MILLIONTREESNYC, GREEN INFRASTRUCTURE, AND URBAN ECOLOGY: BUILDING A RESEARCH AGENDA

Report from the Workshop

MillionTreesNYC Advisory Board Research & Evaluation Subcommittee

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milliontrees NYC
A PLANYC INITIATIVE WITH NYC PARKS AND NEW YORK RESTORATION PROJECT

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Michael R. Bloomberg, Mayor
Adrian Benepe, Commissioner

NYRP

PlaNYC

Northern Research Station
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EXECUTIVE SUMMARY

MillionTreesNYC is a citywide, public-private initiative with an ambitious goal: to plant and care for one million new trees across New York City's five boroughs by 2017. The Spring 2009 workshop *MillionTreesNYC, Green Infrastructure, and Urban Ecology: Building a Research Agenda* brought together more than 100 researchers, practitioners and New York City policymakers to collaboratively develop a research agenda to support the management, practice, and rationale for MillionTreesNYC and to contribute to the accumulating knowledge on the sociology and ecology of urban landscapes and green infrastructure. The workshop was organized by the Research & Evaluation Subcommittee of the MillionTreesNYC Advisory Board. Agendas, participants and other materials are included in the Appendices.

Workshop activities included (1) prepared presentations by NYC officials, USDA Forest Service scientists, and university researchers, (2) site visits to a variety of MillionTreesNYC planting sites and (3) a two-day workshop consisting of dialogue within and among discussion groups. The discussion groups were categorized into eleven topic areas:

- **Ecosystem Services: Local Air Quality and Urban Heat Island**
- **Ecosystem Services: Water Quality, Storm Water Management**
- **Economic Impacts: Quantifying Returns on Investment**
- **Education**
- **Human Health and Well-Being**
- **Stewardship and Management**
- **Green Jobs and Social Justice**
- **Reforestation Dynamics and Forest Health**
- **Biodiversity and Ecological Communities**
- **Green Infrastructure**
- **Implications of Scale**

These eleven topics span an enormous range of intellectual and natural resources management activity and show how broadly the MillionTreesNYC campaign touches the population, economy, institutions and built environment of New York City.

Overarching conclusions of the workshop were (1) that there is much enthusiasm among both researchers and practitioners for research that integrates science and management, and (2) there are many important fundamental and applied research questions that need to be addressed. Each of the topic groups created a list of specific research areas and questions to be investigated and identified a variety of impediments to such research. Four classes of impediments cut across topic areas: (1) the need for better and more regular communication between researchers and practitioners, (2) little coordination of access to existing and current datasets and research sites, (3) insufficient integration between research results, management actions, and policy decisions and (4) a shortage of available funding. The discussion groups also recommended a variety of solutions to these impediments, including researcher-practitioner working groups and the creation of liaisons within city agencies that would facilitate access to collaborators, research sites and datasets, and research funding.

The workshop is intended to be the first step in a broader process of integration between researchers and practitioners working to understand and improve New York's environment and green infrastructure. A symposium of invited papers, contributed papers, and continued dialogue is planned for Spring 2010. More information about this symposium can be found at http://www.milliontreesnyc.org/research.

ACKNOWLEDGMENTS

The workshop was a product of the MillionTreesNYC Advisory Board Research & Evaluation Subcommittee.

Many people and organizations contributed to making this conference successful. The principal organizing committee included Lindsay Campbell, Cristiana Fragola, Jacqueline W. T. Lu, Marianne Krasny, Gina Lovasi, David Maddox, Simon McDonnell, P. Timon McPhearson, Andrew Newman, Ruth A. Rae, Megan Shane, Erika Svendsen, Nina Bassuk, and Keith G. Tidball.

Sponsoring organizations included New York City Department of Parks & Recreation, New York Restoration Project, US Forest Service Northern Research Station, Cornell University Center for a Sustainable Future, Tishman Environment and Design Center at The New School, the Furman Center at New York University and Sound Science LLC.

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NEW YORK CITY'S NATURAL RESOURCES

1,651 ACRES OF FRESHWATER WETLAND

INTRODUCTION

Why do we manage the landscapes around us? Ultimately, we have an idea or need for how we want them to function and what we want them to look like, or not look like. We are interested in managing our landscapes in more intelligent, efficient and effective ways that achieve specific goals. This is the essence of what is called "adaptive management" – the collection and application of new knowledge about the effectiveness of management actions. That is, we wish to accumulate knowledge that can be used to improve the understanding and practice of natural resource management. Such landscape management techniques are especially relevant to urban areas, where undeveloped land is a scarce commodity and natural environments are typically shared public spaces.

1,498 ACRES OF SALT MARSH

The accumulation and flow of useful natural resource management knowledge is the core idea of the workshop *MillionTreesNYC, Green Infrastructure, and Urban Ecology: Building a Research Agenda*, held in New York from April 29 to May 1, 2009. The workshop focused on fostering the creation of knowledge relating to the constellation of management actions and economic, sociological and ecological processes that are affected by MillionTreesNYC.

MillionTreesNYC, a citywide effort to plant one million trees over ten years, is an enormous endeavor, with significant and broad ecological and social benefits. Increased knowledge derived from both basic and applied research is essential, and strengthening core research involving MillionTreesNYC has a variety of potential values. These include:

1. **Better practice and application of land management techniques (e.g., planting designs, tree survivorship, etc.);**
2. **Improved quality of life for New Yorkers (including improved human health);**
3. **Strengthened rationale for the policy decisions made in support of land management actions, including specific knowledge regarding the benefits of green infrastructure; and**
4. **Greater understanding in the broader arena of urban ecological and social research, much of which could be applied to the problems of other cities.**

It is for these purposes the research and practitioner communities from New York City and beyond were brought together: to create an integrated research agenda that supports the implementation of MillionTreesNYC, highlights the resulting benefits to New York's citizens, and contributes to the larger body of knowledge on urban ecology and green infrastructure.

HISTORY, PURPOSE AND DESIGN OF MILLIONTREESNYC

MillionTreesNYC is a citywide, public-private initiative with an ambitious goal: to plant and care for one million new trees across the city's five boroughs by 2017. Entire neighborhoods throughout New York City are being transformed into beautiful greenscapes. Every planted tree is registered online. The New York City Department of Parks & Recreation (Parks) is planting 600,000 trees on streets, parks and other public spaces. New York Restoration Project (NYRP) is planting approximately 100,000 trees on public housing campuses, schoolyards, playgrounds, cultural institutions and other properties that are accessible to the public. NYRP also seeks to galvanize non-profit and community organizations, homeowners, landowners and developers to plant the remaining 300,000 on private properties throughout the city.

Launched on October 9, 2007 by Mayor Michael Bloomberg, MillionTreesNYC has so far planted over 280,000 trees throughout New York City, exceeding planting projections by 20%. An Advisory Board composed of members from over 70 organizations was formed alongside the launch of MillionTreesNYC to provide oversight and strategic leadership in several areas: research, tree planting, education, public policy, and stewardship. The Workshop *MillionTreesNYC, Green Infrastructure, and Urban Ecology: Building a Research Agenda* grew out of the Research & Evaluation subcommittee. It was a response to the interest of researchers in collaborating with MillionTreesNYC to study the effects of this large initiative and other greening strategies on urban ecology. At the same time, due to the citywide scale and magnitude of the MillionTreesNYC plantings, the program offers a great opportunity for establishing baseline data for short and longer-term research.

This workshop was one of a series of events celebrating April as "MillionTreesNYC Month", which culminated in a spring planting event where tens of thousands of trees were planted by volunteers at sites across the five boroughs. The spring 2009 planting season engaged almost 1,800 volunteers contributing in excess of 6,000 hours of service to plant over 20,000 trees. MillionTreesNYC Month 2009 also launched the MillionTreesNYC Stewardship Corps program, developed to engage New Yorkers in the care and maintenance of all newly planted trees. The MillionTreesNYC Initiative has received funding from the Rockefeller Foundation, Bloomberg Philanthropies, the Home Depot Foundation, Toyota, BNP Paribas, the rock band The Police, and numerous other donors.

Focusing on communities with low tree canopy cover and high rates of respiratory illness has been a priority for MillionTreesNYC from the start. Tree planting was prioritized in six "Trees for Public Health" neighborhoods across the city. In spring 2009, two of these communities became fully stocked with street trees after two years of targeted planting: Far Rockaway in Queens and Stapleton in Staten Island.

The emergence of MillionTreesNYC as a research opportunity coincides with the completion of the Urban Field Station, a new laboratory and short-term residential facility shared by Parks and the Forest Service and located in Bayside, Queens. The Urban Field Station is the outcome of a Memorandum of Understanding signed in 2006 between NYC Parks and the USFS Northern Research Station (NRS) to establish a long-term research partnership to deepen our understanding of urban ecology and strengthen urban natural resource management. The Urban Field Station is one of the institutions through which the work of the MillionTreesNYC Research & Evaluation Committee and the research efforts initiated through this workshop will be supported and continued.

A city park worker waters a newly planted tree.

PLANYC

MillionTreesNYC is just one aspect of the implementation of PlaNYC 2030, a comprehensive plan of 127 initiatives designed to support the long-term sustainability of New York City. PlaNYC began as an attempt to develop a strategy for managing the city's growing needs within a limited amount of land as the city's population was projected to increase by another million people by 2030. The challenge was to develop a coherent, holistic plan that addressed systemic problems stemming from environmental stress and an aging and deteriorating infrastructure, while at the same time preparing to meet the challenge of global climate change. Focusing on the five key dimensions of the city's environment — land, air, water, energy and transportation — PlaNYC is the most sweeping plan to strengthen New York's urban environment in the city's modern history.

Parks is responsible for implementing several other PlaNYC initiatives in addition to MillionTreesNYC. Each of these initiatives is designed to enhance or create more open spaces, ensuring that all New Yorkers live within a 10-minute walk of a park. These initiatives include efforts to transform schoolyards to open community playgrounds, replace asphalt fields with turf, develop lighting for existing recreational fields and create several new regional parks throughout the city. To date, the following has been accomplished: over 95 schoolyards have been renovated or opened as community playgrounds with the help of Parks and Department of Education staff, students, and surrounding communities; 20 asphalt fields have been designed; and 7 regional parks are either in design or on their way to being completed. Despite the addition of more than 300 acres of new parkland in the last five years, New York City has less open space per person than almost any other major city in America. With the vision and resources provided by PlaNYC, the Department of Parks & Recreation has launched the most ambitious parks program in half a century, creating new open spaces, and expanding and restoring the city's urban forest and natural resources.

600 COMMUNITY GARDENS

2,383 GREENSTREETS

NEW YORK CITY'S URBAN FOREST

New York City, the country's largest metropolitan area, is a highly complex ecosystem. Because of its sheer size and diversity, New York City has an internal complexity that merits study at citywide and neighborhood scales. The city has a wide variety of environments and natural habitats, including over 5.2 million trees, and 29,000 acres of city parkland, 11,000 acres of which are still natural, ranging from beaches and rocky shorelines to freshwater wetland, salt marshes, meadows and forests.

The urban forest is the system of trees and plants that grow individually, in groups or under forest conditions on public and private lands across the municipal landscape. This includes all the trees that grow along streets and parkways, in front and backyards, in community gardens, in large and small parks, in forests and natural areas, in empty lots, industrial lands, and other property types. The urban tree canopy is the layer of leaves, branches and stems of trees that cover the ground when viewed from above.

In New York City, tree canopy covers 24% of the entire land area[1]. This is higher than Chicago (11%) and Philadelphia (15.7%), approximately the same as Boston, but below Seattle (25%), Austin (34%), and Atlanta (36.7%). The national average for urban canopy cover is 27.1%[2]. Additionally, from 1984 to 2002, New York City lost 9,000 acres of vegetative cover[3]. MillionTreesNYC is therefore a fundamental part of the strategy to reverse the loss in NYC's urban canopy cover.

1. Calculated by Parks GIS staff using 3-foot resolution Emerge color infrared images collected in September, 2001. Cover dataset developed by the USDA Forest Service, Northeastern Research Station. Statistical field sampling in New York City in 1997 by the USDA Forest Service found a citywide tree canopy cover of 20.9 % with an error of ± 2%.

2. Nowak, D, Civerolo, KL, Trivikrama Rao, S, Sistla, G, Luley, CJ, Crane, DE. 2000. A modeling study of the impact of urban trees on ozone. Atmospheric Environment 34:1601–1603.

3. Lu, J.W.T., 2004. Vegetation cover change in New York City, 1984–2002. New York City Department of Parks & Recreation.

5,136 ACRES OF FOREST

2,000,000 TREES IN LANDSCAPED PARK AREAS (ESTIMATED)

593,132 STREET TREES

BUILDING A BETTER PRACTITIONER-RESEARCHER ALLIANCE

To advance knowledge for better natural resources management, we need an effective and collaborative community that joins researchers and practitioners. By practitioners we mean a diverse set of land managers, policy makers and city workers — people working on the ground — who take direct action to shape our urban landscape. Researchers are a community of scientists, experimentalists, and thinkers, often at universities but sometimes within government agencies, NGOs and not-for-profit organizations, who study fundamental patterns, causes, and mechanisms of system behavior and performance. These categories are not perfect, and many individuals mix roles. But, generally, these categories can be seen as distinct.

We often think of practitioners and researchers as being a natural match: basic information plus application resulting in improved understanding and practice. In an idealized relationship, specific requests for information and community-based knowledge flows toward the researcher. Answers and data flow back toward the practitioner. Certainly, well-practiced adaptive management functions like this. However, this model is simplistic, difficult to achieve, and often does not occur in practice. Recognition of these inherent challenges to collaborative research and the MillionTreesNYC staff's desire to foster research collaborations led to the development of the workshop.

THE DISTINCT CHARACTERISTICS OF "SUCCESS" FOR PRACTITIONERS AND RESEARCHERS

Need answers to specific, often narrow questions

Management decisions often have to be made with a minimum of "science"

Drawn to synthetic questions with broad theoretical reach

Rewarded for rigorous science (experiments, defensible statistics, etc.)

A central impediment to successful practitioner-researcher alliances is that the two sides of the equation may not communicate often enough or view success in the same ways (see the Figure below). Practitioners tend to require answers to questions that are narrowly focused. Did the planting succeed? Did the trees survive? Has the stewardship outreach program attracted enough participants? Researchers at universities are drawn to, and tend to be rewarded for, broad and synthetic questions. Answers to their research questions can require significant time and investment. Practitioners can often make decisions (and often must make decisions) with a minimum of information and on short timelines. It can often be reasonably clear when a management action is working or not. Intense and expensive sampling and experimental analysis can seem like a waste of resources.

Compromise is clearly important in devising successful integrated relationships and we should recognize that both sides have styles of working that are not just choices, but are built into the fabric of their professions. We also believe that such collaborations are critical for the advance of useful knowledge. In particular, in building these types of fruitful relationships:

1. Practitioners need to look for innovative ways to support research. Their focused questions are important, but often are insufficient to support or engage researchers.
2. Researchers need to recognize that there are specific management questions that require answers. These questions must be incorporated into the research design and communicated in ways that meet the typically short decision-making schedules of practitioners.
3. Both sides should recognize that policy makers and politicians need convincing and well-expressed rationales for management actions and their benefits in order to justify expenditures to the public.

In short, both sides need to look for ways to simultaneously support and integrate the other while getting their own work done for the sustainable good of social-ecological communities.

WORKSHOP DESIGN

The sessions were designed to bring researchers and practitioners together in a workshop format to provide a networking opportunity and to give both parties a chance to discuss potential research projects. The sessions were also designed to create the elements of an integrated research agenda that could improve the land management practices of MillionTreesNYC and advance the state of knowledge in urban social-ecological research and green infrastructure. We specifically sought to create a document that could serve as a road map for future research collaborations and improved adaptive management, and foster relationships between researchers and practitioners.

Appendices to this document contain the full agenda (Appendix A**), the roster of participants (**Appendix B**) and descriptions of field site visits (**Appendix C**).**

Eleven topic areas were designed to reflect the broad spectrum of interests, needs and necessary work in the sociology, community context, green infrastructure and ecology of New York City. Specific focus was given to MillionTreesNYC (see the Text Box**) as a way of concentrating discussion on practice and the application of knowledge. For each topic we held a moderated session that mixed researchers and practitioners who collaboratively created a prospectus for a research agenda. These eleven topic areas are broad by design and reflect the immense reach and importance of MillionTreesNYC, both in terms of its effect on citizens and as a model for critical multidisciplinary work in the urban ecological and social landscapes.**

For each topic, four products were developed by consensus, guided by a moderator. These products were:

1. **A written prospectus for integrated applied and basic research in support of MillionTreesNYC.**
2. **A list of impediments to this research.**
3. **A list of potential solutions to the listed impediments.**
4. **A list of research projects that flow from the prospectus.**

ELEVEN TOPIC AREAS AROUND WHICH BREAKOUT GROUPS WERE FORMED

- Ecosystem Services: Local Air Quality and Urban Heat Island
- Ecosystem Services: Water Quality, Storm water Management
- Economic Impacts: Quantifying Returns on Investment
- Education
- Human Health and Well-Being
- Stewardship and Management
- Green Jobs and Social Justice
- Reforestation Dynamics and Forest Health
- Biodiversity and Ecological Communities
- Green Infrastructure
- Implications of Scale

1,444 ACRES OF MEADOW/GRASSLAND

WORKSHOP DESIGN (continued)

Overall, the structure of the ideal practitioner-research community is depicted below. Together the four products from each group form a statement of a research agenda for MillionTreesNYC. They can be the basis of new collaborations. They can also point the way toward long-term, structural actions that could advance research, MillionTreesNYC practice and, ultimately, the quality of life for all New Yorkers (see the Text Box **at right).**

BENEFITS OF THE WORKSHOP

New avenues of collaboration between practitioners and researchers

Improved structures within city government that support effective research (e.g., access to sites, permits, data) leading to useful knowledge

A research agenda that can inform specific RFPs

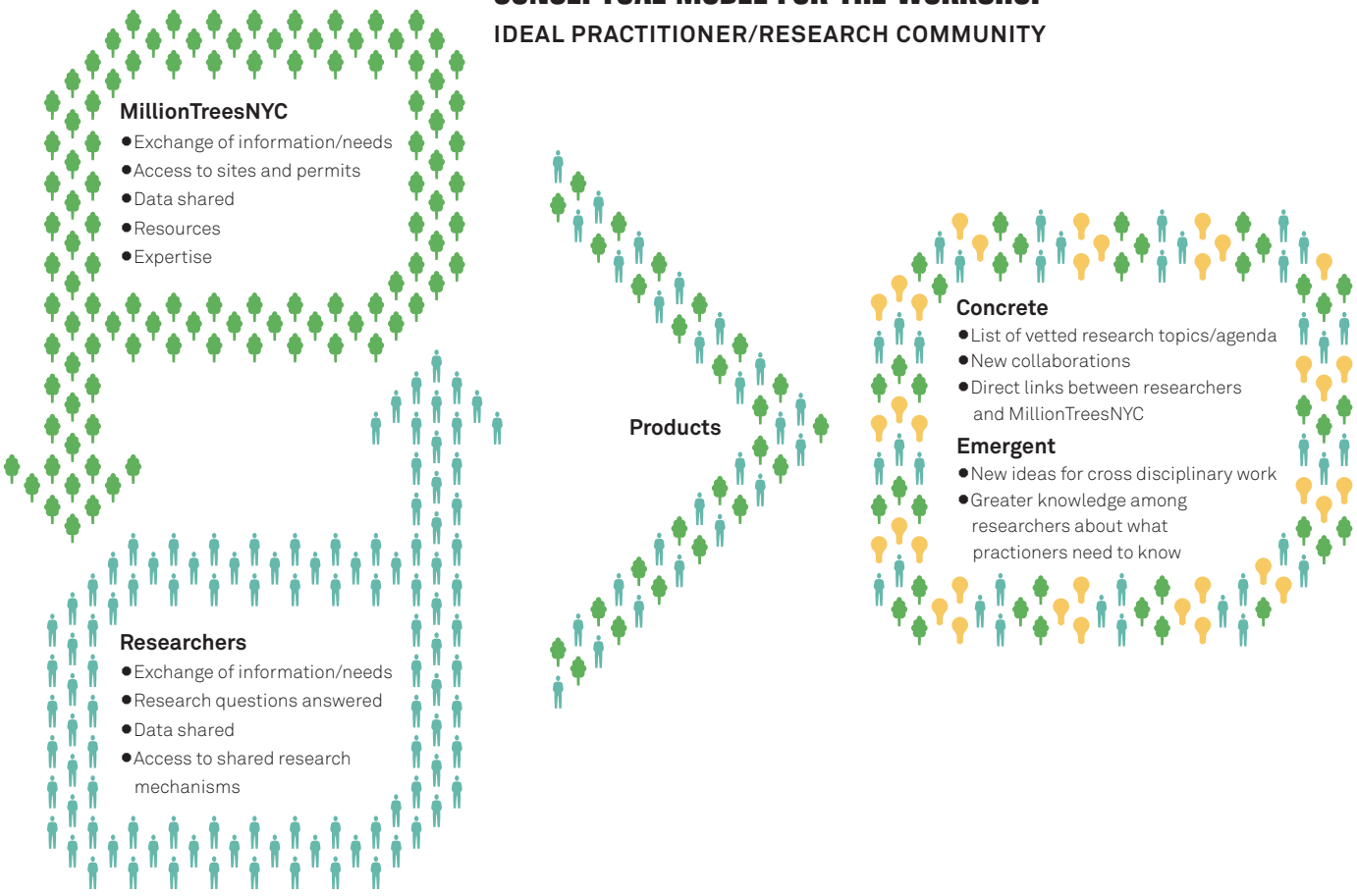
Better communication from practitioners about what they need to know, and when they need to know it

Scientific evidence for land management actions that can be used in policy and political decisions

Capture of current questions, issues, and lessons learned for sharing with the public, including other cities that are pursuing similar campaigns.

CONCEPTUAL MODEL FOR THE WORKSHOP

IDEAL PRACTITIONER/RESEARCH COMMUNITY



RESULTS AND NEXT STEPS

Summary of Results

Knowledge is the key to adaptive (and effective) management. The topic-based dialogues demonstrated:

1. The depth and breadth of the social-ecological system in New York.
2. That knowledge about the ecological and sociological system has immense implications for policy, human health, the economy, social justice, and biodiversity.
3. Dialogues that frankly explore impediments and solutions to the challenges of researcher-practitioner collaborations can develop a framework for better interactions.
4. A system of dialogue and exchange is needed that recognizes both the shared and distinct needs of the researcher and practitioner communities.

Overarching Results, Impediments, and Solutions

Overarching conclusions of the workshop were (1) that there is much enthusiasm for research that integrates science and management, and (2) there are many important research questions that need to be addressed.

Nevertheless, the topic groups identified a variety of impediments to such research. Four classes of impediments cut across topic areas:

1. The need for better and more regular communication between researchers and practitioners;
2. An absence of coordination of access to existing datasets and research sites,
3. A lack of integration between research results, management actions, and policy decisions; and,
4. A shortage of research/project funds for specific projects and long-term research.

The groups also recommended a variety of solutions to these impediments, including researcher-practitioner working groups and the creation of liaisons within city agencies that would facilitate access to collaborators, research sites, and datasets.

The specific results of each of the eleven groups are reported in the sections that follow. The content of the sections is not identical, reflecting the process that each group of individuals practiced as it developed its material.

- Ecosystem Services: Local Air Quality and Urban Heat Island
- Ecosystem Services: Water Quality, Storm water Management
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Next Steps

The workshop is intended to be the first step in a larger and continuing process of integration between researchers and practitioners working to understand and improve New York's environment and green infrastructure. A symposium of invited papers, contributed papers and continued dialogue is planned for March 5–6 2010. Further information about this symposium can be found at http://www.milliontreesnyc.org/research.

ECOSYSTEM SERVICES: LOCAL AIR QUALITY AND URBAN HEAT ISLAND

Facilitator: Tom Whitlow, Cornell University, Department of Horticulture

There are opportunities for air quality and atmospheric research in the context of urban ecology, but some of this research may not be specifically aligned with the MillionTreesNYC initiative. This is in part because the broad scale of atmospheric effects can be difficult to relate to specific tree planting efforts. Atmospheric research is clearly important, but more thought needs to be given to how to integrate it with the specific needs and imperatives of MillionTreesNYC.

Two classes of impediments exist to such integration between research and MillionTreesNYC. First, the scale at which atmospheric research is applied may not lead to clear recommendations for planning and site design, which occurs at narrower scales. Second, the positive effects of tree planting programs may be difficult to identify statistically, since such effects may be impossible to separate and statistically isolate from other processes in the urban ecosystem.

Seven necessary, but not sufficient, elements must be in place for meaningful and informative research:

1. In order to quantify temperature effects and carbon sequestration at the scale of the metropolitan heat island, a network of observation stations able to detect the synoptic scale effects is needed. This may or may not be able to be organized and arranged on the landscape based on foreknowledge of local microclimates.
2. At the same time, meteorological and air quality stations are needed at ground level, where human exposure occurs.
3. Create baseline data to establish observations before changes occur and maintain long-term observations.
4. Partnerships are needed among practitioners, agencies and scientists to maintain observation networks and report on data produced by them.
5. Liaisons to researchers are needed within agencies and research institutions to facilitate the design of nimble and useful experiments and to help navigate city's complexity.
6. Liaisons or joint committees should coordinate research opportunities and logistical constraints.
7. An *a priori* set of defined response metrics is needed that would balance the needs of short-term decision-making (both policy and planting design) and longer-term research. Metrics should be expressed to policy makers in appropriate biophysical currencies before dollar values are assigned. This would include multiple metrics at replicated plots/ observation stations.

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ECOSYSTEM SERVICES: LOCAL AIR QUALITY AND URBAN HEAT ISLAND (continued)

IMPEDIMENTS

Agency jurisdictional conflicts that inhibit research and data sharing

Insufficient baseline knowledge of local air quality, including a lack of rigorous replication

Different payoffs between practitioners and scientists

Security of equipment and staff

Hypothesis drivers vs. outcome drivers that result in poor integration of research goals between scientists and practitioners

Will we be disappointed in the results?

SOLUTIONS

Effective collaborations and small-scale efforts

Work with and adapt data and research efforts already in place, even if they are not perfectly aligned with MTNYC's goals

Use reference sites

Give practitioners credit in published results

Integrate maintenance and monitoring for greater efficiency

Armor for equipment security

Orchestrate win-win solutions and think small

Increase monitoring efforts and broaden access to data

TOP RESEARCH DIRECTIONS AND QUESTIONS

Restoration: How does the quality of forest restoration affect the quantity of pollutants removed/carbon sequestered/ozone mitigated? How does planting design affect this?

We need measurements of the impact of trees on air quality. What is the best approach?

Distributed vs. clumped trees. Which is more effective?

What is the relative importance of dispersion and filtration?

Research the effect of trees on air quality at various scales

Network of eddy flux towers in the five boroughs

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ECOSYSTEM SERVICES: WATER QUALITY, STORM WATER MANAGEMENT

Facilitator: Franco Montalto, Drexel University, Department of Civil, Architectural, & Environmental Engineering

The group organized the research prospectus into a) data acquisition activities, b) knowledge-building activities (experiments), and c) efforts to improve management and design.

An effort needs to be made to consolidate various spatial data sets into one GIS database that could then be used to identify the geographical context of individual street tree sites. This contextual information could, in turn, be used to establish replicate experiments to study how specific species of trees respond to different sets of conditions. Experiments would seek to quantify how different vegetation types, root characteristics, soil, climate and physical conditions influence the ability of trees to provide ecosystem services (water quality improvement and storm water management). Other potentially significant research projects could involve how these systems perform in response to different pollutant loading rates and how pollutants build up and leach out of the systems. This could help us to better understand tree mortality and success under variable conditions. It is important to develop consistent performance and maintenance criteria and integrate these systems into various infrastructure contexts. In terms of action, we developed a series of projects, including both long and short-term experimental tree sites and a consolidated mapping system to facilitate research.

Mapping includes the creation of a GIS database to compare tree pit locations taking into account the following factors:

- Soil and geological properties
- Land use and canopy cover
- Topographic relief
- Site history

Knowledge building activities are required, including experiments that will study:

- Loading, build-up and eventual leaching of pollutants from vegetated controls
- How does water quality and hydrologic performance vary with vegetation type and root zone characteristics?
- Causes of mortality/success of existing tree pits and other vegetated controls
- Volume and treatment capacity of different vegetated systems subjected to various stormwater loading conditions
- Variability in hydrologic, hydraulic and water quality performance in different infrastructure contexts
- Variability in performance under different climate conditions

Efforts to improve the design of studies and the policy application of results are needed:

- Consistent set of performance criteria to guide planning, design, and management
- Identify design criteria that are acceptable to multiple agencies
- Identify appropriate maintenance activities and schedules
- Develop multifunctional engineered soils and pit designs
- Better quantification of maximum potential water capture per tree
- Vegetated controls specifically designed to cost-effectively reduce CSOs
- Better integration of vegetated controls into landscapes, and engineered infrastructure contexts
- Improved hydraulic designs

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ECOSYSTEM SERVICES: WATER QUALITY, STORM WATER MANAGEMENT (continued)

IMPEDIMENTS

Extensive variability that is difficult to characterize cost-effectively

Some trees will need to be sacrificed for scientific purposes

Long-term, centralized data collection and management repository is lacking

Security of expensive instrumentation

Accessibility of data to different stakeholders and users

SOLUTIONS

Statistically sound design of short- and long-term experimental pilot and baseline studies

Develop centralized GIS database that integrates all pertinent datasets

Form advisory committee composed of government, community, & academic members

Coordination at the Mayor's office level

TOP RESEARCH DIRECTIONS AND QUESTIONS

Short- and long-term experimental field studies

Relative value of new and existing tree pits and other vegetated spaces (shoulders, medians, parkland)

Replicated study sites in a variety of soil, geological and eco-hydrological conditions

Relative value of different vegetation types

Relative value of engineered and natural soils

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ECONOMIC IMPACTS: QUANTIFYING RETURNS ON INVESTMENT

Facilitator: Simon McDonnell, New York University, Furman Center for Real Estate and Urban Policy

MillionTreesNYC offers an opportunity to build upon the work of STRATUM[4] in quantifying economic benefits of urban trees. The key objective is to provide policy makers with information about the ongoing impact of their investment in urban trees and provide academics with exciting and practical research.

We want to broaden the research agenda to include the ongoing impacts (cost and benefits, short- and long-term) of urban tree plantings in areas such as energy use, air quality, climate change mitigation and adaptation and water quality. Beyond these areas, we would like to further our research to quantify social benefits including, human health, job development, and community interaction as well as quantifying economic benefits (using proxies such as real estate prices).

In terms of quantifying impacts, cost avoidance should be included as a potential benefit (storm water capture, flood control and energy use requirements through heat island reduction). At the very least, alternative "no action"/"business as usual" scenarios should be included in analyses of policy interventions in this area. Analysis should also align larger scale objectives with local implementation (where conflicts often occur).

IMPEDIMENTS

It is often unclear what the economic benefits of tree planting will be

Developers often want to eliminate green space

Curb cutting and other sidewalk conflicts

Community gardens and parks are public goods with economic benefits, but when they become run down or crime centers, then they may have a negative impact. Need to ensure that analyses of interventions include qualitative aspects of each development project

Difficulty training people how to maintain trees (i.e., stewardship)

SOLUTIONS

Develop datasets to support policy by demonstrating economic impacts

Relate tree planting efforts to the economic benefits of mitigating local climate change

Estimate the effect of tree maintenance on the success of gardens

Partner with other agencies to conduct research and communicate findings to the public.

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4. Street Tree Resource Analysis Tool for Urban Forest Managers (STRATUM) is software developed by the USDA Forest Service to provide an economic value of individual trees through tree inventory data.

ECONOMIC IMPACTS: QUANTIFYING RETURNS ON INVESTMENT (continued)

TOP RESEARCH DIRECTIONS AND QUESTIONS

What is the accessibility to green space?

How to quantify the economic impacts of urban green spaces?

How do tree plantings impact how neighborhoods are seen in terms of development potential?

Ecosystem services — What monetary values can be assigned to green infrastructure?

Direct vs. indirect impacts, short-term vs. long-term — how can value be assessed?

What is the value of investing in green education?

What are the social vs. economic issues associated with improved neighborhoods?

Community stewardship and cost avoidance: what will happen if we do not take a particular action?

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EDUCATION

Facilitator: Marianne Krasny, Cornell University, Department of Natural Resources

Three main research questions frame the education and evaluation research agenda:

1. What social marketing and communication campaigns (e.g., public service announcements) most effectively deliver intended messages (e.g., volunteer to plant trees, support MillionTreesNYC efforts) to diverse NYC audiences?

Research related to this question can be used to design future communications campaigns. In particular, communications campaigns were discussed as a means to address opposition to tree planting in some communities.

2. What are the outcomes of various educational programs (e.g., RESPECTrees and Talking Trees of NYRP, Citizen Tree Pruners and school programs of Trees NY) and strategies embedded in these programs (e.g., school lectures, hands-on tree planting, youth teaching other youth and adults about tree planting and care, long-term tree stewardship internships, social networking through the internet) at the level of the individual (e.g., science understanding related to trees, stewardship behaviors, sense of place, sense of community, career choices, self-efficacy, cognitive functioning, physical health); of the social system or community (e.g., social connectedness, trust, associational involvement [social capital]); and of the ecosystem (e.g., tree number and diversity, tree survival)?

A number of educational programs (treatments) currently ongoing as part of MillionTreesNYC offer the opportunity for natural experiments, which are critical to conducting more rigorous research than often is possible within the field of environmental education. For example, NY Restoration Project's RESPECTrees currently encompasses ten classes in ten different schools, and a series of discrete educational interventions, including classroom lectures and discussions, hands-on tree planting, and peer-to-peer teaching. While recognizing certain realities (e.g., the order in which these interventions are implemented may vary, control groups will still be exposed to a low level treatment as a result of peer-peer teaching), this program offers the potential for control groups, pre-pre-post tests, delayed treatment, and other experimental methods, which could increase the rigor of any studies conducted on this program and thus make it possible to add significantly to the scientific literature while answering questions important to NYRP. Further, by focusing not just on the individual level, but also on the social and ecological system levels in examining program outcomes, this type of research can answer questions about the role of educational programs in conferring social-ecological system resilience.

3. How do community development strategies (e.g., those being implemented by Partnerships for Parks in Greening Morissania) build community capacity?

Community development/engagement programs can promote social learning, both in the sense of learning as increasing levels of participation in a tree management or advocacy practice, and of learning among a group of stakeholders that results in concerted action to address management dilemmas.
A more qualitative, participatory research approach may be useful in examining the outcomes at the individual and community level of community engagement, as well as its contributions to the tree planting and care goals of MillionTreesNYC campaigns.

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→ Stewardship and Management
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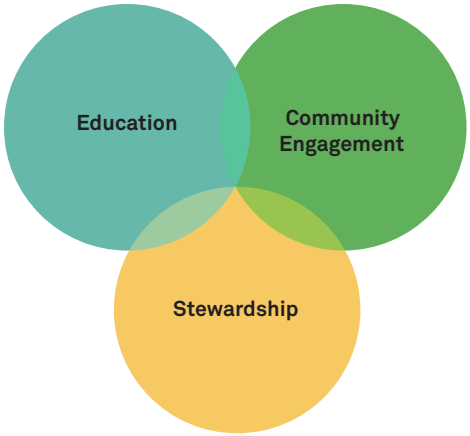
→ Biodiversity and Ecological Communities
→ Green Infrastructure
→ Implications of Scale

EDUCATION (continued)



A challenge for research-practitioner partnerships focusing on education will be balancing the passion and beliefs of educators who are committed to youth and the changing government policies relative to environmental education, with the more deliberate approach of researchers seeking rigor and attempting to maintain a level of objectivity. However, we saw numerous opportunities to collaborate as the practitioners have a strong desire to learn what about their programs is effective in meeting their larger goals, and the researchers saw opportunities for rigorous research designs.

Finally, it should be noted that some recent research defines learning as increasingly skilled level of participation in authentic practices, or communities of practice. Consistent with this "learning as participation" perspective, education programs can be situated in hands-on tree planting, tree care, and similar stewardship practice, rather than solely in classrooms. Thus, education has significant overlap with stewardship and community development initiatives, as well as with other civic ecology practices that integrate community/social and environmental goals.

IMPEDIMENTS

Research rigor including good metrics, opportunities for comparative study rather than simply evaluation, and self-selection bias

Identifying desired outcomes

Identifying level of analysis (individual, community, ecosystem)

SOLUTIONS

Identify desired outcomes and appropriate measures

Work with natural experiments, such as that provided by NYRP programs

TOP RESEARCH DIRECTIONS AND QUESTIONS

Which social marketing and communication campaigns (e.g., public service announcements) most effectively deliver intended messages (e.g., volunteer to plant trees, support MillionTreesNYC efforts) to diverse NYC audiences?

What are the outcomes of various educational programs (e.g., RESPECTrees and Talking Trees of NYRP, Citizen Tree Pruners and school programs of Trees NY) and strategies embedded in these programs (e.g., school lectures, hands-on tree planting, youth teaching other youth and adults about tree planting and care, long-term tree stewardship internships, social networking through the internet) at the level of the individual (e.g., science understanding related to trees, stewardship behaviors, sense of place, sense of community, career choices, self-efficacy, cognitive functioning, physical health); of the social system or community (e.g., social connectedness, trust, associational involvement [social capital]); and of the ecosystem (e.g., tree number and diversity, tree survival)?

How do community development strategies (e.g., those being implemented in Morissania) build community capacity?

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→ Ecosystem Services: Water Quality, Storm water Management
→ Economic Impacts: Quantifying Return on Investment
→ Education
→ Human Health and Well-Being
→ Stewardship and Management
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HUMAN HEALTH AND WELL-BEING

Facilitator: Gina Lovasi, Columbia University, Mailman School of Public Health

Trees, total vegetative cover, and the extent of tree planting efforts may be relevant to human health and wellbeing due to their effects on:

1. **Air quality and temperature**
2. **Time spent outdoors and engaged in physical activity**
3. **Affective and cognitive responses to views of or being surrounded by natural environments**
4. **Hands-on interactions with the environment in the process of planting, gardening, maintenance**

Two broad themes and guiding concerns should drive research in this area. First, how can we accurately measure the positive health effects of trees? Impediments in this arena of research are similar to those articulated by the Air Quality group. It can be difficult to determine the causal effects of tree planting program on patterns in health attributes. Nevertheless, policy makers and site designers need research results that link health with tree planting efforts.

Second, how do people react to trees? Comprehensive studies are needed to record the health impact of citywide tree plantings in multiple public health contexts. Physical impacts, addressed above, are important, but so too are the effects of tree plantings on mental and emotional health.

The scale of analysis will be important for both understanding the patterns and applying the results. A general model of causes and effects can be proposed here (see the model **below). These are valuable targets of research.**

IMPEDIMENTS

Difficulty isolating the effects of trees themselves from social and physical contexts (individual plants and planting designs)

Measurement challenges related to the scale and timing of available data (e.g., ecological fallacy, limited coordination across agencies, the need for "pre-" data for pre-post analysis)

Complexity of neighborhood change (e.g.; heterogeneity of responses to tree plantings, population migration makes longitudinal health data difficult to interpret

Who will conduct this research?

Lack of data coordination

SOLUTIONS

Measure social environment

Use longitudinal designs

Case studies for greater detail, coordination of neighborhood change data across agencies and groups

Diversity of methodological, qualitative and quantitative approaches, from focus groups to citywide health cohort

Avoid blanket statements about effects averaged across the city; use diverse populations and neighborhoods in research and report their differences

Look for both positive and negative effects on health

NYC Parks department is in "new era of willingness" to accomplish these projects. Perhaps new collaborations are possible

Data are potentially available from a variety of current sources. These need to be researched, coordinated, and made available

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HUMAN HEALTH AND WELL-BEING (continued)

TOP RESEARCH DIRECTIONS AND QUESTIONS

- What is the correlation (and, when possible, causal relationship) between trees and human health at various scales?
- Do trees contribute to pedestrian comfort or safety?
- What is the relationship between the presence of trees and crime?
- How do culturally defined communities react differently to trees?
- How does the degree of exposure (trees seen from window, being physically close) influence health?
- Why do people react negatively to trees?
- How do we construct environments that everyone respond well to?
- Monitor change in air quality post-planting, ideally on the neighborhood level (but see the Air Quality group, which believes that such fine linkages will be difficult to distinguish)
- How views of/access to trees impact mental health, cognitive function, physical activity, absenteeism?

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INDEPENDENT VARIABLES → → →

- Trees
- Physical environment
- Planting designs/Planting process

MEDIATORS → → →

- Time spent outdoors
- Time spent with others
- Views of nature
- Heat effects/shade
- Air quality
- Aesthetic improvements

HEALTH RELATED OUTCOMES

- Culture/ethnicity/age
- Process/stewardship
- Tree type/maturity
- Nearby pollution sources
- Cardio-vascular disease
- Respiratory illness
- Asthma
- Physical activity/obesity
- School absenteeism
- Quality of life
- Psychological wellbeing
- Relationship to nature
- Mortality rates

STEWARDSHIP AND MANAGEMENT

Facilitator: Richard Stedman, Cornell University, Department of Natural Resources

Research on programs of stewardship of tree planting should focus on the effects of stewardship actions on outcomes: that is, the "so what" questions. Proximate outcomes such as effects on tree health and viability are clearly important. For example, how does direct stewardship action improve the viability of individual trees and groups of plantings? Ultimate outcomes also deserve study. These include the ripple effects of stewardship on neighborhoods (such as changes in crime rates and the capacity of communities to solve other problems) and individuals (such as attachments and investments in neighborhoods and social behavior).

Conceptual models of stewardship behavior and its effects should be developed that can drive research. What "causes" stewardship? For example, what individual and neighborhood attributes affect rates and effectiveness of stewardship? Classes of potential drivers include socio-economic status (SES), levels of local political support and opposition, and indicators of local capacity for stewardship. What patterns of individual motivations and perceptions are correlated with stewardship? How do the characteristics of stewardship programs affect behavior and effectiveness? For example, do top-down or demand driven programs perform best? Are outreach efforts to attract stewards effective? Such research can then be used to design or refine effective stewardship programs.

The definitions and measurement instruments will vary by discipline, but all must be understandable and usable by managers and practitioners. The ability to apply results at multiple scales will be important for the planning of stewardship programs.

IMPEDIMENTS

Timing: getting research done before policy decisions are made

Science and management expectations differ, and may be in conflict

Lack of money

Lack of integration among agencies, making work difficult and inefficient

SOLUTIONS

Build understanding about process between practitioners and researchers

Articulate research needs more clearly, with "buy-in" at a high administrative level

Empower people who care the most to take action

Combine research and outreach

Form long-term relationships between researchers and practitioners

Create a fact sheet about stewardship and its benefits

Maximize and facilitate what people are already good at

Examine the effective use of resources in other cities

Create a data clearinghouse

Communicate research to practitioners

Link stewardship campaigns with other types of community engagement and social services

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→ Green Infrastructure
→ Implications of Scale

STEWARDSHIP AND MANAGEMENT (continued)

TOP RESEARCH DIRECTIONS AND QUESTIONS

What is the effectiveness of various tools being used for motivation and what causes people to come together sustainably?

What are motivations, values, beliefs that encourage engagement and "ownership" in urban forestry projects at individual and community levels?

What types of organizational structures and groups of people are more effective at stewardship (by community)? Do these depend on demographic factors?

What is the long-term survivability of trees planted on blocks that were requested vs. unrequested plantings?

How do people from different parts of city view civic responsibility vs. government responsibility in relation to street trees?

What are the differences in outcomes and effectiveness between contract planting and community forestry?

What are the best forms of engaging youth? Does this vary by age cohort?

Can the process of "stewardship" be leveraged to do other work, for example improving schools, or non-environmental causes?

Concerns about gentrification: Is this an impediment to success?

What elements are successful in other cities? Can they be translated to work in NYC?

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GREEN JOBS AND SOCIAL JUSTICE

Facilitator: Lynne Westphal and Erika Svendsen, U.S. Forest Service Northern Research Station

Two broadly overlapping concerns drive research and practice in this area: (1) the meaning and social benefits of green jobs, and (2) concerns about gentrification pressures that may result from programs that "green up" neighborhoods. Progress in the two areas can sometimes be in conflict, but both, and their relationship, require additional study.

What are "green jobs"? The popular definition is considered to be limiting and should be expanded to include not only energy and conservation jobs but also jobs in natural resources, support positions, and jobs associated with businesses that follow green practices (even when the products of the business are not necessarily green). With this expanded definition, the benefits of green jobs are not restricted to benefits for energy conservation, but can be seen as social benefits, such as pathways out of poverty and establishing new career tracks. Related to these issues is the structure of MillionTreesNYC itself, which currently depends on large-scale contractors. Can programs like MillionTreesNYC help support local jobs and build skills in communities that are underserved? For example, the MillionTreesNYC Training Program is a seven-month course for youth ages 18–24 entering the job market.

In certain instances, residents view greening and open space projects as a precursor to gentrification, which causes them to be skeptical of how they will fit into a changing or new community. The causes and consequences of gentrification are complex and poorly understood, and so the public often tends to assume impending displacement. In fact, gentrification may not be as persistent a problem as originally though, but research suggests that the perception remains. Education is needed to provide to communities proper information on local green projects and the causes of gentrification. Significant investment in research is needed to devise green infrastructure initiatives that are compatible with social justice.

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→ Implications of Scale

5. NYCHA is the New York City Housing Authority.

GREEN JOBS AND SOCIAL JUSTICE (continued)

IMPEDIMENTS

Lack of funding for research and dedicated programs

Lack of data (including longitudinal data)

Coordinating research and programs

Coordination and communication on lessons learned between the city, neighborhoods, NGOs, researchers

SOLUTIONS

Pool existing data (and metadata)

Build on recent programs & research (e.g., CUNY GIS and Parks research)

Share and replicate efforts with other cities

Use both quantitative and qualitative methods

House data at a stable institution

Develop relationships and trust

Examine processes & paperwork for the possibility of adding research questions (e.g., hiring process)

Recognize programmatic flexibility where it exists and build on it

Scale databases to neighborhoods

Create Opportunities for Long-term Studies

TOP RESEARCH DIRECTIONS AND QUESTIONS

What job opportunities are available to those who participate in green-job training programs?

Who is hiring for green jobs and what are the rates of pay?

What skills are needed to progress up the green-job ladder?

What sort of jobs need to be there for each of four sectors (built, green, labor and government) and what policies need to be in place?

What in-school training programs exist?

How do green jobs channel people into long-term jobs?

What areas are being underserved in terms of access to resources?

Do community initiatives or city initiatives lead to gentrification more frequently?

Can you get economic benefits of greening a neighborhood without causing gentrification?

Does planting trees interact with peoples' sense of ownership or having a stake in NYCHA housing?

What are the cultural issues involved in tree planting?

In green job training programs are graduates and participants interested in "traditional" environmental issues? Do they enjoy the work after they graduate? Is there a sense of purpose, or more so than the average job training program? Is it "just a job?"

Can models of data collection be transferred to other cities and projects?

How can technologies, data, and systems developed here work for other projects?

The City can be an instigator of and innovator in data collection. How can this these facts be used to better advantage?

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REFORESTATION DYNAMICS AND FOREST HEALTH

Facilitator: P. Timon McPhearson, The New School, Tishman Environment and Design Center

What is the effect of the MillionTreesNYC reforestation effort, already well underway, on urban ecosystem structure and functioning? Urban ecosystem studies typically examine changes through time ranging from the distant past into the future. Many factors affect temporal changes in the spatial structure of forested patches in urban areas. These include social and behavioral patterns, economic forces, ecological succession, erosion, and other forces. Therefore, evaluating the success or failure of reforestation efforts requires answering many challenging research questions. A long-term ecosystem approach to these issues will seek to understand the linkages, feedbacks, controls, and cycles in patchiness in urban forests.

Such a coordinated research project requires scientific collaboration, resources, and public-private partnerships that until now have been largely absent in the New York City metropolitan area. Now more than ever, researchers at academic and non-profit institutions must be directly in dialogue with practitioners and managers in relevant offices including the NYC Department of Parks and Recreation, the Office of Long-Term Planning and Sustainability, the U.S. Forest Service, and MillionTreesNYC. Further, if the goal is to understand the implications of reforesting parkland in NYC on the structure and functioning of urban ecosystems, then three overlapping foci should drive research and evaluation in this area:

1. Botanical Focus
How does plant diversity (tree, shrub, and herbaceous) affect species recruitment, time to canopy closure, vertical structure, and reproduction in existing forests? How does edge vs. interior affect long-term tree survival in MillionTreesNYC afforestation areas? How does plant diversity and density affect carbon dynamics, including sequestration and storage, in urban ecosystems? How does climate change affect forest ecosystem dynamics? What are the best planting strategies and designs for creating communities that are self-regulating, resistant to invasive species, and resilient to urban disturbances?

2. Soil Focus
What is the impact of heterogeneous urban soils on tree survival and growth? What is the impact of land use/land history on tree survivability? How much heterogeneity exists in NYC soils? What is the effect of reforestation planting strategies on soil carbon dynamics?

3. Human Focus
How does human use of the forest affect long-term ecological dynamics? How does education affect resident behavior towards urban forests? What are the drivers of environmental stewardship and how can they be harnessed to improve the structure and functioning of urban ecosystems?

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REFORESTATION DYNAMICS AND FOREST HEALTH (continued)

IMPEDIMENTS

- Inadequate data sharing
- Lack of baseline data
- Need for increased site evaluation
- Gaps in current research and understanding
- Lack of data to answer management needs
- Need for standardization of data to lower the number of explanatory variables
- Timing (MillionTreesNYC planting schedule vs. time to establish research)
- Staffing: Who will collect the data?
- Unclear communication: To whom do you talk to begin research in NYC?
- Need for clear networks: How do researchers join with each other and appropriate projects?
- Need for more conferences/workshops to promote data sharing and collaboration

SOLUTIONS

- Intensive analysis of existing data
- Attract funding for urban ecosystem research
- Disperse funding for short-term and long-term planning, research, and implementation
- Develop online network for sharing information (i.e. other projects people are working on)
- Coordinated data management/data sharing
- Engage citizen scientists
- Funding for graduate and post-doctoral research
- Create formal partnerships
- Create a regional research network using NSF ULTRA funding

TOP RESEARCH DIRECTIONS AND QUESTIONS

- What is the impact of land use/land history on survivability?
- What is the impact of urban soils on tree survival?
- How does edge vs. interior affect long-term tree survival?
- How does tree, shrub, and herb diversity affect natural recruitment into forests?
- How does diversity affect carbon dynamics?
- How does climate change affect forest ecosystem dynamics?
- How does human use of the forest affect long-term ecological dynamics?
- How does education of the public (i.e., information campaigns) affect resident behavior towards urban forests?
- What are the drivers of stewardship?
- How can we maximize soil building processes?
- What are the best practices for assembling communities on “made” soils?

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→ Education
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→ Stewardship and Management
→ Green Jobs and Social Justice
→ Reforestation Dynamics and Forest Health
→ Biodiversity and Ecological Communities
→ Green Infrastructure
→ Implications of Scale

BIODIVERSITY AND ECOLOGICAL COMMUNITIES

Facilitator: Ellen Pehek, New York City Department of Parks & Recreation

Two broad questions should influence research on biodiversity and ecological communities, with respect to MillionTreesNYC:

1. **In what ways can biodiversity be usefully viewed as both a response to and an indicator of other relevant environmental conditions in New York City?**
2. **What aspects of life in New York City does biodiversity influence?**

Numerous programs and projects in recent years have highlighted the richness of New York City's remaining native biological diversity. However, research and outreach on biodiversity and ecological communities, specifically in the context of the City's green infrastructure programs, should be strengthened.

Several research strategies should be pursued. First, researchers should identify short-term questions that build assets (both useful data and appreciation for biodiversity). Second, biodiversity goals should be developed and used to inform planting strategies and site-specific designs to ensure that planting activities contribute positively to biodiversity. Third, a 30-year strategy for protecting and conserving biodiversity and natural areas is needed in the five boroughs. Finally, we must use existing and developing data on biodiversity to demonstrate how it enhances tree populations and other quality of life issues for New Yorkers.

A variety of factors influence biodiversity within the City, especially in the context of MillionTreesNYC:

- **Site-specific and citywide planting designs**
- **Management actions (e.g., control of exotic species)**
- **Historic land-use**
- **Present land-use**
- **Connectivity/ fragmentation**
- **Neighborhood patterns of culture**
- **Pollution and heat islands**
- **Hydrology**
- **Aerodynamic effects and habitat provision from buildings**
- **Disturbance**

Additional research is needed to determine how these factors influence patterns of biodiversity in New York, both at small scales and in their effects on the ability of species to move or spread within the City.

IMPEDIMENTS

Focus on trees can detract from other biodiversity goals
Lack of baseline data
Lack of money for biodiversity projects
Lack of city focus on restoration and its benefits (e.g., more restoration projects would increase biodiversity)

SOLUTIONS

Develop better rationale for biodiversity protection
Demonstrate the benefits of biodiversity
Use data on biodiversity to demonstrate how it may promote tree longevity
Coordinate data through a working group
Utilize citizen science both for data collection and for outreach
Coordinate with clubs interested in specific taxa (e.g., birdwatchers)
Emphasize restoration projects and their benefits (e.g., migratory bird habitat) with outreach programs

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→ Education
→ Human Health and Well-Being
→ Stewardship and Management
→ Green Jobs and Social Justice
→ Reforestation Dynamics and Forest Health
→ Biodiversity and Ecological Communities
→ Green Infrastructure
→ Implications of Scale

BIODIVERSITY AND ECOLOGICAL COMMUNITIES (continued)

Biodiversity and ecological communities also influence valuable social and ecological attributes, including:

- **Ecosystem services, such as: pollinator services; nutrient cycling; air filtration; storm water control and filtration; moderation of urban heat island effects**
- **Aesthetics**
- **The human component (health, property values, educational value and benefit to education of urban youth)**
- **Habitat value for migratory and resident animals**

Here, too, additional research is needed to determine the magnitude and value of these influences.

Research and continuing discussions concerning biodiversity and ecological communities in the context of MillionTreesNYC would also benefit from a focus on specific elements of this diversity rather than on the abstract idea of "biodiversity". For example, discussions might focus on different categories of plants, animals, and microorganisms, and on different types of ecological communities such as salt marshes, forests, freshwater marshes, stream corridors, etc.

Information from such expanded research on biodiversity and ecological communities in the context of MillionTreesNYC — research on both the factors shaping biodiversity in the City, and the benefits that biodiversity provides — could help guide decisions about planting strategies and develop a broader rationale for the protection of biodiversity within MillionTreesNYC and across the City in general.

TOP RESEARCH DIRECTIONS AND QUESTIONS

How do the various types of planting programs affect biodiversity at various scales (i.e. neighborhood, across boroughs, regionally?)

How are social perceptions of planting programs affected by increases in biodiversity?

Do patterns of biodiversity affect the success of tree plantings?

→ Ecosystem Services: Local Air Quality and Urban Heat Island
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GREEN INFRASTRUCTURE AND PLANTING SITE DESIGN

Facilitator: Jacqueline W. T. Lu, New York City Department of Parks & Recreation

Green infrastructure is a term used to describe construction or engineering practices that are designed to mimic natural processes to provide services and enhance overall environmental quality, most often using soil and vegetation to reduce the impacts of stormwater runoff. Street tree planting sites can be designed to reduce impervious surface cover in order to maximize reductions in stormwater runoff, but there are a myriad of factors unrelated to design that can reduce the stormwater reduction benefit of any planting site. For example, soils can be compacted in the process of construction reducing overall infiltration capacity. The great heterogeneity of planting sites makes it difficult to assess the role of design in the success of the planting.

A number of central research questions remain poorly understood. Chief among these is an incomplete understanding of the causes and patterns of street tree success and mortality. This lack of understanding of factors affecting street tree survival, many of which involve design decisions, makes it difficult to evaluate the effectiveness of different planting designs on secondary outcomes such as reduction in stormwater runoff.

These problems are not entirely due to a lack of data, although to date there has been relatively poor coordination of sources of existing data. Additionally, results have not been consistently communicated between researchers and practitioners. The NYC Department of Parks & Recreation has collected a significant amount of survivorship data on street trees through their daily operations, but lacks the resources to perform the complex analyses these large datasets require. Also, while large datasets can potentially be mined to uncover factors affecting tree mortality, there is an inherent tension between the focused, high quality and often high-cost data needed by scientists for research and publications, versus the availability of extensive basic data that tracks completed work and the associated expenditures for management purposes.

Because of these challenges relatively basic research questions still need attention. First, existing survivorship data that can be gleaned from operational records need to be comprehensively analyzed and reported to uncover broad patterns in tree mortality. Second, a comprehensive long-term monitoring protocol should be implemented on a controlled set of planting sites to specifically assess the effectiveness of planting designs on minimizing tree mortality rates. Ideally the monitoring should continue well into the trees' lives and until mortality rates are low and the dominant patterns of mortality are clear. However the long lifespan of trees poses challenges for the sustained, intensive data collection needed for research. Third, a study should be conducted that specifically examines how pit infiltration rates are affected by factors such as planting design, construction and disturbance history, underlying soil types and the surrounding built environment.

→ Ecosystem Services: Local Air Quality and Urban Heat Island
→ Ecosystem Services: Water Quality, Storm water Management
→ Economic Impacts: Quantifying Return on Investment
→ Education
→ Human Health and Well-Being
→ Stewardship and Management
→ Green Jobs and Social Justice
→ Reforestation Dynamics and Forest Health
→ Biodiversity and Ecological Communities
→ Green Infrastructure
→ Implications of Scale

GREEN INFRASTRUCTURE AND PLANTING SITE DESIGN (continued)

IMPEDIMENTS

- Lack a data on what causes tree success and mortality
- Lack of a monitoring protocol
- Poor coordination of existing data
- Research results are not effectively communicated to practitioners
- All "green" elements become the responsibility of Parks, when in fact there are interagency issues
- Difficulty in keeping up with tree maintenance
- Parks has lots of data but not enough resources to analyze it
- Little analysis or follow-up on long-term tree success

SOLUTIONS

- Generate a comprehensive monitoring protocol
- Coordinate interagency solutions to problems
- Develop systems for sharing data

TOP RESEARCH DIRECTIONS AND QUESTIONS

- What have been the outcomes of other previous large-scale tree plantings in other programs? What were the common mistakes made?
- What is the water retention capacity of various tree pit designs?
- Comprehensive monitoring of tree survivorship
- Comprehensive analysis of existing tree mortality data
- Is the quality of surface run-off good for vegetation?
- How much precipitation can street tree canopies actually absorb? What factors affect this?

→ Ecosystem Services: Local Air Quality and Urban Heat Island
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→ Green Infrastructure
→ Implications of Scale

IMPLICATIONS OF SCALE

Facilitator: Keith G. Tidball, Cornell University, Department of Natural Resources

What do we want New York City to "look like"? The scale of observation affects the presentation and perception of the patterns and benefits of MillionTreesNYC. For example, improvements in air quality and human health that result from tree plantings may only be observable (statistically) at broad, borough and citywide scales, or even beyond. However, perceptions of quality of life that are affected by trees may only be observable at the level of neighborhoods or smaller. Political decisions and patterns of public support for management decisions that result from such observations may also be intensely scalar.

In general, it will be important for researchers to recognize scale as a significant factor in detecting the effects of tree plantings. Furthermore, when matters of biological and ecosystem scales do not match with the scale of political and land management decision-making, dialogue will be needed to reach a productive common ground.

When one is attempting to understand the implications of scale for MillionTreesNYC and how it affects the outcomes of the program, four classes of questions are important.

1. **How can we know what scale stakeholders, decision-makers, and implementers see themselves "situated in" (tree, street, block, neighborhood, city, watershed, region, global)? How should observed differences affect policy?**
2. **What is the appropriate scale at which to focus in order to maximize both the biophysical and social impacts of MillionTreesNYC?**
3. **How well do perceptions of scale and the scale at which the program is most effective (i.e., questions 1 and 2) match up?**
4. **How do we measure and interpret results on the implications of scale, and how can results be incorporated into policy that increases the benefits of MillionTreesNYC?**

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IMPLICATIONS OF SCALE (continued)

IMPEDIMENTS

Technological limitations of aerial imagery and other approaches

Political turf battles, or workings of different groups may inhibit discussion at diverse scales of observation

Problems with sharing information

Data quality & quantity

Lack of availability/awareness of current NYC data in usable and accessible forms

Lack of maintenance and evaluation plans for spatial data

Concerns with sustainability, related to forestry norms dealing with 100+ year cycles

General lack of time scale appreciation, resulting in skewed "baselines"

Sustainability of MillionTreesNYC

Lack of money

SOLUTIONS

Coordinated communication and collaboration, on a regular basis

Information dissemination from practitioners to students at universities and USFS

A forum for dialogue among policy makers and managers.

Create intermediate metrics for mid-term data

Attract systems scholars (those looking at scalar issues in other places)

Connect with existing projects that are studying larger scales

Publishing that balances practitioner needs with academic interests

Match people doing research at specific sites with city staff for partnerships with a longer life than the Bloomberg agenda.

TOP RESEARCH DIRECTIONS AND QUESTIONS

How does long-term maintenance affect forest health at different scales?

How do we validate models for carbon sequestration of street trees using MillionTreesNYC campaign?

What are indicators of how to prioritize of where to plant trees?

Examine the ranges of animals and where they go — plant trees to match these patterns. Using GIS and hormone sensing plus aerial imagery.

How do actions at certain scales affect other scales?

How do stewards see their responsibilities (through time)?

→ Ecosystem Services: Local Air Quality and Urban Heat Island
→ Ecosystem Services: Water Quality, Storm water Management
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APPENDIX A – AGENDA

Tuesday 28 April, 2009

6:00–8:00pm

Evening: Welcome kickoff event at Arsenal
The Arsenal roof, 830 Fifth Avenue
(at East 64th Street and Fifth Avenue,
just inside Central Park)

Speakers:

Adrian Benepe, Commissioner, City of New York Parks & Recreation (NYC Parks)

Drew Becher, Executive Director of New York Restoration Project (NYRP)

Lynne Westphal, US Forest Service Northern Research Station

Wednesday 29 April, 2009

8:30–11:00am (breakfast at 8 am)
Opportunities for Research and Collaboration
in the Context of MillionTreesNYC
Gracie Mansion, East End Avenue at 88th Street

Speakers:

Susan Donoghue, Assistant Commissioner for PlaNYC, NYC Parks

Cristiana Fragola and Megan Shane, Directors for MillionTreesNYC, NYC Parks and NYRP

Fiona Watt, Assistant Commissioner for Forestry, Horticulture & Natural Resources, NYC Parks

Morgan Grove, Research Social Scientist, US Forest Service Northern Research Station

P. Timon McPhearson, Assistant Professor of Urban Ecology, The New School

David Maddox, Chief Scientist, Sound Science LLC

11:15am Depart by bus for lunch at
Swindler Cove

11:45–1:00pm Lunch at Swindler Cover
(bag lunch provided)

1:00–5:30pm Field visits to MillionTreesNYC planting and research locations
Locations around New York City

Field visits to MillionTreesNYC planting and research locations across a variety of site typologies such as street trees, public housing grounds and natural area reforestation. At each site there will be presentations and discussion by practitioners and researchers concerning current work, challenges to success, and the needs and opportunities for research.

APPENDIX A – AGENDA (continued)

Thursday 30 April, 2009
8:30am–5:00pm
Federal Building, 290 Broadway (at Duane St), 30th Floor

8:30am Jacqueline Lu "What NYC can offer researchers"

8:50am David Maddox "Introduction to the process of the day"
Small groups to develop thematic research agendas in diverse topics

Facilitated breakout sessions and discussions in small groups, each of which develop a draft research agenda (i.e., research questions) in one of several subject areas. Attendees to participate in two groups; one in the morning and one in the afternoon.

9:00am–12:15pm
Morning discussion groups

Green Infrastructure and Planting Site Design
Ecosystem Services: Local air quality and urban heat island
Biodiversity and Ecological Communities
Economic Impacts (Simon McDonnell)
Human Health, Well-Being, and Quality of Life
Stewardship, civic engagement, social capital

12:15–1:30pm
Lunch (on your own)

1:30–4:45
Afternoon discussion groups

Reforestation Dynamics and Forest Health
Ecosystem Services: Water quality, Stormwater Management
Implications of scale (regional, climate, watersheds, population)
Education
Green Jobs & Social Justice

4:45 End of Day

Friday 1 May, 2009
8:30am–1:15pm
Federal Building, 290 Broadway (at Duane St), 30th Floor

8:30am
Keith G. Tidball, Associate Director of Initiative for Civic Ecology, Cornell University
"Synthesizing an Interdisciplinary Research Agenda"

8:45am
Steward T.A. Pickett, Director, Baltimore Ecosystem Study, Cary Institute of Ecosystem Studies
"Building science collaborations between cities and researchers: Lessons from Baltimore"

9:30am–12:30pm
Review and Q&A for each of Thursday's Topics

Designated Leaders from each Topic Group 15 minutes per group (including discussion). Open discussion, with emphasis on opportunities for collaboration, cross-disciplinary work.

12:30pm–1:00pm Erika Svendsen, US Forest Service
"Thank you, Summary, Products for the Future"

1:15pm Adjourn

APPENDIX B – LIST OF REGISTRANTS AND ATTENDEES

Rohit Aggarwala
Mayor's Office of Long Term Planning & Sustainability

Christine Alfsen
UNESCO

Michael Allegretti
The Climate Group

John Ameroso
Cornell University Cooperative Extension NYC

Ellen Arnstein
New York City Dept. of Parks & Recreation, MillionTreesNYC

Urshula Barbour
Pure + Applied

Martina Barnes
USDA Forest Service Northeastern Area

Heather Barnhardt
US EPA Region 2

Drew Becher
New York Restoration Project

Adrian Benepe
New York City Dept. of Parks & Recreation

Chanda Bennett
New York Aquarium, Wildlife Conservation Society

David Berman
New York City Center for Economic Opportunity

Jessie Braden
New York City Dept. of Parks & Recreation

David Braun
Sound Science LLC

Lorraine Brooks
Cornell University Cooperative Extension NYC

Matthew Brown
Soil Water & Ecology Lab, Central Park Conservancy

Lindsay Campbell
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Ramon J. Cruz
Energy and Environment, Partnership for NYC

Claudia DeMegret
Partnership for Parks

Jessica DiCicco
Prospect Park Alliance

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Alex Felson
Yale University

Gretchen Ferenz
Cornell University Cooperative Extension NYC

Rich Field
US EPA

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Columbia University Dept. of Sociology

Luisa Ford

Todd Forrest
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Isaac Gertman
Pure + Applied

Alisha Goldstein
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Susan Gooberman
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Kevin Griffin
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Morgan Grove
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APPENDIX B – LIST OF REGISTRANTS AND ATTENDEES (continued)

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Youth Ministries for Peace & Justice

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Michael Marrella
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G. Max Zhang
Cornell University Sibley School of Mechanical and Aerospace Engineering

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APPENDIX C – DETAILS PROVIDED TO EACH PARTICIPANT IN THE SITE VISITS

Field Site Visit Information

After a bag lunch at Swindler Cove, we will visit three different planting locations across a variety of site typologies. The following gives specific information on the sites and presenters.

Swindler Cove Park

Swindler Cove Park is a 5-acre park New York Restoration Project (NYRP) helped create in northern Manhattan on the site of what was once an illegal dumping ground on the Harlem River. Opened to the public in August 2003, Swindler Cove Park represents the full spectrum of NYRP's efforts to reclaim open space as a catalyst for community revitalization and environmental conservation.

From 1996 to 1999, NYRP removed thousands of tons of garbage, construction debris, and sunken boats from this waterfront site. NYRP partnered with the State of New York Department of Transportation to transform the reclaimed land into a magnificent riverfront park, for which NYRP has been designated the official caretaker by the New York City Department of Parks & Recreation. With a garden and planting design by landscape designer Billie Cohen, Swindler Cove Park now features restored wetlands, native plantings, a freshwater pond, and gracious pathways. The park is also home to our Riley-Levin Children's Garden, where youngsters from nearby public schools tend their own beds of vegetables, flowers, and herbs through free in-school, after-school, and summer programs.

The park also features our Peter Jay Sharp Boathouse. Opened in June 2004, this unique floating structure is where NYRP and partner New York Rowing Association introduce local children and adults to the Olympic sport of rowing, which once flourished on the Harlem River. Our ultimate goal is that by participating in boathouse programs, at-risk youngsters will develop important life and leadership skills and be led to athletic scholarships at American universities with rowing programs.

New York City Housing Authority: Throggs Neck Development

A TREE PLANTING PARTNERSHIP

Under MillionTreesNYC, NYRP is charged with pursuing tree planting opportunities in publicly-accessible properties across New York City. In an effort to identify large-scale tree planting opportunities, NYRP has worked to cultivate planting partnerships with many of the city's major institutional landholders. Since the initiative's launch, NYRP's principal planting partner has been the New York City Housing Authority.

The New York City Housing Authority (NYCHA) is the largest public housing authority in North America, having jurisdiction over approximately 178,426 apartments at 343 developments in 2,618 buildings across the five boroughs of New York City. NYCHA has 173,731 families living in its developments and 403,370 residents. Based on the 2000 Census, NYCHA represents 8.3% of NYC's rental apartments and is home to 5% of the City's population. The Throggs Neck Development (including an addition built in 1971) has 33 three to eleven story buildings with 1,469 housing units and a total of 3,460 residents. Citywide, NYCHA has approximately 2,600 acres of open space on its grounds.

On March 23, 2009 NYRP donated and planted 103 trees on the lawns of the Throggs Neck NYCHA Housing Development. The species planted is based on the Department of Parks & Recreation's (NYC Parks) recommended street tree list, modified to include tree species suitable for lawn plantings. NYRP mainly plants large shade-providing tree species to achieve the greatest environmental and energy saving benefits; smaller stature species are planted in smaller lawn areas. NYRP does not plant any Asian Longhorn Beetle host species, as 45% of the trees in NYC are species are susceptible to this pest. NYRP also works closely with NYCHA to cultivate and support resident-based tree maintenance and protection. The recent launch of NYCHA's own greening initiative provides a framework to encourage resident involvement in MillionTreesNYC activities.

APPENDIX C – DETAILS PROVIDED TO EACH PARTICIPANT IN THE SITE VISITS

(continued)

NYCHA COMMUNITY GARDENS

The objective of the NYCHA Garden & Greening Program is to support public housing residents who beautify the grounds of housing developments by cultivating flower, vegetable or theme gardens. Since the program began in the 1960s, it has grown to include about 650 active gardens on NYCHA grounds and have 3,000 gardeners, approximately 2,700 who are youth. The Housing Authority's Garden & Greening Program provides material resources such as free seeds, bulbs, compost and technical assistance to the New York City Housing Authority's residents' gardens annually. 0f the 650 gardens, approximately 500 participate in an annual garden competition.

Bronx Street Tree Planting

STREET TREE PLANTING AND ITS TRANSFORMATIVE EFFECT ON THE SOUTH BRONX

The New York City Department of Parks & Recreation developed the Greening Morrisania Community Forestry Management Plan in 2006, which proposed 90% stocking of street trees by 2016 in a neighborhood with high childhood asthma rates and few trees. Thanks to PlaNYC funded Block Plantings, the Yankee Restitution Project and grant funding from NYSERDA (New York State Energy Research Development Authority) NYC Parks is on track to exceed this goal and complete 100% street tree stocking before the end of 2010. What follows is a brief description of three projects and their impact on the target area.

- Parks' block-planting contracts target low canopy neighborhoods with a relatively high population. Much of the South Bronx fits into this category. Each season a large portion of the budget allocated to block planting is spent in the South Bronx
- During the construction phase of the new Yankee stadium a large number of trees were removed; in an effort to mitigate the impact on the community the city sponsored the planting of some 8,000 trees in the surrounding area — now nearly halfway complete. Trees planted under the Yankee Project are 3.5–4" in caliper, larger than those normally planted by Parks therefore making a greater immediate impact than our typical street tree planting (2.5–3").
- The NYSERDA grant ($1.75 million) allowed us to pilot a number of innovative planting techniques (e.g. structural soil, root breakout zones, under-plantings), install iron tree guards as well as hire a full time staff member to focus on community outreach and education. The funding will result in over 600 trees and 90 tree guards in Morrisania (213 trees are in the ground).

Pelham Bay Park, Hunter Island

PLANYC REFORESTATION

PlaNYC Reforestation is one of 127 initiatives launched by Mayor Bloomberg on Earth Day 2007 to make New York City greener and greater by 2030. The reforestation initiative builds on the forest restoration work that NYC Parks' Natural Resources Group (NRG) has been conducting since 1984. PlaNYC Reforestation has increased the scale and scope of forest restoration in New York City, committing the City to forest 2,000 acres of public land by 2017. Expanding forested areas within New York City will help to improve environmental quality within the city today, and help us adapt to climate change in the future. Some of the expected benefits of reforestation include reduction of the urban heat island effect, improvement of air quality, reduction of stormwater surges, and improvement of species diversity and habitat quality within the City. Over the last year and a half, Parks has planted 82,995 trees through the reforestation program. This spring, forest restoration plantings will include planting over 35,000 native trees.

Forest restoration sites mimic natural forest succession, where many trees sprout in woodland openings, gradually thinning out as they grow larger and compete with each other for the available space. Growing close together, the new trees quickly fill the woodland opening and the process repeats itself elsewhere in the forest. In urban areas the natural progression of new forest growth needs human intervention to first remedy degraded soils, re-introduce native trees in areas that have been isolated from natural seed dispersal, and keep invasive plants from overwhelming the new plantings until the trees have grown to establish a new forest.

APPENDIX C – DETAILS PROVIDED TO EACH PARTICIPANT IN THE SITE VISITS

(continued)

Pelham Bay Park, at over 2,700 acres, is New York City's largest park. Among the habitats found in Pelham Bay Park are nearly 200 acres of salt marsh and nearly 800 acres of forest, many of them in several Forever Wild Nature Preserves. Forested habitat supports interior-dependent area sensitive passerines including Wood Thrush, Red-eyed Vireo and White-breasted Nuthatch. Hunter Island is a section of Pelham Bay Park that bears the name of former owner John Hunter, an auctioneer, and collector of fine objects. Hunter's Mansion, built between 1803 and 1811, was constructed and landscaped at great cost. The mansion sat at the highest point on the island where traces of Hunter's gardens still remain. Hunter Island is connected to the rest of Pelham Bay Park by the Orchard Beach parking lot that was created by Robert Moses on fill in the 1930s.

NRG's forest restoration work at Hunter Island started with the Urban Forest and Education Program (UFEP) program in 1994. The restoration work in the 1990s focused on improving the quality of the existing forest by removing invasive plants, and planting native trees and shrubs in gaps and edges of the forest. The current forest restoration work being led by Rich Love began in 2007. Over the last two years, Rich Love's crew has been continuing the restoration within the existing forested area, as well as beginning to expand the forest edge into a patch of invasive vines between the forested area and the Orchard Beach parking lot. The restoration work in this area has focused on the removal of invasive vines such as multiflora rose, oriental bittersweet, and porcelain berry, and planting of native trees. Tree species planted include red maple, eastern red cedar, tupelo, pin oak, and white birch. Overtime, the area would undergo natural succession from manicured lawn to northern hardwood forest. The restoration work is supports this natural process in order to improve the ecological and public health benefits of expanded forests in New York City.

PELHAM PARKWAY AT BURR AVENUE (DRIVE BY VIEW)

The site along Pelham Parkway at Burr Avenue was chosen as a forest restoration site to expand on existing forest canopy, reduce air and noise pollution, and beautify the Bronx. This site provided a good opportunity for forest restoration as it was previously a large undeilized lawn area adjacent to the Pelham Parkway and the Bruckner Expressway. New forest at this location will reduce noise and air pollution from the highways, provide habitat and ecological benefits, as well as reduce City maintenance costs. During the spring and fall of 2008, 2,982 native trees were planted at the site to create a new forest. Small trees were planted by Parks staff and volunteers, and larger trees were planted by contractors.