Forest Management Framework for New York City

Natural Areas Conservancy

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Acknowledgements
BAND Foundation
Doris Duke Charitable Foundation
Ittleson Foundation
JPB Foundation
Mayor's Fund to Advance NY
The New York Community Trust
The Tiffany & Co. Foundation
Robert Wilson Charitable Trust
Wildlife Conservation Society Climate Adaptation Fund

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Please cite this report as follows:
Pregitzer, Clara C., Helen M. Forgione, Kristen L. King, Sarah Charlop-Powers, and Jennifer Greenfeld. 2018. *Forest Management Framework for New York City.* Natural Areas Conservancy, New York, NY.

COVER:
Mature forest in Inwood Hill Park, Manhattan

Forest Management Framework for New York City

Natural Areas Conservancy

Natural Areas Conservancy

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April 2018

Dear New Yorkers,

The Natural Areas Conservancy (NAC) is proud to present a bold new vision for the restoration and long-term care of our city's forests with our partners at the New York City Department of Parks and Recreation (NYC Parks). The Forest Management Framework is a roadmap for the next 25 years to invest in and take care of the agency's 7,300 acres of forested natural areas. A sustained investment in this resource will:

- ensure safe, high-quality public access to nature for every New Yorker and
- protect New York City's biodiversity and unique forest communities.

Despite being the most densely populated city in the nation, New York has robust pockets of nature across every borough where people can lose themselves among the great trees and birdsong. Spending time in nature reduces stress, improves fitness, and refreshes the spirit. Our natural areas also provide clean air and water, cooler summer temperatures, and protection against storms and flooding. We want to ensure they continue to benefit future generations of New Yorkers.

NYC Parks realized the importance of our natural areas decades ago with the establishment of the Natural Resources Group, one of the first public divisions in the nation dedicated to natural areas restoration and conservation. More recently, the MillionTreesNYC program included the planting of over 500,000 trees in forested natural areas in all five boroughs and activated thousands of local stewards.

The NAC was formed in 2012 to build on the successes of NYC Parks' natural areas management and to envision and advocate for their future. The NAC has produced valuable data on the health and condition of our natural areas and added expertise to the forest management of NYC Parks. We have also given fuller voice and a higher profile to the conservation of nature in New York City.

The Forest Management Framework comes at just the right time: our city is growing, and more people will need the open spaces of nature for recreation, renewal, and resilience in the face of climate change. Join us in our call to action: **to make forests a resource on par with the other great cultural resources of our city.**

Sincerely,

Sarah Charlop-Powers
Executive Director, Natural Areas Conservancy

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Dear Park Lovers:

When we at NYC Parks talk about our 30,000 acres of parkland, it is common to picture basketball courts, playgrounds, and the landscaped lawns of Central Park. But forested natural areas make up nearly a quarter of parkland in New York City—and they serve a vital purpose. These forests strengthen not only our city's ecosystem, but also the health and well-being of the New Yorkers who use them for free, accessible exercise and relaxation.

You can find Parks forests in every borough, from Conference House Park on Staten Island's southern tip to Pelham Bay Park at the northern border of the Bronx; in Riverside Park in Manhattan, Prospect Park in Brooklyn, and of course in Forest Park in Queens. And in all of our forests, you can find the work of our partner, the Natural Areas Conservancy, which since 2012 has supported the study and restoration of our natural areas through initiatives ranging from tree planting and trail blazing to data collection and creating tools for better management.

The new Forest Management Framework, a joint project of the Natural Areas Conservancy and NYC Parks, represents a significant step forward in improved management and resources for our natural areas. NYC Parks is excited by this framework's potential to improve one quarter of our park system and the health and well-being of all New Yorkers. The framework provides key insights into the state of our forests and recommends a 25-year investment to improve their long-term health. It is my hope and expectation that this framework will inform forest management not only here in New York City, but in cities across the country and around the world.

Thank you,

Mitchell J. Silver, FAICP, Hon. ASLA

Contents

Executive Summary 9

A New Vision for Urban Forest Management 10

Forest Management Goals 12

Overview of NYC's Forests 13

What Are the Conditions of NYC's Forests? 14

Major Findings 15

Developing a Citywide Model 22

Implementing the Management Framework 25

Conclusion 31

Appendices 33

Notes 40

Figures

1	Invest in Forests to Improve Their Condition	9
2	NYC's Land Cover	13
3	NYC's Natural Areas	13
4	NYC Parks' Forests	13
5	NYC's Parks	14
6	NYC's Forests by Borough	16
7	Most Common Plant Species by Forest Layer	16
8	Key Findings	17
9	NYC's Forest Condition Index	22
10	Forest Condition Matrix	23
11	Forest Condition Drives Management Strategy	27
12	Staffing Vision	28

Sidebars

Trails	18
Citywide Social Assessment of NYC's Parks and Natural Areas	19
Who Takes Care of Urban Landscapes?	26
Aligning Forest Management across NYC— Conservancy Engagement Program	29
Climate-Adapted Planting Palettes	29

Appendices

A	Key Ecological Attributes of Healthy Urban Forests	33
B	NYC's Forest Management Budget	34
C	NYC's Parks in City Council Districts	36
D	City Council Districts for NYC's Forested Parks	37
E	Rapid Site Assessment Checklist	38

Native trees staged to be planted in Kissena Park, Queens

Volunteers planting trees
at a forest restoration site

Executive Summary

NYC's forested natural areas provide important benefits to the city including high-quality recreation, enhanced biodiversity, and improved air and water quality. The Natural Areas Conservancy (NAC) and the New York City Department of Parks and Recreation (NYC Parks) have developed a 25-year Forest Management Framework intended to guide the restoration and management of NYC Parks' 7,300 acres of forested natural areas. The framework, NYC's first citywide forest management plan, is based on new comprehensive data that includes ecological conditions and visitor perceptions and experiences. The framework categorizes the condition of forests in more than 50 parks across the five boroughs, based on metrics for ecological health and threat. Each condition category was correlated with best practices, staffing and contractual structures, and cost estimates. This approach facilitates the prioritization of future restoration activities, the ability to track changes in forest health over time, and the ability to estimate the level of investment needed to maximize ecological condition and visitor experience at the scale of a park, borough, or city. **The framework calls for an investment of $385 million over 25 years to ensure that our city's forests achieve their full potential for recreation and conservation.**

FIGURE 1

Invest in Forests to Improve Their Condition

Through increased financial investment and targeted forest management, NYC will improve the health of our forests over time. Healthy forests are less expensive to manage.

A New Vision for Urban Forest Management

NYC contains significant forested natural areas. NYC is 40.5% green—including landscaped parkland, private yards, cemeteries, and campuses, in addition to natural areas. The 7,300 acres of forested natural areas under NYC Parks' jurisdiction represent an area eight times as large as Central Park. These are not just open spaces but gateways to nature and all its history, complexity, and wonder. Healthy forests support habitat for native wildlife such as great horned owls, downy woodpeckers, coyotes, and red-backed salamanders, and native wildflowers such as spotted joe pye weed and New York aster: all species that have long called NYC home.

The urban forest has never been more important for people. An unprecedented 80% of Americans live in urban areas,[1] and communities are increasingly disconnected from the natural world. Across multiple demographics children are spending more time using screen-based electronics and less time out of doors than their peers did 30 years ago.[2] Spending time in nature provides significant cognitive and emotional benefits, especially for youth in poor and underserved areas.[3] High-quality urban nature has been shown to decrease crime and increase community cohesion.[4] Safe access is therefore the first step toward realizing the benefits that nature provides for individuals and communities. As NYC grows in population, smart management of forested natural areas is critical.

Urban forests contribute to a healthy environment. Trees are vital for mitigating urban heat-island effects and can lower air temperatures by up to nine degrees Fahrenheit.[5] NYC's forested natural areas also naturally capture millions of gallons of stormwater each year and filter pollutants from that water.[6] These forests are habitat for hundreds of species of resident birds and pollinators, as well as occupying a crucial location on the migratory paths of hundreds of additional species.

New data enables a new vision and leadership for forest conservation in NYC. In 2013 and 2014, the NAC conducted the first standardized assessment of 10,000 acres of forests and wetlands in 53 parks, including 7,300 acres of forested natural areas. These forests are incredibly diverse and are under threat from longstanding urban challenges such as fragmentation and the increased prevalence of invasive species, as well as the effects of climate change. The framework articulates management practices that directly address these threats and will restore and sustain healthy forests and secure their associated benefits over the long term.

The Forest Management Framework's 25-year plan to restore and conserve NYC's forests is grounded in robust ecological data, decades of professional expertise, and in-depth information about the staffing, costs, and practices associated with urban conservation activities. It includes guidelines for projecting costs, adapting best practices, encouraging local stewardship, and continued monitoring and research. If fully funded, the framework will ensure that 100% of the city's forests are under active management, are healthy, and are meaningful to and provide essential benefits for communities.

Healthy Forest
A healthy forest is characterized by its native canopy and multiple horizontal layers, including shrubs and ground cover.

Unhealthy Forest
An unhealthy forest is characterized by the dominance of invasive vines that can topple trees and disturb the canopy.

Forest Management Goals

The Forest Management Framework will result in forests that are healthy, provide recreation and enjoyment for all New Yorkers, and are fully supported financially.

Forests Are Healthy

People Benefit from Forests

Forests Are Supported

To realize these goals we must:

- Reduce ecological threats; bring the proportion of invasive species under 10%
- Promote healthy natural regeneration and biodiversity and the growth of native trees
- Make forests resilient to climate change
- Employ diverse and protective management strategies that are aligned with ecological conditions
- Provide safe, well-marked trails in natural areas; use trail-building techniques that contribute to forest health
- Help people find inspiration, reduce stress, improve fitness, and build communities
- Create opportunities for green jobs and encourage environmental education
- Increase collaboration between NYC Parks and other land managers, including park conservancies and other public agencies
- Galvanize an informed, involved, and active community around forest management and land stewardship
- Ensure NYC Parks Forever Wild protection guidelines continue to guard against forest fragmentation or inappropriate development

To achieve this vision, NYC Parks and its partners will need to commit $385 million over 25 years.

Overview of NYC's Forests

FIGURE 2

NYC's Land Cover: 40.5% of NYC Is Green

Source: Natural Areas Conservancy Ecological Covertype Map[7]

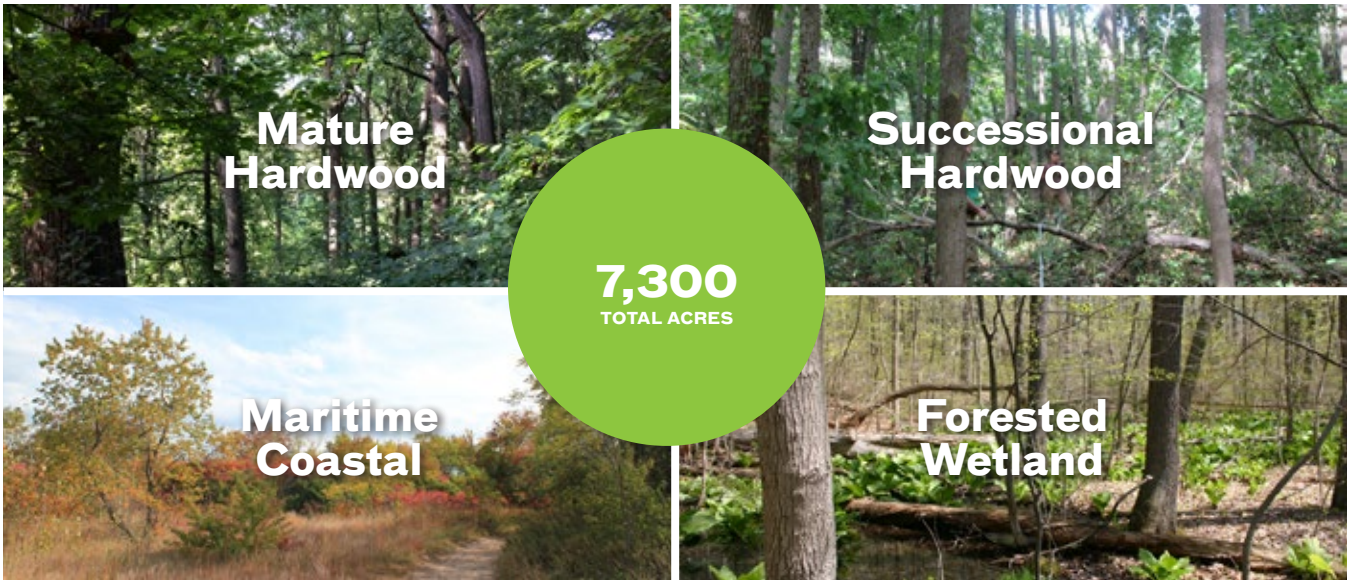
FIGURE 3

NYC's Natural Areas: 11.6 % of NYC's Land Cover Is Natural Areas

Source: Natural Areas Conservancy Ecological Covertype Map[8]

FIGURE 4

NYC Parks' Forests: 60% of NYC's Forests Are in NYC Parks



Source: Classification of Natural Areas Conservancy's Ecological Assessment Plots[9]

What Are the Conditions of NYC's Forests?

Assessment of NYC's Natural Areas

Using both remotely-sensed data and fieldwork, the NAC assessed the condition of 10,000 acres of natural areas under NYC Parks' jurisdiction. Assessments were conducted in freshwater wetlands, saltmarshes, and 7,300 acres of forested natural areas. Field data on forest character and condition was collected in 53 parks from 1,156 sampling plots (see Appendix A). Data included size and health of trees, species composition, and soil condition.[10] Working in partnership with the US Forest Service, the NAC also conducted a social assessment to better understand how park visitors perceive, use, and value urban natural areas.[11] This assessment data forms the foundation of the Forest Management Framework.

FIGURE 5

NYC's Parks

Major Findings

Our first-ever citywide research shows incredible diversity and the need for an immediate increase in management activities.

1. NYC's forests are diverse and dominated by native trees.

Forest canopies are mostly native (85%) and composed of 109 native tree species and 43 unique forest types.[12] Some of the most common forest types include oak-hickory, oak–tulip tree, and successional sweetgum. Less common forest types include chestnut-oak and successional birch habitats. Vestiges of larger maritime-coastal forests, which are not commonly found elsewhere in the state, remain across the coastal areas of NYC.

2. The next generation is less healthy.

Despite a high percentage of native trees in the canopy, native species are less prevalent in the midstory and understory layers. Invasive herbaceous species are common (present in 85% of plots), and invasive vines were found climbing on trees in 57% of forest plots. Invasive herbaceous species can prevent native seedlings from reaching the canopy, affecting ecosystem composition and function. Invasive vines can repress growth and shorten the lifespan of native trees. Without intervention, these challenges will negatively affect the health and species composition of mature trees in the future.

3. NYC's most common forest type is also its most vulnerable.

We found that 40% of NYC's forests are successional hardwood forests, reflecting recent disturbance. These forest types typically have a higher stem density and have lower average tree diameters. Additionally, these successional forests have, on average, a 34% greater presence of invasive herbaceous species than mature hardwood forest types in NYC.

4. All forests need management, but not the same kind.

Accurate data on forest conditions across the whole city has increased the level and scope at which we understand our forests and changed how we prioritize and align management activities. To achieve healthy forests, interventions such as low-density tree planting or more surgical invasive species removal can be applied in areas that are relatively healthy or to stands in transition. In contrast, forests that are relatively unhealthy and dominated by invasive species might require afforestation, essentially planting a forest from scratch.

5. Well-managed forests are more welcoming.

Forests with fewer invasive vines offer higher visibility for visitors. Areas that receive regular maintenance, including formal trail systems and clear signage, feel safer and are more inviting.

Collecting data in Van Cortlandt Park, the Bronx

FIGURE 6

NYC's Forests by Borough

There are more than 10,500 acres of forested natural areas in all of the five boroughs of NYC. These forests are found on city, state, and federal property as well as on private property.

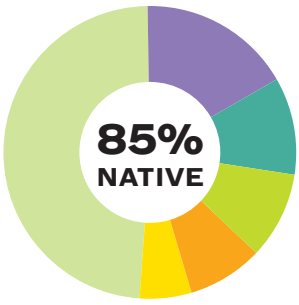
Borough of NYC	Acres of Forest	Percentage of Forests
Bronx	2,041	19%
Brooklyn	599	6%
Manhattan	365	3%
Queens	1,971	19%
Staten Island	5,566	53%
Total	**10,542**	**100%**

FIGURE 7

Most Common Plant Species by Forest Layer

Canopy

We found 85% of all overstory species measured were classified as native to NYC. Sweetgum was recorded as the most common species, accounting for 16.9% of all species measured, followed by northern red oak, accounting for 10.5% of all species, and the greatest proportion of basal area (21.6%). The most common invasive tree species recorded was black locust (5.3%), followed by Norway maple (1.7%). Standing dead trees can provide important habitat for birds and wildlife. We found that 10.9% of the standing trees in the canopy were dead.

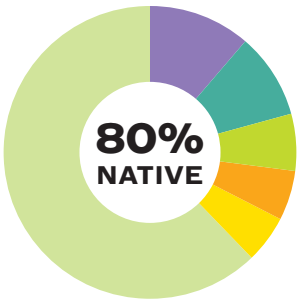


Top 5 Species

- Sweetgum
- Northern Red Oak
- Black Cherry
- Red Maple
- Sassafras
- All Other

Midstory

Non-native species were more prevalent in the midstory than in the canopy. We found that 80% of all midstory species were native. The five most abundant native midstory species were spicebush (12.5%), black cherry (7.5%), sweetgum (6.4%), red maple (6.4%), and sassafras (5.5%). The most common invasive species were crab apple (3%), Norway maple (2.3%), Japanese angelica tree (2.1%), and black locust (2.3%).

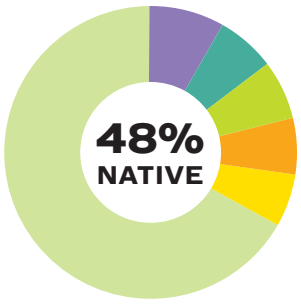


Top 5 Species

- Spicebush
- Black Cherry
- Sassafras
- Sweetgum
- Red Maple
- All Other

Understory

Non-native species were more prevalent in the understory, with the mean proportion of native species at 48%. The most frequently occurring understory plants were woody vines. These included natives such as poison ivy and Virginia creeper, as well as non-natives such as Japanese honeysuckle and oriental bittersweet. Of the 10 most abundant species in terms of relative cover, half were non-native. Invasive vines pose a significant threat to standing trees by repressing growth and shortening lifespans.



Top 5 Species

- Poison Ivy
- Mugwort*
- Japanese Honeysuckle*
- Multiflora Rose*
- Virginia Creeper
- All Other

* Invasive non-native species

FIGURE 8

Key Findings

Forest Canopy

In our assessment we found 213 tree species and that 85% of all tree species were native. This forest layer represents the most mature trees and is a representation of which tree species have successfully survived in a forest over time.

Midstory

Trees and shrubs found in this layer are important for creating structure for wildlife habitat and make up the next generation of trees for the canopy. We found that 80% of trees in the midstory were native.

Understory

While this layer held the greatest floristic diversity (561 species, or 73% of all species recorded in the study), the understory also had the lowest proportion of native species of all layers, with vines found to be the most frequently occurring type. Notably, 57% of NYC's forest plots had invasive vines in canopy trees, suggesting that the management of vines as well as invasive tree species may be critical for maintaining native-dominated urban forests.

Forest Floor

Organic matter including leaf litter and fallen trees and branches is an important component for nutrient cycling and habitat. Coarse woody debris was found in 38% of our plots, with the majority being recently fallen.

Soil

We found soils to be highly variable, with soil pH ranging from 2.54 to 6.77 and texture ranging from 0% to 100% sand, both factors that could limit or enourage specific forest types and species presence. These patterns can help us better manage and understand our forest. In addition, 19% of our plots fell within soil classified as anthropogenic, something unique to the urban context.

Deer Browse

High deer populations can cause significant damage to forest plants by eating vegetation or rubbing on saplings. In our assessment we found evidence of damage to vegetation by deer in 46% of our forest plots, with extreme prevalence in the borough of Staten Island, where 89% of plots showed evidence of deer browse.

Human Impacts

Forests in the urban environment are exposed to greater human activity compared to more rural forests. We found that 80% of our plots had some evidence of human modification: 67% had human-generated trash, 27% were bisected by a path, and 9% contained park infrastructure such as a fence, bench, or hydrant.

Natural areas trail work in Forest Park, Queens

Trails

There are over 300 miles of trails within NYC's natural areas. The networks are often confusing and mostly unmarked. NYC Parks and the NAC have been working together since 2016 to formalize trails and improve their condition across the entire city. This work includes establishing well-marked networks in each park to improve public access and safety, strengthening community engagement, and improving forest health. Unwanted and redundant social trails ("desire lines") are closed using restoration techniques such as decompaction and planting. After formal networks are established, the public can access hiking maps for natural areas, and NYC Parks and the NAC recruit volunteers to work on trail improvement projects along the official paths. This work ultimately decreases forest fragmentation while also creating a better user experience in natural areas across NYC. Trail formalization and improvement are especially successful when coupled with larger forest restoration efforts.

Before

After

Before and after maps of the 130-acre maritime forest in Marine Park, Brooklyn. Trail closures and plantings are in progress and will create the final trail system.

Citywide Social Assessment of NYC's Parks and Natural Areas

Despite the importance of urban natural areas to the health and well-being of New Yorkers, we have little systematic evidence about how park visitors perceive, use, and value parks. A better understanding of this can provide insight into how parks can best serve visitors in a rapidly changing environment.

The US Forest Service, the NAC, and NYC Parks conducted a citywide social assessment of NYC's parks and natural areas to explore the social meaning of approximately 9,000 acres of NYC parkland, including almost 5,000 acres of natural areas.

In this study, the primary research question was the following: What are the uses, functions, and values of parkland and natural areas as conveyed through people's park behaviors, descriptions, and narratives? In addition, researchers explored the differences in park use and social meaning according to site type and the gender of respondents. Drawing upon previous research, three data collection approaches were triangulated: direct observations of human activities, observations of material signs of human use, and 1,600 interviews with park users. The intent of this study was to capture why, how, when, and where urban residents engage with the outdoors in NYC.

Conducting the social assessment in Marine Park, Brooklyn

Findings

- Urban parkland is a crucial form of "nearby nature" that provides space for recreation, activities, socialization, and environmental engagement and helps people feel connected to place and to each other. These interactions produce vital cultural ecosystem services that may help to strengthen social resilience.

- Urban parks support psychological, social, and spiritual well-being for a wide range of people who are seeking to connect with nature and a larger reality, as well as with the self and with others.

- New Yorkers describe both landscaped and natural park areas as a space for relaxation. However, natural areas offer visitors a sense of refuge and attachment to place and space for walking and nature recreation activities, while landscaped park areas provide space for sports activities, socializing, and structured children's play.

- 59% of park users interviewed in 2014 reported going into urban natural areas. Many of those who did not visit described a personal preference for recreating in other park areas, and others revealed a potential willingness to visit in the future. Those who did not visit natural areas cited concerns about safety, accessibility, or suitability for children.

- Women are more likely to bring children to parks than men are and are more likely to seek out parks for specific amenities. In addition, women are less likely than men to visit natural areas, citing concerns about safety in forests and wetland areas.

- People who participate in environmental stewardship groups are more likely to visit natural areas, suggesting that enhancement of stewardship programs may be a way to create a more inclusive experience for all New Yorkers in natural areas citywide.

Trail blazing in Bayswater Park, Far Rockaway, Queens

Forest management in Bronx Park, the Bronx
Photograph: Adam Stoltman

Developing a Citywide Model

Since the formation of the Natural Resource Group in 1984, NYC Parks has managed its natural areas park by park. In contrast, the Forest Management Framework uses information about the range of biological conditions across forested natural areas to prioritize activities, plan for the future, and evaluate the success of restoration across the five boroughs. It also provides the opportunity to understand the condition of an individual area within a single park relative to all forests within that park, forest type, or city.

To understand and communicate the conditions of forests citywide, the forest assessment created two indices: one to represent ecological health and the other for ecological threat. These indices enable representations of health and threat status at the assessment plot level that can be compared among plots citywide.

This framework captures the full range and extent of conditions that exist within NYC's forested natural areas. It allows land managers to anticipate and match the appropriate effort and resources required to improve forests across a broad range of current conditions, as well as to prioritize sites across all of NYC's natural areas.

A forest assessment plot that is high on the health axis and low on the threat axis is in good condition and requires little management intervention. If a plot has a high health score but also a high threat score, this plot is at risk of decline in function and composition; management will be critical to protect its healthy attributes. A plot that is low on the health axis but high on the threat axis represents the most degraded forests. These forests require intensive management intervention to shift their trajectory toward sustained health. The costs for management are lowest in the healthiest and less threatened forests and highest in the least healthy and most threatened forests.

FIGURE 9

NYC's Forest Condition Index

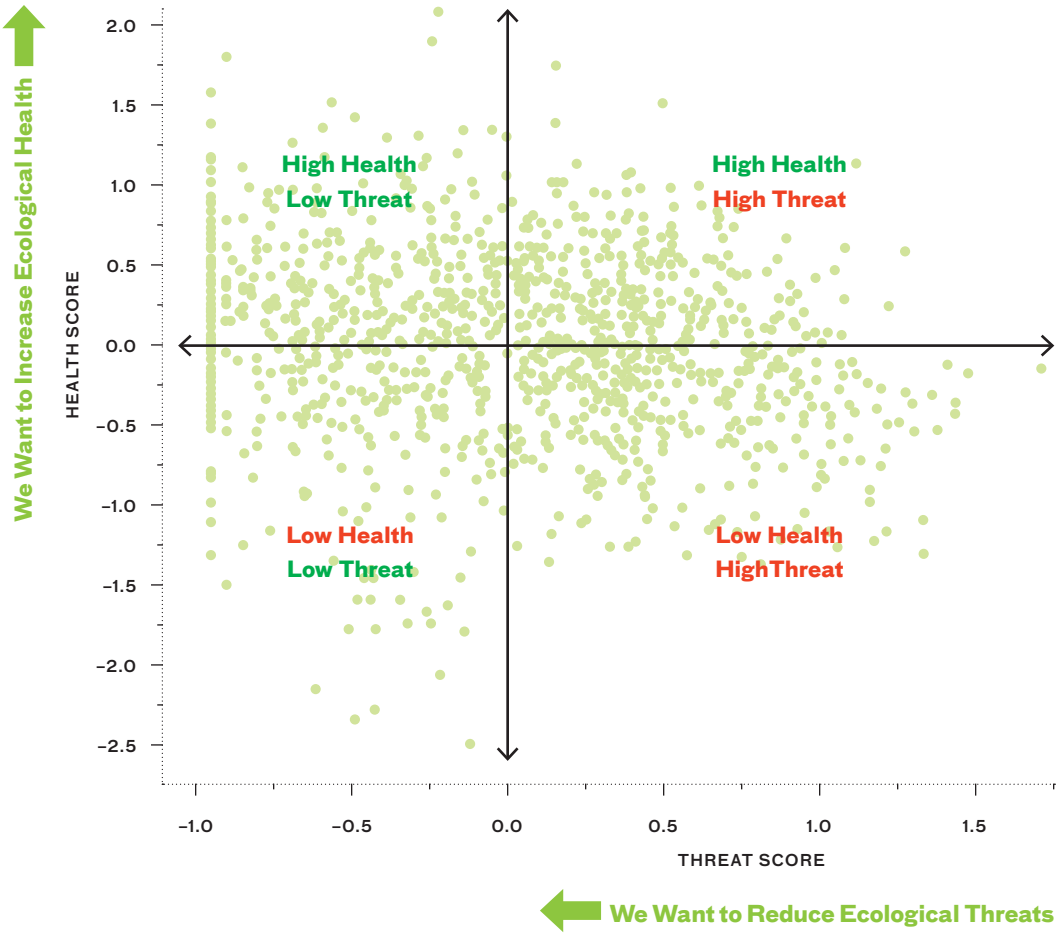
Using field data collected across all of NYC's forests, an ecological index was created to represent overall forest health and overall forest threat. Indices for ecological heath primarily represent desired vegetation conditions and are specific to different forest types. Threat indicators are relatively uniform across all forest types and only one index was created. All data was standardized to develop the index.

Ecological Health Index	
Mature Hardwood Forest	Native Forest Canopy + Native Midstory + Native Tree Seedlings + Native Herbaceous Cover + Native Species Richness
Successional Hardwood Forest	Native Forest Canopy + Native Midstory + Native Tree Seedlings + Native Herbaceous Cover + Native Shrubs + Native Species Richness
Maritime Coastal Forest	Native Midstory + Native Tree Seedlings + Herbaceous Cover + Native Species Richness
Swamp and Floodplain Forest	Native Forest Canopy + Native Midstory + Native Tree Seedlings + Native Herbaceous Cover + Native Shrubs + Native Species Richness
Ecological Threat Index	
All Forest Types	Invasive Forest Canopy + Invasive Midstory + Invasive Vines on Trees + Invasive Tree Seedlings + Invasive Herbaceous Cover

FIGURE 10

Forest Condition Matrix

Each point on this figure represents the standardized condition score of an ecological assessment plot (total 1,156 plots) in one of 53 parks.



High Health / Low Threat
Forests in this category are the highest quality. Less management intervention is needed, but monitoring is required to ensure that quality remains high and these forests are protected.

High Health / High Threat
These forests are in transition. While they have many threats, they also contain many of the metrics we look for in high-quality forests. Management is required to protect and shift the trajectory of these stands.

Low Health / Low Threat
Forests in this category have minimal threats, but desired structure and composition metrics are not met. Management can be used to accelerate the transition into high health, but monitoring over time with little intervention could result in improved health.

Low Health / High Threat
Forests in this category are the most degraded in NYC and require the most management. Management actions could range from invasive species removal, tree planting, and afforestation and may take several years.

NAC field ecologists collecting forest data in the Staten Island Greenbelt

Implementing the Management Framework

The Forest Management Framework offers a systems approach to forest management. Ecological assessment of all forested natural areas has allowed the NAC to sort forest acreage according to health and threat (see Figure 10). The framework focuses on reducing threats, most notably removing invasive species that are the general underlying cause of poor forest health. It is easier to control threats than to directly improve baseline forest health. For example, we know how to remove invasive species, clear dumped material, and protect against browsing deer, but less straightforward actions are needed to increase leaf-litter depth or the basal area of native canopy trees. Other interventions do impact forest health directly, most notably the planting of native trees, which can increase the overall proportion of native seedlings.

The intensity of forest management strategies varies in relation to site condition as described by the ecological assessment; the most degraded sites require the most intensive form of work, usually "forest restoration," while sites that require less intensive work but need hands-on attention fall into the category of "forest management" (see Figure 11). We use our knowledge about condition to tailor the management approach to specific conditions. Below, we describe the primary strategies.

Forest Restoration (Contractor)

This strategy can include site clearing, invasive plant removal, soil decompaction, soil and compost amendment, and other activities. Contractors can use heavy machinery and work in difficult-to-access areas that are steep, wetland-adjacent, or otherwise impenetrable. Historically, NYC Parks has applied this tactic to the most difficult-to-manage areas, such as vinelands or former landfill sites that have few intact functional elements that might be damaged in the process of their work.

Forest Restoration (In-House)

This strategy involves the assignment of in-house field crews to difficult restoration projects that are generally smaller in size than those assigned to contractors and are unlikely to require the use of heavy machinery or specialized techniques. The primary work here includes significant invasive plant removal and revegetating the site by planting native species. In-house crews are a great resource when working in or around areas of mixed native and invasive species.

Forest Management (In-House)

These sites have a lower proportion of invasive plant cover than restoration sites and do not require full replacement of the vegetation community by planting. This strategy is applied in areas that were previously restored. The primary activity in management sites is invasive species removal, with a focus on protecting existing native plants. This work can be performed by skilled professionals but also by volunteer participants with appropriate supervision.

Forest Management (Volunteer)

Forest management sites that are easily accessible and do not require detailed training are appropriate for volunteers. A high staff-to-volunteer ratio during engagement events and outreach makes volunteer participation more expensive than other practices. However, volunteer opportunities are an investment in the future of NYC's communities: volunteering gives New Yorkers valuable interactive experiences, improves long-term stewardship, and increases the constituency for the management of these spaces.

Forest Monitoring and Maintenance (In-House and Volunteer)

Before and after conducting restoration and management, staff will use the Rapid Site Assessment Checklist (Appendix E) to conduct monitoring to document conditions. After management work is complete, maintenance entails periodic "sweeps" of large tracts of forest that are in generally good condition to check for invasive species in the understory. Regular monitoring and maintenance are critical to safeguarding the health of the highest-quality forests. For example, if a storm or other type of large disturbance were to impact an area, regular visits would identify threats so the area's condition could be recategorized and a more intensive management strategy applied.

Planting (In-House, Contractor, and Volunteer)

This strategy can be combined with any of the above. Just as management is customized to forest condition, so is planting. Most intensive planting is for only those acres where native regeneration is failing.

Staffing Vision

Comprehensive forest management requires sufficient staffing of qualified professionals. The framework's vision for a team of forest management professionals includes field crews, contract managers, monitoring experts, and experts in volunteer engagement (see Figure 12).

Management Over Time

Forests are dynamic, and the framework reflects the need to adapt management strategies over time. The reduction of threats will eventually call for less intensive management strategies, reducing investment levels while resulting in an improvement in forest health that can be tracked through time.

Volunteers plant trees at Marine Park, Brooklyn

Who Takes Care of Urban Landscapes?

The Stewardship Mapping and Assessment Project (STEW-MAP) aims to answer this question.

STEW-MAP surveys civic groups of two or more people who work to conserve, manage, monitor, transform, educate on, or advocate for the local environment. The STEW-MAP survey collects data across three categories: organizational characteristics (including year founded, mission, and budget); stewardship turf, or the area where each group works; and social networks, the other groups that serve as partners, members, and collaborators.

STEW-MAP databases and interactive maps enable the public, municipal agencies, and nonprofits to visualize where and how hundreds of civic environmental stewardship groups are working throughout a city or region. This tool highlights existing stewardship gaps and overlaps in order to strengthen organizational capacities, promote broader civic engagement with on-the-ground environmental projects, and build effective partnerships among stakeholders involved in urban sustainability and resilience. The map and database have facilitated collaborations, helped to connect previously siloed groups, and enabled groups to get recognition, resources, and power. STEW-MAP is critical to identifying and nurturing groups as they help care for these essential resources.

To learn more about STEW-MAP in NYC, visit www.nrs.fs.fed.us/stewmap.

FIGURE 11

Forest Condition Drives Management Strategy

The assessed condition of the forest determines the management strategy, resources needed, and costs estimated.

Forest Restoration **Forest Management** **Forest Monitoring and Maintenance**

		High Threat	Medium Threat	Low Threat	Very Low Threat
Acreage	**Total Acres in Category**	**519**	**2,527**	**3,090**	**1,184**

Ecological Conditions	**Percent Invasive Herbaceous Cover**	≥ 70%	40–70%	10–40%	≤ 10%
	Invasive Vines on Trees* *Where there are >350 trees/hectare	> 50%	20–50%	1–20%	0
	Invasive Canopy Basal Area (m^2/ha)	> 10	4–10	.1–4	0
	Invasive Midstory (stem count/hectare)	> 500	100–500	1–100	0

To qualify for Forest Monitoring & Maintenance and be in the Very Low Threat status forests must also have a minimum of 5,000 native tree seedlings/hectare, 100 native midstory stems/hectare, and 6 native herbaceous species present.

	Work Type	Forest Restoration (Contractor)	Forest Restoration (In-House)	Forest Management	Forest Monitoring & Maintenance
Work Type and Cost	**Average Cost per Acre**	$42,076	$6,078	$2,074 (in-house) $28,500 (volunteer)	$1,037

FIGURE 12

Staffing Vision

Comprehensive forest management requires sufficient staffing of qualified professionals. The framework's vision for a team of forest management professionals includes NYC Parks publicly funded staff and NAC privately funded staff. Current positions as of April 2018. Proposed positions are the projected total needed to implement this plan.

Crew / Team	Type of Work	Current Positions	Proposed Positions
Natural Resource Management In-House (NYC Parks)	Director of Natural Resources	1	1
	Gardener I	10	40
	Gardener II (Supervising Gardener)	5	10
	Field Crew Manager	2	5
Contractor Restoration Supervision (NYC Parks)	Forester II	3	3
	Senior Forester	1	1
Public Access Formalization (NYC Parks)	Community Associate (Crew Member)	0	4
	Trail Crew Leader	1	1
Volunteer Engagement (NYC Parks)	Community Associate (Volunteer Coordinator)	3	3
	Stewardship Crew Manager	4	4
Assessment and Monitoring (NYC Parks)	Assessment Field Staff	1	4
	Ecologist (Assessment Crew Manager)	0	1
	Data and Analytics Manager	1	1
Natural Areas Conservancy	Executive Director	1	1
	Senior Ecologist	1	1
	GIS Analyst	1	1
	Project Manager	1	1
	Trail Program Manager	1	1
	Total	**36**	**82**

Conservancy engagement tour of Brooklyn Bridge Park, Brooklyn

Aligning Forest Management Across NYC—Conservancy Engagement Program

As a component strategy of the Forest Management Framework, the NAC is sponsoring a citywide Conservancy Engagement Program in 2018 and 2019. This free program will be available through a competitive application process to four nonprofit organizations who conduct forest management in NYC Parks' natural areas.

NAC ecologists will communicate the process, steps, recommendations, best practices, and goals for forest management developed by the framework directly to these organizations. The chosen conservancies will receive scientific support, training, data tools, resources, and management recommendations from the NAC during an intensive three-month period. The iterative process of presentations, discussions, and trainings will culminate in specific management plans for each conservancy.

This important part of the framework will begin to create alignment of conservation efforts across the city and allow practitioners to track their management and stewardship activities over time. Working within the framework will also allow easy access to information on natural areas to plan forest restoration within existing conservancy programs and to engender future program support.

Climate-Adapted Planting Palettes

Due to the heat-island effect in large cities, urban forests are experiencing the extremes of regional climate trends before surrounding rural areas. Climate change forecasts indicate that future weather conditions in NYC could be less suitable for some of its native tree species. At the same time, other native tree species that are more tolerant of heat and drought are predicted to thrive.

In order to ensure the health and resilience of our native forests, the NAC and NYC Parks have created climate-adapted planting palettes (lists) for forest restoration sites. These palettes are based on the kind of forest community the plantings will occur in and predicted resilience of individual tree species to future climate conditions. The quantities of less climate-adapted species will be reduced in future plantings while the more resilient tree species will be maximized. Strategies will also incorporate using local ecotypes and planting more genetically diverse populations to promote adaptation.

The tools created for this project can help guide practitioners of forest restoration through future plantings: from identifying the type of forest community the project is taking place in, to selecting tree species for planting that are appropriate for the site both now and in the future.

Maritime forest restoration planting using climate-adapted palettes in Marine Park, Brooklyn

Measuring forest carbon in
Van Cortlandt Park, the Bronx

Conclusion

We value what we measure.

Investment in and focus on NYC's forested natural areas has fluctuated over the past three-and-a-half decades. But the time is right to adopt a proactive approach to managing these valuable but historically underresourced areas for the decades to come.

Focused on improving the data and expertise available for conservation, the vision and tools in the NAC's Forest Management Framework create a foundation for a new long-term approach that will keep these wonderful places thriving. The framework celebrates the importance of our forests for expanded and meaningful recreation and enhanced community cohesion while also recognizing them as essential to protecting and restoring biodiversity and buffering the impacts of climate change.

In addition to guiding the work of the NAC and NYC Parks' Natural Resources Group, the framework creates the ability to incorporate natural forests into a broad range of future planning. In 2018, the NAC launched a conservancy engagement program, providing technical support to nonprofits that manage forested parkland.

If we commit to activating the full breadth of the Forest Management Framework today, the next 25 years will bring more effective capital investments, more professional opportunities, more meaningful public engagement, and more sustainable healthy forests.

Mature sweetgum forest in
Wolfe's Pond Park, Staten Island

Appendices

APPENDIX A

Key Ecological Attributes of Healthy Urban Forests

Attributes, Indicators, and Field Measurements Used in NAC Forest Assessment

Attributes	Indicators	Field Measurements (10m radius plot, 4 1m x 1m subplots)
Forest Canopy Dominated by Native Species	Relative basal area (m^2/ha) of native tree species	All trees ≥ 10cm DBH: species and DBH
Canopy Closure >50% to Help Limit Invasive Plant Growth	% canopy closure	Analysis of canopy photos and visual estimate of % canopy closure in fixed-area plot (4 photos/plot)
Healthy Forest Canopy	Proportion of trees with a healthy canopy	Dieback, discoloration of foliage, defoliation, and vigor class estimations of trees >10cm DBH
Complex Vertical Structure	Vegetation lifeforms in the understory, midstory, and overstory	Abundance and size class for woody plants (< 2cm DBH were sampled in 1m x 1m subplots)
Forest Understory Dominated by Native Species	Diversity and relative cover of native herbaceous species	% cover of all herbaceous plants and woody plants < 2cm DBH (1m x 1m subplots)
Soil Quality and Chemistry Suitable for Supporting Native Plants	Healthy range of pH, organic matter, macro- and micronutrients, limited heavy metals	Soil sample collected at each forest plot
Structure in Forest Floor	Leaf litter and downed woody material present on the forest floor	Leaf litter and duff depth measurements; % cover forest floor substrate; volume of fine, medium, and coarse woody material; decay class of coarse woody material
Limited Pest Damage to Plants	Browse on vegetation (deer), missing leaf tissue (insect defoliation)	% herbivory classes for understory plants and trees/shrubs (2–10cm DBH)
Native Tree Regeneration	Tree seedlings present in the understory	Seedling % cover and individual count (1m x 1m subplot)
Limited Encroachment and Anthropogenic Alterations	Dumping piles, desire lines, vandalism, trash	% cover of any infrastructure, evident environmental modification, or trash by category
No Invasive Vines Overtaking the Forest Canopy	Species and stage class invasive vines in the understory, tree trunk, and tree canopy	Vine presence on trees and stage (1, 2, 3)

APPENDIX B

NYC's Forest Management Budget

	Restoration		Planting			Management	
	In-House Restoration Acres	Contractor Restoration Acres	In-House Planting	Contractor Planting	Volunteer Planting	In-House Management	Volunteer Management
Cost/Acre	$6,078	$42,076	$75,543	$162,041	$99,177	$2,075	$28,534
Year	Acres in Worktype						
1	63	89	26	0	9	140	16
2	126	178	26	0	9	140	16
3	126	178	44	22	22	276	31
4	126	178	44	22	22	289	32
5	126	178	44	22	22	291	32
6	126	178	44	22	22	317	35
7	126	178	44	22	22	209	23
8	126	178	44	22	22	185	21
9	126	178	44	22	22	185	21
10	149	155	44	22	22	185	21
11	174	130	44	22	22	185	21
12	179	125	44	22	22	185	21
13	183	121	48	24	24	193	21
14	187	117	48	24	24	194	22
15	191	113	49	24	24	194	22
16	195	109	49	25	25	195	22
17	199	105	50	25	25	196	22
18	204	100	50	25	25	197	22
19	208	96	50	25	25	198	22
20	212	92	51	25	25	199	22
21	217	87	34	17	17	60	7
22	—	83	34	17	17	61	7
23	—	79	9	4	4	15	2
24	—	74	9	5	5	16	2
25	—	71	10	5	5	17	2

*Capital costs increase by 3% per year

*Expense costs increase by 1% per year

Monitoring					
Maintenance	Conservation (Monitoring)		Capital Funding	Expense Funding	Total Funding
$1,037	$35				
		Year	Budget by Funding Type		
0	685	1	$3,744,764	$3,970,545	**$7,715,309**
0	685	2	$3,857,107	$4,010,251	**$7,867,358**
155	685	3	$7,711,847	$7,610,110	**$15,321,957**
155	840	4	$7,943,203	$7,759,896	**$15,703,098**
307	995	5	$8,181,499	$8,016,989	**$16,198,488**
321	1,302	6	$8,426,944	$8,267,600	**$16,694,544**
323	1,623	7	$8,679,752	$7,763,044	**$16,442,797**
352	1,946	8	$8,940,145	$7,753,440	**$16,693,585**
232	2,298	9	$9,208,349	$7,709,565	**$16,917,914**
206	2,530	10	$8,223,006	$7,918,811	**$16,141,817**
206	2,736	11	$8,338,508	$8,021,539	**$16,360,047**
206	2,942	12	$8,468,682	$8,123,768	**$16,592,450**
206	3,148	13	$9,061,226	$8,833,801	**$17,895,027**
206	3,354	14	$9,265,266	$9,021,173	**$18,286,439**
214	3,560	15	$9,473,394	$9,220,945	**$18,694,338**
215	3,774	16	$9,685,670	$9,415,707	**$19,101,377**
216	3,989	17	$9,896,755	$9,614,055	**$19,510,810**
217	4,205	18	$10,044,135	$9,741,444	**$19,785,579**
218	4,422	19	$10,259,701	$9,945,372	**$20,205,073**
219	4,640	20	$10,478,424	$10,152,520	**$20,630,943**
220	4,859	21	$8,139,465	$6,798,098	**$14,937,563**
221	5,079	22	$8,287,590	$6,976,174	**$15,263,765**
67	5,300	23	$4,400,136	$2,602,038	**$7,002,175**
68	5,367	24	$4,428,571	$2,733,787	**$7,162,359**
17	5,435	25	$4,586,471	$2,787,602	**$7,374,073**
		Total	**$199,730,611**	**$184,768,273**	**$384,498,883**

APPENDIX C

NYC's Parks in City Council Districts

Borough	District	Parkland Acreage	Natural Area Acreage	Forested Natural Area Acreage	NYC's Parks with Natural Areas
Manhattan	5	40	3	0	Mill Rock Park
Manhattan	6	1,089	74	68	Central Park, Riverside Park
Manhattan	7	192	13	12	Fort Washington Park, Riverside Park
Manhattan	10	610	220	156	Fort Tryon Park, Fort Washington Park, Harlem River Park, Inwood Hill Park, Sherman Creek
Bronx	11	1,509	695	562	Bronx Park, Raoul Wallenberg Forest, Riverdale Park, Seton Park, Spuyten Duyvil Shorefront Park, Van Cortlandt Park
Bronx	12	137	74	43	Givans Creek Woods, Pelham Bay Park, Seton Falls Park
Bronx	13	3,353	1,505	668	City Island Wetlands, Pelham Bay Park
Bronx	17	272	26	14	North Brother Island, South Brother Island
Bronx	18	434	134	17	Castle Hill Park, Harding Park Beautification Project, Pugsley Creek Park, Soundview Park
Queens	19	1,060	332	56	Alley Pond Park, Flushing Meadows Corona Park, Powell's Cove Park, Udall's Park Preserve
Queens	20	410	124	38	Flushing Meadows Corona Park, Kissena Corridor Park, Kissena Park
Queens	23	1,166	626	532	Alley Pond Park, Cunningham Park, Kissena Corridor Park
Queens	24	472	106	7	Flushing Meadows Corona Park
Queens	30	705	328	300	Forest Park, Highland Park
Queens	31	1,563	501	36	Brant Point Wildlife Sanctuary, Brookville Park, Dubos Point Wildlife Sanctuary, Hook Creek Park, Idlewild Park, Jamaica Bay Park, Rockaway Beach and Boardwalk, Seagirt Ave. Wetlands, Vernam Barbadoes Peninsula
Queens	32	869	62	7	Broad Channel American Park, Spring Creek Park, Spring Creek Park Addition, Sunset Cove Park
Brooklyn	39	528	110	75	Prospect Park
Brooklyn	42	265	92	6	Fresh Creek Nature Preserve, Spring Creek Park
Brooklyn	43	558	40	0	Calvert Vaux Park
Brooklyn	46	1,460	788	87	Canarsie Park, Four Sparrow Marsh, Fresh Creek Nature Preserve, Marine Park, McGuire Fields, Paerdegat Basin Park
Staten Island	49	847	175	105	Clove Lakes Park, Eibs Pond Park, Graniteville Swamp Park, Shooters Island
Staten Island	50	3,537	2,000	1,208	Blood Root Valley, Bradys Pond Park, Deere Park, Freshkills Park, Great Kills Park, Greenbelt Native Plant Center, High Rock Park, Last Chance Pond Park, LaTourette Park, Meredith Woods, Ocean Breeze Park, Pralls Island, Reed's Basket Willow Swamp Park, Richmond Parkway, Saw Mill Creek Marsh, Staten Island Industrial Park, Willowbrook Park
Staten Island	51	2,832	1,824	1,235	Arden Woods, Bloomingdale Park, Blue Heron Park, Bunker Ponds Park, Conference House Park, Crescent Beach Park, Fairview Park, Freshkills Park, Great Kills Park, Hybrid Oak Woods Park, Isle of Meadows, Kingfisher Park, LaTourette Park, Lemon Creek Park, Long Pond Park, Richmond Parkway, Siedenburg Park, Wolfe's Pond Park

APPENDIX D

City Council Districts for NYC's Forested Parks

Park Name	City Council Districts
Alley Pond Park	19, 23
Arden Woods	51
Blood Root Valley	50
Bloomingdale Park	51
Blue Heron Park	51
Brady's Pond Park	50
Brant Point Wildlife Sanctuary	31
Broad Channel American Park	32
Bronx Park	11, 15
Brookville Park	31
Bunker Ponds Park	51
Calvert Vaux Park	43, 47
Canarsie Park	42, 46
Central Park	6
City Island Wetlands	13
Clove Lakes Park	49
Conference House Park	51
Crescent Beach Park	51
Cunningham Park	23
Deere Park	50
Douglaston Park Golf Course	23
Dubos Point Wildlife Sanctuary	31
Eibs Pond Park	49
Fairview Park	51
Flushing Meadows Corona Park	19, 20, 21, 24
Forest Park	29, 30
Fort Tryon Park	10
Fort Washington Park	7, 10
Four Sparrow Marsh	46
Fresh Creek Nature Preserve	42, 46
Freshkills Park	50, 51
Givans Creek Woods	12
Grand Central Parkway	23, 24
Graniteville Swamp Park	49
Great Kills Park	50, 51
High Rock Park	50
Highland Park	30
Hook Creek Park	31
Hybrid Oak Woods Park	51
Idlewild Park	31
Inwood Hill Park	10
Isle of Meadows	51
Jamaica Bay Park	31
Kingfisher Park	51
Kissena Corridor Park	20, 23
Kissena Park	20
Last Chance Pond Park	50
LaTourette Park & Golf Course	50, 51
Lemon Creek Park	51
Long Pond Park	51

Park Name	City Council Districts
Marine Park	46
Meredith Woods	50
Mill Rock Park	5
North Brother Island	17
Ocean Breeze Park	50
Paerdegat Basin Park	46
Pelham Bay Park	12, 13
Powell's Cove Park	19
Pralls Island	50
Prospect Park	39
Pugsley Creek Park	18
Raoul Wallenberg Forest	11
Reed's Basket Willow Swamp Park	50
Richmond Parkway	50, 51
Riverdale Park	6, 7, 11
Rockaway Beach and Boardwalk	31, 32
Saw Mill Creek Marsh	50
Seagirt Ave. Wetlands	31
Seton Falls Park	12
Sherman Creek	10
Shooters Island	49
Siedenburg Park	51
Soundview Park	18
South Brother Island	17
Spring Creek Park Addition	32, 42
Spuyten Duyvil Shorefront Park	11
Staten Island Industrial Park	50
Udall's Park Preserve	19
Van Cortlandt Park	11
Vernam Barbadoes Peninsula	31
Willowbrook Park	50
Wolfe's Pond Park	51

APPENDIX E

Rapid Site Assessment Checklist

This checklist is used for forest monitoring to align management within the Forest Management Framework by measuring pre- and post-management conditions and evaluating success. Analysis of the checklist data feeds into the health and threat indices for NYC forests.

Site ID: _____ **Park Name:** _____ **Date:** _____

Staff Initials: _____ **Start Time:** _____ **End Time:** _____

Site Impacts	<5%	5–25%	26–50%	51–75%	76–100%
Dumping/Trash					
Coarse Woody Debris					

Deer Evidence (scat, trails, rubs, herbivory) ☐ High ☐ Low

Wetland Features ☐ Yes ☐ No **If Yes, what kind of feature?** _____

Impervious Surface ☐ Yes ☐ No **If Yes:** _____**%**

Social Use (party, hang-out vandalism, trails, desire lines) ☐ Yes ☐ No

ATV, Motorized or Nonmotorized Biking ☐ Yes ☐ No

Comments/Suggested Work & General Site Notes:

Site: List all species and estimate coverage for each species in the entire site (check one box).

Species Name (Scientific Name)	<1%	1–10%	11–25%	26–50%	51–75%	76–100%

Notes:

Observation Points: All Woody Species

Observation Point #	Species Name (Scientific Name)	< 2cm (Seedling) Tally	MIDSTORY 2–9cm DBH	Invasive Vines Present on MIDSTORY (Tally)	OVERSTORY 10–30cm DBH	31–50cm DBH	51–75cm DBH	>75cm DBH	Invasive Vines Present on OVERSTORY (Tally)

Trail in Marine Park, Brooklyn, running through one of two remaining maritime forests in NYC

Notes

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Successional sweetgum forest
in Alley Pond Park, Queens

Tulip-tree seedlings propagated
at the Greenbelt Native Plant Center,
Staten Island