Final Report to the USDA Forest Service for the *Urban Canopy Enhancements through Interactive Mapping Project* in New York City

A Project funded through the Forest Service's Title VIII Urban and Community Forestry Program
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Background

The "Urban Canopy Enhancements through Interactive Mapping" project builds on the OASIS application launched in 2001 in New York City. OASIS – the Open Accessible Space Information System – is the city's first interactive mapping website dedicated to open space resources. It was developed by NYPIRG's Community Mapping Assistance Project (CMAP) for the USDA Forest Service and a coalition of more than 40 nonprofit organizations, government agencies, businesses, and academic institutions, including the city's Department of Parks and Recreation, the NYC Environmental Justice Alliance, and the New York Restoration Project. The award-winning site – www.oasisnyc.net – enhances the stewardship of open space by providing comprehensive and detailed information about the "green infrastructure" of the city.

In Spring 2001, the Forest Service awarded a Title VIII grant to NYPIRG CMAP to enhance and expand OASIS with a focus on neighborhood trees. The purpose of the grant was to ensure that new data about neighborhood trees and the urban canopy in New York City is delivered to a wide audience of decision makers, greening advocates, the media, and community residents using Internet-based mapping tools, sophisticated data analysis, and a team of on-the-ground community based groups. The grant supported the work of several partner organizations in this effort: CMAP, Council on the Environment of New York City (CENYC), Trees New York, the Environmental Systems Research Institute (ESRI), and the State University of New York's School of Environmental Science and Forestry (SUNY-ESF) working with the Forest Service's Northeastern Research Station. The project also benefited from in-kind matches from each of these organizations, as well as other participants in the OASIS partnership such as the NYC Department of Parks and Recreation.

The partners included the following teams:

NYPIRG CMAP	CENYC	Trees New York	ESRI	Northeastern Research Station/SUNY-ESF
Steven Romalewski	Lenny Librizzi	Mat Cahill	Johan Herrlin	David Nowak
Christy Knight	Meredith Olson	Susan Gooberman	Dave LaShell	Jeffrey Walton
Marty DeBenedictis				
Meg McCarron				
Kim Morehouse				

The project's goals were to:

1. improve public understanding of and participation in the management of New York City's urban forest;
2. expand the analytical understanding of the impact of urban trees on environmental health;

3. help close the loop among community residents who benefit directly from urban forests, resource managers and researchers responsible for maintaining the forests, and decision makers who develop policies that affect the forests; and
4. help demonstrate the use of technology to improve urban forest management, in a way that is transferable to other cities and communities across the country.

The objectives for achieving these aims included:

1. enhancing the OASIS website as a tool to provide information about neighborhood trees and urban forest resources, including the development of maps and map layers that can be used to select best locations to plant trees and calculate tree benefits/values;
2. analyzing street tree data collected in the selected neighborhoods (e.g., carbon storage, air pollution removal, tree values);
3. using and testing geographic information systems (GIS) as a vehicle for improved tree data collection, education about the power of computer mapping to address urban canopy issues; and
4. developing a user-friendly manual for other communities in New York City and throughout the country to identify areas for tree planting that will have the maximum impact on human health and environmental quality.

Methodology

The grant envisioned that local teams of Citizen Pruners and educators would be trained in computer mapping technology to use the data-rich maps, images, and statistics from OASIS in order to target their efforts to identify and maintain neighborhood trees. The Citizen Pruner program is an existing initiative sponsored by Trees New York to train and certify local volunteers in neighborhood tree identification and stewardship. Through the Title VIII grant, the Citizen Pruner program was enhanced by incorporating a computer mapping element. The Pruners used OASIS's maps to help them undertake a neighborhood tree inventory, and then provided the inventory data back to OASIS so the tree locations could be displayed interactively in relation to other open space resources.

The effort was undertaken in the following three communities in New York City, each one chosen to obtain a mix of neighborhood tree characteristics:

- South Bronx: this area has fewer trees than most other areas in the city and has vacant land and other potential tree planting sites;

- North Shore of Staten Island: specifically the area east of Snug Harbor, which is a low rise neighborhood with mostly 1 and 2 family homes and a large number of street and yard trees; and

- Lower East Side of Manhattan: a more densely populated area than the South Bronx or the Staten Island's North Shore and has a large number of street trees with an active community stewardship presence.

The OASIS Title VIII project focused on how neighborhood tree data can be collected by community partners, enhanced through computer mapping and analysis, and returned to the community and others through a sophisticated, web-based delivery mechanism. Therefore, the geographic scope of the project was intentionally limited. The project's resources prevented the

partners from surveying the entire city, and others such as the city Parks Department's Central Forestry Office already have developed comprehensive tree inventory databases.

The tree data collected by the Citizen Pruners were also used by the Northeastern Research Station and SUNY-ESF to analyze individual tree effects using the Urban Forest Effects (UFORE) model. Individual tree effects (e.g., air pollution removal, carbon storage) were then mapped to each tree in GIS. High-resolution digital tree, grass, and impervious cover maps were also produced using 3-foot resolution color infra-red images from Emerge Corp. These maps were combined with other GIS data including population statistics to help prioritize areas for local tree planting.

CMAP integrated the results of this inventory and analysis into the OASIS website, in order to make the results widely available to decision-makers, greening advocates, media, and community residents. The web-based GIS tools at OASIS will enable these constituencies to visualize how local data analysis can create a picture of the extent of green resources in a neighborhood. OASIS users will now be able to click on a particular tree to see its environmental and public health benefits, and then can share this information with local policy makers by creating their own customized maps of the information. They can also display cover maps of the three communities, highlighting the pollution removal characteristics of trees in these neighborhoods, as well as the best areas of planting new trees.

The Title VIII project partners are also at work on the final outcome of the project: the preparation of a manual explaining to other communities how local tree data can be collected and incorporated into a GIS – on the web or on local computers – to analyze the benefits of neighborhood trees. The partners are working closely with the NYC Department of Parks and Recreation and local community groups to prepare this manual in a way that best assists the Parks Department and neighborhood groups.

Citizen Pruner Tree Surveys

The Title VIII project was launched on May 16, 2001 when the project partners met to develop a detailed timeline and plan of action for each component. During spring 2001, CMAP, Trees New York, and the Forest Service's David Nowak – one of the nation's top experts on urban tree analysis – worked together to modify the Citizen Pruner course materials and tree survey forms so the data to be collected would be included seamlessly in the OASIS website. Questions on the final survey form were determined by the variables needed for the Northeastern Research Station to determine tree value and air pollution removal and carbon storage effects, information that was important for the city Parks Department's forestry needs, and location information important for computer mapping needs. The updated Citizens Pruner manual was compiled primarily by Mat Cahill of Trees New York using existing tree information, GIS training materials, and information about OASIS. The partners worked collaboratively on the specific instructions on data collection, the use of the measuring tools, and information pages that would be helpful to the data collectors.

CENYC and Trees New York developed a training schedule for late summer/early fall 2001, with assistance from ESRI to secure training space with computers and Internet connections. The partners had begun researching the possibilities for equipping some of the Citizen Pruners with ESRI's ArcPad software on handheld computers. Also, the partners met with other members of the OASIS steering committee to begin outlining modifications to the OASIS mapping functionality and web interface that will accommodate data collected by the Citizen Pruners.

The tragic events of September 11, 2001 forced much of this work to be delayed, but by Spring 2002 the Citizen Pruner courses had been rescheduled and the tree inventory plans were again in full swing. During that time, some of the Title VIII work had continued, including enhancements to the OASIS website to accommodate new information about trees and open spaces, parks, and community gardens. An initial urban canopy analysis by the Forest Service's David Nowak and his Northeastern Research Station team and SUNY-ESF had also proceeded and was incorporated into OASIS.

Between CENYC and Trees New York, the Pruners were trained and deployed to collect tree data in the three communities, with CENYC focusing on Staten Island's North Shore and Trees New York on the South Bronx and Manhattan's Lower East Side. The partner groups also used two different collection methods to determine the best way to gather tree information:

- paper surveys: the Pruners in the South Bronx and the Lower East Side used a printed survey prepared by Trees New York, supplemented with printed maps from OASIS and CENYC (including aerial photographs from OASIS), to collect tree information and location. The tree locations noted on the printed maps were entered into an ArcPad application written by ESRI at desktop computers at Trees New York's office through "heads-up" digitizing (manually adding the locations onto the computer screen using the approximate location on paper); and

- hand-held computers using ESRI's ArcPad software: the Pruners on Staten Island entered tree information directly into the ArcPad application installed on a hand-held computer, with the tree locations plotted automatically each time a Pruner clicked at the appropriate location on a map displayed on the ArcPad hand-held screen.

Recruiting Pruners

Citizen Pruners for the Title VIII project were recruited from people who had taken earlier Pruner classes. On Staten Island, CENYC sent a letter (attached) to approximately 50 people who had taken the Citizen Pruner class on Staten Island. Twelve people expressed an interest and 11 took the Title VIII classes. CENYC divided the classes into two 2-hour indoor sessions and one 3-hour field session. Students were asked to attend all 3 sessions and commit to 10 hours of tree surveying. Class attendance was almost perfect. Scheduling conflicts caused 2 students to miss one of the classes each. Not all of the students contributed the 10 hours of surveying time. The extreme heat of the summer was probably the biggest contributing factor although a couple of students felt that even though this was a pilot project that the task of potentially surveying all of the trees in Staten Island was too overwhelming.

Trees New York held two separate classes, one in Community Board 3 in Manhattan and the other in Community Board 2 in the Bronx. The course consisted of two 2-hour classroom sessions and one 4-hour field session. Manhattan classes were held on Tuesdays and Bronx classes were held on Wednesdays. The Manhattan class had a very large response to the letter sent out to the Citizen Pruners who lived in the area. Twenty-four pruners responded to the letter, 15 of which were accepted into the class. Class size was limited due to the number of computers available in the classroom. In the Bronx, 7 students responded to the letter but only 3 of the students attended all the classes. Students who were turned

away from the Manhattan class were told that they could attend the Bronx class, but none did.

ArcPad and Handheld
The Title VIII grant enabled the partners to purchase a Hewlett Packard Jornada pocket PC model 568, with Microsoft® Pocket PC Software 2002 operating system and 64 MB of RAM and a 206 MHz processor; enough memory and computing power to run ArcPad with the necessary base map and layers.

The project also purchased an optional camera attachment, HP Jornada pocket camera (F1869A#ABA).

ESRI – the worldwide leader in GIS software and applications, and one of the founders of the OASIS project – donated 6 copies of ArcPad and its Application Builder, as part of ESRI's in-kind matching support for the Title VIII project. Johan Herrlin from ESRI's New York City office worked closely with the Title VIII partners to develop a customized application for the Citizen Pruners to use ArcPad to collect tree inventory data, and most importantly the geographic location of the trees. This included determining the variables and layout for the data forms for the field collecting. He stressed the importance of being able to validate entries, so for as many entries as possible drop down lists were used.

The tree identification entry included a slider bar with leaf images to aid in the identification process (see photo at right).

The foliage density entry included a GIF image which showed the user what a tree canopy value would look like in 10% increments from 5% to 95% (see photo at left).

The tree identification leaf images and the foliage density image were also included in the printed data collection instructions which were laminated for outdoor use. Other entries such as diameter breast height (dbh) and tree height also had built in error

messages which would prompt the data collector to verify an entry that was higher than the range of expected values. Certain data entries were required before the user would be allowed to move to the next data form or complete the entry (see photo at right).

Maps and Data

Paper maps were produced by Christy Knight of CMAP for all three study areas which included building footprint, street and street case layers. Other maps were produced of the aerial photos and from infrared aerial imagery obtained with Title VIII funds from the EMERGE company.

For the handheld, an ArcView project was created from an area of Staten Island's north shore clipped from New York City's new Basemap, which included borough boundary, streets, tax block, and building footprint layers (see photo below).

This basemap was loaded onto the handheld along with the ArcPad application.

Securing classroom space

Finding classroom space that was free or low cost, with enough computers, internet access, availability when we needed to use the space, and a convenient location was not easy. The process was also complicated by the events of September 11, 2001. Our initial plans were to start classes in September of 2001 and schedule field work in the fall and spring. But the CENYC, Trees New York, and CMAP offices are all located in lower Manhattan, and phone and internet access in our offices was difficult or impossible in the aftermath of 9/11. Therefore, we decided to postpone the classes until Spring 2002.

For Staten Island, Covenant House on Bay Street had a computer classroom that was available. CENYC agreed to assist GED students in their class project to turn the small area behind the building into a garden/outdoor classroom in exchange for use of the classroom space. Internet access was limited but we worked around that by creating a PowerPoint presentation which included screen shots from the OASIS web site, photos and other information about the project.

For Manhattan, classroom space was provided through University Settlement. Located at 184 Eldridge Street, the classroom was in the basement of their building. There were 15 computers, all with internet access. At times the connection was very slow, causing delays in the class agenda, but it did not cause any serious delays. It was a good location with several subway stops near by, making it ideal for students to get to. For the Bronx, classroom space was through the Seneca Center in Hunts Point. Located at 1241 Lafayette Avenue, the center had many computers available, but most were very old. Internet connection speeds were fair, but also slowed down the progression of the class. There was only one subway nearby, so the students that came regularly were the ones who lived close by.

Preparing Curriculum
The new Citizen Pruner manual that had been prepared by Trees New York was used as the primary text for all three communities. A PowerPoint presentation which included screen shots from the OASIS web site, photos, and other information about the project was the second important piece of the curriculum.

Classes
For the Staten Island group, Lenny Librizzi of CENYC trained 11 citizen pruners in 2 classroom sessions and a field session (7 hours total). In the Bronx, 3 students attended all the classes. The classes covered the following topics:

1. Introduction to OASIS and GIS and review of tree identification
   In each of the initial classes, CENYC and Trees New York used a PowerPoint presentation that introduced the Title VIII project, provided some basics on GIS, and showed screen shots of the OASIS web site that led the class through the process of searching for and accessing maps. The National Arbor Day Foundation's online tree identification pages were also used for review of tree identification.

2. Data collecting parameters, equipment, and ArcPad
   The second class included an in-depth review of the data collection form both on paper and on the handheld. The class reviewed the equipment that we would be using; measuring wheel, diameter measuring tapes, Biltmore stick and clinometer. For the Staten Island group, the class also looked at the use of the handheld and the ArcPad application.

The Staten Island field class was held on a Saturday morning. Each student was given the opportunity to learn the use of the Biltmore stick, clinometer, measuring wheel, diameter measuring tape and Arc Pad. The field class was divided into groups of 3 and collected data using a handheld device (HP Jornada) with the custom application for ArcPad allowing for trees to be located directly on the base map. The base map included streets and building footprints for the data collection area. The extra field surveyors used paper survey forms and paper maps. With only one handheld the 11 students did not get enough time to learn the handheld and its quirks. For example the amount of pressure exerted on the screen varied from person to person and some students would often double tap the screen which would halt the initial operation and sometimes cause the unit to freeze up. Most of the students could not master the use of the clinometer and it was not used in any of the subsequent outings.

Fieldwork
On Staten Island, six outings were held in addition to the fieldwork class, and the Pruners collected data on 212 trees. They were held on July 8th and 14th 2002, August 2nd, 3rd, and 23rd 2002 and September 16th 2002.

In Manhattan, data were collected for 62 trees in Manhattan. In the Bronx, data were collected for 50 trees. The Manhattan class was much larger so students could be spread throughout the study area further than they were in the Bronx. This reduced, in part, the number of trees measured because students spent time walking from the initial meeting point to their survey area. However, in the Bronx, with a much smaller class size, students were still able to measure a good deal of trees. This was due to the fact that near the meeting point there were many recently planted trees. The final distribution of the measured trees throughout the study area was larger in Manhattan than it was in the Bronx for those reasons.

Measuring tree height

Where data were collected on paper survey forms and maps the trees were located on the paper maps and coded on the survey form by location. The location, species and condition codes and pit condition list were all included on the printed data collection instructions. These data were later entered onto the ArcPad project on a desktop computer in CENYC's office which is synchronized with the handheld device. The other tree data were collected and entered directly through ArcPad on the HP handheld device.

Measurements were taken in feet for height, canopy and height to crown. Tree heights and height to canopy were measured in feet using a Biltmore stick. Canopy was measured in feet using a measuring wheel or 100 ft tape measure and taking the average of 2 perpendicular measurements. The height and canopy measurements were difficult where there were a number of large trees

planted closely together. DBH was measured in inches and tenths of an inch at 4.5 feet height using a diameter tape measure. Tree age was determined using DBH and multiplying by a factor from 3 to 8 based on a tree list which was included in the printed data collection instructions. Where the species was not listed we used an average factor of 4.

Pruners names, the date, the address of the property and location (front, side, etc.) were entered. Pruners using printed surveys indicated the location of each tree on a printed map that included building footprints. When the printed forms were brought back in from the field, the locations for these trees were entered electronically into the ArcPad application at CENYC's office. Pruners using ArcPad in the field placed a point directly on the digital ArcPad map along the closest building footprint displayed on the map. Street addresses or tax lot boundaries were not used in the ArcPad project because the addresses were not specific enough, and the GIS boundary layer for tax lots would was too large for the handheld. The building footprint layer, provided by the New York City Department of Information Technology and Telecommunications as part of the city's new Basemap project, was more useful for locating the trees.

Pruners were given several tree ID aids to help determine species. On the handheld, a scrollbar was utilized and whatever choice was left on the screen was entered into the database. Unknown species were left unknown. There were none in the Staten Island data. "Other" species were entered with the botanical name. The Pruners also used several tree identification booklets and manuals.

Condition was limited to Excellent, Good, Poor or Dead with description of the parameters of each category included in the data collection instructions. Pit size was measured in square feet. Pit Condition was entered from a predetermined list, a drop down list on the handheld. The list is included in the attached instruction sheet. Comments were included where they were important.

Data Maintenance and Verification
The Title VIII partners experienced some problems with downloading the data and ensuring that it remained accurate and inclusive. The partners always kept a backup file to make sure all of the work was not lost. The database was reviewed for errors or corrections that were needed and submitted the verified data to the Forest Service's Northeastern Research Station.

In Manhattan and the Bronx, data was collected on paper inventory sheets. The data from those sheets was then input directly into the ArcPad program on a desktop PC. This caused more indoor work for the project coordinator, but enabled more students to work simultaneously while in the field. The limiting factor of the handheld device is the cost. However it provides for greater input accuracy and easy data transfer into ArcPad. While inputting the data into ArcPad, several issues arose, including the following:

1. DBH and tree age are rounded to the nearest whole number when using the Identify tool;
2. When choosing Other from Species drop menu, the species name must be the last thing entered or else it is not saved;
3. The Location drop menu does not contain the Back option;
4. Whenever the "no pit" option is chosen for a tree, the Pit Condition drop menu remains empty for the duration of the session;
5. When using the Information tool, trees that have Other species names seem to change species randomly; and
6. Photographs are not associated with trees, neither in the view nor in the database.

These issues have been resolved in the updated version of the ArcPad application.

Results: Individual Street Tree Inventory and Urban Forest Canopy Analysis

By Fall 2002 the Citizen Pruner data collection was complete. Tree inventory results in the three communities were as follows:

1. South Bronx:

   - 3 Pruners
   - 50 trees inventoried
   - Pruners used printed maps and survey forms

2. North Shore of Staten Island:

   - 11 Citizen Pruners
   - 212 trees inventoried
   - Pruners used ArcPad on a handheld computer

3. Lower East Side of Manhattan:

   - 15 Pruners
   - 60 trees inventoried
   - Pruners used printed maps and survey forms

Interesting statistics were compiled for the 212 trees surveyed on Staten Island, such as the following:

- 41 species are represented. The most common were Platanus x acerifolia with 64 trees or 30% and Acer platanoides with 30 trees or 14%;
- the estimated tree age ranged from 9 years to 320 years old with 80 or 38% estimated to be 100 or more years old. The 5 trees estimated at 200 or more years included a 58 inch Platanus x acerifolia estimated to be 200 years old, a 54 inch Liriodendron tulipifera estimated to be 214 years old, a 27 inch Aesculus hippocastanum estimated to be 216 years old, a 39 inch Fagus sylvatica estimated to be 234 years old and a 40 inch Aesculus hippocastanum estimated to be 320 years old. The median age is 74 years and the mean age is 77 years; and
- DBH ranged from 3 to 58 inches. The mean and the median are both 19". There were 10 trees measured at 28 inches; 11 trees measured at 8 inches and 13 trees measured at 7 inches. Eight trees were measured at 40 or more inches in diameter.

The tree survey data collected by the Citizen Pruners were submitted to the Forest Service's Northeastern Research Station to be analyzed by SUNY's School of Environmental Science and Forestry, using the Urban Forest Effects (UFORE) model to determine individual tree carbon storage, annual carbon sequestration and carbon value; air pollution removal and value; and tree compensatory value based on the Council of Tree and Landscape Appraisers. Results for individual trees were mapped to their specific location on a map using GIS. This process and its results are discussed in more detail in the Project Summary Report prepared by the Northeastern Research Station.

The UFORE model was used to calculate the following results for each tree:

- Ground area (square meters) – the area of the tree canopy projected to the ground.
- Leaf area (square meters) – the amount of leaf area (one-side) in the tree.
- Leaf area index – leaf area divided by ground area.
- Leaf biomass (kg) – the dry weight of the leaf biomass.
- Carbon storage (kg) – amount of carbon currently stored within the tree (this carbon has been accumulated over the life of the tree).
- Carbon storage value ($) – value of the carbon storage based on the estimated marginal social costs of carbon dioxide emissions of $20.3 tC.
- Gross carbon sequestration (kg / yr) – estimated amount of carbon to be accumulated over the next year due to tree growth.
- Gross carbon sequestration value ($ / yr) - value of the carbon sequestration based on the estimated marginal social costs of carbon dioxide emissions of $20.3 tC.
- Structural tree value ($) – value of tree based on a combination of Council of Tree and Landscape Appraisers (CTLA) formulas.
- Native or Exotic – Is the tree native to New York State (Yes or No).
- Pollution removal (gram / yr) – amount of carbon monoxide, nitrogen dioxide, ozone, particulate matter less than 10 microns, and sulfur dioxide removed by the tree based on 2000 pollution and weather conditions.
- Pollution removal value ($ / yr) – value of pollution removal based on median externality values for United States for each pollutant.
- Volatile organic compound emissions (gram / yr) – annual emissions of isoprene, monoterpene and other volatile organic compounds based on 2000 weather conditions.

Individual Tree Results
Results of the analysis reveal that the 322 inventoried street trees:

- store approximately 203 metric tons of carbon ($4,100 value);
- remove about 4.3 metric tons of carbon annually ($90 value);
- have a structural or compensatory value of around $1 million;
- remove about 228 kg of pollution per year ($1,250 annual value):
    - 99 kg of ozone ($670 annual value)
    - 51 kg of nitrogen dioxide ($345)
    - 38 kg of particulate matter less than 10 microns ($170)
    - 28 kg of sulfur dioxide ($45)
    - 12 kg of carbon monoxide ($12); and
- emit approximately 80 kg of volatile organic compounds annually:
    - 52 kg of isoprene
    - 9 kg of monoterpenes
    - 20 kg of other volatile organic compounds

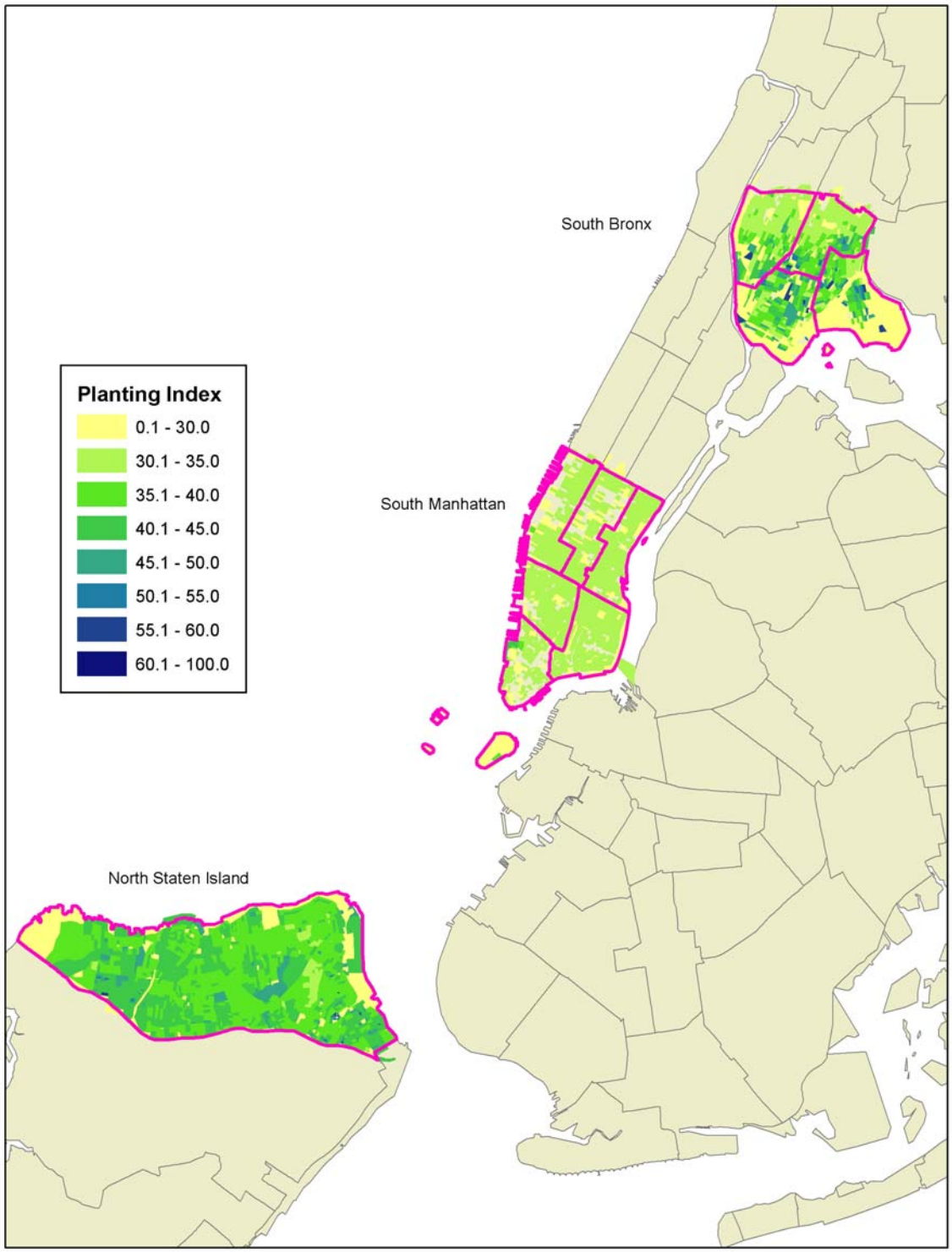
Individual tree results can be found in the tables included with this report.

Best Areas to Plant New Trees
The Northeastern Research Station and SUNY-ESF also prepared a digital "cover map" of the three neighborhoods surveyed through the Title VIII project, based on color infrared images (3-foot resolution) collected in September 2001 by EMERGE Corporation. The cover map classifies each pixel of the image as either tree/shrub, grass/soil, impervious (building or other) or water. The intent was to use the cover map to help determine the best areas for tree planting in the three communities, as well as to calculate pollution removal and economic benefits of trees on a neighborhood-by-neighborhood basis.

To determine the best locations to plant trees, data from the cover map were used in conjunction with 2000 U.S. Census data to produce an index of planting priority. Index values were produced for each census block with the higher the index value, the higher the priority of the area for tree planting. The criteria used to make the index were:

- Population density: the greater the population density, the greater the priority for tree planting;
- Tree stocking levels: the lower the tree stocking level (the percent of available greenspace (tree, grass, and soil cover areas) that is occupied by tree canopies), the greater the priority for tree planting; and
- Tree cover per capita: the lower the amount of tree canopy cover per capita (m^2/capita), the greater the priority for tree planting.

Each criteria was standardized on a scale of 0 to 1 with 1 representing the Census block with the highest value in relation to priority of tree planting (in other words, the census block with highest population density, lowest stocking density, or lowest tree cover per capita were standardized to a rating of 1). Individual scores were combined based on a formula to produce an overall priority index value between 0 and 100. Based on this index, planting priority maps were produced. An overview map from the Northeastern Research Station and SUNY-ESF is reproduced below:



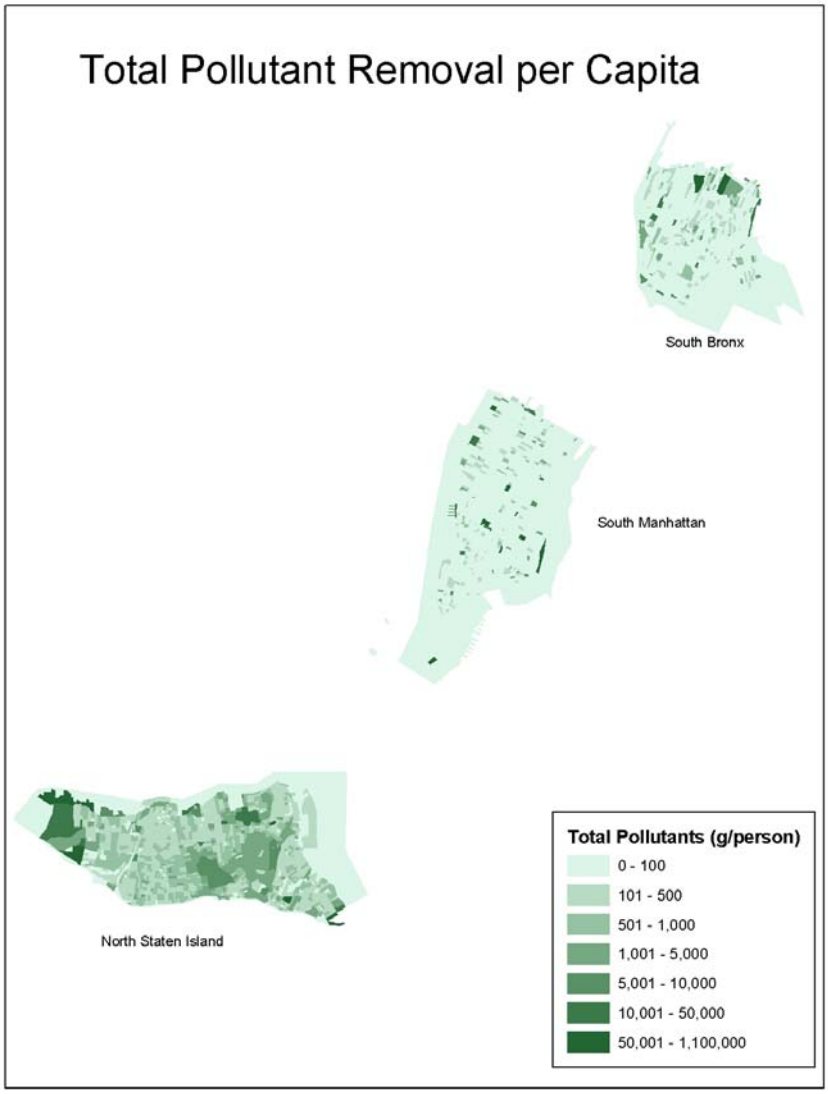
Priority planting index for three communities (100 = highest priority)

Pollution Removal Analysis

Based on the UFORE analyses, a total of 143 metric tons of pollution in 2000 ($814,000 annual value) is estimated to be removed by trees annually in the three areas, as follows:

Pollutant	Pollutant Removal (metric tons) South Bronx	South Manhattan	N. Staten Island
Ozone	7.8	6.7	45.6
Particulate matter less than 10 µm	4.6	5.9	19.4
Nitrogen dioxide	4.9	7.3	25.1
Sulfur dioxide	3.5	1.8	3.2
Carbon monoxide	1.4	1.4	4.7
Total	22.2	23.2	98.0

An overview map displaying pollution removal per capita based on the urban canopy in each of the three Title VIII areas, as prepared by Northeastern Research Station and SUNY-ESF, is reproduced below:



The quantitative results of this Title VIII project – the individual tree locations, details about each tree's environmental and economic benefits, and the digital cover map for each community indicating the best areas for tree planting – as well as this report and the project summary from Northeastern Research Station/SUNY-ESF, are available at the OASIS website (www.oasisnyc.net).

Conclusions & Recommendations

Much of these final notes will be included in a more detailed "how-to" manual that is being prepared by the Title VIII partners in collaboration with the Parks Department, NYC Environmental Justice Alliance, and the Forest Service.

Tree inventory training and data collection
In the course of this project the partners learned through trial and error and began to find areas where more work needs to be done and where we could improve the project. We were able to compare using the handheld device with entering information on paper and then transferring that information to the database.

It became clear that collecting all of the information that we wanted was very time consuming but was the only way that it could be done to satisfy the data needs of the researchers and for the OASIS web site. Setting up data collection outings was difficult because of scheduling conflicts. The extreme heat in summer 2002 also limited the times we could hold outings. Using the handheld did save time and an extra step but having only one handheld was a limiting factor.

The handheld had some limitations which have been fixed in the updated version of the application. The most important improvement to the application is to be able to include the file name of the photo taken of the tree in the database with the tree data. These devices can be intimidating to some people. On one occasion where several students had a fieldwork session without the instructor, none of the students could figure out how to start the application. Youth and familiarity with computers in general will determine the users who feel most comfortable with the device. The handheld can be set to be more or less sensitive to pressure from the stylus. This setting would be problematic to change each time when a number of people are using it. Some users have a habit of tapping the screen twice which tends to freeze the application.

Most of the surveyors were interested in doing work in their own neighborhoods. Setting up an ongoing project/system to allow more data to be collected and inputted would be a suggested next step.

Residents tended to be interested in what we were doing and how the information was going to be used. A few were suspicious but most were very supportive. Those who heard about the project from a neighbor wanted their yard trees surveyed. People offered us a cold drink and often sought information or advice about their trees or trees in general. We asked for permission first before surveying most of the yard trees.

Two comments that are unique to the area of Staten Island that we surveyed were that since many of the trees were older (80 of the 212 trees were estimated to be 100 years or older), they tended to be outgrowing their tree pits and heaving the concrete or slate sidewalks. We also surveyed some backyard trees where the homeowners were interested in the project or wanted to know the species size or age of the tree in their yard. Again these were mostly older trees that in some cases needed care. There is a need for a program of some kind to care for older trees that may not qualify as "Great Trees" and the sidewalks they impact.

Overall, this Title VIII project was successful and showed that citizens can be willing and successful data collectors. We learned enough to know what improvements or changes should be made to move the project forward. Some questions remain to be resolved once the information is available on the web site and more people are interested in participating.

Urban canopy analysis
Overall, as the Northeastern Research Station/ESF project summary notes, the various data produced for this project can provide significant benefits if used to help sustain or increase urban tree cover and health in New York City. The data provide information on the amount of vegetation, some of the beneficial vegetation effects, available spaces to increase tree cover, and the spatial patterns of vegetation in relation to various impervious surfaces. It is hoped that forest managers in New York City utilize these data sets to help improve urban forest management and the urban forests effects on human health and environmental quality in the city.

The Northeastern Research Station and SUNY's School of Environmental Science and Forestry also are completing a similar, though more comprehensive, analysis of New York City's tree cover throughout the five boroughs and extending into New Jersey, Connecticut, and Long Island. That initiative is funded through the Forest Service's "Living Memorials Initiative" and is supplementing the Title VIII project. Both projects will take regional infrared imagery and convert that data to a thematic urban canopy cover map to broaden the analytical work regarding individual trees inventoried through Title VIII. This information also will be accessible through the OASIS mapping site.

Additional information

The following materials mentioned in this report that were used as part of the Title VIII project can be found at the OASIS website (www.oasisnyc.net):

- Project Summary Report from the State University of New York's School of Environmental Science and Forestry and the Forest Service's Northeastern Research Station
- Spreadsheets of individual tree inventory data
- Introductory PowerPoint presentation from the Citizen Pruner classes
- Data collecting instructions for Citizen Pruners
- Letter to recruit students

Copies of the Citizen Pruner Manual that was used in the courses to train Citizen Pruners to collect the tree data can be obtained by contacting Trees New York at:

Trees New York
51 Chambers St., #1412A
212-227-1887
treesny@treesny.com