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It Takes a Stewardship Village: Effect of Volunteer Tree Stewardship on Urban Street Tree Mortality Rates

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Abstract

This report describes a five year urban forestry stewardship initiative to foster volunteer street tree stewardship within an urban neighborhood. Throughout the five year period, every tree added by planting and every tree removed due to death or accident was recorded, and regular measurements of the living trees were taken. The effect of this stewardship initiative was assessed by observing differences in street tree mortality rates between street trees that were stewarded and those in the area that were not. The overall mortality rate among street trees without stewards was more than three times that of street trees with stewards. This result supports the view that community-wide citizen stewardship of street trees in highly urbanized areas can be effective for promoting street tree viability, despite the many human and environmental stresses on urban street trees.

Keywords

Street trees; tree mortality; community stewardship; New York City; TriBeCa

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Introduction

Accelerated street tree mortality is a fact of life in city environments. Numerous studies have recorded this in urban tree populations, although rates of annual street tree mortality vary greatly. Nowak et al. (1990) reported an average annual mortality rate of 19% in inner city Oakland, CA during the first two years, for trees planted without community involvement. In 2004, Nowak et al. reported tree mortality rates of 6.6% annually for trees sampled in 1999 and 2001 in randomly distributed plots across a variety of urban site types. A briefing paper for the city of Providence, RI asserts annual street mortality rates of trees less than 10 years is 15 – 20% (Brown University 2000). Bond (2005) reviewed several studies of street tree and other urban trees and found annual tree mortality rates between 3% in Cleveland, OH and 20% in Oakland, CA for trees without community participation in planting or continued stewardship. Bond (2005) concluded that when formulating policy for increasing air quality, policies should target tree survival rather than focusing exclusively on tree planting.

Intrigued by the potential relationship between stewardship and street tree survival, the not-for-profit group Friends of Greenwich Street (FGS) conducted a census of its neighborhood street trees in 2003-2004. FGS is a volunteer-centered group with two areas of focus: (1) to beautify and maintain the Greenwich Street pedestrian promenade and (2) to expand TriBeCa's urban forest. Triangle Below Canal, commonly called TriBeCa, is a portion of southern Manhattan in New York City comprising 81 hectares (200 acres). FGS and I recorded key measurements like species, height and crown area for the 503 living street trees in TriBeca and were able to calculate that the urban forest canopy provided shade for 0.7% of the TriBeCa neighborhood (New York City Department of Parks and Recreation 2010). FGS also took a census of trees in the neighborhood's parks and other spaces, and learned they added another 0.5%, for a total urban forest canopy in the study area of 1.2%. In comparison, street trees accounted for 6% of the New York City urban forest canopy in 2005, and for all trees in all locations (including private property and city parks) canopy totaled 24% (Grove et al. 2006).

In light of the FGS street tree census findings, the FGS Board initiated a project to help expand the study area's urban forest canopy, and agreed to undertake a ten-year plan to help expand its street tree population from 503 to 900. In tandem with these tree-planting goals, FGS sought to match the study area's street trees with tree stewards committed to fostering their street tree's health and longevity. The overall vision was to approach the City's average of 6% urban forest canopy from street trees in the study area by 2015.

Building a Stewardship Village

As FGS undertook its project to increase the neighborhood's urban forest canopy, two complementary goals were established: double the number of trees, and assign stewards to at least 50% of the neighborhood street trees. To accomplish this, four key dimensions were identified for the project:

1. Combine tree data with stewardship data in a spatially-referenced database.
2. Recruit and train tree stewards.
3. Monitor the health of every street tree.
4. Plant new trees and replace existing trees in coordination with the New York City Department of Parks & Recreation and residential and commercial property owners.

Mapping

The initial mapping, identification, and measurement of each TriBeCa tree began in 2002 and was completed one year later. Tree data were recorded in Microsoft Excel ® and further enhanced with maps drawn by using Excel's drawing features. This census served as the project baseline. The census was facilitated with the help of trained neighborhood volunteers (following the methodology of Bloniarz

and Ryan 1996). As of 2005, when tree steward recruiting began, the TriBeCa tree population stood at 503. Using collected tree crown data, FGS calculated percent canopy cover by estimating each tree's canopy area ((crown radius)$^2 \times \pi$) and relating it to the total neighborhood area. Of the 200 acres that comprise TriBeCa, only 1.4 acres were shaded by street tree canopy. Few locations along the community's sidewalks had any shade.

In 2006, FGS was awarded a New York State Department of Environmental Conservation grant, which funded an enhanced mapping and database tool. Lotinfo® LLC enhanced their software to meet FGS specifications, enabling FGS to describe the neighborhood trees (e.g., tree height, species, tree steward ID) and map the locations where additional trees could or could not be planted (obstacles included marquees, vaults, and driveways). Once the original census data were transferred to the new software, an effective and efficient project tool was ready to use (Tribeca Trees 2007).

Volunteers and Data Collection

Identifying tree stewards in an urban neighborhood with both residential and major commercial tenants (e.g., Citibank, Bank of New York Mellon) required several approaches. The strategy included word-of-mouth, solicitations to Co-op and condominium boards, conversations with managers of retail stores and outreach through neighborhood networks and community newspapers.

Stewardship training typically took place at the steward's assigned tree. Sessions were scheduled as soon as possible after hearing of the volunteer's interest and provided the opportunity to practice maintenance on both the tree and the tree pit. Topics critical to tree health and longevity were discussed during the training. These included: watering (technique and schedule), tree pit care and improvements, and the importance of volunteer commitment.

During training, tree condition was also examined. Species characteristics were discussed with the stewards. Data from this inspection were added to the database. The stewards were reminded that they were part of a shared community-wide effort. In this neighbor-to-neighbor meeting FGS trainers also learned about the steward's prior gardening and tree care experience. In many cases, stewards voiced heartfelt concern about the condition or treatment of "their" tree. Providing them a path to positive and effective action was the key point of the meeting. The training concluded with a discussion of the tasks that the new steward would agree to undertake.

Following training, the chosen tree was considered to have an assigned steward. The database steward status for the tree was recorded as "yes". A "steward code" was added, which cross-referenced to a separate, secure name and address file. Steward statuses and contact details were reviewed and updated annually.

TriBeCa's Urban Forest

The study area is a highly urban neighborhood of 19th century warehouse buildings interspersed with larger, newer structures, and has a mix of residential, commercial, and governmental uses. Its surface area is composed of 59% buildings, 27% streets, and 11% sidewalks. Parks and other open space cover the remaining 2%.

The study area's street trees are almost entirely planted in tree pits cut out of the sidewalk surface adjoining the street. Unlike some areas of New York City, there are no grass strips between the street and sidewalk where street trees can be planted. About one quarter of the street trees are planted within continuous trenches; some trenches are surfaced with cobblestones set in sand; other trenches are cement-covered between the pit locations. Most street tree pit openings followed the traditional standard

dimension of about 1.1m by 1.5m. (see Figure 1); less than 10% of the tree pits are of the larger sizes encouraged under new city policies in place since 2007 (New York City Department of Parks and Recreation 2010).

Although sidewalks in the study area have provided the best opportunities for expanding the urban forest, due to infrastructure constraints roughly 50% of the study area's sidewalks are unavailable for street tree (in-ground) planting. Many sidewalks serve as roofs over basements or "vaults" that extend to the street curb; subway lines run beneath three of the six major north-south roadways as well as their adjoining sidewalks; dense networks of utility lines and pipes are below ground; and finally, landmark preservation provisions prohibit cutting into 19th century stone sidewalk surfaces in order to create tree pits (City of New York Landmarks Preservation Commission 2005).

Findings and Discussion

The research focus of the project was to determine if stewards' care of street trees reduced the mortality rate for TriBeCa's trees over the five-year period of data collection.

Figure 1. Typical Street Tree pit– 1.1m x 1.5m (3.5ft x 5ft).

To distinguish newly planted trees from established trees (trees planted four or more years prior to time of data collection), the planting year of street trees was estimated. Many trees' ages were determined by asking long-time residents when they had been planted, and were assumed to be accurate enough to confirm them to be more or less than four years since planting. Other planting dates were derived from known timing of construction projects. At the beginning of 2005, Tribeca's street tree population included 103 trees planted in 2001 or later; the balance (400) had been planted in 2000 or earlier. TriBeCa's street tree population expanded by nearly 38% during the 2005 to 2009 period, with new plantings outweighing tree deaths by more than 4:1 (Table 1).

Table 1. Study area tree population overview, Jan. 1, 2005 – Aug. 1, 2009

Street trees in Tribeca as of January 1, 2005	503
Tree deaths during period	(57)
Trees planted during period	250
Trees disappeared during period	(3)
Trees removed with authorization during period	(6)
Trees rescued during period	7
Living Street trees as of August 1, 2009	694

Statistical analyses of tree mortality rates

Each growing season was viewed as a discrete "event" and, for this project, was viewed as independent from earlier seasons and other trees for each specific tree in question. For each of the growing seasons in which a street tree was alive during the stewardship initiative, the presence or absence of a steward for that tree was noted. From the stewards' point of view, some individual stewards took care of one or two trees; at the other extreme, FGS was able to "enlist" a building manager who deployed building maintenance staff to provide tree stewardship services for 33 street trees. Table 2 shows the number of trees with stewards by year.

Table 2. Change in number of trees through five growing seasons. Right-hand column notes the number and proportion of trees with stewards January 1, 2005 to October 1, 2009.

	Trees Alive in January	Trees Planting in Spring	Trees Used for Analysis	Trees Planted in Fall minus Dead or Removed Trees	Number of trees with Stewards During Growing Season (%)
2005	503	7	510	12-0 = 12	96 (18)
2006	522	10	532	33-13 = 20	100 (19)
2007	552	29	581	29-23 = 6	194 (33)
2008	587	82	669	8-15 = (7)	295 (44)
2009	662	49	711	0-17 = (17)	332 (47)

Table 3 includes the key data points and the corresponding statistical analyses that, together, test the null hypothesis that there are no statistically significant differences in rates of mortality for street trees with stewards as compared to the street trees without stewards. The results support rejection of that (null) hypothesis at 98% significance level for recently planted street trees, established street trees (98%) and the street tree population as a whole (99%). The benefits of street tree stewardship in this highly urban setting are statistically significant for this population of street trees. Similar results were found when the tree populations were split into "established" trees and "recently planted" trees. Stewardship of street trees increased the likelihood of tree survival (Tables 4 and 5).

Table 3. Street tree stewardship and tree mortality data from January 2005 to August 2009, for all tree ages.

	All trees (all ranges of time periods since planting)	
Stewardship status	With stewardship	Without stewardship
Number of growing seasons*	1,017	1,991
Street tree deaths during period	8	49
Annual (growing season) mortality rate (%) during period	0.79	2.46
χ^2	9.83	
P_0	<0.01	

* The number of growing seasons represents the sum of the discrete years of tree growth (roughly March through November) spanning up to all years of the five-year period if the tree was in place during those years. During those growing seasons, each tree either was provided or was not provided with the services of a street tree steward. Any mortality of any street tree is assigned to a corresponding column of street trees with steward or without a steward.

Table 4. Street tree stewardship and tree mortality data from January 2005 to August 2009, for trees planted more than four years prior.

	Established trees (greater than four years since planting)	
Stewardship status	With stewardship	Without stewardship
Number of growing seasons**	617	1,511
Street tree deaths during period	3	29
Annual (growing season) mortality rate (%) during period	0.49	1.92
χ^2	5.93	
P_0	<0.02	

** The number of growing seasons (approximately March through November) represents the sum of the discrete years of tree growth. During those growing seasons, each tree either was provided or was not provided with the services of a street tree steward. Any mortality of any street tree is assigned to corresponding column of street trees with steward or without a steward.

Table 5. Street tree stewardship and tree mortality data from January 2005 to August 2009, for trees planted four years or less prior.

	Recently planted trees (four years or less since planting)	
Stewardship status	With stewardship	Without stewardship
Number of growing seasons***	400	480
Street tree deaths during period	5	20
Annual (growing season) mortality rate (%) during period	1.25	4.17
χ^2	6.37	
P_0	<0.02	

*** The number of growing seasons represents the sum of the discrete years of tree growth (roughly March through November). During those growing seasons, each tree either was provided or was not provided with the services of a street tree steward. Any mortality of any street tree is assigned to corresponding column of street trees with steward or without a steward.

Tree rescues and reduction in observed tree mortality rates

In addition to the basic street tree stewardship activities provided by the tree stewards described above, tree stewards observed several threats to established street trees during the project period that seemed to jeopardize the trees' survival. These situations were beyond the capability of the tree stewards to address, and required a professional arborist or other resources to save the trees.

A substantial number of street trees in extreme threat situations were observed during the project. In all, 53 established street trees – representing more than 10% of the initial 2005 street tree population - were observed in clearly lethal situations that required tree rescues if they were to be saved. Of the 53 rescued street trees, only two were assigned a tree steward. Five of these 53 damaged street trees died despite the rescue actions. In discussions with the arborists who observed these trees and provided emergency care for them, they emphasized that most if not all of these street trees would have succumbed within a few years after these problems were assessed unless rapid and appropriate resources were deployed to remove the threats.

Conclusions

The experience gained during this project strongly suggests that consistent and active volunteer citizen stewardship services supplemented with public or institutional tree rescue resources substantially reduce mortality rates of both recently planted and established trees (Figure 2). In addition, we have found that expanding the definition of tree stewardship to include trained volunteers stewards who can simply "walk around" and recognize threats to the street trees can pay large benefits, if, and only if, such "observational tree stewardship" is coupled with rapidly engaged professional tree rescue resources. During this study period, such street tree rescues reduced street tree mortality of established street trees by at least 24% (much more if the other likely tree deaths without tree rescues are considered).

Effective strategies for optimizing urban forest canopy levels should consider including tree maintenance programs that successfully promote and facilitate volunteer stewardship of street trees in coordination with sufficient professional tree services for tree threat rescues and interventions. Furthermore, resources should be allocated judiciously between the front-end planting stage and the back-end tree stewardship maintenance period to achieve such an optimal resource mix and through this, a maximum tree canopy level. In the long term, it will be difficult to achieve projected urban forest canopy implementation plan targets unless there is continual stewardship of established as well as recently planted street trees.

Figure 2. TriBeCa neighborhood.

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