable Future* impacted equity in urban forestry initiatives? ● How is equity incorporated into your work currently? How is equity considered in tree planting? Stewardship programs? ○ How are places identified to plant trees? ● What would be your recommendations to advance equity in NYC's urban forest?
Final thoughts	● Is there anything else you would like to share with me? ● Is there anyone else you think would be especially important for me to talk to?

Figure 6: Organizational Stakeholder Interview Example Guide

Focus Area/Guiding Question	**Potential Questions**
Introductory	Name/title/position/years with organization What drew you to support NYC's urban forest?
Operational overview	● What does/did your organization/program do? ● Do/did you focus in a particular geographic area? ● How does/did your organization/program support NYC's urban forest? ● What is/was the most difficult part of your job? ● What does/did it take to plant and maintain a tree in an urban environment?
Leaning into Organizational Partners' Experience What roles do organizational partners play in urban forestry management and initiatives?	● What makes NYC a leader in urban forest management? ● What are the strengths of NYC's process/management? ○ What are areas for improvement? ● NYC is regarded for its completion of the MillionTreesNYC campaign. What were its strengths? What were areas for improvement? How has this impacted the work you do at the organizational level? ● With a Million More Trees Initiative proposed by 2030, how would you approach it differently?
Working collaboratively with communities In what ways are communities involved in NYC's urban forestry projects and initiatives?	● How does your organization/program work with, involve or engage communities? ● What role do communities/residents/volunteers play in NYC's urban forest? ● What resources are needed for communities to play a greater role? What resources do you need to support communities in a larger way? ● What would it look like if communities had greater control in NYC's urban forestry initiatives? ● What barriers do communities face in engaging in tree stewardship/NYC's urban forest? ● What are opportunities to engage residents further in urban forestry work? ● Do you think there is a greater role for communities to play in urban forestry management? ● What are the other resources or organizations that you would direct people to related to forest management in NYC?

Working collaboratively with NYC Parks	● Please describe your role/relationship with NYC Parks ● What are strengths of this relationship? What are areas for improvement? ● Do you think there is more that NYC Parks can do to support communities in supporting the urban forest?
Equity How can NYC prioritize and advance equity? (maybe preface what equity is/how it is being defined)	● How is equity incorporated into your work currently? ● In what ways do you think NYC Parks prioritizes equity in its urban forestry work? ● How has NYC Parks's prioritization of equity in urban forestry changed over the years? ○ How has the 2014 Community Parks Initiative and NYC Parks' *Framework for an Equitable Future* impacted equity in urban forestry initiatives? ● What does tree equity mean to you? ● Briefly describe how NYC can advance equity in urban forestry initiatives?
Final thoughts	● Is there anything else you would like to share with me? ● Is there anyone else you think would be especially important for me to talk to?

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