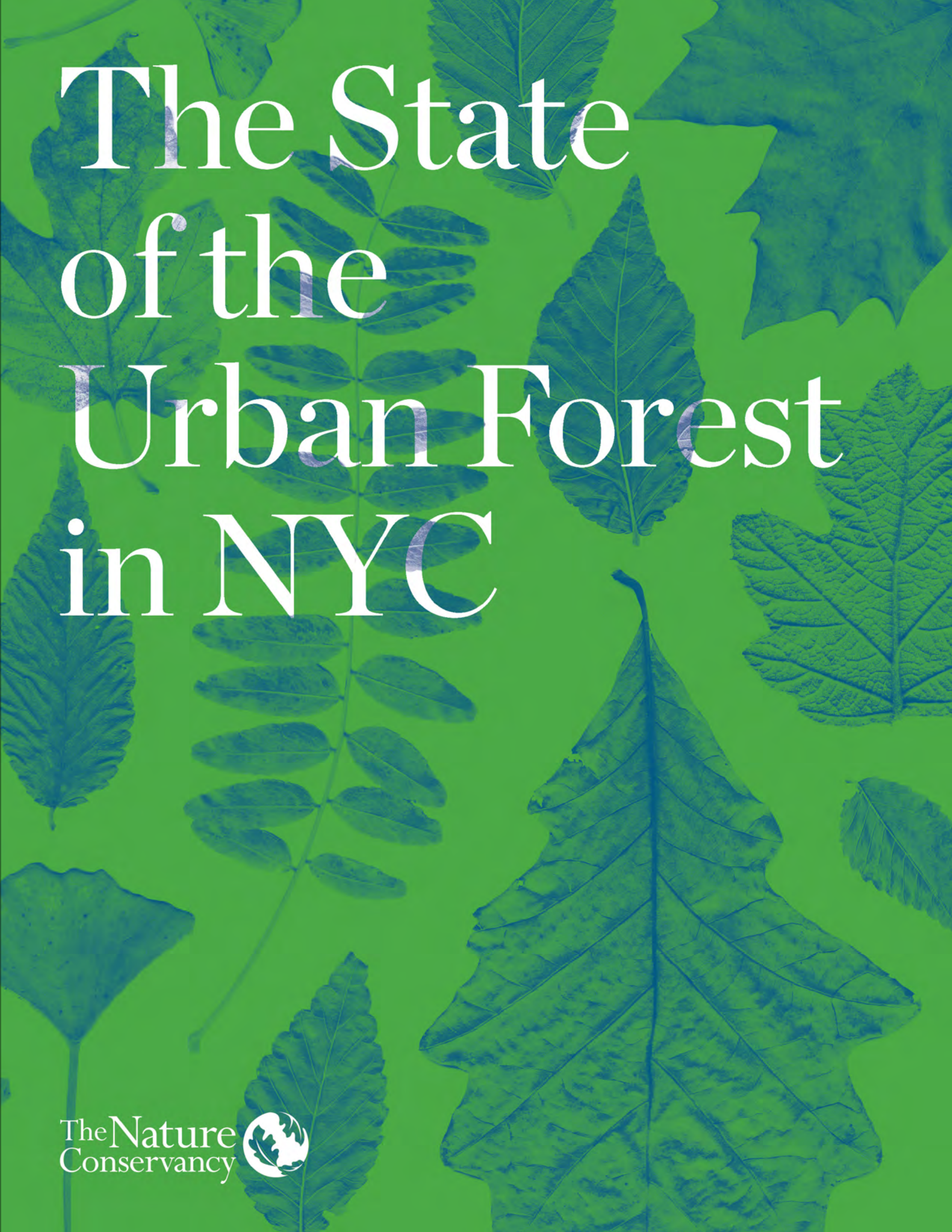
The State of the Urban Forest in NYC



The Nature Conservancy

The State of the Urban Forest in New York City

Emily Nobel Maxwell
Dr. Michael L. Treglia
Dr. Montserrat Acosta-Morel
Dr. Darran Crabtree
Kate Galbo
Tami Lin-Moges
Alaina Van Slooten

The Nature Conservancy
nature.org

The East River and lower Manhattan skyline, as seen through the trees in Brooklyn Bridge Park, Brooklyn.

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Project Team
Project Director and Lead Author, Emily Nobel Maxwell
Lead Scientist and Lead Author, Dr. Michael L. Treglia
Production Managers: Alaina Van Slooten, Kate Galbo, Tami Lin-Moges
Contributing Authors and Analysts: Dr. Montserrat Acosta-Morel, Dr. Darran Crabtree, Tami Lin-Moges, Kate Galbo, Alaina Van Slooten

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Editors
Ann Holcomb, Heather L. Sisan

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MGMT. design

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Early fall foliage overhead.

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The sun shines through a tree on Governors Island, Manhattan, with New York Harbor and the Statue of Liberty behind it.

Letter from The Nature Conservancy

Dear Reader,

As dendrophiles, it was easy for us to launch a project to learn as much as we could about trees in New York City. When we started to research and write *The State of the Urban Forest in New York City*, we anticipated that it would be a tremendous learning experience and a labor of love. But the project has surpassed our expectations as our appreciation of and love for the NYC urban forest and the incredible community of New Yorkers who care for it have grown.

From the tiniest sapling to the rare stand of old growth, the urban forest in NYC offers endless opportunities for exploration and inspiration. We were inspired to explore it as holistically as we could, through a variety of lenses, to paint the fullest picture possible. And yet, we are only scratching the surface. As we share this report, more and more information is becoming available, so we anticipate and hope that others will build on this effort.

As you read, we ask that you picture your own favorite trees in NYC, or that, if you have not yet found them, you seek them out. We encourage you to help make our urban forest more visible by discussing it with friends, family, neighbors, and colleagues. To care for and appreciate our forest can mean so many things—you may plant, water, prune, or hug a tree; you may advocate for tree planting and care on your block, in your community, or across the city; you may study the forest; or you may simply enjoy sitting on a shady bench on a hot summer day, taking in spring blossoms, watching migrating birds, or gazing at autumn's changing colors in all their glory.

At its heart, our urban forest is a thriving living system, part of a rich continuum of forests across our planet. Here in the dense urban landscape of New York City, less than a quarter of our land is canopied. But this has not always been the case. Centuries ago, when the area we now call New York City was predominantly inhabited by the Lenape people, it was primarily covered by forest. We ask you to imagine that, and strive for a future with healthier, better supported, and more just and diverse ecological and social systems. We offer *The State of the Urban Forest in New York City* as a snapshot of today, so that together we may cultivate a better tomorrow.

Sincerely,

Emily Nobel Maxwell   Michael L Treglia

Emily Nobel Maxwell and Michael L. Treglia
The Nature Conservancy

Executive Summary

The urban forest of New York City (NYC) includes over seven million trees, as well as the physical and social infrastructure that supports them. In *The State of the Urban Forest in New York City*, we characterize the resource holistically based on existing research in conjunction with available data and new analysis. Our aim is to establish a common baseline of information that can be used by various audiences across sectors, including land managers, policymakers, advocacy groups, and researchers. Future efforts can build on this work and examine change through time.

The canopy of the NYC urban forest covered just over 22% of the landscape as of 2017, and it varied across the city—higher percentages of canopy cover were generally present in areas with large parks and portions of the city with generally lower density development. The lowest canopy cover was in heavily developed areas. We estimate that over half of the canopy in NYC is associated with trees managed by the NYC Department of Parks and Recreation (NYC Parks), including the about 28.40% on City Parkland, and the 25.10% associated with rights of way, generally street trees. Just over one third of the canopy is associated with private land, and the remainder (11.24%) is associated with land owned by a combination of other City, State, and Federal entities.

Canopy increased in most parts of NYC and in every borough as a whole between 2010 and 2017, yielding a citywide net increase of almost 2%. Some of the greatest gains were seen in areas with the lowest canopy. Areas of NYC that lost canopy were generally those coastal areas hardest hit by Superstorm Sandy. These changes in canopy were ultimately the result of myriad factors, with gains attributable to a combination of tree planting, natural regeneration, and growth of existing trees, whereas losses may be associated with various disturbances and stressors (e.g., severe storms, soil compaction, pests, disease), natural tree aging and death, and removal for development and infrastructure work.

As of the most recent street tree census, there were 652,088 living street trees, and there have been ongoing increases based on the three decadal street tree censuses to date (1995–2015). There may be an opportunity to plant approximately 250,000 additional street trees. Another inventory was recently conducted for trees on landscaped portions of City Parkland (2017–2018), which documented 154,982 living trees in these spaces. Both of these inventories indicate a generally healthy age distribution of the trees and a diversity of species.

Forested natural areas across the city are estimated to account for the majority of individual trees in NYC. While they account for only 6.09% of the land area in NYC, as of 2017 they accounted for about 27.61% of all canopy citywide, primarily on City Parkland but also within other jurisdictions. Canopy in natural areas increased in general during 2010–2017, with the exception of small decreases on private property. These ecosystems are generally healthy and dominated by native species with clear evidence of regeneration. However, long-term management is critical for maintaining the health of these areas given the higher frequencies of invasive species in the midstory and understory.

The NYC urban forest provides myriad benefits. It supports opportunities for relaxation, a feeling of attachment to place, chances to experience nature, and community cohesiveness. The presence of vegetation in general has been shown to reduce stress (evidenced through reduced heart rate and blood pressure), and it can contribute to improved educational outcomes. Forested natural areas, in particular, support outdoor recreation such as hiking and birding, while supporting biodiversity. Some of the more measurable benefits of the urban forest include storing carbon, decreasing the urban heat island effect, reducing the stormwater management burden of the City, and reducing air pollution. There are undoubtedly nuances in some of the benefits, particularly given complexities like potential damage resulting from falling limbs and allergies that people experience from pollen.

The uneven distribution of the urban forest across NYC translates to an unequitable distribution of its benefits. There

The urban forest of NYC has expanded in recent years...However, the resource and its benefits are not equitably distributed.

tends to be less canopy in parts of NYC with higher proportions of people of color and with lower median per capita incomes. These inequities in part stem from historic policies and zoning. Further, less vegetation contributes to higher heat vulnerability within communities. There have been efforts in recent decades to expand the urban forest in some areas facing these inequities, as part of strategic initiatives, although it will take time for the trees to grow and confer their full benefits. Many of these areas have limited space for additional plantings and will require creative solutions. Such efforts must consider and mitigate potential unintended consequences such as gentrification, which has been associated with local increases in the urban forest.

Policy related to the NYC urban forest is generally governed by City, State, and Federal entities and associated with land they own or manage. Trees under NYC Parks' jurisdiction may ultimately be removed but generally receive the most protection via permit and replacement requirements. Some zoning regulations related to the NYC urban forest also exist, though protection for trees through zoning is only afforded to those in select Special Districts covering a small portion of the city, and trees on private property are otherwise legally unprotected. Though plans from mayoral administrations can support the urban forest of NYC in various ways, they are ultimately temporary. There are opportunities to expand and improve existing policy.

Information about funding to support the NYC urban forest is very limited. However, the single entity within NYC responsible for the largest portion of the this resource, NYC Parks, receives an average of only 0.04% of the entire non-personnel NYC expense budget to manage it, an amount that varies substantially from year to year. It is largely inconsistent and insufficient. Other City, State, and Federal entities may have portions of their budgets that support management of the urban forest, generally within their jurisdiction, but these comprise small portions of the resource.

As with funding, management of the NYC urban forest is best understood for portions within NYC Parks' jurisdiction (street trees and both landscaped park trees and forested natural areas on City Parkland). These spaces have at least some degree of active management, conducted by the agency itself (or hired contractors) and a variety of organized groups and volunteers that partner to care for the asset. Management needs are largely well characterized in these realms, albeit the proactive care they receive is variable, ultimately constrained by funding. Some other portions of the NYC urban forest, beyond NYC Parks' jurisdiction are actively managed, but most are not, or have no documentation of the management. This is particularly the case for most privately owned property.

Lastly, research indicates that, in general, people have positive attitudes toward trees and the urban forest, which can translate to behaviors that support the resource. However, attitudes of people can vary substantially, and there has been little work on this topic within NYC. Efforts to fill this gap can inform policies such as those intended to protect and expand the urban forest, and to further engage New Yorkers in its management.

Overall, the urban forest of NYC has expanded in recent years, and, based on multiple indicators, it is healthy. However, the resource and its benefits are not equitably distributed, nor is it well protected or funded overall, and management for large portions of it is poorly understood. The strengths of the NYC urban forest can be leveraged to support its long-term health and resilience. Addressing challenges will require long-term planning, policy, management, monitoring, research, and investments in the resource and those that care for it.

1

Introduction

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These leaves are from the pin oak tree (*Quercus palustris*), a large tree that provides many benefits, including shade for humans and acorns that feed wildlife. Pin oaks are common in NYC, and are often found as street trees, in landscaped parks, and in forested natural areas. The pin oak is sometimes referred to as the swamp oak because of its tolerance for wet conditions.

CHAPTER 1

Introduction

Nature is critical infrastructure for New York City (NYC). The many parks, open spaces, and trees enhance people's quality of life, provide respite, and make our city more livable and resilient. The more than seven million trees that span our city are a major part of nature and infrastructure in NYC—their canopy covers over a fifth of the landscape. These trees, along with their associated physical and social infrastructure, constitute the urban forest: a vital system that provides enormous benefits and services. Yet, currently the urban forest is not treated as a whole system and thus is not comprehensively maintained, expanded, protected, and connected to New Yorkers, leaving this natural infrastructure often overlooked and at risk. *The State of the Urban Forest in New York City* describes the resource as a whole system to inspire a new way of "seeing the forest for the trees." We make the case that the urban forest should be treated as a whole system of critical natural infrastructure to sustain New York City for decades to come.

The Urban Forest in New York City

The urban forest is a unique, complex, and verdant system that includes the more than seven million trees in NYC, and the physical and social infrastructure on which they depend.* NYC contains close to as many trees as human residents. They grow across our whole landscape—in tree beds along our streets, in yards and courtyards, in landscaped parks, in forested natural areas, and beyond. The physical components of the system are interconnected natural and built parts of the ecosystem spanning public and private land; the social components include the people, behaviors, policies, programs, budgets, and investments that relate to the NYC urban forest.

The urban forest of NYC provides many benefits to people (**Figure 1.1**). Interactions between people and trees can catalyze stronger connections with nature, support social and cultural connections, nurture mental health, and much more. It provides critical habitat for many plant and animal species that inhabit the city year-round or migrate through it. It keeps the air cooler in the summer, saving energy that would otherwise be needed for air conditioning, and reduces air pollution, thereby benefiting public health. The urban forest also mitigates climate change by storing carbon as biomass and reduces stormwater runoff, helping protect properties in flood-prone areas from damage.

Despite the enormous benefits of the urban forest, there are inequities in the distribution of this resource and all that it offers. If not expanded to better cover all neighborhoods, the urban forest may continue to fall short of equitably serving all New Yorkers. Further, trees can present some risks[2] particularly if they are not adequately maintained and managed. Many of these challenges may be mitigated through strategic

* This definition is adapted from the USDA Forest Service, which states: "Urban forests are composed of all the trees within our urban lands. The definition conceptually extends to include the various ecosystem components that accompany these trees (e.g., soils or understory flora)...Urban forests can contain forested stands, like in rural areas, but they also contain trees found along streets, in residential lots, in parks, and in other land uses. The forests are a mix of planted and naturally regenerated trees."[1] For purposes of this report, we refer to the aforementioned "forested stands" as "forested natural areas."

Aerial view of Governors Island, with a mix of young and mature trees, looking toward lower Manhattan.

planning and planting decisions, as well as management and stewardship. There is no guarantee that the services provided by the urban forest in NYC will persist, as the resource largely relies on the will of current stakeholders and is subject to a continuum of protection and investment. Large sections are not supported by rules and standards, so they are particularly at risk.

A large part of the NYC urban forest (trees on City Parkland and most along public roadways) is under the jurisdiction of the NYC Department of Parks and Recreation (NYC Parks), which, with its many partners, invests in its care. Highlights from the past 30 years include proactive street tree pruning, a full street tree census every 10 years, aggressive management of invasive species, and innovative partnerships with scientists. This portion of the urban forest has some of the strongest tree replacement requirements in the country and NYC Parks has adopted a management program based on the latest standards in tree risk management in the industry. While other stakeholders are responsible for major portions of the urban forest, the largest share is in NYC Parks' jurisdiction. However, the NYC Parks portion of the City budget, and particularly that allocated for the urban forest, has long been insufficient and highly variable, with extended periods of underinvestment. This funding is often first on the chopping block during lean budget times, as demonstrated by cuts during the COVID-19 pandemic.

This disinvestment in our urban forest occurred at a precarious time for this resource in cities across the country. A recent analysis of canopy change in urban areas across the country indicated either loss or no gain in recent years.[3] In New York State (NYS), urban areas were estimated to lose canopy between 2008 and 2013. This analysis of urban areas indicated that net gains occurred in only three states, and none of those were statistically significant.

Figure 1.1 Summary of key benefits provided by the urban forest.

Providing habitat for various species of plants, animals, fungi, and microbes

Cooling communities, and helping reduce energy usage and associated carbon emissions

Improving physical and mental health, and supporting people's overall well-being

Three people climbing stairs in Brooklyn Bridge Park, Brooklyn, in the shade of tree canopy.

The aim of this report is to inspire and provide a foundation for discussions and planning for the urban forest of NYC as well as future analyses.

The national trend of urban forest loss is occurring even though it is well documented that trees play an important role in mitigating and adapting to the impacts of climate change, as well as reducing urban environmental stressors, such as the urban heat island effect,[4–7] air pollution,[5,6,8] and stormwater.[9] In New York City, extreme heat and extreme rain events are expected to significantly increase due to climate change,[10] and pervasive air quality issues increase rates of asthma and respiratory illness.[11] Trees can help ameliorate these threats as well as mitigate greenhouse gases.

Purpose and Development of this Report

This report characterizes the state of the urban forest in NYC throughout the five boroughs, including its biological and physical state, distribution, the benefits it provides, and related topics of equity, policy, regulation, management, funding, and attitudes in order to support a common understanding of this important asset of the city. Holistically characterizing the urban forest as a system is an initial step that we hope will galvanize action to improve the state of the NYC urban forest.

NYC does not have a comprehensive approach to managing the entire urban forest. The City has an opportunity to create a master plan and to set shared goals and policies to protect, maintain, expand, and use the urban forest. The recently released *NYC Urban Forest Agenda*,* developed by the NYC Urban Forest Task Force and advocated by Forest for All NYC, issues a call to action to accomplish just this.

Our characterizations of the NYC urban forest rely on existing information and data from a variety of sources including research by the Natural Areas Conservancy, NYC Parks, and the U.S. Department of Agriculture Forest Service. New analyses we present are based on data both shared by partners and accessed from public platforms such as the NYC Open Data portal. Data sources and methods for analyses are described in Appendix 1, and supplementary data tables are available in Appendix 2 (see respective appendices for links to supporting code and data files). As necessary, we note gaps in the body of knowledge and research. Any omissions are our own.

We intend this report to be useful for urban forest professionals and those working in related fields, organizations doing work related to the urban forest, policymakers at all scales seeking robust information on related topics, individuals seeking to learn more deeply about the resource, urban planners, and allied practitioners working to create a healthier, more just city. We encourage effective decision-making and collaboration among policymakers, communities, institutions, and researchers.

The aim of this report is to inspire and provide a foundation for discussions and planning for the urban forest of NYC as well as future analyses. NYC has an opportunity to lead the way with innovative and ambitious approaches to caring for the vast resource of its urban forest. This could also advance City and State climate goals and provide an example to other cities facing similar challenges of management and resource allocation to care for their urban forests. Ultimately, greater investment in our urban forest will result in a greener, more resilient, and more livable city.

* Available from: https://forestforall.nyc/nyc-urban-forest-agenda/


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Distribution and Biophysical Status

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These leaves are from the London planetree (*Platanus × acerifolia*), which grows to a large size (about 100 feet tall) and is actually a hybrid of two species. London planetrees are commonly planted in cities, as they are considered tolerant of various stressors in urban environments. They are the most common trees in NYC, both in landscaped portions of City Parkland and as street trees.

CHAPTER 2

Distribution and Biophysical Status

The urban forest of New York City (NYC) is composed of at least seven million trees, with tree canopy* covering 22.04% of the land as of 2017. Between street trees and trees in City Parkland, approximately 53.50% of the canopy fell within the jurisdiction of the NYC Department of Parks and Recreation (NYC Parks). Another 35.26% of the canopy occurred on private property, and the remainder was on public property not belonging to NYC Parks. Forested natural areas (across jurisdictions) contributed less than one third of the canopy but are estimated to contain the majority of trees in the city. From 2010 to 2017, canopy generally increased across the city and across different jurisdictions and land uses. However, when we look at canopy change and other metrics at smaller geographic scales, we see variation across the city, for example with canopy loss in some areas.

We convey information about the distribution and biophysical status of the NYC urban forest to establish a baseline understanding so that we can track change through time. This ultimately enables managers, policymakers, and other stakeholders to evaluate the efficacy of interventions and adjust management and goals. Leveraging a combination of published research and available data (see Appendix 1), particularly from the Natural Areas Conservancy (NAC), NYC Parks, NYC Open Data, and the United States Department of Agriculture Forest Service (USDA Forest Service), we characterize the following to establish a common, shared understanding of the resource and data related to it:

- Tree canopy (2010–2017) throughout NYC
- Distribution of tree canopy across site types
- Drivers of change
- Status of street trees
- Status of landscaped park trees in City Parkland
- Status of forested natural areas
- Summary of the NYC urban forest

* Canopy is defined in the underlying data as vegetation at least eight feet above the ground, as delineated in NYC-specific land cover and tree canopy datasets.

Aerial view of the urban forest along Grand Army Plaza in Brooklyn, with the Manhattan skyline in the background.

Tree Canopy (2010–2017)

The canopy in NYC as of 2010 and 2017 is the focus of the following discussion. Tree canopy is one way to understand the extent and distribution of the urban forest. It does not capture the number of trees, nor does it describe tree or forest health or composition, which are discussed later in this chapter.

Understanding long-term dynamics in canopy, particularly in the context of long-term policies and programs, requires data spanning decades[1] which do not exist for NYC as a whole. Thus, we describe canopy change across the longest period for which comparable data are available, 2010–2017, and do not attempt to holistically associate changes with specific policies, programs, or events (e.g., individual storms). As various scales of analysis have value for different stakeholders, we present data at the citywide level and by borough, City Council District, Community District, and Neighborhood Tabulation Area (NTA) (see **Box 2.1**), which depict more local nuance.

The distribution of canopy among boroughs was not proportional to the boroughs' land area in either 2010 or 2017 (**Table 2.1**). Staten Island was a particular outlier, as it contained about 27.52% of the city's canopy but has less than 20% of the city's land area. The Bronx also had a disproportionately large amount of canopy for its land area, while Manhattan had nearly equal shares of the canopy and land area of NYC. In contrast, both Brooklyn and Queens had disproportionately less of the canopy in NYC (about 5%) than land area.

BOX 2.1

Understanding the Geographic Scales Used in this Report

In addition to examining NYC as a whole, we consider the following geographic scales to characterize the urban forest, recognizing their relevance to different audiences: boroughs, City Council Districts, Community Districts, and Neighborhood Tabulation Areas (NTAs). For Community Districts and NTAs, many large, unpopulated areas such as Central Park, Prospect Park, and the airports are mapped as distinct units. Neighborhood Tabulation Areas were the smallest units we considered for drawing general conclusions across NYC, and changes at this scale can sometimes be associated with local drivers such as targeted planting initiatives or major storms. In the text, we generally discuss Community Districts and NTAs together, given the general alignment of their boundaries (the latter are generally nested within the former).

Boroughs are the five individual counties within NYC. Though they all function as part of the City, each borough has an elected Borough President who advises the Mayor and advocates for borough needs in City budgeting processes. The boroughs vary substantially in population and level of development.

City Council Districts are political units that each contain about 160,000 people (as of the 2010 census) and are represented by an elected City Council Member. There are 51 Council Districts in NYC, and their boundaries are updated every 10 years to maintain rough parity of population. Large unpopulated areas, such as Central Park, are generally assigned to a single City Council District.

Community Districts are administrative units that have appointed boards of community members (Community Boards), who advise the Borough President, relevant City Council members, and City agencies regarding land use and zoning decisions, budget allocations, and broader community concerns. There are 59 Community Districts in New York City. Their boundaries do not change over time, providing consistency for long-term planning, and, as of the 2010 census, they had an average of 132,000 residents.

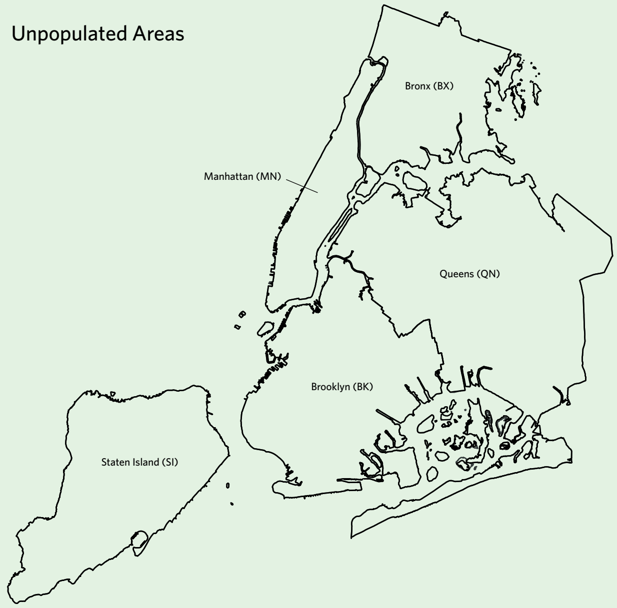
Neighborhood Tabulation Areas are apolitical units that were established for planning purposes and contain a minimum of 15,000 residents (based on the 2010 census). There are 188 populated NTAs in NYC. They are not political units, but are useful for analysis, as they are smaller than other units considered here, allowing for a more nuanced understanding of the urban forest across NYC.

Maps of the above units are presented in **Figure 2.1**. Community Districts are referenced in the text as borough abbreviation and number (e.g., MN-1 for Manhattan), and NTAs are referred to by borough abbreviation followed by N and the number (e.g., MN-N1 for NTA 1 in Manhattan). City Council Districts are referred to by the District number. Enlarged maps are available in Appendix 2.

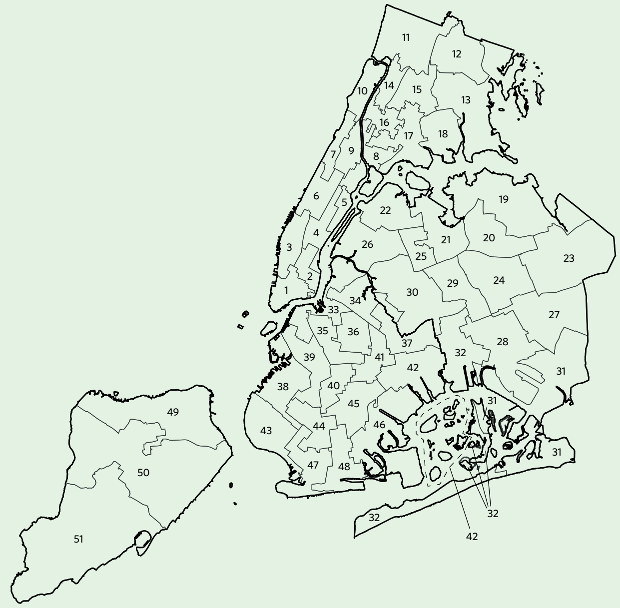
2

Geographic Scales of Analysis

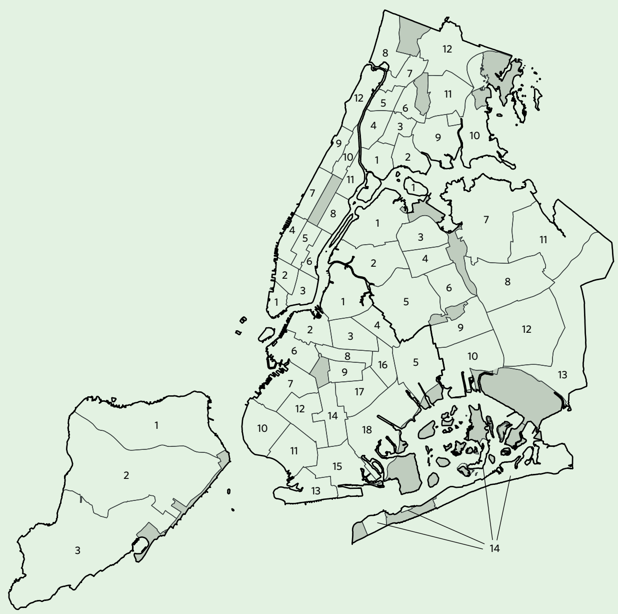
Unpopulated Areas



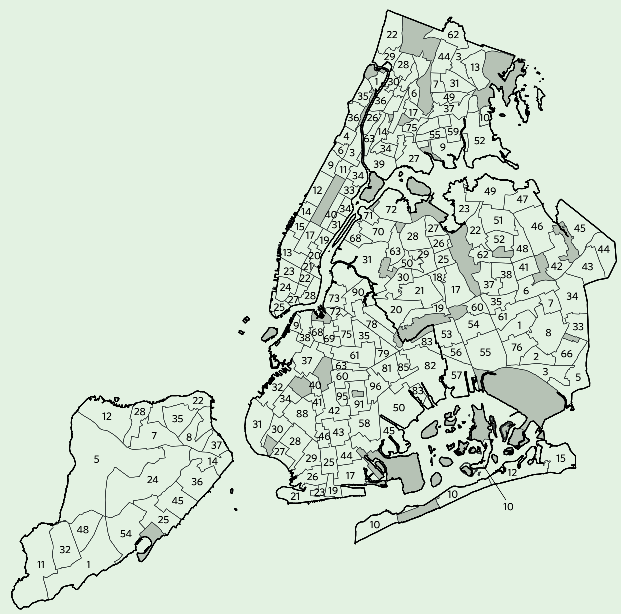
Boroughs



City Council Districts



Community Districts



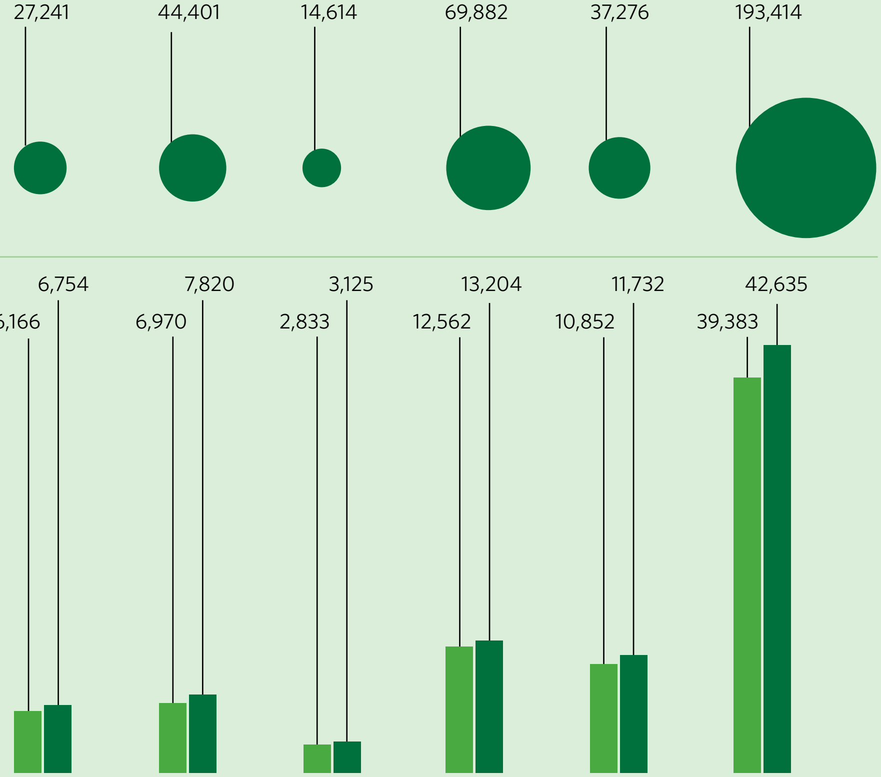
Neighborhood Tabulation Areas

Figure 2.1 Maps of geographic units of analysis used in this report: boroughs, City Council Districts, Community Districts, and Neighborhood Tabulation Areas. Note, for Community Districts and Neighborhood Tabulation Areas numbers restart for each borough.

Data source: NYC Department of City Planning

Canopy and Canopy Change by Borough, 2010–2017

Population	Bronx 1,437,872	Brooklyn 2,600,747	Manhattan 1,632,480	Queens 2,298,513	Staten Island 474,101	Citywide 8,443,713
Land Acreage	27,241	44,401	14,614	69,882	37,276	193,414
Canopy Acreage, 2010	6,166	6,970	2,833	12,562	10,852	39,383
Canopy Acreage, 2017	6,754	7,820	3,125	13,204	11,732	42,635
Percent Canopy, 2010	22.63%	15.70%	19.38%	17.98%	29.11%	20.36%
Percent Canopy, 2017	24.79%	17.61%	21.38%	18.90%	31.47%	22.04%
Percentage of NYC Canopy, 2010	15.66%	17.70%	7.19%	31.90%	27.56%	100.00%
Percentage of NYC Canopy, 2017	15.84%	18.34%	7.33%	30.97%	27.52%	100.00%
Absolute Change (change in percent canopy)	2.16%	1.91%	2.00%	0.92%	2.36%	1.68%
Relative Change (change compared with canopy in 2010)	9.54%	12.19%	10.31%	5.11%	8.11%	8.26%
Acreage of Canopy Gain, 2010–2017	1,380	2,230	670	3,213	2,237	9,730
Acreage of Canopy Loss, 2010–2017	791	1,380	378	2,571	1,357	6,477
Acreage of No Canopy Change, 2010–2017	5,374	5,590	2,455	9,991	9,495	32,905
Net Change in Canopy (acres)	588	850	292	642	880	3,253



Data sources: Land area information derived from Borough Boundaries data (NYC Department of City Planning); Canopy metrics derived from 2017 Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications); Population based on U.S. Census, American Community Survey data for 2018

Table 2.1 Detailed statistics about tree canopy and canopy change from 2010 to 2017, by borough and citywide.

Below are some of our main findings regarding canopy and canopy change citywide and by borough (refer to **Table 2.1** for more detail). We generally focus on net change in percent area covered by canopy rather than change in area covered, as the various geographies are different sizes.

- From 2010 to 2017, the percentage of citywide land area covered by canopy increased from 20.36% to 22.04%, and it increased across all five boroughs.
- The largest increases in percentage of land covered by canopy were observed in Staten Island and the Bronx, both of which had an increase in canopy of over 2%, while Queens exhibited the smallest increase, less than 1%.
- Brooklyn and Manhattan showed the largest canopy gains relative to 2010, each with more than a 10% relative increase. Queens exhibited the smallest relative increase in canopy, only 5.1%.
- The net increase in canopy (3,253 acres) resulted from a combination of 9,730 acres of gross canopy gain between 2010 and 2017, and a gross loss of almost 6,500 acres. Queens actually had a greater gross gain in canopy than any other borough, but it simultaneously lost more canopy than other boroughs.

In terms of canopy at smaller scales, we found that as of 2017 (see **Figure 2.2**, and Appendix 2 for complete results):

- Community Districts representing unpopulated areas of City Parkland, such as Central Park, Prospect Park, and Van Cortlandt Park, tended to have the highest canopy cover. Of these areas, Forest Park in Queens had the most canopy cover (77.65%).
- Community Districts with the lowest canopy cover were unpopulated areas representing JFK International and LaGuardia Airports. Both had <3% canopy cover.
- Among populated Community Districts, the highest canopy cover was in BX-8 (Kingsbridge/Riverdale/Marble Hill), with 39.47% canopy, followed by SI-3 (southern Staten Island), with 35.23%. The top 10 populated Community Districts in terms of canopy cover were in every borough except Brooklyn. These areas tended to have large amounts of parkland and generally lower-density residential development.
- The lowest canopy cover for populated Community Districts was in MN-5 (Midtown Manhattan), with 3.98% canopy, followed by BX-2 (Hunts Point/Longwood) with 8.37%.
- The general patterns of canopy by NTA were similar to those of Community Districts. This scale shows local patterns that drive trends at larger scales, while depicting exceptions. For example, much more heterogeneity is discernible in northern Manhattan.
- The inclusion of large unpopulated areas in City Council Districts influences canopy dynamics compared with Community Districts. District 11 (northern Bronx), which includes Van Cortlandt Park, had the most canopy, followed by District 6 in Manhattan, which includes Central Park and the area west of it.
- City Council Districts with large areas of developed, unpopulated land (e.g., airports), such as Districts 21, 28, and 31, were among the lower canopy areas. However, the City Council Districts with the lowest canopy cover were District 3 (Lower West Side of Manhattan), District 26 (southwestern Queens), and District 34 (northern Brooklyn).

Canopy loss was the exception for all geographic scales (**Figure 2.3**). Key findings for canopy change from 2010 to 2017 include:

- Unpopulated Community Districts and NTAs representing Central Park, parts of the Rockaway Peninsula, and LaGuardia Airport experienced net losses in canopy. The area containing Central Park actually exhibited the greatest loss, in terms of percentage of land area, of any Community District (about 3%).
- Most Community Districts throughout the city gained canopy. The largest net gains were in MN-10 (Central Harlem), BK-3 (Bedford-Stuyvesant/Stuyvesant Heights), and BX-3 (Claremont/Crotona Park East).
- Three populated Community Districts lost canopy, albeit with decreases of less than 1% of their land area: BK-13 (Brighton Beach/Coney Island/Gravesend), QN-14 (The Rockaways), and BK-15 (Sheepshead Bay/Gerritsen Beach/Manhattan Beach). All of these areas are along the southern coast of these boroughs.

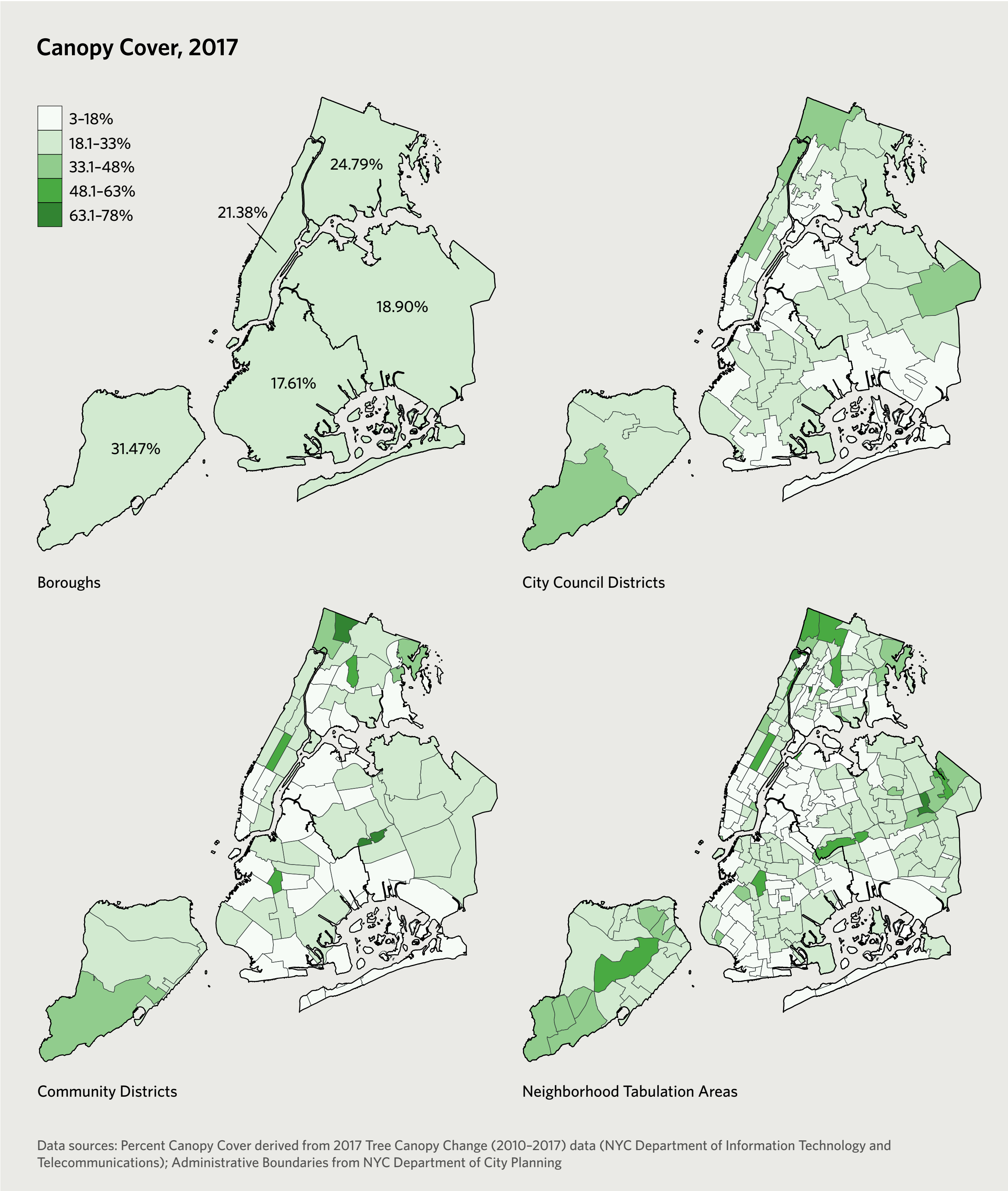
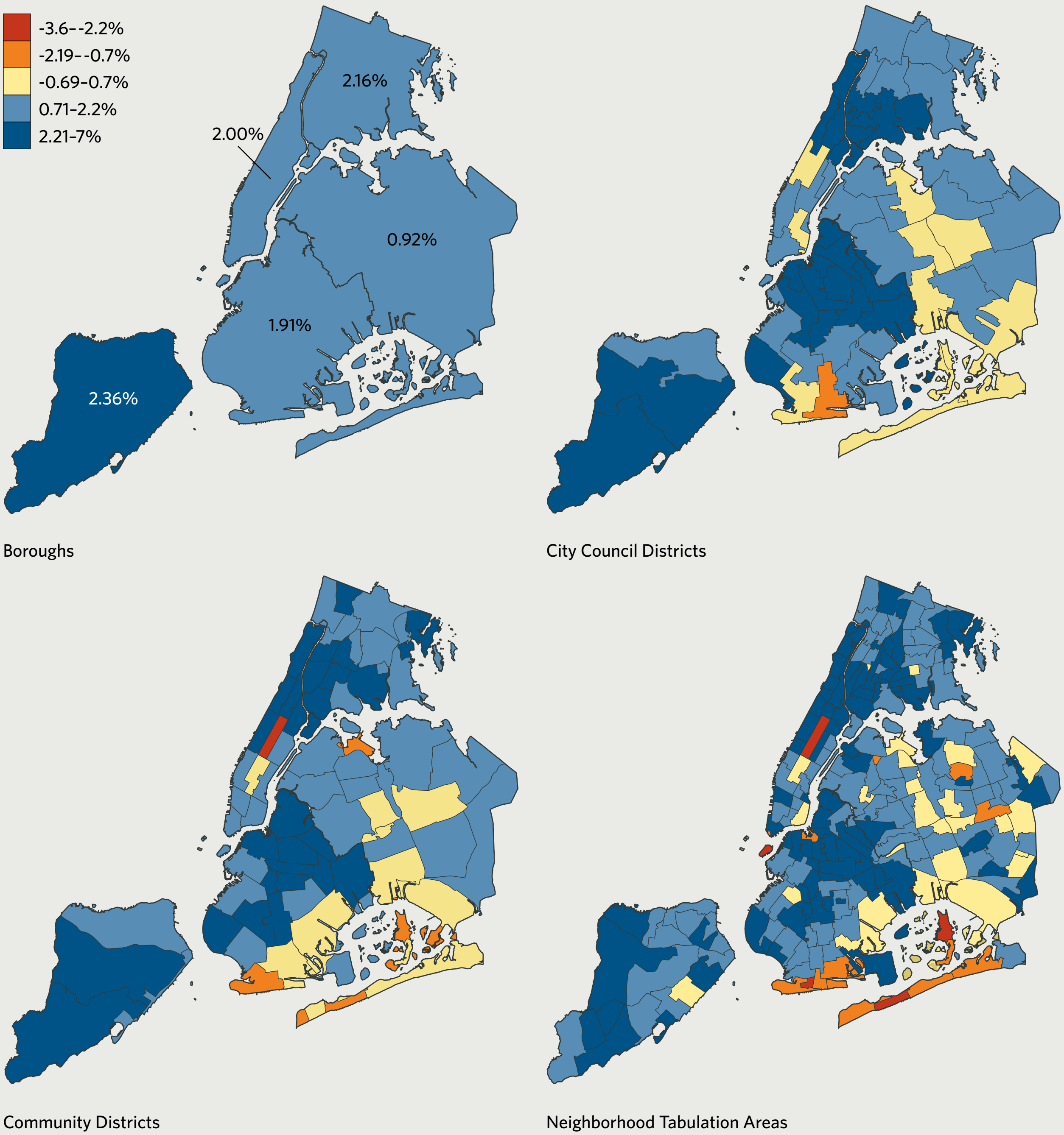


Figure 2.2 Percentage of land covered by tree canopy by borough, City Council District, Community District, and Neighborhood Tabulation Area (NTA) (the legend applies to all scales). Unpopulated NTAs with multiple parts were separated into separate units for this visualization.

Net Change in Canopy Cover, 2010–2017



Data sources: Percent Change in Canopy derived from 2017 Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications); Administrative Boundaries from NYC Department of City Planning

Figure 2.3 Change in percentage of land covered by canopy from 2010–2017, by borough, City Council District, Community District, and Neighborhood Tabulation Area (NTA) (the legend applies to all scales). Unpopulated NTAs with multiple parts were separated into separate units for this visualization.

- Data at the scale of NTAs illustrate local nuances in canopy change, particularly for loss. In addition to the broader Community Districts that lost canopy, smaller areas in Queens did as well—QN-N6 (Jamaica Estates), QN-N54 (East Flushing), and QN-N51 (Murray Hill)—and MN-N28 (the Lower East Side of Manhattan).
- The City Council Districts with the largest canopy gains were District 9 (around Central Harlem, Manhattan) and District 36 (near Bedford-Stuyvesant in Brooklyn). These overlapped some of the Community Districts with large canopy increases.
- The only City Council Districts to exhibit net decreases in canopy were Districts 32 (Queens) and 48 (Brooklyn), both along coastal areas. They exhibited net losses of 0.37% and 0.81%, respectively.

Drivers of change in the urban forest are discussed in further depth later in this chapter, though some drivers are evident in the maps. For example, loss of canopy around Community District QN-14 (The Rockaways) was likely driven to a large degree by Superstorm Sandy in 2012, and local canopy gains in BX-1, BX-3, and BX-4 in the South Bronx were likely associated with targeted tree planting efforts. The maps depict further complexities—for example, while canopy increased in the South Bronx, this area still had relatively low canopy in 2017. This is likely because many trees were only recently planted there and have not reached their full potential; in addition, the area is heavily developed, with limited opportunities for new plantings.

Distribution of Tree Canopy Across Site Types

In order to understand who manages the urban forest and how (Chapter 7), and what legal protections it receives (Chapter 5), it is important to understand the distribution of this resource in terms of jurisdiction and land use (jointly referred to hereafter as "site types"). There are nearly 900,000 individual properties* in NYC, covering 76.92% of the landscape, almost all of which, numerically, are privately owned and managed by distinct entities. Public entities own a relatively small number of the individual properties within NYC, but a large share of the land area in general, with proportionately more canopy than privately owned land (**Figure 2.4**). The rest of the landscape is classified as right of way and is generally composed of sidewalks, roads, medians, and the like. These are mostly under the jurisdiction of the NYC Department of Transportation† though in many cases property owners are responsible for adjacent sidewalks.[2] Street trees growing along sidewalks are under the jurisdiction of NYC Parks and managed with the support of various stewards (Chapter 7). Details of how we discerned site types from available data are described in Appendix 1.

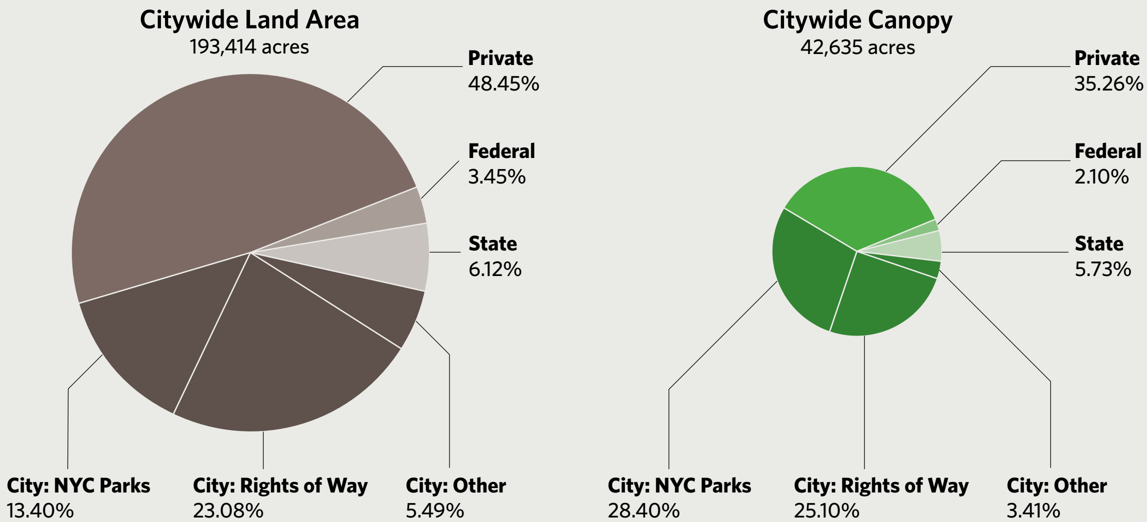
We consider the following site types across NYC in terms of canopy and canopy change.

- City land is under the jurisdiction of agencies including NYC Parks and NYC Department of Environmental Protection. Major categories of City land include:
  - Rights of way
  - City Parkland
  - Other City-owned land
- State land is under the jurisdiction of New York State (NYS) agencies and public benefit corporations. This includes land managed by the NYS Department of Environmental Conservation (NYS DEC), the NYC Housing Authority (NYCHA), City and State University campuses, the Port Authority of NY and NJ, and the Metropolitan Transit Authority.
- Federal land is under the jurisdiction of various Federal entities. It includes National Monuments, National Recreation Areas, and other Federal properties such as Post Offices.

* For the purposes of this report, we consider "properties" as both tax lots recognized by the NYC Department of Finance, and Parkland, which is not necessarily in tax lots (based on data from NYC Parks, the State of New York, and the National Park Service).

† Although most rights of way in NYC are under the jurisdiction of the NYC Department of Transportation, highways are generally under the NYS Department of Transportation. Given the limits of available data, we are unable to separate these rights of way for discussion or analysis here.

Land Area and Canopy by Jurisdiction



Data sources: Land Area derived from NYC parcel data MapPLUTO 20v6 (NYC Department of City Planning) and agency- or entity-specific datasets where available; Canopy metrics derived from 2017 Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications)

Figure 2.4 Pie charts of land area (left) and canopy (right) by jurisdiction, illustrating that canopy is not distributed across jurisdictions in proportion to land area. Pie chart areas are scaled to total area of land and canopy, respectively.

- Private land is owned by private entities (including individuals, companies, and nonprofits).* We consider these lands by use:
  - One- and two-family residential properties
  - Multifamily (3+) residential properties (including apartment buildings and mixed commercial/residential buildings)
  - Non-residential developed properties (including commercial and office buildings, industrial and manufacturing buildings, transportation and utility, and parking facilities)
  - Open space and outdoor recreation properties
  - Cemeteries
  - Vacant land

We describe canopy as of 2017 and canopy change between 2010 and 2017 across site types citywide and we discuss dynamics on natural and developed parts of the landscape.† Borough-level and citywide summaries are presented in **Table 2.2**.

Overall, most individual properties exhibited some net gain or loss of canopy, ultimately scaling up to trends across geographies and site types. At the citywide scale, canopy losses were more than made up for with gains, although local losses can translate into a loss of local benefits (such as wildlife habitat, or cooling benefits in the most heat-vulnerable communities) that may not be compensated for by canopy elsewhere in the city.

In all boroughs, the majority of canopy occurred within City lands, in a combination of City Parkland and rights of way (with approximately all trees in those spaces under the jurisdiction of NYC Parks). However, in Brooklyn, Queens,

* We also discuss these land uses, to a degree, in the context of State land, although there are limits in how well available data capture land uses for government-owned properties in general. These categories were adapted from data available for parcels, as detailed in Appendix 1.

† These lands considered "natural" outside City Parkland were delineated based on natural cover type classes from the Ecological Covertype Map dataset.

Canopy and Canopy Change by Borough and Jurisdiction, 2010-2017

	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Citywide
City (Right of Way)						
Land Area (acres)	6,422	11,360	3,820	16,508	6,524	44,634
Canopy Cover, 2017	19.86%	23.88%	20.18%	24.87%	28.17%	23.98%
Percent of Total Borough Canopy, 2017	18.88%	34.69%	24.67%	31.10%	15.67%	25.10%
Absolute Change in Canopy Cover (2010–2017)	3.94%	3.63%	4.96%	2.41%	4.25%	3.43%
City (Parks)						
Land Area (acres)	5,879	3,899	2,707	6,507	6,928	25,920
Canopy Cover, 2017	51.05%	33.47%	51.49%	41.97%	53.09%	46.72%
Percent of Total Borough Canopy, 2017	44.44%	16.69%	44.60%	20.68%	31.35%	28.40%
Absolute Change in Canopy Cover (2010–2017)	2.72%	2.43%	1.19%	2.25%	3.10%	2.50%
City (Other)						
Land Area (acres)	2,148	2,129	829	2,575	2,933	10,614
Canopy Cover, 2017	9.57%	7.44%	9.76%	10.51%	25.15%	13.69%
Percent of Total Borough Canopy, 2017	3.04%	2.02%	2.59%	2.05%	6.29%	3.41%
Absolute Change in Canopy Cover (2010–2017)	1.55%	1.29%	1.20%	0.68%	7.69%	1.70%
State						
Land Area (acres)	1,130	1,511	1,029	5,989	2,188	11,847
Canopy Cover, 2017	28.74%	32.17%	25.77%	7.35%	42.37%	20.62%
Percent of Total Borough Canopy, 2017	4.81%	6.22%	8.48%	3.33%	7.90%	5.73%
Absolute Change in Canopy Cover (2010–2017)	3.26%	3.09%	2.28%	0.84%	3.14%	1.91%
Federal						
Land Area (acres)	4	2,787	53	2,932	904	6,681
Canopy Cover, 2017	4.01%	12.93%	18.72%	11.29%	21.28%	13.38%
Percent of Total Borough Canopy, 2017	0.00%	4.61%	0.32%	2.51%	1.64%	2.10%
Absolute Change in Canopy Cover (2010–2017)	2.17%	2.06%	7.37%	-0.58%	2.77%	1.03%
Private						
Land Area (acres)	11,657	22,715	6,176	35,370	17,799	93,719
Canopy Cover, 2017	16.70%	12.31%	9.78%	15.06%	24.49%	16.04%
Percent of Total Borough Canopy, 2017	28.83%	35.77%	19.33%	40.34%	37.16%	35.26%
Absolute Change in Canopy Cover (2010–2017)	0.90%	0.93%	0.54%	0.13%	1.14%	0.64%

Data sources: Land Area derived from NYC parcel data MapPLUTO 20v6 (NYC Department of City Planning), agency- or entity-specific datasets where available, and NYC administrative boundaries from NYC Department of City Planning; Canopy metrics derived from 2017 Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications)

Table 2.2 Land area, tree canopy, and tree canopy change by jurisdiction and borough.

and Staten Island, more canopy fell within private property than within City Parkland or rights of way, individually. All jurisdictions across all boroughs gained canopy, with the exception of Federal lands in Queens (likely associated with impacts of Superstorm Sandy at Jamaica Bay Wildlife Refuge), though in most cases, canopy increases were smaller on private property than on other jurisdictions (**Table 2.2**).

City Lands

City lands encompass about 40% of NYC land area and contained over 56.91% of the total canopy in 2017 (**Figure 2.4**). Almost all of this canopy was attributable to trees within the jurisdiction of NYC Parks, either as street trees within rights of way or within City Parkland. City Parkland (excluding areas that extend into waters of NY Harbor) accounted for 28.40% of all NYC canopy, within 13.40% of citywide land area, and rights of way composed 25.10% of all NYC canopy on 23.08% of the land area. Thus, NYC Parks is ultimately responsible for approximately 53.50% of all canopy within NYC. Other City land composes 5.49% of NYC land area and is held by various City agencies and typically has more developed land uses. It contained 3.41% of all NYC canopy in 2017 (1,453 acres, 588 of which were in natural areas across the landscape).

City lands saw a net gain in canopy of 2,359 acres from 2010 to 2017, with the majority of that in rights of way. Rights of way gained 1,531 acres of canopy—a 16.69% relative increase that resulted in over 3.43% more of these lands being covered by canopy. This was likely due to a combination of new plantings (e.g., as part of the Million Trees NYC Initiative [MillionTreesNYC]) and the growing canopy of existing trees, both street trees and trees on individual properties whose canopy overhangs rights of way. City Parkland also had a substantial net gain in canopy of 648 acres (425 of which were in natural areas). Lands run by other City agencies (e.g., NYC Department of Environmental Protection, NYC Department of Sanitation) had a net increase in canopy of 180 acres (51 acres in natural areas).

For City Parkland, the single property type with the greatest area and canopy, 66.37% of the canopy as of 2017, was within natural areas and 33.63% was in landscaped parkland. Both natural and landscaped portions of City Parkland saw canopy increases. The largest canopy increases by area were in Pelham Bay Park in the Bronx (49-acre increase; relative change of 5.50%), Van Cortlandt Park in the Bronx (33-acre increase; relative change of 4.63%) and LaTourette Park and Golf Course on Staten Island (28-acre increase; relative change of 5.68%). In fact, most golf courses in NYC are within City Parkland,* operated as concessions. They occupy a total of about 1,969 acres and had 695 acres of canopy in 2017 (35.30% canopy cover); this was an increase from 644 acres in 2010, and gains were seen on all of these golf courses.

Net loss of canopy was rare within individual parcels of City Parkland. Central Park was a notable exception, with a net loss of 25 acres, or a 3% reduction in area of the park covered by canopy (relative change of -5.63%). The park is delineated as its own (unpopulated) Community District and actually lost more canopy as a percent of its total area than any other Community District. Other City Parks with large areas of net canopy loss were Paerdegat Basin Park in Brooklyn (10-acre loss; relative change of -43.34%) and Great Kills Park in Staten Island (9-acre loss; relative change of -22.00%). These are both in coastal areas and were heavily inundated by Superstorm Sandy. Again, canopy loss on City Parkland was the exception.

Canopy gains were the norm on non-Parks City lands as well. One especially large gain was across a set of properties that are portions of the former Freshkills Landfill (planned to become part of Freshkills Park but not yet delineated as such), which exhibited a net increase of 32 acres (relative change of 33.57%). However, there were also some examples of substantial canopy loss on non-Parks City lands. A suite of parcels and the unbuilt roads between them in Queens contained 16 acres of canopy in 2010 but lost 57% of this by 2017 (**Figure 2.5**, top), and a large lot adjacent to the Brooklyn Navy Yard that was mostly wooded in 2010 lost 98% of its canopy, about five acres, by 2017 (**Figure 2.5**, bottom). These instances of canopy loss were clearly associated with land clearing for development (parking lots and buildings), though losses on other individual properties could have been driven by other factors, such as storms.

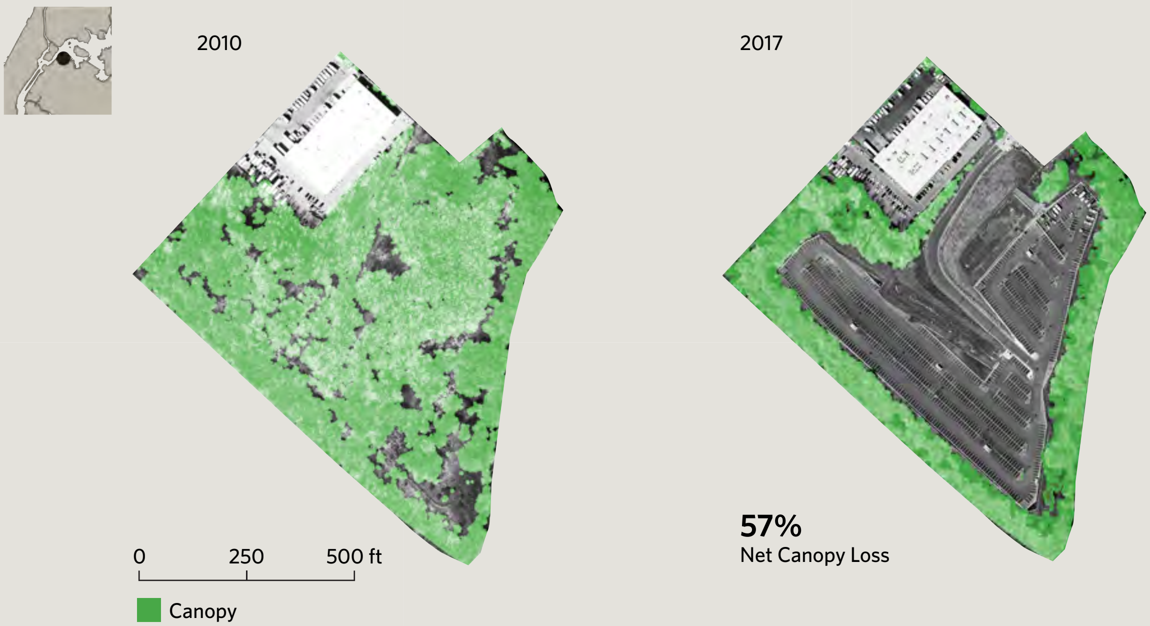
State Lands

State lands represent about 6.12% of all NYC land area (11,847 acres), and in 2017 they contained 5.73% of all canopy in NYC. These lands had 20.62% canopy cover overall. About half of these lands have non-residential developed uses, generally associated with airports, ports, and rail lines (e.g., under the jurisdiction of the Port Authority of NY and NJ or the Metropolitan Transit Authority) and contributed to a small fraction of the canopy with very low canopy cover (6.11% canopy cover, composing only 0.84% of citywide canopy).

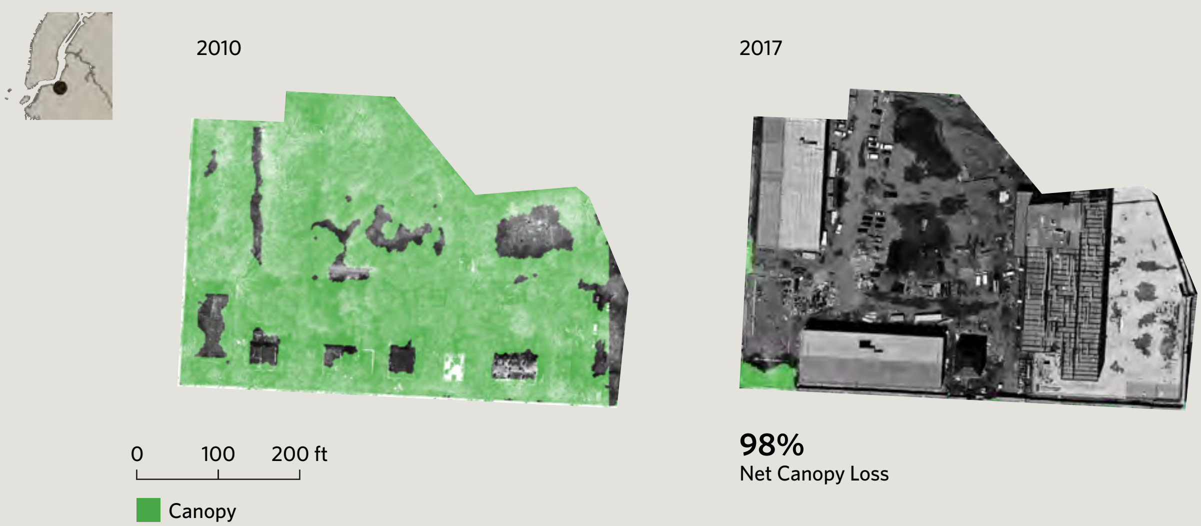
* Analysis of golf courses was based on NYC Parks-specific data. Golf courses are not otherwise represented accurately in other available data; thus we do not generally discuss them in other jurisdictions.

Localized Examples of Canopy Loss, 2010–2017

Site in Ditmars-Steinway area of Queens



Site of recent development at the Brooklyn Navy Yard



Data sources: Canopy change derived from 2017 Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications); Imagery from 2010 and 2016 collections of Orthoimagery for NYC (NYC Department of Information Technology and Telecommunications)

Figure 2.5 Examples of non-NYC Parks City properties that lost canopy between 2010 (left) and 2017 (right). Canopy loss values reflect the percentage of the canopy lost relative to the area of canopy present in 2010. Note, the site in Ditmars-Steinway reflects multiple properties that were developed together, and are treated as one area for this visualization.

Just under half of all NYC land, and 35.26% of all canopy in 2017, were on private property.

New York City Housing Authority (NYCHA) properties* comprise just under 20% of State land area (2,234 acres; 1.15% of all land in NYC), yet 38.98% of all canopy on State land fell on these spaces (2.23% of all NYC canopy). Thus, we estimate that NYCHA represents one of the largest individual holders of canopy in NYC. The NYS DEC and NYS Office of Parks, Recreation, and Historic Preservation hold smaller portions of land—0.29% and 0.23% of NYC land, respectively, with 0.65% and 0.62% of citywide canopy. Other State properties comprise a generally small portion of the land and canopy in NYC, including various public facilities and institutions such as public university campuses. About 30% of the canopy within State lands fell within natural areas, generally under the jurisdiction of the NYS DEC.

State lands exhibited net increases in canopy, ultimately increasing from 18.71% canopy cover on these lands to 20.62% from 2010 to 2017 (226 acres). The large majority of the net increases (196 acres) occurred in landscaped or developed areas. Sites with the greatest canopy gains by acreage were the College of Staten Island campus (increase of 15 acres; relative change of 17.45%), JFK International Airport (increase of 14 acres; relative change of 18.17%), and the North Mount Loretto State Forest (increase of 10 acres; relative change of 9.22%). Most NYCHA properties gained canopy during this time, resulting in a net increase of 76 acres of canopy on these lands (relative change of 8.66%).

The largest property-specific loss occurred at the Aqueduct Racetrack (owned by NYS and run by the New York Racing Association), which lost four acres due to construction or redevelopment on the grounds (relative change of -30.78%). While NYCHA complexes as a whole gained canopy, about 20% of the properties lost canopy; the largest loss in terms of acreage was at the Baruch Houses complex, which lost four acres of canopy (relative change of -24.44%).

Federal Lands

Federal lands comprise 3.45% (6,681 acres) of all NYC land area and contained 2.10% (894 acres) of the total NYC canopy in 2017 (13.38% canopy cover on these lands). Almost all (96.14%) of this land is part of Gateway National Recreation Area, which includes over 6,400 acres of land and about 850 acres of tree canopy (751 acres of this canopy were within natural areas). Other federal properties that include large tracts of greenspace include Fort Hamilton, Ellis Island, and Liberty Island. The remaining federal lands are generally associated with government offices or service providers, run by entities such as the General Service Administration or the U.S. Postal Service.

Federal properties gained a net 69 acres of canopy, resulting in 1.04% more of these spaces being covered with canopy. Gateway National Recreation Area had a net increase of 62 acres, though some portions lost canopy, such as coastal areas along Jamaica Bay that were inundated during Superstorm Sandy. Liberty Island also lost some canopy, which appeared to be associated with construction of a new visitor center.

Private Property

Just under half of all NYC land, and 35.26% of all canopy in 2017, were on private property. These spaces are owned by hundreds of thousands of different entities (e.g., individuals, businesses, institutions, faith-based organizations) and host various land uses. One- and two-family residential properties were the single type of private property with the most land and the most canopy (**Figure 2.6**). These lands had 18.13% canopy cover and accounted for 17.95% of all canopy in NYC. In general, other private lands tend to be more heavily developed and had less canopy; less developed cemeteries and vacant lands make up much smaller portions of the landscape but as of 2017 they had much more canopy cover than developed classes and likely have the potential for more. Cemeteries cover 4,187 acres (with 21.25% canopy cover), and vacant lands cover 3,807 acres (29.98% canopy cover).

* Properties managed by third parties as part of NYCHA's Permanant Affordability Commitment Together (PACT) and Rental Assistance Demonstration (RAD) programs as of January 2020 were excluded from this analysis based on guidance from NYCHA staff. Those properties consist of a relatively small portion of the land and do not affect the trends presented here.

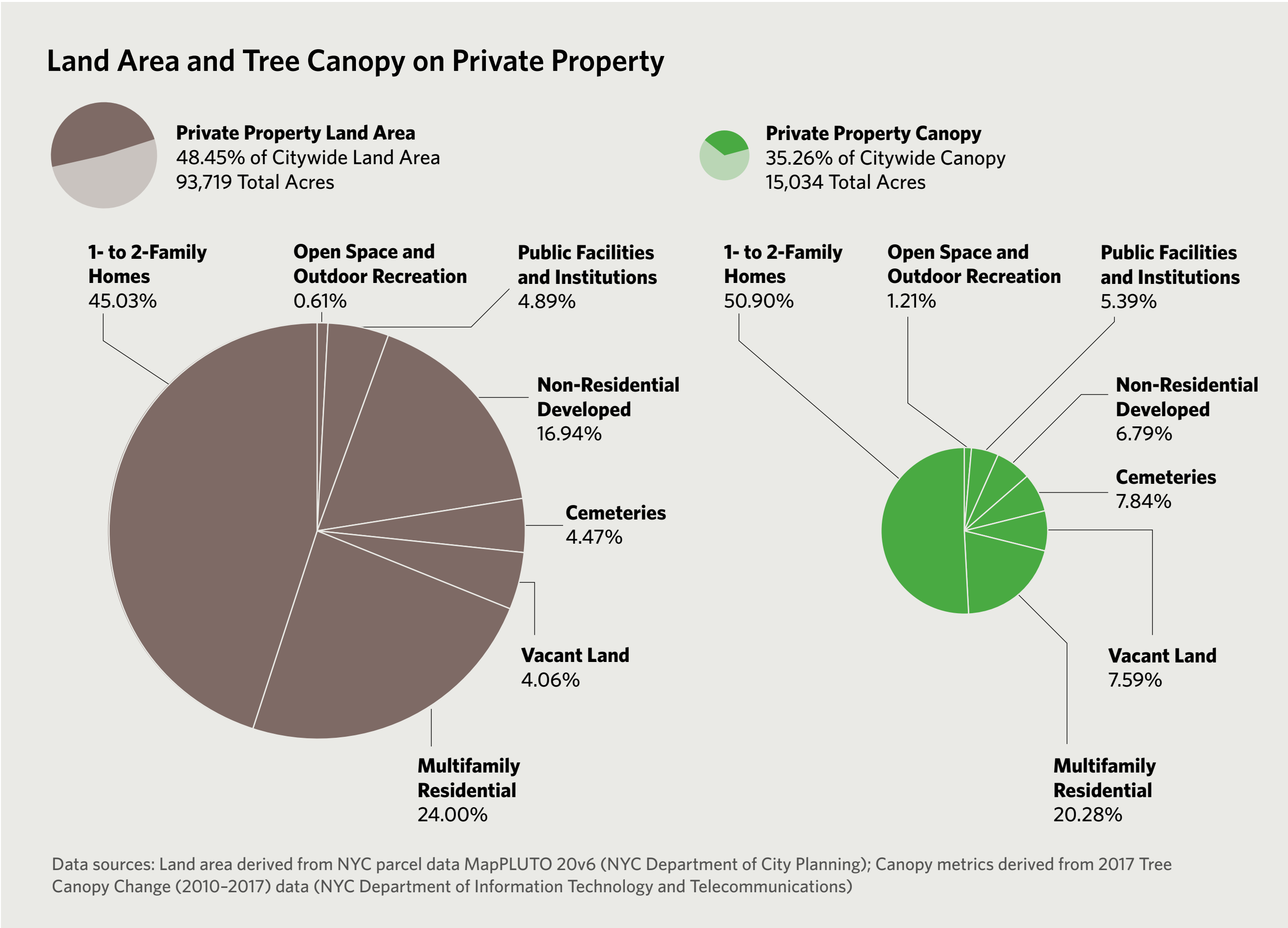


Figure 2.6 Pie charts of land area (left) and canopy (right) by site type for private properties. Pie chart areas are scaled to land and canopy area, respectively.

Private lands had a net canopy gain of 599 acres (the total portion of these lands covered by canopy increased 0.64%; relative gain of 4.15%), and all land uses citywide exhibited increases. The greatest increases in canopy, by land use, were on residential lands as a whole—multifamily residential properties showed 222 more acres of canopy (relative gain of 7.86%) and one- and two-family properties had 121 more acres of canopy (relative gain of 1.60%).

Although when aggregated by land use, all types of private properties saw canopy gains, about 30% of privately owned parcels (258,269 parcels) exhibited losses. Furthermore, while these lands as a whole exhibited net gains, canopy within natural areas on private property decreased by 45 acres. As detailed in Chapters 5 and 7, private property often faces development pressure, and trees on private property have no protection in most cases, amidst inconsistent, often limited management.

Drivers of Change

The urban forest we see in NYC today is the product of both human and biophysical drivers across both short and long time scales.[3] Anthropogenic drivers include both long-term factors (e.g., historic symbolism of certain species, broader planning and management of the landscape) and recent ones (e.g., socioeconomic shifts, construction, short-term planting efforts).[1,3] Biophysical drivers can include a wide array of factors, such as major disturbances associated with storms, pests, and disease outbreaks.[3] At local levels, the urban forest can be influenced by things like how property owners manage their individual properties[4] and the regeneration of trees and other forest vegetation within the city landscape that forms urban forest patches.[5]

A home in Bay Ridge, Brooklyn with several trees in the front yard. Of all land uses on private property, one- and two-family residential properties contain the most tree canopy.

Though changes in the urban forest are influenced by the broad suite of aforementioned factors, we describe more immediate drivers of tree and canopy change that may relate to the 2010–2017 period for which we have canopy change data. We discuss the following (not prioritized or listed in order of impact), and describe the magnitude of canopy change associated with these factors when possible:

- Increases in trees and canopy
  - New tree planting
  - Natural regeneration
  - Tree growth
- Declines in trees and canopy
  - Disturbances and stressors
    - Stressors of urban environments
    - Severe storms
    - Pests and diseases
  - Tree aging and death
  - Development, infrastructure work, and similar activities

While one may expect that pruning of trees would contribute to canopy reduction, appropriate pruning, in general, only minimally changes canopy and can ultimately support canopy expansion, as it supports tree health. Given these nuances, we note pruning in certain instances that follow, but do not discuss it in depth. It is an important aspect of caring for many trees (e.g., street trees and those in landscaped parkland) that mitigates risk, improves form, and manages conflicts with utilities.

Increases in Trees and Canopy

Myriad factors contribute to increases in trees and canopy in the urban forest. The following are key proximate causes, which are tied to a number of complex factors, including policy and management.

Some of the most prominent examples of tree plantings in NYC include 136,871 street trees and 17,440 trees in landscaped portions of City Parkland that were planted during FY10–16.

New Tree Planting

Planting can be one of the most direct drivers of increases in the urban forest. Trees are planted by various stakeholders, including City agencies and private property owners. Newly planted trees contribute to increases in the number of trees in the urban forest, although LiDAR-based canopy assessments leveraged in this report only consider vegetation to be canopy if it is at least eight feet tall. Thus, smaller, more recently planted trees may not have been captured as canopy in the most recent data. Newly planted street trees and trees in landscaped portions of City Parkland generally meet the eight-foot threshold at planting, given minimum stem diameter requirements.[6] However, many other trees planted across site types are below this height. For example, ecological restoration or afforestation projects in natural areas use much smaller trees, often at high densities that self-thin as the plants become established.[7,8]

Between 2010 and 2017, there was a gross increase of 9,730 acres of canopy. Of that, 1,281 acres (13.17%) was disjunct from canopy that existed in 2010, so we generally assume it was the result of new plantings, although some of this canopy undoubtedly belonged to isolated trees that grew past the eight-foot threshold during the focal time.* We see this as a coarse estimate, as there are a number of nuances for which we cannot account, such as new tree plantings near existing canopy and formation of new urban forest patches through natural processes (as discussed by Johnson et al.[5])

Some of the most prominent examples of tree plantings in NYC include 136,871 street trees and 17,440 trees in landscaped portions of City Parkland that were planted during FY10–16.† Afforestation and reforestation of natural areas have also involved substantial plantings—for example, during MillionTreesNYC, hundreds of thousands of smaller trees were planted in natural areas[9,10] and other trees were planted on various publicly and privately owned lands. In some places, newly planted trees may not have increased the canopy (e.g., trees planted under existing canopy), or the trees that were planted were too small to count in canopy analyses. However, in many cases, the increases in canopy due to tree planting can easily be seen (**Figure 2.7**).

Natural Regeneration

Natural regeneration is a critical process for maintaining healthy forest ecosystems.[11] Regeneration also contributes to new urban forest patches that can stem from deliberate planning or neglect.[5] Natural regeneration occurs when trees reproduce in the environment through dispersal and germination of their seeds, or through rhizomes (sprouting new growth from underground shoots). These processes are influenced by both local conditions and broader anthropogenic drivers.[12] In many parts of the landscape, mowing or manicuring prevents new vegetation from growing beyond an initial seedling stage, but in forested natural areas and in less managed properties (e.g., some vacant lands), vegetation can grow taller. In fact, most of the forested natural areas in NYC are the product of regeneration across lands that had previously been cleared for use as farmland, lawns, and other open-cover landscapes (C. Pregitzer, personal communication).

Regeneration plays a critical role in the NYC urban forest, not simply in the revegetation of historically cleared lands, but also in maintaining forested natural areas. The understory and midstory in the forested natural areas of NYC are robust, providing a varied vertical structure that is vital for a healthy forest ecosystem.[11,13] Some of this vegetation will ultimately increase the canopy cover in the long term, filling light gaps

* This was based on analysis of canopy change data, identifying portions of canopy that were new as of 2017 and not adjacent to canopy that existed in 2010.

† Data provided by NYC Parks.

and contributing to ecological succession along the edges of forests. In other cases, the younger vegetation will maintain existing canopy by replacing old trees that deteriorate with age. Research on regeneration in local forested natural areas has confirmed that this process is taking place, though the species composition is changing, with non-native species becoming more prevalent in the understory and midstory.[11]

In NYC, regeneration in forested natural areas is influenced by site characteristics such as existing canopy cover and the presence of other vegetation.[14] White-tailed deer, which are present in parts of the city, can limit natural regeneration by foraging new tree growth.[15] Piana et al.[16] found that forested natural areas in NYC tend to be limited at the early stages of regeneration (e.g., at the seedling stage) and exhibit different dynamics than more rural areas, though they noted that natural regeneration is still a vital, ongoing process in the city. To our knowledge, there is no formal research in NYC on regeneration beyond natural areas, though anecdotally it occurs across the landscape in untended and unmowed properties (e.g., on vacant lands, along fence lines).

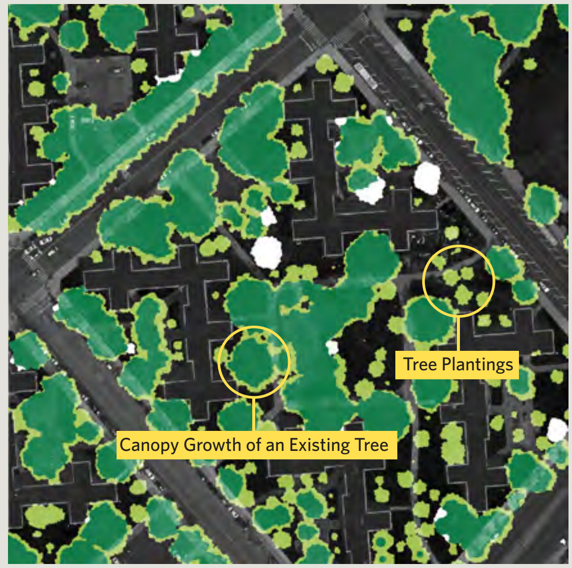
One example of an urban forest patch that likely originated as the result of regeneration is about 14 acres of canopy on approximately 30 acres of land along a defunct rail line on the north shore of Staten Island. Much of the canopy there was present in the 2010 canopy assessment, and both growth of that canopy, and additional trees originating from natural regeneration, contributed to expansion of this patch.

Tree Growth

Growth of existing trees is a major driver of canopy increase. NYC exhibited a gross increase in canopy of 9,730 acres between 2010 and 2017; of this, 8,449 acres (86.83%) occurred on the periphery of canopy that was present in 2010, often reflecting the growth of existing trees. We cannot precisely estimate how much of this was attributable to the growth of existing trees due to various nuances (e.g., trees are sometimes planted near others such that their canopies become contiguous), but we anticipate that the majority of it was.

A variety of factors affect the growth of trees.[17] For example, species naturally grow to different sizes, and there is greater potential for canopy spread with large-growing species like red oak or London planetree than smaller species such as flowering dogwood or Eastern redbud. While it is important to choose tree species for planting based on local conditions, canopy potential is another consideration. Local site conditions and stewardship can also influence the growth of trees.[17,18]

Canopy Change at Breukelen Houses, Brooklyn



No Change   Gain   Loss

Data sources: Canopy change derived from 2017 Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications); Imagery from 2010 and 2016 collections of Orthoimagery for NYC (NYC Department of Information Technology and Telecommunications)

Figure 2.7 Canopy change, attributable to various factors, seen on a portion of Breukelen Houses, a NYCHA property in Brooklyn. This property saw a net gain of seven acres of canopy across a 64-acre area from 2010 to 2017. Planting and tree growth were discerned from aerial imagery and canopy change data.

Declines in Trees and Canopy

Declines in the urban forest are complex. Sometimes the loss of trees or canopy are clearly attributable to individual factors like construction, land conversion, or events like major storms, while other times it is more nuanced. For example, trees may become stressed due to local conditions, which makes them more susceptible to the impacts of events like storms. Data from the Mayor's Management Reports* during the period we consider (FY10-16) indicate a loss of 115,556 trees that were either removed or felled by storms. The planting of 154,311 trees across these spaces, combined with the growth of existing trees, outweighed these losses, and these lands exhibited substantial net increases in canopy (1,753 acres in total). However, we are unable to characterize these dynamics, let alone quantify the impacts of different drivers more holistically.

Disturbances and Stressors

Stressors of Urban Environments: Trees in cities can face a variety of stressors. For example, the urban heat island effect (discussed further in Chapter 3) can contribute to heat stress. Altered precipitation and hydrologic patterns across the landscape may also influence water availability either positively or negatively. Street trees, in particular, are sometimes constrained by too-small tree beds, are impacted by soil compaction due to pedestrians walking over them or vehicles driving over them, and can become overloaded with salts and nutrients from various sources. More immediate incidents can also damage trees, such as being hit by vehicles and being pruned improperly.

Trees affected by these and other factors (e.g., pests and pathogens) may lose foliage and limbs, and can require severe pruning (retrenchment) or even removal to mitigate risk. In some cases, damaged or dead trees are not removed, as they can play a role in the ecosystem and those located in forested natural areas, away from trails, generally do not pose significant risks to people or property.

Severe Storms: Severe storms can have major impacts on the urban forest. For example, after Superstorm Sandy in 2012, NYC Parks documented 10,926 fallen street trees and landscaped park trees within City Parkland due to the physical impact of wind and debris (NYC Parks, personal communication). There were also longer-term impacts, as about 30,000 acres of land containing approximately 48,000 street trees (in addition to trees on other site types) were inundated by the storm.[19] While areas outside the inundation zone experienced 1.6 times more canopy gain than loss, the inundation zone as a whole gained and lost about equal amounts of canopy. Areas along southern Brooklyn and Queens were particularly hard-hit with substantial inundation (e.g., **Figure 2.8**; the general pattern seen holds throughout the inundation zone).

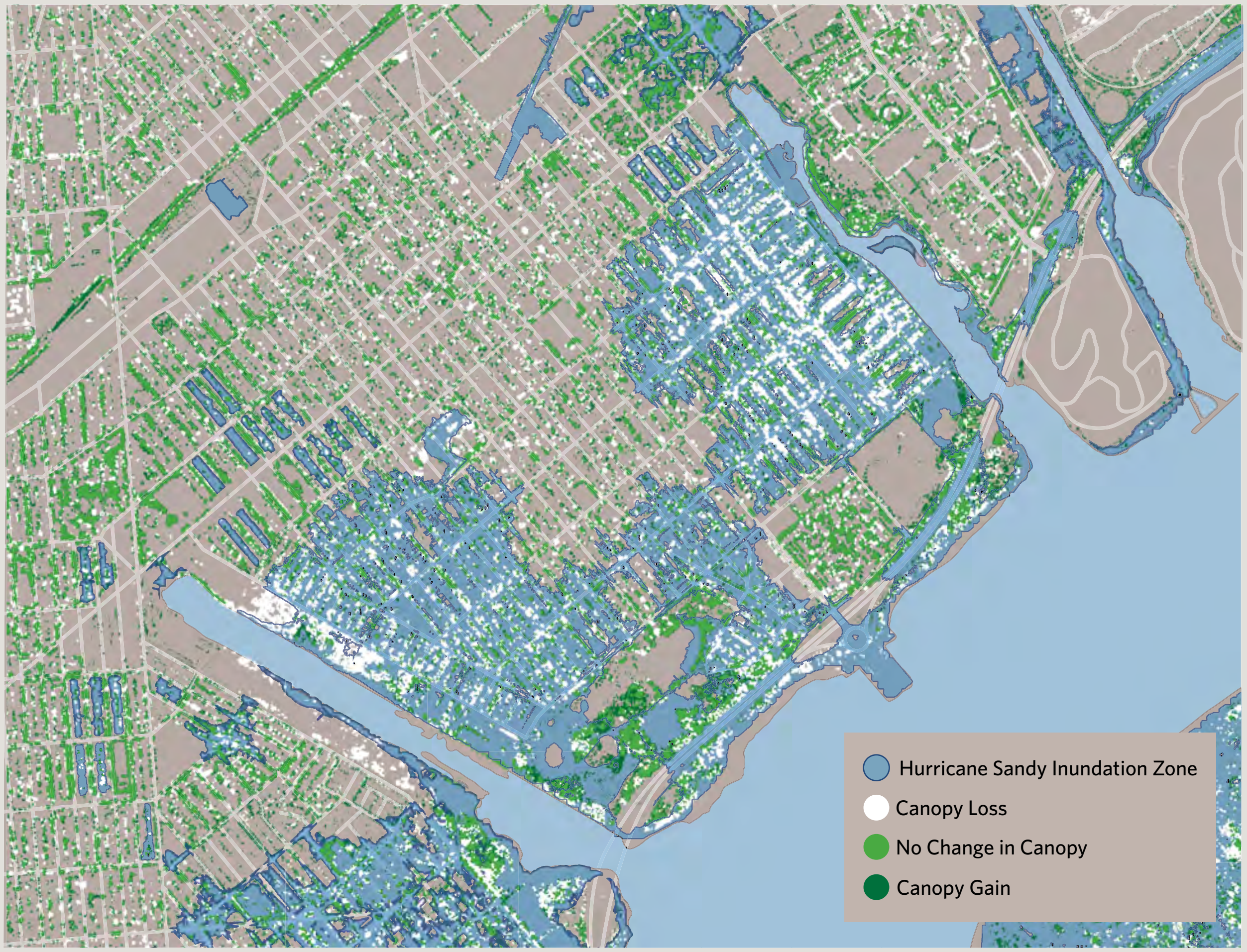
Species composition played at least some role in the differential impacts of Sandy across the city. Hallett et al.[19] found that, in general, London planetrees inundated by Sandy within Queens did not recover, while red maples did. Such differences in species vulnerability can exacerbate impacts on canopy, as London planetrees tend to have larger canopies than red maples. Sandy was an exceptional storm, but smaller storms also impact the urban forest, causing broken limbs and downed trees. For example, historic blizzards have impacted the urban forest, and on August 4, 2020, Tropical Storm Isaias struck NYC with heavy winds that ultimately resulted in 3,370 downed street trees and trees in landscaped parts of City Parkland (NYC Parks, personal communication), as well as causing power outages and property damage. Coastal areas of NYC also face storm surges, and sea-level rise that will regularly expose trees to increased salinity and ultimately contribute to vegetation transitions in affected areas.

Pests and Diseases: Forests of all types are susceptible to pests and pathogens, and urban forests have historically experienced substantial impacts. For example, American elm trees, which historically made up large portions of many cities' urban forests (e.g., they composed 45% of the trees in Chicago in 1971), were decimated by Dutch elm disease after its arrival to the United States in 1930.[20] Trees in NYC face potential threats from at least 31 exotic insects and diseases.[21] Other stressors, such as heat, can compound effects and make the resource more vulnerable overall.[22] In the case of one current challenge, the invasive emerald ash borer, infested trees within the jurisdiction of NYC Parks are often removed, as they can quickly become a public safety risk. Trees that are pre-emptively removed are generally replaced with other species to reduce the risk of infestation by the emerald ash borer.[23]

One recent success story related to pests and diseases is the eradication of the Asian longhorned beetle from NYC in 2019.[24] This species often targets maples and other hardwoods,[25] and it affected a number of species in the NYC urban forest.

* The Mayor's Management Report is released every fiscal year, as mandated by the City Charter, and available from: https://www1.nyc.gov/site/operations/performance/mmr.page.

Canopy Change in an Area Inundated by Superstorm Sandy



Data sources: Canopy change from 2017 Tree Canopy Change (2010–2017) data and basemap are both courtesy of NYC Department of Information Technology and Telecommunications; Hurricane Sandy Inundation Zone from NYC Department of Small Business Services

Figure 2.8 Canopy change around Canarsie and Paerdegat Basin in Brooklyn, overlaid with the inundation zone from Superstorm Sandy. Note substantial loss of canopy (white) within the inundation zone (darker blue). Gains (darker green) were likely due to restoration plantings and canopy growth from individual trees.

Tree Aging and Death

Deterioration and death, or senescence, is a natural process in trees. Its timing varies with species, environmental conditions, and management, among other factors.[26,27] Dead trees in unmanaged parts of the landscape may remain upright for a time, but they ultimately decay and fall. In more managed parts of the landscape, such as in landscaped parks and rights of way, falling limbs from dead trees are more likely to cause injuries or damage because of their proximity to people and property. Thus, in these landscapes, they may be retrenched or removed completely to manage the risk.

Development, Infrastructure Work, and Similar Activities

While the aforementioned factors may ultimately lead to tree removal to mitigate risk, healthy trees are also removed for a variety of reasons, including:

- To clear land for development
- To accommodate various type of above- and below-ground utility work
- To follow the preference of property owners

A street tree felled by a tornado in 2010 led to downed wires and a blocked road in Queens. Severe weather events are predicted to increase with climate change, which poses challenges for the urban forest.

As detailed in Chapter 5, there are no restrictions on tree removal from most site types. In some cases, tree planting or natural regeneration may contribute to replacing that canopy in the long term, but when trees are removed to make way for buildings, roads and other impermeable surfaces, and other infrastructure, their removal can translate to a sustained loss of canopy.

Trees within NYC Parks' jurisdiction, accounting for about 53.50% of the canopy in NYC, are a substantial part of the urban forest and are protected from removal in certain cases. Removal of these trees falls into three categories: 1) removal to avoid risk; 2) permitted tree removal; and 3) illegal removal. For the first category, trees are inspected based on service requests from the public (e.g., via NYC's 311 system) or during routine pruning, then removed when their condition warrants it. These removals are typically associated with the factors listed above, such as degradation and aging, or storm damage. In permitted tree removal, entities (including agencies such as NYC Parks) apply for a permit to remove a tree and are required to either plant a replacement or pay a fee to NYC Parks that covers the cost of a replacement. Illegal tree removal, which occurs without a permit, is punishable by law, and perpetrators must replant or pay fees.[28]

Status of Street Trees

Rights of way contained about a quarter of all tree canopy in NYC in 2017. Although some canopy in these spaces is from trees growing on individual properties (where the canopy overhangs into rights of way), a substantial portion of right-of-way canopy is attributable to hundreds of thousands of street trees* that are planted along streets, sidewalks, and medians of surface roads (generally excluding rights of way along highways). Unlike most other portions of the urban

* Given the limits of available data, we cannot specifically characterize the breakdown of canopy in rights of way attributable to street trees, compared with other trees.

forest, street trees have been systematically inventoried at the level of individual stems. We leverage these data to describe the status of this resource.

The data we present are primarily from the most recent (2015–2016) street tree census led by NYC Parks, with some data from previous street tree censuses (1995–1996 and 2005–2006). Data for all of these tree censuses were collected by a combination of NYC Parks staff and volunteers and are high in quality. Research from the most recent census found strong agreement between professional arborists and volunteers for most variables.[29] We focus analyses on boroughs and on populated Community Districts and NTAs, given the lack of street trees in large, unpopulated spaces such as large parks and airports (which are inherently included in City Council Districts; data on street trees by City Council District are available in Appendix 2).

We focus on living trees,[*] as they provide the most benefits, and draw on our own analysis of the available data (methods described in Appendix 1). When describing the distribution of street trees, we leverage stocking rates (the percent of living trees of the estimated capacity) to standardize numbers across geographies, given that there are limitations on where street trees can be planted.[†] We only describe stocking rates as of the 2015–2016 street tree census, as the capacity analysis leveraged GIS data contemporary with that effort.

Street Tree Distribution and Change Through Time

The 2015 street tree census counted 652,088[‡] living street trees in NYC, an increase from 584,525 in 2005 and 482,509 in 1995—ultimately a 35% increase over this 20-year period, distributed across all boroughs. Street trees as a whole account for nearly 10% of the estimated seven million trees in NYC,[21] though the number and stocking rate of street trees vary across the city. Total capacity for street trees citywide is estimated to be 903,139, leaving space for approximately 250,000 additional street trees. Summaries of street trees by borough are presented in **Figure 2.9** (see Appendix 2 for more complete tables of street tree data).

At the scale of Community Districts, stocking rates in 2015 were uneven across NYC. Even within different parts of boroughs, there was noticeable heterogeneity, evident at the smaller scale of NTAs. (**Figure 2.10**). Here are some of these dynamics:

- The highest stocking rates in NYC were in Manhattan, including MN-7 (the Upper West Side), MN-8 (the Upper East Side), and MN-10 (Central Harlem). The maximum was 90.29% in MN-7. However, Manhattan also had areas with very low stocking rates, such as MN-1 (Lower Manhattan) and MN-5 (Midtown Manhattan), which had stocking rates of about 50% and 40%, respectively.
- Outside Manhattan, SI-3 (southern Staten Island) had the highest stocking rate (82.11%), although other portions of the borough had much lower stocking rates (such as SI-1, northern Staten Island, 63.65%).
- In Brooklyn, Community Districts near or adjacent to Prospect Park, including BK-3 (Bedford-Stuyvesant), BK-4 (Bushwick), BK-6 (Gowanus/Park Slope/Red Hook), and BK-8 (Crown Heights/Prospect Heights), tended to have higher stocking rates, as high as 81.72% in BK-6. Other portions of Brooklyn varied, however, and the lowest stocking rate of street trees in that borough was 52.69%, in BK-13 (Brighton Beach/Coney Island/Gravesend).
- In the Bronx, the highest stocking rate was 80.28%, in BX-5 (Fordham/Morris Heights). Adjacent and nearby Community Districts to the east (BX-2, BX-3, BX-4, and BX-6) had the next highest stocking rates in the borough, although multiple Community Districts had much lower stocking rates, such as BX-8, with 68.78%.

* The 2015–2016 street tree census also captured data on dead trees and stumps. These sites may present opportunities to plant trees, though the actual suitability of those beds for new trees is highly variable. It is generally assumed that planting of new trees may require cutting new beds along sidewalks.

† We used capacity estimates modeled by NYC Parks following the 2015–2016 street tree census. The methodology applied by NYC Parks took zoning into consideration as a potential factor that functionally influenced street tree capacity. However, as with any modeled estimate, there are limits to the accuracy of these capacity figures, and they may over- or underestimate street tree capacity in individual cases. We also examined street trees as density of trees per road mile, which generally showed similar trends; these data are available in Appendix 2.

‡ A small percentage of trees were captured in both the 2015–2016 street tree census and the Parks Tree Inventory. We are unable to accurately separate the trees that were counted in both inventories; thus we report full numbers. In addition, some trees captured by the street tree census actually fall outside NYC boundaries (e.g., in Nassau and Westchester Counties) and are excluded from these results.

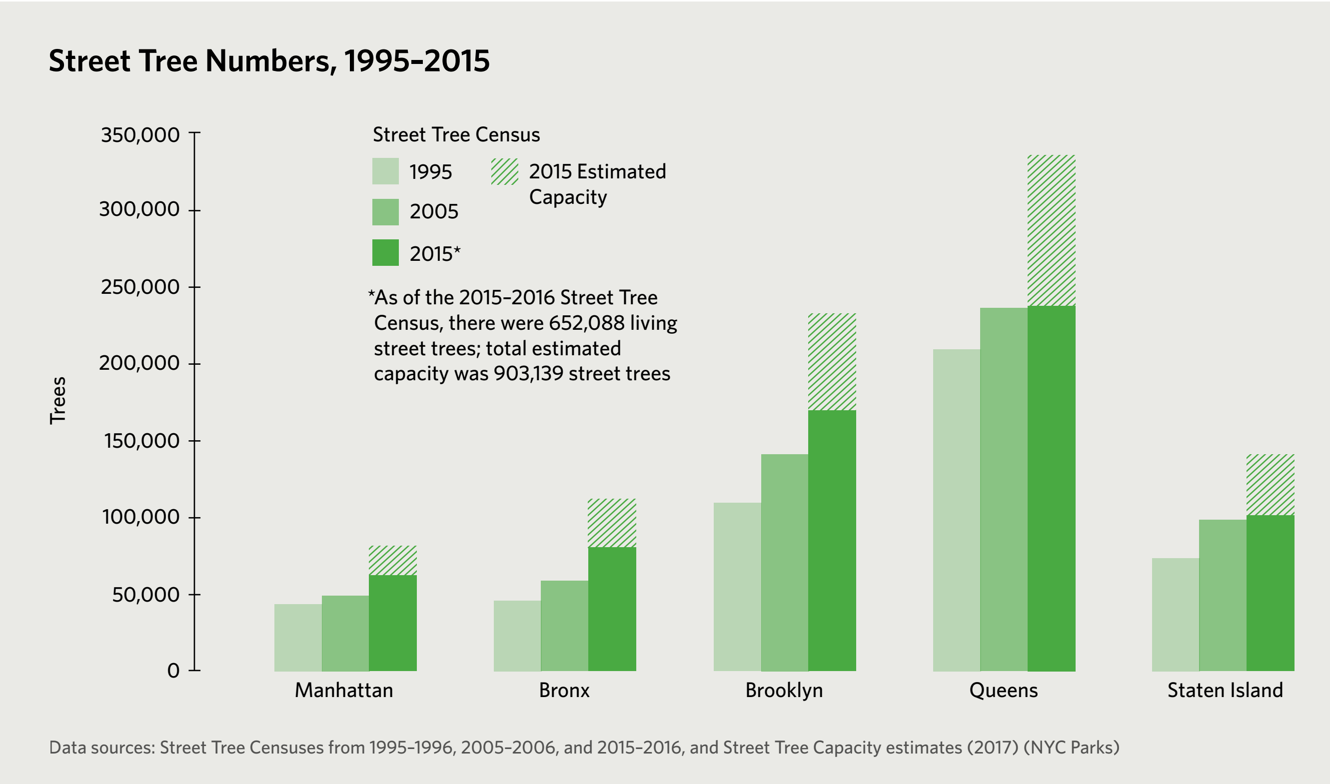


Figure 2.9 Number of living street trees by borough, based on data from the three decennial Street Tree Censuses, and estimated capacity for street trees based on analysis by NYC Parks. All boroughs gained street trees during this time period and have additional estimated capacity for more.

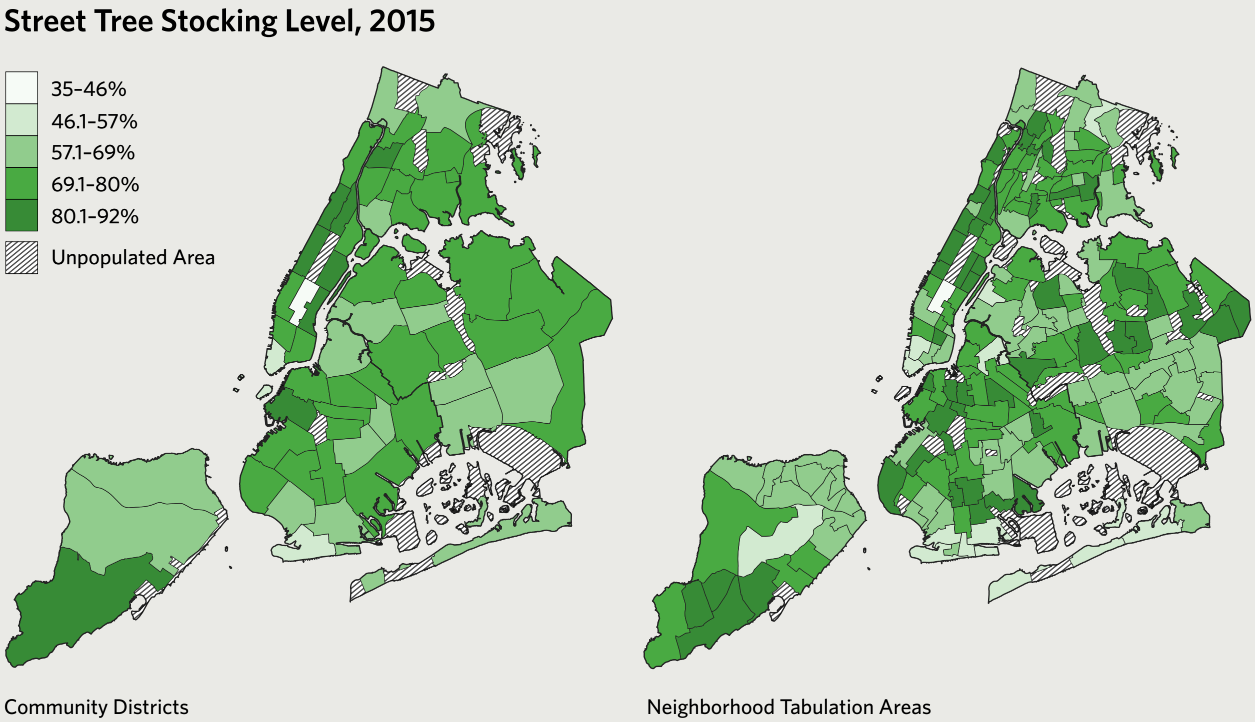
- The highest stocking rate in Queens was 79.50%, in QN-6 (Forest Hills/Rego Park). This was lower than the highest stocking rates found in other boroughs. The lowest stocking rates in Queens were in QN-2 (Long Island City/Sunnyside/Woodside) and QN-14 (The Rockaways), 60.74% and 57.54%, respectively.

The number of street trees generally increased through time at all scales (data in Appendix 2); only three Community Districts (out of 59) and 14 NTAs (out of 188) exhibited net losses of street trees from 1995 to 2015, although some areas with net gains during this period lost street trees between either 1995 and 2005 or 2005 and 2015. The three Community Districts were QN-9 (Kew Gardens/Woodhaven), MN-6 (Murray Hill/Stuyvesant Town), and MN-5 (Midtown Manhattan). The NTAs with net losses of street trees were largely consistent with the Community Districts that lost street trees, though they also included BX-N22 (Riverdale), BX-N85 (Woodlawn and Wakefield in the northern Bronx), BK-N19 (Brighton Beach), and QN-N19 (central Queens, around Glendale).

Street Tree Species Composition

The 2015 street tree census recorded 132 kinds of street trees in NYC (identified to genus, species, or cultivar). London planetree was the most prevalent, followed by honey locust, Callery pear, pin oak, and Norway maple (**Figure 2.11**) and historically these have been among the most common. Other species rose in prevalence since past street tree censuses, with cherry, Japanese Zelkova, and Sophora trees only appearing in the top 10 in 2015. The most common street trees varied across boroughs, Community Districts, and NTAs although the most common kinds in each unit were generally among the top three citywide and always in the top 10.

Managing the distribution and relative abundance of street trees species can be critical to the long-term health and resilience of the urban forest as some species are susceptible to specific pests and disturbances that can lead to substantial declines or loss.[30] The species palette for street trees has been adjusted through time, in part to help manage these challenges, and newer plantings have reduced the dominance of the most common species.



Data sources: 2015–2016 Street Tree Census and Street Tree Capacity estimates (2017) (NYC Parks); administrative boundaries from NYC Department of City Planning

Figure 2.10 Estimated stocking rates of street trees across NYC based on data about living trees from the 2015–2016 Street Tree Census and capacity analysis by NYC Parks.

In 1995, the five most common kinds of street trees made up almost 60% of the total stock, with Norway maple alone composing 21% of them. By 2015, while the five most common kinds were the same (but in a different order), they composed <50% of all street trees.[31] Thus, the trend in NYC is toward a more even and diverse palette of street trees. This will ultimately support resilience of the urban forest to climate change—for example, some species are more vulnerable to pests in warmer temperatures, which may become more prevalent due to the urban heat island effect and the changing climate,[22] and some species are particularly vulnerable to saltwater inundation, which will become more frequent in coastal areas.[19] Having a diverse set of species enables the forest as a whole to adapt to change.

Street Tree Size

The size of street trees is another important factor, generally related to age, species, and local conditions. Larger trees tend to have a broader canopy and can provide more ecosystem services, such as intercepting rainfall, storing carbon, and providing shade and cooling (see Chapter 3 for further discussion of benefits). The main size metric available for street trees is diameter at breast height (DBH).* This is the diameter of the tree measured at 4.5 feet above the ground. This commonly used metric can ultimately be leveraged to infer other dimensions and benefits.[17,21] A schematic representation of a pin oak at various sizes is presented in **Figure 2.12** to give a sense of scale.

* Crown et al.[29] reported that that of all metrics collected during the 2015–2016 Street Tree Census, DBH measured by volunteers had the lowest reliability compared with DBH measured by NYC Parks staff. Despite their limitations, these data from the street tree census remain the best available data.

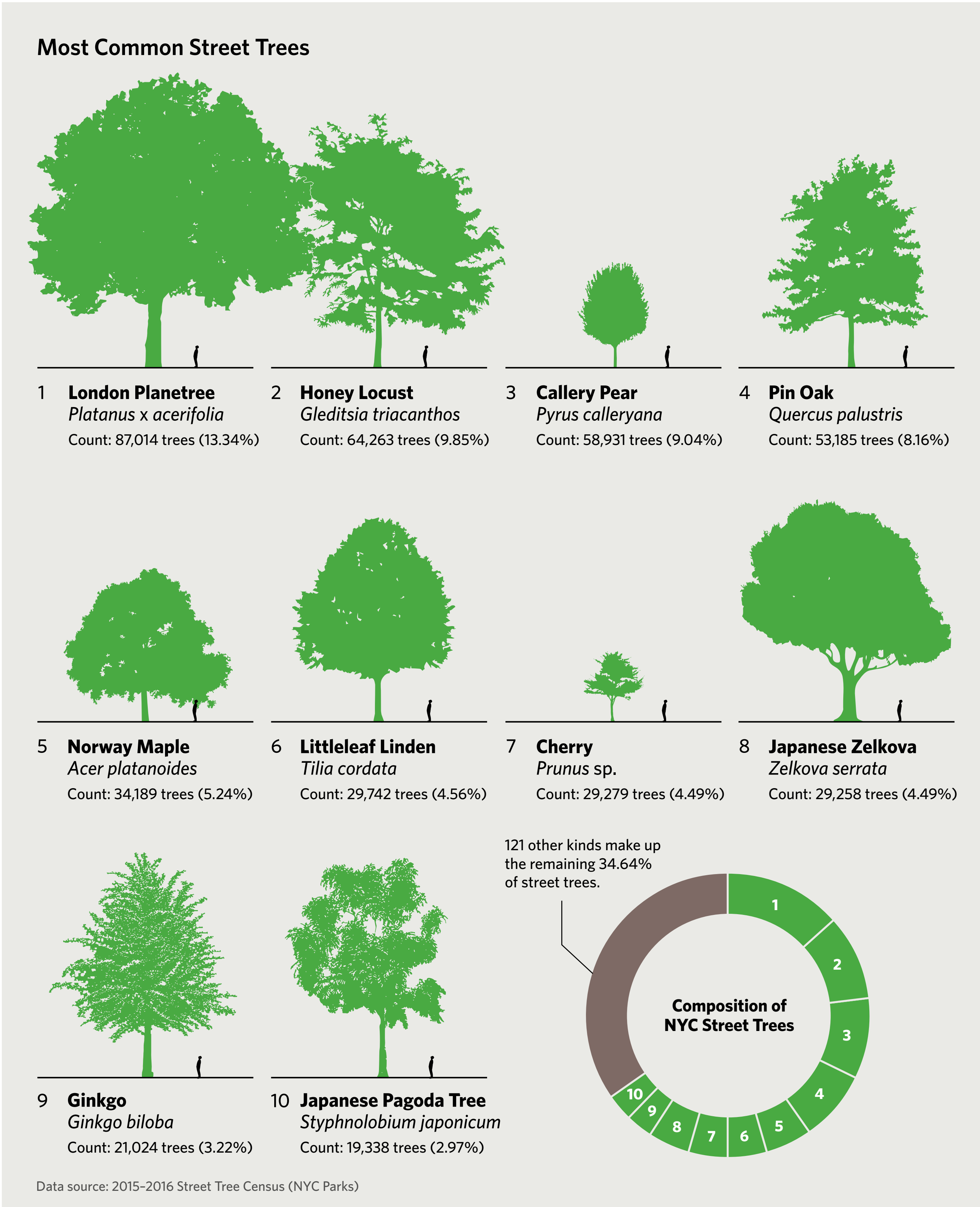
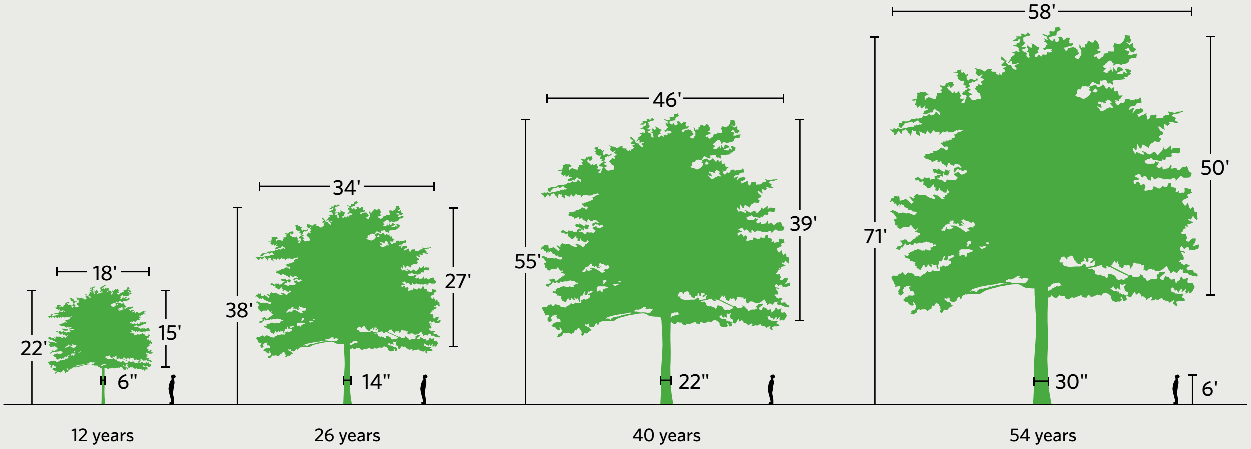


Figure 2.11 The top 10 most common street trees as of the 2015–2016 Street Tree Census, which comprised 65.36% of all street trees in NYC. Trees are shown to scale, based on average heights according to the Missouri Botanical Garden Plant Finder, alongside a 6-foot-tall person.

Relative Tree Size by Age



Data source: Tree dimensions at different ages for a pin oak were estimated using urban tree growth equations derived from McPherson et al. (2016). Urban tree database and allometric equations (General Technical Report PSW-GTR-235, 1–86). USDA Forest Service, Pacific Southwest Research Station.

Figure 2.12 Scale illustration of a pin oak (*Quercus palustris*) in an urban environment as it grows.

A diversity of age or size classes is a characteristic of a healthy forest and can support resilience of the urban forest to large-scale disturbances.[32] A higher prevalence of younger trees supports long-term sustainability for canopy cover as they replace older trees through time.[21] Street trees in NYC have a relatively healthy size distribution. Their population is dominated by smaller trees, with relatively few larger ones, both across the entire city and within each borough (**Figure 2.13**). The smallest classes (0–3" DBH) actually had fewer trees than the next largest class, which may indicate a need to increase the planting of new trees, although the general trend of more smaller trees than larger ones generally holds.*

Size distributions of trees vary greatly across the city (**Figure 2.14**). For example, about 10% of the trees in QN-9 (Kew Gardens/Woodhaven) had a DBH >30", much greater than the citywide average (3.5%), whereas 1% or fewer of all trees in all but one of the Community Districts in Manhattan, and half of the Bronx Community Districts, were in that large size class. Community District BX-5 (Fordham/Morris Heights) had the largest portion of trees <6" DBH (57%); other portions of the South Bronx, as well as small areas in other boroughs, also tended to have greater prevalence of small trees. Similar trends are present at the smaller scale of NTAs. Though potential sizes and growth rates vary by species and local conditions, areas with more small street trees may see greater canopy increases as these trees reach their potential.

* Newly planted street trees typically have a diameter of 2.5–3.5″ at 6″ above the ground. While we do not have an estimate of diameter at breast height for these trees, we recognize that this specification may inherently limit the number of trees in the smallest size class considered.

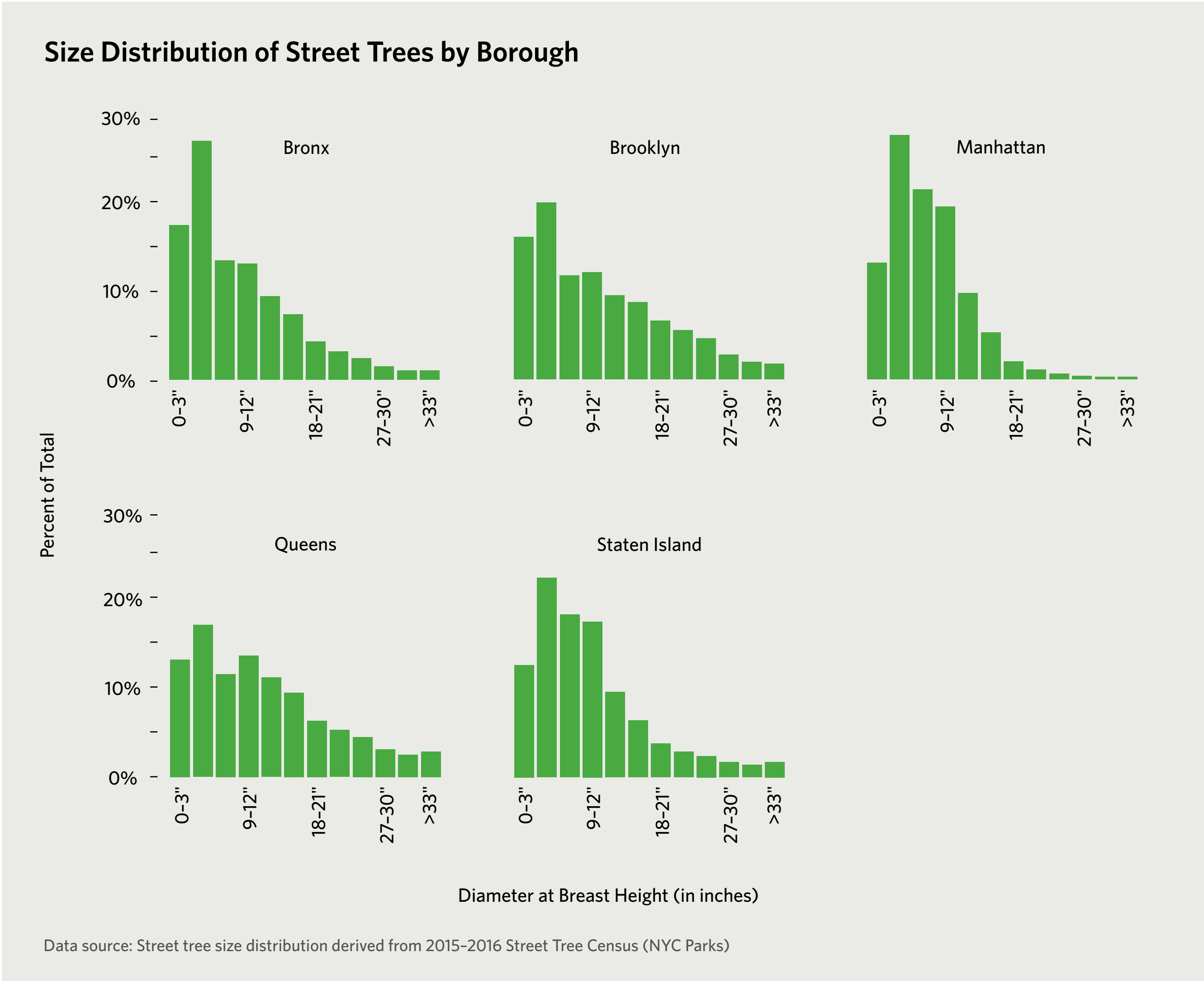


Figure 2.13 Histograms of diameter at breast height (DBH) for living street trees in the five boroughs as of the 2015–2016 Street Tree Census. Bins represent 3-inch increments, except for the right-most, representing all trees with a DBH greater than 33 inches. DBH recorded as 0 was considered unreliable and those trees were omitted for these figures.

A diversity of age or size classes is a characteristic of a healthy forest and can support resilience of the urban forest to large-scale disturbances.

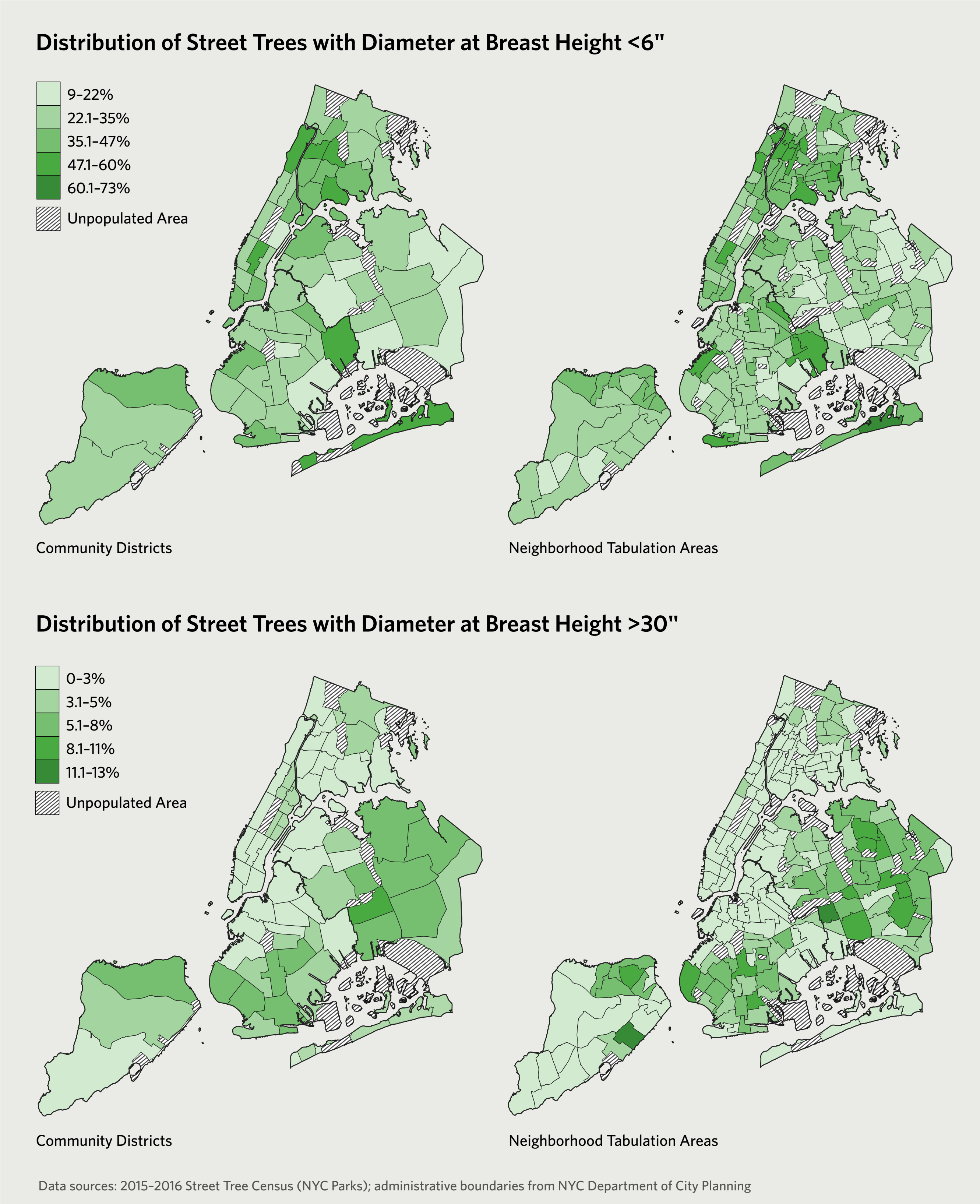


Figure 2.14 Distribution of small (Diameter at Breast Height <6") and large (Diameter at Breast Height >30") living street trees across NYC, as of the 2015–2016 Street Tree Census.

Landscaped park trees in autumn at Conference House Park, Staten Island. Landscaped park trees provide shade for park users and help cool the area, while serving as habitat for wildlife.

Status of Landscaped Park Trees in City Parkland

Landscaped park trees are purposely planted in areas with playgrounds, picnic areas, athletic fields, bike paths, lawns, and in other actively programmed areas of parkland, generally with at least some degree of management. These trees provide myriad benefits, can be an amenity for park users (e.g., by providing shade and lowering temperatures), and serve as wildlife habitat. We focus on living trees in landscaped portions of City Parkland, which were comprehensively inventoried for the first time during 2017 and 2018 (the Park Tree Inventory). This inventory was also leveraged to delineate NYC Parks' more developed or landscaped park areas from natural, often less intensively managed landscapes, which enabled analyses herein (methods are discussed in Appendix 1). While this section specifically describes stem-based metrics for trees in landscaped portions of City Parkland, as described earlier, these spaces comprise 6.06% of total NYC land area and 9.55% of all canopy in NYC. Landscaped portions of City Parkland had 34.73% canopy cover in 2017, an absolute increase of 1.90% since 2010.

Number and Distribution of Landscaped Park Trees

The Park Tree Inventory documented 154,982 living trees. Most boroughs had fairly comparable raw numbers of these trees, ranging from about 32,000 to just over 40,000. Staten Island was an exception, with only 10,817 trees, though it also has the least landscaped City Parkland in general (**Figure 2.15**). The overall density of landscaped park trees (trees per acre) in City Parkland was 13.21 trees per acre, although this varied substantially across the five boroughs. The highest density, by a large margin, was in Manhattan (19.31 trees per acre). All other boroughs had densities of <13 trees per acre, with the lowest in Staten Island. Although landscaped parkland includes active recreation fields and unvegetated spaces like basketball courts, these differences in density indicate that there may be disparities by borough that ultimately require further investigation—an opportunity for future work. Parkland, in general, is highly variable across NYC. We do not delve into more granular geographies here but note that other relevant work (albeit not tree-specific) has been conducted, such as that found in Open Space Profiles developed by the nonprofit New Yorkers for Parks.[33]

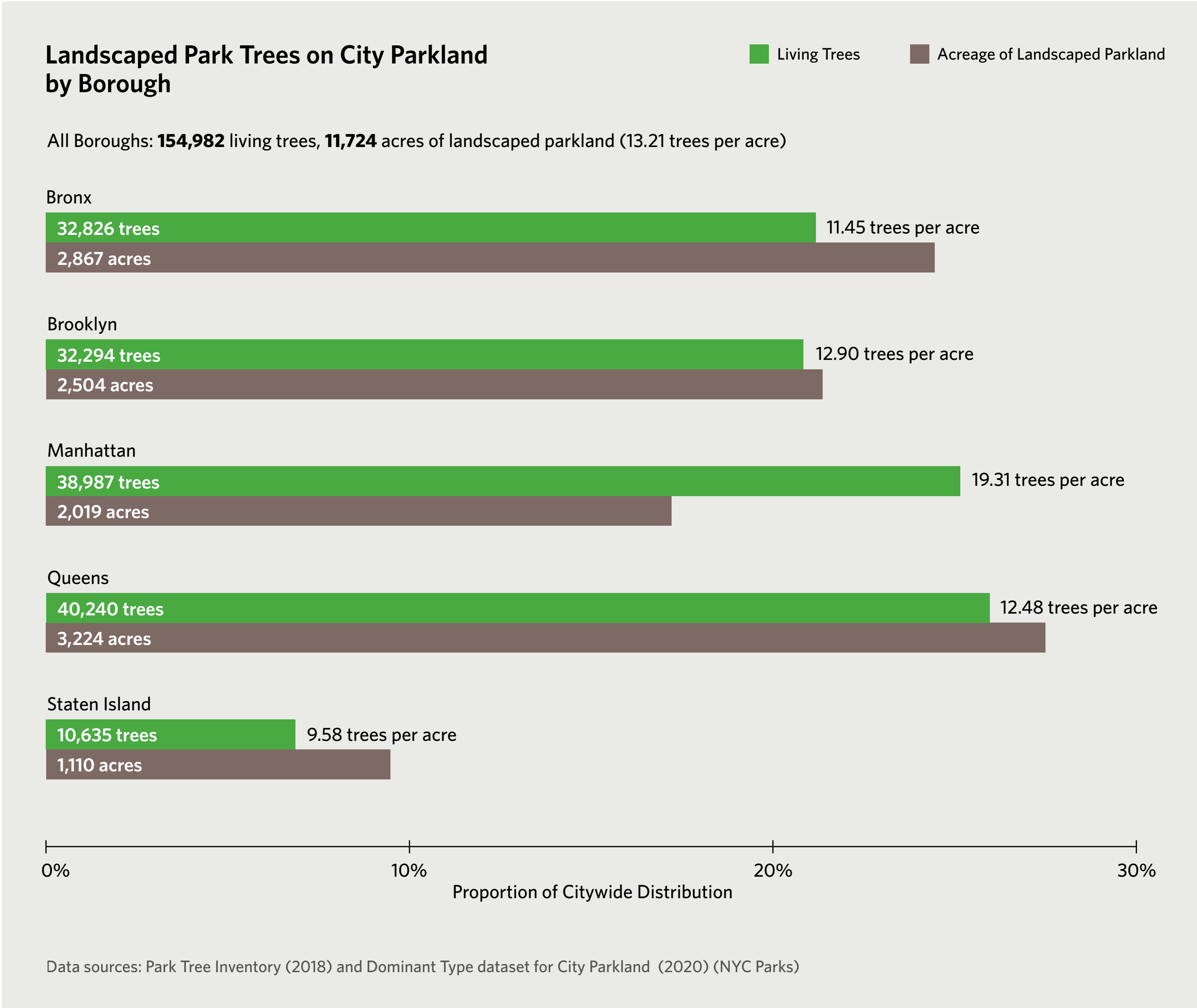


Figure 2.15 Number and density of living trees in landscaped portions of City Parkland as of the Park Tree Inventory (2017–2018), and total area of these spaces, by borough.

Landscaped Park Tree Species Composition

The Park Tree Inventory revealed 291 kinds of landscaped park trees (identified to genus, species, or cultivar) in NYC. The most common was the London planetree (18,139 living individuals, 11.7% of the total), followed by the pin oak (14,990 trees, 9.67% of the total) and honey locust (6,922 trees, 4.47% of the total) (**Figure 2.16**). Though many of the most common landscaped park trees are also among the most common street trees, American elm, sweetgum, and apple were common landscaped park trees but not common street trees. Compared with street trees, London planetrees were not as dominant in landscaped parks, and the total number was distributed across more different kinds of trees. The most common kind varied by borough but was always either the London planetree or pin oak.

Landscaped Park Tree Size

The average DBH of landscaped park trees in City Parkland, citywide, was 14.39", and this was fairly consistent across the

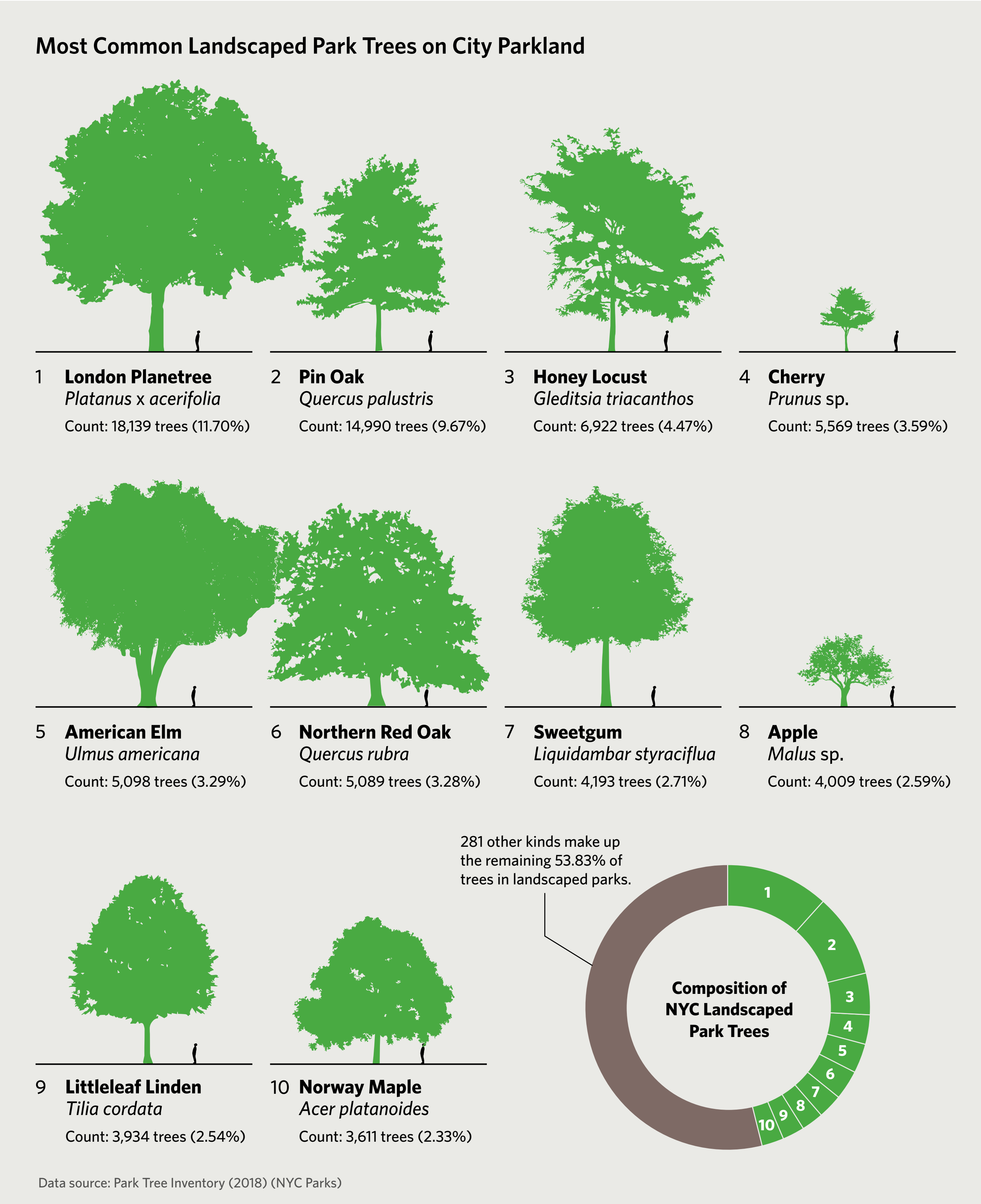


Figure 2.16 The top 10 most common trees in landscaped portions of City Parkland. Together, they represent 46.17% of all landscaped park trees in NYC. Trees are shown to scale, based on average heights according to the Missouri Botanical Garden Plant Finder, alongside a 6-foot-tall person.

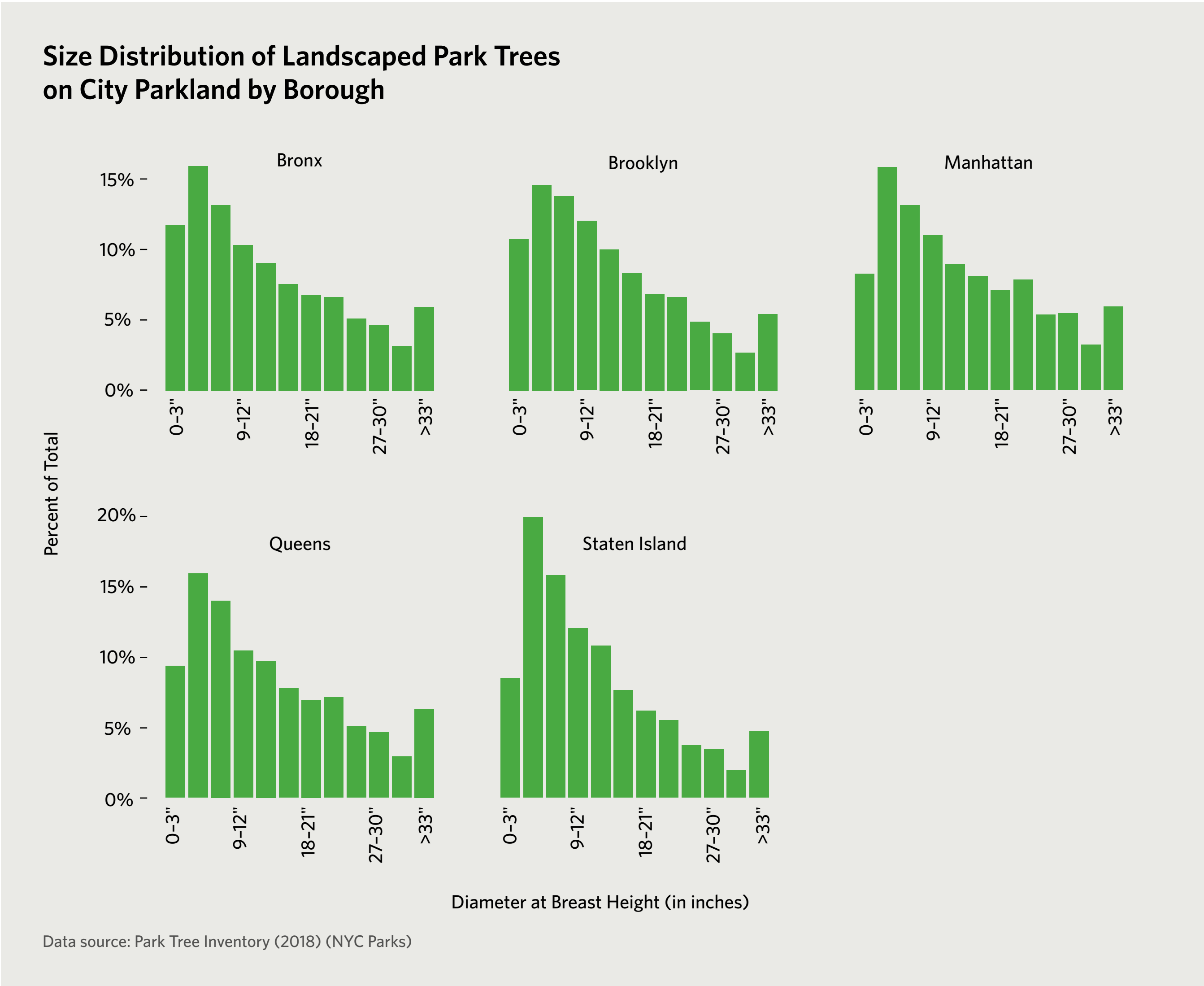


Figure 2.17 Histograms of diameter at breast height (DBH) for trees in landscaped portions of City Parkland as of the Park Tree Inventory (2017–2018). Bins represent 3-inch increments, except for the the right-most, representing all trees with a DBH greater than 33 inches. DBH values recorded as 0 were considered unreliable and were omitted for these figures.

boroughs.* The trees in Staten Island had the smallest average DBH, 13.01", and those in Manhattan had the largest, 15.08".

As with street trees, landscaped park trees showed a fairly healthy size and age distribution across all boroughs, with substantially more trees belonging to smaller size classes than larger ones (**Figure 2.17**). The smallest size class considered (0–3") appears to contain fewer trees than the next larger class, which may indicate a need to increase new plantings.† The lower density of landscaped park trees in some boroughs could, to some extent, be compensated for by larger trees that offer more canopy and greater per-tree benefits, but this phenomenon does not appear to be present.

* Numbers are approximate. The dataset contained a number of trees with DBH recorded as 0, and two trees in Central Park had unrealistically large DBH values of 415″ and 625″. These were removed from consideration.

† Newly planted trees in landscaped areas of City Parkland typically have a diameter of 2.5–3.5″ at 6″ above the ground. We do not have an estimate of diameter at breast height for these trees.

Birch trees along a trail at the Jamaica Bay Wildlife Refuge in Queens, part of Gateway National Recreation Area. Forested natural areas can be biodiverse and are estimated to contain the majority of trees in NYC.

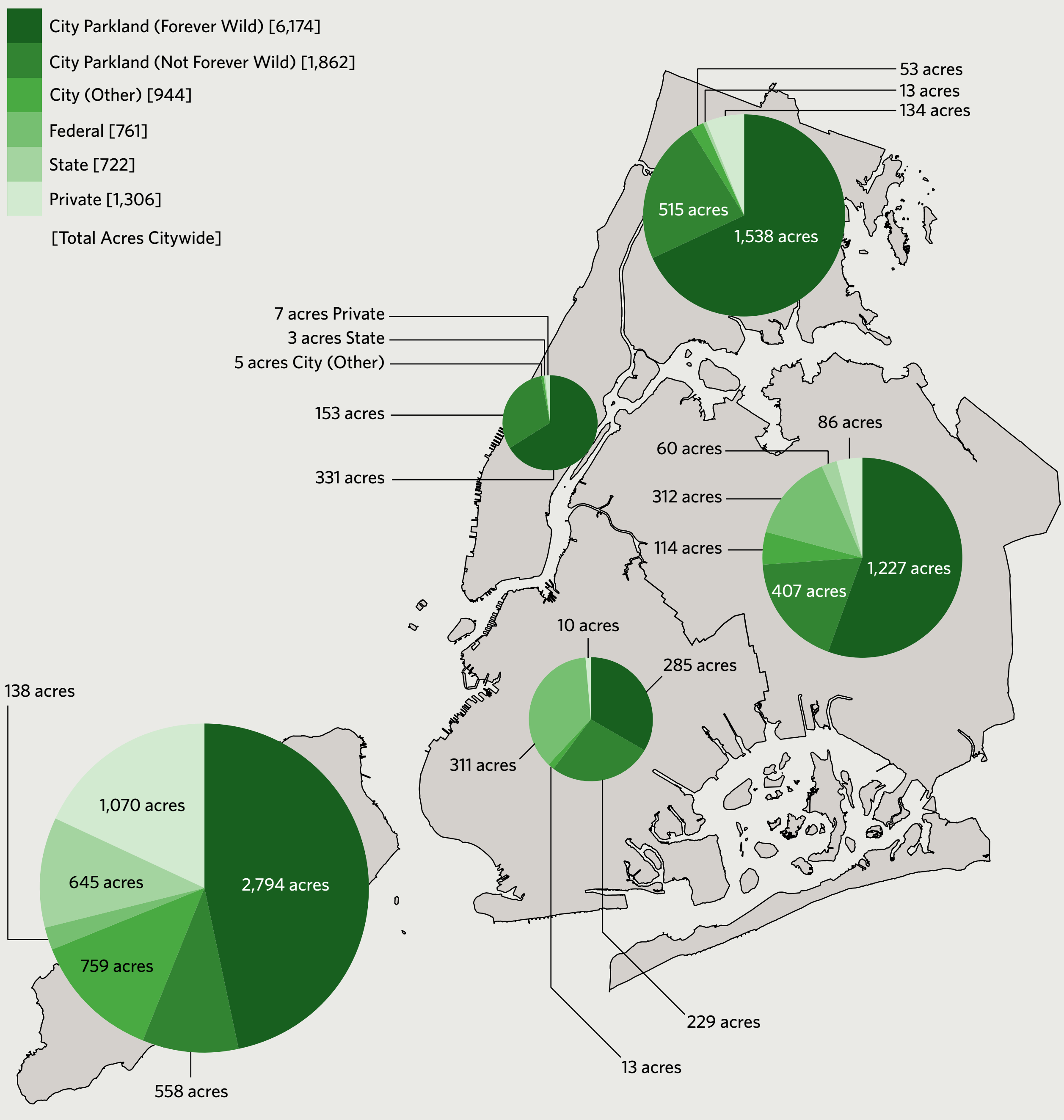
Status of Forested Natural Areas

Forested natural areas are a subset of the urban forest that is distinct from street trees, landscaped park trees, and other trees in more manicured landscapes in terms of biodiversity, size, composition, and management.[34] These rich and complex ecosystems covered approximately 6.09% of land area in NYC in 2017 (see methods in Appendix 1), and they are estimated to account for the majority of individual tree stems in NYC.[35] Forested natural areas have largely existed historically or self-established through regeneration, reclaiming portions of the landscape that had been farmed, built, or otherwise cleared (C. Pregitzer, personal communication). While forested natural areas are largely sustained through regeneration of vegetation, many of them also receive active management to maintain their long-term ecological health (detailed further in Chapter 7). Most forested natural areas specifically fall within City Parkland, though sizeable portions are found within Federal and State parks as well (**Figure 2.18**). Furthermore, within City Parkland, 6,174 acres of forested natural areas are within areas designated as Forever Wild lands, which are specifically managed to retain their ecological value.[36]

Natural areas in City Parkland were delineated based on NYC Parks' Dominant Type dataset; natural areas in other jurisdictions were delineated based on the Ecological Covertype Map (ECM) Level 2 dataset.[37] Forested portions of both were calculated based on the most recent tree canopy dataset (2017).

The ECM classified land in NYC into ecological types based on LiDAR and other data.[37] It delineated natural areas covering 23,932 acres of land in NYC across all jurisdictions, 10,539 acres of which were forested with a canopy at least eight feet high in 2010 (the ECM data have not been updated to reflect 2017 values). These areas were dominated by coastal

Forested Natural Areas by Jurisdiction and Borough, 2017



Data sources: Forested natural area information was derived from Dominant Type dataset for City Parkland, 2020 (NYC Parks), NYC Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications), and the Ecological Covertype Map (O'Neil-Dunne J, MacFaden S, Forgione H, Lu J. Urban ecological land-cover mapping for New York City. Final Report Spatial Informatics Group, University of Vermont, Natural Areas Conservancy, NYC Department of Parks and Recreation. 2014.) Jurisdictional data were based on MapPLUTO 20v6 (NYC Department of CIty Planning) and agency or entity-specific datasets.

Figure 2.18 Pie charts illustrating the area of forested natural areas across the five boroughs within different jurisdictions. The area of pie charts is scaled to area of forested natural areas by borough.

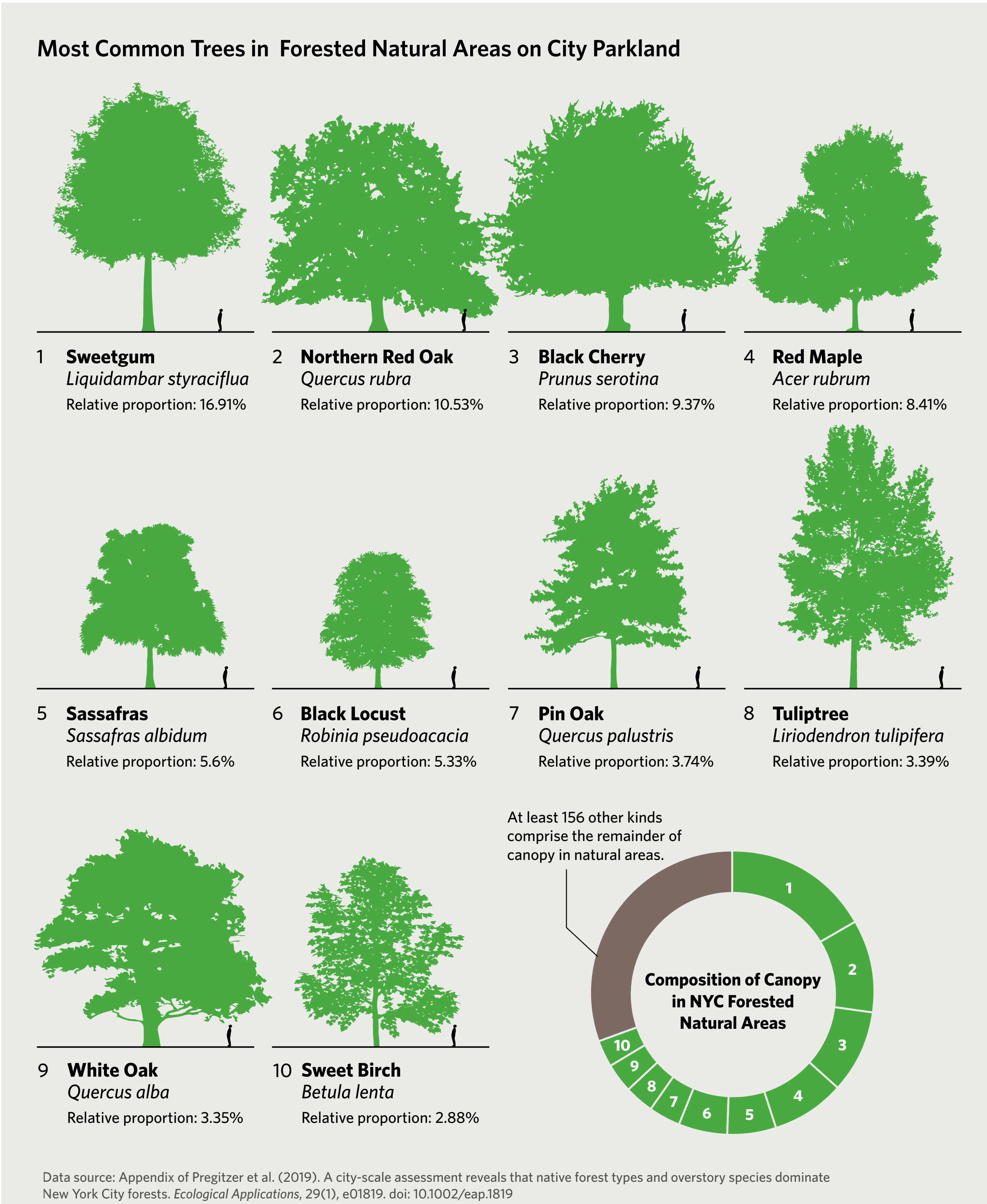


Figure 2.19 The top 10 most common trees in forested natural areas within City Parkland, based on data from the Ecological Assessment, carried out for areas considered as Forever Wild by NYC Parks. Assessment of most common trees was based on relative contribution to canopy in these areas. Trees are shown to scale, based on average heights according to the Missouri Botanical Garden Plant Finder alongside a 6-foot-tall person.

oak–hickory forest (37% of forested natural areas), oak–tulip forest (23%), and northern and central hardwood and conifer ruderal forest (23%). The ECM allows characterization of the entire NYC landscape with fine ecological detail and has informed local forest restoration efforts.[13]

The Ecological Assessment (EA) developed by the NAC and NYC Parks complements the ECM, providing insight into the ecological health of these systems based on data from 1,124 separate 3,380ft^2 (314m^2) plots across NYC Parks' Forever Wild areas. While this assessment did not capture natural areas within other jurisdictions, the lands it did characterize account for over half of the city's forested natural areas delineated in the ECM. Summaries of key results are presented here, and additional details are available in a suite of published papers[11,13,35] and in the *Forest Management Framework for New York City*.[15]

The EA indicated that forested natural areas are composed primarily of native species, both overall and in terms of contribution to canopy. Only one of the top 10 species in terms of proportion of canopy (**Figure 2.19**) is considered invasive, the black locust.

However, the portion of native species decreases from the overstory (82%) to the midstory (75%) to the understory (53%).[11] In the understory, most vegetation was native, but half of the 10 most common species were non-native. Many non-native taxa that were documented are problematic invasive species that are on the NYS invasive species list, including mugwort, multiflora rose, and Japanese honeysuckle.[38] The non-native species in the understory and midstory pose a long-term threat to the native-dominated overstory.[11,15]

Pregitzer et al.[35] estimated based on the EA data that forested natural areas alone are composed of 6,070,000 (± 146,581) individual living trees. Thus, while forested natural areas comprise a small portion of all NYC land area, they contained 27.61% of the total canopy in NYC in 2017, and they are estimated to contain the majority of the trees in the city.[35] In addition to serving as the foundation for robust characterizations of forested natural areas, the EA has also enabled planning. In particular, the data supported development of a holistic management plan for forested natural areas, the *Forest Management Framework for New York City*,[15] further discussed in Chapters 6 and 7.

Summary of the NYC Urban Forest as a Whole

This chapter has described the NYC urban forest in terms of canopy and canopy change, and for major site types as data allow (e.g., street trees, landscaped portions of City Parkland, forested natural areas). It is challenging to characterize the resource more holistically because ownership and management of lands and the trees within them vary so much, and because limited, if any, data are available for most spaces. The USDA Forest Service has helped to fill gaps by collecting and analyzing field data throughout NYC.[21,39] We leverage the most recent body of work (Nowak et al.[21]), which involved analysis of data collected in 2013 from 296 plots across the five boroughs, to complement previous content. Plots were distributed proportionally by borough area, but not by site type—thus, this work may not be able to fully characterize individual site types. For example, 40 plots fell within City Parkland, and only 11 of those were in forested natural areas. Thus, those specific systems are more thoroughly and accurately captured by the Park Tree Inventory and the EA, respectively.

The work by Nowak et al.[21] is the only recent study to estimate the total number of trees in NYC: 6,977,000 trees (95% confidence interval:* 5,263,960 to 8,690,040). However, based on much higher sampling intensity associated with the EA, Pregitzer et al.[35] estimated that there are 6,070,000 trees within forested natural areas (delineated in the ECM) alone. A complete street tree census and an inventory of trees in landscaped portions of City Parkland together counted almost 800,000 trees. Acknowledging that trees on other public and private lands accounted for a substantial portion of the canopy, we see the estimate developed by Nowak et al.[21] to likely be a minimum. The true number of trees in NYC may be closer to or even beyond the high end of their confidence interval.

Nowak et al.[21] reported 138 kinds of trees in the city. While this is similar to the number documented in the most recent street tree census (132 kinds), the Park Tree Inventory and the EA both documented substantially more (291 and 167 kinds, respectively). Different site types undoubtedly vary in tree diversity, and additional sampling across site types can yield a more accurate picture. In their samples, Nowak et al.[21] found that invasive species comprised a substantial portion of the trees, with Norway maples and tree of heaven both representing over 5% of the total. While Norway maples and some other common street tree species are non-native, the

* Calculated based on the standard error of the estimate provided by Nowak et al.:[21] 874,000.

Tree canopy overhead in front of a row of brick apartment buildings in Sunnyside, Queens.

prevalence of non-native species reported by Nowak et al.[21] may not be representative of all forest types. For example, the EA documented that while under- and midstory trees in forested natural areas contained more non-native species than overstory trees, forested natural areas overall were dominated by native species.[11]

Although the different studies and datasets we have examined leveraged different sampling methodologies and intensities, they consistently indicate that the size and age structure of the urban forest is generally healthy. Our illustrations of size distribution for street and landscaped park trees, and work by Nowak et al.[21] both showed many more smaller trees contributing to the urban forest than older ones, which will allow for continued canopy growth. Similarly, the EA documented high densities of under- and midstory trees in forested natural areas.[11] This age structure, coupled with high diversity of species, can promote resilience of the resource, although invasive species can pose challenges. The USDA Forest Service, as part of the Urban Forest Inventory and Analysis program, is tracking these and other types of data through time.

Nowak et al.[21] presented general management considerations related to the NYC urban forest, with a focus on pests and pathogens that pose substantial threats. They detailed 31 exotic insects and tree diseases that have been assessed for their potential impact on the resource. In descending order, *Lymantria dispar*,[*] oak wilt, large aspen tortrix, and laurel wilt disease pose the most serious threats, based on the number of trees susceptible to infestation, and all but laurel wilt disease were confirmed present in NYC. The Asian longhorned beetle was also listed as a confirmed threat, though NYC was declared free of this pest in 2019. If this pest were to return,

* *Lymantria dispar* is a moth species formerly known as the gypsy moth. The common name has been recognized as derogatory by the Entomological Society of America and is undergoing revision; thus we use the scientific name for this species in the text.

it could have the greatest potential impact in terms of the number of trees lost (1.5 million trees; compensatory value of $1.6 billion). However, the compensatory value of trees that could be lost to *Lymantria dispar* was greater, due to the particular species that would likely be lost (1.4 million trees; compensatory value of $2.3 billion). Two other noteworthy pests were the southern pine beetle and emerald ash borer, which could cause losses of up to 163,000 trees (compensatory value of $246 million) and 40,000 trees (compensatory value of $99 million), respectively. A new and emerging threat in NYC is the spotted lanternfly, an invasive pest that preferentially feeds on the invasive tree of heaven but will also infest myriad other species, including native taxa.

Though Nowak et al.[21] did not discuss other threats in depth, their results in concert with other work indicate that there are broader challenges to trees besides pests. For example, as previously noted, some areas have high densities of trees that are susceptible to certain threats, such as London planetrees near Jamaica Bay that were impacted heavily by Superstorm Sandy.[19]

Summary

A rich set of data is available on the NYC urban forest, including high-resolution land cover data, rigorous sampling of natural areas, and complete censuses for street trees and trees in landscaped portions of City Parkland. There are various data gaps, however, including a relative paucity of information about trees that are not within NYC Parks' jurisdiction, general tree health, and susceptibility of the urban forest to various threats. Even when such data are collected, they are often retained by the campuses, cemeteries, and botanical gardens that conduct respective tree inventories; there is no centralized database for tree-related inventories, research, and management that spans all site types across NYC. While the data we do have on canopy, stem count, species, and size are substantive, we need broader, deeper, and more frequent characterizations of the resource to support early detection and management of challenges.

While the urban forest of NYC faces myriad challenges, available data and recent research show positive signs. For example, canopy has increased across site types and most geographies due to a mix of new tree plantings and continued growth of existing trees. The NYC urban forest generally has a relatively healthy age structure and is dominated by smaller trees that can replace older ones and grow to fill canopy through time. However, the urban forest is unevenly distributed, with some areas having higher canopy cover, stocking rates of street trees, and densities of landscaped park trees than others. Furthermore, the urban forest in different parts of NYC faces different threats. For example, thousands of trees were impacted by Superstorm Sandy; similar storms and sea-level rise will continue to pose challenges across coastal areas of NYC as we experience the impacts of climate change. Myriad forest pests and pathogens also have the potential to harm the urban forest.

Stem count, canopy, and size distribution are informative metrics for the urban forest, but land managers need data on additional measures to best manage the resource. Forested natural areas, in particular, are valuable ecosystems that support a diversity of native flora and fauna and offer recreational experiences for people. Continued tracking of species composition and natural regeneration in these spaces is important to guide management; work to date has already informed efforts such as the *Forest Management Framework for New York City*. Canopy and stem count may be less relevant in these areas, as what matters is not simply "how much" urban forest there is, but of what it is composed—now and into the future.

In addition to expanding monitoring of the urban forest, there are opportunities to expand the resource itself. The last street tree census showed that there was potential to increase the number of living street trees by about 250,000. We anticipate that there are also spaces across other property types where more trees can be planted, and across all site types, it is critical to replace trees that are felled or removed. Furthermore, there are likely opportunities to apply improved management to further the long-term health, expansion, and resilience of the urban forest in NYC.


3

Benefits

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These leaves are from the honey locust tree (*Gleditsia triacanthos*), which is common in landscaped portions of City Parkland and as a street tree in NYC. The honey locust is a member of the legume or pea plant family, and its flowers are popular with bees.

CHAPTER 3

Benefits

The urban forest of New York City (NYC) provides various ecosystem services, or benefits attributable to nature.[1] Ecosystem services are frequently assessed through economic valuation, which estimates the financial value of the benefits that nature provides.[2] While we present monetized benefits when they are available, they are complex to estimate and in many cases, benefits cannot be monetized.[3] For example, it is difficult to assign an economic value to trees for their roles as living memorials, their provisioning of wildlife habitat, and their capacity to support people's mental health. Thus, we provide economic benefit estimates when possible, and note that they are incomplete due to these complexities (see discussion of economic benefit estimates that we leveraged in Appendix 1).

Benefits provided by nature, including the urban forest (**Figure 3.1**), can generally be categorized as cultural, provisioning, supporting, and regulating services.[1,3] Cultural services include nature serving as a space for recreation, contributing to human well-being, supporting social opportunities, and giving spiritual pleasure. Provisioning services include providing food and pharmaceutical products that people use, and supporting clean drinking water. In addition, nature supports ecosystem processes and functions that enable other services to occur, such as pollination and seed dispersal (supporting services). Finally, regulating services include trees reducing greenhouse gas emissions (regulating climate and air quality), buffering high winds to protect our coastal areas, and purifying water, among many other services. Specific benefits sometimes fall into multiple categories of ecosystem services.

Cultural Benefits

Many city dwellers, including in NYC specifically, value urban forests for the psychosocial benefits they provide.[4–6] Parks and natural areas provide an opportunity for relaxation, a feeling of attachment to place, a sense of refuge, and a chance to experience nature.[4,7,8] The presence of vegetation has been shown to reduce stress (evidenced by lower heart rate, lower blood pressure, and relaxed brain patterns), decrease cognitive fatigue, and improve the attitudes of employees on the job.[5,8,9] Trees can also increase the cohesiveness of communities by fostering stronger connections between neighbors,[5,9,10] and caring for them can contribute to increases in other forms of civic engagement.[11] Though we illustrate some examples of cultural services (**Table 3.1**),[12] myriad examples are further discussed in other literature.[1,13]

Nature in cities also offers a chance for movement and activity. New Yorkers use landscaped parks to relax and do

Cultural Benefits Provided by Nature

Type	Description	Examples
Recreational	Opportunities for rest, refreshment, and recreation	Ecotourism, bird-watching, outdoor sports
Aesthetic	Sensory enjoyment of functioning ecosystems	Proximity of houses to scenery, open space
Science and education	Use of natural areas for scientific and educational enhancement	Field laboratory and reference areas
Spiritual and symbolic	Serving as symbols or emblems of spiritual, historical, or other significance	Use of nature as national symbols, natural landscapes with significant religious values

Adapted from Alleman L, Carrera J, Maxwell EN, Smith EC, Freed A, Kaiser C, et al. (2015). Urban coastal resilience: valuing nature's role. Case study-Howard Beach, Queens. The Nature Conservancy and CH2M Hill Engineering.[12]

Table 3.1 Examples of cultural benefits provided by nature of various forms, including the urban forest.

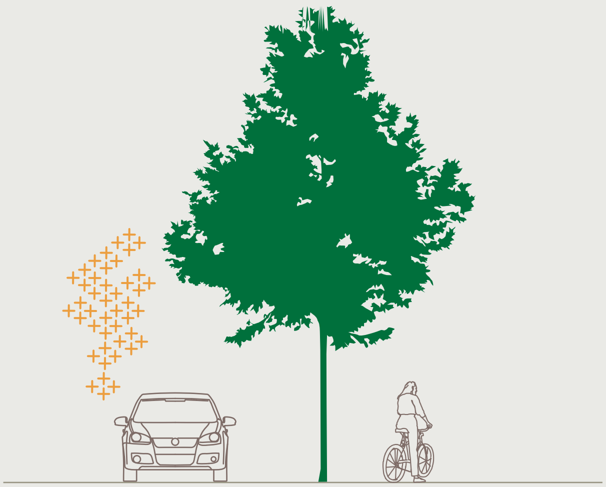
activities with children, play or watch sports, and socialize with others.[8] In an effort to better understand social dimensions and value of public green space in NYC, Campbell et al.[4] found that one-third of park users were socializing in groups, while about one-quarter were participating in sports and recreation activities. Thus, nature can serve as a space that fosters better health and fitness, which is especially important for children and vulnerable populations. The urban forest can support the reduction of childhood obesity rates, since vegetated areas encourage children to spend more time outdoors engaging in physical activity.[14] Adults also benefit from an increase in outdoor exercise. Further, there is evidence of improved pregnancy outcomes (reduced risk of babies being small for gestational age) for women who live in areas with higher canopy cover.[15]

People also place a spiritual and symbolic value on urban forests and trees, often using landscaped spaces as living memorials.[5,6,16] This is true in general, and also well documented for both acute and chronic disturbances and events that affect communities (e.g., see examples in Campbell et al.[17]). In NYC, for example, those who died in the 9/11 terrorist attacks were memorialized in landscape-based memorials that promoted healing and contemplation.[16]

City trees also increase the value of the homes near them. Higher levels of vegetation in urban neighborhoods, including trees and grass cover, are associated with fewer property crimes, improved aesthetics, and reduced noise.[18,19] One study found that single-family homes sold for more money when the property featured landscaped trees.[20] Another study reported that street trees increased home values from 3% to 15%.[21] Additional work found that homes near natural areas were priced 8% to 20% higher than similar properties in other areas.[22] Commercial areas also experienced higher rental rates and increased shopping traffic if they had high-quality landscapes.[22] Finally, trees along roads reduce glare for drivers, beautify roadways, and serve as buffers for air, light, and noise pollution for nearby residents.

In NYC, for analysis of data from the 2015–2016 street tree census, the NYC Department of Parks and Recreation (NYC Parks) applied i-Tree Streets, which employs the methodology of Anderson and Cordell,[20] who used property sale price, the size of trees in the front yard, and tree species to estimate the association between street trees and sales price. Based on this, NYC Parks estimated that the aesthetic value alone of street trees in NYC is $86.37 million annually, an average of $130 per tree.[23]

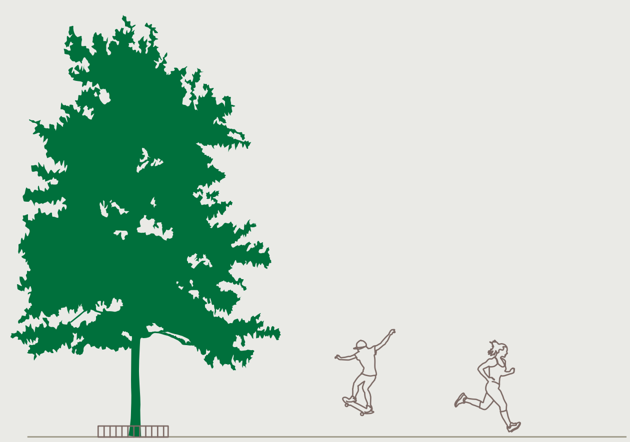
Benefits of the NYC Urban Forest



Removes 1,100 tons of pollutants from the air per year, which improves air quality and leads to fewer emergency room visits, lower rates of chronic diseases, and fewer hospitalizations

Stores 1.2 million tons of carbon and annually sequesters 51,000 tons of carbon (or 187,000 tons of CO_2)

Increases the cohesiveness of communities by fostering stronger connections between neighbors, feelings of attachment to place, and an opportunity to experience nature



Encourages children and adults to spend more time outdoors engaging in physical activity, therefore reducing childhood obesity rates and improving fitness

Figure 3.1 Estimated benefits that the urban forest provides in NYC. Quantitative values are based on research by the USDA Forest Service.

Decreases air temperature by an average of 0.13˚F, therefore cooling city streets and mitigating the urban heat island effect and extreme heat

Reduces stress (as shown by slower heartbeats, lower blood pressure, and relaxed brain patterns) and promotes healing and contemplation

Reduces stormwater runoff by 69 million cubic feet per year, decreases the rate that runoff travels off surfaces (e.g., streets and sidewalks), and stabilizes soil by preventing erosion

Provides habitat and refuge for a variety of wildlife and plant species and enables pollinators, seed dispersers, and other species to move throughout the region

Data source: Nowak et al. (2018). The Urban Forest of New York City. Resource Bulletin NRS-117; 1–82. USDA Forest Service, Northern Research Station

The NYC urban forest supports a variety of animal species, including (clockwise from top left) eastern garter snake (*Thamnophis sirtalis*), raccoon (*Procyon lotor*), blue-headed vireo (*Vireo solitarius*), and spring peeper (*Pseudacris crucifer*).

Provisioning Benefits

Urban forests, like forests in general, can be sources of food and other materials that are useful to people;[24] these benefits are called provisioning services. As the presence of these materials can promote foraging activity, which is a cultural practice, forests that offer provisioning services also support cultural services.[25] Foraging is not permitted in parks within NYC, though a number of their plant species have edible parts[25] and at least one study noted that foraging in NYC could support management of invasive species.[26]

Supporting Benefits

The urban forest provides habitat for a variety of animal, plant, and fungi species year-round, and it enables pollinators, seed dispersers, and others to move throughout the region.[27] Work by New York Botanical Garden estimates that there are 2,029 plant species within the five boroughs, of which 1,359 are native (approximately two-thirds). These plant species provide unique habitats at the intersection of the mid-Atlantic and northeast regions[28] and support myriad services, such as regulating air quality, supporting pollination, and providing places to relax and recreate.

The NYC urban forest itself includes a diversity of native plants, which provide numerous benefits, such as preventing erosion and providing forage for wildlife. Examples of this diversity include taxa that are ranked critically endangered worldwide, such as four species of

Work by New York Botanical Garden estimates that there are 2,029 plant species within the five NYC boroughs, of which 1,359 are native...

ash trees, American chestnut trees, and at least historically, Bayard's adder's-mouth orchids. The different species and their varied phenology support the ecosystem in various ways throughout the year.[28]

The urban forest of NYC also supports numerous animal species, including reptiles, amphibians, and invertebrates. Though local flora and fauna are generally well characterized, new species are still being described, such as the dwarf centipede that was first discovered in Central Park in 2002. Many of the 230 species of bees that occur in NYC are associated with the urban forest; bees and many other insects also provide ecosystem services themselves, such as pollinating plants across the landscape. One species, the Gotham bee, was only first described in 2012, based on a specimen from Brooklyn Botanic Garden.[29]

Birds are one of the more visible forms of wildlife, often serving as a local spectacle for passersby. Red-tailed hawks and peregrine falcons are among many species that are present in even densely built Manhattan. NYC supports birds that reside year-round, birds that only spend their nesting season in the city, and birds that stop over during spring and fall migration (as the city lies in the Atlantic Flyway).[29] Birds attract many nature lovers, and the sheer number of species that can be found in NYC at various times of year is impressive. Over 332 species of birds have been sighted in the past 25 years,[30] and about 210 species can be found in Central Park.[31]

The value of wildlife habitat in NYC is difficult to estimate.[3] One approach is to consider the economic value associated with related recreational activities (which are cultural services). The National Survey of Fishing, Hunting, and Wildlife-Associated Recreation indicates that the value can be substantial—in 2011, about 4.2 million people watched wildlife in New York State (NYS), spending about $4.2 billion in related expenses (e.g., equipment and travel).[32] Most expenses were associated with activities that were "close to home," and approximately 72% of respondents indicated that they lived in a large city with at least one million residents, like NYC. Thus, we infer that the NYC-specific share of expenditures was about $3 billion per year. Bird-watching was reported as a particularly common activity.[32] Bird-watching and similar outdoor activities may occur in various ecosystems (not just forests), but the urban forest provides key habitats for many species of interest. Furthermore, by serving as a location for these activities, the urban forest is also providing cultural services.

Regulating Benefits

Removal of Pollutants and Greenhouse Gases

Like all plants, trees absorb gaseous and particulate pollutants, removing these compounds from the surrounding air. The amount absorbed depends on the species and its characteristics, such as number of leaves, leaf attributes, tree biomass, tree height, and diameter of the trunk. However, when the tree decays or when it is cut down, some of the matter it has absorbed is released back into the atmosphere.

Carbon Storage and Sequestration

Carbon dioxide is the main greenhouse gas that is absorbed by trees during the process of photosynthesis. Nowak et al.[33] estimated carbon storage and carbon sequestration of NYC trees. Carbon storage refers to the amount of carbon in trees that will be released if the trees die and decompose, while carbon sequestration is the process by which trees store carbon from the atmosphere in their biomass. Nowak et al.[33] found that gross annual carbon sequestration was approximately 51,000 tons of carbon (or 186,000 tons of CO_2 per year), and carbon storage from the NYC urban forest added up to 1.2 million tons. Trees and soils within natural areas are responsible for a substantial portion of this carbon storage and sequestration.[34]

Vehicles on the Brooklyn-Queens Expressway in Brooklyn.

BOX 3.1

How Much Carbon Does the NYC Urban Forest Capture?

To better understand the greenhouse gas emissions captured by the NYC urban forest, we considered data for greenhouse gas emissions from passenger vehicles in NYC in 2017* and the carbon sequestration potential of NYC trees from Nowak et al.[33] Passenger vehicles emitted approximately 12.45 million tons of CO_2-equivalent emissions in NYC in 2017, and the urban forest captures approximately 186,000 tons CO_2/year. Therefore, the NYC urban forest can capture approximately 1.5% of emissions from the passenger cars in the city each year, assuming the 2017 emissions level. Although this is a small percentage of the total current emissions, it still marks the urban forest's potential to reduce the net greenhouse gas emissions in NYC, while providing myriad other benefits.

* Estimated greenhouse gas emissions from passenger vehicles were sourced from an interactive tool, the Inventory of New York City Greenhouse Gas Emissions, available at https://nyc-ghg-inventory.cusp.nyu.edu/.

Air Quality and Associated Human Health

The urban forest improves air quality by removing pollutants from the air, beyond greenhouse gases. Pollutants settle on the leaves of a tree and are absorbed through the stomata, or pores. Trees affect the concentration of pollutants and other aspects of air quality in several ways:

- They absorb particulate matter and gaseous pollutants.
- They cause changes in air circulation because they block the wind or generate fluctuations in wind direction that can reduce or increase air pollution, depending on the local landscape and context.[35]
- They emit biogenic volatile organic compounds, which are non-methane hydrocarbons produced by plants. These compounds contribute to ground-level ozone formation, which can ultimately impact people's respiratory health.
- They produce pollen, which can have negative effects for people who have allergies to the pollen of those particular kinds of trees.[36,37]

The New York City Community Air Survey has tracked street-level air pollution at about 100 locations throughout the city every season since 2008. The pollutants measured can impact human health year-round and include the following:[38]

- Fine particulate matter ($PM_{2.5}$) is produced by fuel combustion, particularly in intense vehicular traffic and power plants. It is the air pollutant that causes the most harm to people's health, increasing the incidence of lung and heart diseases and cancer.
- Nitrogen oxides (NO_X), including nitrogen dioxide (NO_2) and nitric oxide (NO), are produced by the combustion of fuels such as oil, diesel, gas, and organic matter. They cause respiratory conditions and increase the response to allergens, worsening asthma. NO_X contributes to acid rain and, together with ozone, is responsible for smog.
- Ozone (O_3), the main ingredient in smog, is created by the combination of sunlight, NO_X, and volatile organic compounds. It is most concentrated during the summer months, in areas away from the emissions sources. Ozone causes health effects similar to those caused by $PM_{2.5}$, such as chest pain, coughing, throat irritation, and airway inflammation. It worsens bronchitis, emphysema, and asthma.

The urban forest of NYC was estimated to reduce air pollution by 735 tons of O_3, 242 tons of NO_2, 88 tons of SO_2, and 41 tons of $PM_{2.5}$ annually: 1,106 tons of pollutants in total.

- Black carbon is a product of the incomplete combustion of biomass and fossil fuels and, as suggested by its name, looks like a black, sooty material. It can negatively affect respiratory and cardiovascular health and contributes to global warming.
- Sulfur dioxide (SO_2) contributes to acid rain and can cause respiratory conditions such as asthma. It is produced by burning fossil fuels (coal and oil) and smelting mineral ores (aluminum, copper, zinc, lead, and iron) that contain sulfur.

As highlighted by the PEAK Coalition, an alliance formed to end the pollution burden from power plants on the most climate vulnerable people in NYC, fossil fuel-burning power-plants operated during periods of high electricity demand pose a particular challenge in parts of the city, as notable sources of particulate matter, sulfur dioxide, and nitrogen oxides.[39] There are 16 of these plants, known as peaker plants, in operation. They date from as early as the 1950s, and some are located in or near vulnerable communities that have relatively low tree canopy, such as in Hunts Point and Mott Haven in the South Bronx. The lower level of tree canopy in these areas means that there are fewer trees to absorb air pollution (see Chapters 2 and 4 for discussion of canopy distribution and equity in NYC).

Air pollution in NYC has generally declined in recent years, with a 29% decrease in the total NO_X and a 32% decrease in total $PM_{2.5}$ documented between 2009 and 2018.[38] These declines may be associated with multiple factors, such as City and State regulations prohibiting use of heavy fuel oil, and a broader transition toward cleaner burning fuels. The urban forest also plays a role, and as of 2010 was estimated to reduce air pollution by 735 tons of O_3, 242 tons of NO_2, 88 tons of SO_2, and 41 tons of $PM_{2.5}$ annually: 1,106 tons of pollutants in total.[33]

While there are nuances in the relationship between the urban forest and air quality,[35,40] trees are generally understood to improve local air quality and contribute to improved health outcomes (see discussion of these benefits in Nowak et al.[33]). To estimate public health benefits associated with air pollution reductions by the urban forest, researchers calculate the costs of respiratory illness that would have occurred if trees had not reduced the concentration of air pollutants. In other words, the value of trees for people's health is based on the number of cases per year of avoided health impacts due to the trees' reduction in pollution. The urban forest helps avoid nearly 16,700 health events, translating to about $77.9 million in benefits per year.[33] These benefits are not equal throughout NYC, as canopy cover, pollution, and the socioeconomic characteristics of communities vary across the landscape. Pollutant removal was estimated to be highest in the Community Districts of southern Staten Island and eastern Queens, and it was generally lowest in Midtown and Downtown Manhattan and the South Bronx.[33]

Asthma rates are highest among people of color and more prevalent in the Bronx than in other boroughs.[41,42] While street trees remove an estimated 59 tons of air pollution per year in the Bronx overall,[23] the South Bronx, in particular, has relatively low canopy cover, and it has poorer air quality due to local emissions from fossil fuel–burning power plants, sludge processing plants, waste disposal industries, and highways with truck routes.[38,42] As there are varying levels of development across NYC, addressing challenges such as these can require creative and different uses of space to increase tree planting.

The aforementioned estimates of benefits that the urban forest provides related to air quality are based on models that do not account for air dispersion, pollen production, and contribution to O_3 production; thus there is uncertainty in the estimates.[36,43] Further, deciduous trees, which lose their leaves in the winter, do not significantly reduce pollution during this season, the same time of year when air pollution might increase due to the use of fossil fuels to heat homes.

Photo by iStock.com/Terraxplorer.

Trees grow in front of an elementary school in Harlem, Manhattan. Planting trees around sites such as schools can bring many benefits, including reduced stress and enhanced physical activity and mental health.

Cooling

An urban heat island is a metropolitan area, like NYC, that exhibits warmer summer air temperatures than the surrounding areas, even at night. This is caused by built surfaces that absorb, retain, and re-radiate heat, and heat emitted by air conditioning equipment, vehicles, and the like. During extreme heat conditions in the summer months, which are increasing in prevalence and extent due to climate change,[44] urban residents are especially vulnerable. Extreme heat can increase heat-related illness, increasing the number of hospital visits, and even cause death.

Trees mitigate the urban heat island effect through the process of evapotranspiration (in which water evaporates from vegetation, resulting in a local cooling effect), by providing shade, and by generally reflecting infrared radiation away from earth's surface (unlike many paved surfaces and buildings). Therefore, the urban forest helps reduce summertime temperatures of major cities. The coolest areas in a city are generally those with the most vegetation (**Figure 3.2**). While individual trees contribute to reduced temperatures, an increase in the total area of vegetation and tree canopy can yield larger and more meaningful effects.[45,46]

A study of canopy cover in the more arid environment of Phoenix, Arizona,[47] found that during the hottest months of summer, the shade provided by urban trees during the day could reduce surface temperature by an average of 50°F. The effect was even greater at night because all day long the trees had blocked heat from being stored in the built environment. This effect of shade alone may be smaller in NYC because it has relatively high humidity compared with Phoenix, but it is likely substantial. In NYC, trees reduce exposure to ultraviolet radiation by 25% to 48% and decrease air temperature by an average 0.13°F.[33] An analysis that used the 2009–2016 NYC Community Air Survey summer temperature data from 3 a.m.

to 5 a.m. showed that the presence and quantity of vegetation explained lower nighttime temperatures.[46]

There is evidence that lower temperatures indoors, which can ultimately be supported by the urban forest, can benefit learning in schools. A cross-sectional study of American students taking the PSAT, a standardized achievement test,[48] demonstrated that extreme heat (temperatures of 90°F or more) contributed to a reduction in achievement, albeit to a small degree (one-sixth of a percent). Over the course of a school year, a 1°F increase in average outdoor temperature reduces student learning by 1%.[48] The authors noted that future global climate change scenarios indicate a likely increase in average temperatures of 5°F; sustained increases in temperature of only 3.6°F are estimated to reduce schoolchildren's achievement.[48] Though comparable analyses of student performance and temperature have not been conducted in NYC, students can similarly face warm conditions. Further, climate change is predicted to increase temperatures, with a predicted range of 25 to 75 days per year (10th to 90th percentile projections) above 90°F by 2080, compared with a baseline of about 10 days above this temperature per year in the recent past.[44]

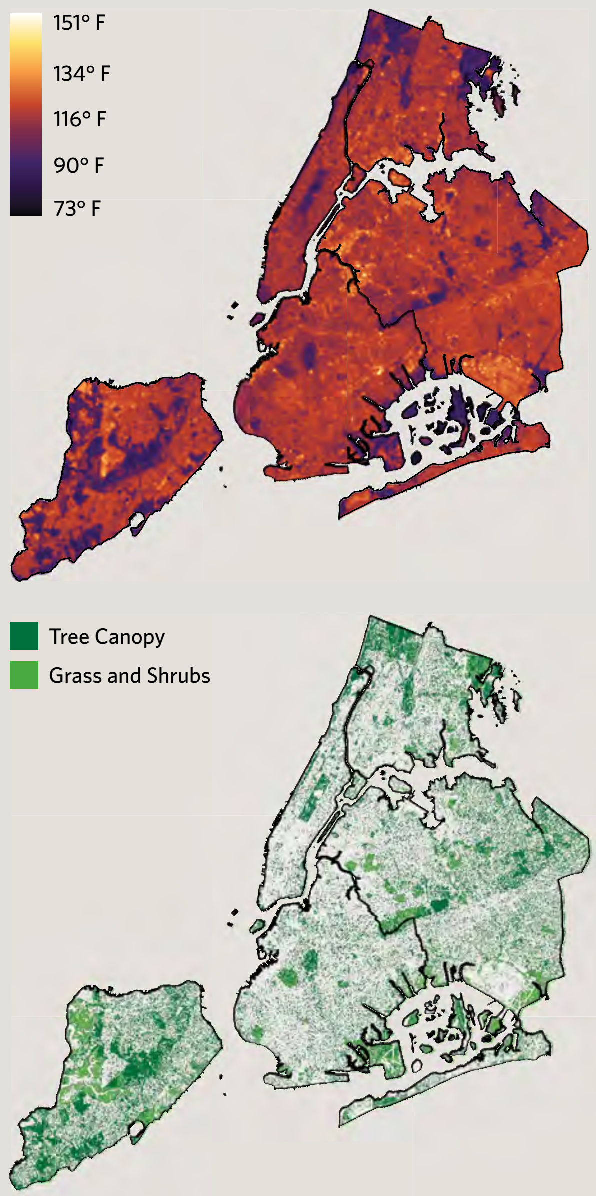
The shading effect of trees also reduces energy costs by reducing the amount of energy required to cool buildings, especially during the summer months. In NYC, trees reduce annual energy costs for residential buildings by an estimated $17.1 million for heating and cooling; the majority of this energy reduction occurs for cooling during the summer months and corresponds to approximately 64,900 MWh.[33] Additional cooling by the urban forest, in conjunction with more efficient air conditioning systems, may ultimately help reduce peak demand, which would reduce the need for highly polluting peaker plants.

Heat Vulnerability Index

The New York City Department of Health and Mental Hygiene tracks the health impacts of heat at the levels of Community Districts and Neighborhood Tabulation Areas by calculating the heat vulnerability index (HVI). The HVI uses social and environmental factors to calculate the statistical risk of heat-related illness or death across NYC neighborhoods. Some of the factors used to calculate the HVI are daytime surface temperature, percentage of green space, people living below the Federal poverty level, percentage of non-Latinx Black residents, and percentage of households that have air conditioning.[49]

All neighborhoods in NYC contain at least some residents who are at high risk for heat-related illness or death, but

Surface Temperature and Vegetation Across NYC



Data sources: Temperature Data: Provisional Surface Temperature from Landsat 8, July 6, 2020 (U.S. Geological Survey); Vegetation Data: 2017 Land cover raster dataset (NYC Department of Information Technology and Telecommunications)

Figure 3.2 Estimates of surface temperature across the landscape of NYC based on satellite imagery (top), and vegetated landcover based on high-resolution landcover data (bottom). In general, areas with more vegetation tend to have lower temperatures.

Rain garden on Columbus Street in Manhattan. Green infrastructure such as this absorbs stormwater, reducing runoff and combined sewer overflow events that can carry pollutants into New York Harbor.

those with a higher HVI have a larger proportion of residents at risk. As discussed in Chapter 4, there is a notable concentration of high-HVI neighborhoods in the South Bronx. This area also faces relatively high levels of air pollutants such as black carbon and fine particulate matter, associated with highways, industrial activities, and buildings burning fossil fuel for heating.[38] These factors can be compounding, with each issue exacerbating the others. While the urban forest can help reduce local air temperatures and mitigate air pollution, canopy is relatively low in the areas that face these challenges.

Stormwater

Stormwater runoff can carry pollutants into local ecosystems and overwhelm wastewater treatment infrastructure. In older cities like New York, heavy rainfall events can even lead to the discharge of untreated sewage into local waterways.* The urban forest mitigates these challenges in multiple ways: the tree canopy can intercept precipitation before it reaches the ground; soil associated with trees allows infiltration of water into the ground; and trees soak up water through their roots, using some of it in photosynthesis and releasing the remainder back into the atmosphere. The capacity of the urban forest to help manage stormwater can vary according to size and shape of trees (influencing interception), and soil conditions (influencing the potential for infiltration).

In general, urban forests have been shown to intercept as much as 66.5% of rainfall.[50] For NYC specifically, Nowak et al.[33] estimated that this resource reduces runoff by approximately 69 million cubic feet a year based on analyses with i-Tree Eco. They found that London planetree and Norway maple together had some of the greatest species-specific contributions, each reducing runoff by over seven million cubic feet per year, or in sum, about 20% of the total runoff reduction associated with the urban forest.

Potential Costs and Disservices

It is important to note that trees in urban areas require resources and can have unintended negative consequences.[51] Trees need water, especially during periods of drought;[9] in particular, young trees may require supplemental watering during dry periods and may die without it, necessitating their removal or replacement. Trees release pollen, affecting people with seasonal allergy conditions and worsening conditions for those with asthma.[37,40] The NYC urban forest also emits up to 804 tons per year of biogenic volatile organic compounds,[33] which are harmful to human health. Some researchers have found that the release of pollen and biogenic volatile organic compounds have significant health effects.[36]

In addition, the urban forest imposes liability and its associated costs on the City. While there is evidence that trees can promote traffic calming and reduced accidents,[52] they can pose potential risks due to falling limbs, slippery leaves, and increased risk of collisions if wrongly located or ill-maintained such that they impair a driver's line of sight.[53] Infrastructure repair and handling of trip-and-fall claims associated with trees can be expensive.

Trees also require maintenance, including inspection, pruning, and removal and disposal of dead trees. NYC Parks carries out inspection and pruning for the trees within their jurisdiction, but additional care, such as watering and mulching, is generally up to residents or businesses. Planting of trees also requires time, effort, and money, all of which vary with factors such as planting site, tree species, and size (discussion of costs for tree planting in Chapter 6).

Summary

The urban forest of NYC provides residents with places to recreate, exercise, foster stronger connections with nature, remember or honor loved ones, nurture mental health and spiritual healing, and more. It is also a refuge for many plant and animal species that inhabit the city year-round or migrate through it. This resource reduces air temperatures in the summer, contributing to energy savings, and it reduces air pollution. The urban forest further contributes to mitigating climate change by absorbing and storing carbon. In addition, trees reduce surface water runoff, making them particularly important in flood-prone and polluted metropolitan areas. Many of these benefits are difficult to quantify and value and they may not be distributed evenly (see Chapter 4), but they are clearly substantial.

* Such occurrences are referred to as combined sewer overflow events and they are associated with stormwater management systems in certain parts of NYC. The NYC Department of Environmental Protection is under a Consent Order agreement with the NYS Department of Environmental Conservation to reduce combined sewer overflow events and improve local harbor water quality.

4

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These leaves are from the sassafras tree (*Sassafras albidum*), a common native species in the understory of forests that is often found in forested natural areas of NYC. The aromatic leaves, bark, and roots have been used in medicines, root beer, and the seasoning filé powder.

CHAPTER 4

Equity and Environmental Justice

Inequities in the urban forest are documented in cities across the United States, including New York City (NYC). This is an environmental justice issue that must be remedied in order for all NYC residents to fully access the benefits urban forests have to offer. We describe current dynamics, as well as potential drivers of inequities that exist today.

Environmental Justice

People of color, Indigenous people, and low-income communities face disproportionate environmental risks that negatively affect their health and that of future generations. The field of environmental justice serves as a frame that connects racism, injustice, and environmentalism.[1–4]

Environmental justice embraces the principle that all people and communities are entitled to equal protection through environmental and public health laws and regulations (see **Box 4.1** for U.S. legal definition).[5,6] It also elevates the right to community self-determination that underscores the interdependence of people and the environment,[7] and takes a broad perspective on the environment that considers jobs, housing, and both cultural and biological diversity.[8]

A deep body of research demonstrates that communities of color and low-income groups bear a disproportionate burden of negative environmental impacts.[3–5,8–11] These environmental burdens are often the results of institutional or political decisions, such as historic housing policy and siting of highways, industrial areas, and hazardous waste facilities, including Superfund sites. For example, vehicles in traffic along major roadways produce air pollution that has been shown to increase respiratory illness, lung cancer, and cardiovascular disease. These areas also tend to have less access to environmental amenities, such as high-quality parks and greenspace. People living along roadways often face compound stressors that can increase their risk of chronic illness and even shorten their lifespans.[12]

Initially, environmental justice focused on the disproportionate exposure of people of color to environmental harms, such as hazardous and toxic waste sites.[1,9–11] More recently, researchers have studied access to environmental goods, assets, and amenities.[12–14] Many researchers have noted that people of color have less access to environmental goods, in addition to disproportionately high exposure to environmental harms.[2,3,15]

The discussion of cumulative impacts (combined, incremental effects of different human activities) is directly relevant to people in environmental justice communities who often face both environmental insults and a lack of environmental amenities. This ties to the urban forest, as its presence or absence may interact with an array of environmental threats or benefits that a given community experiences. One local example of cumulative impacts is highlighted by the NYC Environmental Justice Alliance. Their Waterfront Justice Project illustrated that Significant Maritime and Industrial Areas in NYC, which contain clusters of public infrastructure, including water pollution control plants, waste transfer stations, energy facilities, and heavy manufacturing uses, are generally located in low-income communities and communities of color.[16]

Inequity

Previous Analyses

While there is limited research on environmental justice with regard to the urban forest in NYC, work from other parts of the United States can help set a context for current trends and suggest dynamics to evaluate locally. Previous work has documented inequity by race and income in a number of cities. Multiple studies have documented lower tree cover in lower-income communities.[17] This was the general finding in a meta-analysis of studies by Gerrish and Watkins[18] and in some research on specific cities, such as Tampa, Florida.[19] However, in a comparison of seven cities, Schwarz et al.[20] found that, while median income of residents predicted the tree cover near their homes, the relationship between these variables could be either positive or negative, depending on the city.

The relationship between race, ethnicity, and the urban forest also appears to vary across cities. In a meta-analysis of urban forest equity and race, Watkins and Gerrish[21] documented that relationships varied across racial groups and with city characteristics. For example, they found Black and African American residents generally experienced higher urban forest inequity in cities with less segregation between white and African American residents, and there tended to be less inequity in larger cities. However, inequities varied with different aspects of the studies (e.g., whether Black and African American populations were compared with other specific groups or with the population as a whole). The study found significant evidence of race-based inequity on public land, but that tree cover on private land was positively associated with the proportion of people of color, particularly for Black and African American residents. In a separate study examining seven cities, Schwarz et al.[20] generally did not find negative relationships between the percentage of people of color and urban tree canopy, except in Los Angeles and Sacramento, California.

Studies of individual cities can provide further insight into these dynamics. Duncan et al.[22] found a negative correlation between tree density and the percentage of the non-Hispanic Black residents in neighborhoods of Boston, Massachusetts. This relationship, however, was not significant when accounting for spatial autocorrelation (the phenomenon that things closer together tend to be either very similar or very different from one another). In Washington, D.C., Frey[23] found a significant negative relationship between canopy and racial/ethnic variables (percent Black and percent Hispanic), even after correcting the analysis for spatial effects. Frey[23] also found that street trees were planted in equal proportions across white and Black neighborhoods, although neighborhoods that were predominantly Hispanic had fewer street trees. In Baltimore, Maryland, Grove et al.[3] documented higher canopy cover in African American neighborhoods, which they ultimately connected to the city's history of racial and economic segregation. In many cases, landscape-level dynamics of the urban forest and distribution of different

BOX 4.1

The Legal Definition of Environmental Justice in the United States

Environmental justice is defined by the U.S. Environmental Protection Agency as "The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no population, due to policy or economic disempowerment, is forced to bear a disproportionate share of the negative human health or environmental impacts of pollution or environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local and tribal programs and policies."[6]

BOX 4.2

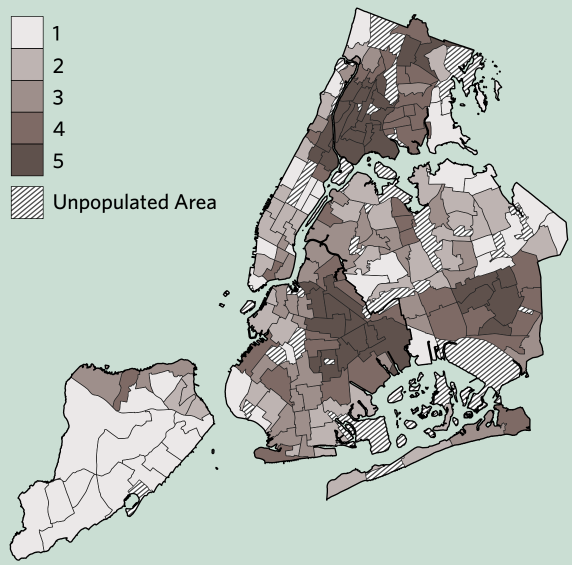
Understanding Heat and Social Vulnerability of Communities

Multiple metrics help characterize how vulnerable people and communities are to various types of perturbations or circumstances. We focus on the Heat Vulnerability Index (HVI), developed by the NYC Department of Health and Mental Hygiene, and the Social Vulnerability Index (SVI), developed by the Centers for Disease Control and Prevention.

The HVI indicates how susceptible people in communities are to adverse health impacts or death due to heat waves. The HVI incorporates information about race and ethnicity, poverty, access to air conditioning, local daytime surface temperatures, and vegetation. These data are combined in a standardized way, and geographies across NYC are ranked 1 through 5, with 1 representing the lowest vulnerability and 5 representing the highest. Some communities are at greater risk than others, but every neighborhood has some residents who are at risk for heat illness and death. These data are available for geographic units of Community Districts and Neighborhood Tabulation Areas (NTAs) for NYC. This report primarily relies on data from 2017, with temperature data from 2018.

The SVI estimates how vulnerable communities are to human suffering and financial loss in the event of disasters. It is designed to support public health officials and planners in identifying and supporting communities that may be at greatest risk in emergency events such as severe weather, floods, disease outbreaks, or chemical exposure. The SVI is calculated on the basis of 15 variables from the U.S. Census American Community Survey. There are four component indices: Socioeconomic Status, Household Composition and Disability, Minority Status and Language, and Housing Type and Transportation, as well as a single holistic index based on these components. The indices are developed at the scale of census tracts, which we have aggregated for purposes of this report, to the scale of NTAs. The latest version of these data, used in the report, are based on 2018 American Community Survey data.

Heat Vulnerability Index



Social Vulnerability Index

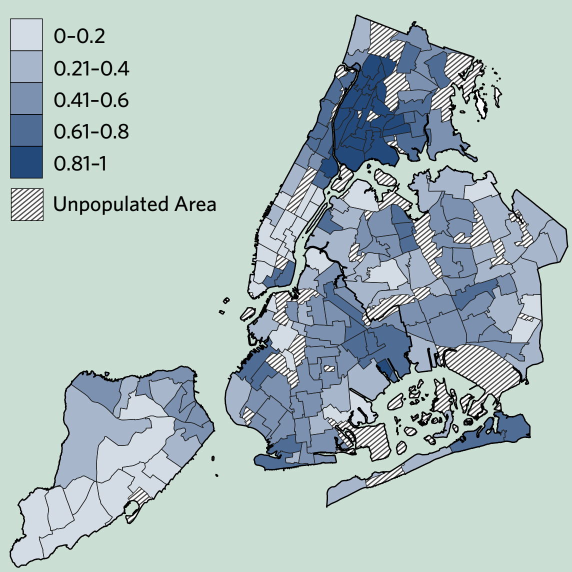


Figure 4.1 Heat Vulnerability Index (top) and Social Vulnerability Index (bottom), both shown at the Neighborhood Tabulation Area scale. Data on Social Vulnerability were aggregated from census tract data from the Centers for Disease Control and Prevention and standardized to range from 0 to 1.

Data sources: 2018 Heat Vulnerability Index from NYC Department of Health and Mental Hygiene (2020); 2018 Social Vulnerability Index from Centers for Disease Control and Prevention (2020)

A lone American hornbeam tree (*Carpinus caroliniana*) stands on an industrial street in Mott Haven, Bronx.

socioeconomic groups of residents have been influenced—at least to some degree—by historic factors and structural racism (e.g., housing and lending policy).

In NYC specifically, several studies have examined equity of the urban forest, though none have been comprehensive, focusing instead on specific geographies or limited measures. For example, in a study of the economically disadvantaged areas of northern Manhattan and the Bronx, Lovasi et al.[24] found that tree canopy was negatively correlated with population density, positively correlated with the percentage of the population living below the Federal poverty line, and positively correlated with the percentage of the population that identified as Black. Neckerman et al.[25] similarly found that poorer areas had lower street tree densities and higher rates of crime and pedestrian–vehicle collisions. Schwarz et al.[20] found that in NYC, median income was negatively associated with canopy cover, though the actual effect was very small. The differences between citywide studies and more localized ones suggest there are different patterns within regions of the city compared with NYC as a whole.

New Analysis of NYC Urban Forest Equity

Given the relative lack of available information on equity and the urban forest in NYC, we examined relationships between three major urban forest metrics (tree canopy, relative canopy change, and stocking rate of living street trees) and several socioeconomic variables related to social and heat vulnerability (see **Box 4.2**), by Neighborhood Tabulation Area (NTA), both citywide and by borough. Methods are summarized in **Box 4.3** and detailed in Appendix 1. This data-driven approach is limited, as it does not include local knowledge or other forms of information that are ultimately needed to paint a fuller picture of the dynamics of equity and environmental justice. We present our summary findings at a high level, and a table of the full results is available in Appendix 2. While results regarding a variety of socioeconomic metrics are discussed below, some key datasets are depicted in **Figure 4.1** and **Figure 4.2**.

Relationships between the urban forest and socioeconomic characteristics are complex. Citywide, relationships were generally weak.* However, our main findings do identify several citywide dynamics of note:

- More socially and heat-vulnerable communities tended to have lower canopy cover. In particular, there was less canopy in and around NTAs with higher rates of household crowding and a higher HVI.
- Higher income communities tended to have more canopy, and areas with higher poverty rates tended to have less.
- Areas with more residents aged 65+ had less relative gain in canopy, and sometimes even lost canopy between 2010 and 2017.
- Relative increases in canopy between 2010 and 2017 tended to be greater in areas with higher poverty rates and with higher social and heat vulnerability.
- At the citywide scale, there were no strong relationships between stocking rates of living trees and the socioeconomic variables we assessed.

Analysis of urban forest and socioeconomic data by NTA within each borough yields more nuanced insight. For example, Manhattan is generally an outlier that does not follow the same trends as other boroughs (see **Figure 4.3**) and the South Bronx has some unique dynamics (**Box 4.4**). Canopy cover was clearly related to socioeconomic data in some boroughs but not others. Here are some key findings of analysis by borough:

- In all boroughs except Manhattan, NTAs with higher per capita income had higher canopy cover, and those with higher social vulnerability had less canopy.
- In the Bronx and Staten Island, there was generally less canopy in and around NTAs with more residents who have limited English proficiency or do not identify as white.
- Relative change in canopy between 2010 and 2017 was generally lower, and sometimes negative, in NTAs with a larger percentage of residents 65 years old or older. This relationship was significant in all boroughs except Staten Island. The spatial pattern of this variable generally differs from other metrics related to vulnerability of communities and is worthy of future exploration.

* Unless otherwise stated, correlations referenced are statistically significant based on $p < 0.05$, and within these, we focus on relationships with $R \geq 0.2$ to highlight the stronger relationships. Even significant correlation coefficients (R) were generally low, often ≤ 0.2.

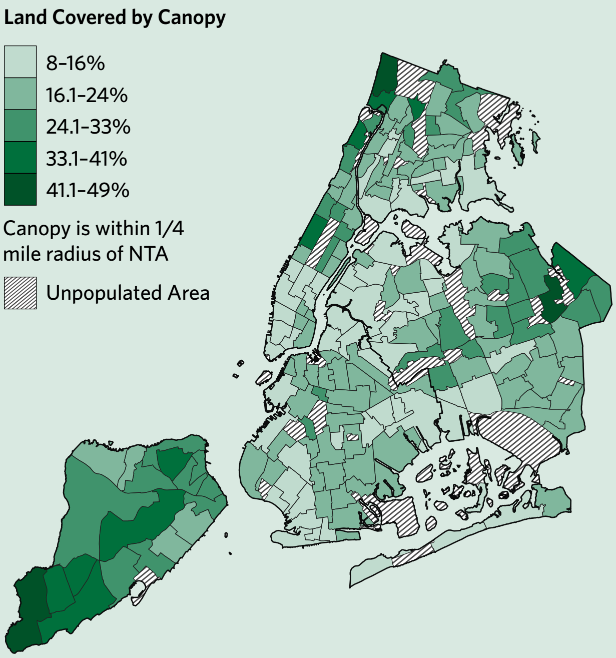
BOX 4.3

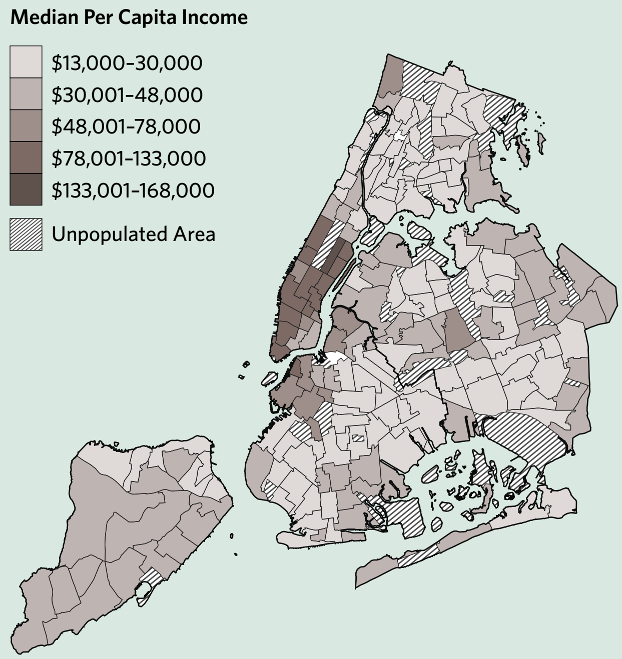
Analyzing the Urban Forest and Socioeconomic Data

The urban forest metrics we considered were canopy cover in 2017, relative change in canopy cover from 2010 to 2017, and street tree stocking rate based on the 2015–2016 street tree census and estimated capacity data provided by NYC Parks. The socioeconomic data we leveraged included median per capita income, percentage of people below the Federal poverty line, percentage of people 65 years old or older, percentage of people 17 years old or younger, percentage of people with limited English proficiency, percentage of residents who do not identify as white or Hispanic (percentage of people of color), percentage of housing units with more people than rooms, NYC Heat Vulnerability Index (HVI), and thematic and composite metrics of social vulnerability (based on these variables and others; see **Box 4.2**).

We conducted this analysis at the scale of Neighborhood Tabulation Areas (NTAs). Areas such as parks and airports are often delineated as unpopulated NTAs, but people in neighboring communities do experience those environments and receive benefits from the urban forest there, so we conducted canopy analyses based on NTAs plus a quarter-mile buffer. The quarter-mile buffer approximates a 5-minute walk radius (in a straight line) and captures benefits provided by vegetation in the surrounding area, such as reducing temperature.[26] We considered only street trees within the specific boundaries of respective NTAs, as assets that people interact with on a more frequent basis (e.g., benefiting directly from shade). The broader benefits of street trees as part of the urban forest are generally captured in the canopy analyses. We used nonparametric correlation analyses (Kendall's tau) to examine relationships between urban forest and socioeconomic data. See Appendix 1 for complete information about data sources and methods used in these analyses, and Appendix 2 for tables of results.

Canopy and Socioeconomic Data in NYC





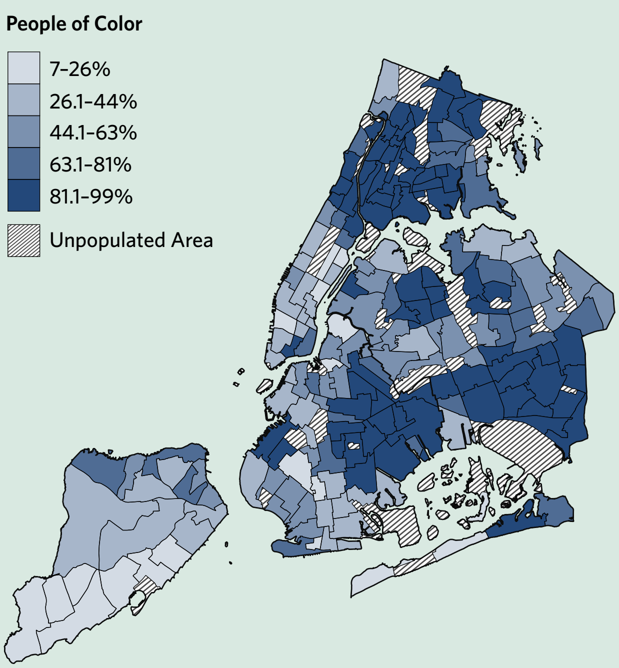


Figure 4.2 Canopy cover (top left), median per-capita income (top right), and percentage of people of color (bottom) by Neighborhood Tabulation Area. Canopy cover represents canopy within these areas plus a quarter-mile buffer. Socioeconomic data were aggregated to this scale from data available for census tracts.

Data sources: Data for Neighborhood Tabulation Area boundaries from NYC Department of City Planning; Tree Canopy data from Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications); Data on Income and population of People of Color from the 2018 U.S. Census – American Community Survey, distributed with the 2018 Social Vulnerability Index (Centers for Disease Control and Prevention). See Appendix 1 for details on how data were processed for this work.

- NTAs in the Bronx consistently had among the strongest relationships between relative canopy change during 2010–2017 and the socioeconomic and demographic variables, with a trend of larger canopy increases in and around NTAs with lower per capita incomes, higher percentages of residents 17 years old or younger, higher percentages of people of color, higher heat vulnerability (**Figure 4.4**), and higher social vulnerability scores.
- Street tree stocking rates were lower in NTAs characterized by higher social and heat vulnerability in Brooklyn, Queens, and Staten Island. This relationship is particularly true in Staten Island, where low stocking rates tended to coincide with higher social vulnerability, both holistically and by various component metrics (e.g., limited English proficiency, proportion of people of color, and housing crowding; **Figure 4.5**).
- Trends between street tree stocking rate and socioeconomic metrics were generally the opposite in the Bronx, compared to those in Brooklyn, Queens, and Staten Island. NTAs there with higher heat and socially vulnerable populations generally had greater tree stocking rates. Manhattan did not exhibit strong relationships between street tree stocking rates and the socioeconomic variables we considered (**Figure 4.6**).

Inequity of Tree Canopy and its Distribution of Benefits

Given the general trends of lower canopy in areas with lower per capita incomes and higher percentages of people of color, it may be assumed that the direct benefits (Chapter 3) of the urban forest are also unequally distributed. These affected communities thus have reduced access to benefits of the urban forest, such as improvements to air quality, reduction in the urban heat island effect, and overall benefits for well-being.

This dynamic may be especially problematic during catastrophic events, such as the COVID-19 pandemic. For example, to help residents deal with heat waves, the City typically opens air-conditioned cooling centers where residents can spend time. However, in the summer of 2020, the capacity of cooling centers was reduced to facilitate social distancing; thus, the effects of urban trees to reduce local temperatures and provide shade became particularly critical. Furthermore, there is evidence that long-term exposure to airborne particulate matter increases the risk of death from COVID-19.[27] Given the potential for trees to reduce air pollution, long-term inequities in the distribution of the urban forest may ultimately contribute to local impacts of the pandemic.

BOX 4.4

What's Going On with Trees in the South Bronx?

The South Bronx is unique in multiple ways. For example, the area tends to have high stocking rates in the most socially and heat-vulnerable areas, and while heat-vulnerable NTAs there have fairly low canopy cover, they have seen among the largest relative increases in canopy. This may be explained, in part, by targeted efforts to plant trees and generally green the South Bronx. For example, before the Million Trees NYC Initiative (MillionTreesNYC), NYC Parks identified areas in which to target plantings as part of the Trees for Public Health initiative, which was informed by local health data (such as childhood asthma rates) and this prioritization informed MillionTreesNYC. Two neighborhoods in the South Bronx, Morrisania and Hunts Point, were part of this initiative. Another program was initiated to replace trees that were removed during the building of the new Yankee Stadium. This program planted 7,634 trees from 2007 to 2015 throughout the neighborhoods around the stadium, including many trees that were larger than typical trees for planting. In addition, the redevelopment of the Bronx River Greenway and South Bronx Greenway increased access to greenspace.

Though the South Bronx generally has among the most heat-vulnerable communities in NYC, and was a focal area for plantings as part of the Cool Neighborhoods NYC initiative, those plantings are not reflected in the data presented. The program was not announced until 2017, the same year that key data underlying the canopy dataset were collected, and one year after the most recent street tree census. Thus, we can anticipate further gains in street trees and canopy as more trees are planted and trees from previous plantings continue to grow. However, even though the South Bronx has experienced fairly large relative increases in canopy, compared with other parts of the city, it started with very little tree cover, so it has a long way to go before it will have substantial canopy cover.

Volunteers care for a planted median to beautify the Hunts Point Greenway in Hunts Point, Bronx, at a 2019 event hosted by Sustainable South Bronx and The Nature Conservancy.

Recognizing that the urban forest can ultimately support positive educational and health outcomes, we also considered the distribution of canopy around hospitals and public schools (methodological details are available in Appendix 1). In general, the canopy around these facilities tends to be correlated with the canopy within the surrounding NTA (plus a quarter mile radius), although both schools and hospitals tend to have less canopy than the respective areas. While this finding may be driven, in part, by the large area that these buildings themselves occupy, there is substantial variability in canopy around these facilities. Impacts of disparities in the urban forest may be exacerbated in cases where local hospitals and public schools have especially low canopy, within broader areas lacking canopy. Additional research in this area can yield further insights and support targeted recommendations.

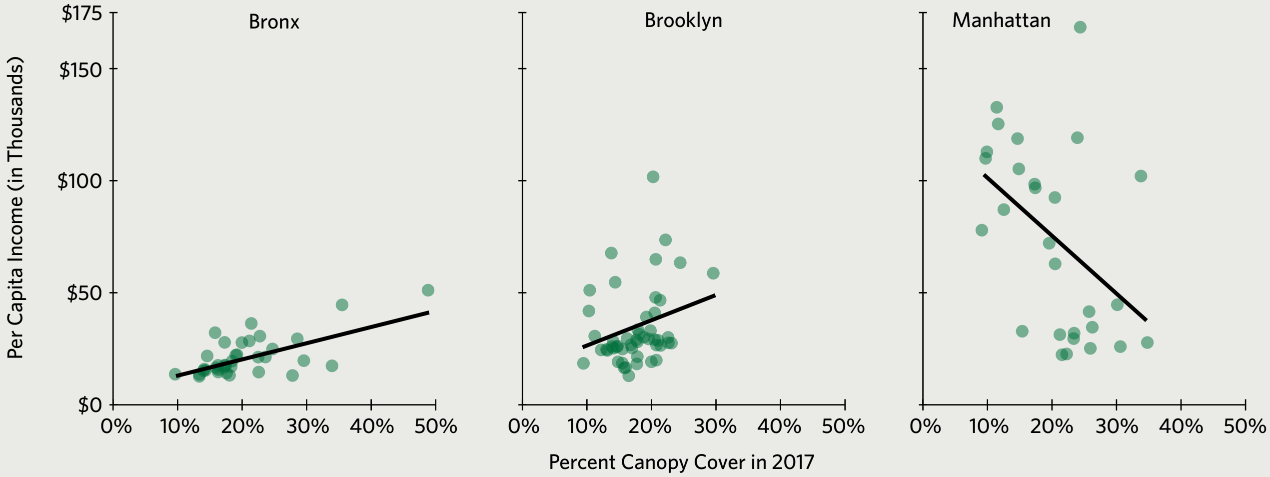
Drivers of Inequity in the NYC Urban Forest

Today's inequities in the urban forest may have been shaped both intentionally and inadvertently by a combination of factors, including decades of policy, zoning, and urban design decisions. We explore these drivers to demonstrate that current and future planning for the urban forest may need to account for and address both legacy effects and present non-forest policy that may directly impact the equity of the resource.

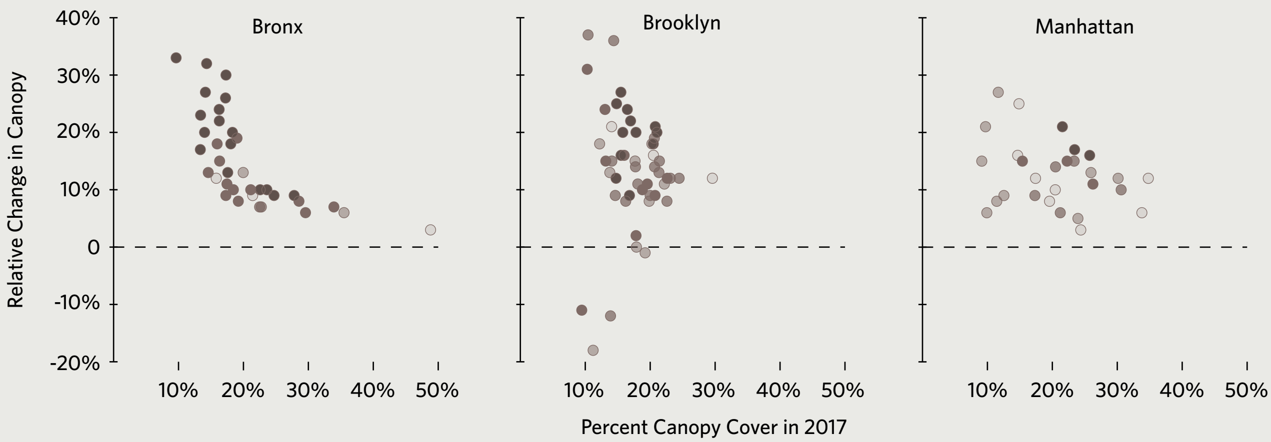
The first driver of note is the historical effect of different policies that advantaged predominately white populations at the expense of people of color. In particular, these policies excluded Black, African American, and Latinx communities from living in certain neighborhoods.

In 1933, as part of the New Deal, Congress passed the Home Owners' Loan Act, establishing the Home Owners' Loan Corporation, which color-coded lending maps to identify areas of risk and laid the foundation for "redlining." Areas or

Canopy Cover and Income by Borough



Canopy Cover, Canopy Change, and Heat Vulnerability Index by Borough



Street Tree Stocking Rate and Social Vulnerability Index by Borough

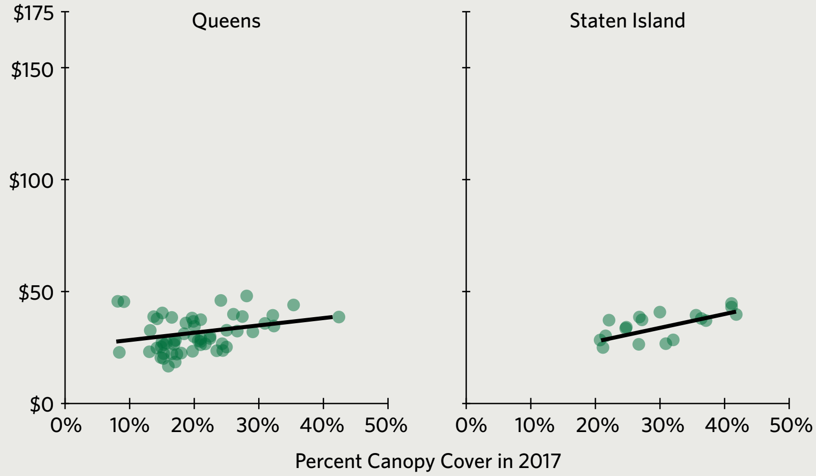


Figure 4.3 Scatterplots illustrating relationships between canopy cover and median per-capita income by borough. Each point represents an individual Neighborhood Tabulation Area. Canopy cover represents canopy within these areas plus a quarter-mile buffer.

● Neighborhood Tabulation Area

— Best-fit line (displayed when the correlation was significant)

Data sources: Per Capita Income derived from the 2018 U.S. Census - American Community Survey, distributed with the 2018 Social Vulnerability Index (Centers for Disease Control and Prevention); Percentage of Canopy in 2017 derived from Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications)

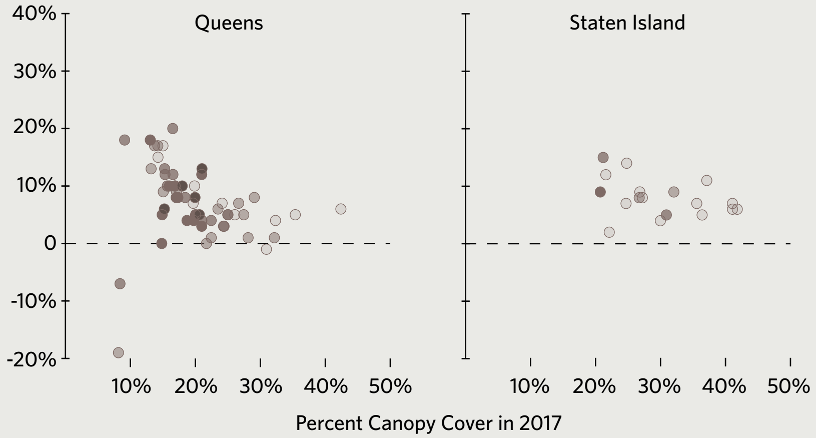


Figure 4.4 Scatterplots illustrating relationships between canopy cover, relative change in canopy, and the Heat Vulnerability Index by borough. Each point represents an individual Neighborhood Tabulation Area. Canopy and canopy change data represent these areas plus a quarter-mile buffer.

Heat Vulnerability Index for Neighborhood Tabulation Area

○1 ●2 ●3 ●4 ●5

Data sources: 2018 Heat Vulnerability Index from NYC Department of Health and Mental Hygiene); Percentage of Canopy in 2017 derived from Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications)

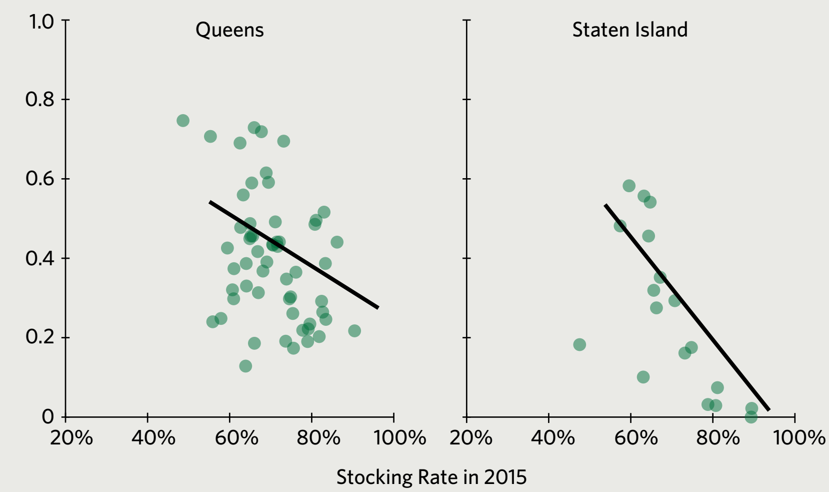


Figure 4.5 Scatterplots illustrating relationships between the stocking rate of living street trees and the Social Vulnerability Index (standardized), by borough. Each point represents an individual Neighborhood Tabulation Area.

● Neighborhood Tabulation Area

— Best-fit line (displayed when the correlation was significant)

Data sources: Stocking rate derived from 2015–2016 Street Tree Census and Street Tree Capacity estimates (2017) (NYC Parks); Social Vulnerability Index is based on 2018 data from the Centers for Disease Control and Prevention

BOX 4.5

Legacy Effects of Redlining Across the Five Boroughs

While legacies of redlining have been shown to persist in numerous cities, including NYC,[15] these legacies can vary, as seen across the five boroughs. In the Bronx, Brooklyn, Queens, and Staten Island, areas with lower canopy cover as of 2017 were significantly associated with lower ratings from the Home Owners' Loan Corporation (HOLC) (**Figure 4.6**). Thus, lower canopy in these areas may be at least partly a legacy effect. Manhattan is an exception, exhibiting no strong relationship between tree canopy and neighborhood ratings.

Canopy Cover by HOLC Grade Across the Five Boroughs

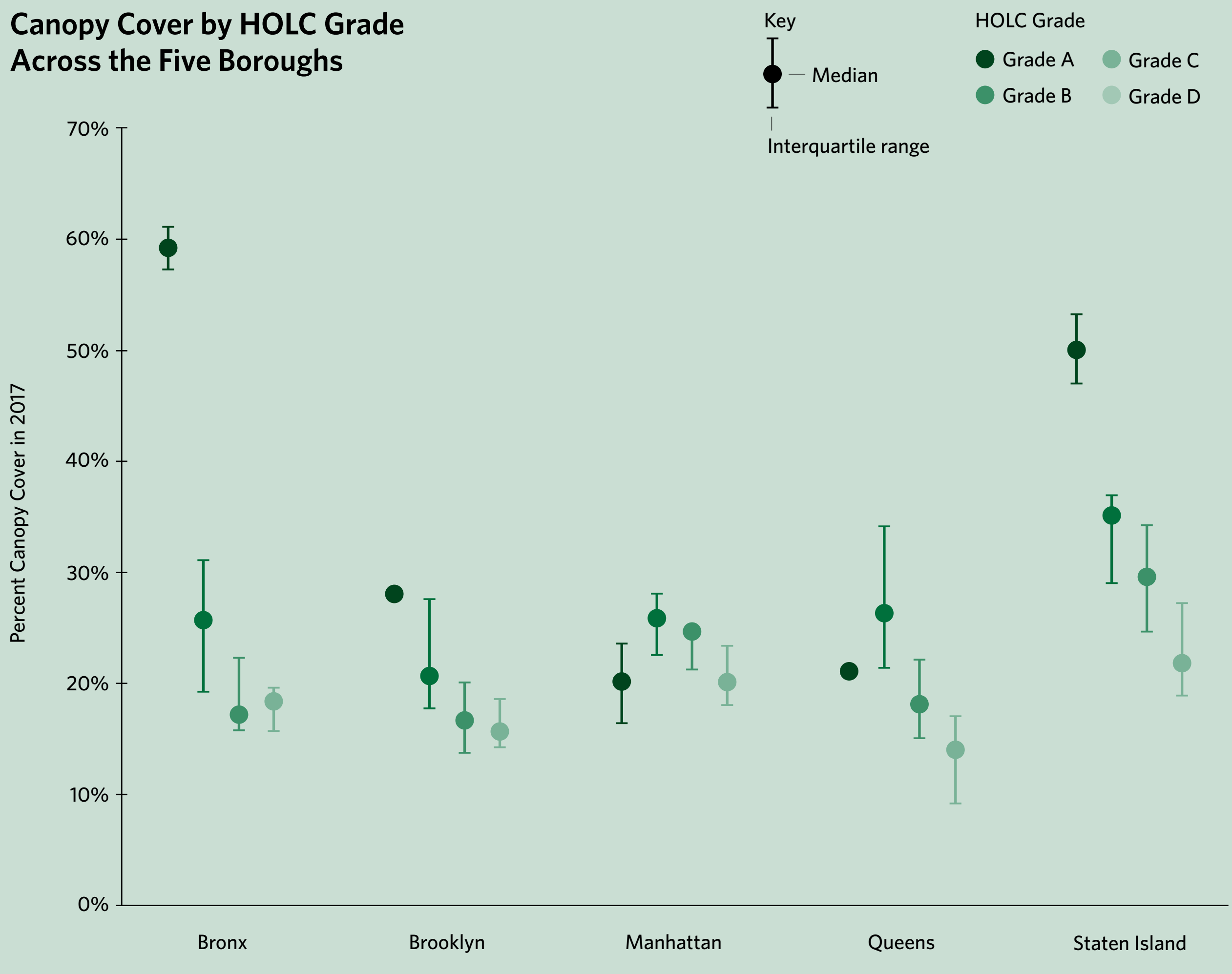


Figure 4.6 Plots illustrating canopy cover for areas that were assigned grades by the Home Owners' Loan Corporation in the 1930s. Areas given an "A" grade were considered highly suitable for loans, and suitability went down with each grade, to a "D," which were areas that were deemed unsuitable for loans (referred to as "redlined" areas). In all boroughs except Manhattan, there were statistically significant trends of less canopy in areas with lower grades based on correlation analysis (Manhattan exhibited no significant trend in either direction; correlation analyses were based on Kendall's tau).

Data sources: Canopy change derived from 2017 Tree Canopy Change (2010–2017) data (NYC Department of Information Technology and Telecommunications); data on HOLC grades are from Nelson, R.K., Winling, L., Marciano, R., Connolly, N. et al. Mapping inequality. American Panorama, ed. Nelson, R.K., and Ayers, E.L. Available: https://dsl.richmond.edu/panorama/redlining/

neighborhoods that were considered at high risk of defaulting were marked in red.[3,15] The discriminatory risk assessment was based on criteria such as race, income, nationality, and percentage of Black or African American residents, among others.[3] The areas deemed "risky" were usually those with a high percentage of Black, African American, and Latinx residents and were rarely predominantly white neighborhoods. Thus, redlining was one method of lending discrimination that allowed banks and mortgage lenders to reject borrowers seeking loans to purchase or even renovate their homes, based on their race or where they lived. The Federal Housing Administration and other lending institutions also adopted this approach soon after these original maps were created. These practices segregated cities, promoted further discrimination, and led to poor housing quality because homeowners could not obtain financial assistance from banks to improve their homes.[15] There was ultimately disinvestment in many denser urban centers. Legacies of redlining persist in many cities, including New York, which has a trend of lower canopy in areas that were redlined (**Box 4.5**).[15]

Another contributing factor to the inequity in access to the urban forest and its benefits is local zoning regulations. A study of the 1916 and 1961 NYC Zoning Resolutions[28] revealed that many neighborhoods with lower income residents and generally higher proportions of people of color were zoned as industrial. Many of these areas had already been redlined, and by law, had limitations on expansion, renovation, and repair in terms of residential uses. Therefore, homes in industrial areas had poor canopy cover by the 1980s. In contrast, areas whose residents had higher incomes and higher levels of education were given greater scope to add vegetation as of 2010.[29]

Other aspects have been found to predict vegetation cover in other cities, but have generally not been considered for NYC: the age of the housing development, lifestyle behavior and preferences (e.g., exercise, gardening, pro-tree), ratio of owners vs. renters, racial and ethnic composition, housing type, building density, road density, and age of householders.[19,30] In addition, if the urban forest is perceived as an amenity, households might plant trees to increase the value of their home and/or pressure public agencies to plant trees; similarly, properties with greater tree canopy might sell for higher prices, so that only people with greater purchasing power can afford them.[19]

Gentrification

While the urban forest affords many benefits for people and communities, an unequal distribution of trees can have negative, unintended consequences in terms of disparities in access to benefits and other dynamics. Not only are many communities facing reduced access to benefits of the urban forest, but tree planting to address disparities can actually contribute to gentrification, exclusion, and displacement. In booming housing markets such as New York, the push toward more visible concentrated greening was associated with sustained whiteness or a shift from higher proportions of people of color to predominately white—a consequence of gentrification processes.[31] For that reason, we discuss green gentrification, "the social consequences of urban greening from an environmental justice and sustainable development perspective."[12]

Because the urban forest and specifically street trees in metropolitan areas are generally perceived as beneficial, planting more trees can make communities more attractive and boost housing demand and prices.[32] The increase in housing prices may induce gentrification and, ultimately, displacement. Gentrification influences socioeconomic and physical characteristics, including culture, housing stock, and amenities, and can lead to the displacement of original residents, usually and especially those with lower incomes or of marginalized ethnicities or races. More affluent residents and upscale businesses often move in.[33] It can be difficult to parse the effects of planting new trees on gentrification, versus other dynamics related to development and zoning changes.[34]

The NYU Furman Center[35] determined that of 55 sub-borough areas, 22 were considered as low income in 1990, and 15 of those experienced gentrification (which they defined as having mainly low-income residents in 1990 and experiencing rent growth above the median for the area between 1990 and 2010–2014). This research revealed that gentrifying neighborhoods have experienced greater increases in college graduates, young adults, childless families, and non-family households compared with other areas in NYC. In addition, these gentrifying areas experienced a decrease in affordable (low-income) rental units and a rapid citywide increase in white residents, with a decrease in the share of the population identifying as Black. Finally, the work indicated that although the number of people living below the poverty line in gentrifying neighborhoods decreased between 2000 and 2010–2014, it was unclear whether low-income residents were moving out of these neighborhoods, or whether poor residents were increasing their household incomes. To our knowledge,

Photo by NYC Department of Parks and Recreation.

Photo by NYC Department of Parks and Recreation.

Before and after street tree planting on West Farms Road in the Bronx.

these sub-borough areas have not been compared with urban forest metrics, though we observe that many areas that have been experiencing gentrification (e.g., northern Brooklyn, northern Manhattan, the South Bronx) had recent increases in canopy.

In NYC, street tree planting has been correlated with increased median housing values.[32] The intensity of street tree planting has similarly contributed to increases in the percentages of white residents in a neighborhood and occupied housing units.[32] Bratspies[36] suggested that the Million Trees NYC Initiative (MillionTreesNYC) in particular may have been associated with gentrification, since by improving the environmental quality of neighborhoods without directly addressing equity concerns, the initiative improved environmental quality, but not social sustainability. Bratspies[36] noted several equity concerns regarding MillionTreesNYC and gentrification, including top-down planting decisions and an unpublished plan that offered little opportunity for public comment. Further, the campaign elevated the economic return on investment of planting trees, which is tied to increased real estate value, a metric associated with gentrification. In addition, MillionTreesNYC coincided with re-zoning that supported high-end residential development in NYC.

Although greening is often authentically or ostensibly intended to improve environmental conditions in neighborhoods, greening initiatives can contribute to gentrification and displacement, pushing out the working class and people of color, and attracting white and wealthier residents to move in. Simply put, urban greening can "richen and whiten" neighborhoods.[12] Overall, the relationships between the urban forest, changes to it, and gentrification are complex and warrant further research. However, without equity-oriented public policy intervention, urban greening can ultimately—intentionally or inadvertently—be negatively redistributive, contributing to the displacement of low-income residents and people of color.

NYC has an unevenly distributed urban forest that contributes to general inequity across communities.

Summary

As is the case in most cities, NYC has an unevenly distributed urban forest that contributes to general inequity across communities. Within NYC as of 2017, areas with communities considered more vulnerable, with lower per capita incomes, and higher percentages of people of color tended to have lower tree canopy. Research on environmental justice in NYC has shown that many of these communities face disproportionate environmental burdens in addition to less tree canopy—for example, higher air pollution and incidence of respiratory ailments, as well as heat vulnerability and inadequate access to air conditioning. Although there is variation in these patterns across the five boroughs, many areas with more vulnerable communities have less canopy.

The disparities in tree canopy are driven to some degree by decades of zoning and housing policy. For example, in all boroughs except for Manhattan, areas that were redlined tend to have less canopy than areas that were not. Historically, some parts of NYC with more vulnerable communities had been zoned as industrial, even when their use had largely been residential. This led to dense development that posed environmental hazards to the residents, and manufacturing zones were heavily increased in some areas with low-income populations, often primarily people of color, such as in the South Bronx.[28]

In recent decades, NYC has attempted to address inequities in the urban forest through initiatives such as the Trees for Public Health effort from NYC Parks and the Cool Neighborhoods NYC program, which were designed to have a redistributive effect on the canopy. As of the 2015–2016 street tree census, some lower-income, heat-vulnerable areas, particularly in the South Bronx, tend to have higher stocking rates of street trees than other parts of the borough. While there have been substantial relative increases in canopy in some of these areas, overall canopy there is often still relatively low. The trees that were planted need time to grow and mature; in the meantime, more planting opportunities can be identified and leveraged to expand canopy if desired. Furthermore, because urban trees are amenities that increase property values and desirability of a neighborhood, which can lead to gentrification and displacement, it is critical that efforts to address inequities in the urban forest be coordinated with strategies to prevent displacement.

These results offer insight into general trends, both across NYC and within individual boroughs, and there is ample opportunity for further analysis. For example, we need to better understand the distribution of the urban forest with respect to specific hazards, and to learn how health and care of trees vary across the city. Ongoing efforts to expand the urban forest should proactively address inequity, specifically prioritizing more heat-vulnerable neighborhoods. Policymakers need spatially explicit information that accounts for dynamics such as zoning history, redlining, and tree planting. Further research can yield additional insights into how various aspects of the urban forest relate to equity, environmental justice, and gentrification in the context of many other factors.


5

Public Policy

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These leaves are from the Japanese pagoda tree (*Styphnolobium japonicum*), which ironically is native to China and Korea, but not Japan, where they have been planted ornamentally. This common street tree is in the pea plant family and has white flowers that bloom in late summer.

CHAPTER 5

Public Policy

Public policy is defined as a "system of laws, regulatory measures, courses of action, and funding priorities… promulgated by a governmental entity or its representatives."[1] It provides a direction for achieving societal outcomes. Policy, or the lack thereof, implicitly outlines what a government believes is important and delineates what it intends to do and not do, and is generally informed by the public and other stakeholders (see **Box 5.1**).

In a city where trees and the spaces where they can grow are limited, ensuring that the urban forest provides benefits across the landscape requires creating, implementing, enforcing, and strengthening policies to effectively protect and manage the resource. These policies can take many forms, ranging from legal regulations to government initiatives, agency rules, and publicly funded programs for urban forestry activities. Together, these various forms of policy, with adequate funding and enforcement, can help the urban forest thrive in perpetuity.

While some policies, including laws, specific agency rules, and zoning regulations, can legally protect the urban forest by prohibiting removal of trees or requiring their replacement, other policies play a role in supporting additional management actions. For example, policy options such as time-bound strategic initiatives (e.g., the Million Trees NYC Initiative) or management plans (e.g., the *Forest Management Framework for New York City*) further enable the long-term health and sustainability of the urban forest by fostering greater stewardship and supplying a guiding vision. Such instruments do not offer the urban forest legal protection from harm or removal, but rather support broader management of it, in various forms, across the landscape.

In NYC, the quantity and quality of the urban forest is influenced by policies that support protection and management of trees and the spaces where they exist. Policy has helped shape a landscape in which millions of people coexist with millions of trees. Policy institutionalized the systems of City Parkland and rights of way, which together contain 53.50% of the urban forest canopy.* While it is illegal to remove or damage trees without permission of the respective property owner (per New York State [NYS] Real Property Actions and Proceedings Law Art.8 §861) most private lands, and even some public lands, are not subject to any other tree-related policies.

There is evidence of a general increase in municipal urban forest policies in the recent past (2005–2014) in the United States, and NYC has been part of this trend.[2] The public has become more aware of the myriad benefits that trees and urban forests provide, and policymakers better understand that urban forests help to advance other public policy priorities, such as mitigating and adapting to climate change, improving water quality, bolstering human health, and increasing community resiliency.[2]

However, even with the increasing attention given to urban forests, there is no unifying, comprehensive policy or management plan for this resource in NYC. This critical natural asset relies on a complicated web of different policies, including NYC's Administrative Rules and Charter, NYC's Zoning Resolution, and time-bound mayoral plans and

* Breakdowns of canopy across site types represent estimates based on 2017 tree canopy data for NYC. See Chapter 2 for additional detail.

Diners enjoy a meal under a row of trees at Brookfield Place, Manhattan. As of 2017, about 35% of all tree canopy in NYC fell on privately owned land. With few exceptions, there are no policies about trees on private property in NYC.

programs, which creates uncertainty for the long-term health of the urban forest.

Here we highlight the major policies and programs that apply to the NYC urban forest (**Table 5.1**). We summarize the characteristics of the most substantial policies, including their jurisdictional or geographic extent and the authority responsible for implementing them.

Land Ownership, Jurisdiction, and Relevant Policies

The ownership and jurisdiction of the ground in which a tree grows is the major determinant of whether and how a tree is legally protected in any way and the types of long-term management and stewardship available for it. Some parts of the urban forest have few protections and little or no coordinated management oversight, such as most privately owned properties, which contain 35.26% of all tree canopy in NYC. In contrast, the parts of the urban forest under the jurisdiction of New York City Department of Parks and Recreation (NYC Parks) are managed under policies aimed at protecting current trees and forested lands, as well as policies tied to long-term management. In general, government-owned lands are subject to more rules and regulations than privately owned lands.

Major Policies Related to the NYC Urban Forest

Policy	Rules and Regulations	Programs and Initiatives	Strategic Plans
New York City			
NYC Administrative Code Tit. 18 Ch. 1: Department of Parks and Recreation	●		
NYC Rules Tit. 43 Ch. 6: City Environmental Quality Review *	●		
NYC Rules Tit. 56 Ch. 1: Use of Parks	●		
NYC Rules Tit. 56 Ch. 5: Rules Governing Tree Replacement	●		
NYC Zoning Resolution	●		
Cool Neighborhoods NYC—A Comprehensive Approach to Keep Communities Safe in Extreme Heat		●	
Forest Management Framework for New York City			●
New York City Green Infrastructure Plan—A Sustainable Strategy for Clean Waterways			●
PlaNYC 2030: A Greener, Greater New York			●
PlaNYC: Update April 2011			●
One New York: The Plan for a Strong and Just City (OneNYC)			●
OneNYC 2050: Building a Strong and Safe City			●
New York State			
NY Codes, Rules and Regulations Tit. 9 Subtitle I: Office of Parks, Recreation and Historic Preservation	●		
NY Consolidated Laws, Environmental Conservation Law Art. 8: Environmental Quality Review**	●		
NY Consolidated Laws, General Municipal Law Art. 5 §96-b: Tree Conservation	●		
NY Consolidated Laws, Real Property Actions and Proceedings Law Art. 8 §861	●		
NYS Urban and Community Forestry Program		●	
NYS Forest Action Plan			●
Federal Government			
Code of Federal Regulations Tit. 36 Ch. 1: National Park Service, Department of the Interior	●		
U.S. Code Tit. 42 Ch. 55: National Environmental Policy***	●		
U.S. National Park Service Federal Lands to Parks Program		●	
USDA Forest Service - NYC Urban Field Station		●	
National Urban and Community Forestry Advisory Council Challenge Cost-Share Grant Program		●	
National Urban and Community Forestry Advisory Council Ten-Year Urban Forestry Action Plan: 2016–2026			●

* Pursuant to Executive Order No. 91 of 1977, As Amended.

** Pursuant to New York's Environmental Quality Review Act of 1975.

***Pursuant to the National Environmental Policy Act of 1969.

Table 5.1 Examples of policies, programs, and plans that affect the NYC urban forest, organized by the associated level of government.

However, protection and management of the urban forest varies a great deal across the range of government-owned lands, depending on jurisdiction.

We consider both public and private lands. On the public side, we discuss the major owners and, as needed, specific jurisdictions under their authority. On the private side, we treat private property owners as one class given their combined significant portion of the forest spread over thousands of individual owners. (See additional detail in Chapter 2.) From largest to smallest holder of canopy, we include: City of New York (56.91% of citywide canopy), private property owners (35.26%), the State of New York (5.73%), and the Federal government (2.10%). We discuss more specific ownership and jurisdiction only in relation to existing policies and highlight opportunities for policy across ownership types in Chapter 9.

City-Owned Lands

City-owned lands account for a total of 56.91% of the total tree canopy in NYC. While almost all City trees are under NYC Parks' jurisdiction (accounting for approximately 53.50% of citywide canopy, including street trees and trees on City Parkland) and are subject to various rules and regulations, the remainder of City-owned lands have few policies related to trees.

Trees Under the Jurisdiction of NYC Parks

The NYC Charter mandates NYC Parks to manage and care for trees in City Parkland and most public rights of way, including, in general, street trees.[3 *] For certain projects, NYC Parks has the right to cut or remove trees within their jurisdiction (e.g., trail building) without a Tree Work Permit. These trees are subject to replacement requirements discussed below. Otherwise, trees under NYC Parks' jurisdiction cannot be cut, removed, damaged, or destroyed by any individual or entity without a Tree Work Permit from NYC Parks.[4,5] No one is permitted to perform work on or within 50 feet of a tree within the jurisdiction of NYC Parks without a Tree Work Permit, including for construction-related activities, excavation, tree pruning, and pest management.[4] Individuals who violate these laws may receive punishment of up to 90 days in prison, a fine of up to $15,000, or both.[5]

BOX 5.1

The Public's Role in Informing Public Policy

Policy is not static, and the public plays a large role in policy creation, implementation, and enforcement. Members of the public can affect policy in a variety of ways including, but not limited to:

- Engaging elected officials, such as the Mayor's Office and City Council, to relay the issues that are important to them.
- Attending public hearings and submitting testimony to inform proposed plans, rules, or legislation.
- Attending or organizing rallies, demonstrations, or other forms of peaceful assembly.
- Organizing and mobilizing communities around specific policy issues.
- Submitting projects for, and voting in, their City Council member's participatory budgeting process (see Chapter 6).
- Attending their local Community Board and Borough Board meetings where zoning changes can be proposed.

5

* Along most streets in NYC, trees are managed by NYC Parks, but there are some exceptions. First, some private streets and neighborhoods fall outside the responsibility of NYC Parks and the rules for rights of way. A less clear exception is in Staten Island, where some streets that functionally operate as public rights of way and even receive standard City services (e.g., sanitation) are in fact legally held as private streets that do not contain the easements granting public rights of way. Without these easements, the trees on these streets are not subject to City code, and therefore are not protected like street trees under NYC Parks' jurisdiction. It is unclear how many Staten Island street trees fall into this category, as the information is accessible only through paper deeds at the Borough President's offices.

With few exceptions, private property owners are permitted to do as they wish with trees on their property; thus a substantial portion of the urban forest in NYC is unprotected.

For lands under NYC Parks' jurisdiction, if trees are removed by any party, or harmed to the point at which removal is warranted, the number, species, and size of replacement trees are governed by specific rules.[6] The approach to assessing the value of existing trees maximizes the size and number of replacement trees, given site constraints, and can serve as a disincentive to remove a tree in the first place. This legally obligated replacement is one of the main policy tools for conserving the urban forest in NYC. Trees that are planted (as new plantings or as replacements) are subject to Local Law 11 of 2013, which promotes biodiversity within NYC by maximizing the use of native trees and other plants.[7,8] It should be noted that in some instances, NYC Parks' own standards are more stringent than what is required by law, as in the case of Local Law 11.

Private Lands

In NYC, 35.26% of the total tree canopy falls on privately owned lands, with 50.90% of that canopy on properties with one- and two-family homes (see additional details in Chapter 2). With few exceptions (see later section on select Special Purpose Districts), private property owners are permitted to do as they wish with trees on their property; thus a substantial portion of the urban forest in NYC is unprotected.

The State empowers municipalities to pass laws for the protection and conservation of trees in their jurisdiction, which can include trees on private property.[9] Specifically, municipalities may apply conditions to the removal or destruction of trees, including on private property. They can require that removal be done in accordance with an approved landscape plan, that the removed trees be replaced, or that replacement trees be planted for screening purposes. However, as of 2021, NYC had no citywide ordinance regulating trees.

State-Owned Lands

In NYC, 5.73% of the total tree canopy falls on lands owned by the State of New York, within the jurisdiction of State agencies or public benefit corporations. Rules, regulations, and plans related to trees vary by entity. For example, regulations explicitly prohibit damage to or removal of trees by the public on State parks and historic sites under the jurisdiction of the NYS Office of Parks, Recreation, and Historic Preservation,[10] such as River Bank State Park in Manhattan, and on recreation areas under the jurisdiction of the NYS Department of Environmental Conservation,[*] such as Saint Francis Woodlands in Staten Island. Some State agencies such as those that emphasize natural resource management (e.g., the NYS Office of Parks, Recreation and Historical Preservation, the NYS Department of Environmental Conservation), also often explicitly consider trees and forested natural areas in management or strategic plans.

NYC Housing Authority (NYCHA) properties are estimated to contain more canopy in NYC than any other State entity, 2.23% of all canopy in the city. Per NYCHA's rental agreement, residents are specifically prohibited from obstructing, damaging, or defacing any common area, including trees.[11] While NYCHA urban design guidelines discuss the importance of trees in open spaces and emphasize their benefits to health,[12] there is no codified requirement pertaining to tree removal and replacement on NYCHA properties. As such, when conflicts between other NYCHA needs and tree preservation arise, they may result in net loss of trees because replacement is not required.

The NYS Department of Transportation has agency rules that prohibit the cutting, mutilation, and removal of any tree, except for Department purposes, within the statewide parkway system to which some Parkways in NYC belong.[13] The Department does not require trees to be replaced. In addition, the Port Authority of New York and New Jersey, which has about 130 acres of tree canopy in NYC, does not

* Rules and regulations for the NYS Depatment of Environmental Conservation are in the New York Codes, Rules, and Regulations. Relevant regulations for trees are in Title 6, Chapter 2, Part 190.8, available from https://www.dec.ny.gov/regulations/regulations.html

A row of young street trees creates patches of shade on a sidewalk in Inwood, Manhattan.

have any governing rules or regulations pertaining to trees, to our knowledge.

Federally Owned Lands

In NYC, about 2.10% of the total tree canopy is within Federal lands. The majority of this canopy is under National Park Service (NPS) management and includes national monuments such as Liberty Island and Ellis Island, as well as the extensive Gateway National Recreation Area. The NPS has a mission to "preserve unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations."[14] It also has specific regulations that prohibit damage or removal of trees in a National Park.[15] Violation of this rule is punishable by up to six months in prison, a fine, or both.[16] In addition to being a property owner with a portion of the urban forest, the Federal government supports research and management of this resource. In particular, the USDA Forest Service – NYC Urban Field Station, whose mission is to improve quality of life in urban areas by conducting and supporting research about social ecological systems and natural resource management, is a notable leader in this realm.

Multi-Jurisdictional Policies

While many policies are jurisdiction-specific, a variety of policy instruments such as strategic plans, government-funded programs and grants, and zoning regulations can apply across jurisdictions. These often rely less on enforceable actions or prohibitions, and more on setting a broad vision and direction.

PlaNYC and MillionTreesNYC

Mayor Michael Bloomberg released *PlaNYC 2030: A Greener, Greater New York* (PlaNYC),[17] a long-term sustainability plan for the city, in 2007 and it launched a major urban forestry initiative. Through municipal greening initiatives, *PlaNYC* set out long-term goals for street tree stocking and broader tree planting, and influenced zoning standards for parking lots and street trees (see section on Zoning below). In support of these efforts, *PlaNYC* catalyzed partnerships among government agencies, and nonprofit, community, and corporate stakeholders to plant trees on streets, parks, residential and institutional properties, and vacant land throughout the city.[17]

These planting efforts were organized and implemented under the umbrella of the Million Trees NYC initiative

(MillionTreesNYC), which set a goal of planting one million trees over 10 years by 2017, with a particular focus on underserved communities, especially low-income neighborhoods with few trees and high asthma rates.[18] In partnership with the local nonprofit New York Restoration Project (NYRP), and with the support of 50,000 volunteers, this initiative achieved its goal in 2015, two years ahead of schedule. Approximately 75% of these new trees were planted on public properties (such as on City Parkland and as street trees) and the other 25% were planted on private properties (particularly in front yards and backyards of residences).[19] The City of New York allocated $309 million to NYC Parks for the effort (see Chapter 6), and NYRP raised $30 million in private funding.[19]

In 2011, the City released *PlaNYC: Update April 2011*.[20] This update included an initiative to conserve natural areas and contributed to the creation of the Natural Areas Conservancy (NAC) for managing the City's Forever Wild sites, as they were deemed the "gold standard of natural habitat" in the city.[20]

The NAC was formed in 2012 to champion "NYC's 20,000 acres of forests and wetlands for the benefit and enjoyment of all."[21*] In partnership with NYC Parks, the NAC created the *Forest Management Framework for New York City* (FMF), a 25-year strategic plan to "guide restoration, management, and community engagement for 7,300 acres of New York City's forested parkland" under the jurisdiction of NYC Parks. The FMF calls on NYC Parks and its partners to commit $385 million over 25 years to meet the goals.[22]

OneNYC and Cool Neighborhoods NYC

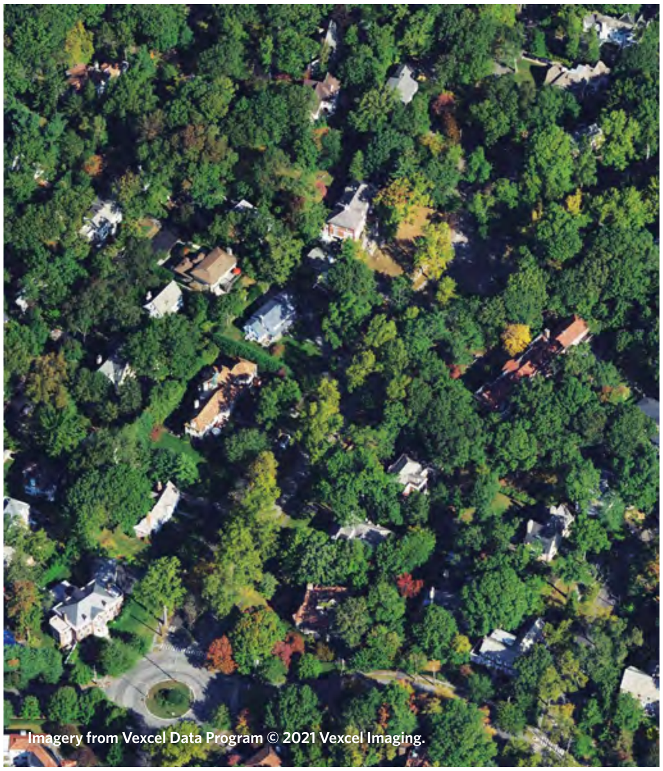
With the change in mayoral administration in 2014 came a new strategic plan. In 2015, Mayor Bill de Blasio released *One New York: The Plan for a Strong and Just City* (OneNYC).[23] This citywide plan is organized around the principles of "growth, equity, sustainability, and resiliency." *OneNYC* contained one initiative to "green the city's streets, parks, and open spaces."[23] Though the initiative asserted that NYC Parks would continue planting trees citywide, it did not commit to any quantitative targets. *OneNYC* also included an update to the City's street tree census and an ecological and social assessment of the city's natural areas, conducted in partnership with the NAC.

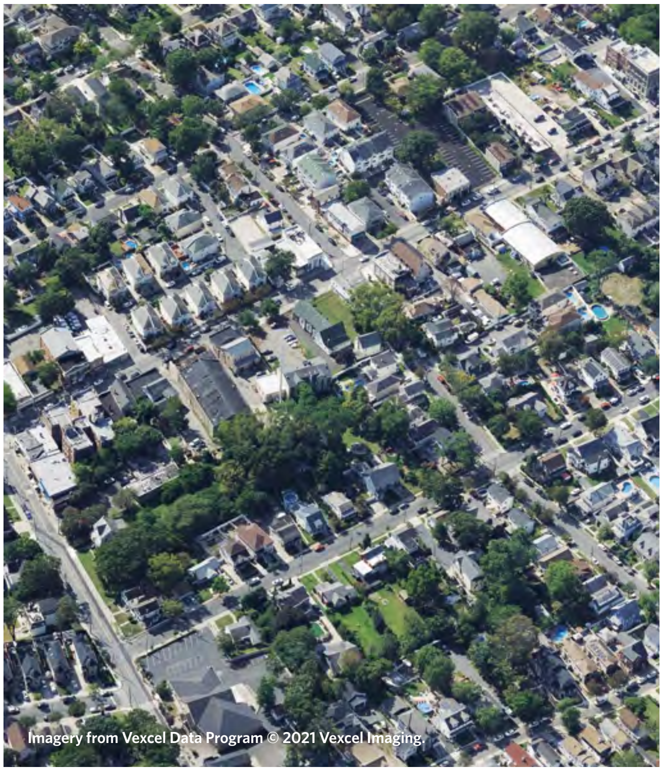
Unlike *PlaNYC* and the 2011 update, both of which prioritized sustainability and climate resiliency, *OneNYC* made equity an explicit guiding principle and lens through which to engage in municipal planning, policymaking, and governance. The new strategic plan made it clear that climate change exacerbates societal inequities, and this was the administration's impetus for tree planting and restoration. Not all the initiatives in *PlaNYC* and *OneNYC* were fully funded, though certain initiatives contained therein were resourced.

In 2017, Mayor de Blasio launched and funded *Cool Neighborhoods NYC: A Comprehensive Approach to Keep Communities Safe in Extreme Heat* (Cool Neighborhoods NYC), a program and strategy to reduce the urban heat island effect driven by accelerated climate change.[24] The program was focused on areas identified by the NYC Department of Health and Mental Hygiene as highly heat-vulnerable (see Chapter 4 for additional detail on the NYC Heat Vulnerability Index). The de Blasio administration committed an additional $106 million to tree-based cooling strategies, including the planting of street and park trees in the most heat-vulnerable neighborhoods, such as the South Bronx, Northern Manhattan, and Central Brooklyn. Some of these funds were also earmarked for forest restoration in forested natural areas throughout the city to maximize carbon storage and air pollution reduction. While MillionTreesNYC prioritized street tree planting in neighborhoods with low street tree stocking levels and neighborhoods with a high prevalence of childhood asthma, Cool Neighborhoods NYC was centered around vulnerability of communities to the health impacts of extreme heat.

In 2019, Mayor de Blasio released the next strategic plan called *OneNYC 2050: Building a Strong and Fair City* (*OneNYC 2050*).[25] It did not introduce new urban forest goals or programs, but committed to "manage and revitalize New York City's urban forest" by continuing to plant trees in areas with high heat vulnerability and to implement the FMF. Furthermore, *OneNYC 2050* committed to a concerted effort to make natural areas, including forested natural areas, more accessible to New Yorkers through an analysis of impediments and opportunities and an expansion of environmental education and youth programs. The City also committed to expand environmental education by highlighting the diverse ecosystems of NYC in school curricula, to improve walking trails in parks to improve accessibility and reduce environmental impacts, and to provide wayfinding guidance to make natural areas easily navigable and welcoming to diverse audiences. However, no funding came with those commitments at that time.

* About half this acreage is City-owned, mostly within NYC Parks' jurisdiction.





Aerial imagery of one portion of the Special Natural Area District, around Fieldston Road in the Bronx (left) and the Special South Richmond Development District around Main Street on Staten Island (right). Properties in these and select other areas are subject to zoning regulations regarding tree removal and replacement.

5

City Zoning

Zoning regulations are applied at the unit of zoning lots, which can be tax lots themselves, or two or more adjacent tax lots within a block (except for mapped parkland). Zoning regulations ultimately govern design and development of these spaces themselves and, in many cases, aspects of the associated street-facing areas (the streetscape). The main zoning regulation that relates to trees is a streetscape regulation, the Street Tree Planting Requirement, which was approved in 2008 as part of the *PlaNYC* effort to increase the number of trees in the city and to improve air quality and stormwater management.[26] This zoning regulation requires that, in all zoning districts except industrial areas,[27] there must be "one street tree, pre-existing or newly planted, for every 25 feet of street frontage of the zoning lot"[26] if there are new developments (major enlargements where the floor area on the zoning lot is increased by 20% or more) or conversions of 20% or more of the floor area of a non-residential building to residential uses. Under this zoning requirement, NYC Parks determines the species, size, location, and other parameters of street trees in accordance with NYC Parks' Street Tree Planting Standards for NYC.[28] The Street Tree Planting Requirement in the zoning regulations is a means to expand the city's urban forest. However, City zoning largely does not provide protections for trees on individual parcels as there are no zoning regulations that require tree replacement on individual properties themselves in the event of damage or removal, except in a few instances in certain Special Purpose Districts.

Special Purpose Districts

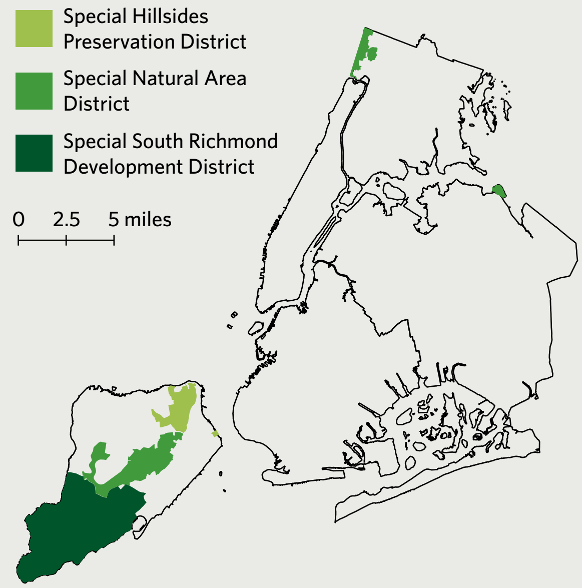
Since 1969, NYC has designated 64 Special Purpose Districts in order to achieve special planning and urban design goals in areas with unique characteristics.[29] The designations supplement (but do not replace) the three basic zoning district classifications (i.e., Residential, Commercial, and Manufacturing). Each Special Purpose District is designed to promote or maintain certain features, including, in some cases, ecologically sensitive areas. Special Purpose Districts are a policy instrument for tailoring zoning requirements to unique community conditions. Special Purpose Districts may share boundaries with, or cut across, the basic zoning districts, and the City may impose regulations and incentives for realizing the intended goals of each one.

As of 2020, at least 27 Special Purpose Districts in NYC had regulations that referenced trees. References to trees in these districts generally concern added design requirements for specific landmarks, additional open space requirements, or amendments to existing regulations to strengthen the street tree planting and urban design requirements.[30]

Regulations in some Special Purpose Districts go beyond regulating the streetscape to govern development to help protect trees on properties subject to zoning regulations. This is true for the Special Natural Area District, the Special Hillsides Preservation District, and the Special South Richmond District, in particular (**Figure 5.1**). Land in these districts that is subject to these requirements (tax lots, excluding mapped parkland)* comprise approximately 4,029 acres of canopy (9.45% of all citywide canopy) across 11,519 acres of land (5.96% of citywide land area). These Special Purpose Districts were generally established to guide new development in ways that maintain natural features and natural terrain for various reasons, such as maintaining irreplaceable natural and recreational resources, for public safety, and to support stormwater management.

Properties in all of these districts are subject to protection and replacement requirements based on a credit system (see **Box 5.2**), but specific regulations vary by district (and are sometimes contingent on aspects of individual properties). In the Special Natural Area District, for example, regulations specify that as-of-right development† is only allowed on small zoning lots with no significant natural features and impose stricter regulations for steep slopes, lot cover control, and private road design standards.[31,32] Furthermore, standards for new development in all lots must maintain either one tree per 1,000 sq. ft. of zoning lot area or 51% of tree credits, whichever is greater. Damaging or removing trees located in this district without prior permission from the City Planning Commission is prohibited, and violators are subject to a minimum fine of $750.[33]

Map of the Special Natural Area, Special South Richmond, and Special Hillsides Preservation Districts



Data Source: Special Purpose District and Borough boundaries from NYC Department of City Planning.

Figure 5.1 Map of Special Purpose Districts subject to tree planting and preservation based on a tree credit system.

Green Infrastructure Plan

In 2010, the NYC Department of Environmental Protection released its *Green Infrastructure Plan* (GIP), a long-term strategic plan to manage stormwater runoff and reduce overloading of the municipal sewer system by leveraging green infrastructure.[34] If successful, this effort would reduce combined sewer overflows, a major environmental challenge for the city, and promote the water quality goals of *PlaNYC*.[34] Green infrastructure, in this context, refers to infrastructure that absorbs and retains rainwater to reduce the amount of stormwater that enters the sewer system; installations can, but are not required to, include vegetated natural features, such as enlarged and enhanced tree beds and rooftops with vegetative cover integrated into them (green roofs).[35]

The GIP cites trees as one solution to stormwater, given their ability to capture rainwater and mitigate street flooding, along with shrubs and other groundcover. The potential addition of enhanced tree beds along streets present opportunities to increase canopy and further distribute trees' benefits to more areas of the city. Without careful coordination, some green infrastructure projects could preclude opportunities to plant trees in suitable areas if they are not included in the design (e.g., a non-vegetated infiltration basin is planned in an area suitable for trees).

* For these calculations we considered all land area that was not estimated to be right of way or City Parkland.

† As-of-right development is defined by the NYC Department of City Planning as development that complies with all applicable zoning regulations, not requiring discretionary actions or approvals by the City Planning Commission or Boards of Standards and Appeals.

BOX 5.2

Understanding Tree Planting and Protection Requirements in Applicable Special Purpose Districts

Sites within the Special Natural Area District, as well as the Special Hillsides Preservation District and Special South Richmond Development District in Staten Island, are subject to requirements for planting and preservation of trees, in part, based on a system of tree credits (**Figure 5.2**). A tree credit is awarded for preserving an existing tree that is at least six inches in diameter, or for planting a tree that is at least three inches in diameter. Credits are counted toward a tree planting and preservation requirement specific to these Districts, per the Zoning Resolution.[30] More credits are earned for larger, more mature trees. Tree credits are ultimately intended to help maintain a balance in the area between development and natural features. Of note, these requirements are different from NYC Parks' tree replacement requirements discussed earlier in this chapter.

Credits for Tree Protection in Applicable Special Purpose Districts

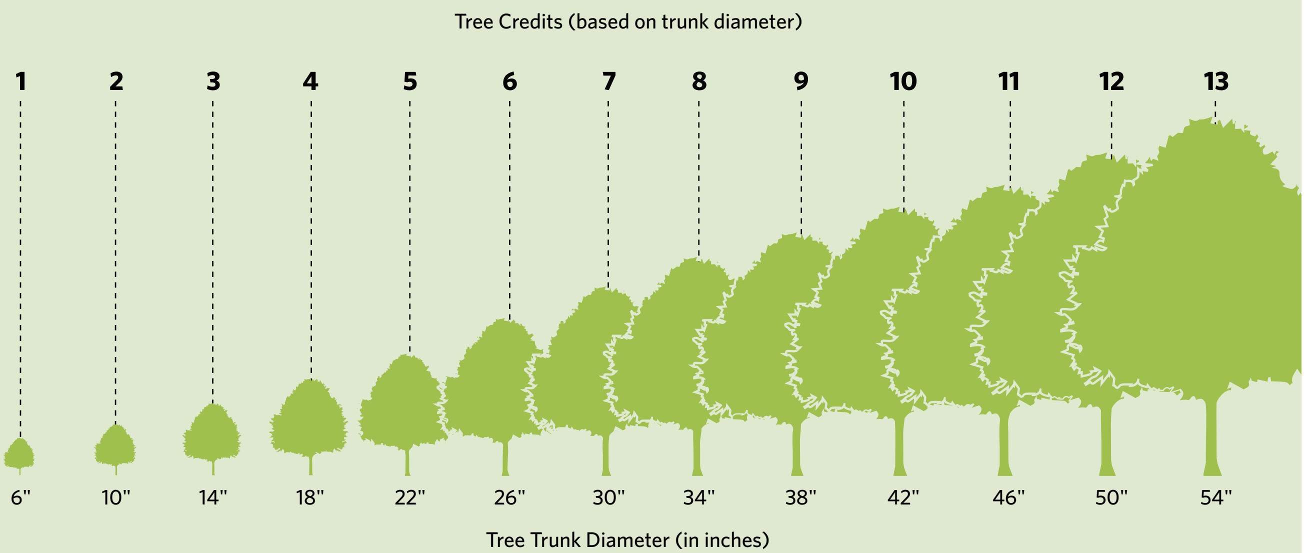


Figure 5.2 Illustration of the tree credit system used by the NYC Department of City Planning for trees preserved on properties in applicable Special Purpose Districts. A "tree credit" is applied to a property owner's tree preservation or planting requirements for preserving an existing tree that is at least six inches in diameter at breast height (measured at 4.5' from the ground), with one additional credit for every additional four inches of diameter. This diagram reflects rules as of this writing; proposed adjustments are under review.

Adapted from: NYC Department of City Planning. (2020). Special South Richmond Development District: Preliminary Recommendations [Government]. https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/si-distriict-text-amendment/special-south-richmond-presentation.pdf

Native plants, including a redbud tree (*Cercis canadensis*) growing along the Gowanus Canal at the Salt Lot, a Gowanus Canal Conservancy stewardship site in Brooklyn.

This patchwork of tree-related policies... jeopardizes...the urban forest.... Further consideration of policies that limit removal, provide broader protection, and provide incentives is warranted.

Environmental Review Processes

Although they are not restricted to the urban forest, required Federal, State, and City environmental review processes can result in protection and replacement of trees. The National Environmental Policy Act (NEPA) requires all Federal agencies proposing legislation or other major actions that would significantly impact the environment to produce an environmental impact report and subject it to public comment.[36,37] NEPA set the precedent for environmental reviews for projects carried out by government agencies, and the State of New York and City of New York each subsequently adopted similar review processes for their respective agencies.

The City of New York established the City Environmental Quality Review (CEQR) in 1977 and the process and procedures must meet or exceed the minimum standards established in the State Environmental Quality Review Act.[38] Per the CEQR Technical Manual, "CEQR requires all City agencies to determine whether discretionary actions they directly approve, fund, or undertake may significantly and adversely affect the environment" prior to embarking on it.[39] CEQR defines an action as a City agency activity that changes the use or appearance of a natural resource or structure, including any potential impacts to trees.[38] CEQR provides City agencies with a methodology and approach for gauging whether a certain action is in line with City sustainability policies. For example, the CEQR manual cites trees (and the NYC Parks rules and regulations governing them) as a crucial consideration with regard to potential actions and provides technical approaches to minimizing the impacts of certain projects on trees. Although these policies are intended to maintain environmental quality in the face of development, none include standardized urban forestry evaluations, such as projections of canopy change, which could be employed to understand the impact of individual projects.

Summary

Myriad policies affect the NYC urban forest. We examined the major public policies in terms of ownership and jurisdiction (City, State, Federal, and private) as well as multi-jurisdictional policies. Federal lands account for the smallest share of tree canopy in NYC by general jurisdiction, but the Federal government provides funding specifically for its research centers, which contribute knowledge and information that can inform urban forest policy. State lands, likewise, account for a relatively small portion of the tree canopy in NYC, but a number of State agencies and public benefit corporations maintain trees within the city with varying rules. NYC itself has several policies that apply to trees, particularly those under the jurisdiction of NYC Parks, and some pertaining to select zoning districts that account for a small but meaningful portion of canopy.

Trees in NYC largely lack protection from removal, which may put the overall urban forest at risk. One important exception is trees on City Parkland and rights of way which are within NYC Parks' jurisdiction and account for 53.50% of citywide canopy. These trees are generally subject to replacement requirements if removed and may not be removed without permits. Another exception is trees on properties within three Special Purpose Districts, which contain 9.45% of citywide canopy (on private property and other land subject to zoning regulations). These properties are subject to tree planting and preservation requirements based on the Zoning Resolution, though development in these sites can still generate net losses of trees and canopy. Thus, the portions of the urban forest under NYC Parks' jurisdiction and subject to regulations of the aforementioned Special Purpose Districts are afforded a degree of protection, although individual trees can ultimately be removed. Even in cases where replacement is required, it can take decades to recover the associated canopy and benefits of larger, old trees that are removed. Generally, the rest of the urban forest (associated with nearly 40% of the canopy), has little to no protection.

Given that many of NYC's more prominent zoning regulations relating to street trees were approved after 2007, properties that have not been developed or renovated since then have not been subjected to the latest regulations, leading to potential for less street trees than would now be required. The current policies governing private lands do not provide standards or incentives for property owners to effectively manage trees on their property, replace removed trees, or plant new ones, except under specific conditions (e.g., within select Special Purpose Districts).

In NYC, this patchwork of tree-related policies on both public and private lands jeopardizes the long-term survival and growth of the urban forest and also causes confusion about requirements, while rendering the requirements harder to enforce. And yet the existing policies, primarily those related to trees under the jurisdiction of NYC Parks and the Special Purpose Districts we considered, both help to conserve a meaningful portion of the forest and provide a promising set of rules and regulations that could be emulated and built upon for other property types. Further consideration of policies that limit removal, provide broader protection, and provide incentives is warranted.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These leaves are from the sweetgum tree (*Liquidambar styraciflua*), commonly known for its spikey, spherical seed pods. The sweet resin for which this tree was named was historically used in medicine, perfume, and chewing gum. In NYC, sweetgum trees are often found in forested natural areas and landscaped portions of City Parkland.

CHAPTER 6

Funding

Public funding is invested in some parts of the New York City (NYC) urban forest. This includes tree-related expenditures by the NYC Department of Parks and Recreation (NYC Parks), which manages approximately half of the citywide canopy, and some State and Federal programs that offer grants for urban forestry. Other City agencies, such as the NYC Department of Education, NYC Department of Environmental Protection, and NYC Department of Transportation, have trees under their jurisdiction, but there is limited information about funding for these trees, which make up a small portion of the NYC urban forest. In addition, some modest private funding sources supplement public expenditures.

City Budget

Through its regular budgeting process, the City of New York provides NYC Parks with expense funds, which come from City tax revenues, and capital funds, which come from City-issued bonds.* In this report, we were only able to analyze Other than Personal Service (OTPS; i.e., non-personnel related) expenditures as part of the expense budget. For City budget numbers as a whole, we leveraged publicly available data from the NYC Office of Management and Budget,[1,2] and received guidance from NYC Parks on the budget codes for tree-related activities. All budget figures from Fiscal Year† 2006–2020 (FY06–20) are adjusted for inflation to FY21.

OTPS expense funds support activities such as:

- Street tree pruning
- Tree and stump removal
- Pest and disease control
- Clean-up after storms
- Decennial tree censuses
- Sidewalk repairs around trees
- Forest restoration
- Deer management

Capital funds support activities such as:

- Street tree planting
- Sidewalk enlargements around trees
- Forest restoration

* The historical expense and capital funding values in this report are strictly public funding (allocated by both the Mayor and NY City Council) and do not include other sources of the City's funding for trees, including regulatory mitigation tree planting funds.

† Fiscal Years for the City of New York run from July 1 of one calendar year through June 30 of the following, and the year assigned to the fiscal year is the year that starts on January 1 during that period.

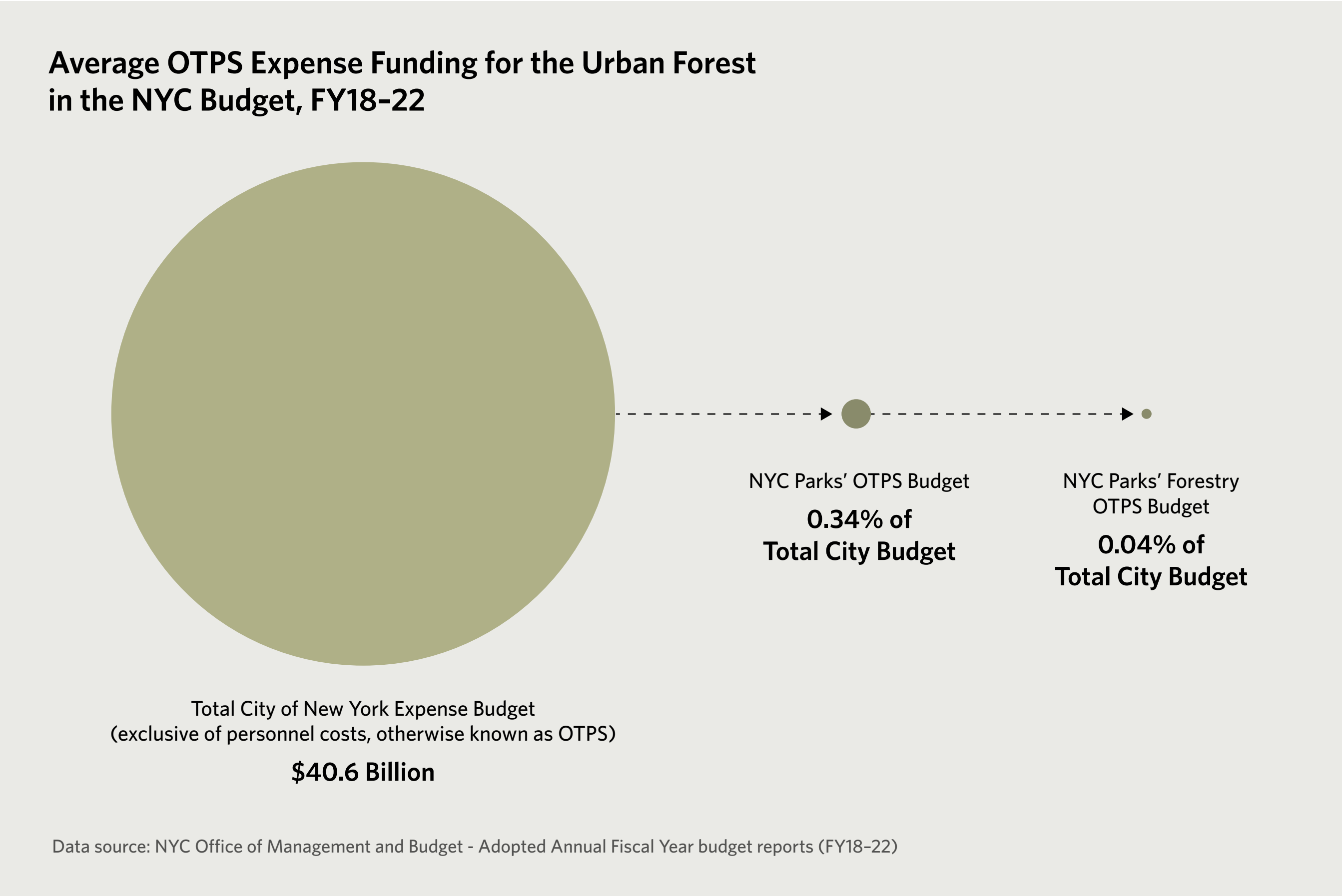


Figure 6.1 Average annual FY18–22 OTPS expense budget for the City of New York, NYC Parks, and forestry activities of NYC Parks. Values for FY18–20 were adjusted for inflation to 2021 dollars before being averaged.

From FY18 to FY22, NYC Parks received an average of 0.34% of the total City OTPS expense budget (or about $140 million of $40.6 billion per year, adjusted for inflation). The portion allocated just to urban forestry work was only 0.04% of the total City OTPS expense budget (or an average of $23 million per year, adjusted for inflation) (**Figure 6.1**). During this period, approximately 12.3% of the agency's OTPS expense budget, and approximately 6.4% of its capital budget, went toward planting street trees, landscaped park trees, and restoration efforts (including tree planting) in forested natural areas.*

Urban forest funding is highly variable and inconsistent from year to year (**Figure 6.2**). Over the last five fiscal years, the total capital and OTPS expense funds allocated for urban forestry ranged from approximately $13 million to $88 million per year (adjusted for inflation to FY21 dollars). This wide range and variability is largely due to the fact that most of NYC Parks' general and tree-related expenses are not baselined into the budget (i.e., they are not guaranteed funding in each budget cycle), and even if baselined, these allocations are subject to removal during budget cuts. Non-baselined funds are more vulnerable to large reductions, although baselined funds can still be vulnerable to reductions when the City of New York requires budget cuts. The significance of this variability is apparent in the FY21 budget cycle. When the COVID-19 pandemic led to a citywide fiscal crisis, NYC Parks' funding for trees was severely cut.

A 6.2% reduction in the City's OTPS expense budget between FY20 and FY21 led to cuts to the already slim NYC Parks' OTPS expense budget for urban forestry. NYC Parks' OTPS expense budget was reduced by 35% (about $55 million), with the urban forestry portion cut drastically,

* The forested natural areas referred to here are specifically those within City Parkland. See Chapter 2 for further descriptions of forested natural areas.

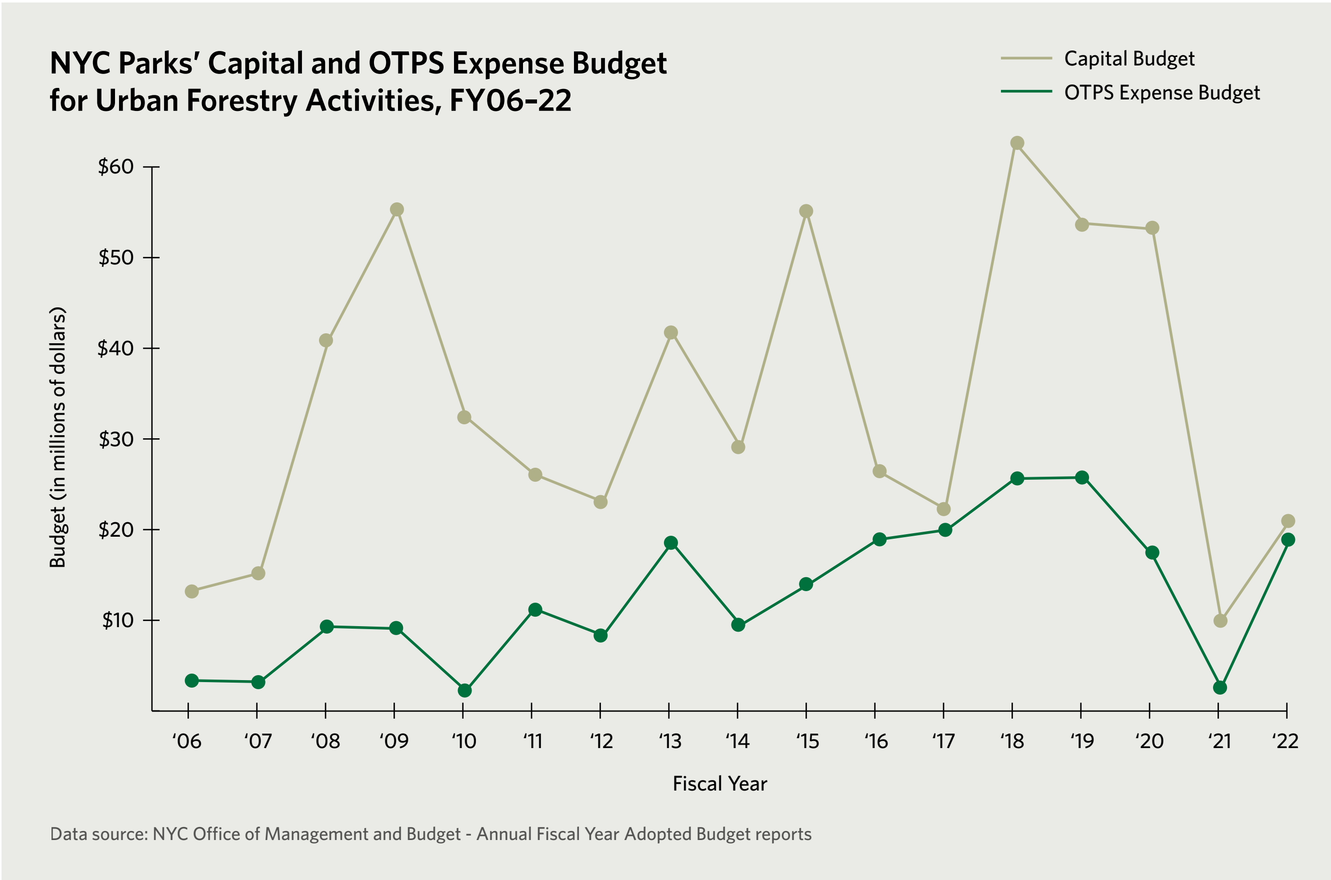


Figure 6.2 NYC Parks' annual capital and OTPS expense budgets for urban forestry activities have fluctuated through the years, with the lowest budget in recent years occurring in FY21. All values from FY06–20 are adjusted for inflation to reflect 2021 U.S. dollars.

by 85% (from $17.4 million in FY20, adjusted for inflation, to $2.6 million in FY21), as shown in **Figure 6.2**. The urban forestry OTPS expense budget was left at its lowest point in 11 years, dropping to about the same levels, adjusted for inflation, as FY10, which was toward the end of the Great Recession. Such budget reductions seriously impair NYC Parks' capacity to provide adequate care and maintenance to all the trees in its portfolio. In FY22, the budget was restored to FY20 levels.

Capital funding for the urban forest also varies from year to year, as shown in **Figure 6.3**, and is heavily dependent on timebound or short-term government initiatives.* Since FY06, the majority (approximately 80%) of NYC Parks' capital funding related to trees has gone toward street tree planting. Despite large increases in the capital budget for street tree planting, the baseline funding for this activity remained steady for 15 years (FY06–20) at approximately $7.3 million per year, and was just recently increased to $10 million per year for FY21 and FY22; no other tree-related activities that rely on capital funds are baselined. While baseline funding has remained mostly stagnant, the costs of tree planting have been rising. In 2020, the average cost of planting a street tree was $2,700, nearly double the cost of five years earlier.[3]

Since FY06, the majority of the increases to the City's tree-related capital budget came from two recent high-profile Mayoral initiatives: the Million Trees NYC Initiative (MillionTreesNYC) and Cool Neighborhoods NYC. Under MillionTreesNYC, the City committed roughly $309 million to NYC Parks for urban forestry work (cut from an initial $391

* It is important to note that unlike expense funds that must be spent in full each year, capital funds that are budgeted each year may be reallocated or carried into future years.

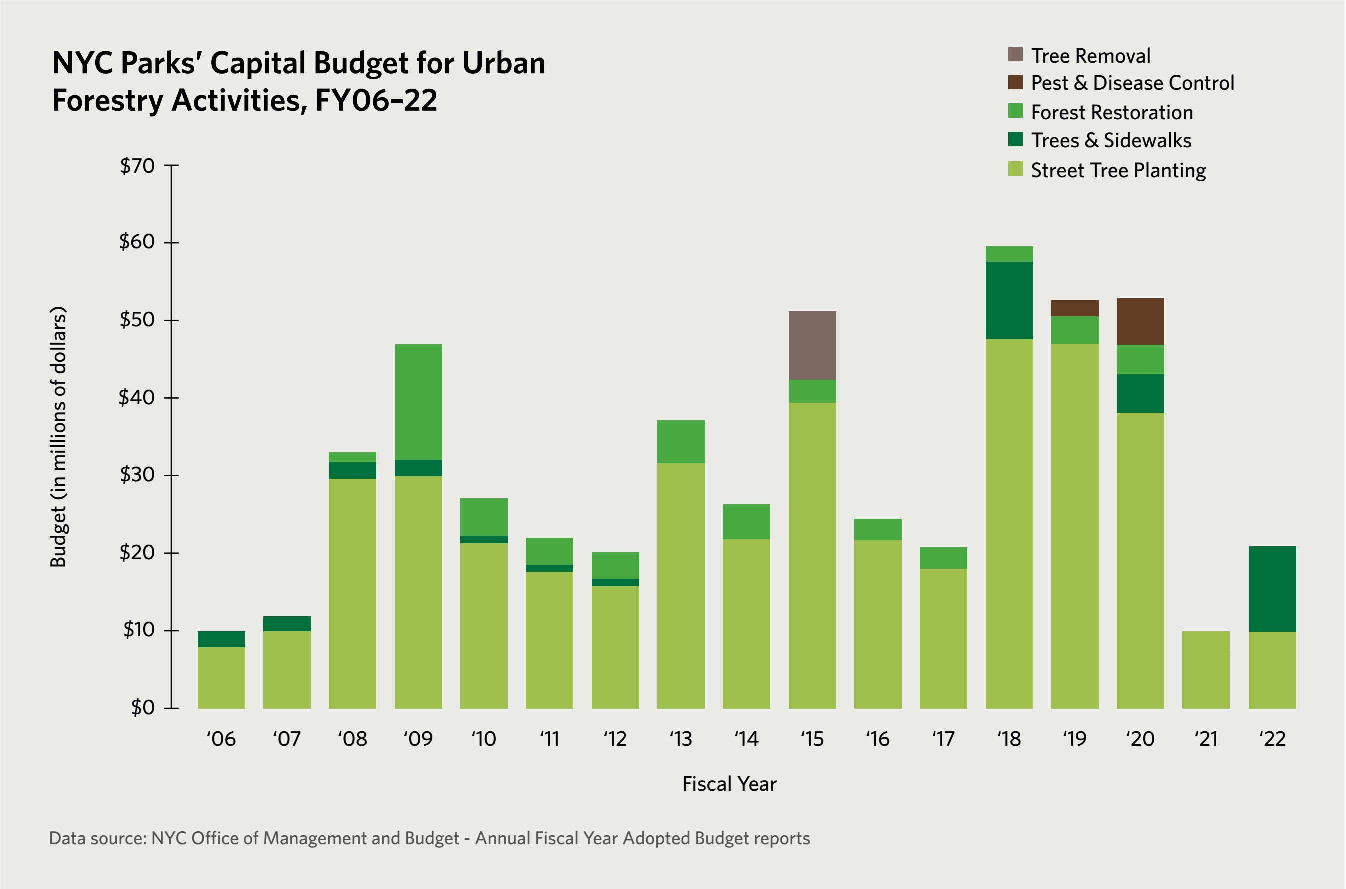


Figure 6.3 NYC Parks' annual capital budget for urban forestry activities has fluctuated through the years, with the lowest budget in recent years occurring in FY21. All values from FY06–20 are adjusted for inflation to reflect 2021 U.S. dollars.

million allocation[4]) over FY08–17.[*,†] Cool Neighborhoods NYC committed $106 million over three years (FY18–20) for trees in order to mitigate extreme heat. Of this amount, the City committed $82 million to street tree plantings in areas that are disproportionately more vulnerable to heat risks, $16 million to support tree plantings in parks, and $7 million to support forest restoration across the five boroughs.[5]

When Cool Neighborhoods NYC funding was completed at the close of FY20, while its implementation was ongoing, there were no new planned mayoral or other government initiatives to consistently and substantially fund urban forestry efforts for the long term. Furthermore, given the economic impacts of COVID-19, in FY21 NYC Parks received the smallest capital budget for urban forestry since FY06, adjusted for inflation. The FY21 budget was only $10 million and it only funded street tree planting and no other programs.

Inconsistent funding creates challenges for long-term planning and management of the urban forest. Tree planting requires years of planning, from coordination with nurseries to provide new trees of the appropriate species (**Box 6.1**), to care of young trees prior to and after planting.[6] Unpredictable budget fluctuations make it difficult to keep up with planting schedules because tree seedlings require at least a few years' lead time of watering, transplanting, and fertilizing before they are ready for planting. At the same time that the seedlings are growing in nurseries, NYC Parks must secure contractors to prepare the site for planting, an effort that also has a lengthy lead time. Time is also required for NYC Parks to select

* Additional private funds for MillionTreesNYC were provided through donations from Bloomberg Philanthropies and David Rockefeller, as well as corporate sponsorships secured through the partnership with the New York Restoration Project.[4]

† Though public funding was allocated through FY17, the initiative reached its planting target early, planting the one millionth tree in 2015.

BOX 6.1

From Farm to Urban Forest: Bespoke Trees of New York City

As a society, we plant trees with thoughts of the future. But tree planting choices are informed by decisions of the past. Many people do not realize that tree nurseries sow their arboreal crops years before they are big enough to sell, hoping the sapling investment will meet future tree demand. To manage this economic risk, private nurseries shape inventories according to what is popular and what will sell. This typically results in 30–40 kinds of trees that are commonly available for purchase in nurseries and therefore commonly found growing in many public and private landscapes. This is relatively low diversity which can pose a risk to the long-term health and resilience of the urban forest, given threats of tree pests, diseases, and our changing climate.

In 2009, spurred by MillionTreesNYC, NYC Parks launched a new model for tree procurement. Instead of buying trees at the time of planting, NYC Parks executed long-term contracts with nurseries to provide a steady supply of trees, at steady prices, for future projects.[7] Specifying a greatly expanded species palette and a range of sizes, the trees are grown to exacting standards, shaped according to their ultimate planting location (limbed up for streets, branched out for some park applications, and grown from local native seed for natural areas), and harvested with utmost care for their journey to New York City. Twelve years, 150 species and 1,110,000 ready-to-plant trees later, the agency's tree procurement program remains a signature achievement and one of the key pillars of NYC Parks' urban forestry program (NYC Parks, personal communication).

appropriate tree species for each site and coordinate with local utility companies to ensure that planting does not conflict with other infrastructure.

Funding inconsistency also creates challenges for routine, programmed pruning schedules. Programmed pruning, one of the foundations of a proactive urban forestry program, is the routine tree maintenance that is conducted on an equal portion of the tree population every year, in contrast with pruning that is primarily conducted on demand, in response to public requests or documented tree risk. NYC Parks reduces system-wide risk through pruning and individual tree risk through regular tree assessment.

In NYC, planning for programmed pruning of street trees is based on a seven-year cycle, which requires a stable flow of funding in order to provide the same level of service across neighborhoods each year. Sudden and significant budget cuts can impact the City's ability to maintain its schedule. Reduced funding in FY21 due to the COVID-19 pandemic, for example, posed a critical challenge to this important work. Funding for programmed pruning was cut by nearly 78%, from $7.1 million (adjusted for inflation) to $1.6 million, in FY21. This smaller level of funding is equivalent to the amount needed in a 40-year pruning cycle, rather than a seven-year cycle, and is the same level of funding that was available for street tree pruning prior to the establishment of the City's routine pruning program in 1998 (NYC Parks, personal communication). Maintaining NYC Parks' proactive, comprehensive approach to urban forestry would require the City to increase and baseline budgets for activities like programmed tree pruning.

Proper tree maintenance, which is crucial to the health, safety, and longevity of the NYC urban forest, also requires personnel. Personnel expense data for NYC Parks' urban foresters are not available; however, the number of allocated staffing positions for permanent employees who work in urban forestry is known. The management of trees, including planting and pruning, is performed by a highly skilled staff of arborists and tree care professionals. In FY21, NYC Parks had an allocation of 159 year-round employees who performed tree maintenance work across NYC's five boroughs, as shown in **Figure 6.4**.* Together, they managed over 800,000 street trees and trees in landscaped park areas (see Chapter 2 for further information on inventories of these types of trees). NYC Parks also employs seasonal forestry workers through external grant funding as well, which suggests that the agency is not receiving adequate funding for its full workforce needs through the City budget. The ability to hire seasonal workers, and the number of seasonal workers, are highly variable from year to year and

* Not all allocated (or allowed) number of staff positions are filled each year, throughout the year, due to various reasons, such as employee attrition.

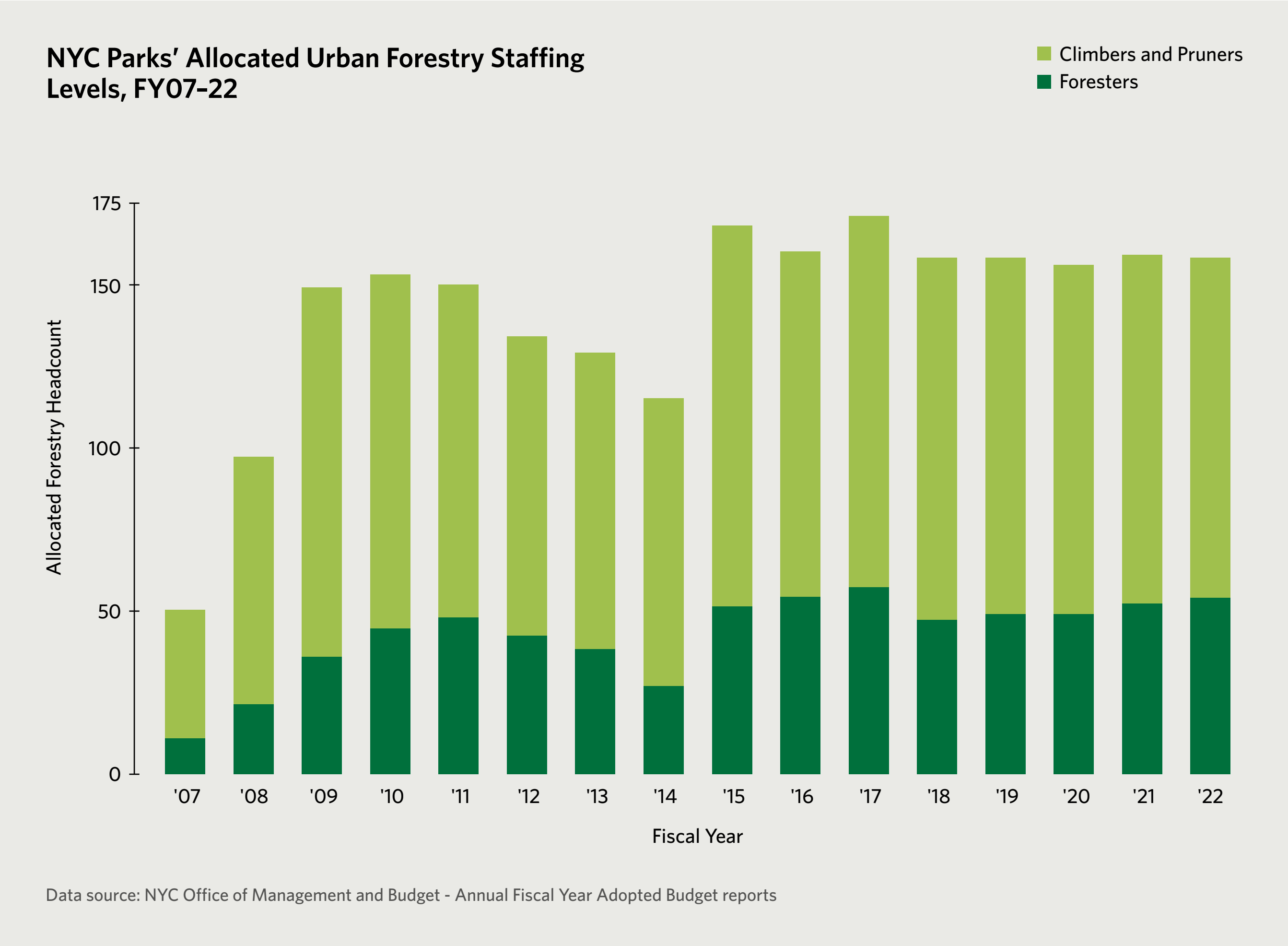


Figure 6.4 The number of year-round urban forestry staff (as opposed to seasonal or contract workers). Approved staffing levels for foresters, climbers, and pruners has fluctuated but remained fairly consistent recently, particularly since FY18. No data were publicly available for FY06.

dependent on the annual budget cycle. To help fill shortfalls, NYC Parks also relies on volunteer tree stewards, as discussed in Chapter 7. Without the full urban forestry headcount, including seasonal staff, it is unclear whether current staffing levels are sufficient.

Role of the Public in the City Budget

Though the NYC urban forest is inconsistently funded and often at risk of budget cuts, the public can do a great deal to secure additional funding for the resource, through advocacy efforts with the Mayor's Office and NY City Council members, and through participatory budgeting (PB). Mayoral funds include both uses of expense funding (for personnel and OTPS) and capital funding, and has composed roughly 80% of tree-related funding between FY06 and FY21. The City Council, which has its own pool of funding, has funded approximately 2.7% of NYC Parks' tree-related budget in that timeframe. Each year, City Council members hold public hearings in which residents, advocates, and City agencies may advocate for additional funding. Between FY15 and FY20, the City Council allocated $1–5 million per year for tree-related expenses. In FY20, the Play Fair coalition (see **Box 6.2**) succeeded in securing a $44-million increase to the NYC Parks' budget through advocacy with the City Council and the Mayor's Office, $4 million of which went toward urban forestry.

New Yorkers also can have a direct role in the City budget through PB. Through this democratic process, community members can propose capital improvements in their City Council District and vote on projects to receive discretionary

BOX 6.2

Needed Investments in Forested Natural Areas of NYC

The only segment of the NYC urban forest that has a long-term, citywide plan, including a formal valuation of required management costs, is forested natural areas. Forested natural areas make up 31% of City Parkland in NYC, an estimated 8,037 acres. According to the *Forest Management Framework for New York City* (FMF), published in 2018 by the Natural Areas Conservancy and NYC Parks, fully supporting NYC Parks' forested natural areas would require an estimated $385 million over the 25 years following the FMF's release, including $200 million for capital funding and $185 million for expense funding.[8]

Forested natural areas of City Parkland have not received the consistent or sufficient funding needed for proper management. For example, the FMF outlines expense needs of nearly $8 million per year, but these spaces received baselined expense funding of only $50,000 per year from FY16–19. In FY20, New Yorkers for Parks led the formation of the Play Fair coalition, which launched the multiyear Play Fair for Parks campaign to meaningfully increase funding for NYC Parks through coordinated advocacy efforts and engagement with the Mayor's Office and City Council. Through this advocacy and other efforts, approximately $4 million was allocated for forested natural areas in FY20.

Part of the FMF was funded for one year, thanks to the Play Fair for Parks campaign, but there is still no long-term commitment to fund its ongoing implementation. Budget cuts in FY21, due to COVID-19, meant that restoration activities for forested natural areas received no capital funding and only $50,000 in OTPS expense funds. Intermittent funding is especially problematic for forested natural areas, as one of the primary threats in these areas is invasive species and managing them requires dedicated and reliable annual funding.

funds. The projects that receive the most votes are then adopted into the City budget and implemented by the relevant City agencies. Starting in FY12, individual City Council members could choose whether to allocate funds through PB. As of 2020, the majority of the 51 City Council members participated in PB and allocated over $40 million annually.[7,8] From FY13 to FY20, the number of tree-related, proposed projects (e.g., tree planting, protection, care) per PB cycle increased, as shown in **Figure 6.5**.[10,11*] The majority of these projects focused on installing tree guards and planting new trees along streets and in parks.

New York State and Federal Funding Programs

A variety of State and Federal funding programs also support urban forestry in NYC. The State of New York administers urban forestry–related programs and resources that relate to the NYC urban forest. The main statewide program is the New York State (NYS) Department of Environmental Conservation Urban and Community Forestry Program (UCF), advised by the NYS Urban Forestry Council. The UCF is a "partnership between Department of Environmental Conservation forestry professionals, public and private individuals, and volunteer organizations who care about trees in urban settings."[12] The UCF and the Urban Forestry Council advisors help to provide technical and financial resources to practitioners who wish to promote urban forestry. These include small or large community grants (a minimum of $11,000 and up to $50,000 and $75,000, respectively, as of 2020) to localities, quasi-governmental entities (such as public benefit corporations, public authorities, or soil and water conservation districts), and nonprofits for urban forestry projects. The grants support projects related to urban and community forest management planning, education programming, tree inventories, maintenance, and planting.[13] In 2018, nine NYC groups were awarded approximately $620,000 from the program (out of $2.24 million awarded statewide).

A parallel organization exists at the Federal level. The National Urban and Community Forestry Advisory Council was established as part of the Food, Agriculture, Conservation, and Trade Act of 1990 with a mandate to develop a National Urban and Community Forestry Action Plan, evaluate the

* Tree-related projects prior to 2017 were identified using Participatory Budgeting project data obtained from the Participatory Budgeting Projects dataset on NYC Open Data. More recent projects, which have not been compiled into the dataset, were obtained through the New York City Council website. Projects with the term "tree" in the title or tree-related work in the description were included.

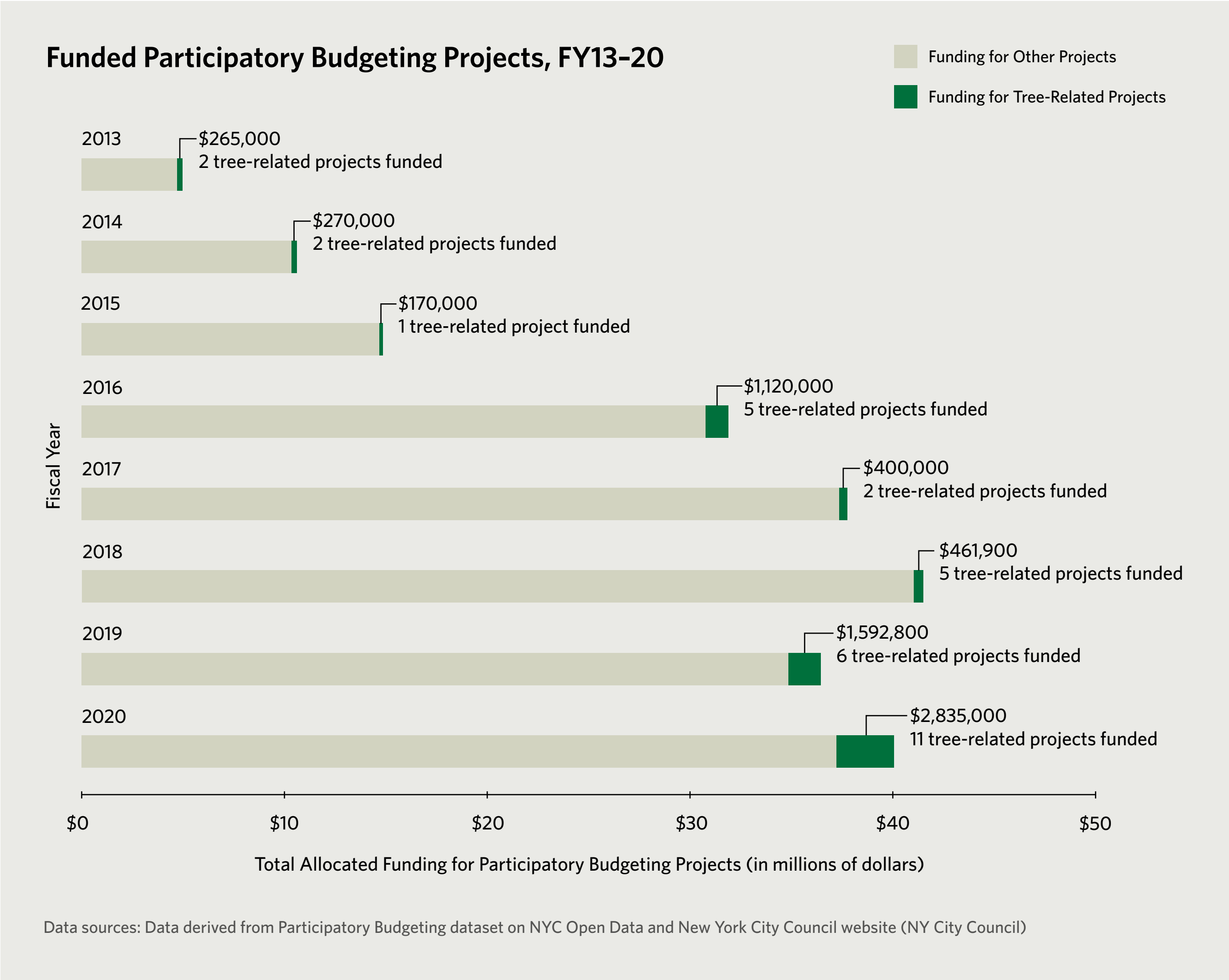
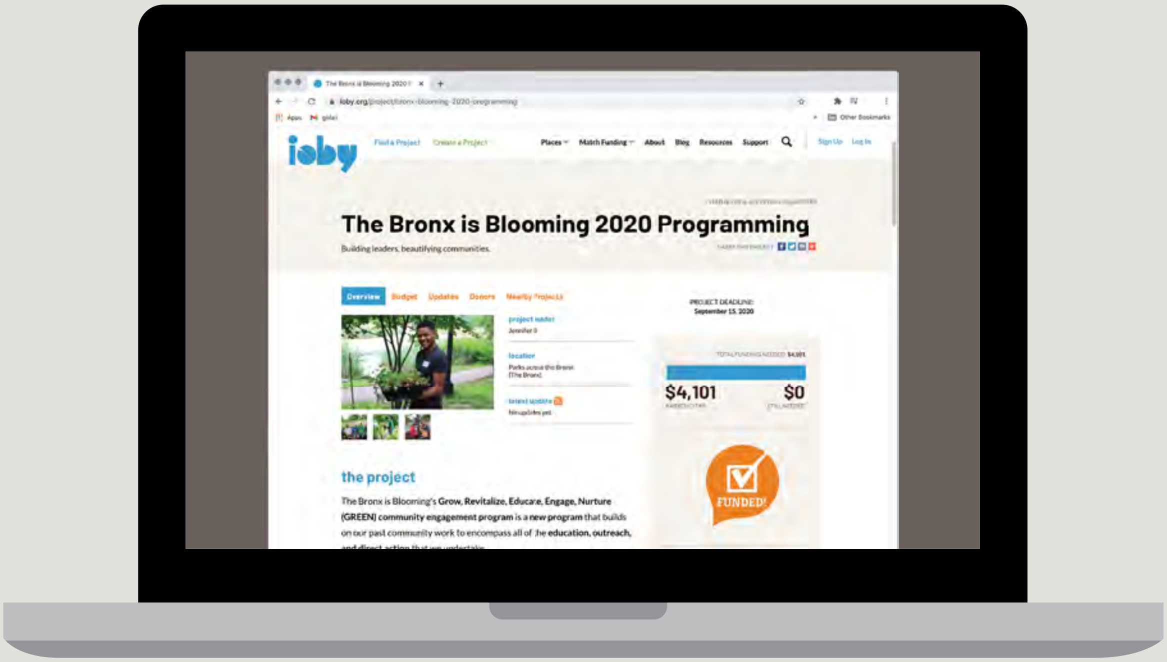


Figure 6.5 Funding for tree-related and other Participatory Budgeting projects FY13–20. A total of approximately $218 million in Participatory Budgeting funding was allocated to selected projects. Of this total, 34 projects were tree-related and received a total of about $7 million in funding. A Participatory Budgeting cycle was not executed in FY21 due to the COVID-19 pandemic.

Overall, funding for the urban forest in NYC is highly variable, short-term, and insufficient to meet the ongoing needs of the resource.

Crowdfunding for the NYC Urban Forest



Screen capture from: ioby, https://ioby.org/project/bronx-blooming-2020-programming

Figure 6.6 An example of a successful crowdfunding effort in the Bronx designed to support the urban forest through a variety of means, including stewardship, outreach, and education. This specific effort, The Bronx is Blooming 2020 Programming, was crowdfunded through the ioby platform.

enactment of that plan, and develop criteria for the Urban and Community Forestry Challenge Cost Share Program. The Cost Share Program funds proposals for program development, study, and collaboration supporting the strategies of their National Ten-Year Urban and Community Forestry Action Plan (2016–2026).[14] Although the total amount of funding available (approximately $900,000 in 2020) is not large, and little funding has flowed to NYC from this initiative, the Council has developed benchmarks for urban forestry that could be adapted to evaluate progress in NYC.

A national program that helps protect forests, including urban forests, is the Land and Water Conservation Fund (LWCF), which was established by the Land and Water Conservation Act of 1964. Since its inception, the LWCF has provided more than 40,000 grants worth over $16 billion to both State and local governments for park and recreation development.[15] New York City received almost 100 of these grants between 1965 and 2011 to support parks such as Inwood Hill Park, Manhattan; Van Cortland Park, the Bronx; and Highland Park, Queens.[16] Many of the parks in NYC that benefited from LWCF grants contain some of the densest tree canopy in the city, and the LWCF has been an important factor in sustaining them.

Funding From Private Sources

Funds from various private sources, including corporations, charities, and foundations and more recently, crowdfunding, make many urban forestry projects possible. For example, the Mayor's Fund to Advance NYC, a nonprofit, partners with NYC Service, a division of the Office of the Mayor focused on volunteerism and service, to offer $1,000 Love Your Block grants and

Brooklyn Botanic Garden arborists check one of the Garden's ash trees (*Fraxinus* sp.) for signs of emerald ash borer (*Agrilus planipennis*).

support from City agencies, including NYC Parks. This program supports resident-led groups for block beautification projects.[17] Partnerships for Parks, a joint program between the City Parks Foundation and NYC Parks, also offers grants to support projects that plant or maintain trees. Crowdfunding platforms such as Kickstarter, GoFundMe, and ioby (in our backyards) can also be used by grassroots organizations or citizens to raise money by requesting small donations within their local communities to fund tree planting and maintenance projects (**Figure 6.6**).

NYC Parks, specifically, has also received private funding to conduct urban forestry work. For example, in 1991, the City Parks Foundation was awarded a grant from the Lila Wallace/Reader's Digest Fund to, collaboratively with NYC Parks Natural Resources Group, develop the Urban Forest and Education Program, which focused on upland forest management.

In addition, non-NYC Parks plantings for MillionTreesNYC were supported in various ways; the New York Restoration Project notably raised $30 million for plantings focused on a variety of publicly accessible private lands.

Summary

Overall, funding for the urban forest in NYC is highly variable, short-term, and insufficient to meet the ongoing needs of the resource. In order to maintain a thriving urban forest, funding to support it needs to be both adequate and consistent. While NYC Parks' funding for trees has increased slightly over the last 16 years due to time-bound government initiatives, it has never been consistent. Inconsistencies in funding exist because most funds for urban forestry in recent years have been tied to temporary government initiatives (e.g., MillionTreesNYC, Cool Neighborhoods NYC), rather than baselined funds for essential programs in the City budget. In addition to funding from the City, there are State and Federal grants that support trees in NYC, but the total number of awards has been small relative to the scale and needs of the resource.

The consequences of this variability in funding could include a decline in the overall health and resiliency of the urban forest, as well as a decline in the many benefits it provides. The public can play an important role in shaping the City's budget for the urban forest into the future, through advocacy for more funding and engagement in the participatory budgeting process.

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These leaves are from the black cherry tree (*Prunus serotina*), a native species often found in forested natural areas of NYC. The fruit of the black cherry is an important food source for wildlife. Black cherry trees have distinct bark that is sometimes described as looking like burnt potato chips.

CHAPTER 7

Management and Stewardship

Active management and stewardship are needed to maintain and grow the New York City (NYC) urban forest and increase the benefits it provides, to mitigate risk, and to maintain the ecological health of the system. Just over half of the NYC urban forest, measured by canopy, falls within the jurisdiction of the New York City Department of Parks and Recreation (NYC Parks) and has clear and coordinated management. The remainder has variable management, dependent largely on ownership and land use, though about a third, on private property, may often be un- or under-managed. The work that is done involves thousands of individuals, including professional staff and volunteers, and costs millions of dollars—and additional effort is ultimately needed.

The management of the urban forest is guided by the goals of City administrators, the perspectives of agency officials, and the attitudes and engagement of various other stakeholders. As described in Chapter 5, decisions about urban trees are largely based on governance—the actors, policies, and decision-making processes that have authority in particular locations,[1] and where trees exist across the landscape (see Chapter 2 for further description of the distribution of the urban forest). Adequate management is essential to sustaining and maximizing the benefits provided by the urban forest.[2]

The stewards of the NYC urban forest are those who manage and care for it. Campbell[2] defines stewardship as "conserving, managing, monitoring, advocating for, or educating the public about local land, air, water, waste, energy, or toxics issues." Stewards include large public agencies that operate at a city, state, regional, or federal level, and smaller civil-society organizations that can include private, not-for-profit, and informal groups.[3] Stewardship groups work on issues ranging from public health to housing. While individual property owners have responsibility for the trees on their own property (Chapter 5), some policies dictate who is responsible for, or even allowed to manage, individual parts of the NYC urban forest. For example, anyone is allowed to water street trees, but not anyone can legally prune them.

The various government agencies, institutions, and individual landowners in NYC have their own budgets, regulations, and priorities related to the urban forest. The scope and responsibilities of each party vary, but they tend to be tied to whether it is a government entity, the scale at which it operates (e.g., City, State, Federal), what the priorities are, and how the entity is related to political geographies, such as NYC Community Districts or Council Districts (including the influence of, or responsiveness to, community-based organizations within their jurisdictions). The organizations for which we have the most information are highlighted here, although others also do valuable, relevant work.

Our research revealed that the following are some of the key management actions (in no specific order) that help sustain the NYC urban forest:

- Inspection and inventory management of trees
- Preservation and protection/conservation of trees
- Tree risk assessment and mitigation
- Protection from damage due to construction, car strikes, storms, and other sources
- Selection, purchase, and propagation/planting of environmentally suitable trees
- Tree bed preparation and care
- Routine pruning
- Control of invasive species, pests, and pathogens, including removal of damaged trees
- Repair of sidewalks around street trees
- Management of wood waste
- Tree valuation and replacement

Potted trees stand in a natural area in Forest Park, Queens, at a planting event hosted by the Natural Areas Conservancy. While natural areas depend largely on natural regeneration of trees, they also require active management for long-term resilience.

- Research and monitoring
- Trail development and maintenance

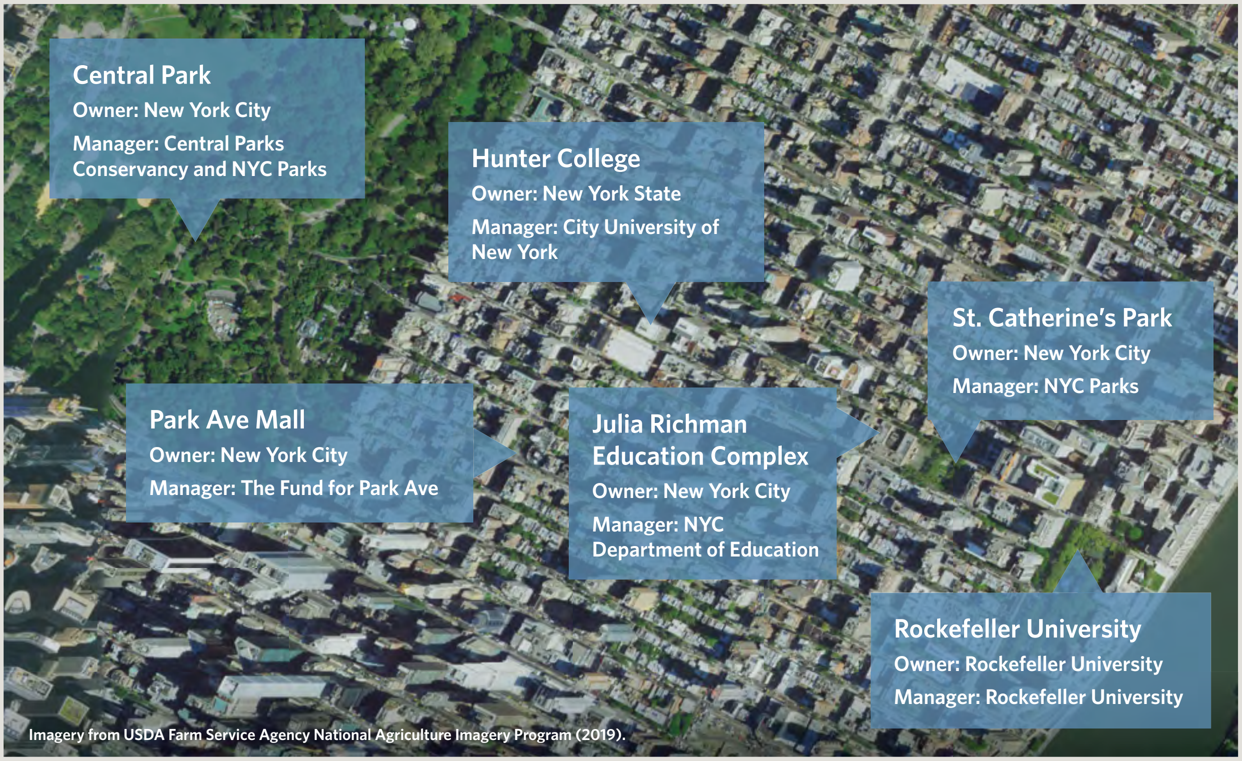
Many of these management actions apply to certain parts of the urban forest. For example, several of these activities, including tree bed preparation, pruning, and tree replacement, are most relevant to trees managed at an individual level (e.g., street trees in public and private landscaped spaces such as landscaped parks, campuses, and yards). Forested natural areas are generally very different but also require active management, research, and monitoring to understand and maintain the health of the ecosystem.[4] As forested natural areas rely substantially on natural regeneration of trees to sustain themselves over time (see Chapter 2), it is particularly important to promote this process for long-term resilience. Furthermore, given the uniqueness of these spaces in cities, additional work is required to maintain safe and inclusive trails that support and benefit people in various ways.[5]

Along with reforestation and afforestation, reduction of invasive species is a primary management activity for forested natural areas in cities.[6] Invasive vegetation, as well as pests and disease, pose substantial threats to the long-term health of local forests. Introduced plants often outcompete native species, reducing the capacity of native vegetation to regenerate and persist in the long term.[7,8] Invasive species contribute to declines in local biodiversity,[9,10] alter forest structure,[11] and disrupt ecosystem processes.[12,13]

Figure 7.1 illustrates some of the complexity of management the urban forest. Overall, NYC Parks is responsible for over half the resource, and they often partner

Who Cares for The Urban Forest in NYC: A Snapshot

The urban forest is managed through a complex web of partnerships in which the skills and assets of each partner are shared to create, maintain, and sustain NYC's trees. Volunteers play a critical role in caring for trees on all property types.



Backyard Trees
Owner: Private property owners
Manager: Private property owners

Street Trees Citywide
Owner: New York City
Manager: NYC Parks and Partners

Forested Natural Areas Citywide
Owner: (Primarily) New York City
Manager: (Primarily) NYC Parks and the Natural Areas Conservancy

Figure 7.1 Examples of the parties that manage or co-manage the urban forest across public and private land in NYC. The resource is ultimately managed by a complex network of entities, including individual volunteers, institutions, and others across these spaces. Note, most forested natural areas are within NYC Parks' jurisdiction; the remainder are in the jurisdiction of other parties.

with others to manage trees in their jurisdiction. Other public spaces are managed by their associated agencies, as discussed in the following text. While many of these entities manage small portions of the urban forest compared to NYC Parks, the total canopy overseen by each may be on the order of hundreds or thousands of acres. In contrast, each private property is under the jurisdiction of one of hundreds of thousands of different private entities or individuals, ranging from institutions, to businesses, and homeowners; most, individually, hold a very small portion of the urban forest.

Some parties in NYC do not manage the urban forest on any specific properties, but are influential in stewardship of the resource. Of note are the U.S. Department of Agriculture (USDA) Forest Service and their research stations, particularly the NYC Urban Field Station, which provides research and technical assistance to land managers, city planners, and policymakers in forestry-related science. Also of note is the New York Restoration Project (NYRP) for their role in the Million Trees NYC Initiative (MillionTreesNYC).

The management of the urban forest is guided by the goals of City administrators, the perspectives of agency officials, and the attitudes and engagement of various other stakeholders.

City, State, and Federal Managers

NYC Parks

As of 2017, more of the urban forest fell within NYC Parks' jurisdiction than any other entity, with about 53.50% of all NYC canopy within either public rights of way (largely attributable to street trees) or City Parkland. In addition to carrying out all of the previously mentioned actions to care for the resource, NYC Parks leads various efforts that support achieving City prerogatives through mechanisms like program implementation, permitting, and establishing standards. NYC Parks also implements censuses of street trees and landscaped park trees in City Parkland; they maintain and manage data for these assets and develop relevant performance metrics. These activities themselves may be accompanied by management of budgets to support them, and training of staff, volunteers, and partners. Specific ways in which NYC Parks manages the urban forest have been adapted through time to follow or establish best practices. For example, prior to 2017, NYC Parks prioritized tree removal requests from the public. With the development of industry-wide tree risk management practices, NYC Parks shifted to a risk-based urban forestry program prioritizing tree work (primarily removals and pruning) to reduce risks to the public, regardless of the origin of the request (NYC Parks, personal communication).

The management of street and parkland trees is carried out by in-house personnel (foresters and climbers/pruners) and contracted arboricultural professionals who are hired and overseen by NYC Parks forestry staff. NYC Parks staff include experienced climbers and pruners who respond to risk-based tree pruning and removal needs, while contractors proactively prune trees on a regular basis. NYC Parks plants (or contracts planting of) street trees in response to requests from residents and in accordance with City priorities. Planting follows a procedure in which foresters determine the specific site and species.[15] NYC Parks also oversees the valuation of trees whose removal and replacement are permitted, and shares information about how to care for street trees. Street trees are generally sourced from tree nurseries with which the City has entered into long-term contracts to grow a large variety of species to standards established by NYC Parks.

Street trees are guaranteed by planting contractors to survive for the first two years, with maintenance and watering conducted by the contractors. If the trees die during this period, the contractors are required to replace them. Beyond the guarantee period, street trees are pruned following a risk-based pruning process or as part of a routine schedule of "programmed pruning." They are pruned by in-house crews until they reach 4–6" diameter, at which time they enter the programmed pruning cycle and are pruned by contractors employed by NYC Parks (though in-house arborists also prune as needed for risk management). The pruning cycle is intended to ensure that all street trees are professionally pruned every seven years, but the timetable is subject to budgetary constraints. Citizen Pruners trained by Trees New York (Trees NY; discussed later in this chapter) may augment professional pruning, but follow a less regular schedule. Data on current fiscal year plans for pruning by contractors, down to the individual tree, can be found on NYC Parks' Tree Work Hub web portal.[16] In addition, NYC Parks systematically inspects trees and follows up on service requests from the public (e.g., 311 requests) regarding dead or hazardous trees. NYC Parks inspects the trees within a timeframe based on the condition reported (i.e., if an extremely hazardous condition is reported, NYC Parks may respond to it within a day) and decides whether to remove, prune, or monitor. Much of the wood from dead trees is chipped and used as mulch throughout City Parkland and for beds of street trees. Trees in landscaped areas of City Parkland are actively planted and pruned for risk management, but on an as-needed basis (as opposed to routine, programmed pruning).

One of NYC Parks' tree-related programs includes repairing sidewalks that have been lifted by growing roots. Until 2003,

A group of people stand before a rain garden in an educational walking tour. In 2018, the Gowanus Canal Conservancy and The Nature Conservancy launched the Gowanus Tree Network to engage and support stewards to care for 130 trees in the Brooklyn neighborhood.

liability for damage or injury caused by such sidewalks was unclear, and property owners could be charged with violations for sidewalk damage caused by tree roots. However, in 2003 the NYC Administrative Code was amended to clarify that owners of Tax Class 1 properties (one-, two-, and three-family homes occupied by owners) were exempt from responsibility for damage caused by tree roots, and in 2005 the City began funding the Trees & Sidewalks Program to repair such problems. NYC Parks prioritizes requested repairs based on multiple criteria, including the extent of sidewalk lift, pedestrian activity in the area, and tree size and health.[17]

NYS Office of Parks, Recreation, and Historic Preservation

The NYS Office of Parks, Recreation, and Historic Preservation (OPRHP) manages a variety of State Parks across the five boroughs, working to conserve, protect, and enhance the resources within the sites they own. OPRHP's *Policy on the Management of Trees and Other Vegetation in State Parks and Historic Sites*[18] describes some of the regular management activities implemented by OPRHP on "developed or managed areas," or areas that are used by visitors within State parks. (This is about 16% of the total area; the remaining 84% is natural habitat and under passive management.) These management activities include tree pruning and removal, invasive species removal, and trail maintenance. Limited funding is available to explicitly focus on monitoring, expanding, and enhancing the urban forest in these spaces. Furthermore, some NYS OPRHP lands are specifically managed in ways that preclude new trees, for example as active recreation spaces or other ecosystem types (e.g., grasslands).

NYS Department of Environmental Conservation

The NYS Department of Environmental Conservation (NYS DEC) manages a suite of State lands on Staten Island, composed of natural areas. For these lands, NYS DEC staff develop Unit Management Plans that assess the natural and physical resources present, considering the public and recreational use of the land. They also develop Recreation Management Plans that identify public recreation and access opportunities on private lands where the department has a conservation easement. For example, a 2009 Unit Management Plan for southern Staten Island covers Mount Loretto Unique Area, Lemon Creek, Arden Heights Woods, and Bloesser's Pond. The plan specifies efforts to manage invasive species, stormwater runoff, illegal activities, and encroachment, in addition to preserving a specific area, Mount Loretto, in its natural state for recreation and education. NYS DEC also provides statewide urban forestry technical assistance, and their ReLeaf program brings together tree care professionals, municipal staff, utility arborists, state and local government officials, educators, tree board members, and interested members of the public in support of urban forestry across the state.[19]

National Park Service

The vast majority of Federal land and canopy is within the jurisdiction of the National Park Service (NPS), generally as part of Gateway National Recreation Area. Gateway spans portions of Brooklyn, Queens, and Staten Island (and into New Jersey). As of 2014, a new management plan for Gateway was adopted.[20] The plan notes that activities related to the urban forest include removal of invasive vegetation and planting trees for various purposes, including habitat management, preventing erosion, and providing shade for visitors at certain sites.[21] During MillionTreesNYC, partnerships with the City of New York were established, and NPS supported achieving the planting goal by planting native species on these lands. Furthermore, while some natural areas are specifically mowed to maintain open, non-forested habitats, natural succession and growth of woody vegetation are allowed to proceed in other areas.

Other Government Entities

Numerous other government entities at the City, State, and Federal level have portions of the urban forest within their jurisdiction. For most of these entities, limited information about how they actively manage the resource (if at all), is publicly accessible. However, a few of these entities exhibit at least some active management. For example, the NYC Housing Authority, a NYS public benefit corporation, has been working to inventory trees across its properties. The NYC Department of Environmental Protection (NYC DEP) often has trees planted as part of right of way bioswales (rain gardens)—while trees are maintained by NYC Parks, these spaces themselves are managed by NYC DEP. In addition, while NYC Parks is responsible for street trees, both the NYC and NYS Departments of Transportation have portions of the urban forest in their jurisdictions along major roadways, such as some parkways and highways. These portions can be managed at least for maintaining safe roadways, but also to improve aesthetics and quality of life in the area.

Management Partnerships

Partnerships among stakeholders are invaluable in ensuring long-term management and protection of the urban forest. Partnerships can exist in various forms and they can change through time; public-private partnerships, in particular, increased during the 1980s and 1990s in response to declining quality and safety of parks.[2,22] Public-private partnerships support planting and care of trees, and garner private support for parks that lack funding.[2] At the same time, it is important to note that these partnerships are not evenly distributed across all NYC parks. Higher-income neighborhoods are more likely to afford and benefit from these initiatives.[2]

While partnerships can support efforts across various jurisdictions, a large number specifically support NYC Parks' management of street trees and trees in City Parkland. Many groups support capital and maintenance projects related to the urban forest, as well as for individual parks themselves, as in the following examples:

- Groups such as Partnerships for Parks, New Yorkers for Parks, and NYRP work citywide on broad issues related to parks.

- Groups such as Prospect Park Alliance, the Union Square Partnership, Friends of the High Line, and the Friends of Pelham Bay Park work to support specific parks. One of the best known examples with a robust urban forest management approach is the Central Park Conservancy, formed in 1980. Through a contract with the City, it is officially recognized as the organization responsible for management of Central Park. Its staff of arborists carefully manages trees in the park, in partnership with NYC Parks' staff.
- Trees NY, a nonprofit organization founded in 1976, works with volunteers in NYC and is licensed to train and certify Citizen Pruners. It supports community tree planting and leads stewardship programs on tree care.
- Since its establishment in 1994, the New York Tree Trust (NYTT),* a joint program of NYC Parks and the City Parks Foundation, has worked to foster public–private partnerships in urban forestry. NYTT works with qualified contractors who follow the City specifications to guide the design of tree beds and tree guards, assist in their installation, and do sidewalk repairs. NYTT also builds partnerships with local Business Improvement Districts to enhance tree care and site conditions (e.g., expanding the existing tree beds, and installing tree guards around them).
- One of the newest conservancies that works closely with NYC Parks, the Natural Areas Conservancy (NAC), was formed in 2012. The Natural Resources Group of NYC Parks and the NAC work together to manage NYC forested natural areas, following NYC Parks' *Guidelines for Urban Forest Restoration*.[23] They collaborated to produce the first-ever citywide management plan for natural areas, the *Forest Management Framework for New York City* (FMF).[5] This plan focused on the long-term management of NYC forested natural areas, setting long-term measures and goals, drilling down into specific management, staffing, and budgetary needs. The FMF established clear funding needs and helped drive a successful campaign for partial funding to date, further detailed in Chapter 6.
- Business Improvement Districts often work to maintain trees in their area of interest, including, in coordination with NYC Parks, street trees.

Management on Private Property

Although over half of the NYC urban forest fell within NYC Parks' jurisdiction as of 2017, and and an additional 11.24% fell on other public properties, over a third of the canopy (35.26%) fell on private land. As discussed in Chapter 2, these lands are highly variable, including residential properties of various types, major facilities and institutions, commercial and manufacturing spaces, and large open spaces, such as cemeteries and vacant land. The portions of the urban forest on these lands may be managed by myriad actors, including homeowners, building managers, renters, hired arborists, or even volunteers. Ultimately, within the bounds of zoning rules (see Chapter 5), private property owners are generally permitted to do as they wish with their land. Some may have well-funded, routine management, but many of these spaces may not be actively managed at all.

However, there are some examples of more institutionalized support for urban forestry activities on private property (e.g., see **Box 7.1**). A key example is the public–private support for tree planting in private lands as part of MillionTreesNYC. Because such a substantial amount of open space in NYC is located on the lots of one- and two-family homes, the initiative included a robust tree giveaway program aimed at NYC homeowners. NYRP partnered with local organizations, such as churches, community gardens, community centers, libraries, and schools, to host and promote the giveaways. The tree species that were given away suited the space availability and ecological conditions of neighborhoods where they were distributed. NYRP required homeowners to plant the tree in a residential yard or community garden (not public parkland) within the five boroughs, and keep the trees watered and maintained. Giveaway events featured live planting demonstrations and information about how to properly plant and care for trees.[24]

NYC Parks also has resources available to support public and private projects, such as guidance for selecting trees. In particular, NYC Parks and their municipal native plant nursery, the Greenbelt Native Plant Center, offers guidance on choosing the right plants for projects and caring for them to ensure their survival and growth, with a focus on native plants to conserve biodiversity.[25]

* In 2021, the New York Tree Trust is rebranding as New York Tree Time.

BOX 7.1

How Some Large Institutions Support Urban Forest Management

There are a variety of large, privately managed, publicly accessible facilities and institutions that contain meaningful tree canopy acreage, urban forest patches, and diverse tree collections. Below are some examples.

A Japanese maple (*Acer palmatum*) displays bright fall colors at The Green-Wood Cemetery in Brooklyn.

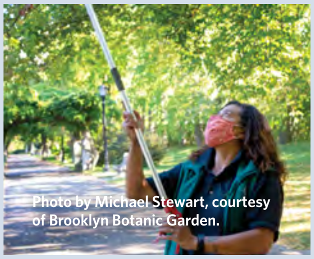
The Green-Wood Cemetery

Occupying 478 acres, the Green-Wood Cemetery is known for its impressive collection of species, with some trees that predate the Cemetery's founding in 1838, and excellent green space management. The cemetery boasts nearly 8,000 trees on the property and over 500 species, qualifying it as a Level III Arboretum. The entire tree collection is mapped and digitized, and management is tracked through time. For example, in 2018, 98 trees deemed structurally unsound or in poor health were removed, and 300 new trees were planted. Green-Wood has received Federal and State grants for forest and tree enhancements. As of 2017, private cemeteries in NYC contained an estimated 1,178 acres of canopy (2.76% of citywide canopy) on 4,187 acres of land (2.16% of citywide land).

Trees surround a patio at the Cornell Tech campus on Roosevelt Island, Manhattan.

College and University Campuses

There are over 100 private colleges and universities in NYC. Their campuses contained an estimated 129 acres of canopy (0.3% of citywide canopy) on 441 acres of land (0.23% of citywide land) as of 2017. Columbia University, Fordham University, Pratt Institute, and many others have discrete landscaped campuses, while New York University, The Cooper Union, The School of Visual Arts, The Juilliard School, and others are incorporated into the urban fabric. NYS-owned colleges and universities, specifically City University of New York and State University of New York campuses, contain approximately 96 acres of canopy (0.22% of citywide canopy) on 529 acres of land (0.27% of citywide land). Fordham University and St. John's University currently meet the requirements of the Arbor Day Foundation's Tree Campus USA program, which are to form a campus tree advisory committee, develop a campus tree care plan, allocate annual expenditures to a campus tree program, observe Arbor Day, and engage in a service-learning project.



A Brooklyn Botanic Garden gardener prunes wisteria (*Wisteria* sp.) in the Osborne Garden.

Botanical Gardens

There are four botanical gardens in NYC (operating as private entities that occupy City Parkland), which manage their own tree collections and, in some cases, also forested natural areas. As an example, the Brooklyn Botanic Garden (BBG) occupies 52 acres and hosts 14,000 varieties of plant species. The property has an arboretum plan, over 100 labeled tree and woody plant species, and paid arborists on staff, qualifying it as a Level II Arboretum. BBG offers extensive community programming that encourages tree stewardship in neighborhoods surrounding the garden and beyond. For over 25 years, BBG has held the Greenest Block in Brooklyn contest, in which neighborhood blocks compete to make their blocks greener through streetscape planting. Queens Botanical Garden, New York Botanical Garden, and Snug Harbor Cultural Center and Botanical Garden similarly have their own carefully managed collections, staff, and engagement activities. Of note, New York Botanical Garden partners with NYC Parks to train forestry staff in urban forest management.

7

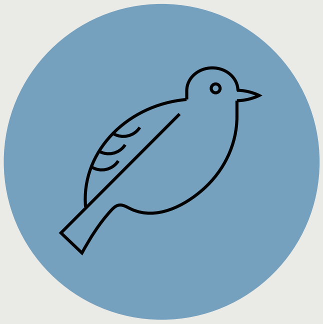
Volunteers with the Jackson Heights Beautification Group tend to a street tree in Jackson Heights, Queens.

Civic Stewardship

Everyone has the potential to become a steward of the urban forest. Individuals can join various types of organizations (e.g., small or large, volunteer or paid); start their own stewardship groups; or do independent stewardship work near their homes, schools, parks, or other areas of interest. Here, we adopt the definition of civic stewardship groups as groups that "conserve, manage, monitor, transform, educate, and advocate for the local environment—including land, air, water, and systems (such as energy, waste, and food systems)."[14] This definition is not limited to the urban forest and includes many types of civic groups with a diversity of resources, causes, and jurisdictions, ranging from "multimillion-dollar formal and/or museum-based environmental nonprofits to completely grassroots, non-501(c)(3) community gardens, clubs, block associations, and other informal groups"[2] that may have few or no paid staff.

Stewardship groups operate throughout NYC with generally higher concentrations in central Brooklyn, the southern Bronx, and portions of Manhattan. Furthermore, some parks, such as Van Cortlandt in the Bronx and Inwood in northern Manhattan, tend to have more stewardship groups associated with them.[14] Some smaller groups have offices in the further reaches of Queens and Staten Island.[2,26] Stewardship groups work on various land types, including street and riparian corridors, vacant lots, public parks and gardens, green roofs, and community gardens.[3] They plant and prune trees, advocate, fundraise, and educate the public. They often fill gaps in the public and private realms, conducting work that is planned and needed, but not fully resourced. Further, they innovate ideas, programs, and visions that may advance stewardship practices more broadly. Stewardship has specifically been associated with higher survival rates of young street trees.[27] **Figure 7.2** illustrates a diversity of functions that stewards of the urban forest perform.[14]

Stewardship Functions Related to the Urban Forest

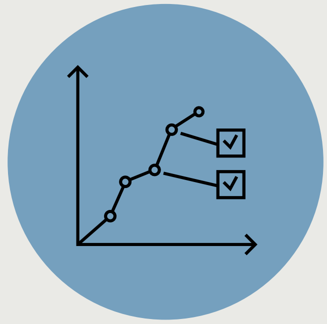


Conserve

- Preserving living memorials
- Protecting green space and trees
- Defending endangered species

Manage

- Maintaining and pruning trees
- Managing, cultivating, and watering tree beds
- Hosting stewardship activities



Monitor

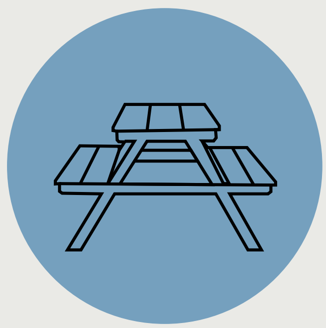
- Collecting and sharing data on tree and ecosystem health
- Tracking habitat metrics
- Surveying the public on attitudes about trees

Educate

- Public programming
- Preparing employees for green jobs

Advocate

- Community organizing
- Supporting environmental justice campaigns
- Voting for sustainable policies



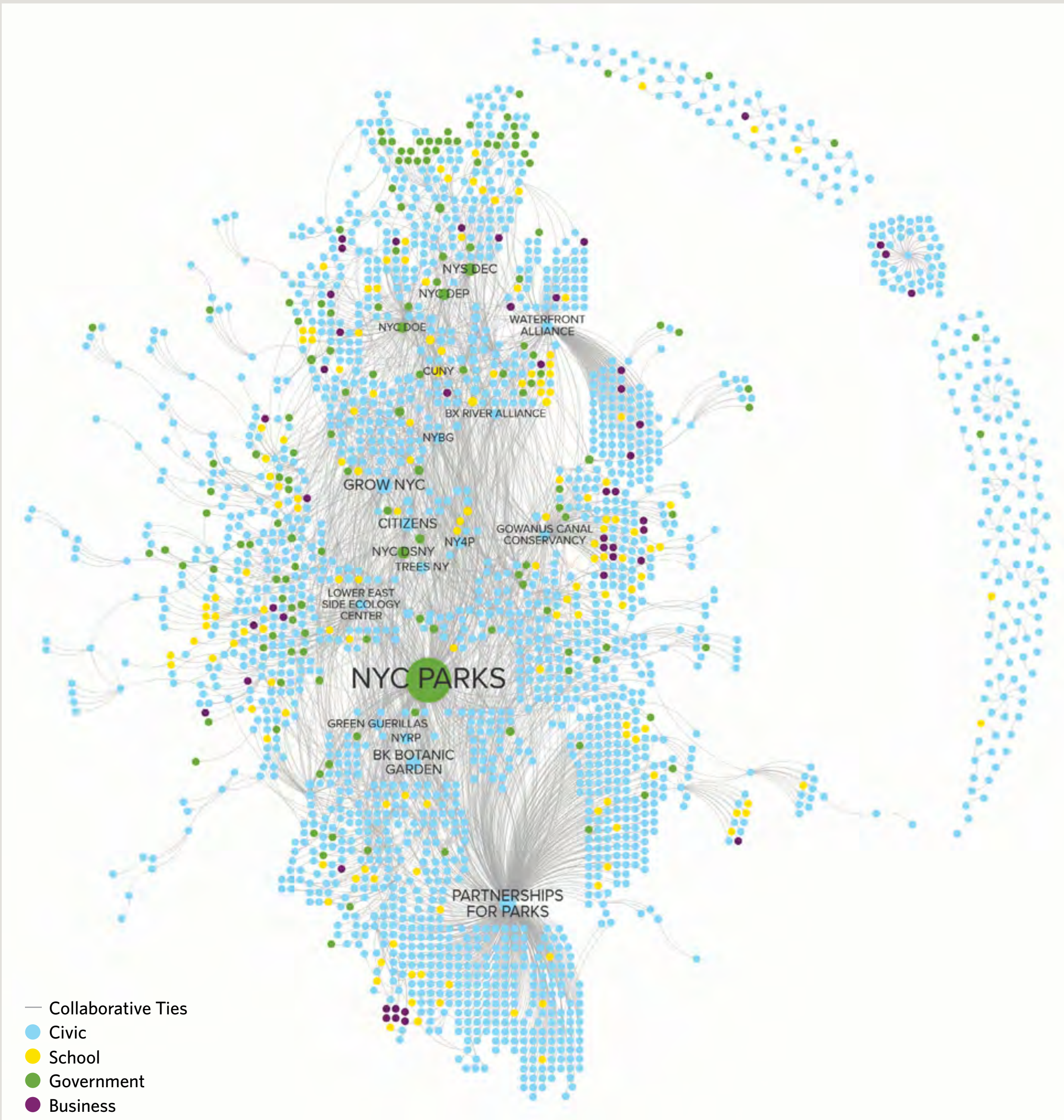
Transform

- Making wood products from repurposed materials
- Collecting compost

Adapted from: Landau, L., Campbell, L. K., Johnson, M., Svendsen, E., & Berman, H. (2019). STEW-MAP in the New York City region: Results of the stewardship mapping and assessment project, 2017 (General Technical Report NRS-189; 1–69). USDA Forest Service, Northeastern Research Station.

Figure 7.2 Functions that environmental stewards serve and examples of actions that can support the urban forest.

Collaboration Network of NYC Respondents and Named Groups from 2017 STEW-MAP Effort



Adapted from: Landau, L., Campbell, L. K., Johnson, M., Svendsen, E., & Berman, H. (2019). STEW-MAP in the New York City region: Results of the stewardship mapping and assessment project, 2017 (General Technical Report NRS-189; 1–69). USDA Forest Service, Northeastern Research Station.

Figure 7.3 Network diagram of respondents from the 2017 STEW-MAP research effort. Colors correspond to sector, and size reflects the in-degree statistic, as a measure of the number of times a group was named by another group.

Interns with a collaborative initiative, Healthy Trees, Healthy Cities, work together to measure the diameter at breast height of a tree at Bailey Playground, Bronx.

The latest results of the Stewardship Mapping and Assessment Project (STEW-MAP) shed light on environmental stewardship groups in NYC.[14] The project reported results of a survey of stewardship groups (see **Figure 7.3**), including 455 civic respondents and 1,774 named partner groups in the full stewardship network. STEW-MAP found that groups in the network include City, State, and Federal entities, civic organizations, school groups, and businesses. In addition to the central role played by government agencies such as NYC Parks, both the 2007 and 2017 STEW-MAP research efforts identified a number of groups that played roles as "brokers" that can serve as connectors of people, information, and resources.[14,28] While some organizations have paid staff, approximately 43% of the organizations have no paid staff and are run entirely by volunteers. Respondents to STEW-MAP outreach were primarily tied to NYC, though some reported operating across NYS.

Stewardship groups pursue a wide range of goals regarding natural resources and the environment. In both 2007 and 2017, respondents to STEW-MAP most often said that they stewarded parks, community gardens, and street trees (other site types were, for example, athletic fields, waste systems, and brownfields). Of 551 groups that answered questions about types of sites they work on, 18% (about 100) focused on parks, 9% (48 groups) focused on street trees, and 27% (149 groups) focused on community gardens. Further, 623 groups answered a question about realms they work in beyond their focal area—274 organizations indicated they work in community gardens, 252 worked in parks, and 226 worked on street trees.[14]

Stewards and Volunteerism

Volunteers accomplish much of the stewardship of the NYC urban forest. NYC Parks works to organize and support volunteer stewards, and many of the civic environmental stewardship groups officially partner with NYC Parks to assist with tree care. Svendsen and Campbell[3] indicated that there are more than 1,000 active park-based stewardship groups in NYC. Some of these groups have leveraged millions of dollars in funding, advocated for tree care, and performed hands-on

Photo by Gowanus Canal Conservancy.

Gowanus Canal Conservancy staff care for a rain garden on 6th Street in Gowanus, Brooklyn.

management that supports and extends the work of NYC Parks. Other groups are smaller or more informal in nature.

NYC Parks enlists volunteers to support the street tree census every 10 years. 2015–2016 marked the third street tree census and the largest community science initiative in NYC Parks' history. The census was completed with the help of 2,241 active volunteers, more than double the number who helped with the 2005 census. The largest increases in participation were in Brooklyn and the Bronx. Volunteers documented 225,595 street trees (34% of the total), surveying about a third of spaces where they could be found, generally with moderate to high accuracy.[29,30]

In addition, NYC Parks has engaged over 80,000 volunteers in tree stewardship since 2000. The NYC Parks Stewardship Program, launched in 2015 through MillionTreesNYC, connects people with their preferred type of environment and type of project. Volunteers for the urban forest can join any of four broad programs and work on forest management sites selected by senior resource managers, participate in highly visible public events that aim to attract large numbers of new volunteers, or lead their own stewardship events after being trained as Super Stewards. These trained stewards work broadly or can focus on specific, defined neighborhoods called Green Neighborhoods, associated with NYC Parks' Green Neighborhoods Program.

Since its inception in 2015, the NYC Parks Stewardship program has engaged with over 30,000 New Yorkers who have cumulatively performed over 100,000 hours of service. Volunteers through this program have stewarded thousands of street trees, and natural areas within City Parkland, have collectively cared for over 256 acres of land by removing invasive vines and debris and planting 93,350 trees and shrubs.[31] People can obtain details on events and sign up to help on the NYC Parks Stewardship website (https://www.nycgovparks.org/reg/stewardship).

In addition to the NYC Parks Stewardship Program, a number of well-organized stewardship groups work directly with NYC Parks to attract private funds and other resources to manage street trees. As noted above, the NYTT is a program of NYC Parks that works as a public–private partner to care for street trees. NYTT allows private citizens to make a donation in exchange for a number of tree-related services (e.g., tree guard installation for street trees). For example, the Hudson Square Business Improvement District partnered with NYTT and local businesses to install expanded tree beds in their district with structural soil, permeable pavers, and tree guards to improve the trees' health and ultimately increase canopy cover.[32]

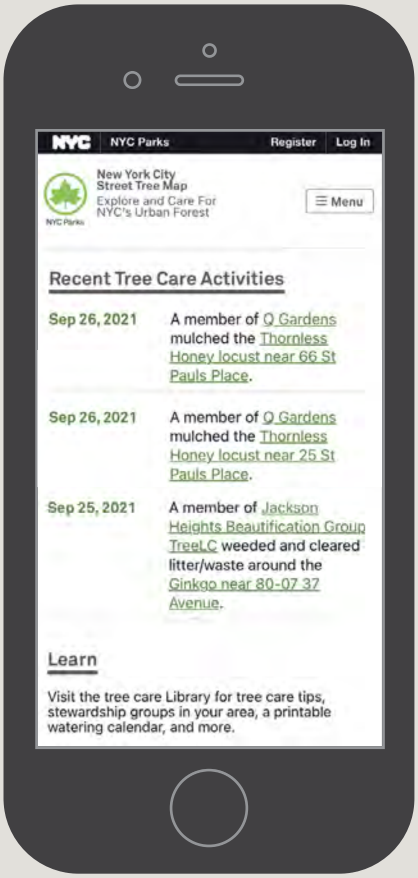
Trees NY is another partner of NYC Parks focused on street tree stewardship. Trees NY trains and certifies Citizen Pruners, the only private individuals allowed to prune street trees. They also lead citywide tree care outings with their network of volunteers to prune, weed, water, cultivate soil, and mulch street tree beds. During the past 10 years, Trees NY has trained over 15,000 Citizen Pruners and 9,000 youth in tree care and stewardship activities, as well as planting over 4,000 trees in underserved communities throughout the city.[33]

The NYC Street Tree Map supports tracking of tree stewardship that can be accessed at https://tree-map.nycgovparks.org (**Figure 7.4**). From its launch in November 2016 through July 2021, volunteers have reported nearly 32,000 tree care activities, including pruning, clearing litter and waste, mulching, and watering street trees. Anyone, including individuals and tree care groups, can create a profile and log stewardship activities on the map, and care activities can be viewed at the level of individual trees. This platform only tracks stewardship of street trees, and it likely under-captures street tree stewardship, as many stewards may not know about or choose not to use this tool.

In some areas, local neighborhood groups have formed to steward their trees. For example, the Gowanus Canal Conservancy is dedicated to facilitating the development of a resilient, vibrant, open space network of community stewards in the Gowanus Watershed. The group recently created a Gowanus Tree Network and has developed a local tree management plan and a tree ambassador program. It hosts regular tree stewardship events in order to build a network of stewards on a block-by-block basis in Gowanus.

Local conservancies and volunteers also help steward forested natural areas. To support these stakeholders, the NAC developed the Conservancy Engagement Program. This program supports park conservancies that manage large areas of forest in NYC with scientific support, training, data, and tools. The program seeks to align individual conservancy goals with the management goals of the FMF for forested natural areas citywide. As of 2020, it has advised the Prospect Park Alliance, Forest Park Trust, the Riverside Park Conservancy for Riverside Park, the Wildlife Conservation Society, the New York Botanical Garden, and the Bronx River Alliance for Bronx Park.[34]

Stewardship Details from the NYC Parks Street Tree Map



Screen capture from: the NYC Parks Street Tree Map, https://tree-map.nycgovparks.org/

Figure 7.4 Screenshot of the NYC Parks Street Tree Map illustrating stewardship activities recorded for individual trees. Users can not only learn about street trees, but also record their own activities to care for them in this platform.

One of the challenges of volunteerism is the cost associated with managing volunteers. While volunteers are not paid, there are costs associated with administering and running the program, providing materials and equipment, tracking, and more. The FMF for NYC estimated that the costs per acre for management using volunteers amount to $28,500, which is higher than the estimate for in-house professional management.[5]

The Natural Areas Conservancy's 2019 interns from the City University of New York learned how to use the Forest Identification & Restoration Selection Tool to identify the type of forest community present in Van Cortlandt Park in the Bronx.

Green Jobs

In addition to volunteer-focused stewardship, paid urban forestry jobs and job training programs are sources of stewards. However, there is limited availability of urban forestry credential programs in the city. For example, there are no forestry degree programs at any of the City University of New York institutions, nor to our knowledge are there such programs at any private NYC-based college or university. Green job training programs offer hard skill development, often pay a wage for training, and can create local job opportunities. Not all people have time or resources to volunteer, and green job training can offer a chance to engage for those who wish to participate in green space management but are limited by the practical need to earn a livelihood. A 2013 study of the MillionTreesNYC Training Program concluded that "Green job training and employment present real opportunities for intellectual stimulation and an increased sense of accomplishment, due in part to the uniqueness of environmental work. Individuals reported positive environmental attitudes and behaviors as a result of green jobs training and employment."[35]

Here are a few of the many, generally early-stage, workforce opportunities that prepare or have prepared participants for urban forestry-related jobs:

- During MillionTreesNYC (2007–2015), NYC Parks and NYRP partnered to offer a seven-month green job training in arboriculture and ecological restoration.[35]

- Green City Force enlists and trains young people from low-income housing communities in NYC for a new and more equitable economy. Participants develop a passion for sustainability and service through driving large-scale environmental and health initiatives in public housing and other frontline communities. (https://www.greencityforce.org)
- Each summer, the NAC runs a paid internship program for City University of New York students on urban ecology. The interns work as field researchers or supervisors and are trained to assess vegetation, wildlife, and other ecological markers. (https://www.qcc.cuny.edu/careerservices/careers-direct/internships/posts/04-20-2020-Natural-Areas-Conservancy.html)
- The NPS, often in collaboration with other organizations, offers internships, transitional/entry-level jobs, and volunteer opportunities in urban forestry.
- Trees NY's Young Urban Forester Internship is designed to remove the barriers that prevent urban youth from entering environmental careers. (https://treesny.org/youth-education/young-urban-foster-internship/)

Summary

The NYC urban forest is managed by a wide network of entities and individuals in the private and public sectors, representing diverse pools of funding and levels of jurisdiction. City, State, and Federal parties are responsible for managing portions of the urban forest on public lands, which together account for 64.74% of the canopy in NYC. Policies and regulations often provide guidance on how these areas should be managed, and there are rules and regulations protecting the trees to varying degrees. Highly varied and largely non-standardized management, or lack thereof, occurs for the urban forest on private lands, which as a whole comprise the remaining 35.26% of the NYC urban forest canopy.

We have highlighted some of the organizations providing training and support regarding landscape design, species selection, and overall care and management of the NYC urban forest. However, there are opportunities to continue learning about the different entities that contribute to urban forest management, including their roles, responsibilities, and resources. This information can improve our understanding of management gaps and the resources needed for better management of the urban forest. Further, while we discuss work by individuals as stewards within specific programs, the role that individuals play is poorly understood across the landscape, considering that we lack data on forest management across most privately owned lands.

As detailed in Chapter 6, public funding that supports management of the urban forest is highly variable and can be particularly at risk in times of fiscal scarcity, as seen during the COVID-19 pandemic. While volunteer stewardship programs from NYC Parks and nonprofits are invaluable in leveraging interest and excitement about the urban forest and contribute to its maintenance, management of these programs requires paid staff, and forestry-related jobs are a key part of a sustainable and equitable urban forest. Formal workforce development programs and certification opportunities that can be obtained locally are needed both to ensure a good urban forest workforce and to provide opportunities for good jobs to New Yorkers.

Stewardship groups often work in collaboration with government managers but may operate with no or few full-time staff and with just a few community volunteers. There are limited resources available to help these groups grow. This threatens the long-term sustainability of the stewardship groups themselves, affects the land managers who attempt to work with these groups,[3] and leaves the resource itself without adequate care as the funding for professional maintenance is inconsistent and insufficient. There is an opportunity to provide more resources to stewardship groups and increase their capacity to assist with forestry.

Stewardship of the NYC urban forest is happening despite the absence of clear long-term goals for the forest, but it is not happening consistently or evenly across the resource as a whole. Clear goals and targets can help drive more effective and adaptive management efforts geared toward achieving these outcomes. The NYC Urban Forest Task Force, a group of nearly 50 organizations convened by The Nature Conservancy, launched the *NYC Urban Forest Agenda* (https://forestforall.nyc/nyc-urban-forest-agenda/) in June 2021 to establish a shared vision and goals. The Agenda proposes common goals and actions, and Forest for All NYC (https://forestforall.nyc), a new coalition that grew out of the NYC Urban Forest Task Force, will continue to work toward realizing them.

7


8

Attitudes

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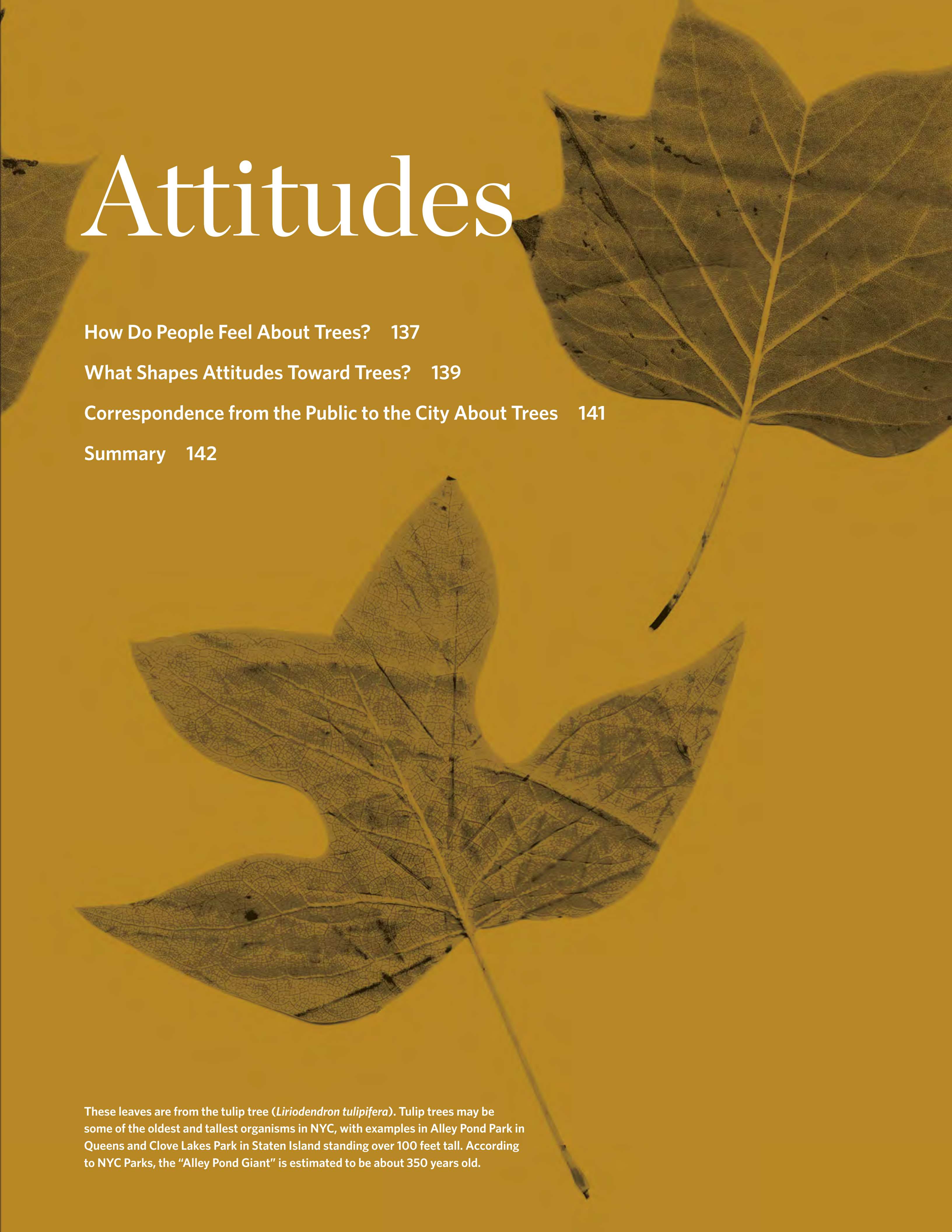

These leaves are from the tulip tree (*Liriodendron tulipifera*). Tulip trees may be some of the oldest and tallest organisms in NYC, with examples in Alley Pond Park in Queens and Clove Lakes Park in Staten Island standing over 100 feet tall. According to NYC Parks, the "Alley Pond Giant" is estimated to be about 350 years old.

CHAPTER 8

Attitudes

People's attitudes ultimately affect any resource, including the urban forest. Attitudes are one's judgments of things or situations, personal truths, or beliefs given previous experiences of the world. They are grounded in people's values and can be positive, negative, or neutral.[1] As it is not possible to directly measure such an abstract concept, we rely on measurable components such as people's behavior and responses to questions about their thoughts and feelings[2] (see **Box 8.1**). Attitudes influence people's behavior, but they are not the sole determinants of it. When attitudes are combined with the perceptions of what is expected by others (i.e., norms) and perceptions of barriers or enabling conditions that could hinder or foster behaviors, the ability to forecast behaviors greatly increases.[3]

Understanding the attitudes of residents toward the urban forest can empower managers and policymakers to leverage, create, and foster enabling conditions that support the resource. In addition, this understanding can help them alleviate barriers for stakeholders who already have positive feelings for trees but need additional support to become more involved in tree stewardship. A better understanding of people's attitudes can also help stakeholders raise general awareness of benefits the urban forest provides and its need for stewardship. Studies have found that trying to change people's attitudes directly to effect change is less successful than improving enabling conditions (through policies) to facilitate involvement by those who are already favorably disposed.[4] Another effective approach is to share the fact that other people are engaged and interested, increasing the perception that becoming involved with trees is a favored activity of others.[5]

In New York City (NYC), limited work has been conducted to assess the attitudes of residents toward the urban forest or trees specifically. However, the Million Trees NYC Initiative (MillionTreesNYC), in particular, provided multiple opportunities to assess the thoughts and feelings of participants (tree planters) and recipients (people who had trees planted in their neighborhood) across a large swath of the city. For example, correspondence to the City and 311 requests showed that residents were sometimes confused by the sudden appearance of new trees along rights of way and were unsure how to care for them.[6] When asked, residents sometimes held inaccurate beliefs about their responsibility to care for trees planted in public spaces, including along streets or in parks.[5,7] These NYC-specific findings provide useful information about residents' attitudes toward trees, but to more fully describe attitudes toward trees, what drives them, and how attitudes are related to behaviors, we draw on research from other cities as well.

Photo by Nina Browne, courtesy of Brooklyn Botanic Garden.

Photo by Nina Browne, courtesy of Brooklyn Botanic Garden.

Photo by Brooklyn Botanic Garden staff.


Photo by Amy Musick, courtesy of Brooklyn Botanic Garden.

Photo by Brooklyn Botanic Garden staff.

Photo by Jonathan Grassi.

Stewarded tree beds in Brooklyn feature flowers, mulch, and educational signs. The Brooklyn Botanic Garden hosts the yearly Greenest Block in Brooklyn contest, inspiring neighbors to care for their block's green space.

Understanding the drivers of attitudes in general, especially among groups that are not acting on behalf of trees, can help increase capacity (e.g., volunteers) and support (e.g., advocacy, funding) for the urban forest. This exploration of attitudes also reveals how other factors, such as what others think or do, contribute to shaping our behavior and intentions. While several studies have explored the attitudes of New Yorkers toward parks and other open spaces,[8–10] we focus on those that attempted to characterize attitudes specifically toward trees or the urban forest as a whole.

How Do People Feel About Trees?

When asked broadly about their feelings toward trees, urban residents strongly favor them. Gwedla and Shackleton[11] found that 80% of those surveyed strongly agreed that trees are greatly important to quality of life in Cape Town, South Africa. In Alabama, 98% of respondents to a statewide survey had favorable feelings toward trees in urban areas.[12] This study also found that urban trees play an important role in people's

People lounge on the grass at Pier 3 in Brooklyn Bridge Park, Brooklyn. NYC park visitors have stated that trees and the shade they provide are important features during the COVID-19 pandemic.

A survey of the largest U.S. metropolitan areas found that 83% of residents strongly agreed that trees were an important part of their lives.

decisions on where to locate—75% said trees are important in selecting a home, and 77% said trees are important in selecting a community in which to live. In another study, over 95% of visitors to Washington, D.C., agreed or strongly agreed that the urban forest makes the city a relaxing, interesting, and better place to visit.[13] In Morelia, Mexico, a survey revealed that 96% of respondents identified as "tree lovers."[14] A survey of the largest U.S. metropolitan areas found that 83% of residents strongly agreed that trees were an important part of their lives.[15] As we describe later in this chapter, this can partly be driven by sociocultural dynamics.

Within cities, people's feelings about trees can vary among groups, depending on gender, age, socioeconomic status, ethnicity, and race.[10,16–18] Specific attributes of trees, such as providing shade, make people favor them in urban areas.[11,19] During the COVID-19 pandemic, trees and their associated shade were an important feature for park users in NYC.[20] Recent polling indicated that 83% of NYC voters support adding more trees and greenery to their neighborhood, including 87% of Hispanic voters, even if it results in fewer parking spaces.[21] Additional qualities of trees that city residents have noted as positive include that they are calming; they reduce noise, smog, and dust; and they attract wildlife.[15] In the same study, residents described some qualities of trees as negative, including: they cause allergies, block signs, crack sidewalks, and may offer cover to criminals.[15]

What Shapes Attitudes Toward Trees?

Several key factors, discussed in more depth below, affect people's attitudes toward trees:

- Personal background and culture
- Impression of health risk posed by trees, including trees' effect on neighborhood crime
- Convenience of tree maintenance
- Overall belief in the role of government
- Personal sense of satisfaction related to tree stewardship

Research indicates that people's personal backgrounds and culture influence their attitudes toward trees. In a nationwide phone survey, Lohr and Pearson-Minns[17] found that participating in active gardening during childhood was the most important variable explaining adult attitudes (e.g., seeing trees as calming) and actions (e.g., taking a gardening class). In

BOX 8.1

Measuring People's Attitudes Toward Trees

To understand people's attitudes, we can note their actions, such as voting or delivering statements to City Council, or we can ask them directly. Open-ended questions, such as "What do you like about trees?" often produce rich narratives, but are less likely to provide statistically representative samples, and more time is required to interpret the results.[19,22] In contrast, multiple-choice questions are easier to score and can reveal broader trends.

A widely used method of collecting data on how people feel about trees is to leverage a questionnaire (a poll or survey) that includes questions with rating scales.[12,13,15,23] Questionnaires that characterize how strongly respondents feel about an issue can provide insight into overall attitudes. Rating scales, like the commonly used Likert Scale, ask respondents to choose answers on a gradient from strongly agree to strongly disagree. Such questionnaires need to be carefully constructed to minimize biases.[24]

Willingness to pay (WTP) is one method used to assess people's feelings about an object or situation. The WTP approach asks how much a respondent is willing to pay to have an object, like a tree, or a service, like shade, exist. For example, Wolf[25] found that shop owners could charge an average of 9.2% more on items from shops surrounded by trees than from shops that lacked trees. WTP (or surrogates like willingness to donate time) for the urban forest is evidenced to increase with respondents' knowledge of urban forestry.[12] Zhu and Zhang,[26] however, found that the WTP for urban forests across the United States is an elastic variable that changes as economic circumstances vary. In addition, WTP depends on the respondents' knowledge of the benefits of trees.

The types of questions asked and how they are asked are important elements of an assessment of people's attitudes, but who we ask is crucial. Exploring how various groups respond differently to questionnaires provides the contextual background necessary to interpret all responses.[24]

addition, growing up near wooded areas has been identified as a strong predictor of attitudes and actions.[15] Fraser and Kenney[16] argued that in NYC, volunteer stewards' personal affinities for trees were affected by differences in cultural aesthetics (e.g., coming from landscapes with trees vs. those with few trees). Further, research has shown that growing up near forested areas or taking care of trees positively influences whether people associate trees with spiritual meaning.[27] Gorman et al.[28] found that people's values regarding street trees depended on whether a street tree was outside their residence at the time. In urbanizing towns in South Africa, respondents to a survey only partly understood the benefits of trees, but the majority of them identified cultural connections to specific trees and to trees in general.[23] Trees are cultural and religious symbols in NYC[9,29–31] and around the world.[32]

Attitudes toward trees are also influenced by how they may relate to people's health. Asthma and allergies affect roughly 10–30% of the adult U.S. population,[33] and while trees can benefit air quality (see Chapter 3), some species can also contribute to respiratory ailments.[33–35] The negative impact of asthma and allergies and their association with tree pollen may affect how people feel about trees and influence their participation in tree-related activities.[32] Fear of injury or property damage from falling limbs or whole trees can also be a concern.

Fear may also influence attitudes toward trees less directly. When people are already concerned about crime, trees may magnify this fear by offering potential places of concealment for attackers and obstacles for people attempting to flee a bad situation.[18,36] In a recent study of NYC park users, Sonti et al.[10] found that men frequented forested natural areas in parks more than women did. The same study found that women, who often came to the parks with children, visited the landscaped sections of parks (rather than the more natural areas) and the parts with fewer trees more often than men. However, in a different study using altered photos, Kuo et al.[37] found that increasing tree density in their adjacent open space increased the sense of safety for residents in Chicago. And Escobeda et al.[38] used crime statistics and found a net decrease in homicide with increasing tree density in Bogota, Colombia.

Convenience also contributes to attitudes toward urban trees. Property owners tend to prefer species that require less maintenance, both in terms of pruning and clean-up, and their feelings are affected by their perception of how much time they have to maintain trees. Some of the key environmental benefits that trees provide, including air and water pollution abatement and wildlife habitat, have less influence on attitudes.[39]

People's overall belief in the role of government also shapes their attitudes toward trees in cities. Moskell et al.[40] found that residents of NYC neighborhoods perceived that the government had primary responsibility for tree care. Because rights of way containing street trees are associated with public streets and also adjacent to residences, some people are uncertain whose responsibility the trees are and may perceive them negatively as a result (see Chapter 7, for discussion of care of these trees). Although people generally have a broad appreciation of trees, many view tree protection as a lower priority if they believe the presence of trees will devalue personal property or reduce their perceived level of control.[41] These perceptions, and others concerning the role of government, may be minimized by sharing information about the overall value of trees, especially with regard to residential preferences and relocation,[12] and by involving the community more in designing and implementing local tree maintenance and protection policies.

Individuals often derive a personal sense of satisfaction from planting trees and from improving their communities.[42–45] Social interactions during tree-planting events create greater neighborhood cohesion and lead to increased civic engagement.[7,32,46–48] Volunteers who participated in MillionTreesNYC had varied motivations and limited knowledge of the community-level impacts of trees; many simply wanted a feeling of comradery or wanted to work outside.[40] A survey of participants in the 2015–2016 street tree census found that volunteers' top motivations were their personal values, a desire to contribute, and an appetite for education or learning.[49] There is also an apparent feedback loop in which participation in an event predicts participation in future tree-related activities.[7,41]

While research indicates that people in cities generally have positive attitudes toward trees, their feelings may be nuanced. At times, they may value street trees as a critical resource due to the shade and cooling they provide (see Chapter 3). However, trees require care that people may not understand well or be able to provide. Some people are concerned about perceived risks posed by trees (e.g., cracked sidewalks, falling limbs, damage to property). Understanding the perceived benefits and disservices trees provide can help make urban forestry programs and associated communications more robust.[50]

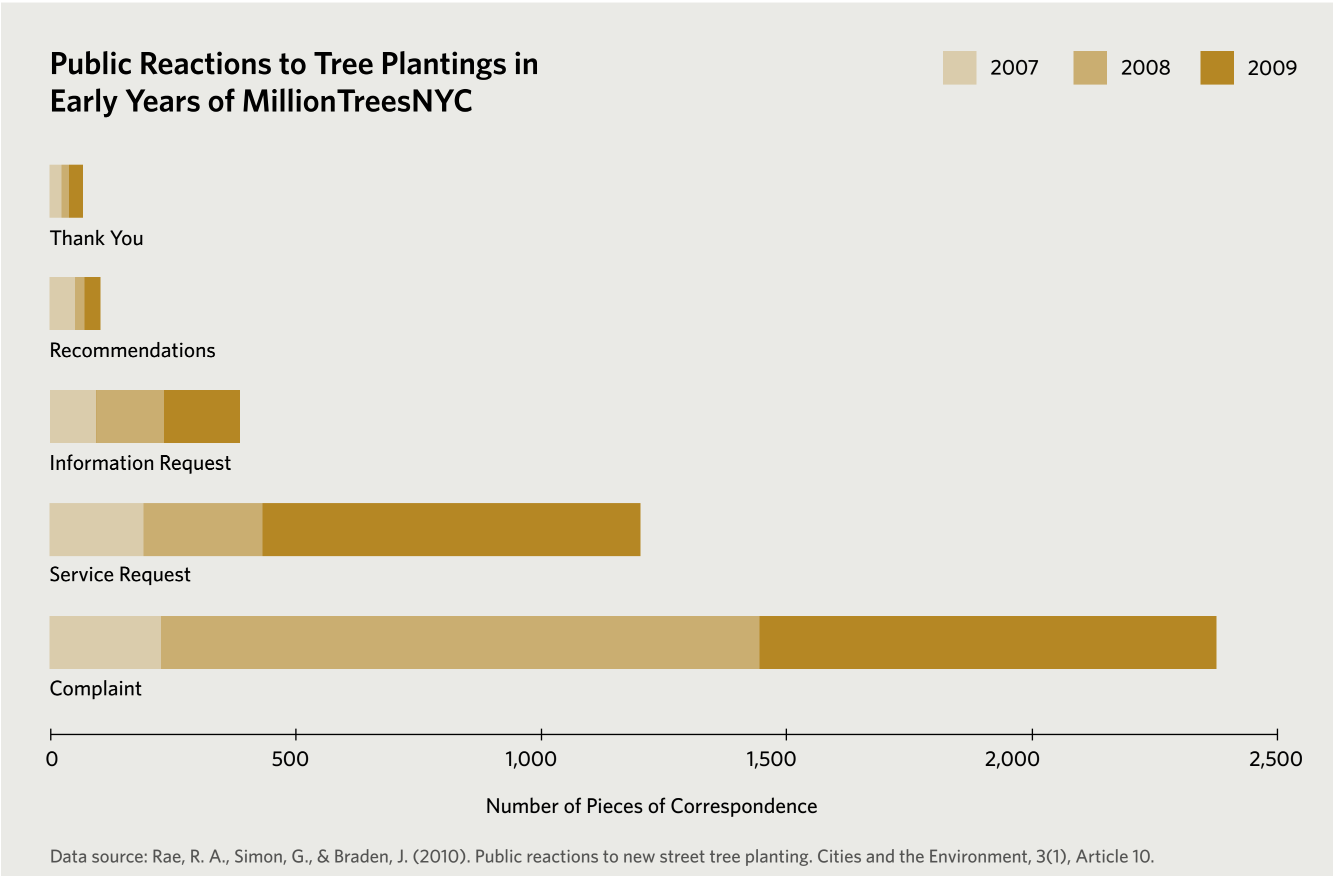

Figure 8.1 Frequency of correspondence received by NYC Parks between 2007 and 2009 related to new tree plantings.

Correspondence from the Public to the City About Trees

Beginning with MillionTreesNYC, the New York City Department of Parks and Recreation (NYC Parks) began planting trees in rights of way and other locations identified as suitable by City foresters, rather than primarily on a by-request basis, as was historically done. Property owners were not given the right to refuse new tree plantings on the sidewalks in front of their property. Between 2007 and 2009, NYC Parks planted 53,235 new street trees and received 4,108 items of correspondence from the public (**Figure 8.1**).[6]

Disagreements with the specific placement of street trees were the most common complaints received during the program. Rae et al.[6] concluded that much of the tension was because NYC sidewalks are a gray zone of ownership: "Even though the sidewalk is legally a public right of way under government jurisdiction, residents can have a psychological sense of ownership over this place that can have personal meaning." Although better outreach to keep residents informed and more appropriate placement of trees in specific instances could have prevented some complaints, the number of complaints (2,360) was relatively low compared with the number of trees that were planted and did not prompt complaints (50,875)—a complaint rate of only 4.4%.

When NYC residents have a non-emergency concern, they can make requests through the 311 system. Between January 1, 2010 and April 2, 2020, New Yorkers made 22,551,199 total service requests, of which 931,947 (4%) were tree-related. The most common tree-related request was to report a damaged tree, and the second most common request was to ask for a new tree (**Figure 8.2**).

311 requests do not constitute an unbiased sample of New Yorkers, as not everyone uses this service equally. People's use of the service is affected by their ethnicity and immigrant status.[51] Auerbach and Eshleman[52] found that after six major storms in New York City, neighborhoods with more renter-occupied homes and unmarried heads of household were less likely to report damaged trees. Thus, these service requests

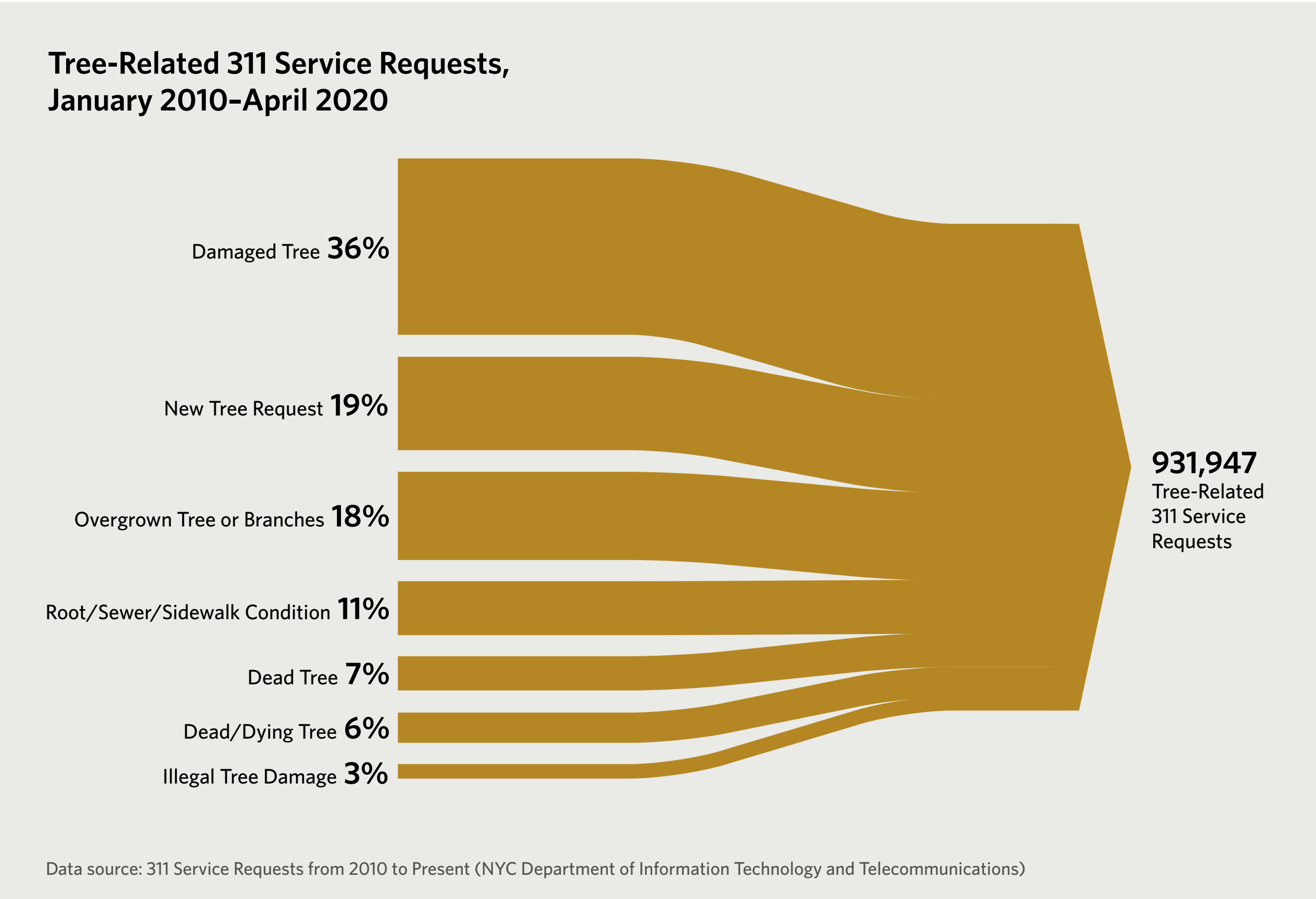

Figure 8.2 Tree-related 311 service requests from January 1, 2010 to April 1, 2020, reflecting a combination of new tree requests, reports of dead and damaged trees, and concerns about the condition of trees and the surrounding environment.

may not represent the perspectives of the population as a whole.

In addition, many 311 requests pertaining to trees, just like other correspondence to the City, do not clearly indicate attitudes toward trees (a request reporting a damaged tree does not indicate either a positive or negative attitude toward the tree). At a minimum, the act of filing the request illustrates some level of engagement with trees or the area that a tree inhabits.

While trees provide myriad benefits, they also have the potential to cause harm—for example, to injure or kill people or damage property when they fall.[53] According to NYC Parks as quoted in a Metro.us newspaper article, 31 people were injured by falling trees or branches between 2011 and 2015.[54] Trees are especially likely to fall during high wind and storm events, which are predicted to increase in frequency and intensity due to climate change.[55] These incidents are relatively rare considering the number of trees and people in the city, and yet, due to media attention, they may have an impact on public attitudes.

Summary

Understanding the attitudes of NYC residents toward the urban forest can guide better management and policy solutions; however, attitudes are often not the overriding determinant of people's actions.[4] Additional factors (such as others' perspectives, incentives or barriers to action, and people's perception of their own control of a given situation) are often more influential on individual actions.[2] Studies of attitudes sometimes focus on some of the most engaged residents in cities, like volunteers, which can skew the results.[40] In addition, volunteers may have reasons for participating that have little to do with the trees themselves (e.g., connecting with others, spending time outdoors).

According to surveys, a majority of urban residents have highly favorable feelings for trees;[15] however, only a small percentage of them dedicate time and money to tree stewardship or urban forest advocacy (see Chapter 7 for more

A visitor to Hudson River Park in Manhattan sits on a bench in the shade of trees, taking in the view of the waterway.

8

about stewardship). What drives these discrepancies between attitudes and behaviors? Beliefs underlying people's attitudes are generally biased toward short-term personal outcomes. Tree planting, care, and advocacy have personal costs, and it can take decades for a tree to provide its full suite of benefits. In addition, people believe that their individual actions alone cannot save the environment, and that their inaction will not destroy it.[3] They believe that only if a multitude of people contribute to an environmental cause will their efforts be effective.

In some cases, changing people's behavior does not mean changing their beliefs. In fact, attempting to change behaviors by focusing on how people feel or think about trees appears to be a low-return approach.[4] A more effective approach may be creating enabling conditions, such as increasing the perception of social acceptance and interest in urban tree programs, and reducing the barriers to involvement in them. These steps facilitate the actions of those who already feel favorably about trees (see Chapter 7).

Our understanding of New Yorkers' attitudes toward trees is limited—additional research in this realm is needed, spanning different geographies of the city, and myriad socio-economic characteristics (e.g., race, ethnicity, age, income). Considering that about a third of the tree canopy in NYC is on private land, we must also study the attitudes of property owners toward the trees they own. Attitudes regarding trees and the outdoor spaces they occupy became particularly impactful in 2020, when the COVID-19 pandemic prompted people to spend more time outdoors.[20]

Ultimately, a better understanding of New Yorkers' attitudes toward trees, and the policies and programs that support them, may contribute to better public policies and programs that both support the NYC urban forest and advance equity and access to it for all New Yorkers.


9

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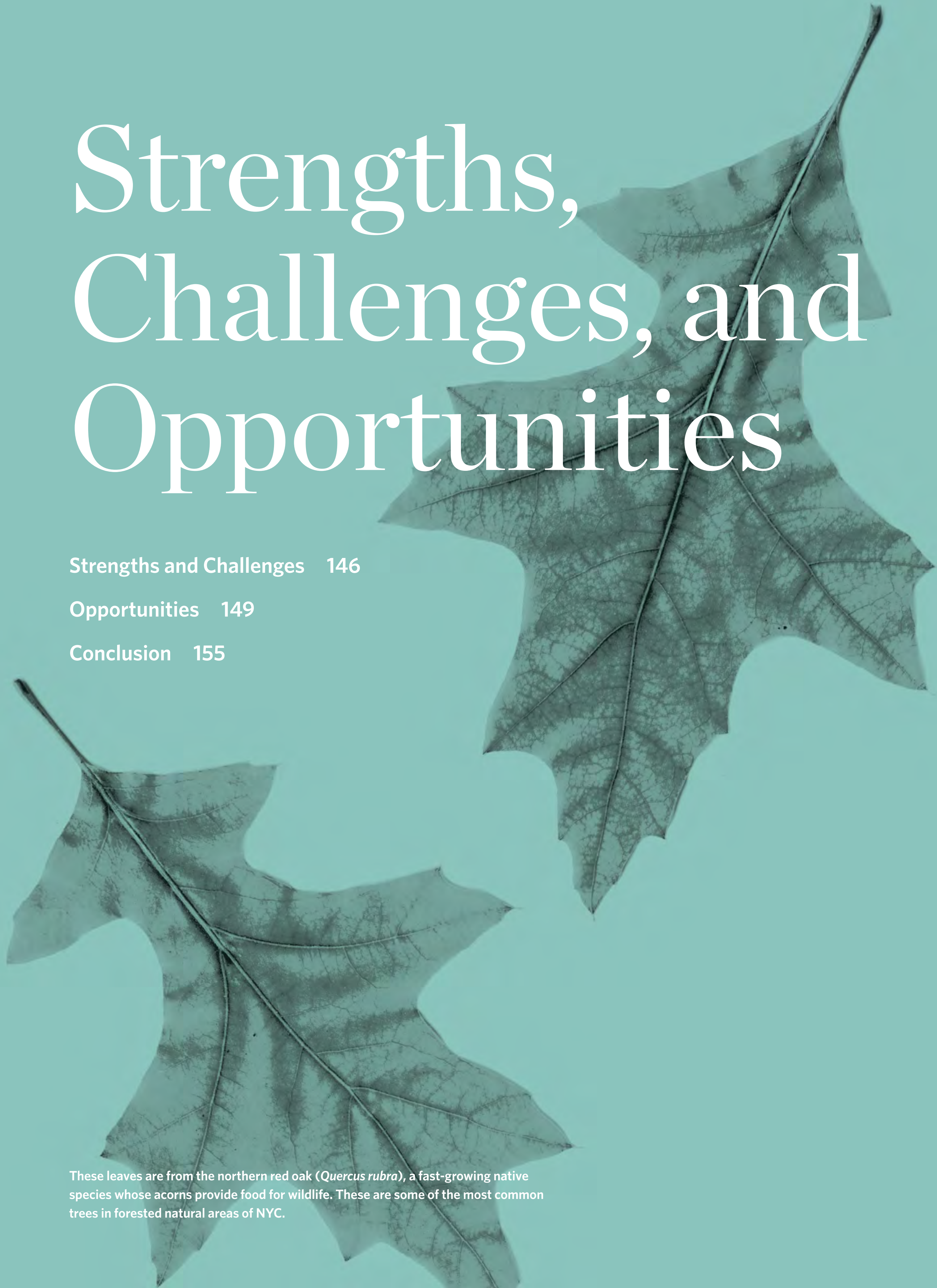

These leaves are from the northern red oak (*Quercus rubra*), a fast-growing native species whose acorns provide food for wildlife. These are some of the most common trees in forested natural areas of NYC.

CHAPTER 9

Strengths, Challenges, and Opportunities

As detailed throughout *The State of the Urban Forest in New York City*, the urban forest has many strengths and faces many challenges. To address the challenges that the New York City (NYC) urban forest faces and to leverage its strengths, we identify prospective opportunities for supporting this important asset. In doing so, we aim to sustain and ultimately expand the services it offers to New Yorkers, while uplifting the intrinsic value of the system. We underscore necessary and important actions to stimulate discussion, and encourage readers to consider additional solutions to the challenges described. While we attempt to be thorough in enumerating major issues the urban forest of NYC faces, we do not intend to be comprehensive, instead aiming to emphasize those of highest concern and potential.

Overall, the urban forest has expanded, and in multiple ways it appears to be healthy. There are well-coordinated efforts for managing parts of it. However, the resource is not equitably distributed, nor is it well protected or funded, and little is known about how large portions of it are managed. These challenges can be addressed but require long-term planning, policy, investments, management, and monitoring. There is substantial opportunity to further expand the NYC urban forest and its benefits.

Strengths and Challenges

State of Knowledge

NYC is rich with urban forest expertise, research, and data, and yet, when writing this report, we encountered limits in the overall understanding of this resource, and what we could do with available information. For example, segmented ownership and limited data meant that it was difficult to analyze the urban forest as a whole (canopy was the only metric we could apply across all jurisdictions), or to arrive at an exact count of trees in the city from which to derive a more complete understanding of the asset. The sheer number and diversity of property owners makes it extremely challenging to characterize and improve practices across jurisdictions and site types. It is also difficult to compare data over time or data from different site types given advancements in technology and the different methodologies often employed.

The strengths and challenges we summarize here are based on the available research and data we have leveraged throughout this report. The conclusions we could draw were influenced by the limits of available information (which we do not comprehensively enumerate), despite substantial and rigorous research that has been done on the NYC urban forest that we reference throughout the report. In the subsequent section on opportunities, we discuss specific opportunities to fill information gaps, generate new knowledge, and maintain the types of understanding we have for the urban forest today.

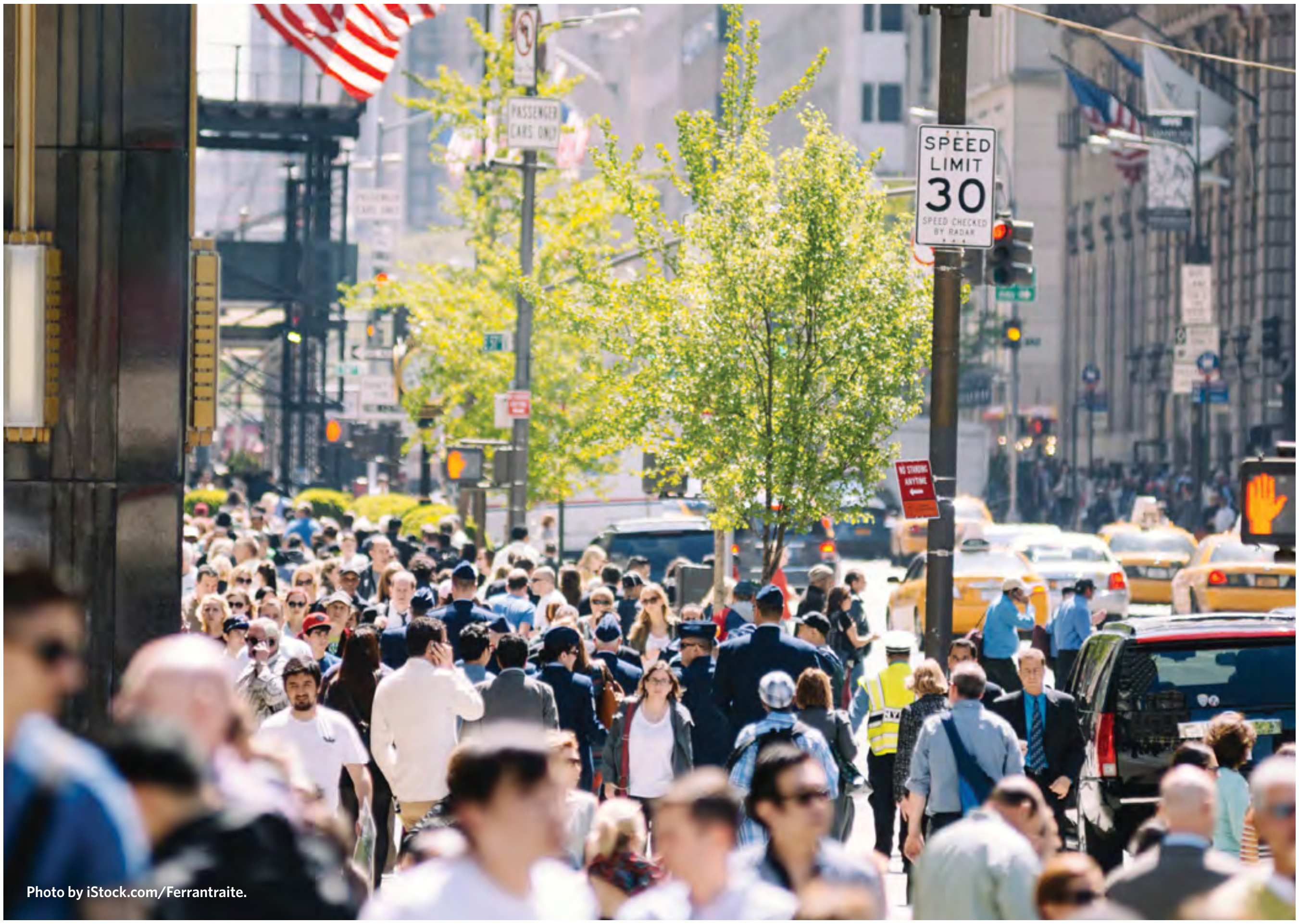

Photo by iStock.com/Ferrantraite.

A crowd of people walks down Fifth Avenue in Manhattan, passing two relatively young street trees.

Distribution Over Time, Benefits, and Equity

From 2010–2017, NYC experienced net gains in tree canopy citywide and across most site types and smaller geographies. This is encouraging news and suggests that strategic planting and maintenance are having positive effects. These increases may support resilience to stressors such as pests, pathogens, and storms. Yet, we also see that at the finer, local scale, some areas lost canopy. Further, some areas still had very low canopy in 2017, in spite of gains since 2010. In addition, while natural areas gained canopy overall, areas identified as forested natural areas on private land as of 2010 actually lost canopy, suggesting ongoing threats from development.

Street trees exhibited net increases citywide and generally at the scales we examined between 1995–2015. However, as with canopy, a handful of areas exhibited net losses in street trees, or while there were net gains across that time, exhibited losses in street trees more recently (2005–2015). Some of the greatest street tree stocking rates are actually in some of the most socially and heat-vulnerable communities. Of interest, the total number of street trees increased more from 1995 to 2005 than from 2005 to 2015, despite the significant efforts of the Million Trees NYC Initiative (MillionTreesNYC). Understanding the drivers of the different rates of increase can be informative for future efforts to stock and maintain street trees.

Across the various segments of the urban forest that have been studied, there is a diversity of the kinds of trees and a healthy age distribution that portends a degree of resilience and succession in coming years. The urban forest faces various environmental stressors, all of which are exacerbated by climate change and require adaptive management. These include the urban heat island effect and extreme heat events, extreme storm events, flooding, shifts in plant hardiness zones, forest pests and pathogens, and invasive species.

Extreme storm events have proven particularly damaging to the NYC urban forest, as seen in the catastrophic tree loss and associated property damage from Superstorm Sandy and Tropical Storm Isaias. These storms felled more than 10,000 and 3,000 trees, respectively, causing utility interruptions and damaging property, requiring emergency responses to remove downed trees and make repairs. Many of the localized losses in the urban forest that we identified appear to be associated with major storms like these.

The NYC urban forest provides substantial tangible and quantifiable benefits. Some, such as cooling of the environment and reduction in energy consumption, and removal of air pollution, can be economically valued. Numerous other benefits that deserve greater study (e.g., some human health benefits, mental well-being, learning benefits) and the intangible benefits and intrinsic value could be better understood, even if not quantified.

Although recently there have been encouraging trends in terms of canopy, the urban forest and its benefits are not equitably distributed. Often, there is less canopy in more socially and heat-vulnerable communities throughout the city, where larger portions of the population are comprised of low-income residents, and people of color. Given broader environmental justice issues and cumulative impacts, lower tree canopy may be a challenge both as a stand-alone and a compounding issue, contributing to lower quality of life, health issues, and shorter lifespans. Further, given relationships between the urban forest and its benefits to educational and health outcomes, areas around facilities such as schools and hospitals could be made a higher priority when considering how to address disparities.

Historical policies, such as redlining, led to segregation and disinvestment in certain communities, and now generally correlate with lower canopy in those areas. Because trees are often perceived as beneficial and have aesthetic value, increasing their numbers in a neighborhood may make the area more attractive, raising housing prices, and displacing current residents, especially those of lower income or people of color. Tree planting in NYC has been associated with increases in housing values and share of white residents, potentially contributing to the gentrification that has been documented in a number of neighborhoods in NYC in recent decades. Thus, this legacy of structural racism is a major challenge, and addressing it can have its own unintended harmful consequences if not carried out in alliance with communities.

COVID-19, which emerged while we were researching this report, fundamentally altered the daily activities of New Yorkers, who relied even more than usual on local open spaces for respite, culture, and community. The neighborhoods hardest hit by COVID-19 often overlap with the most heat- and socially vulnerable communities. Shade was, as always, one of the most valued aspects of park-going, especially given the reduced capacity of cooling centers. However, not all communities enjoy the same level of shade or open space, both of which have proven to be important for mental and physical health throughout the pandemic. The pandemic also facilitated New Yorkers using their streetscapes differently, which has presented more potential conflicts in use of these spaces but also supported creative approaches for leveraging streetscapes.

Current Dynamics in Management, Policy, Funding, and Stewardship

There are no comprehensive or unifying goals, visions, or plans for the NYC urban forest. Rather, this essential natural infrastructure has been largely supported by intermittent, time-bound initiatives and efforts such as Mayoral plans, as well as by annual but inconsistent budget allocations for portions thereof. A limited set of institutionalized policies and rules also help maintain this asset, such as replacement requirements for trees within the jurisdiction of the NYC Department of Parks and Recreation (NYC Parks) and a limited set of zoning regulations. The urban forest has persisted and even expanded from 2010 to 2017 in spite of the lack of centralized efforts, and some gains are likely attributable to major, albeit time-bound, initiatives such as MillionTreesNYC. While an institutionalized, resourced, and long-term citywide plan is not the sole requirement for long-term expansion and resilience of the urban forest, it could create enabling conditions by setting direction for investments in planning, planting, and maintenance. Such a plan could also ultimately support workforce development and civic efforts that support the resource. And, as demonstrated by MillionTreesNYC, when a goal or plan is established and codified, it can be achieved.

The portions of the NYC urban forest under the jurisdiction of NYC Parks—namely street trees, and trees on City Parkland—comprise about 53.50% of the canopy in NYC. These trees have some of the highest levels of protection in NYC, and while there are ultimately no rules protecting any individual trees from being removed, there are replacement requirements for those that are approved to be removed for utility work, construction, or similar activities. However, trees lost to other factors such as storms, pests, disease, and simply stressors of urban environments are not required to be

There are no comprehensive or unifying goals, visions, or plans for the NYC urban forest.

replaced, although these factors cause substantial losses. As climate change increases extreme weather events, the needs for tree salvage, removal, and replacement will likely increase as well.

The large portion of the urban forest within NYC Parks' jurisdiction is notably well characterized. It is supported through centralized, albeit variable, funding, staffing, and civic stewardship. The vast network of civic stewardship groups that maintain, advocate, and educate their communities about the urban forest is another strength to uplift. Thousands of groups operate at different scales and in different areas across the city. Many organizations partner with the City to perform management activities ranging from pruning to developing long-term management goals (e.g., the *Forest Management Framework for New York City*). They often harness private funding to supplement insufficient public budgets and innovate new approaches.

Public funding for the urban forest in NYC is not consistent or stable. Even programs that support more robust management of the resource are frequently funded on a short-term basis, inconsistently, and only for part of the asset. Further, costs may increase (e.g., as with street tree planting) and funding is subject to substantial cuts, as seen in the City budget during the COVID-19 pandemic—even intermittent, punctuated cuts can likely impact management cycles for years to come as they create a backlog of work and lost progress. Volunteers and civic stewards help maintain and promote the urban forest, but significant resources are needed to keep up with demands exceeding volunteer capacity. Private philanthropy and the private sector provide support, but they alone cannot fulfill the full funding needs nor make up for cuts.

The nearly 47% of the urban forest beyond NYC Parks' jurisdiction has a combination of highly variable and poorly documented policies, funding, and management. Many of these factors vary with specific jurisdiction of the land the trees occur on. While some owners, such as the NYS Department of Environmental Conservation and the U.S. National Park Service, as well as certain cemeteries and botanical gardens, have documented plans and policies that relate to the urban forest, most owners do not. This indicates that vast portions of the urban forest may be un- or under-managed.

For most of the urban forest beyond NYC Parks' jurisdiction, property owners can do as they wish with trees on their property. Some of these non-NYC Parks properties are within certain special purpose zoning districts and are subject to their tree preservation requirements (e.g., the Special Natural Area District); some government-owned properties are also subject to other agency-specific rules. However, these areas account for a relatively small portion of the urban forest overall. Thus, while NYC as a whole saw increases in canopy from 2010 to 2017, continuation of this trend is far from guaranteed and is subject, in large part, to the decisions of countless individual property owners.

Opportunities

The biggest challenges facing the urban forest in NYC include limits to understanding the resource holistically, lack of strategic goals, inconsistent and insufficient regulations and standards, and deficient funding for ongoing planting and care. These challenges are exacerbated by two larger dynamics, which must be addressed across all the opportunities that follow—climate change and inequity. Given these challenges, we suggest several major opportunities to improve the state of the urban forest in NYC, often building on its strengths.

Create Enabling Conditions to Effectively Plan, Invest, and Manage

To describe the status and distribution of the urban forest, we primarily leveraged multitemporal data on canopy extent and an ecological covertype dataset for the entire city, as well as three decadal street tree censuses, a recent inventory of landscaped park trees on City Parkland, and an assessment of natural areas on City Parkland. The City has the opportunity to build on and routinely update these robust datasets, which will be critical for tracking change in the urban forest through time. This can be enabled through long-term, institutionalized funding commitments dedicated to fill these needs.

A plant nursery worker transplants seedlings at the Greenbelt Native Plant Center, run by the NYC Department of Parks and Recreation on Staten Island.

Furthermore, some of the aforementioned datasets only capture portions of the urban forest within the jurisdiction of NYC Parks. Very little work has characterized other site types. To holistically characterize the NYC urban forest, it is vital that future efforts capture these less studied parts of the resource with common protocols for data collection and standards that support data sharing for broader impact and applicability. There is substantial potential to build on existing and ongoing work, while leveraging standards such as those developed by NYC Parks, the Natural Areas Conservancy, and the USDA Forest Service. In such efforts it will be critical to incorporate collection of data on tree and forest health, such as presence of pests and disease, to have a holistic picture of the health of the urban forest.

As with the biophysical status and distribution of the urban forest, most information available for its management represents the portions within NYC Parks' jurisdiction. While there is potential to standardize best management practices across jurisdictions and property types, there is limited baseline information regarding management in non-NYC Parks' jurisdictions. Thus, results of targeted research could support more efficient use of resources, for example, by identifying site types that would yield the greatest benefits for the urban forest if management were improved. In addition, long-term cost projections for managing the resource are invaluable for planning and ensuring adequate investments. While projections exist for parts of the urban forest, expanding projections to include the variety of site types across NYC can inform long-term policy and yield a better understanding of the full set of resources required to holistically maintain a healthy urban forest and its myriad benefits.

Information on attitudes that New Yorkers hold toward the urban forest was a notable gap that we faced in developing this report. As a result, most of the research we drew upon regarding attitudes was based outside NYC. Some of the sources that we leveraged for NYC specifically, such as 311 data, are informative, albeit not necessarily reflective of attitudes specifically, or representative of the entire population. We suggest that dedicated research and polling can better account for the varied perspectives held by people across NYC, an understanding of which can be used to inform policy, planning, and engagement with residents. This may further tie to engagement with people in stewardship activities, and to planting, protection, and care of trees on private property.

There is clear evidence that the NYC urban forest offers substantial benefits and there is opportunity for further development of this work. For example, detailed, spatially explicit estimates that account for the local context in which individual trees occur can yield a more comprehensive understanding of cooling, health, air quality, and energy-saving benefits, which may ultimately inform investments, and can even be used to influence public policy, opinion, or behavior. We also acknowledge that there can be disservices of the urban forest and more work is needed to fully understand them.

Lastly, limited work has examined the potential for increasing the distribution of the urban forest, which is critical for long-term planning and goal-setting. The Nature Conservancy, in consultation with the USDA Forest Service and the Natural Areas Conservancy, has attempted to fill this gap with a Practical Canopy Analysis (forthcoming). This work estimates the potential for canopy across the landscape and enables derivation of potential stem counts. Projections for the urban forest can thus be developed, for individual jurisdictions and land uses, as well as individual geographies and the City as a whole.

Plan for a Healthy, Equitable, Robust, and Resilient Urban Forest

There is an opportunity for the City to establish meaningful long-term goals and metrics, as well as a master plan for the urban forest as a whole. The *NYC Urban Forest Agenda* (**Box 9.1**) and forthcoming work from The Nature Conservancy on canopy potential could help to inform such goals and a plan. Such a plan would identify and prioritize areas of potential planting based on both need and opportunity; build on recent gains to keep expanding canopy by supporting tree growth; tailor programs for different property types, from direct planting to incentives for maintaining existing trees; and prioritize equity and environmental justice while anticipating climate impacts.

It will be imperative that planning reflects neighborhood priorities and supports community-scale urban forest plans as well. Local planning can complement a citywide plan and goals, and help bring such an effort to fruition more expediently by increasing relevance and community buy-in. Investments in tree planting and care in areas with lower canopy, particularly those where residents face other environmental stresses or lack other environmental amenities, present tremendous opportunity. If such efforts are developed and implemented in consultation and collaboration with local communities, it is possible to both minimize potential unintended consequences, like gentrification, and to uplift local values, vision, and leadership. In such planning, schools, hospitals, and other community facilities can be prioritized in order to benefit specific vulnerable populations. While there may be landscape factors that constrain opportunities for new planting, lower-canopy areas of NYC are ripe for further investments in long-term planning that can ultimately improve equity of the urban forest.

To create an effective plan, interagency cooperation is needed to maximize expansion of and care for the urban forest on all public property. For example, the NYC Department of Environmental Protection's Green Infrastructure program presents a particular opportunity to both increase tree planting in bioswales, where feasible, and ensure that siting of stormwater management solutions without trees do not inadvertently decrease available tree planting space. Since living infrastructure accounts for only a portion of the program, it could be evaluated to maximize the potential for trees and other vegetative cover. Further, other City, State, and Federal property can be evaluated and planned to maximize cover, prioritizing the land in frontline communities.

Planning during recovery from the COVID-19 pandemic may present a particular set of opportunities, both to incorporate trees into reimagined streetscapes and to protect trees from emergent use conflicts, like outdoor dining. Given the renewed interest in outdoor life, prioritizing trees and shade can be thoughtfully integrated into new approaches to streetscapes. Further, as increased investments are made in greenways, trees can be planted adjacent to them, creating more pleasant and accessible travel routes. Similarly, these efforts can improve connections between natural areas, especially to access current and to-be-developed trails.*

* See the *New York City Strategic Trails Plan*: https://naturalareasnyc.org/trails

BOX 9.1

Building a Shared Vision and Movement for the NYC Urban Forest

The Nature Conservancy's Future Forest NYC initiative aims to galvanize a clear, coordinated, committed, and broad-based voice for protecting, maintaining, and expanding the NYC urban forest and ensuring that its benefits are shared equitably among all New Yorkers. As part of this effort, The Nature Conservancy, alongside many partners, launched the NYC Urban Forest Task Force to elevate, build on, and link the many initiatives, assets, and efforts related to the NYC urban forest. This coalition of nearly 50 diverse organizations and 70 participants collaboratively developed the *NYC Urban Forest Agenda: Toward a Healthy, Resilient, Equitable, and Just New York City*. The *Agenda* is a strategic, concrete, and broadly endorsed roadmap that provides 12 detailed recommendations to meaningfully protect, maintain, expand, research, and promote the NYC urban forest to benefit all New Yorkers in a way that is just and equitable. Priority actions include:

- Achieve 30% Canopy Cover by 2035
- Establish a Master Plan for the Urban Forest
- Grow and Sustain the Forest for All NYC Coalition
- Cultivate Urban Forest Careers
- Increase and Equitably Distribute Funding for Urban Forestry Projects

The NYC Urban Forest Task Force has transitioned into Forest for All NYC to carry out the *Agenda* along with many new coalition members and supporters. More information is available at: https://ForestForAll.NYC

Strengthen Policy, Regulation, and Management Practices

There are myriad opportunities to enact or improve policy, to standardize management practices across land types, and to improve consistency of management of the urban forest through time. Policies can be established to prevent removal of trees, require replacement for removed or downed trees, compel management, and establish planting standards. Specific approaches include the following:

- Enact policies that better prevent removal of healthy, larger trees on public lands (e.g., City Parkland, NYC Housing Authority) that will take decades to replace if lost.
- Expand policies that require replacement of trees lost in general (e.g., due to storms, pests), not just those lost to development, and to include jurisdictions beyond NYC Parks.
- Implement standards to support transfer of best practices, or creation of shared management agreements, for City-owned portions of the urban forest beyond NYC Parks' jurisdiction, to ensure that, at a minimum, all City-owned trees reach an appropriate standard of care; such standards could also be shared or encouraged for other types of property owners as well.
- Institute incentives and requirements to protect and expand the urban forest on private property, which has the potential to achieve thousands of additional acres of canopy, building on and expanding existing requirements for trees, as in select Special Purpose Districts.
- Institute policies to support wood salvage from removed or downed trees.

The NYC urban forest is a tremendous asset, yet its full potential is not being realized.... There is a huge opportunity not only to protect and care for what we have, but also to expand it to grow its benefits and ensure that it reaches New Yorkers more equitably.

Invest in the Expansion and Management of the Urban Forest and the People Who Care for It

While master planning is needed, some specific planting and management opportunities are ready for investment and advancement immediately. On public property, the City could take advantage of opportunities for nearly 250,000 new street trees, and could maximize planting in landscaped parks and forested natural areas while accounting for other uses and ecosystems.

Sufficient public funds are needed to take advantage of the aforementioned opportunities and to expand stewardship such that the urban forest provides benefits more fully and equitably into the future. NYC Parks can be fully resourced to care for all the trees in its portfolio by funding the *Forest Management Framework for New York City* and fully funding management of landscaped park and street trees. This will also require investments to develop urban forestry career pathways and to ensure that these jobs are compensated sufficiently to be competitive. This suggests a need for local forestry and arboriculture degree and certification programs, as well as other professional training.

Investing in NYC Parks is necessary, but not sufficient to care for the whole of the urban forest. Continuing to invest in programs like Cool Neighborhoods NYC that prioritize planting and maintenance in the most heat-vulnerable communities and other environmental justice areas presents a terrific opportunity. These programs can be expanded to ensure that all jurisdictions are included in planting and maintenance efforts.

Another area of opportunity is increasing investment in, and capacity-building for, partnerships that support the urban forest on parkland (across jurisdictions). The many nonprofits, businesses and Business Improvement Districts, and volunteer stewards who tend the resource are beneficial to the care and management of the forest. Identifying more ways to resource, honor, appreciate, celebrate, and grow these efforts is important to the future of the urban forest. In order to go beyond the already engaged audience and broadly embed tree planting and care as priorities of more property owners, there is a need to develop cultural strategies like outreach, promotions, and campaigns, including tree giveaways and technical assistance.

Innovation will also be needed. For example, stabilizing or decreasing the price point for tree planting, be it through expanding the pool of bidders, bringing more aspects of the work in-house, or developing other innovations, is an important area of opportunity to accelerate street tree planting and replacement, although this must be accomplished while ensuring good, living-wage jobs for urban forestry. Decreasing the cost of tree guards is also an area of potential. Innovations in other aspects of urban forestry, including engagement with private property owners, will also be valuable to pursue.

For public funding to be sufficient, State and Federal resources will likely be needed, in addition to a larger, dedicated share of the NYC budget. Generally, advocacy is required to see meaningful increases in public funding. New Yorkers have an opportunity to speak up for urban forest funding as individuals and as part of larger campaigns. There are opportunities to increase urban forestry funding from a variety of sources, including the NYS Environmental Protection Fund, environmental bonds, and federal funding such as the Land and Water Conservation Fund, COVID-19 recovery funds, and forthcoming funds intended to address drivers and impacts of climate change.

A Caucasian wingnut (*Pterocarya fraxinifolia*) at the Brooklyn Botanic Garden.

Conclusion

The NYC urban forest is a tremendous asset, yet its full potential is not being realized. It shows some encouraging signs, but it also has both immediate and long-term needs. There is a huge opportunity not only to protect and care for what we have, but also to expand it to grow its benefits and ensure that it reaches New Yorkers more equitably. In addition to the opportunities above, we encourage readers to look to the *NYC Urban Forest Agenda* (https://forestforall.nyc/nyc-urban-forest-agenda/) for a set of 12 actions generated and agreed upon by a diverse group of stakeholders to establish clear next steps to support the NYC urban forest.

The urban forest is a major element of the NYC landscape and requires significant planning, regulation, investment, management, stewardship, monitoring, and research, all of which can build upon the significant community of practice that already exists. In taking steps to sustain, expand, improve, and use the urban forest, New York City can become more just and resilient.

Aerial view of Crown Heights and Prospect Heights neighborhoods in Brooklyn, with the Manhattan skyline in the background.

Photo by iStock.com/halbergman.

Glossary and Acronym List

Glossary

Attitude	Term from the field of psychology that describes people's overall judgement about objects or situations. Attitudes are shaped over time and influence our behavior to various degrees.
Canopy	Layer of leaves, branches, and stems of trees that cover the ground when viewed from above. Quantitative measures of canopy, as used in this document, are based on data developed using 3D remote sensing techniques, in which vegetation is only considered as canopy if it is more than 8' high. Canopy is often described as the area it covers, or as a percentage of a broader area (adapted from the USDA Forest Service[1]).
Carbon Sequestration	The process of capturing and storing atmospheric carbon dioxide that is used as a method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.[2]
Citizen Pruner	A volunteer who is licensed through Trees New York's Citizen Pruner Tree Care Course to prune public trees.[3]
City Parkland	All lands delineated as NYC Parks properties within New York City.
Civic Stewardship Groups	Civic environmental groups that conserve, manage, monitor, transform, educate, and advocate for the local environment, including land, air, water, and systems (such as energy, waste, and food systems).[4]
Community District	Administrative areas ranging in size from less than 900 acres to 15,000 acres, and in population from just over 50,000 residents up to about 250,000. New York City's 59 community districts, along with accompanying Community Boards, were created by local law in 1975 to create opportunities for active participation in the political process and provision of services.[5]
Cool Neighborhoods NYC	A City program to invest in the most heat-vulnerable neighborhoods in NYC through a range of activities, including tree planting, to address urban heat island effect and its impacts.[6]
Cultivar	A variety of plant deliberately selected through breeding and cultivation.
Cumulative Impacts	Combined, incremental effects of different human activities.
Diameter at Breast Height (DBH)	Diameter of a tree measured at 4.5' above the ground, a common forestry convention that is used by many, including NYC Parks.
Economic Valuation of Ecosystem Services	Quantification of the value of the functions and processes enabled by the ecosystems that are essential for human life.[7]
Ecosystem Services	The conditions and processes through which natural ecosystems and the species that are part of them, help sustain and fulfill human life.[8]

Environmental Justice	Equal distribution of environmental risks, hazards, investments, and benefits, without direct or indirect discrimination, at all jurisdictional levels. Environmental justice also implies equal access to environmental investments, benefits, and natural resources; access to information and justice in environmental matters; and participation in decision-making.[9]
Environmental Racism	The intentional siting of hazardous waste sites, landfills, incinerators, and polluting industries in communities inhabited mainly by Black, African American, Hispanic, Indigenous, and Asian residents, migrant farm workers, and the working poor.[10]
Equity	The fair or just treatment of people. Promoting justice, impartiality, and fairness within the procedures and processes of institutions or systems, as well as in their distribution of resources.[11]
Forest Management Framework for New York City	New York City's first citywide strategic and comprehensive plan to bolster and protect forested natural areas. This was a joint project of the Natural Areas Conservancy and NYC Parks. The 25-year plan is intended to guide restoration, management, and community engagement for approximately 7,300 acres of NYC Parks' forested natural areas.[12]
Forested Natural Areas	A subset of the urban forest that is distinct from street trees, park trees, and trees in more manicured landscapes in terms of biodiversity, size, composition, and management. Forested natural areas are complex ecosystems that include soil, microorganisms, and myriad species of flora and fauna throughout their various life stages, in addition to the humans who live near, visit, and manage these spaces.[13]
Forever Wild Preserves	Preserves that are part of the NYC Parks' Forever Wild Program to protect and preserve the most ecologically valuable lands within the five boroughs. Forever Wild Preserves are intended to provide undisturbed area for plants and animals. They are generally large, composed primarily of native and rare species, and have healthy soils.[14]
Gentrification	A change in an area's socioeconomic and physical characteristics, including culture, housing stock, and amenities, that displaces the original residents and businesses—usually those with lower incomes or of marginalized ethnicities and races—by more affluent residents and upscale businesses.[15]
Green Job	Job that produces goods or provides services that benefit the environment or conserve natural resources.[16]
Greenhouse Gases	Gases that trap heat in the atmosphere.[17]
Habitat	The place or environment where a living organism naturally or normally lives and grows.
Heat Vulnerability Index	A statistical index of the risk of heat-related illness or death calculated using social and environmental factors. The Heat Vulnerability Index considered in this report was developed specifically for NYC by the NYC Department of Health and Mental Hygiene.
Invasive Species	A species that has been introduced to an ecosystem and causes ecological or economic harm, or harm to human health.[18]

Landscaped Park Trees	Trees that are purposely planted in areas with playgrounds, picnic areas, athletic fields, bike paths, lawns, and in other actively programmed areas of parkland, generally with at least some degree of management. Landscaped park trees can exist in parks of various jurisdictions, though portions of this work focus specifically on NYC Parks' landscaped park areas, given specific data available for these sites.
LiDAR	Acronym for Light Detection and Ranging, a remote sensing method that uses light (in the form of a pulsed laser) to measure distances from a sensor and can ultimately yield a 3D representation. In the context of urban forestry, it provides a valuable set of data used to map tree canopy.[19]
Management	Process of planning and implementing practices for the stewardship and use of forests to meet specific environmental, economic, social, and cultural objectives.[20]
MillionTreesNYC	A citywide, public-private program, launched in 2007 as one of the 132 *PlaNYC* initiatives, that set the goal to plant and care for one million new trees across the City's five boroughs.[21]
Native Species	A species that occurs naturally in an ecosystem in which it historically evolved.
Non-native Species	A species that does not occur naturally in an area, but was introduced as the result of deliberate or accidental human activities. Non-native species are not necessarily invasive.[22]
Natural Area	Portions of the landscape that are generally unmanicured, often containing vegetation that grew naturally without human intervention, though these areas are sometimes actively planted and managed.
Neighborhood Tabulation Area	Spatial designations in NYC created to project populations at a small-area level (with a minimum population size of 15,000) from 2000 to 2030 for *PlaNYC*, the long-term sustainability plan for NYC.[23]
OneNYC	NYC's long-term strategic plan, launched in 2013 and created under the requirements of Local Law 84, with the intention to confront the climate crisis, achieve equity, strengthen democracy, and build a strong and fair city.[24]
Parkway	A designation of certain roadways in NYC, which generally have vegetated or heavily treed landscapes along them.
Peaker Plants	Power plants that run only when there is high demand for energy.[25]
PlaNYC	A strategic plan for a greener, greater NYC released in 2007, to prepare for a growing population, strengthen the economy, combat climate change, and enhance the quality of life for all New Yorkers.[26]
Pruning	Selectively removing unwanted branches from a tree to improve tree structure, promote tree health, and, at times, to resolve conflicts with other infrastructure.
Public Policy	A system of laws, regulatory measures, courses of action, and funding priorities promulgated by a governmental entity.[27]

Redlining	A method of lending discrimination used that allowed banks and mortgage lenders to reject the loans of borrowers for purchasing or even renovating their homes based on their race or where they lived. This practice, now outlawed in the United States, began in the 1930s when financial institutions adopted a system of labeling areas and neighborhoods that were considered the highest risk for lenders with the color red.[28,29]
Relative Canopy Change	The percent change in canopy between two points in time, relative to the amount of canopy present in the first of those two points in time.
Right-of-Way Trees	Trees growing in the mapped right of way, defined as all areas outside of mapped properties. Right-of-way tree canopy is generally attributable to street trees along sidewalks, trees growing in traffic triangles and plazas, and trees along roads and highways.
Senescence	The halting of regeneration of plant tissue, leading to deterioration of condition, halting of reproduction, and ultimately plant death.
Social Justice	Justice in terms of the distribution of wealth, opportunities, and privileges within a society.[30]
Social Vulnerability Index	Index comprised of 15 U.S. Census variables that are grouped into four themes (Socioeconomic Status, Household Composition, Race/Ethnicity/Language, and Housing/Transportation), designed to help local officials identify communities that may need support before, during, or after disasters.[31]
Species Diversity	The number of species in a given locality (species richness) generally weighted by some measure of relative abundance of species (species evenness).[32]
Stewards	People who seek to conserve, manage, monitor, restore, advocate for, and educate the public about a wide range of issues related to sustaining the local environment.
Stewardship	Doing any of the following: conserving, managing, monitoring, advocating for, or educating the public about local land, air, water, waste, energy, or toxics issues.[33]
Stewardship Mapping and Assessment Project (STEW-MAP)	A research methodology, community organizing approach, and partnership mapping tool developed by scientists at the USDA Forest Service Northern Research station to understand the structure and function of stewardship groups across the landscape.[34]
Stem Count	The number of individual trees in an area. This measure can be used to derive density of trees (e.g., trees per unit area or trees per mile of road) or stocking rate (number of trees compared with the capacity).
Street Trees	Trees that are planted along streets, sidewalks, and medians of surface roads; in designated tree beds that are within the sidewalk or along the curb; or in grass strips between the sidewalk and the curb.
Street Tree Census	An inventory of street trees in which location, size, species, and condition of each individual street tree within NYC is recorded. Three decadal street tree censuses have been conducted, starting in 1995, and led by NYC Parks, with support from volunteers.[35]

Street Tree Stocking Rate	Number of living street trees compared to estimated capacity for them in a given area (e.g., citywide or within more granular areas). Street tree stocking rates may be expressed as percentages or proportions.
Tax Lot	A parcel of land identified with a unique borough, block, and lot number for property tax purposes. A zoning lot comprises one or more adjacent tax lots within a block.[36]
Tree	A woody perennial plant, typically large, with a single well-defined stem carrying a more or less definite section of foliage (a crown).[37]
Tree Bed	Area with soil for tree roots and surface treatment (e.g., mulch or plantings) created in parts of the landscape that are otherwise hardscaped, such as sidewalks.
Tree Guard	A fence around the perimeter of a tree bed that serves as a physical barrier to ultimately reduce soil compaction, shield the tree from physical damage, and prevent waste buildup.[38]
Urban Heat Island	A phenomenon caused by the lack of trees, vegetation, and green open spaces in urban areas, combined with dense, hard surfaces of concrete and asphalt. Heat is generated by solar radiation and anthropogenic sources such as idling traffic and air conditioning of buildings and homes. Landscapes of cities tend to trap this heat, creating a feedback loop that further exacerbates high temperatures.[39]
Urban Forest	Socioecological system that includes all the trees in NYC and the physical and social infrastructure on which they depend.
Urban Forest Management Plan	A roadmap for a city to establish and execute urban forestry goals over a certain set period of time that can help increase urban tree canopy, create cost-effective maintenance routines, build partnerships with local stakeholders, and help reach sustainability goals.[40]
Urban Forest Patch	A place where forest vegetation is spontaneously regenerating and predominantly self-organizing, located in a matrix of urban land uses, such as the built environment.[41]
Urban Forestry	The planting, management, maintenance, care, and protection of tree populations and forest resources in urban settings.[42]
Zoning	Laws that limit how land may be used by property owners in order to guide development across neighborhoods and cities. In New York City, zoning regulations address issues such as building shape, affordable housing, walkability, and climate change.[43]
Zoning Lot	A tract of land that is the basic unit for zoning regulations and comprises a single tax lot or two or more adjacent tax lots within a block. An apartment building on a single zoning lot, for example, may contain separate condominium units, each occupying its own tax lot.[36]

Acronyms

CEQR	City Environmental Quality Review
DBH	Diameter at Breast Height
EA	Ecological Assessment
ECM	Ecological Covertype Map
FMF	Forest Management Framework for New York City
HVI	Heat Vulnerability Index
LWCF	Land and Water Conservation Fund
NAC	Natural Areas Conservancy
NEPA	National Environmental Policy Act
NPS	National Park Service
NTA	Neighborhood Tabulation Area
NYC	New York City
NYC DEP	NYC Department of Environmental Protection
NYC Parks	NYC Department of Parks and Recreation
NYCHA	NYC Housing Authority
NYRP	New York Restoration Project
NYS	New York State
NYS DEC	NYS Department of Environmental Conservation
NYTT	New York Tree Trust
OPRHP	NYS Office of Parks, Recreation, and Historic Preservation
SVI	Social Vulnerability Index
Trees NY	Trees New York
UCF	NYS Department of Environmental Conservation Urban and Community Forestry Program
USDA	U.S. Department of Agriculture
WTP	Willingness to pay

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CHAPTER 1
Introduction

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CHAPTER 8

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Personal Communications with NYC Parks, referenced throughout this report, were with staff from the NYC Department of Parks and Recreation Division of Forestry, Horticulture and Natural Resources, including Jennifer Greenfeld, Assistant Commissioner, and Fiona Watt, Senior Advisor.

Personal Communications with C. Pregitzer, referenced in this report, were with Dr. Clara Pregitzer, Deputy Director of Conservation Science with the Natural Areas Conservancy.

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APPENDIX 1

Methods and Data Sources

General Notes and Data Used in Analyses

This section describes how analyses were conducted for *The State of the Urban Forest in New York City*; this information, further annotated for technical users and with supporting code, is available on GitHub at https://github.com/tnc-ny-science/NYC_StateOfUrbanForest_Docs.

All spatial analysis was conducted with data projected in the NY State Plane—Long Island Zone coordinate system (datum NAD83), EPSG code 2263. This coordinate reference system uses feet as the units. For presentation of results in the report we converted units to acres (1 acre = 43,560 ft^2).

Datasets used in analyses are listed below (**Table A1.1**). When referencing specific attributes of individual datasets by name, for concision we follow a convention of DatasetName.FieldName, where "DatasetName" refers to the dataset, and the "FieldName" refers to the column or field. We used the data that were most recent and that we considered most appropriate for this work at the time of analysis. Thus, for example, some older datasets that were not comparable to newer ones were not leveraged for this report, and we may not have been able to leverage more recent datasets if they were released during the later stages of this report.

Data Sources Used in Analysis in Report

Table A1.1

Dataset*	Source**
MapPLUTO - version 20v6 (Tax lot boundaries)	NYC Department of City Planning; https://www1.nyc.gov/site/planning/data-maps/open-data/dwn-pluto-mappluto.page
Borough Boundaries (Clipped to Shoreline)	NYC Department of City Planning; https://www1.nyc.gov/site/planning/data-maps/open-data/districts-download-metadata.page
City Council Districts (Water Areas Included)	NYC Department of City Planning; https://www1.nyc.gov/site/planning/data-maps/open-data/districts-download-metadata.page
Community District Boundaries (Water Areas Included)	NYC Department of City Planning; https://www1.nyc.gov/site/planning/data-maps/open-data/districts-download-metadata.page
Neighborhood Tabulation Areas - 2010	NYC Department of City Planning; https://www1.nyc.gov/site/planning/data-maps/open-data/census-download-metadata.page
NYC Special Purpose Districts (Zoning)	NYC Department of City Planning; https://www1.nyc.gov/site/planning/data-maps/open-data/dwn-gis-zoning.page
LION - version 16a (Linear Features for NYC)	NYC Department of City Planning; https://www1.nyc.gov/site/planning/data-maps/open-data.page#lion
IPIS (Integrated Property Information System)	NYC Open Data; Dataset is no longer available from NYC Open Data, but archived version is available from QRI at https://qri.cloud/nyc-open-data-archive/ipis-integrated-property-information-system
FacDB (Facilities Database)	NYC Department of City Planning; https://www1.nyc.gov/site/planning/data-maps/open-data/dwn-selfac.page
Heat Vulnerability Index for NYC - 2018	NYC Department of Health and Mental Hygiene; data available at https://a816-dohbesp.nyc.gov/IndicatorPublic/VisualizationData.aspx?id=2411,719b87,107,Map,Score,2018
NYC Parks Forever Wild Area Boundaries	NYC Open Data; https://data.cityofnewyork.us/Environment/NYC-Parks-Forever-Wild/48va-85tp
Street Tree Census - 1995–1996	NYC Open Data; https://data.cityofnewyork.us/Environment/1995-Street-Tree-Census/tn4g-ski5
Street Tree Census - 2005–2006	NYC Open Data; https://data.cityofnewyork.us/Environment/2005-Street-Tree-Census/29bw-z7pj

* Where available, specific versions of datasets are indicated, and data were generally accessed in October 2020.
** In cases where no URL is indicated, datasets were shared by the respective entities and used with permission.

(Table A1.1 Continued)

Dataset*	Source**
Street Tree Census - 2015–2016	NYC Open Data; https://data.cityofnewyork.us/Environment/2015-Street-Tree-Census-Tree-Data/pi5s-9p35
Tree Canopy Change – 2010–2017	NYC Open Data; https://data.cityofnewyork.us/Environment/Tree-Canopy-Change-2010-2017-/by9k-vhck
NYC Parks Dominant Type Dataset	NYC Department of Parks and Recreation; Dominant Type, 2020
NYC Parks Golf Course Boundaries	NYC Department of Parks and Recreation; Golf Courses, 2020
NYC Parks Park Tree Inventory for Landscaped Park Areas of City Parkland	NYC Department of Parks and Recreation; Park Tree Inventory, 2018
Street Tree Capacity Estimates	NYC Department of Parks and Recreation; Street Tree Capacity, 2017
Social Vulnerability Index - 2018	U.S. Centers for Disease Control and Prevention; https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html
Home Owners' Loan Corporation (HOLC) Boundaries and Grades	University of Richmond, Digital Scholarship Lab; Nelson, R.K., Winling, L., Marciano, R., Connolly, N. et al. Mapping inequality. American Panorama, ed. Nelson, R.K., and Ayers, E.L. Available: https://dsl.richmond.edu/panorama/redlining/
Gateway National Recreation Area Boundaries	National Park Service
Ecological Covertype Map (ECM)	The Natural Areas Conservancy; O'Neil-Dunne, J., MacFaden, S., Forgione, H., & Lu, J. (2014). Urban ecological land-cover mapping for New York City. Final Report. Spatial Informatics Group, University of Vermont, Natural Areas Conservancy, NYC Department of Parks and Recreation.
NYC Housing Authority Properties	NYC Housing Authority
NYS State-Owned Parcels	NYS GIS Clearinghouse; http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1300
NYS Department of Environmental Conservation Lands (NYS DEC Lands)	NYS GIS Clearinghouse; https://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1114

* Where available, specific versions of datasets are indicated, and data were generally accessed in October 2020.
** In cases where no URL is indicated, datasets were shared by the respective entities and used with permission.

(Table A1.1 Continued)

Dataset*	Source**
NYS Historic Sites and Park Boundary (NYS OPRHP Lands)	NYS GIS Clearinghouse; https://gis.ny.gov/gisdata/inventories/details.cfm?DSID=430

Breakdown of Site Types

We developed a holistic data layer that encompassed a broad suite of datasets representing land ownership and jurisdiction, zoning, land use, administrative and political boundaries, and biophysical data such as Natural Area types into a single data layer (referred to as the "mashup"). This was done in coordination with staff from the NYC Department of Parks and Recreation (NYC Parks) Division of Forestry, Horticulture, and Natural Resources for consistency in data used across similar efforts, and with contracted support from the geospatial technology company, Azavea. Some of the input data are not publicly available and were used with permission or under data-sharing agreements. This mashup ultimately enabled us to describe the urban forest across site types, described in the report, based on ownership or jurisdiction and land use characteristics, as well as other specific breakdowns such as select Special Purpose Districts.

We restricted all analyses to the land area of New York City (NYC), based on the dataset of "Borough Boundaries (Clipped to Shoreline)" from the NYC Department of City Planning (DCP). Given that different datasets representing the land area of NYC are sometimes used or created by different City agencies (among others), whenever possible we leveraged datasets that were not restricted to land area, but only considered areas within those borough boundaries for consistency. For example, the version of the Parcels dataset for NYC (MapPLUTO) that is clipped to the shoreline sometimes differs in the representation of the shoreline, thus we used the "unclipped" version of that dataset (in which some parcels extend into New York Harbor) in the mashup, but only considered portions of the parcels within the DCP Borough Boundaries (Clipped to Shoreline) dataset for all analysis and numbers presented in the report.

Land Ownership and Jurisdiction

While some data (e.g., administrative and political boundaries) were leveraged in the mashup as provided, we processed other datasets to fit our specific purposes or to overcome known limits, to the extent possible. This was particularly the case for ownership and jurisdiction. The best available, single dataset that represents spatial boundaries, ownership, and land use (among other attributes) of parcels (i.e., tax lots) is MapPLUTO, publicly available from DCP, developed from a suite of datasets available from City agencies. While it is an invaluable dataset, and there are ongoing efforts to improve it,[*] MapPLUTO has limits. For example, MapPLUTO offers limited resolution for the OwnerType field, not specifically delimiting State, Federal, or private, tax-exempt entities. Furthermore, our understanding for publicly owned properties, on which taxes are not collected, is that the ownership or jurisdictional information is not reliably updated. Thus, in some cases ownership information for public properties is outdated. To improve and simplify characterizations of ownership, particularly for public entities, we developed holistic approximations of ownership based on generalizations we drew from inspecting MapPLUTO data in conjunction with the MapPLUTO data dictionary,[†] and by leveraging additional data as described below. Our re-classifications of the ownership or jurisdictional information are imperfect due to nature of the data, but they enabled a clearer breakdown that was sufficient for our intents and purposes. In many cases we are not able to accurately discern granular ownership or jurisdiction such as those of most individual government agencies. These results were primarily leveraged for Chapter 2 of the report, but many are referenced throughout.

* Changes are captured in the code base underlying this product, available on GitHub at https://github.com/NYCPlanning/db-pluto, as well as in the Read Me files associated with each release. The Read Me document for the version used in this report is available: https://www1.nyc.gov/assets/planning/download/pdf/data-maps/open-data/pluto-readme.pdf?r=20v6.

† Version used for this report available: https://www1.nyc.gov/assets/planning/download/pdf/data-maps/open-data/pluto_datadictionary.pdf?r=20v6.

- For properties where MapPLUTO.OwnerType was recorded as either City or Mixed (mixed City and private ownership), we classified these as City-owned.
- For properties where MapPLUTO.OwnerType was recorded as Other (owned by a public authority or the State or Federal government), we classified these as State-owned.
- For properties where MapPLUTO.OwnerType was blank, or was recorded as Private or as a "fully tax-exempt" entity, we classified these as privately-owned.
- For a suite of properties where owner name was listed in MapPLUTO as federal entities (e.g., U.S. Post Office), we classified these properties as Federally-owned.
- We leveraged other datasets to supplement MapPLUTO. Where these overlapped MapPLUTO, they were given priority over MapPLUTO as they were generally seen as more reliable. In cases where multiple datasets overlapped, the ownership delineation earlier in the list was given precedence:
  - NYC Parks' Dominant Type dataset represents properties designated and managed as City Parkland, under the jurisdiction of NYC Parks. This dataset delineates each area as "Natural" or "Developed." In some cases, mapped but unbuilt roads adjacent to or within formal properties are included, and these areas are managed as City Parkland. All land captured in this dataset was assumed to be City-owned, and more specifically within NYC Parks' jurisdiction. Notably, some areas within these datasets are not designated as tax lots but are mapped as City Parkland and were treated as such for all analysis.
  - Based on data representing the boundaries of Gateway National Recreation Area, we considered tracts of land as Federal, and National Park Service – Gateway property.
  - NYC Housing Authority Properties (NYCHA) were considered State-owned, and those that were not delineated as part of Rental Assistance Demonstration/Permanent Affordability Commitment Together (RAD/PACT) programs (which focus on leveraging private and non profit partnerships) were considered within the jurisdiction of NYCHA.
  - Properties in the NYS-owned, NYS Office of Parks, Recreation and Historic Preservation (NYS OPRHP), and NYS Department of Environmental Conservation (NYS DEC) properties datasets were considered State-owned. Properties in the latter two datasets were assumed to be in the jurisdiction of those agencies, respectively.
  - We incorporated data from the Integrated Property Information System (IPIS), based on the parcel identifier (borough, block, and lot number), reflecting whether properties are owned or leased by the City of New York. When the IPIS data indicated that properties were owned by the City, we considered them City-owned in the mashup. For properties with multiple, conflicting entries (i.e., some entries for one property indicated City-ownership, while others indicated City-leased), we assumed the properties were City-owned.
  - Lands that were not within any of the aforementioned datasets were considered rights of way. NYC Parks developed a specific layer depicting these that were included in the mashup.

Land Use

To distill how land is used, we leveraged some of the aforementioned information as well as specific information from MapPLUTO related to land use (MapPLUTO.LandUse) and building class (MapPLUTO.BldgClass), as follows. Rules that applied to all lands within certain categories superseded earlier rules (e.g., NYC Parks properties were considered Parkland, regardless of designations in MapPLUTO). We used information from MapPLUTO as provided, with the following exceptions:

- Properties MapPLUTO.LandUse coded as Multi-Family Walk-Up, Multi-Family Elevator, and Mixed Residential & Commercial Buildings were classified as Multifamily Residential.
- Properties with MapPLUTO.LandUse coded as Commercial & Office, Industrial & Manufacturing, Transportation & Utility, and Parking Facilities, were classified as Non-Residential Developed. A small percentage (0.34%) of tax lots did not have land use information in MapPLUTO. After spot-checking some of those sites with aerial imagery, we grouped them in this category.
- While cemeteries generally have MapPLUTO.LandUse coded as Open Space and Outdoor Recreation, we specifically considered them as cemeteries based on the building class code (MapPLUTO.BldgClass of "Z8").
- For all properties associated with NYC Parks, Gateway National Recreation Area, NYCHA, NYS DEC, and NYS OPRHP, we classified the land use to be aligned with the owning or managing entity (e.g., NYC Parks properties were all considered City Parkland).

Colleges/Universities, Schools, and Hospitals
For select analyses or reporting numbers in the report (found in Chapter 7), we also noted Colleges and Universities specifically based on the building class information in MapPLUTO (MapPLUTO.BldgClass coded as either "W5" or "W6"). We also identified Public Schools in NYC, leveraging the Facilities Database (FacDB) developed by DCP (leveraged in Equity Analyses for Chapter 4). We considered public schools to be any properties for which the Facility Subgroup (FacDB.FACSUBGRP) was coded as "PUBLIC K-12 SCHOOLS" and joined these data to the mashup based on the borough, block, and lot number (BBL). Similarly, we identified hospitals (for analysis in Chapter 4) in NYC based on the Facilities Database, where FacDB.FACTYPE was coded as "Hospital" again, joining the data to the mashup based on the BBL.

Select Special Purpose Districts
To report the canopy and land area of applicable properties within select Special Purpose Districts in the context of zoning regulations (found in Chapter 5), we leveraged the Special Purpose Districts dataset from DCP. We specifically examined land that was within tax lots (i.e., not rights of way) and excluded land considered City Parkland, per the above. Special Purpose Districts of interest were identified based on the 'SDNAME' field.

Delineation of Natural Areas

To delineate natural areas from the rest of the landscape (primarily discussed in Chapter 2), we leveraged both the Dominant Type dataset from NYC Parks for City Parkland and the Ecological Covertype Map (ECM) from the Natural Areas Conservancy (NAC) for other portions of the NYC landscape. For City Parkland, Natural Areas were any areas considered "Natural" in the Dominant Type dataset (as opposed to "Developed"); we also captured whether lands were designated as ForeverWild areas based on the respective dataset. For the rest of the landscape, we considered natural areas as those classified in the ECM as "Forested Wetland," "Freshwater Aquatic Vegetation," "Freshwater Wetland," "Inland Water," "Maritime Forest," "Off-shore Water," "Saltwater Aquatic Vegetation," "Tidal Wetland," "Upland Forest," or "Upland Grass/Shrub." For purposes of this report, we considered forested natural areas as those that had canopy, according to the Tree Canopy Change dataset.

A small portion of the area of NYC near the edges of the borough boundaries (3.5 acres total) had not been classified at all in the ECM, likely due to slight changes in available data layers representing borough boundaries since the time the ECM was created. These areas generally fell in suburban areas in far Queens (along the boundary with Nassau County) and the Bronx (along the boundary with Westchester County). Based on our observations of the data, we considered these areas as non-natural areas.

Analysis of Canopy Distribution and Canopy Change (Chapter 2)

We calculated the area and percentage of tree canopy across NYC in 2010 and 2017, as well as change in canopy, across different geographies and site types by overlaying the tree canopy change dataset data with the mashup. Every polygon in the tree canopy change dataset is classified as "Gain," "Loss," or "No Change." Gain polygons reflect canopy present in 2017 but not 2010; Loss polygons reflect canopy present in 2010 but not 2017; No Change polygons reflect canopy present in both years. Calculations could therefore be conducted based on the following relationships:

- Canopy Area 2010 = [Area of "Loss" Polygons] + [Area of "No Change" Polygons]
- Canopy Area 2017 = [Area of "Gain" Polygons] + [Area of "No Change" Polygons]
- Canopy Area Change 2010–2017 = [Canopy Area 2017 – Canopy Area 2010]

The version of the tree canopy change data we used had minor corrections applied to remove rare instances of overlaps among polygons. The total area of overlaps in the original dataset was 48.84 ft^2, so there would have been no measurable difference in results had we used the raw data from NYC Open Data.

The spatial overlay analysis split every polygon in the tree canopy change dataset by every polygon boundary in the mashup. Based on that result, we summed area of Gain, Loss, and No Change by geographic unit, jurisdiction, and land use categories, and from there calculated the area of canopy in 2010 and 2017.

Every polygon in the mashup has its own area, calculated from the spatial data, thus, for analyses in which we considered total area of geographic units (e.g., boroughs, Community Districts) and site type categories (based on ownership and land use), we aggregated area of polygons accordingly. Canopy percentage by area was calculated as:

- Canopy % [Year]$_i$ = [Canopy Area [Year]$_i$] / [Total Area$_i$]

Canopy Area [Year] refers to Canopy Area 2010 or Canopy Area 2017, and the Total Area refers to the sum of all polygons for the areas of interest (e.g., the focal geography, ownership, or land use categories). The subscripted i refers to the focal geography (e.g., each individual, borough, Community District), or site type category.

Percentage changes in canopy can be calculated as:

- Net Canopy Change (%)$_i$ = [Canopy % 2017$_i$] – [Canopy % 2010$_i$]
- Relative Canopy Change (%)$_i$ = 100 * ([Canopy % 2017$_i$] – [Canopy % 2010$_i$])/[Canopy % 2010$_i$]

Analysis of Street Trees (Chapter 2)

Analysis of street trees was primarily based on the data from the 199–1996, 2005–2006, and 2015–2016 street tree census datasets. Analysis of street tree stocking rates was based on estimated street tree capacity data developed by NYC Parks.

Distribution, Size, and Common Species by Geography

For street trees, analysis focused on data from the most recent street tree census, although older datasets were used for estimated numbers of street trees in the respective time periods. Living trees were delineated based on StreetTreeCensus2015.Status being recorded as 'Alive.' For 1995–1996, living trees were counted as those for which StreetTreeCensus1995.Condition was not recorded as "Dead," "Planting Space," "Shaft," or "Stump," and for 2005–2006, living trees were counted as those for which StreetTreeCensus2005.Status was not recorded as "Dead."

To understand the distribution of street trees across NYC as of the most recent street tree census, we leveraged the spatial data with each tree point, conducting overlay analyses to identify which trees were in each focal unit (borough, Community District, City Council District, and Neighborhood Tabulation Area). Though this information was already associated with the data, for consistency in our work, we conducted this analysis using the data available. For the previous street tree censuses, some points did not have spatial data, thus we leveraged the information on borough, Community District, City Council District, and Neighborhood Tabulation Area that was associated with the tree data as available.

We leveraged the most recent street tree census data to represent information about size of the trees, both generally and by geography. We calculated median and mean diameter at breast height (DBH) for living trees (based on StreetTreeCensus2015.tree_dbh), as well as the number and percentage of trees less than 6″ DBH and greater than 30″ DBH. We also processed data to identify the most common entry on StreetTreeCensus2015.spc_common field for living trees by geography to understand the most common species in each unit.

Stocking Rate and Density per Road Mile

In the report, we present information on stocking rate of trees, which we calculated as the number of existing (living) street trees, per the 2015 street tree census, out of the total estimated capacity. Capacity was estimated by NYC Parks following the street tree census, at the scale of block faces (the linear spaces along streets and sidewalks that could theoretically contain tree beds). In some instances, block faces span multiple geographic or administrative units (e.g., a Neighborhood Tabulation Area boundary may be in the middle of a block). In such cases we split the block-face lines based on the respective boundaries and assigned the capacity to each new line based on the relative length from the original block face. For example, if a block face was split by a Community District boundary, such that 60% of the original length fell in one Community District and 40% fell in the other, 60% of the original capacity for that full block face was assigned to the Community District with the 60% of the line. Numbers were rounded to the nearest whole number. Stocking rates were then calculated as the number of living street trees divided by the total capacity within the respective geographic unit.

Tables in Appendix 2 have information on living street tree density (trees per road mile) by geographic unit. The patterns we observed across NYC were generally similar between stocking rates and trees per mile, thus, for concision, we only presented stocking rate data in the body of the report. To calculate the mileage of relevant roads within each geographic unit, we leveraged the LION dataset for NYC, which represents a variety of linear features such as streets and sidewalks. We used version 16A which captures the landscape as of early 2016, as an approximation of the landscape during the 2015–2016 street tree census. We only considered line features in LION coded as "streets" (LION.RW_TYPE = 1) and excluded those that were coded as private (LION.FeatureTyp = 6). Furthermore, we only considered those identified as either a roadbed, an undivided street, or a roadbed segment (LION.SegmentTyp = U, B, or R), and excluded those coded as inaccessible to pedestrian usage (as street trees are generally along sidewalks; LION.NonPed = D). After selecting the appropriate features in LION, we split them based on geographic boundaries and calculated the total length of roads within each unit. Trees per road mile were then derived as the total number of living street trees within each area, divided by the total mileage of roads within that area.

Analysis of Landscaped Park Trees in City Parkland (Chapter 2)

For analyses of trees in landscaped portions of City Parkland, we leveraged two key datasets: a recent inventory of these trees (the Park Tree Inventory) from NYC Parks, and the Dominant Type dataset for City Parkland. We leveraged the borough associations of the trees after spot-checking for data for consistency with boundaries, only considering trees presumed to be alive (i.e., those for which ParkTreeInventory.Condition was not coded as "Dead"). We derived the area of landscaped portions of City Parkland from the mashup, only considering the areas within the land boundaries of NYC and those where the area was indicated as "Developed," rather than "Natural"). Density of trees in landscaped portions of City Parkland was calculated as the number of these living trees divided by the area.

Analysis of relative abundance of the different kinds of trees in these spaces was based on a unique field that captured the kinds of trees. Analysis of size was based on a field representing the DBH.

Analysis of Equity of the NYC Urban Forest (Chapter 4)

Urban Forest and Socioeconomic Metrics

In considering equity of the urban forest, we examined correlations between three variables representing attributes of the urban forest of NYC and a suite of socioeconomic variables. We used Neighborhood Tabulation Areas (NTAs) as the units of analysis. For the canopy metrics (canopy cover and relative change in canopy), we calculated variables for each NTA buffered by one-quarter mile (clipped to land area), as a way to help capture access to the urban forest and its benefits present in adjacent areas. Natural areas and large parks or cemeteries, such as Central Park, would otherwise be excluded from analysis, based on the boundaries of NTAs.

Urban forest metrics were computed following the same overall methods described in previous sections, and included:

- Canopy cover as of 2017 (%) for each NTA (+0.25 mile buffer)
- Relative change in canopy (+0.25 mile buffer)
- Street tree stocking rate

Below are the socioeconomic variables we included in the analysis. Most were based on data from the 2018 Social Vulnerability Index, developed by the U.S. Centers for Disease Control and Prevention (CDC). These are indicated with a parenthetical remark, indicating the original variable name from the Social Vulnerability Index data ("SVI variable [variable name]"). Those variables were ultimately sourced or derived by the CDC from U.S. Census 2014–2018 American Community Survey estimates, at the scale of census tracts. We aggregated the data to the scale of NTAs based on standardized data from DCP. For these aggregations, we averaged values, weighted by estimates of total population within each census tract (included within the original Social Vulnerability Data). The Heat Vulnerability Index (HVI) was sourced from the NYC Department of Health and Mental Hygiene for the scale of NTAs, representing approximately 2018.

- Per Capita Income (SVI variable EP_PCI)
- Percent of People Below the Federal Poverty Level (SVI variable EP_POV)
- Percent of People Aged 65 or Older (SVI Variable EP_AGE65)
- Percent of People Aged 17 or Younger (SVI Variable EP_AGE17)

- Percent of People with Limited English (SVI variable EP_LIMENG)
- Percent of People of Color (SVI variable EP_MINRTY)
- Percent of Housing Units with More People than Rooms (SVI variable EP_CROWD)
- Percent of Households with No Vehicle (SVI variable EP_NOVEH)
- Socioeconomic SVI Theme (SVI variable SPL_THEME1)
- Household Composition SVI Theme (SVI variable SPL_THEME2)
- Minority Status/Language SVI Theme (SVI variable SPL_THEME3).
- Housing Type/Transportation SVI Theme (SVI variable SPL_THEME4)
- Combination SVI Theme (SVI variable SPL_THEMES)
- Heat Vulnerability Index

We analyzed correlations between each urban forest metric and each socioeconomic metric based on Kendall's tau correlation. We did this with all data together, and with data grouped by borough. SVI Theme variables were leveraged as-is for analysis, given that the correlation metric we used is based on ranks; for display purposes those data were rescaled to a range of 0–1.

Canopy around Schools and Hospitals

We examined whether canopy around hospitals and public schools was related to the canopy in the respective NTAs (plus the quarter-mile buffer) within which the respective institutions were located to understand whether these were representative of the broader trends or unique in terms of canopy cover. We considered canopy cover (%) within a 500-ft. buffer of these properties, restricted to land area (see earlier section on Colleges/Universities, Schools, and Hospitals for how these were identified). We calculated Kendall's tau correlation coefficient and the associated *p*-value between the canopy cover within each NTA plus the quarter mile buffer (per the previous section) and the canopy within the 500-ft. buffer of school and hospitals, respectively.

Canopy and HOLC Grades (Redlining)

We examined the relationship between current canopy cover and grades historically assigned to geographic areas by the Home Owners' Loan Corporation (HOLC) as an initial exploration into potential legacy effects of redlining on the distribution of the urban forest of NYC. We calculated canopy cover (%) as of 2017, constrained to land area, for each area that had a HOLC grade, using data from the Mapping Inequality project at the University of Richmond's Digital Scholarship Lab. We conducted correlation analyses considering the HOLC grade as an ordinal variable, as they are ordered (A [highest] to D [lowest]), and used Kendall's tau correlation.

Additional Notes about Information Presented in This Report

Other Available Data on Canopy and Vegetation in NYC

In addition to the work leveraged in this report, other analyses of vegetation and tree canopy in NYC have been conducted through the years. We did not include them in our analysis because they were not comparable with the most recent data, or generally with each other. Particular works that may interest readers include: analysis for a 2006 report about existing and potential canopy in NYC that leveraged aerial imagery;[1] research on estimating vegetation abundance based on spectral mixture analysis leveraging Landsat imagery;[2,3] and analysis of vegetation change based on spectral mixture analysis leveraging Landsat imagery.[4]

Notes about the Economic Valuation of Benefits Presented (Chapter 3)

We drew on a variety of studies related to benefits of the urban forest in NYC, with two specific efforts to offer estimates of economic valuation of those benefits. We recognize, as with all modeled estimates, there are limits, and included information from both, recognizing they capture different aspects or different benefits of the urban forest. The two efforts we leveraged were an analysis of samples of the urban forest throughout NYC (stratified by borough)[5] that leveraged i-Tree Eco;[6] and an analysis of street tree data by NYC Parks,7 following the most recent street tree census that leveraged i-Tree Streets.[8] The distinct input data and the different tools likely contributed to different results presented in these works.[9]

In discussing specific economic benefits of trees in NYC, we primarily used the former analysis,[5] as it attempted to estimate benefits for the entire urban forest of NYC, and i-Tree Eco is undergoing regular updates. We used the results from NYC Parks to supplement information about different benefits presented, such as those relating to aesthetics and air pollution removal.

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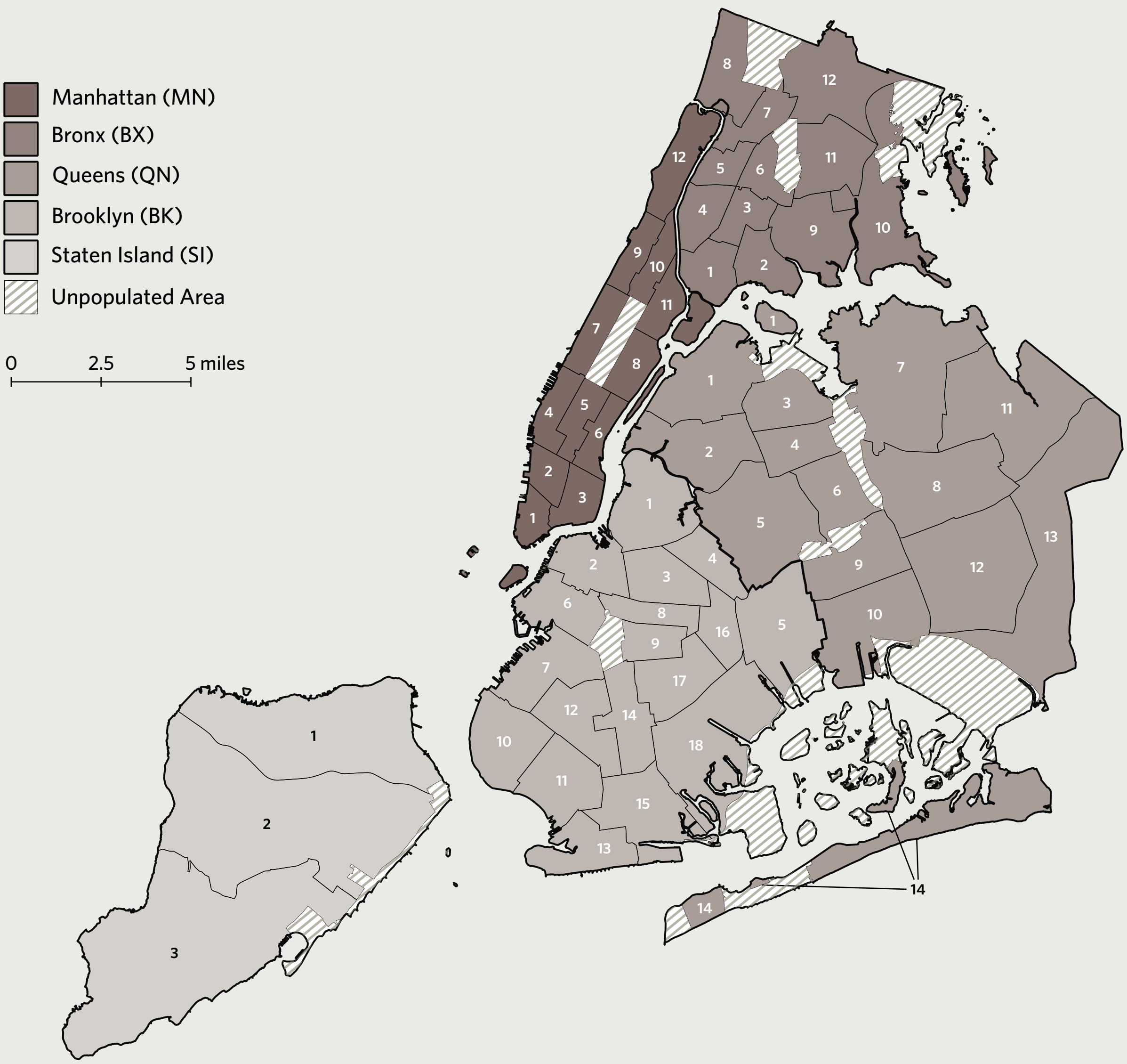
Supplementary results files are also available in digital formats at https://zenodo.org/record/5210261

Community Districts

Figure A2.1



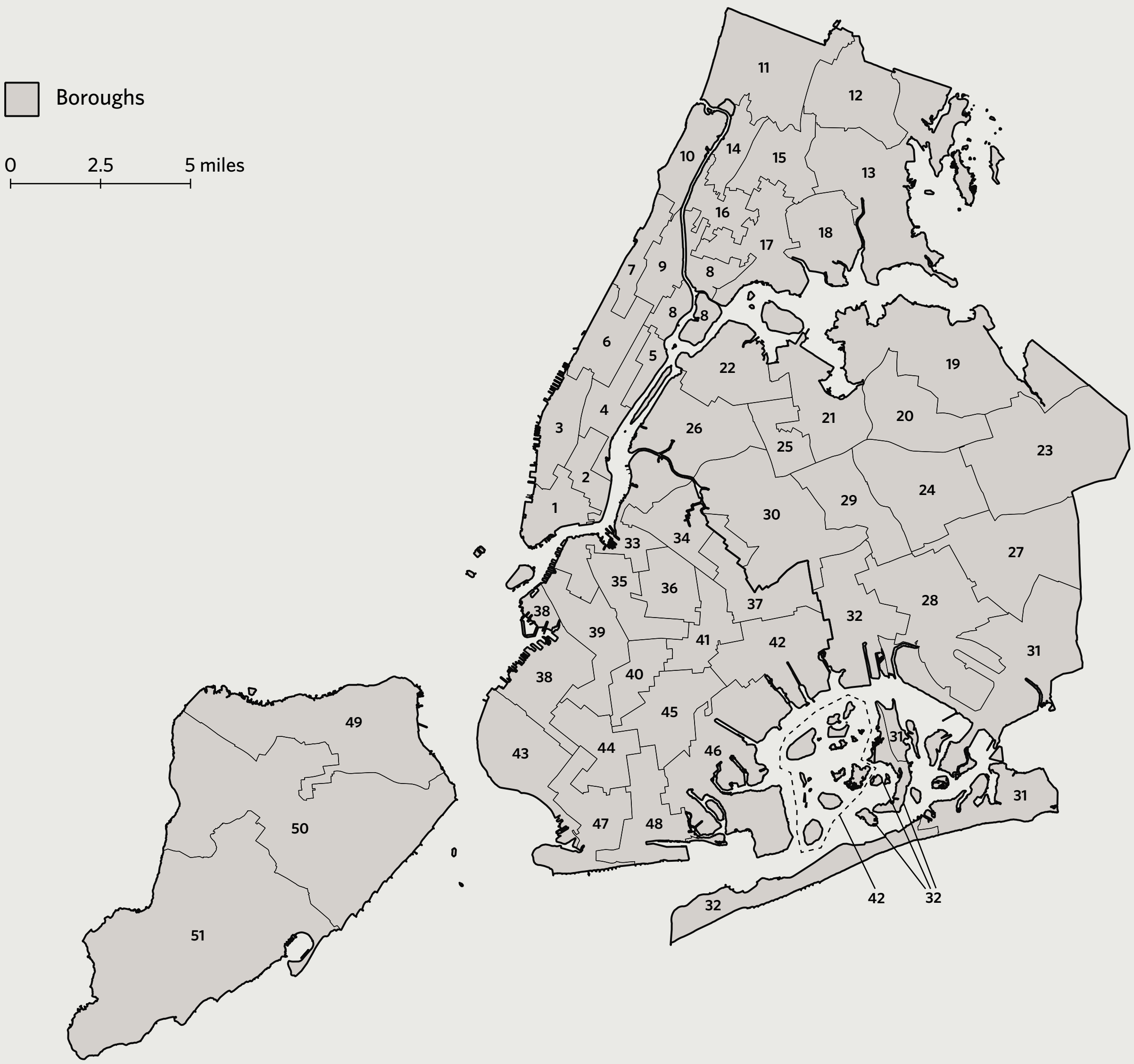
Data source: NYC Department of City Planning (2020). Details about Community Districts are available at https://communityprofiles.planning.nyc.gov/
Note: In tables in this Appendix, Community District identifiers are indicated as Borough Abbreviation-Number. For example, Community District 1 in Manhattan is represented as MN-01.

Community Districts Key

BX-01 Melrose, Mott Haven, Port Morris
BX-02 Hunts Point, Longwood
BX-03 Claremont, Crotona Park East, Melrose, Morrisania
BX-04 Concourse, Concourse Village, East Concourse, Highbridge, Mount Eden, West Concourse
BX-05 Fordham, Morris Heights, Mount Hope, University Heights
BX-06 Bathgate, Belmont, Bronx Park South, East Tremont, West Farms
BX-07 Bedford Park, Fordham, Kingsbridge Heights, Norwood, University Heights
BX-08 Fieldston, Kingsbridge, Marble Hill (MN), North Riverdale, Riverdale, Spuyten Duyvil
BX-09 Bronx River, Castle Hill, Clason Point, Harding Park, Parkchester, Soundview, Soundview-Bruckner, Unionport
BX-10 City Island, Co-op City, Country Club, Edgewater Park, Pelham Bay, Schuylerville, Throgs Neck, Westchester Square
BX-11 Allerton, Bronxdale, Indian Village, Morris Park, Pelham Gardens, Pelham Parkway, Van Nest
BX-12 Baychester, Eastchester, Edenwald, Olinville, Wakefield, Williamsbridge, Woodlawn
BK-26 Unpopulated area
BX-27 Unpopulated area
BX-28 Unpopulated area
BK-01 East Williamsburg, Greenpoint, Northside, Southside, Williamsburg
BK-02 Boerum Hill, Brooklyn Heights, Clinton Hill, Downtown Brooklyn, DUMBO, Fort Greene, Fulton Ferry, Navy Yard, Vinegar Hill
BK-03 Bedford-Stuyvesant, Stuyvesant Heights, Tompkins Park North
BK-04 Bushwick
BK-05 Broadway Junction, City Line, Cypress Hills, East New York, Highland Park, New Lots, Spring Creek, Starrett City
BK-06 Carroll Gardens, Cobble Hill, Columbia St, Gowanus, Park Slope, Red Hook
BK-07 Sunset Park, Windsor Terrace
BK-08 Crown Heights, Prospect Heights, Weeksville
BK-09 Crown Heights South, Prospect Lefferts Gardens, Wingate
BK-10 Bay Ridge, Dyker Heights, Fort Hamilton
BK-11 Bath Beach, Bensonhurst, Gravesend, Mapleton
BK-12 Borough Park, Kensington, Ocean Parkway
BK-13 Brighton Beach, Coney Island, Gravesend, Homecrest, Sea Gate, West Brighton
BK-14 Ditmas Park, Flatbush, Manhattan Terrace, Midwood, Ocean Parkway, Prospect Park South
BK-15 Gerritsen Beach, Gravesend, Homecrest, Kings Highway, Manhattan Beach, Plumb Beach, Sheepshead Bay
BK-16 Broadway Junction, Brownsville, Ocean Hill
BK-17 East Flatbush, Farragut, Flatbush, Northeast Flatbush, Remsen Village, Rugby, Erasmus
BK-18 Bergen Beach, Canarsie, Flatlands, Georgetown, Marine Park, Mill Basin, Mill Island, Paerdegat Basin
BK-55 Unpopulated area
BK-56 Unpopulated area
MN-01 Battery Park City, Civic Center, Ellis Island, Governors Island, Liberty Island, South Street Seaport, Tribeca, Wall Street, World Trade Center
MN-02 Greenwich Village, Hudson Square, Little Italy, NoHo, SoHo, South Village, West Village
MN-03 Chinatown, East Village, Lower East Side, NoHo, Two Bridges
MN-04 Chelsea, Clinton, Hudson Yards
MN-05 Flatiron, Gramercy Park, Herald Square, Midtown, Midtown South, Murray Hill, Times Square, Union Square
MN-06 Beekman Place, Gramercy Park, Murray Hill, Peter Cooper Village, Stuyvesant Town, Sutton Place, Tudor City, Turtle Bay
MN-07 Lincoln Square, Manhattan Valley, Upper West Side
MN-08 Carnegie Hill, Lenox Hill, Roosevelt Island, Upper East Side, Yorkville
MN-09 Hamilton Heights, Manhattanville, Morningside Heights, West Harlem
MN-10 Central Harlem
MN-11 East Harlem, Harlem, Randall's Island Park, Wards Island Park
MN-12 Inwood, Washington Heights
MN-64 Unpopulated area
QN-01 Astoria, Astoria Heights, Queensbridge, Dutch Kills, Long Island City, Ravenswood, Rikers Island (BX), Steinway
QN-02 Blissville, Hunters Point, Long Island City, Sunnyside, Sunnyside Gardens, Woodside
QN-03 East Elmhurst, Jackson Heights, North Corona
QN-04 Corona, Corona Heights, Elmhurst, Lefrak City
QN-05 Glendale, Maspeth, Middle Village, Ridgewood
QN-06 Forest Hills, Forest Hills Gardens, Rego Park
QN-07 Auburndale, Bay Terrace, Beechhurst, Clearview, College Point, Downtown Flushing, East Flushing, Flushing, Malba, Murray Hill, Queensboro Hill, Waldheim, Whitestone
QN-08 Briarwood, Fresh Meadows, Hillcrest, Holliswood, Jamaica, Jamaica Estates, Jamaica Hills, Kew Gardens Hills, Pomonok, Utopia
QN-09 Kew Gardens, Ozone Park, Richmond Hill, Woodhaven
QN-10 Howard Beach, Lindenwood, Old Howard Beach, Ozone Park, South Ozone Park
QN-11 Auburndale, Bayside, Douglaston, Hollis Hills, Little Neck, Oakland Gardens
QN-12 Hollis, Jamaica, Jamaica Center, North Springfield Gardens, Rochdale, South Jamaica, St. Albans
QN-13 Bellaire, Bellerose, Brookville, Cambria Heights, Floral Park, Glen Oaks, Laurelton, New Hyde Park, Queens Village, Rosedale, Springfield Gardens
QN-14 Arverne, Bayswater, Belle Harbor, Breezy Point, Broad Channel, Edgemere, Far Rockaway, Hammels, Neponsit, Rockaway Park, The Rockaways, Roxbury, Seaside, Somerville
QN-80 Unpopulated area
QN-81 Unpopulated area
QN-82 Unpopulated area
QN-83 Unpopulated area
QN-84 Unpopulated area
SI-01 Arlington, Castleton Corners, Clifton, Elm Park, Fox Hills, Graniteville, Grymes Hill, Howland Hook, Livingston, Mariner's Harbor, New Brighton, Old Place, Park Hill, Port Ivory, Port Richmond, Randall Manor, Rosebank, Shore Acres, Silver Lake, St. George, Stapleton, Sunnyside, Tompkinsville, Ward Hill, West Brighton, West New Brighton, Westerleigh, Willowbrook
SI-02 Arrochar, Bloomfield, Bulls Head, Chelsea, Concord, Dongan Hills, Egbertville, Emerson Hill, Grant City, Grasmere, Heartland Village, Lighthouse Hill, Manor Heights, Midland Beach, New Dorp, New Dorp Beach, New Springville, Old Town, South Beach, Todt Hill, Travis, Willowbrook
SI-03 Annadale, Arden Heights, Bay Terrace, Butler Manor, Charleston, Eltingville, Fresh Kills, Great Kills, Greenridge, Huguenot, Oakwood, Oakwood Beach, Oakwood Heights, Pleasant Plains, Prince's Bay, Richmond Town, Richmond Valley, Rossville, Sandy Ground, Tottenville, Woodrow
SI-95 Unpopulated area

City Council Districts

Figure A2.2



Data source: NYC Department of City Planning (2020).
Details about City Council Districts are available at
https://council.nyc.gov/districts/

City Council Districts Key

Manhattan

1 Battery Park City, Civic Center, Chinatown, Financial District, Little Italy, the Lower East Side, NoHo, SoHo, South Street Seaport, South Village, TriBeCa & Washington Square
2 East Village, Gramercy Park, Kips Bay, Lower East Side, Murray Hill, Rose Hill
3 Chelsea, Hell's Kitchen, Greenwich Village, West SoHo, Hudson Square, Times Square, Garment District, Flatiron, Upper West Side
4 Upper East Side, Carnegie Hill, Yorkville, Central Park South, Midtown East, Times Square, Koreatown, Stuyvesant Town and Peter Cooper Village, Waterside Plaza, Tudor City, Turtle Bay, Murray Hill, Sutton Place
5 Upper East Side's Yorkville, Lenox Hill, Carnegie Hill, Roosevelt Island, Midtown East, Sutton Place, El Barrio in East Harlem
6 Central Park, Lincoln Square, Upper West Side, Clinton
7 Manhattan Valley, Manhattanville, Morningside Heights, Hamilton Heights
8 Manhattan: El Barrio/East Harlem; Bronx: Mott Haven, Highbridge, Concourse, Longwood, Port Morris
9 Central Harlem, Morningside Heights, Upper West Side, East Harlem
10 Washington Heights, Inwood, Marble Hill

Bronx

11 Bedford Park, Kingsbridge, Riverdale, Norwood, Van Cortlandt Village, Wakefield, Woodlawn
12 Wakefield, Olinville, Edenwald, Eastchester, Williamsbridge, Baychester, Co-op City
13 Allerton, City Island, Country Club, Edgewater Park, Ferry Point, Locust Point, Morris Park, Pelham Bay, Pelham Gardens, Pelham Parkway, Schuylerville, Silver Beach, Spencer Estates, Throggs Neck, Van Nest, Waterbury LaSalle, Westchester Square, Zerega
14 Morris Heights, University Heights, Fordham, Kingsbridge
15 Bedford Park, Fordham, Mount Hope, Bathgate, Belmont, East Tremont, West Farms, Van Nest, Allerton, Olinville
16 Claremont, Concourse, Concourse Village, Highbridge, Morris Heights, Mount Eden, Morrisania
17 Concourse Village, Crotona Park East, East Tremont, Hunts Point, Longwood, Melrose, Morrisania, Port Morris, West Farms, North Brother Island, South Brother Island
18 Soundview, Castle Hill, Parkchester, Clason Point, Harding Park

Queens

19 Auburndale, Bay Terrace, Bayside, Beechhurst, College Point, Douglaston, Flushing, Little Neck, Malba, Whitestone
20 Downtown Flushing, Murray Hill, Queensboro Hill
21 East Elmhurst, Elmhurst, Jackson Heights, and Corona in Queens, including Flushing Meadows Corona Park, Lefrak City and LaGuardia Airport
22 Astoria, East Elmhurst, Jackson Heights, Woodside
23 Bayside Hills, Bellerose, Douglaston, Floral Park, Fresh Meadows, Glen Oaks, Hollis, Hollis Hills, Holliswood, Little Neck, New Hyde Park, Oakland Gardens, Queens Village
24 Kew Gardens Hills, Pomonok, Electchester, Fresh Meadows, Hillcrest, Jamaica Estates, Briarwood, Parkway Village, Jamaica Hills, Jamaica
25 Elmhurst, Jackson Heights
26 Sunnyside, Woodside, Long Island City, Astoria, Dutch Kills
27 Cambria Heights, Hollis, Jamaica, St. Albans, Queens Village, and Springfield Gardens
28 Jamaica, Richmond Hill, Rochdale Village, South Ozone Park
29 Rego Park, Forest Hills, Kew Gardens, Richmond Hill
30 Glendale, Maspeth, Middle Village, Ridgewood, Woodhaven, Woodside
31 Arverne, Brookville, Edgemere, Far Rockaway, Laurelton, Rosedale, Springfield Gardens
32 Belle Harbor, Breezy Point, Broad Channel, Howard Beach, Lindenwood, Neponsit, Ozone Park, Richmond Hill, Rockaway Park, Roxbury, South Ozone Park, West Hamilton Beach, Woodhaven

Brooklyn

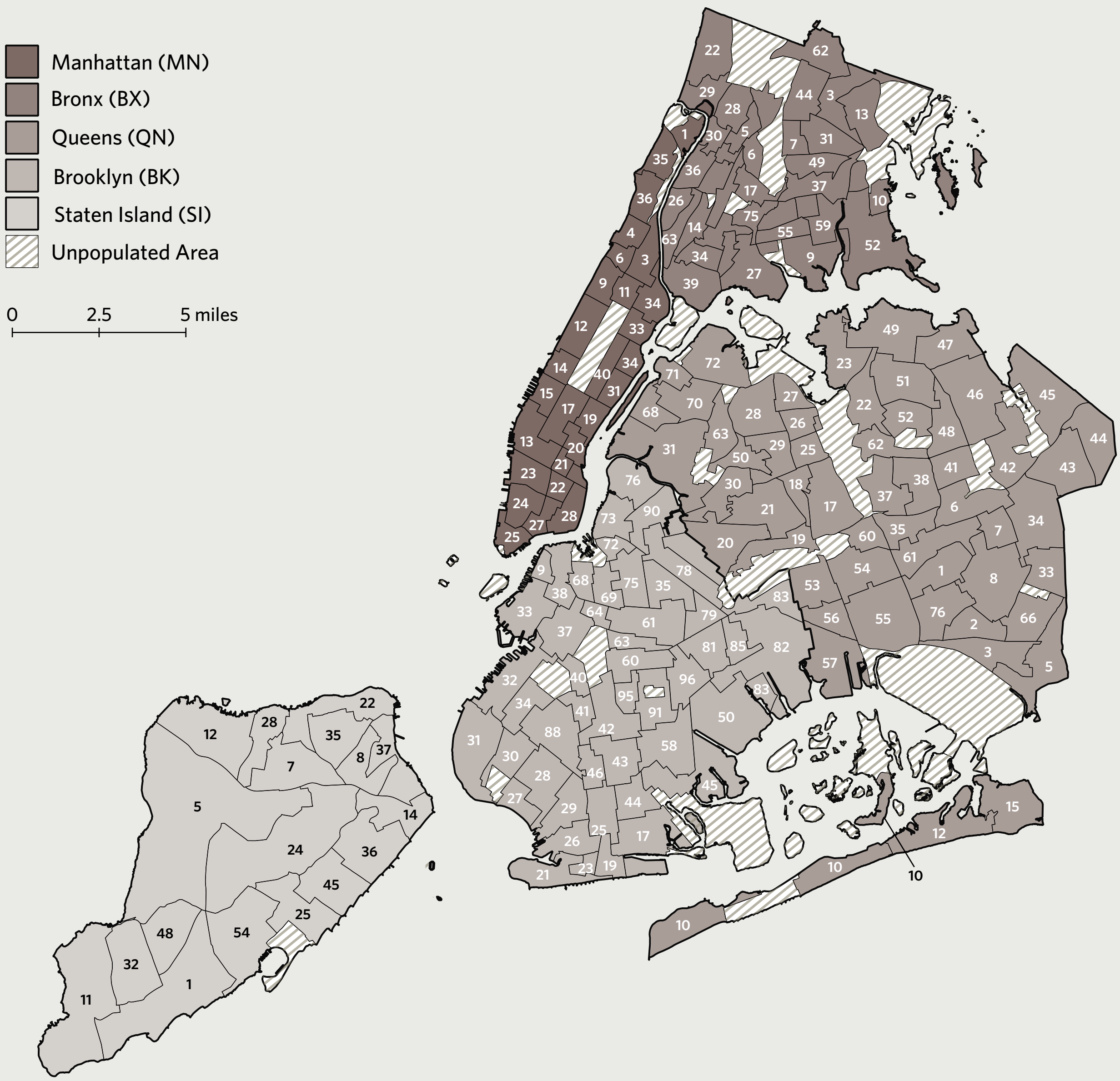
33 Boerum Hill, Brooklyn Heights, Brooklyn Navy Yard, Downtown Brooklyn, Dumbo, Fulton Ferry, Greenpoint, Vinegar Hill, Williamsburg
34 Williamsburg, Bushwick, Ridgewood
35 Fort Greene, Clinton Hill, Crown Heights, Prospect Heights, Bedford Stuyvesant
36 Bedford Stuyvesant, Northern Crown Heights
37 Cypress Hills, Bushwick, City Line, Ocean Hill, Brownsville, East New York
38 Red Hook, Sunset Park, Greenwood Heights and portions of Windsor Terrace, Dyker Heights, and Boro Park
39 Cobble Hill, Carroll Gardens, Columbia Waterfront, Gowanus, Park Slope, Windsor Terrace, Borough Park, Kensington
40 Crown Heights, East Flatbush, Flatbush, Kensington, Midwood, Prospect Park, and Prospect Lefferts Gardens
41 Bedford-Stuyvesant, Ocean Hill-Brownsville, East Flatbush, Crown Heights
42 East New York, New Lots, Remsen Village, Spring Creek, Starrett City
43 Bay Ridge, Dyker Heights, Bensonhurst, Bath Beach
44 Bensonhurst, Borough Park, Midwood, Ocean Parkway
45 Flatbush, East Flatbush, Midwood, Marine Park, Flatlands, Kensington
46 Bergen Beach, Canarsie, Flatlands, Georgetown, Gerritsen Beach, Marine Park, Mill Basin, Mill Island, Sheepshead Bay
47 Bensonhurst, Coney Island, Gravesend, Sea Gate
48 Brighton Beach, Manhattan Beach, Sheepshead Bay, Homecrest, Trump Village, Luna Park, Brightwater Towers, Midwood

Staten Island

49 Arlington, Clifton, Clove Lakes, Concord, Elm Park, Graniteville, Livingston, Mariners Harbor, New Brighton, Port Richmond, Randall Manor, Rosebank, St. George, Snug Harbor, Silver Lake, Stapleton, Sunnyside, West Brighton and Tompkinsville
50 Arrochar, Bloomfield, Bulls Head, Castleton Corners, Chelsea, Concord, Dongan Hills, Egbertville, Emerson Hill, Fort Wadsworth, Graniteville, Grant City, Grasmere, Heartland Village, Isle of Meadows, Lighthouse Hill, Manor Heights, Meiers Corners, Midland Beach, New Dorp, New Springville, Oakwood, Ocean Breeze, Old Town, Prall's Island, Richmondtown, Rosebank, Shore Acres, South Beach, Todt Hill, Travis, Westerleigh, and Willowbrook
51 Annadale, Arden Heights, Bay Terrace, Charleston, Eltingville, Great Kills, Greenridge, Heartland Village, Huguenot, New Springville, Pleasant Plains, Prince's Bay, Richmond Valley, Rossville, Tottenville, Woodrow

Neighborhood Tabulation Areas

Figure A2.3



Data source: NYC Department of City Planning (2020). More information about Neighborhood Tabulation Areas (NTA) is available at https://www1.nyc.gov/site/planning/data-maps/open-data/census-download-metadata.page
Note: In tables with data at the scale of Neighborhood Tabulation Areas in this Appendix, identifiers are indicated as Borough Abbreviation-Number. For example, NTA 1 in Manhattan is represented as MN-01 in these tables.

Neighborhood Tabulation Areas Key

BX-01	Claremont-Bathgate
BX-03	Eastchester-Edenwald-Baychester
BX-05	Bedford Park-Fordham North
BX-06	Belmont
BX-07	Bronxdale
BX-08	West Farms-Bronx River
BX-09	Soundview-Castle Hill-Clason Point-Harding Park
BX-10	Pelham Bay-Country Club-City Island
BX-13	Co-op City
BX-14	East Concourse-Concourse Village
BX-17	East Tremont
BX-22	North Riverdale-Fieldston-Riverdale
BX-26	Highbridge
BX-27	Hunts Point
BX-28	Van Cortlandt Village
BX-29	Spuyten Duyvil-Kingsbridge
BX-30	Kingsbridge Heights
BX-31	Allerton-Pelham Gardens
BX-33	Longwood
BX-34	Melrose South-Mott Haven North
BX-35	Morrisania-Melrose
BX-36	University Heights-Morris Heights
BX-37	Van Nest-Morris Park-Westchester Square
BX-39	Mott Haven-Port Morris
BX-40	Fordham South
BX-41	Mount Hope
BX-43	Norwood
BX-44	Williamsbridge-Olinville
BX-46	Parkchester
BX-49	Pelham Parkway
BX-52	Schuylerville-Throgs Neck-Edgewater Park
BX-55	Soundview-Bruckner
BX-59	Westchester-Unionport
BX-62	Woodlawn-Wakefield
BX-63	West Concourse
BX-75	Crotona Park East
BX-98	Rikers Island
BX-99	park-cemetery-etc-Bronx
BK-09	Brooklyn Heights-Cobble Hill
BK-17	Sheepshead Bay-Gerritsen Beach-Manhattan Beach
BK-19	Brighton Beach
BK-21	Seagate-Coney Island
BK-23	West Brighton
BK-25	Homecrest
BK-26	Gravesend
BK-27	Bath Beach
BK-28	Bensonhurst West
BK-29	Bensonhurst East
BK-30	Dyker Heights
BK-31	Bay Ridge
BK-32	Sunset Park West
BK-33	Carroll Gardens-Columbia Street-Red Hook
BK-34	Sunset Park East
BK-35	Stuyvesant Heights
BK-37	Park Slope-Gowanus
BK-38	DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill
BK-40	Windsor Terrace
BK-41	Kensington-Ocean Parkway
BK-42	Flatbush
BK-43	Midwood
BK-44	Madison
BK-45	Georgetown-Marine Park-Bergen Beach-Mill Basin
BK-46	Ocean Parkway South
BK-50	Canarsie
BK-58	Flatlands
BK-60	Prospect Lefferts Gardens-Wingate
BK-61	Crown Heights North
BK-63	Crown Heights South
BK-64	Prospect Heights
BK-68	Fort Greene
BK-69	Clinton Hill
BK-72	Williamsburg
BK-73	North Side-South Side
BK-75	Bedford
BK-76	Greenpoint
BK-77	Bushwick North
BK-78	Bushwick South
BK-79	Ocean Hill
BK-81	Brownsville
BK-82	East New York
BK-83	Cypress Hills-City Line
BK-85	East New York (Pennsylvania Ave)
BK-88	Borough Park
BK-90	East Williamsburg
BK-91	East Flatbush-Farragut
BK-93	Starrett City
BK-95	Erasmus
BK-96	Rugby-Remsen Village
BK-99	park-cemetery-etc-Brooklyn
MN-01	Marble Hill-Inwood
MN-03	Central Harlem North-Polo Grounds
MN-04	Hamilton Heights
MN-06	Manhattanville
MN-09	Morningside Heights
MN-11	Central Harlem South
MN-12	Upper West Side
MN-13	Hudson Yards-Chelsea-Flatiron-Union Square
MN-14	Lincoln Square
MN-15	Clinton
MN-17	Midtown-Midtown South
MN-19	Turtle Bay-East Midtown
MN-20	Murray Hill-Kips Bay
MN-21	Gramercy
MN-22	East Village
MN-23	West Village
MN-24	SoHo-TriBeCa-Civic Center-Little Italy
MN-25	Battery Park City-Lower Manhattan
MN-27	Chinatown
MN-28	Lower East Side
MN-31	Lenox Hill-Roosevelt Island
MN-32	Yorkville
MN-33	East Harlem South
MN-34	East Harlem North
MN-35	Washington Heights North
MN-36	Washington Heights South
MN-40	Upper East Side-Carnegie Hill
MN-50	Stuyvesant Town-Cooper Village
MN-99	park-cemetery-etc-Manhattan
QN-01	South Jamaica
QN-02	Springfield Gardens North
QN-03	Springfield Gardens South-Brookville
QN-05	Rosedale
QN-06	Jamaica Estates-Holliswood
QN-07	Hollis
QN-08	St. Albans
QN-10	Breezy Point-Belle Harbor-Rockaway Park-Broad Channel
QN-12	Hammels-Arverne-Edgemere
QN-15	Far Rockaway-Bayswater
QN-17	Forest Hills
QN-18	Rego Park
QN-19	Glendale
QN-20	Ridgewood
QN-21	Middle Village
QN-22	Flushing
QN-23	College Point
QN-25	Corona
QN-26	North Corona
QN-27	East Elmhurst
QN-28	Jackson Heights
QN-29	Elmhurst
QN-30	Maspeth
QN-31	Hunters Point-Sunnyside-West Maspeth
QN-33	Cambria Heights
QN-34	Queens Village
QN-35	Briarwood-Jamaica Hills
QN-37	Kew Gardens Hills
QN-38	Pomonok-Flushing Heights-Hillcrest
QN-41	Fresh Meadows-Utopia
QN-42	Oakland Gardens
QN-43	Bellerose
QN-44	Glen Oaks-Floral Park-New Hyde Park
QN-45	Douglas Manor-Douglaston-Little Neck
QN-46	Bayside-Bayside Hills
QN-47	Ft. Totten-Bay Terrace-Clearview
QN-48	Auburndale
QN-49	Whitestone
QN-50	Elmhurst-Maspeth
QN-51	Murray Hill
QN-52	East Flushing
QN-53	Woodhaven
QN-54	Richmond Hill
QN-55	South Ozone Park
QN-56	Ozone Park
QN-57	Lindenwood-Howard Beach
QN-60	Kew Gardens
QN-61	Jamaica
QN-62	Queensboro Hill
QN-63	Woodside
QN-66	Laurelton
QN-68	Queensbridge-Ravenswood-Long Island City
QN-70	Astoria
QN-71	Old Astoria
QN-72	Steinway
QN-76	Baisley Park
QN-98	Airport
QN-99	park-cemetery-etc-Queens
SI-01	Annadale-Huguenot-Prince's Bay-Eltingville
SI-05	New Springville-Bloomfield-Travis
SI-07	Westerleigh
SI-08	Grymes Hill-Clifton-Fox Hills
SI-11	Charleston-Richmond Valley-Tottenville
SI-12	Mariner's Harbor-Arlington-Port Ivory-Graniteville
SI-14	Grasmere-Arrochar-Ft. Wadsworth
SI-22	West New Brighton-New Brighton-St. George
SI-24	Todt Hill-Emerson Hill-Heartland Village-Lighthouse Hill
SI-25	Oakwood-Oakwood Beach
SI-28	Port Richmond
SI-32	Rossville-Woodrow
SI-35	New Brighton-Silver Lake
SI-36	Old Town-Dongan Hills-South Beach
SI-37	Stapleton-Rosebank
SI-45	New Dorp-Midland Beach
SI-48	Arden Heights
SI-54	Great Kills
SI-99	park-cemetery-etc-Staten Island

Column Name Keys

Definitions for columns presented in the subsequent tables. Details on how these metrics were computed are provided in Appendix 1.

Columns for Table A2.1 – Table A2.6, Table A2.11

Area (acres): Total land area in acres.

Canopy Loss (acres): Total acreage of tree canopy that was present in 2010, but not in 2017.

Canopy Gain (acres): Total acreage of tree canopy that was present in 2017, but not in 2010.

Canopy Unchanged (acres): Total acreage of tree canopy that was present in both 2010 and 2017.

Canopy Acreage 2010: Total acreage of tree canopy that was present in 2010. For natural areas (Table A2.11) this represents the area of forested natural areas in 2010.

Canopy Acreage 2017: Total acreage of tree canopy that was present in 2017. For natural areas (Table A2.11) this represents the area of forested natural areas in 2017.

Net Canopy Change (acres): Difference in total acreage of canopy between 2017 and 2010.

Canopy Cover 2010 (%): Percent of land area covered by canopy in 2010. For natural areas (Table A2.11) this represents the percent of natural area that was considered forested in 2010.

Canopy Cover 2017 (%): Percent of land area covered by canopy in 2017. For natural areas (Table A2.11) this represents the percent of natural area that was considered forested in 2017.

Net Canopy Change (%): Change in the percent of land area covered by canopy between 2017 and 2010.

Relative Canopy Change (%): Change in total area of tree canopy in 2017 compared to tree canopy in 2010.

Columns for Table A2.7 – Table A2.10

Number of Trees 1995: The number of living street trees as of the 1995–1996 street tree census. Does not include stumps or dead trees.

Number of Trees 2005: The number of living street trees as of the 2005–2006 street tree census. Does not include stumps or dead trees.

Number of Trees 2015: The number of living street trees in as of the 2015–2016 street tree census. Does not include stumps or dead trees.

Estimated Street Tree Capacity: The maximum number of street trees that could be planted in the geographic unit. This was based on street tree capacity estimates developed by NYC Parks following the 2015–2016 street tree census for individual block faces (sidewalks along streets). When block faces extended across administrative boundaries, or beyond boundaries, they were split accordingly, with resultant sections assigned a proportionate number for estimated capacity.

Stocking Rate of Street Trees 2015: Percentage of living street trees as of the 2015–2016 street tree census compared to the estimated capacity.

Most Common Species: The most common kind of tree among all living street trees in the geographic unit as of the 2015–2016 street tree census.

Percent of Trees with DBH <6 inches: Percent of living street trees with less than 6 inches diameter at breast height as of the 2015–2016 street tree census.

Percent of Trees with DBH >30 inches: Percent of living street trees with greater than 30 inches diameter at breast height as of the 2015–2016 street tree census.

Trees per Road Mile 2015: Number of living street trees as of the 2015–2016 street tree census, divided by the total length in miles of all roads within the geographic unit.

Columns for Table A2.12.

(Note: these represent the variables that were used in correlation analyses, with the urban forest metrics represented presented in rows.)

Per Capita Income*: Median per-capita income as of 2018.

Percent of People Below Poverty Level*: Percent of people living below the federal poverty level.

Percent of People Aged 65 or Older*: Percent of people 65 years old or older.

Percent of People Aged 17 or Younger*: Percent of people 17 years old or younger.

Percent of People with Limited English*: Percent of people (age 5+) who speak English "less than well."

Percent of People of Color*: Percentage of people who identify as being part of all racial and ethnic groups except for non-Hispanic white (synonymous with "minority" classification in original Social Vulnerability Index data).

Percent of Households with More People than Rooms*: Percent of housing units with more people occupying them than rooms.

Percent of Households with No Vehicle*: Percent of households with no vehicle available.

Heat Vulnerability Index Rank: Heat Vulnerability Index, as determined by the NYC Department of Health and Mental Hygiene, ranging 1 (lowest) to 5 (highest). More information about this heat vulnerability index is available at https://a816-dohbesp.nyc.gov/IndicatorPublic/HeatHub/hvi.html.

SVI- Socioeconomic Theme*: Social Vulnerability Index for socioeconomic theme based on: poverty rates, unemployment, per capita income, and no high school diploma ("SPL Theme 1" in the Social Vulnerability Index data).

SVI- Household Composition Theme*: Social Vulnerability Index for household composition based on: percent of people age 65 and older, age 17 and younger, disabled, and single-parent households ("SPL Theme 2" in the Social Vulnerability Index data).

SVI- Minority Status/Language Theme*: Social Vulnerability Index for minority status and language theme based on: percentage of people of color and people who speak English less than well ("SPL Theme 3" in the Social Vulnerability Index data).

SVI- Housing Type/Transportation Theme*: Social Index for housing and transportation based on variables index including: percentage of housing in structures with 10 or more units, percentage of mobile homes, no vehicle, crowding, and percentage of people in institutionalized group quarters ("SPL Theme 4" in the Social Vulnerability Index data).

SVI- All Themes*: Combined Social Vulnerability Index based on the four other themes ("SPL Themes" in the Social Vulnerability Index data).

* Data are from the 2018 Social Vulnerability Index developed by the Centers for Disease Control and Prevention. Original data and metadata are available at https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. The original data are available at the scale of census tracts, based on U.S. Census, 2014–2018 American Community Survey data. Data were aggregated to the scale of Neighborhood Tabulation Areas as described in Appendix 1.

Tree Canopy and Canopy Change by Borough

Table A2.1

	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
Bronx	27,240.91	791.49	1,379.76	5,374.18	6,165.67	6,753.94	588.28	22.63%	24.79%	2.16%	9.54%
Brooklyn	44,400.62	1,379.98	2,229.57	5,590.40	6,970.38	7,819.97	849.60	15.70%	17.61%	1.91%	12.19%
Manhattan	14,614.38	378.13	670.11	2,454.51	2,832.63	3,124.62	291.99	19.38%	21.38%	2.00%	10.31%
Queens	69,881.61	2,571.11	3,213.49	9,991.00	12,562.11	13,204.49	642.39	17.98%	18.90%	0.92%	5.11%
Staten Island	37,276.39	1,356.66	2,237.09	9,495.34	10,852.00	11,732.43	880.42	29.11%	31.47%	2.36%	8.11%
Citywide	193,413.91	6,477.36	9,730.03	32,905.42	39,382.78	42,635.45	3,252.67	20.36%	22.04%	1.68%	8.26%

Tree Canopy and Canopy Change by Community District

Table A2.2

(* indicates unpopulated area)

Community District	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
BX-01	1,386.63	21.56	62.75	138.05	159.60	200.80	41.20	11.51%	14.48%	2.97%	25.81%
BX-02	1,419.99	16.72	47.46	71.36	88.08	118.83	30.74	6.20%	8.37%	2.17%	34.90%
BX-03	1,028.83	25.39	60.58	145.61	171.00	206.19	35.19	16.62%	20.04%	3.42%	20.58%
BX-04	1,274.88	30.32	67.83	144.08	174.39	211.90	37.51	13.68%	16.62%	2.94%	21.51%
BX-05	879.64	24.79	44.39	96.17	120.96	140.55	19.59	13.75%	15.98%	2.23%	16.20%
BX-06	979.44	20.36	46.57	104.63	124.99	151.21	26.22	12.76%	15.44%	2.68%	20.97%
BX-07	1,223.87	38.86	57.21	172.10	210.96	229.31	18.35	17.24%	18.74%	1.50%	8.70%
BX-08	2,113.67	103.64	127.54	706.70	810.34	834.24	23.89	38.34%	39.47%	1.13%	2.95%
BX-09	2,623.19	70.47	143.72	380.65	451.12	524.37	73.25	17.20%	19.99%	2.79%	16.24%
BX-10	4,108.40	114.83	199.69	486.56	601.39	686.25	84.86	14.64%	16.70%	2.07%	14.11%
BX-11	2,302.89	82.71	115.23	329.63	412.34	444.86	32.52	17.91%	19.32%	1.41%	7.89%
BX-12	3,555.96	128.14	195.65	667.68	795.82	863.33	67.51	22.38%	24.28%	1.90%	8.48%
BX-26*	1,160.84	22.32	58.24	708.16	730.48	766.40	35.92	62.93%	66.02%	3.09%	4.92%
BX-27*	721.58	34.39	44.37	389.30	423.69	433.67	9.98	58.72%	60.10%	1.38%	2.36%
BX-28*	2,119.48	57.57	107.22	838.58	896.15	945.80	49.65	42.28%	44.62%	2.34%	5.54%
BK-01	3,024.39	41.86	126.20	220.55	262.41	346.75	84.35	8.68%	11.47%	2.79%	32.14%
BK-02	1,821.15	49.41	100.01	280.94	330.35	380.95	50.60	18.14%	20.92%	2.78%	15.32%
BK-03	1,824.18	58.27	124.02	274.12	332.40	398.15	65.75	18.22%	21.83%	3.60%	19.78%
BK-04	1,300.79	37.17	76.51	147.29	184.46	223.80	39.34	14.18%	17.21%	3.02%	21.33%
BK-05	3,569.38	93.70	201.06	398.34	492.04	599.40	107.36	13.79%	16.79%	3.01%	21.82%
BK-06	1,962.76	58.20	91.16	239.40	297.60	330.56	32.96	15.16%	16.84%	1.68%	11.07%
BK-07	2,390.51	65.16	107.95	305.44	370.60	413.39	42.79	15.50%	17.29%	1.79%	11.55%
BK-08	1,046.67	31.82	65.95	155.04	186.86	221.00	34.13	17.85%	21.11%	3.26%	18.27%
BK-09	1,040.55	29.19	52.30	129.06	158.25	181.36	23.11	15.21%	17.43%	2.22%	14.61%
BK-10	2,555.74	60.61	133.25	396.50	457.11	529.76	72.64	17.89%	20.73%	2.84%	15.89%
BK-11	2,368.64	45.03	89.67	188.43	233.46	278.10	44.63	9.86%	11.74%	1.88%	19.12%
BK-12	2,284.79	67.93	120.69	286.64	354.57	407.33	52.76	15.52%	17.83%	2.31%	14.88%
BK-13	2,024.69	87.88	72.25	167.52	255.39	239.76	-15.63	12.61%	11.84%	-0.77%	-6.12%
BK-14	1,886.49	81.09	127.43	327.47	408.56	454.90	46.34	21.66%	24.11%	2.46%	11.34%
BK-15	3,022.11	134.60	131.50	381.68	516.28	513.17	-3.10	17.08%	16.98%	-0.10%	-0.60%
BK-16	1,188.45	30.87	67.16	138.85	169.73	206.01	36.29	14.28%	17.33%	3.05%	21.38%
BK-17	2,153.59	64.21	95.20	245.53	309.74	340.73	30.99	14.38%	15.82%	1.44%	10.00%
BK-18	5,405.35	234.44	273.59	750.03	984.47	1,023.62	39.15	18.21%	18.94%	0.72%	3.98%
BK-55*	600.17	25.94	40.66	305.93	331.87	346.59	14.72	55.30%	57.75%	2.45%	4.44%

(Table A2.2 Continued)

Community District	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
BK-56*	2,987.60	82.60	134.63	253.48	336.07	388.11	52.03	11.25%	12.99%	1.74%	15.48%
MN-01	979.98	22.33	42.17	90.76	113.09	132.93	19.84	11.54%	13.56%	2.02%	17.54%
MN-02	865.23	18.02	34.21	84.70	102.72	118.91	16.19	11.87%	13.74%	1.87%	15.76%
MN-03	1,076.20	44.87	54.35	182.18	227.05	236.53	9.48	21.10%	21.98%	0.88%	4.18%
MN-04	1,132.04	14.76	38.69	79.53	94.29	118.22	23.93	8.33%	10.44%	2.11%	25.38%
MN-05	1,005.29	7.59	12.87	27.18	34.77	40.06	5.28	3.46%	3.98%	0.53%	15.19%
MN-06	889.18	22.90	36.22	126.01	148.91	162.23	13.32	16.75%	18.24%	1.50%	8.94%
MN-07	1,220.22	29.64	66.44	236.41	266.04	302.84	36.80	21.80%	24.82%	3.02%	13.83%
MN-08	1,266.58	37.78	59.08	177.64	215.42	236.72	21.31	17.01%	18.69%	1.68%	9.89%
MN-09	961.71	22.91	48.97	205.36	228.28	254.34	26.06	23.74%	26.45%	2.71%	11.42%
MN-10	897.26	16.96	54.46	136.78	153.74	191.24	37.50	17.13%	21.31%	4.18%	24.39%
MN-11	1,518.50	35.05	81.73	203.33	238.38	285.06	46.68	15.70%	18.77%	3.07%	19.58%
MN-12	1,789.87	36.07	94.27	486.48	522.55	580.75	58.20	29.20%	32.45%	3.25%	11.14%
MN-64*	879.53	66.75	41.14	403.68	470.43	444.82	-25.61	53.49%	50.57%	-2.91%	-5.44%
QN-01	3,936.94	84.35	160.43	381.39	465.74	541.82	76.08	11.83%	13.76%	1.93%	16.34%
QN-02	3,213.17	56.54	102.43	217.86	274.40	320.29	45.89	8.54%	9.97%	1.43%	16.72%
QN-03	1,916.66	69.97	94.47	247.39	317.36	341.86	24.50	16.56%	17.84%	1.28%	7.72%
QN-04	1,509.17	48.49	70.08	145.81	194.30	215.89	21.58	12.87%	14.31%	1.43%	11.11%
QN-05	4,830.02	154.48	237.37	698.63	853.10	936.00	82.90	17.66%	19.38%	1.72%	9.72%
QN-06	1,898.59	99.70	109.67	377.77	477.47	487.44	9.97	25.15%	25.67%	0.52%	2.09%
QN-07	7,536.46	320.63	394.34	1,148.42	1,469.05	1,542.76	73.71	19.49%	20.47%	0.98%	5.02%
QN-08	4,764.90	253.74	264.75	1,235.58	1,489.33	1,500.34	11.01	31.26%	31.49%	0.23%	0.74%
QN-09	2,465.10	101.40	122.35	336.03	437.44	458.39	20.95	17.75%	18.60%	0.85%	4.79%
QN-10	3,950.75	144.87	168.71	410.18	555.05	578.89	23.84	14.05%	14.65%	0.60%	4.30%
QN-11	5,988.72	298.07	389.10	1,551.85	1,849.92	1,940.95	91.03	30.89%	32.41%	1.52%	4.92%
QN-12	6,137.13	232.14	335.43	827.65	1,059.79	1,163.08	103.29	17.27%	18.95%	1.68%	9.75%
QN-13	8,045.67	352.33	449.79	1,215.21	1,567.53	1,664.99	97.46	19.48%	20.69%	1.21%	6.22%
QN-14	4,510.87	167.47	137.91	292.66	460.13	430.57	-29.56	10.20%	9.55%	-0.66%	-6.42%
QN-80*	752.20	16.68	2.85	16.46	33.14	19.31	-13.83	4.41%	2.57%	-1.84%	-41.74%
QN-81*	1,091.72	34.26	49.86	158.19	192.45	208.05	15.60	17.63%	19.06%	1.43%	8.10%
QN-82*	556.89	15.96	17.70	414.75	430.71	432.44	1.74	77.34%	77.65%	0.31%	0.40%
QN-83*	4,408.27	24.27	42.71	73.95	98.21	116.66	18.44	2.23%	2.65%	0.42%	18.78%
QN-84*	2,785.34	97.65	68.73	248.78	346.43	317.52	-28.92	12.44%	11.40%	-1.04%	-8.35%
SI-01	8,660.55	381.44	535.81	1,868.40	2,249.84	2,404.21	154.37	25.98%	27.76%	1.78%	6.86%
SI-02	13,606.88	388.82	767.04	3,490.13	3,878.94	4,257.17	378.22	28.51%	31.29%	2.78%	9.75%
SI-03	13,752.39	535.81	868.46	3,976.36	4,512.17	4,844.81	332.64	32.81%	35.23%	2.42%	7.37%
SI-95*	1,256.56	50.60	65.78	160.45	211.05	226.24	15.19	16.80%	18.00%	1.21%	7.20%

Tree Canopy and Canopy Change by City Council District

Table A2.3

City Council District	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
1	1,809.59	38.07	68.97	191.28	229.35	260.24	30.90	12.67%	14.38%	1.71%	13.47%
2	1,090.39	44.88	50.12	161.10	205.99	211.22	5.24	18.89%	19.37%	0.48%	2.54%
3	1,894.28	29.19	65.28	138.48	167.67	203.76	36.09	8.85%	10.76%	1.91%	21.52%
4	1,618.32	31.49	51.42	158.02	189.51	209.45	19.93	11.71%	12.94%	1.23%	10.52%
5	854.37	26.64	40.79	125.47	152.11	166.26	14.15	17.80%	19.46%	1.66%	9.31%
6	1,919.13	90.39	94.98	606.22	696.61	701.20	4.59	36.30%	36.54%	0.24%	0.66%
7	1,180.20	26.66	59.18	236.00	262.66	295.18	32.52	22.26%	25.01%	2.76%	12.38%
8	2,359.86	47.09	117.11	276.83	323.92	393.94	70.01	13.73%	16.69%	2.97%	21.61%
9	1,314.58	27.26	81.42	210.69	237.95	292.10	54.16	18.10%	22.22%	4.12%	22.76%
10	1,683.07	35.69	90.77	471.59	507.28	562.36	55.08	30.14%	33.41%	3.27%	10.86%
11	4,721.24	176.70	266.86	1,750.24	1,926.94	2,017.09	90.15	40.81%	42.72%	1.91%	4.68%
12	3,166.10	100.59	167.79	483.64	584.23	651.43	67.21	18.45%	20.58%	2.12%	11.50%
13	7,510.60	231.20	372.56	1,537.22	1,768.42	1,909.79	141.37	23.55%	25.43%	1.88%	7.99%
14	1,185.68	36.17	58.98	144.65	180.82	203.63	22.81	15.25%	17.17%	1.92%	12.62%
15	2,237.99	71.08	109.28	532.88	603.96	642.15	38.19	26.99%	28.69%	1.71%	6.32%
16	1,327.62	36.13	76.45	174.94	211.07	251.39	40.32	15.90%	18.94%	3.04%	19.10%
17	3,100.39	51.41	131.18	258.53	309.94	389.71	79.77	10.00%	12.57%	2.57%	25.74%
18	2,442.23	67.01	136.66	361.99	429.00	498.66	69.66	17.57%	20.42%	2.85%	16.24%
19	7,627.24	372.90	455.05	1,361.62	1,734.52	1,816.67	82.15	22.74%	23.82%	1.08%	4.74%
20	3,262.65	139.93	174.67	523.35	663.28	698.03	34.75	20.33%	21.39%	1.06%	5.24%
21	3,040.22	92.30	108.64	294.03	386.33	402.67	16.33	12.71%	13.24%	0.54%	4.23%
22	3,303.02	85.90	138.45	333.25	419.15	471.70	52.55	12.69%	14.28%	1.59%	12.54%
23	7,011.01	306.21	416.26	1,925.74	2,231.95	2,342.00	110.05	31.83%	33.40%	1.57%	4.93%
24	4,260.15	219.89	226.07	761.48	981.37	987.55	6.18	23.04%	23.18%	0.15%	0.63%
25	1,459.16	47.65	75.70	181.06	228.72	256.76	28.05	15.67%	17.60%	1.92%	12.26%
26	3,493.09	61.04	123.70	281.31	342.35	405.01	62.66	9.80%	11.59%	1.79%	18.30%
27	5,090.82	206.53	260.26	662.27	868.80	922.53	53.74	17.07%	18.12%	1.06%	6.18%
28	5,591.88	154.59	213.82	526.07	680.66	739.89	59.23	12.17%	13.23%	1.06%	8.70%
29	2,756.89	138.48	156.18	532.13	670.60	688.31	17.71	24.32%	24.97%	0.64%	2.64%
30	5,823.22	177.11	258.07	1,110.88	1,287.99	1,368.95	80.96	22.12%	23.51%	1.39%	6.29%
31	9,858.87	280.79	337.57	828.45	1,109.24	1,166.02	56.78	11.25%	11.83%	0.58%	5.12%
32	7,257.27	277.93	251.17	629.83	907.76	881.00	-26.76	12.51%	12.14%	-0.37%	-2.95%
33	2,852.11	54.95	131.80	272.99	327.93	404.79	76.86	11.50%	14.19%	2.69%	23.44%
34	2,401.68	42.14	103.88	178.95	221.09	282.83	61.74	9.21%	11.78%	2.57%	27.92%

(Table A2.3 Continued)

City Council District	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
35	1,871.23	60.77	118.63	326.30	387.08	444.93	57.85	20.69%	23.78%	3.09%	14.95%
36	1,749.81	57.62	120.27	267.57	325.19	387.84	62.65	18.58%	22.16%	3.58%	19.27%
37	2,256.51	70.64	126.87	282.86	353.50	409.73	56.23	15.67%	18.16%	2.49%	15.91%
38	3,176.78	80.37	120.84	334.76	415.13	455.61	40.47	13.07%	14.34%	1.27%	9.75%
39	2,674.40	84.45	156.06	573.13	657.58	729.19	71.61	24.59%	27.27%	2.68%	10.89%
40	1,439.25	48.29	85.45	199.48	247.77	284.93	37.16	17.22%	19.80%	2.58%	15.00%
41	1,794.23	48.99	94.70	234.83	283.82	329.54	45.72	15.82%	18.37%	2.55%	16.11%
42	4,529.99	87.34	206.45	376.53	463.88	582.99	119.11	10.24%	12.87%	2.63%	25.68%
43	3,371.37	75.57	174.06	464.59	540.16	638.65	98.49	16.02%	18.94%	2.92%	18.23%
44	2,129.42	66.82	110.27	278.25	345.07	388.52	43.44	16.20%	18.25%	2.04%	12.59%
45	2,680.56	99.26	141.33	385.57	484.83	526.90	42.07	18.09%	19.66%	1.57%	8.68%
46	6,391.85	285.73	341.52	891.41	1,177.14	1,232.93	55.79	18.42%	19.29%	0.87%	4.74%
47	2,879.25	88.09	101.51	244.03	332.12	345.53	13.41	11.53%	12.00%	0.47%	4.04%
48	2,665.29	140.70	119.00	326.24	466.94	445.23	-21.70	17.52%	16.70%	-0.81%	-4.65%
49	7,562.32	325.55	468.73	1,647.99	1,973.54	2,116.72	143.18	26.10%	27.99%	1.89%	7.25%
50	14,662.40	495.69	838.74	3,697.15	4,192.83	4,535.88	343.05	28.60%	30.94%	2.34%	8.18%
51	15,051.67	535.43	929.62	4,150.20	4,685.63	5,079.82	394.19	31.13%	33.75%	2.62%	8.41%

Tree Canopy and Canopy Change by Neighborhood Tabulation Area

Table A2.4

(* indicates unpopulated area)

Neighborhood Tabulation Area	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
BX-01	377.69	6.20	20.00	38.78	44.98	58.78	13.80	11.91%	15.56%	3.65%	30.69%
BX-03	924.17	30.24	49.11	183.75	213.99	232.86	18.87	23.16%	25.20%	2.04%	8.82%
BX-05	344.33	9.84	14.71	33.93	43.77	48.65	4.88	12.71%	14.13%	1.42%	11.14%
BX-06	311.28	7.32	14.69	42.48	49.80	57.17	7.37	16.00%	18.37%	2.37%	14.81%
BX-07	348.61	10.72	17.40	57.79	68.51	75.19	6.67	19.65%	21.57%	1.91%	9.74%
BX-08	346.30	8.18	16.72	42.49	50.68	59.22	8.54	14.63%	17.10%	2.47%	16.85%
BX-09	1,193.38	32.94	64.26	171.07	204.01	235.33	31.33	17.09%	19.72%	2.63%	15.36%
BX-10	921.36	34.73	52.78	123.94	158.67	176.72	18.05	17.22%	19.18%	1.96%	11.38%
BX-13	914.46	20.22	45.10	118.90	139.12	164.01	24.89	15.21%	17.93%	2.72%	17.89%
BX-14	418.31	7.32	21.43	28.89	36.21	50.32	14.11	8.66%	12.03%	3.37%	38.96%
BX-17	442.04	9.07	22.05	43.20	52.27	65.25	12.98	11.83%	14.76%	2.94%	24.83%
BX-22	1,125.99	64.24	74.82	490.46	554.70	565.28	10.58	49.26%	50.20%	0.94%	1.91%
BX-26	377.82	9.46	22.74	51.68	61.14	74.42	13.28	16.18%	19.70%	3.52%	21.73%
BX-27	1,141.86	11.64	31.57	40.45	52.10	72.02	19.93	4.56%	6.31%	1.75%	38.25%
BX-28	589.21	19.71	24.35	87.23	106.93	111.57	4.64	18.15%	18.94%	0.79%	4.34%
BX-29	532.92	21.89	31.07	142.91	164.80	173.98	9.18	30.92%	32.65%	1.72%	5.57%
BX-30	302.19	10.16	15.52	42.70	52.86	58.22	5.36	17.49%	19.27%	1.78%	10.15%
BX-31	727.57	28.17	41.69	108.98	137.15	150.67	13.52	18.85%	20.71%	1.86%	9.86%
BX-33	246.38	3.23	13.67	19.19	22.42	32.86	10.44	9.10%	13.34%	4.24%	46.57%
BX-34	396.51	6.44	23.59	47.45	53.89	71.04	17.15	13.59%	17.92%	4.33%	31.83%
BX-35	387.78	9.56	23.81	46.13	55.68	69.93	14.25	14.36%	18.03%	3.68%	25.59%
BX-36	487.96	17.46	27.80	69.53	86.98	97.33	10.34	17.83%	19.95%	2.12%	11.89%
BX-37	833.38	25.74	33.10	83.89	109.63	116.99	7.36	13.16%	14.04%	0.88%	6.71%
BX-39	961.86	16.19	39.74	101.33	117.52	141.08	23.55	12.22%	14.67%	2.45%	20.04%
BX-40	144.83	3.01	6.36	8.97	11.98	15.33	3.35	8.27%	10.59%	2.31%	27.98%
BX-41	337.85	6.65	13.57	28.14	34.79	41.71	6.92	10.30%	12.35%	2.05%	19.90%
BX-43	360.99	13.52	19.82	64.34	77.86	84.16	6.30	21.57%	23.31%	1.75%	8.09%
BX-44	832.77	29.20	41.47	92.21	121.42	133.68	12.26	14.58%	16.05%	1.47%	10.10%
BX-46	210.85	8.60	9.42	48.70	57.30	58.12	0.82	27.18%	27.57%	0.39%	1.44%
BX-49	528.76	21.34	29.59	96.27	117.60	125.86	8.25	22.24%	23.80%	1.56%	7.02%
BX-52	2,030.32	59.94	97.89	241.09	301.03	338.98	37.95	14.83%	16.70%	1.87%	12.61%
BX-55	373.13	7.53	20.17	45.40	52.93	65.57	12.64	14.19%	17.57%	3.39%	23.88%
BX-59	549.71	12.85	23.49	41.89	54.74	65.38	10.64	9.96%	11.89%	1.94%	19.45%
BX-62	912.28	32.66	50.72	136.29	168.95	187.01	18.06	18.52%	20.50%	1.98%	10.69%
BX-63	444.90	9.65	19.71	36.11	45.75	55.82	10.07	10.28%	12.55%	2.26%	22.00%
BX-75	374.44	6.52	19.76	32.32	38.84	52.08	13.24	10.37%	13.91%	3.54%	34.09%
BX-98*	416.99	1.91	5.20	7.55	9.46	12.75	3.29	2.27%	3.06%	0.79%	34.74%
BX-99*	5,069.73	157.48	280.87	2,277.72	2,435.20	2,558.59	123.39	48.03%	50.47%	2.43%	5.07%

(Table A2.4 Continued)

Neighborhood Tabulation Area	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
BK-09	229.19	6.50	14.33	41.35	47.85	55.68	7.83	20.88%	24.29%	3.42%	16.36%
BK-17	1,454.12	80.21	58.36	192.67	272.88	251.04	-21.84	18.77%	17.26%	-1.50%	-8.00%
BK-19	394.40	21.24	14.03	33.46	54.70	47.49	-7.21	13.87%	12.04%	-1.83%	-13.19%
BK-21	890.31	41.03	25.93	45.81	86.84	71.74	-15.10	9.75%	8.06%	-1.70%	-17.39%
BK-23	200.62	13.72	6.43	24.06	37.78	30.49	-7.30	18.83%	15.20%	-3.64%	-19.32%
BK-25	688.52	21.61	32.46	80.08	101.70	112.54	10.85	14.77%	16.35%	1.58%	10.67%
BK-26	719.51	17.19	31.92	77.18	94.38	109.11	14.73	13.12%	15.16%	2.05%	15.60%
BK-27	471.42	8.62	20.91	43.17	51.79	64.08	12.29	10.99%	13.59%	2.61%	23.72%
BK-28	1,071.41	19.99	39.35	83.15	103.14	122.51	19.37	9.63%	11.43%	1.81%	18.78%
BK-29	821.35	17.08	29.42	65.91	82.98	95.32	12.34	10.10%	11.61%	1.50%	14.87%
BK-30	686.84	16.03	29.01	74.47	90.50	103.47	12.97	13.18%	15.07%	1.89%	14.34%
BK-31	1,542.09	38.84	85.45	246.83	285.67	332.28	46.60	18.53%	21.55%	3.02%	16.31%
BK-32	1,147.61	16.25	32.11	57.65	73.90	89.76	15.86	6.44%	7.82%	1.38%	21.47%
BK-33	1,023.91	27.37	41.58	103.21	130.58	144.79	14.21	12.75%	14.14%	1.39%	10.88%
BK-34	622.36	13.57	26.73	65.80	79.37	92.53	13.16	12.75%	14.87%	2.11%	16.58%
BK-35	721.00	25.65	50.56	117.77	143.41	168.33	24.91	19.89%	23.35%	3.46%	17.37%
BK-37	975.87	32.51	52.96	140.83	173.34	193.79	20.45	17.76%	19.86%	2.10%	11.80%
BK-38	653.76	12.89	33.48	92.35	105.24	125.83	20.59	16.10%	19.25%	3.15%	19.57%
BK-40	322.35	9.29	22.10	54.34	63.63	76.44	12.81	19.74%	23.71%	3.97%	20.13%
BK-41	364.86	11.21	21.21	47.94	59.15	69.15	10.00	16.21%	18.95%	2.74%	16.90%
BK-42	1,038.91	43.56	72.69	192.87	236.43	265.56	29.13	22.76%	25.56%	2.80%	12.32%
BK-43	821.85	39.78	56.48	136.64	176.42	193.12	16.70	21.47%	23.50%	2.03%	9.46%
BK-44	628.54	24.23	32.61	85.53	109.76	118.14	8.38	17.46%	18.80%	1.33%	7.64%
BK-45	1,594.67	81.03	73.63	225.12	306.15	298.75	-7.40	19.20%	18.73%	-0.46%	-2.42%
BK-46	408.22	14.06	21.22	55.81	69.87	77.03	7.16	17.12%	18.87%	1.76%	10.25%
BK-50	1,884.73	102.50	95.94	268.77	371.27	364.72	-6.55	19.70%	19.35%	-0.35%	-1.77%
BK-58	1,247.52	42.62	61.65	176.17	218.79	237.82	19.03	17.54%	19.06%	1.53%	8.70%
BK-60	726.33	21.70	35.94	83.93	105.63	119.87	14.24	14.54%	16.50%	1.96%	13.48%
BK-61	1,185.05	35.07	74.22	176.61	211.68	250.83	39.15	17.86%	21.17%	3.30%	18.49%
BK-63	367.08	8.47	17.36	42.90	51.37	60.27	8.89	13.99%	16.42%	2.42%	17.31%
BK-64	234.82	8.28	14.78	34.25	42.53	49.03	6.50	18.11%	20.88%	2.77%	15.28%
BK-68	378.39	10.96	26.16	79.77	90.73	105.93	15.20	23.98%	27.99%	4.02%	16.75%
BK-69	471.26	17.67	32.67	82.28	99.95	114.95	15.00	21.21%	24.39%	3.18%	15.00%
BK-72	266.07	6.60	16.05	39.28	45.88	55.33	9.45	17.24%	20.80%	3.55%	20.60%
BK-73	662.76	9.57	35.71	51.33	60.90	87.05	26.14	9.19%	13.13%	3.94%	42.93%
BK-75	749.08	20.67	49.79	103.69	124.36	153.48	29.12	16.60%	20.49%	3.89%	23.42%
BK-76	810.88	11.01	33.06	50.10	61.11	83.16	22.05	7.54%	10.26%	2.72%	36.08%
BK-77	572.27	12.21	29.07	42.83	55.05	71.90	16.85	9.62%	12.56%	2.94%	30.61%
BK-78	922.16	22.28	50.95	93.77	116.05	144.72	28.67	12.58%	15.69%	3.11%	24.71%
BK-79	461.20	12.67	27.27	44.60	57.27	71.87	14.60	12.42%	15.58%	3.17%	25.49%
BK-81	751.13	18.70	41.58	96.00	114.70	137.57	22.88	15.27%	18.32%	3.05%	19.94%

(Table A2.4 Continued)

Neighborhood Tabulation Area	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
BK-82	2,686.49	46.86	127.67	220.38	267.24	348.05	80.81	9.95%	12.96%	3.01%	30.24%
BK-83	633.84	21.40	34.79	77.76	99.17	112.55	13.39	15.65%	17.76%	2.11%	13.50%
BK-85	445.31	8.98	25.41	35.09	44.07	60.50	16.43	9.90%	13.59%	3.69%	37.29%
BK-88	1,239.78	34.21	64.26	152.88	187.09	217.14	30.06	15.09%	17.51%	2.42%	16.07%
BK-90	898.37	10.61	27.05	50.54	61.15	77.59	16.44	6.81%	8.64%	1.83%	26.89%
BK-91	788.82	27.38	35.82	92.12	119.50	127.94	8.44	15.15%	16.22%	1.07%	7.06%
BK-93	266.28	11.02	18.24	45.29	56.31	63.53	7.22	21.15%	23.86%	2.71%	12.82%
BK-95	333.39	7.25	14.89	26.31	33.57	41.21	7.64	10.07%	12.36%	2.29%	22.76%
BK-96	750.85	18.98	29.94	74.35	93.33	104.29	10.96	12.43%	13.89%	1.46%	11.74%
BK-99*	5,173.06	178.82	284.34	965.36	1,144.18	1,249.69	105.51	22.12%	24.16%	2.04%	9.22%
MN-01	407.09	8.30	18.68	48.81	57.11	67.49	10.38	14.03%	16.58%	2.55%	18.18%
MN-03	583.18	11.75	33.97	93.21	104.96	127.19	22.23	18.00%	21.81%	3.81%	21.18%
MN-04	369.52	9.60	19.45	72.29	81.89	91.74	9.85	22.16%	24.83%	2.67%	12.03%
MN-06	244.42	4.00	11.07	38.73	42.73	49.80	7.08	17.48%	20.38%	2.90%	16.57%
MN-09	462.72	11.59	25.25	125.60	137.18	150.85	13.67	29.65%	32.60%	2.95%	9.96%
MN-11	331.48	5.36	21.94	35.97	41.32	57.91	16.59	12.47%	17.47%	5.00%	40.13%
MN-12	789.25	20.64	44.96	178.23	198.87	223.19	24.32	25.20%	28.28%	3.08%	12.23%
MN-13	850.97	10.52	27.38	58.26	68.78	85.63	16.85	8.08%	10.06%	1.98%	24.50%
MN-14	362.84	7.32	17.16	40.53	47.85	57.69	9.84	13.19%	15.90%	2.71%	20.55%
MN-15	421.54	5.58	13.85	29.39	34.98	43.25	8.27	8.30%	10.26%	1.96%	23.65%
MN-17	693.10	4.88	7.22	12.86	17.74	20.07	2.34	2.56%	2.90%	0.34%	13.17%
MN-19	399.20	6.98	12.10	35.70	42.68	47.81	5.13	10.69%	11.98%	1.28%	12.01%
MN-20	332.55	8.35	11.25	34.95	43.30	46.20	2.90	13.02%	13.89%	0.87%	6.70%
MN-21	172.79	4.32	6.55	19.66	23.98	26.20	2.23	13.88%	15.16%	1.29%	9.29%
MN-22	250.10	8.09	13.37	39.67	47.76	53.04	5.28	19.10%	21.21%	2.11%	11.06%
MN-23	573.25	14.29	26.85	72.23	86.52	99.08	12.56	15.09%	17.28%	2.19%	14.52%
MN-24	574.67	6.17	16.50	28.88	35.06	45.38	10.33	6.10%	7.90%	1.80%	29.45%
MN-25	436.51	3.49	20.46	28.46	31.95	48.92	16.97	7.32%	11.21%	3.89%	53.11%
MN-27	332.92	6.79	12.99	39.72	46.51	52.71	6.20	13.97%	15.83%	1.86%	13.33%
MN-28	534.82	30.96	29.05	107.03	138.00	136.08	-1.91	25.80%	25.44%	-0.36%	-1.39%
MN-31	493.77	16.10	22.09	68.31	84.42	90.40	5.99	17.10%	18.31%	1.21%	7.09%
MN-32	312.26	10.51	15.60	52.85	63.37	68.46	5.09	20.29%	21.92%	1.63%	8.03%
MN-33	382.25	8.58	23.01	63.40	71.98	86.41	14.43	18.83%	22.61%	3.78%	20.05%
MN-34	562.33	15.63	35.16	92.99	108.62	128.15	19.53	19.32%	22.79%	3.47%	17.98%
MN-35	520.37	12.96	30.06	132.44	145.40	162.50	17.10	27.94%	31.23%	3.29%	11.76%
MN-36	530.14	8.96	23.58	78.30	87.26	101.89	14.63	16.46%	19.22%	2.76%	16.76%
MN-40	460.64	11.16	21.39	56.47	67.64	77.86	10.23	14.68%	16.90%	2.22%	15.12%
MN-50	128.15	4.43	8.47	39.87	44.30	48.34	4.04	34.57%	37.72%	3.15%	9.11%
MN-99*	2,101.55	100.81	100.68	729.68	830.49	830.36	-0.13	39.52%	39.51%	-0.01%	-0.02%
QN-01	917.63	35.11	57.40	123.72	158.83	181.12	22.29	17.31%	19.74%	2.43%	14.03%
QN-02	652.72	23.01	38.87	109.76	132.77	148.63	15.86	20.34%	22.77%	2.43%	11.95%

(Table A2.4 Continued)

Neighborhood Tabulation Area	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
QN-03	993.78	35.96	49.64	107.27	143.23	156.91	13.68	14.41%	15.79%	1.38%	9.55%
QN-05	1,413.43	52.11	85.33	207.66	259.77	292.99	33.22	18.38%	20.73%	2.35%	12.79%
QN-06	982.32	77.03	60.23	291.70	368.73	351.93	-16.80	37.54%	35.83%	-1.71%	-4.56%
QN-07	525.43	25.53	29.18	72.72	98.25	101.90	3.65	18.70%	19.39%	0.69%	3.71%
QN-08	1,777.15	76.92	101.42	269.55	346.47	370.97	24.49	19.50%	20.87%	1.38%	7.07%
QN-10	2,300.52	89.33	52.78	94.44	183.77	147.22	-36.55	7.99%	6.40%	-1.59%	-19.89%
QN-12	1,420.93	49.89	37.97	71.87	121.76	109.83	-11.93	8.57%	7.73%	-0.84%	-9.80%
QN-15	1,243.34	50.75	69.67	158.82	209.57	228.50	18.92	16.86%	18.38%	1.52%	9.03%
QN-17	1,327.54	79.05	81.43	271.56	350.61	352.99	2.38	26.41%	26.59%	0.18%	0.68%
QN-18	457.80	17.74	23.37	71.44	89.19	94.81	5.62	19.48%	20.71%	1.23%	6.30%
QN-19	689.09	22.56	36.07	93.33	115.89	129.40	13.51	16.82%	18.78%	1.96%	11.66%
QN-20	1,159.21	30.19	60.92	129.48	159.67	190.40	30.73	13.77%	16.43%	2.65%	19.25%
QN-21	1,324.26	52.07	69.60	205.78	257.84	275.38	17.54	19.47%	20.79%	1.32%	6.80%
QN-22	869.26	23.46	34.39	98.54	122.00	132.94	10.93	14.04%	15.29%	1.26%	8.96%
QN-23	1,160.56	28.75	54.79	106.78	135.53	161.56	26.04	11.68%	13.92%	2.24%	19.21%
QN-25	460.91	16.06	18.86	41.34	57.39	60.20	2.81	12.45%	13.06%	0.61%	4.89%
QN-26	413.31	14.38	19.08	36.85	51.22	55.93	4.71	12.39%	13.53%	1.14%	9.19%
QN-27	452.87	21.45	21.47	58.61	80.06	80.07	0.01	17.68%	17.68%	0.00%	0.02%
QN-28	1,098.68	36.10	56.14	151.59	187.69	207.73	20.03	17.08%	18.91%	1.82%	10.67%
QN-29	750.12	22.70	37.47	79.07	101.77	116.54	14.77	13.57%	15.54%	1.97%	14.52%
QN-30	818.02	22.12	31.96	75.71	97.83	107.67	9.84	11.96%	13.16%	1.20%	10.06%
QN-31	2,351.28	29.02	62.40	117.66	146.68	180.06	33.38	6.24%	7.66%	1.42%	22.75%
QN-33	759.34	30.89	38.62	107.04	137.92	145.66	7.74	18.16%	19.18%	1.02%	5.61%
QN-34	1,596.27	77.28	80.13	213.51	290.79	293.64	2.85	18.22%	18.40%	0.18%	0.98%
QN-35	674.41	31.67	36.06	111.32	142.99	147.38	4.39	21.20%	21.85%	0.65%	3.07%
QN-37	869.80	47.58	50.57	168.18	215.77	218.75	2.99	24.81%	25.15%	0.34%	1.39%
QN-38	891.55	44.47	54.33	160.82	205.29	215.15	9.86	23.03%	24.13%	1.11%	4.80%
QN-41	637.62	31.85	39.16	163.90	195.75	203.05	7.31	30.70%	31.85%	1.15%	3.73%
QN-42	1,171.02	53.99	75.56	319.42	373.41	394.98	21.57	31.89%	33.73%	1.84%	5.78%
QN-43	1,266.86	53.77	84.27	262.37	316.13	346.63	30.50	24.95%	27.36%	2.41%	9.65%
QN-44	1,048.37	51.54	66.11	191.69	243.23	257.80	14.57	23.20%	24.59%	1.39%	5.99%
QN-45	1,570.11	95.65	105.85	416.58	512.23	522.43	10.20	32.62%	33.27%	0.65%	1.99%
QN-46	1,854.88	98.51	119.30	357.32	455.83	476.62	20.79	24.57%	25.70%	1.12%	4.56%
QN-47	1,062.73	36.01	57.44	202.43	238.44	259.87	21.43	22.44%	24.45%	2.02%	8.99%
QN-48	784.32	36.83	48.87	128.86	165.68	177.72	12.04	21.12%	22.66%	1.53%	7.27%
QN-49	1,585.18	74.24	86.28	229.46	303.70	315.74	12.04	19.16%	19.92%	0.76%	3.96%
QN-50	503.39	16.29	24.71	56.94	73.23	81.65	8.42	14.55%	16.22%	1.67%	11.50%
QN-51	1,204.97	77.83	70.14	216.40	294.23	286.54	-7.69	24.42%	23.78%	-0.64%	-2.61%
QN-52	676.16	43.16	35.15	108.16	151.32	143.31	-8.01	22.38%	21.20%	-1.18%	-5.29%
QN-53	850.19	33.37	42.52	113.38	146.75	155.90	9.14	17.26%	18.34%	1.08%	6.23%
QN-54	1,170.30	43.16	52.36	120.92	164.08	173.28	9.20	14.02%	14.81%	0.79%	5.61%

(Table A2.4 Continued)

Neighborhood Tabulation Area	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
QN-55	1,893.05	73.37	76.90	197.28	270.65	274.18	3.53	14.30%	14.48%	0.19%	1.30%
QN-56	574.31	17.56	28.65	74.90	92.45	103.55	11.09	16.10%	18.03%	1.93%	12.00%
QN-57	1,482.12	54.45	63.82	140.14	194.59	203.96	9.37	13.13%	13.76%	0.63%	4.82%
QN-60	470.44	26.95	28.49	120.00	146.95	148.48	1.54	31.24%	31.56%	0.33%	1.05%
QN-61	1,086.04	24.47	36.89	69.29	93.77	106.18	12.42	8.63%	9.78%	1.14%	13.24%
QN-62	609.32	29.85	36.99	89.61	119.46	126.60	7.14	19.60%	20.78%	1.17%	5.98%
QN-63	648.46	18.85	31.39	74.71	93.55	106.09	12.54	14.43%	16.36%	1.93%	13.40%
QN-66	913.34	42.92	45.50	124.86	167.78	170.37	2.58	18.37%	18.65%	0.28%	1.54%
QN-68	535.29	8.58	19.26	58.20	66.78	77.47	10.68	12.48%	14.47%	2.00%	16.00%
QN-70	903.03	21.70	43.87	90.05	111.75	133.92	22.17	12.37%	14.83%	2.46%	19.84%
QN-71	358.58	9.19	19.05	36.36	45.54	55.41	9.87	12.70%	15.45%	2.75%	21.66%
QN-72	1,325.17	41.56	56.72	127.44	169.00	184.16	15.16	12.75%	13.90%	1.14%	8.97%
QN-76	1,010.98	42.31	63.07	157.63	199.95	220.70	20.75	19.78%	21.83%	2.05%	10.38%
QN-98*	5,238.72	37.07	45.33	81.93	119.00	127.26	8.25	2.27%	2.43%	0.16%	6.94%
QN-99*	7,095.12	212.89	259.68	1,854.67	2,067.56	2,114.35	46.79	29.14%	29.80%	0.66%	2.26%
SI-01	3,238.27	117.07	208.86	1,190.45	1,307.52	1,399.31	91.79	40.38%	43.21%	2.83%	7.02%
SI-05	7,513.55	128.34	383.58	1,316.17	1,444.50	1,699.75	255.25	19.23%	22.62%	3.40%	17.67%
SI-07	1,452.16	74.11	87.48	374.92	449.04	462.40	13.37	30.92%	31.84%	0.92%	2.98%
SI-08	866.68	40.18	61.82	279.99	320.16	341.81	21.65	36.94%	39.44%	2.50%	6.76%
SI-11	3,344.23	165.62	234.58	1,190.30	1,355.92	1,424.89	68.96	40.55%	42.61%	2.06%	5.09%
SI-12	2,054.69	59.76	118.34	334.77	394.53	453.11	58.58	19.20%	22.05%	2.85%	14.85%
SI-14	939.66	36.73	53.51	166.82	203.56	220.34	16.78	21.66%	23.45%	1.79%	8.24%
SI-22	1,286.28	65.65	85.76	288.48	354.13	374.24	20.10	27.53%	29.09%	1.56%	5.68%
SI-24	4,244.30	147.87	229.98	1,826.83	1,974.70	2,056.81	82.11	46.53%	48.46%	1.93%	4.16%
SI-25	1,284.71	53.40	74.36	214.87	268.27	289.22	20.96	20.88%	22.51%	1.63%	7.81%
SI-28	836.09	37.61	47.80	116.62	154.23	164.43	10.20	18.45%	19.67%	1.22%	6.61%
SI-32	1,491.35	58.06	104.37	436.12	494.18	540.49	46.31	33.14%	36.24%	3.11%	9.37%
SI-35	1,082.12	52.91	68.43	299.94	352.85	368.37	15.52	32.61%	34.04%	1.43%	4.40%
SI-36	1,538.33	62.66	106.84	206.62	269.29	313.46	44.17	17.51%	20.38%	2.87%	16.40%
SI-37	1,065.81	49.50	65.69	172.46	221.96	238.14	16.19	20.83%	22.34%	1.52%	7.29%
SI-45	1,272.48	58.05	63.05	190.75	248.80	253.80	5.00	19.55%	19.95%	0.39%	2.01%
SI-48	1,157.28	39.92	71.54	377.08	417.00	448.61	31.61	36.03%	38.76%	2.73%	7.58%
SI-54	2,057.08	85.86	129.41	431.90	517.75	561.31	43.56	25.17%	27.29%	2.12%	8.41%
SI-99*	551.32	23.36	41.69	80.25	103.62	121.95	18.33	18.79%	22.12%	3.32%	17.69%

Tree Canopy and Canopy Change by Owner Type, by Borough, and Citywide

Table A2.5

	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
City: Parks											
Bronx	5,879.38	189.45	349.12	2,652.28	2,841.73	3,001.40	159.67	48.33%	51.05%	2.72%	5.62%
Brooklyn	3,899.16	165.21	259.96	1,045.27	1,210.48	1,305.23	94.75	31.04%	33.47%	2.43%	7.83%
Manhattan	2,707.14	131.12	163.27	1,230.51	1,361.63	1,393.78	32.15	50.30%	51.49%	1.19%	2.36%
Queens	6,506.67	206.16	352.58	2,378.06	2,584.22	2,730.64	146.42	39.72%	41.97%	2.25%	5.67%
Staten Island	6,927.51	152.30	366.90	3,310.74	3,463.04	3,677.64	214.60	49.99%	53.09%	3.10%	6.20%
Citywide	25,919.86	844.24	1,491.83	10,616.86	11,461.10	12,108.69	647.59	44.22%	46.72%	2.50%	5.65%
City: Right of Way											
Bronx	6,422.12	147.12	400.19	874.92	1,022.04	1,275.11	253.07	15.91%	19.86%	3.94%	24.76%
Brooklyn	11,359.69	356.61	768.87	1,943.72	2,300.33	2,712.59	412.26	20.25%	23.88%	3.63%	17.92%
Manhattan	3,819.91	73.38	262.81	508.08	581.47	770.90	189.43	15.22%	20.18%	4.96%	32.58%
Queens	16,508.19	668.59	1,067.07	3,039.28	3,707.87	4,106.35	398.47	22.46%	24.87%	2.41%	10.75%
Staten Island	6,524.28	228.56	506.10	1,331.95	1,560.52	1,838.05	277.53	23.92%	28.17%	4.25%	17.78%
Citywide	44,634.19	1,474.27	3,005.03	7,697.96	9,172.23	10,703.00	1,530.77	20.55%	23.98%	3.43%	16.69%
City: Other											
Bronx	2,148.09	29.68	63.05	142.54	172.22	205.58	33.37	8.02%	9.57%	1.55%	19.38%
Brooklyn	2,128.73	31.32	58.70	99.60	130.92	158.30	27.38	6.15%	7.44%	1.29%	20.91%
Manhattan	829.15	13.55	23.48	57.49	71.03	80.97	9.93	8.57%	9.76%	1.20%	13.98%
Queens	2,575.37	55.83	73.41	197.20	253.03	270.61	17.58	9.83%	10.51%	0.68%	6.95%
Staten Island	2,932.62	51.05	143.18	594.45	645.51	737.64	92.13	22.01%	25.15%	3.14%	14.27%
Citywide	10,613.95	181.43	361.82	1,091.28	1,272.70	1,453.09	180.39	11.99%	13.69%	1.70%	14.17%
Federal											
Bronx	4.00	0.04	0.12	0.04	0.07	0.16	0.09	1.85%	4.01%	2.17%	117.31%
Brooklyn	2,787.08	67.63	124.92	235.52	303.15	360.44	57.29	10.88%	12.93%	2.06%	18.90%
Manhattan	53.29	1.86	5.78	4.19	6.05	9.97	3.93	11.34%	18.72%	7.37%	64.97%
Queens	2,931.98	96.33	79.36	251.55	347.88	330.91	-16.97	11.87%	11.29%	-0.58%	-4.88%
Staten Island	904.40	29.25	54.32	138.24	167.49	192.56	25.07	18.52%	21.29%	2.77%	14.97%
Citywide	6,680.75	195.09	264.50	629.54	824.64	894.04	69.41	12.34%	13.38%	1.04%	8.42%

(Table A2.5 Continued)

	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
New York State											
Bronx	1,129.91	31.94	68.82	255.91	287.84	324.73	36.88	25.48%	28.74%	3.26%	12.81%
Brooklyn	1,510.75	54.83	101.58	384.49	439.32	486.07	46.75	29.08%	32.17%	3.09%	10.64%
Manhattan	1,028.54	31.49	54.97	210.10	241.59	265.07	23.48	23.49%	25.77%	2.28%	9.72%
Queens	5,989.17	82.69	132.92	307.00	389.70	439.92	50.23	6.51%	7.35%	0.84%	12.89%
Staten Island	2,188.22	49.37	117.99	809.20	858.58	927.19	68.61	39.24%	42.37%	3.14%	7.99%
Citywide	11,846.57	250.32	476.28	1,966.70	2,217.03	2,442.98	225.95	18.71%	20.62%	1.91%	10.19%
Private											
Bronx	11,657.42	393.27	498.46	1,448.50	1,841.76	1,946.96	105.19	15.80%	16.70%	0.90%	5.71%
Brooklyn	22,715.21	704.38	915.56	1,881.79	2,586.17	2,797.34	211.17	11.39%	12.31%	0.93%	8.17%
Manhattan	6,176.34	126.73	159.80	444.14	570.87	603.93	33.06	9.24%	9.78%	0.54%	5.79%
Queens	35,370.24	1,461.50	1,508.16	3,817.91	5,279.41	5,326.06	46.65	14.93%	15.06%	0.13%	0.88%
Staten Island	17,799.37	846.12	1,048.60	3,310.75	4,156.88	4,359.36	202.48	23.35%	24.49%	1.14%	4.87%
Citywide	93,718.58	3,532.01	4,130.57	10,903.08	14,435.09	15,033.65	598.56	15.40%	16.04%	0.64%	4.15%

Tree Canopy and Canopy Change by Site Type on Private Land, by Borough, and Citywide

Table A2.6

	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
Cemeteries											
Bronx	542.69	27.11	32.15	160.61	187.73	192.76	5.04	34.59%	35.52%	0.93%	2.68%
Brooklyn	908.87	47.09	51.37	237.27	284.36	288.64	4.28	31.29%	31.76%	0.47%	1.51%
Manhattan	18.46	2.03	1.00	8.64	10.67	9.65	-1.03	57.80%	52.25%	-5.55%	-9.61%
Queens	2,129.69	70.85	92.17	352.77	423.62	444.94	21.32	19.89%	20.89%	1.00%	5.03%
Staten Island	586.94	17.82	40.48	202.01	219.83	242.49	22.66	37.45%	41.31%	3.86%	10.31%
Citywide	4,186.65	164.91	217.18	961.31	1,126.22	1,178.49	52.27	26.90%	28.15%	1.25%	4.64%
Non-Residential Developed											
Bronx	2,490.78	32.64	55.09	96.36	129.00	151.45	22.45	5.18%	6.08%	0.90%	17.40%
Brooklyn	4,003.20	46.15	65.80	92.41	138.56	158.21	19.65	3.46%	3.95%	0.49%	14.18%
Manhattan	1,440.98	10.28	18.70	28.07	38.36	46.77	8.42	2.66%	3.25%	0.58%	21.94%
Queens	5,203.56	72.36	98.33	200.34	272.70	298.67	25.97	5.24%	5.74%	0.50%	9.52%
Staten Island	2,737.96	83.21	106.02	259.72	342.93	365.74	22.81	12.52%	13.36%	0.83%	6.65%
Citywide	15,876.48	244.65	343.95	676.90	921.55	1,020.85	99.29	5.80%	6.43%	0.63%	10.77%
Private Parks and Recreation Land											
Bronx	52.21	1.98	2.76	9.04	11.02	11.81	0.79	21.11%	22.61%	1.50%	7.13%
Brooklyn	84.09	3.50	3.57	6.84	10.34	10.42	0.08	12.30%	12.39%	0.09%	0.73%
Manhattan	52.92	0.97	2.90	7.45	8.42	10.35	1.93	15.91%	19.55%	3.64%	22.89%
Queens	117.84	3.92	3.96	12.26	16.18	16.22	0.03	13.73%	13.76%	0.03%	0.21%
Staten Island	263.05	9.50	11.12	121.86	131.36	132.98	1.62	49.94%	50.55%	0.62%	1.24%
Citywide	570.10	19.87	24.32	157.45	177.32	181.77	4.45	31.10%	31.88%	0.78%	2.51%
Public Facilities and Institutions											
Bronx	934.84	38.50	41.62	175.83	214.34	217.46	3.12	22.93%	23.26%	0.33%	1.46%
Brooklyn	986.65	21.95	32.90	70.75	92.70	103.65	10.95	9.39%	10.50%	1.11%	11.81%
Manhattan	743.44	25.27	18.67	71.09	96.36	89.75	-6.60	12.96%	12.07%	-0.89%	-6.85%
Queens	1,167.09	37.49	46.44	124.13	161.62	170.57	8.95	13.85%	14.61%	0.77%	5.54%
Staten Island	749.48	29.88	41.71	187.03	216.91	228.74	11.84	28.94%	30.52%	1.58%	5.46%
Citywide	4,581.51	153.08	181.34	628.83	781.91	810.16	28.25	17.07%	17.68%	0.62%	3.61%

(Table A2.6 Continued)

	Area (acres)	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010	Canopy Acreage 2017	Net Canopy Change (acres)	Canopy Cover 2010 (%)	Canopy Cover 2017 (%)	Net Canopy Change (%)	Relative Canopy Change (%)
One- and Two-Family Residences											
Bronx	3,682.97	169.36	199.79	544.66	714.02	744.45	30.42	19.39%	20.21%	0.83%	4.26%
Brooklyn	8,726.02	349.51	433.43	866.22	1,215.72	1,299.64	83.92	13.93%	14.89%	0.96%	6.90%
Manhattan	174.77	8.69	9.46	29.96	38.65	39.43	0.77	22.12%	22.56%	0.44%	2.00%
Queens	19,199.75	1,003.38	943.45	2,237.91	3,241.29	3,181.35	-59.93	16.88%	16.57%	-0.31%	-1.85%
Staten Island	10,421.37	583.83	649.43	1,737.40	2,321.23	2,386.83	65.61	22.27%	22.90%	0.63%	2.83%
Citywide	42,204.88	2,114.76	2,235.55	5,416.15	7,530.91	7,651.70	120.79	17.84%	18.13%	0.29%	1.60%
Multifamily Residences											
Bronx	3,515.53	103.07	139.52	353.44	456.51	492.95	36.45	12.99%	14.02%	1.04%	7.98%
Brooklyn	7,560.69	219.12	304.19	562.66	781.77	866.84	85.07	10.34%	11.47%	1.13%	10.88%
Manhattan	3,655.92	77.48	105.36	293.12	370.60	398.49	27.88	10.14%	10.90%	0.76%	7.52%
Queens	6,694.28	234.18	285.35	778.66	1,012.84	1,064.02	51.18	15.13%	15.89%	0.76%	5.05%
Staten Island	1,064.68	40.64	62.20	164.55	205.19	226.75	21.56	19.27%	21.30%	2.03%	10.51%
Citywide	22,491.10	674.49	896.63	2,152.43	2,826.92	3,049.06	222.14	12.57%	13.56%	0.99%	7.86%
Vacant Land											
Bronx	438.40	20.60	27.53	108.54	129.14	136.08	6.93	29.46%	31.04%	1.58%	5.37%
Brooklyn	445.68	17.06	24.29	45.64	62.70	69.93	7.22	14.07%	15.69%	1.62%	11.52%
Manhattan	89.86	2.01	3.70	5.80	7.81	9.50	1.69	8.69%	10.57%	1.88%	21.68%
Queens	858.02	39.32	38.46	111.84	151.16	150.30	-0.86	17.62%	17.52%	-0.10%	-0.57%
Staten Island	1,975.89	81.25	137.63	638.19	719.44	775.82	56.38	36.41%	39.26%	2.85%	7.84%
Citywide	3,807.86	160.24	231.61	910.01	1,070.25	1,141.62	71.37	28.11%	29.98%	1.87%	6.67%

Street Tree Metrics by Borough

Table A2.7

	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Estimated Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
Bronx	45,998	58,759	80,291	111,598	71.95%	Honey Locust	37.28%	2.05%	82.66
Brooklyn	109,567	141,322	169,751	232,372	73.05%	London Planetree	30.72%	3.69%	98.53
Manhattan	43,711	49,223	62,716	81,984	76.50%	Honey Locust	32.79%	0.52%	87.03
Queen	209,567	236,523	237,887	335,960	70.81%	London Planetree	25.63%	5.33%	93.68
Staten Island	73,666	98,425	101,443	141,225	71.83%	Callery Pear	27.77%	3.13%	107.89
Citywide	482,509	584,252	652,088	903,139	72.20%	London Planetree	29.41%	3.70%	94.58

Street Tree Metrics by Community District

Table A2.8

(* indicates unpopulated area)

Community District	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
BX-01	1,126	1,623	4,516	6,564	68.80%	Honey Locust	41.45%	0.09%	71.14
BX-02	396	2,069	4,702	5,967	78.80%	Honey Locust	47.64%	0.30%	90.00
BX-03	1,461	1,942	4,613	6,070	76.00%	Honey Locust	42.03%	0.50%	100.16
BX-04	2,037	2,606	6,060	7,799	77.70%	Honey Locust	39.11%	0.61%	97.18
BX-05	1,559	2,289	4,520	5,630	80.28%	Honey Locust	53.39%	0.77%	94.17
BX-06	1,261	2,584	4,607	6,038	76.30%	Honey Locust	50.05%	0.54%	86.94
BX-07	2,849	3,561	5,036	6,653	75.70%	Honey Locust	39.00%	1.05%	91.69
BX-08	5,020	6,607	5,642	8,203	68.78%	Pin Oak	28.16%	2.87%	79.10
BX-09	4,644	5,466	9,597	12,787	75.05%	London Planetree	42.77%	1.98%	86.62
BX-10	6,938	8,647	10,752	15,515	69.30%	London Planetree	27.97%	2.47%	67.90
BX-11	7,014	8,684	9,496	12,813	74.11%	London Planetree	28.64%	4.03%	101.44
BX-12	7,737	8,989	10,439	17,073	61.14%	London Planetree	31.50%	3.48%	80.39
BX-26*	1	27	283	411	68.86%	Pin Oak	21.20%	23.68%	75.35
BX-27*	N/A	N/A	283	318	88.99%	Pin Oak	46.29%	7.77%	53.11
BX-28*	N/A	N/A	34	103	33.01%	Green Ash	23.53%	8.82%	11.18
BK-01	4,261	8,680	11,542	16,910	68.26%	Honey Locust	33.37%	0.78%	85.98
BK-02	5,840	7,469	8,474	10,825	78.28%	London Planetree	25.90%	0.98%	102.10
BK-03	4,343	5,794	9,165	11,481	79.83%	Honey Locust	34.62%	1.26%	106.94
BK-04	2,175	3,778	6,817	8,527	79.95%	Honey Locust	43.08%	0.68%	121.04
BK-05	5,218	6,592	15,912	20,887	76.18%	London Planetree	51.87%	2.48%	101.71
BK-06	6,468	9,154	9,702	11,872	81.72%	London Planetree	28.37%	0.94%	112.75
BK-07	3,700	5,131	7,630	9,944	76.73%	London Planetree	41.59%	2.02%	93.90
BK-08	2,993	3,904	5,453	6,918	78.82%	Honey Locust	26.28%	1.96%	119.92
BK-09	2,901	5,058	4,911	6,427	76.41%	London Planetree	22.01%	3.97%	115.02
BK-10	8,424	10,167	10,119	13,086	77.33%	London Planetree	22.61%	8.03%	116.37
BK-11	6,211	7,568	9,002	13,760	65.42%	London Planetree	26.77%	5.15%	88.15
BK-12	8,057	10,568	11,977	15,374	77.90%	London Planetree	28.12%	5.00%	120.06
BK-13	2,366	3,410	3,725	7,069	52.69%	London Planetree	38.36%	3.30%	60.37
BK-14	9,823	10,263	10,016	12,728	78.69%	London Planetree	22.86%	6.87%	116.07
BK-15	10,646	12,126	12,981	19,504	66.56%	London Planetree	25.98%	6.58%	95.06
BK-16	2,509	2,893	5,043	7,433	67.85%	London Planetree	34.29%	3.81%	80.55
BK-17	6,156	6,850	8,063	12,546	64.27%	London Planetree	28.45%	5.33%	83.42
BK-18	14,471	18,443	18,347	26,022	70.51%	London Planetree	21.18%	4.36%	97.47
BK-55*	13	187	770	837	92.00%	Norway Maple	29.87%	2.86%	47.82
BK-56*	N/A	N/A	102	222	45.95%	London Planetree	4.90%	2.94%	7.79
MN-01	1,040	1,562	2,297	4,518	50.84%	Honey Locust	38.35%	0.09%	36.03

(Table A2.8 Continued)

Community District	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
MN-02	3,811	4,061	4,833	6,612	73.09%	Honey Locust	27.58%	0.04%	95.06
MN-03	2,750	2,938	4,709	6,632	71.00%	Honey Locust	38.76%	0.02%	77.21
MN-04	3,134	3,540	4,419	6,110	72.32%	Honey Locust	33.72%	0.02%	90.74
MN-05	2,068	1,764	2,015	5,096	39.54%	Honey Locust	49.48%	0.00%	32.26
MN-06	5,019	4,732	4,865	5,879	82.75%	Honey Locust	25.69%	0.08%	108.94
MN-07	6,062	7,569	8,332	9,228	90.29%	Honey Locust	24.76%	0.50%	124.01
MN-08	8,354	8,422	8,428	9,604	87.76%	Honey Locust	21.43%	0.10%	120.56
MN-09	2,488	3,157	4,755	5,840	81.42%	Honey Locust	33.92%	2.21%	102.23
MN-10	2,269	3,739	5,632	6,531	86.23%	Honey Locust	34.93%	0.21%	116.28
MN-11	1,820	2,859	4,465	5,907	75.59%	Honey Locust	38.48%	0.05%	67.36
MN-12	3,114	3,438	6,745	8,719	77.36%	Honey Locust	48.81%	0.92%	109.10
MN-64*	12	13	932	961	96.98%	American Elm	26.40%	8.91%	36.10
QN-01	9,860	9,910	12,239	17,141	71.40%	London Planetree	35.77%	2.69%	83.34
QN-02	5,548	7,986	8,300	13,664	60.74%	London Planetree	31.35%	2.29%	69.12
QN-03	9,000	9,586	10,301	13,119	78.52%	London Planetree	28.77%	4.31%	116.08
QN-04	5,230	6,695	6,243	9,714	64.27%	Honey Locust	21.59%	3.00%	82.24
QN-05	17,333	18,248	18,420	24,523	75.11%	London Planetree	21.35%	4.35%	105.44
QN-06	8,056	10,233	9,717	12,223	79.50%	London Planetree	25.38%	6.10%	116.44
QN-07	23,894	29,046	29,092	38,942	74.71%	London Planetree	28.30%	6.41%	103.72
QN-08	15,045	18,826	19,562	26,420	74.04%	London Planetree	23.68%	6.41%	106.34
QN-09	12,272	10,456	10,663	15,911	67.02%	London Planetree	23.88%	9.54%	88.20
QN-10	14,102	15,193	14,266	21,347	66.83%	London Planetree	18.49%	6.10%	90.04
QN-11	20,660	27,307	26,869	34,358	78.20%	London Planetree	21.40%	6.89%	106.25
QN-12	20,220	20,019	24,980	38,349	65.14%	London Planetree	24.64%	5.88%	91.30
QN-13	31,117	33,819	35,148	48,769	72.07%	Norway Maple	20.62%	4.85%	106.43
QN-14	5,595	8,088	11,155	19,385	57.54%	Honey Locust	52.39%	0.49%	69.02
QN-80*	17	15	156	226	69.03%	Honey Locust	25.64%	4.49%	69.80
QN-81*	N/A	N/A	214	292	73.29%	London Planetree	37.85%	3.74%	10.19
QN-82*	14	56	259	561	46.17%	Pin Oak	12.36%	14.67%	29.35
QN-83*	N/A	N/A	4	176	2.27%	London Planetree	0.00%	0.00%	0.07
QN-84*	N/A	N/A	299	840	35.60%	London Planetree	24.08%	0.33%	15.71
SI-01	15,433	21,000	24,688	38,788	63.65%	London Planetree	36.07%	5.72%	82.50
SI-02	18,688	23,231	24,812	38,741	64.05%	London Planetree	28.86%	4.40%	86.75
SI-03	38,093	49,895	51,843	63,139	82.11%	Callery Pear	23.24%	1.30%	148.36
SI-95*	16	149	100	557	17.95%	Sophora	55.00%	2.00%	18.38

Street Tree Metrics by City Council District

Table A2.9

Council District	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
1	2,568	3,389	5,432	9,815	55.34%	Honey Locust	39.36%	0.04%	47.03
2	4,382	4,446	5,316	6,909	76.94%	Honey Locust	34.12%	0.09%	89.77
3	6,279	6,742	8,201	11,460	71.56%	Honey Locust	30.40%	0.04%	88.16
4	8,372	7,816	8,222	11,030	74.54%	Honey Locust	25.63%	0.02%	84.31
5	4,407	4,807	4,688	5,553	84.42%	Honey Locust	24.53%	0.13%	124.46
6	5,634	6,287	7,857	8,713	90.18%	Honey Locust	24.42%	1.59%	95.41
7	3,127	4,503	6,247	7,648	81.68%	Honey Locust	35.12%	1.68%	106.17
8	2,373	3,501	6,774	9,428	71.85%	Honey Locust	39.47%	0.16%	65.73
9	3,343	5,347	7,870	9,225	85.31%	Honey Locust	34.16%	0.18%	112.49
10	2,793	3,183	6,122	7,781	78.68%	Honey Locust	47.96%	1.05%	110.48
11	7,552	9,564	9,349	13,981	66.87%	Pin Oak	27.74%	3.12%	78.88
12	6,944	8,811	10,177	16,060	63.37%	London Planetree	30.72%	2.98%	82.83
13	11,205	14,291	16,775	23,566	71.18%	London Planetree	27.99%	3.69%	76.98
14	2,524	3,553	5,856	7,294	80.29%	Honey Locust	47.23%	0.85%	99.38
15	2,960	4,225	7,578	10,142	74.72%	Honey Locust	47.48%	1.40%	84.12
16	1,815	2,276	5,953	7,864	75.70%	Honey Locust	41.22%	0.52%	95.53
17	2,285	4,890	11,138	14,575	76.42%	Honey Locust	45.64%	0.40%	89.56
18	4,315	5,265	9,452	12,537	75.39%	London Planetree	43.00%	1.99%	88.75
19	25,663	33,611	32,974	42,384	77.80%	London Planetree	25.62%	7.12%	103.65
20	11,151	13,172	13,441	18,323	73.36%	London Planetree	26.11%	5.85%	103.78
21	5,107	5,946	7,587	11,035	68.75%	Honey Locust	32.89%	4.35%	78.68
22	8,669	9,180	10,993	14,638	75.10%	London Planetree	33.37%	3.27%	90.25
23	24,559	30,412	29,182	37,962	76.87%	London Planetree	16.95%	5.17%	115.76
24	14,578	17,232	18,246	23,601	77.31%	London Planetree	25.60%	6.04%	108.70
25	7,972	8,650	7,519	10,074	74.64%	Honey Locust	20.03%	3.10%	105.54
26	7,122	9,037	10,260	16,145	63.55%	London Planetree	34.59%	2.00%	74.26
27	15,672	14,625	18,992	31,551	60.19%	London Planetree	29.91%	7.90%	82.71
28	13,875	14,478	14,911	23,368	63.81%	London Planetree	17.74%	6.67%	74.09
29	11,038	13,173	13,269	17,009	78.01%	London Planetree	25.80%	6.75%	110.71
30	16,979	17,785	17,544	25,074	69.97%	London Planetree	21.28%	5.19%	91.23
31	14,024	16,573	21,911	33,404	65.59%	Honey Locust	33.48%	2.87%	82.70
32	14,925	19,202	18,256	28,008	65.18%	London Planetree	25.85%	4.72%	79.62
33	6,484	10,996	12,330	16,749	73.62%	Honey Locust	30.29%	0.78%	93.85
34	4,601	7,211	10,187	14,354	70.97%	Honey Locust	36.43%	0.43%	95.77

(Table A2.9 Continued)

Council District	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
35	5,972	8,241	10,156	12,476	81.40%	London Planetree	23.83%	2.23%	121.86
36	4,259	5,663	8,750	10,909	80.21%	Honey Locust	33.98%	1.36%	108.10
37	3,739	4,913	10,489	13,761	76.22%	Honey Locust	43.90%	2.81%	100.65
38	4,380	5,872	9,077	12,937	70.16%	London Planetree	44.80%	2.20%	80.62
39	9,129	12,372	13,392	16,060	83.39%	London Planetree	24.97%	2.14%	117.02
40	5,077	6,107	6,587	8,833	74.57%	London Planetree	27.59%	5.65%	106.30
41	4,463	5,148	7,920	11,336	69.87%	London Planetree	32.35%	3.31%	91.62
42	4,732	6,102	12,572	17,448	72.05%	London Planetree	48.78%	2.23%	92.45
43	10,137	11,986	12,616	16,936	74.49%	London Planetree	23.42%	7.40%	108.38
44	8,217	10,020	11,240	14,208	79.11%	London Planetree	25.88%	5.26%	118.38
45	8,194	10,859	11,221	16,107	69.67%	London Planetree	22.09%	6.94%	93.74
46	13,262	16,329	16,164	23,890	67.66%	London Planetree	21.15%	4.19%	91.37
47	5,657	7,954	8,819	13,906	63.42%	London Planetree	29.15%	5.44%	86.19
48	9,449	10,691	11,033	15,848	69.62%	London Planetree	27.99%	5.85%	93.31
49	11,890	16,330	20,196	32,176	62.77%	London Planetree	37.51%	5.29%	86.83
50	23,590	29,394	32,043	49,196	65.13%	London Planetree	28.89%	5.07%	85.14
51	34,808	48,551	49,204	59,852	82.21%	Callery Pear	23.04%	0.99%	148.52

Street Tree Metrics by Neighborhood Tabulation Area

Table A2.10

(* indicates unpopulated area)

Neighborhood Tabulation Area	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
BX-01	422	652	1,538	2,295	67.02%	Honey Locust	50.33%	0.65%	82.27
BX-03	1,896	2,014	2,423	4,383	55.28%	London Planetree	36.15%	4.05%	67.24
BX-05	1,018	1,226	1,721	2,350	73.23%	Honey Locust	41.26%	0.58%	89.69
BX-06	647	676	1,413	1,710	82.63%	Honey Locust	47.28%	0.64%	75.55
BX-07	786	1,377	1,378	2,130	64.69%	Pin Oak	25.98%	3.99%	88.4
BX-08	1,035	865	1,551	2,070	74.93%	Honey Locust	37.78%	0.97%	96.34
BX-09	1,665	2,127	3,589	5,188	69.18%	London Planetree	39.98%	2.48%	64.03
BX-10	2,016	3,038	3,047	4,379	69.58%	London Planetree	26.75%	4.04%	86.2
BX-13	1,090	1,920	2,030	3,030	67.00%	London Planetree	27.44%	1.23%	75.52
BX-14	821	951	2,228	2,874	77.52%	Honey Locust	40.08%	0.49%	97.45
BX-17	486	1,496	2,252	2,904	77.55%	Honey Locust	46.98%	0.27%	102.76
BX-22	2,671	3,138	1,870	3,214	58.18%	Norway Maple	23.80%	2.83%	59.5
BX-26	445	583	1,671	2,178	76.72%	Honey Locust	42.43%	0.66%	91.77
BX-27	271	1,274	3,293	4,219	78.05%	Honey Locust	54.36%	0.40%	82.7
BX-28	1,530	1,739	2,235	2,734	81.75%	Pin Oak	29.75%	3.94%	91.09
BX-29	1,144	1,737	1,813	2,679	67.67%	Pin Oak	32.65%	2.04%	80.2
BX-30	553	654	1,111	1,375	80.80%	Pin Oak	47.89%	0.63%	100.64
BX-31	3,159	3,872	3,609	4,851	74.40%	London Planetree	20.50%	4.82%	111.51
BX-33	185	886	1,476	1,802	81.91%	Honey Locust	32.79%	0.14%	118.05
BX-34	489	733	1,997	2,594	76.99%	Honey Locust	41.01%	0.20%	102.3
BX-35	597	903	2,135	2,667	80.05%	Honey Locust	40.38%	0.28%	108.42
BX-36	734	1,153	1,988	2,561	77.63%	Honey Locust	50.30%	1.06%	87.14
BX-37	1,845	1,971	3,001	3,978	75.44%	London Planetree	45.79%	2.57%	97.47
BX-39	634	862	2,377	3,763	63.17%	Honey Locust	41.61%	0.00%	57.98
BX-40	296	412	995	1,141	87.20%	Honey Locust	59.80%	0.30%	119.44
BX-41	708	1,002	1,881	2,432	77.34%	Honey Locust	50.88%	0.80%	86.29
BX-43	754	1,366	1,709	2,220	76.98%	Honey Locust	33.76%	1.00%	115.01
BX-44	1,299	2,331	3,086	5,024	61.43%	Honey Locust	42.39%	3.18%	83.49
BX-46	167	433	773	1,222	63.26%	Honey Locust	37.65%	0.91%	107.09
BX-49	1,596	1,811	2,177	2,844	76.55%	Norway Maple	29.22%	4.00%	91.28
BX-52	3,561	3,684	4,851	7,211	67.27%	London Planetree	22.47%	2.60%	54.7
BX-55	1,137	1,150	1,849	2,259	81.85%	London Planetree	41.92%	2.76%	117
BX-59	968	1,233	2,709	3,291	82.32%	Honey Locust	55.37%	1.40%	105.67
BX-62	4,042	3,836	3,802	5,632	67.51%	Honey Locust	18.10%	3.18%	95.64
BX-63	637	902	1,979	2,527	78.31%	Honey Locust	37.19%	0.51%	90.89
BX-75	493	630	1,332	1,787	74.54%	Honey Locust	46.92%	0.38%	93.16
BX-98*	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BX-99*	81	127	1,402	2,082	67.34%	Pin Oak	30.10%	8.63%	64.14

(Table A2.10 Continued)

Neighborhood Tabulation Area	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
BK-09	1,457	2,051	1,685	1,970	85.53%	London Planetree	16.80%	0.24%	132.71
BK-17	4,852	5,243	4,891	8,905	54.92%	London Planetree	25.07%	5.07%	73.58
BK-19	1,174	1,047	1,141	2,292	49.78%	London Planetree	31.99%	6.66%	58.35
BK-21	394	1,389	1,357	2,413	56.24%	Honey Locust	55.12%	0.44%	68.68
BK-23	267	365	459	721	63.66%	London Planetree	36.17%	2.83%	65.73
BK-25	2,467	3,123	4,072	5,105	79.76%	London Planetree	28.51%	6.78%	129.03
BK-26	930	1,108	1,323	2,703	48.95%	London Planetree	20.56%	3.63%	54.71
BK-27	1,441	1,272	1,671	2,589	64.54%	London Planetree	25.25%	3.17%	87.43
BK-28	3,020	3,723	4,091	6,383	64.09%	London Planetree	25.64%	6.60%	88.37
BK-29	1,785	2,615	3,244	4,866	66.67%	London Planetree	28.02%	4.84%	86.8
BK-30	2,912	3,568	3,086	4,283	72.05%	London Planetree	21.78%	6.58%	98.94
BK-31	5,384	6,338	6,606	8,143	81.12%	London Planetree	22.95%	9.01%	130.01
BK-32	1,332	1,609	3,114	4,566	68.20%	London Planetree	53.15%	0.80%	68.88
BK-33	2,221	3,411	4,136	5,374	76.96%	London Planetree	33.22%	0.60%	92.71
BK-34	1,415	2,104	3,020	3,770	80.11%	London Planetree	41.89%	3.21%	117.77
BK-35	1,779	2,665	3,773	4,697	80.33%	London Planetree	31.62%	1.59%	107.06
BK-37	4,364	5,781	5,895	6,843	86.15%	London Planetree	26.09%	1.27%	129.45
BK-38	1,901	3,070	2,881	4,146	69.49%	London Planetree	31.31%	0.45%	82.09
BK-40	1,322	1,813	2,030	2,385	85.12%	London Planetree	25.37%	3.01%	133.49
BK-41	1,140	2,002	2,153	2,693	79.95%	London Planetree	25.87%	5.20%	132.69
BK-42	5,762	5,910	5,713	7,322	78.03%	London Planetree	23.67%	8.52%	118.5
BK-43	4,495	4,785	4,664	5,624	82.93%	London Planetree	22.13%	4.76%	130.46
BK-44	2,863	3,146	3,362	4,162	80.78%	London Planetree	26.12%	8.48%	119.53
BK-45	4,930	6,730	6,965	8,549	81.47%	London Planetree	23.17%	4.44%	124.62
BK-46	1,503	2,281	2,474	2,885	85.75%	London Planetree	30.15%	4.73%	146.68
BK-50	5,387	6,437	5,634	9,079	62.06%	London Planetree	21.89%	2.79%	83.81
BK-58	4,081	5,144	5,308	7,798	68.07%	London Planetree	17.01%	5.43%	90.59
BK-60	1,761	2,446	2,925	3,972	73.64%	London Planetree	28.68%	3.76%	104.74
BK-61	3,480	4,343	6,181	7,793	79.31%	Honey Locust	25.71%	2.41%	116.56
BK-63	1,166	2,199	1,917	2,449	78.28%	London Planetree	24.20%	3.70%	114.75
BK-64	565	1,298	1,463	1,743	83.94%	Honey Locust	24.20%	0.68%	139.73
BK-68	1,319	1,371	1,967	2,440	80.61%	London Planetree	24.56%	1.58%	106.91
BK-69	1,764	1,743	2,835	3,314	85.55%	London Planetree	29.56%	1.62%	126.37
BK-72	853	1,475	1,595	2,075	76.87%	London Planetree	18.43%	1.76%	108.44
BK-73	1,267	2,156	3,271	4,430	73.84%	Honey Locust	41.06%	1.25%	96.98
BK-75	1,531	2,144	3,588	4,644	77.26%	Honey Locust	38.38%	0.95%	103.21
BK-76	1,044	2,582	3,292	4,428	74.35%	Honey Locust	29.86%	0.30%	93.76
BK-77	830	1,376	3,245	4,114	78.88%	Honey Locust	49.77%	0.96%	112.8
BK-78	1,593	2,977	4,334	5,909	73.35%	Honey Locust	38.21%	0.35%	104.9
BK-79	725	875	2,262	3,185	71.02%	Honey Locust	36.25%	1.59%	85.05
BK-81	1,873	2,075	2,973	4,493	66.17%	London Planetree	33.70%	5.42%	78.98

(Table A2.10 Continued)

Neighborhood Tabulation Area	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
BK-82	2,876	3,589	9,162	12,518	73.19%	London Planetree	57.83%	1.71%	94.97
BK-83	1,630	1,614	3,384	4,353	77.74%	London Planetree	44.06%	4.64%	104.68
BK-85	829	1,382	2,856	3,360	85.00%	Honey Locust	49.41%	1.68%	124.54
BK-88	4,362	5,073	5,709	7,847	72.75%	London Planetree	24.73%	5.59%	104.68
BK-90	769	1,556	2,178	3,880	56.13%	London Planetree	34.07%	0.46%	66.42
BK-91	2,550	2,808	2,772	4,600	60.26%	London Planetree	21.61%	8.01%	79.76
BK-93	58	192	682	965	70.67%	London Planetree	14.81%	0.15%	88.19
BK-95	697	812	1,329	2,102	63.23%	London Planetree	45.60%	3.09%	85.98
BK-96	2,417	2,863	3,178	4,842	65.63%	London Planetree	24.86%	4.03%	78.59
BK-99*	38	356	1,905	2,651	71.86%	London Planetree	26.09%	6.56%	42.89
MN-01	841	1,018	1,639	2,105	77.86%	Japanese Zelkova	49.73%	1.04%	102.64
MN-03	1,458	2,135	3,355	3,983	84.23%	Honey Locust	35.98%	0.09%	113.05
MN-04	1,081	1,458	2,299	2,622	87.68%	Pin Oak	34.06%	1.74%	130.81
MN-06	382	544	862	1,283	67.19%	Honey Locust	43.85%	0.23%	76.61
MN-09	1,399	1,818	2,492	2,896	86.05%	Honey Locust	27.29%	3.13%	102.95
MN-11	895	1,761	2,485	2,778	89.45%	Honey Locust	33.76%	0.12%	120.08
MN-12	4,313	5,178	5,616	6,124	91.70%	Honey Locust	22.28%	0.59%	132.2
MN-13	2,115	2,174	2,841	4,392	64.69%	Honey Locust	36.04%	0.00%	76.61
MN-14	1,459	1,804	2,022	2,392	84.53%	Honey Locust	31.11%	0.00%	94.16
MN-15	1,269	1,586	1,887	2,427	77.75%	Honey Locust	34.02%	0.05%	95.94
MN-17	1,294	1,123	1,136	3,288	34.55%	Honey Locust	49.91%	0.00%	26.53
MN-19	2,611	2,077	2,162	2,734	79.08%	Honey Locust	26.09%	0.00%	105.27
MN-20	1,455	1,598	1,658	2,094	79.18%	Honey Locust	28.83%	0.00%	91.02
MN-21	1,087	1,080	1,087	1,363	79.75%	Honey Locust	30.82%	0.37%	92.37
MN-22	1,348	1,292	1,512	1,769	85.47%	Honey Locust	31.35%	0.00%	99.35
MN-23	3,196	3,054	3,675	4,668	78.73%	Callery Pear	22.83%	0.05%	107.96
MN-24	1,133	1,568	2,128	3,850	55.27%	Honey Locust	44.60%	0.00%	66.26
MN-25	496	945	1,266	2,424	52.23%	Honey Locust	32.78%	0.16%	50.68
MN-27	456	662	1,402	2,297	61.04%	London Planetree	41.30%	0.00%	63.83
MN-28	972	1,016	1,845	2,729	67.61%	Honey Locust	42.17%	0.05%	70.27
MN-31	2,085	2,204	2,215	2,735	80.99%	Honey Locust	23.57%	0.05%	104.1
MN-32	2,314	2,364	2,133	2,401	88.84%	Honey Locust	19.69%	0.23%	158.22
MN-33	854	1,136	1,750	2,384	73.41%	Honey Locust	42.23%	0.06%	81.3
MN-34	882	1,561	2,403	3,182	75.52%	Honey Locust	36.62%	0.04%	92.59
MN-35	1,114	1,133	2,410	2,959	81.45%	Honey Locust	46.43%	0.62%	124.83
MN-36	1,302	1,587	2,695	3,560	75.70%	Honey Locust	48.39%	0.45%	102.55
MN-40	3,955	3,854	4,080	4,467	91.34%	Callery Pear	21.18%	0.05%	116.38
MN-50	306	327	428	651	65.75%	Honey Locust	23.83%	0.00%	123.61
MN-99*	34	75	1,233	1,428	86.34%	American Elm	31.31%	8.52%	18.61
QN-01	3,040	3,216	3,890	6,144	63.31%	Pin Oak	18.30%	3.68%	89.81
QN-02	2,426	2,600	2,809	3,929	71.49%	Littleleaf Linden	9.40%	3.10%	105.67

(Table A2.10 Continued)

Neighborhood Tabulation Area	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
QN-03	2,061	2,737	3,567	5,691	62.68%	Cherry	29.61%	3.22%	87.97
QN-05	4,543	4,945	5,170	6,934	74.56%	Honey Locust	19.54%	3.77%	112.41
QN-06	2,119	3,986	3,965	5,821	68.12%	Pin Oak	22.12%	8.90%	103.98
QN-07	2,414	1,769	2,435	3,736	65.18%	London Planetree	30.39%	9.04%	95.84
QN-08	5,951	4,991	6,767	11,151	60.69%	London Planetree	31.57%	9.96%	85.89
QN-10	3,043	3,944	3,541	6,337	55.88%	Honey Locust	46.15%	0.42%	64.42
QN-12	640	1,131	2,932	6,028	48.64%	Callery Pear	72.68%	0.31%	54.06
QN-15	1,910	3,011	4,702	7,126	65.98%	Honey Locust	44.64%	0.68%	87.16
QN-17	6,313	8,175	7,327	8,891	82.41%	London Planetree	27.04%	6.85%	125.9
QN-18	1,731	1,966	2,283	2,998	76.15%	Honey Locust	19.49%	3.46%	107.26
QN-19	4,686	4,612	4,099	5,153	79.55%	London Planetree	15.76%	6.39%	117.75
QN-20	4,589	5,382	6,095	7,314	83.33%	Honey Locust	25.05%	1.31%	125.08
QN-21	4,749	5,513	5,044	6,848	73.66%	London Planetree	20.02%	6.03%	111.63
QN-22	2,256	2,619	2,912	4,192	69.47%	Pin Oak	26.61%	4.29%	85.82
QN-23	2,084	2,358	3,294	4,769	69.07%	London Planetree	39.74%	5.28%	84.17
QN-25	1,309	1,950	1,826	2,920	62.53%	Callery Pear	23.99%	4.44%	82.37
QN-26	952	1,243	2,141	2,926	73.17%	Pin Oak	44.09%	4.86%	103.7
QN-27	1,659	1,540	2,055	2,982	68.91%	Pin Oak	30.37%	5.06%	97.52
QN-28	6,554	7,020	6,528	7,864	83.01%	London Planetree	23.94%	3.86%	127.84
QN-29	2,955	3,653	3,169	4,846	65.39%	Honey Locust	17.67%	1.99%	86.04
QN-30	3,247	2,722	3,107	4,847	64.10%	London Planetree	23.98%	5.09%	76.55
QN-31	3,447	4,641	5,015	8,663	57.89%	London Planetree	32.70%	1.30%	61.6
QN-33	3,036	3,075	3,099	4,850	63.90%	London Planetree	24.23%	6.62%	89.73
QN-34	5,924	6,013	6,396	10,477	61.05%	London Planetree	25.63%	7.88%	84.8
QN-35	2,935	2,851	3,134	4,406	71.13%	London Planetree	24.98%	6.03%	101.23
QN-37	3,894	4,432	4,902	5,688	86.18%	London Planetree	25.48%	6.08%	125
QN-38	4,229	4,435	4,766	5,879	81.07%	London Planetree	24.95%	6.71%	117.71
QN-41	2,064	3,249	2,572	4,218	60.98%	London Planetree	17.61%	4.47%	81.47
QN-42	4,489	5,123	5,569	6,736	82.68%	London Planetree	21.01%	6.36%	124.68
QN-43	5,481	6,566	6,056	7,257	83.45%	Norway Maple	15.37%	5.40%	128.55
QN-44	5,863	7,012	6,432	7,111	90.45%	Norway Maple	9.70%	1.26%	157.19
QN-45	4,295	6,490	6,927	8,752	79.15%	Pin Oak	24.53%	7.00%	86.36
QN-46	7,434	10,713	9,468	12,558	75.39%	London Planetree	19.71%	6.56%	110.73
QN-47	2,377	3,331	2,788	3,690	75.56%	Pin Oak	21.09%	3.91%	98.95
QN-48	4,702	5,104	5,039	6,158	81.83%	London Planetree	21.02%	8.14%	125.85
QN-49	5,890	7,680	7,256	9,325	77.81%	London Planetree	30.07%	5.71%	106.76
QN-50	1,575	2,094	1,877	3,157	59.46%	Honey Locust	19.45%	4.10%	71.4
QN-51	6,068	6,897	6,838	8,465	80.78%	London Planetree	23.74%	8.66%	128.28
QN-52	2,929	3,493	2,966	4,209	70.47%	Pin Oak	28.42%	8.70%	103.72
QN-53	5,089	4,450	3,957	6,029	65.63%	London Planetree	19.16%	11.40%	84.45
QN-54	4,799	4,238	4,713	7,254	64.97%	London Planetree	29.92%	7.55%	88.62

(Table A2.10 Continued)

Neighborhood Tabulation Area	Number of Trees 1995	Number of Trees 2005	Number of Trees 2015	Est. Street Tree Capacity	Stocking Rate of Street Trees 2015	Most Common Species	Percent of Trees with DBH <6 Inches	Percent of Trees with DBH >30 Inches	Trees per Road Mile 2015
QN-55	7,534	7,807	6,886	10,608	64.91%	London Planetree	14.35%	9.45%	89.65
QN-56	2,877	3,060	3,093	4,314	71.70%	Honey Locust	11.19%	4.17%	105.94
QN-57	3,815	4,342	4,381	6,539	67.00%	London Planetree	30.02%	2.21%	83.38
QN-60	2,280	1,763	1,935	2,620	73.85%	Pin Oak	19.54%	10.49%	89.74
QN-61	2,362	2,743	4,043	5,968	67.74%	Honey Locust	35.72%	2.35%	85.08
QN-62	2,181	2,664	2,701	3,745	72.12%	London Planetree	30.47%	6.18%	106.68
QN-63	1,813	2,661	2,610	3,905	66.84%	Pin Oak	32.76%	3.95%	85.75
QN-66	4,151	3,458	4,414	6,684	66.04%	Norway Maple	27.57%	5.82%	92.86
QN-68	1,108	862	1,305	2,359	55.32%	London Planetree	42.61%	1.07%	56.86
QN-70	3,223	3,147	4,183	5,586	74.88%	Pin Oak	40.55%	1.53%	107.7
QN-71	931	896	1,245	1,944	64.04%	Honey Locust	45.54%	2.33%	84.75
QN-72	4,075	4,415	4,913	6,218	79.01%	London Planetree	29.98%	3.93%	111.83
QN-76	3,650	4,259	4,545	6,440	70.57%	London Planetree	16.94%	4.38%	103.19
QN-98*	17	12	155	373	41.55%	Honey Locust	39.36%	1.94%	2.69
QN-99*	222	446	2,050	4,328	47.37%	London Planetree	20.68%	5.81%	27.53
SI-01	10,436	13,504	12,538	15,532	80.72%	Callery Pear	24.28%	0.93%	145.87
SI-05	5,421	6,338	8,094	11,442	70.74%	Callery Pear	31.86%	1.26%	84.53
SI-07	3,806	5,026	4,844	7,683	63.05%	Pin Oak	27.19%	7.21%	88.91
SI-08	1,419	2,394	2,442	3,863	63.22%	London Planetree	36.73%	5.94%	90.26
SI-11	4,882	7,169	7,910	10,038	78.80%	Callery Pear	26.26%	1.01%	133.5
SI-12	1,785	2,262	3,582	5,567	64.34%	Callery Pear	44.89%	1.90%	90.18
SI-14	1,660	2,800	2,085	3,632	57.41%	Callery Pear	24.46%	2.97%	73.01
SI-22	2,039	2,783	3,756	6,303	59.59%	London Planetree	37.38%	6.42%	81.13
SI-24	3,999	4,814	4,688	9,862	47.54%	Callery Pear	28.05%	2.03%	63.23
SI-25	3,834	3,922	5,460	7,301	74.78%	London Planetree	27.73%	3.97%	114.84
SI-28	1,762	2,036	2,995	4,520	66.26%	London Planetree	39.03%	5.34%	58.21
SI-32	6,333	8,433	8,840	9,879	89.48%	Callery Pear	21.58%	0.43%	205.06
SI-35	2,828	3,807	3,444	5,250	65.60%	London Planetree	28.89%	10.54%	93.29
SI-36	3,490	4,507	4,805	7,153	67.17%	Pin Oak	27.76%	2.60%	97.6
SI-37	1,794	2,692	3,625	5,600	64.73%	Cherry	41.79%	2.35%	85.33
SI-45	4,178	5,009	5,339	7,296	73.18%	London Planetree	27.89%	13.32%	111.68
SI-48	5,621	7,049	6,729	7,532	89.34%	Callery Pear	19.48%	0.70%	188.19
SI-54	6,943	9,730	10,267	12,655	81.13%	Callery Pear	21.25%	1.70%	139.07
SI-99*	N/A	N/A	N/A	116	N/A	N/A	N/A	N/A	N/A

Tree Canopy and Canopy Change for Natural Areas by Owner Type, by Borough, and Citywide

Table A2.11

	Natural Areas (acres)*	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010 (forested natural areas)	Canopy Acreage 2017 (forested natural areas)	Net Canopy Change (acres)	Canopy Cover 2010 (percent of natural areas that is forested)	Canopy Cover 2017 (percent of natural areas that is forested)	Net Canopy Change (%)	Relative Canopy Change (%)
City: NYC Parks' Forever Wild											
Bronx	2,235.11	51.18	117.00	1,421.27	1,472.45	1,538.27	65.82	65.88%	68.82%	2.94%	4.47%
Brooklyn	804.93	44.13	67.25	217.45	261.58	284.70	23.12	32.50%	35.37%	2.87%	8.84%
Manhattan	357.78	6.94	17.90	312.87	319.81	330.77	10.96	89.39%	92.45%	3.06%	3.43%
Queens	2,334.32	53.04	119.45	1,107.16	1,160.19	1,226.61	66.42	49.70%	52.55%	2.85%	5.72%
Staten Island	4,348.40	88.86	210.77	2,583.11	2,671.97	2,793.89	121.92	61.45%	64.25%	2.80%	4.56%
Citywide	10,080.54	244.15	532.39	5,641.85	5,886.01	6,174.24	288.23	58.39%	61.25%	2.86%	4.90%
City: NYC Parks Not Forever Wild											
Bronx	777.08	27.03	57.79	457.34	484.37	515.12	30.75	62.33%	66.29%	3.96%	6.35%
Brooklyn	589.88	22.04	38.77	189.78	211.82	228.56	16.74	35.91%	38.75%	2.84%	7.90%
Manhattan	330.62	7.88	20.20	132.95	140.83	153.14	12.32	42.59%	46.32%	3.73%	8.75%
Queens	948.83	23.39	40.25	366.90	390.29	407.16	16.87	41.13%	42.91%	1.78%	4.32%
Staten Island	1,468.85	25.98	86.21	472.24	498.22	558.45	60.23	33.92%	38.02%	4.10%	12.09%
Citywide	4,115.26	106.32	243.22	1,619.21	1,725.53	1,862.43	136.90	41.93%	45.26%	3.33%	7.93%
City: Right of Way											
Bronx	213.85	3.99	2.51	28.89	32.88	31.40	-1.47	15.37%	14.68%	-0.69%	-4.49%
Brooklyn	54.19	4.48	1.04	1.82	6.31	2.86	-3.45	11.64%	5.28%	-6.36%	-54.64%
Manhattan	9.22	0.43	0.26	2.45	2.89	2.71	-0.18	31.33%	29.43%	-1.90%	-6.07%
Queens	332.52	10.41	6.41	47.55	57.96	53.96	-4.00	17.43%	16.23%	-1.20%	-6.90%
Staten Island	575.32	20.25	36.09	229.54	249.79	265.63	15.83	43.42%	46.17%	2.75%	6.34%
Citywide	1,185.09	39.57	46.30	310.25	349.82	356.56	6.74	29.52%	30.09%	0.57%	1.93%
City: Other											
Bronx	159.02	2.22	7.55	13.72	15.95	21.28	5.33	10.03%	13.38%	3.35%	33.41%
Brooklyn	64.47	1.67	3.14	6.65	8.32	9.79	1.47	12.90%	15.19%	2.28%	17.70%
Manhattan	26.18	0.24	0.21	2.56	2.80	2.77	-0.04	10.71%	10.57%	-0.14%	-1.27%
Queens	267.73	16.40	19.23	41.28	57.68	60.50	2.82	21.54%	22.60%	1.05%	4.90%
Staten Island	820.31	18.48	59.50	433.93	452.41	493.43	41.02	55.15%	60.15%	5.00%	9.07%
Citywide	1,337.70	39.02	89.63	498.14	537.16	587.77	50.61	40.16%	43.94%	3.78%	9.42%

* Natural Areas for City Parkland were delineated based on the Dominant Type Dataset from NYC Parks, and those for other jurisdictions were delineated based on the Ecological Covertype Map. See Appendix 1 for further detail.

(Table A2.11 Continued)

	Natural Areas (acres)*	Canopy Loss (acres)	Canopy Gain (acres)	Canopy Unchanged (acres)	Canopy Acreage 2010 (forested natural areas)	Canopy Acreage 2017 (forested natural areas)	Net Canopy Change (acres)	Canopy Cover 2010 (percent of natural areas that is forested)	Canopy Cover 2017 (percent of natural areas that is forested)	Net Canopy Change (%)	Relative Canopy Change (%)
Federal											
Bronx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00%	0.00%	0.00%	0.00%
Brooklyn	1,690.47	56.58	106.41	204.98	261.56	311.39	49.83	15.47%	18.42%	2.95%	19.05%
Manhattan	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00%	0.00%	0.00%	0.00%
Queens	2,561.79	90.90	73.08	238.75	329.64	311.82	-17.82	12.87%	12.17%	-0.70%	-5.41%
Staten Island	503.94	23.91	37.41	100.47	124.38	137.88	13.50	24.68%	27.36%	2.68%	10.85%
Citywide	4,756.20	171.38	216.89	544.20	715.59	761.09	45.51	15.05%	16.00%	0.96%	6.36%
New York State											
Bronx	23.40	0.66	0.82	12.66	13.32	13.48	0.15	56.95%	57.61%	0.66%	1.15%
Brooklyn	5.08	0.18	0.53	0.42	0.60	0.94	0.35	11.71%	18.58%	6.87%	58.66%
Manhattan	27.32	0.10	1.54	1.08	1.18	2.62	1.43	4.32%	9.57%	5.25%	121.44%
Queens	351.47	12.67	17.11	42.42	55.08	59.53	4.45	15.67%	16.94%	1.26%	8.07%
Staten Island	958.64	22.18	45.60	599.86	622.04	645.46	23.42	64.89%	67.33%	2.44%	3.76%
Citywide	1,365.91	35.80	65.59	656.43	692.23	722.03	29.80	50.68%	52.86%	2.18%	4.30%
Private											
Bronx	234.21	20.88	7.55	126.27	147.15	133.82	-13.32	62.83%	57.14%	-5.69%	-9.06%
Brooklyn	116.23	6.27	4.24	5.44	11.70	9.68	-2.03	10.07%	8.33%	-1.74%	-17.31%
Manhattan	11.28	0.40	0.22	6.67	7.07	6.89	-0.19	62.67%	61.02%	-1.65%	-2.63%
Queens	303.37	18.95	10.77	75.29	94.25	86.07	-8.18	31.07%	28.37%	-2.70%	-8.68%
Staten Island	2,216.05	147.97	126.99	942.59	1,090.55	1,069.58	-20.97	49.21%	48.27%	-0.95%	-1.92%
Citywide	2,881.14	194.47	149.78	1,156.25	1,350.72	1,306.03	-44.69	46.88%	45.33%	-1.55%	-3.31%

Correlations Between Urban Forest and Socioeconomic Variables Used in Equity Analysis

Correlations greater than 0.2 or less than -0.2

Significant *p*-values (<0.05)

	Per Capita Income		Percent of People Below Poverty Line		Percent of People Aged 65 or Older		Percent of People Aged 17 or Younger		Percent of People with Limited English		Percent of People of Color		Percent of Households with More People than Rooms	
	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value
Canopy % (NTA + 1/4-mile buffer)														
Bronx	0.41	<0.001	-0.37	0.001	0.36	0.002	-0.42	<0.001	-0.39	<0.001	-0.41	<0.001	-0.31	0.007
Brooklyn	0.23	0.016	-0.12	0.225	-0.09	0.345	0.05	0.587	-0.30	0.002	-0.04	0.670	-0.10	0.304
Manhattan	-0.36	0.007	0.20	0.150	0.02	0.891	0.49	<0.001	0.22	0.101	0.19	0.162	0.13	0.336
Queens	0.24	0.010	-0.25	0.006	0.33	<0.001	-0.15	0.110	-0.02	0.865	-0.05	0.553	-0.17	0.068
Staten Island	0.50	0.003	-0.36	0.039	0.23	0.201	0.05	0.823	-0.45	0.009	-0.36	0.039	-0.31	0.081
Citywide	0.17	<0.001	-0.16	0.002	0.18	<0.001	-0.06	0.248	-0.15	0.003	-0.12	0.018	-0.21	<0.001
Relative Canopy Change (NTA + 1/4-mile buffer)														
Bronx	-0.41	<0.001	0.42	<0.001	-0.36	0.002	0.46	<0.001	0.32	0.006	0.54	<0.001	0.19	0.113
Brooklyn	-0.11	0.261	0.22	0.027	-0.48	<0.001	-0.05	0.603	-0.08	0.421	0.14	0.159	0.02	0.827
Manhattan	-0.21	0.117	0.24	0.084	-0.52	<0.001	0.15	0.275	0.21	0.127	0.30	0.031	0.33	0.015
Queens	-0.08	0.375	0.11	0.236	-0.26	0.006	0.05	0.575	0.04	0.635	0.03	0.760	0.02	0.793
Staten Island	-0.34	0.056	0.03	0.879	-0.13	0.445	0.16	0.360	0.09	0.593	0.19	0.285	0.11	0.541
Citywide	-0.17	<0.001	0.32	<0.001	-0.41	<0.001	0.13	0.007	0.07	0.170	0.16	0.002	0.18	<0.001
Stocking Rate														
Bronx	-0.37	0.001	0.31	0.008	-0.33	0.004	0.30	0.009	0.49	<0.001	0.19	0.100	0.38	<0.001
Brooklyn	0.26	0.007	-0.10	0.288	-0.23	0.016	0.06	0.509	-0.25	0.009	-0.18	0.060	-0.11	0.266
Manhattan	0.04	0.769	-0.10	0.468	0.08	0.544	0.11	0.445	-0.17	0.215	-0.12	0.399	-0.28	0.037
Queens	0.22	0.016	-0.16	0.082	0.26	0.005	-0.16	0.077	0.10	0.283	-0.26	0.004	-0.17	0.070
Staten Island	0.28	0.112	-0.45	0.009	0.19	0.293	-0.23	0.201	-0.54	0.001	-0.53	0.002	-0.58	<0.001
Citywide	0.07	0.151	0.02	0.705	-0.09	0.073	0.02	0.760	-0.02	0.718	-0.10	0.042	-0.06	0.256

Table A2.12

Percent of Households with No Vehicle		Heat Vulnerability Index Rank		SVI - Socioeconomic Theme		SVI - Household Composition Theme		SVI - Minority Status/ Language Theme		SVI - Housing Type/ Transportation Theme		SVI - All Themes	
Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value	Corr.	*p*-value
-0.43	<0.001	-0.35	0.007	-0.37	0.001	-0.22	0.058	-0.53	<0.001	-0.17	0.138	-0.34	0.004
-0.01	0.953	-0.08	0.441	-0.21	0.032	-0.18	0.067	-0.27	0.007	0.17	0.075	-0.16	0.093
-0.31	0.020	0.09	0.539	0.28	0.041	0.44	<0.001	0.20	0.139	0.00	1.000	0.28	0.041
-0.35	<0.001	-0.23	0.019	-0.29	0.001	-0.12	0.203	-0.07	0.445	-0.20	0.028	-0.20	0.026
-0.33	0.057	-0.33	0.090	-0.42	0.014	-0.03	0.881	-0.41	0.017	-0.19	0.293	-0.27	0.131
-0.25	<0.001	-0.23	<0.001	-0.16	<0.001	-0.03	0.541	-0.14	0.004	-0.15	0.002	-0.13	0.007
0.40	<0.001	0.53	<0.001	0.41	<0.001	0.44	<0.001	0.50	<0.001	0.24	0.046	0.42	<0.001
0.39	<0.001	0.24	0.026	0.20	0.046	-0.26	0.008	0.06	0.524	0.13	0.175	0.13	0.180
0.30	0.028	0.27	0.074	0.21	0.127	-0.04	0.796	0.23	0.092	0.30	0.031	0.17	0.211
0.20	0.038	0.07	0.479	0.12	0.204	-0.02	0.859	0.00	0.972	0.00	0.994	0.02	0.870
-0.01	0.939	0.21	0.284	0.12	0.492	0.05	0.760	0.20	0.252	0.05	0.760	0.08	0.647
0.37	<0.001	0.28	<0.001	0.24	<0.001	0.04	0.378	0.13	0.009	0.30	0.000	0.22	<0.001
0.31	0.007	0.25	0.061	0.38	<0.001	0.12	0.297	0.38	<0.001	0.43	<0.001	0.40	<0.001
0.06	0.553	-0.17	0.110	-0.22	0.021	-0.28	0.004	-0.33	<0.001	0.06	0.530	-0.23	0.018
-0.31	0.020	-0.08	0.566	-0.08	0.544	0.08	0.544	-0.16	0.246	-0.16	0.246	-0.08	0.544
-0.14	0.123	-0.41	<0.001	-0.26	0.005	-0.18	0.048	-0.08	0.366	-0.12	0.208	-0.20	0.028
-0.53	0.002	-0.31	0.110	-0.52	0.002	-0.25	0.152	-0.53	0.002	-0.59	<0.001	-0.62	<0.001
0.15	0.002	-0.06	0.294	-0.04	0.413	-0.09	0.054	-0.05	0.324	0.14	0.003	-0.03	0.500