The Need to Standardize At-planting Data

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Arborists, municipal urban foresters, tree-planting non-profits, and researchers want to know many things about trees in the urban forest. Urban forest managers may want to know about species composition and size distribution, and how these are changing over time in their urban forest. Those charged with planting trees in a city may want to identify areas in the city in which trees have not been planted recently, or areas that have particularly low canopy cover. Individuals responsible for securing funds for urban tree management may want to estimate the ecosystem services provided by recently planted trees as a way of justifying their investment. Researchers may want to know the rate of survival and growth of planted trees, as well as what factors influence tree success (e.g., survival, condition, growth), so as to make recommendations of best planting and management practices. And finally, researchers, as well as practicing urban foresters, might want to compare trees in different parts of a city over time, or to compare trees in one city to trees in another. All of this information helps those who plant and manage trees make strategic choices about where, when, and what trees are planted or maintained (e.g., watered, pruned, removed).

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Data needs emerge from this list of stated interests. To know where trees have been planted, to know the survival and growth of these planted trees, and to determine what factors influence survival and growth, one needs to gather data at the time trees are planted. To compare the survival and growth of (or other things about) planted trees across cities, one needs to have standardized at-planting data. To date, in most cases, little information is gathered at planting, and when it is, it may be inconsistent over time or across cities.

In this article, we briefly discuss recent efforts to standardize tree inventory methods and highlight the gaps these methods have in specifying at-planting data. We then use a case study to illustrate the importance of gathering at-planting data. Finally, we offer a preliminary standardized set of variables that might be collected at the time of planting.

Efforts to Standardize Inventory Methods

Inventories of urban tree stock provide information about urban forest composition, distribution, and health. Tree inventories conducted at different points in time or in different cities that use a standardized set of methods can allow urban forest researchers and practitioners to compare tree populations. A recent review of inventory methods published in *Arboriculture & Urban Forestry* (Nielsen et al. 2014) uncovered 57 academic studies that used single-tree inventory methods, 46 of which used some type of field survey method performed by crews working on the ground, tree-by-tree, to collect data. However, there is little consistency in the data collected across inventories (Keller and Konijnendijk 2012). These inconsistencies make it difficult to compare the inventory results for the same city across different years, and even more difficult to compare data across cities.

Many attempts have been made over the last decade to standardize the methods used to gather data in urban tree inventories. During the early 2000s, a collaboration by the International Union of Forestry Research Organizations (IUFRO), the International Society of Arboriculture (ISA), and the U.S. Forest Service (USFS) attempted to standardize tree inventory practices and in 2010 published a draft of "Standards for Urban Forestry Data Collection" (IUFRO et al. 2010). However, this effort never moved beyond a draft version.

Most recently, a multi-year effort by the ISA-affiliated Urban Tree Growth and Longevity (UTGL) Working Group (www.urbantreegrowth.org) of the Arboriculture Research and Education Academy (AREA) has worked to develop the Urban Tree Monitoring Protocols. This collaboration between researchers, municipal urban foresters and arborists, consulting arborists, spatial data experts, and more has produced simple, usable methods to inventory planted urban trees, including the UTGL "Minimum Data Set" field guide, which specifies the minimally necessary set of parameters one should collect when inventorying a cohort or sample of planted trees (UTGL and Shafer 2014)—available for download online (www.urbantreegrowth.org/field-guide.html).

These efforts to standardize urban forestry inventories are important, as are guides like *Best Management Practices: Tree Inventories* (Bond 2013). They make it possible to begin comparing the structure of the urban forest and the ecosystem services provided through time and across cities. However, the focus has been on post-planting; that is, methods that will be used to collect data months to years after the trees have been transplanted into the landscape. The "standards" (IUFRO et al. 2010) do not contain any recommendations on what data should be gathered at the time trees are planted. And while the UTGL field guide includes methods for collecting data on tree location, site use and land use, species, mortality status, condition, and trunk diameter (UTGL and Shafer 2014), it does not include recommendations for specific variables to be gathered at the time trees are planted.

The Need to Collect At-planting Data

Standardizing our inventory methods for collecting data on planted trees after they've been in the ground for several years is not enough. For instance, without detailed and accurate information about where and when trees are planted, inventories conducted after planting cannot inform us of the survival rates of cohorts of planted trees. Without information about the size of trees at planting, we cannot tell how much the trees have grown.

Urban forestry researchers and practitioners can learn a lot by comparing tree populations as they grow. Tree inventories conducted at different points in time or in different cities that use a standardized set of methods further this ambition.

But perhaps most devastatingly, inventories after planting alone cannot tell us how at-planting decisions might impact the success of the trees. For instance, we know from research in experimental settings that both the size of the tree at planting (e.g., caliper size, container size, height) and the type of planting packaging (e.g., balled-and-burlapped, bare root, different types and sizes of containers or root bags) impact the growth and survival of trees after they are planted in the landscape. But experiments occur in controlled settings where researchers can precisely manage irrigation and other maintenance practices, and therefore experimental trees are often not subject to the same stressors as trees in urban landscapes (e.g., road-salt spray, inconsistent maintenance). It remains unknown whether these at-planting decisions influence tree survival and growth similarly *in situ*—that is, in the actual cities and landscapes in which they are planted. Lacking at-planting data is a key limitation in our ability to make inferences about tree success *in situ*.

There have been several excellent studies conducted in actual cities (e.g., Lu et al. 2011; Koeser et al. 2013); however, these rarely account for at-planting characteristics of trees. For instance, the New York City Young Street Tree Mortality study (www.nycgovparks.org/trees/ystm) examined how a variety of biological, social, and urban design factors impact tree mortality three to nine years after planting (Lu et al. 2011). But apart from those urban design and land-use factors, from which at-planting data can be gleaned but are not actually measured during re-inventory (that may or may not have changed since planting), this study did not examine at-planting decisions.

In practice, little if any data are collected on trees planted in the urban landscape at the time of planting. What minimal data may be collected are generally limited to planting location (e.g., GPS location, street address) and tree species. And if other data are recorded at planting, they are often not the same over time or across organizations or data collectors.

Case Study: Re-inventorying Trees

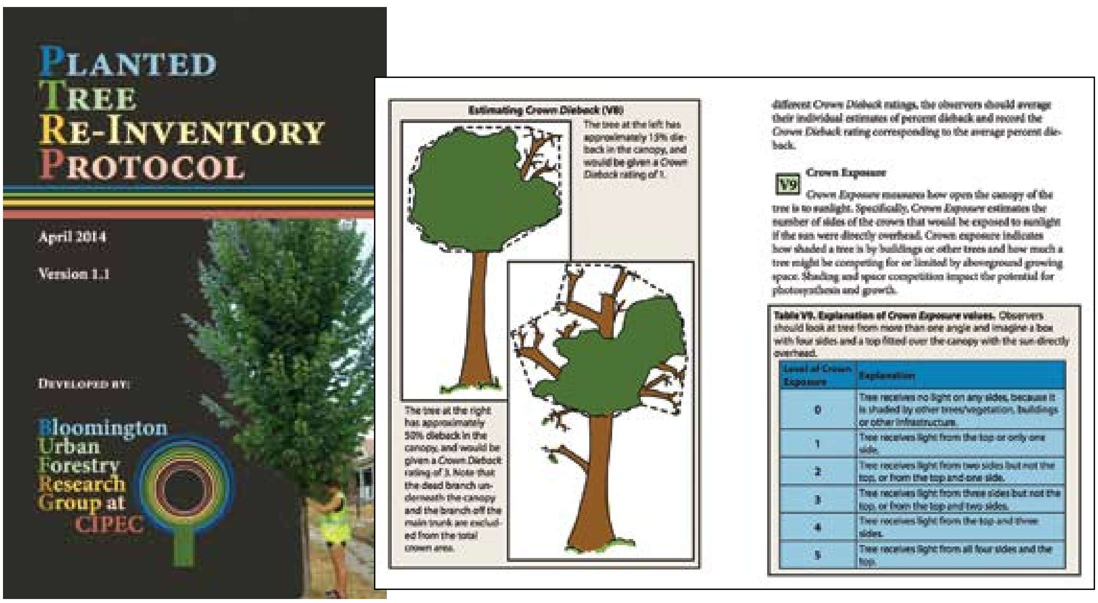
The Bloomington Urban Forestry Research Group (BUFRG) has been working on a project to examine the ecological and social outcomes of nonprofit and neighborhood tree planting in five U.S. cities, with major funding from USFS National Urban and Community Forestry Advisory Council (NUCFAC) and the USFS Northern Research Station (NUCFAC 2015).

Through this project, we have been working with five nonprofit members of the Alliance for Community Trees: Trees Atlanta (Atlanta, Georgia, U.S.), The Greening of Detroit (Detroit, Michigan, U.S.), Keep Indianapolis Beautiful (Indianapolis, Indiana, U.S.), Pennsylvania Horticultural Society (Philadelphia, Pennsylvania, U.S.), and Forest ReLeaf of Missouri (St. Louis, Missouri, U.S.). Each of these nonprofit organizations has been collaborating with local neighborhood and community groups to plant trees in public and common areas in their respective cities.

Among our project objectives are to compare survival and growth of planted trees across cities and identify how characteristics of the trees, the local environment, and the management strategies used to care for those trees influence early survival and growth. To do this, we gathered at-planting data from each organization and trained teams of citizen scientists (volunteers or paid interns) to re-inventory planted trees according to our Planted Tree Re-Inventory Protocol (Vogt and Fischer 2014).

The nonprofit organizations we worked with collect and keep data about their trees at the time of planting. However, because each organization does not keep the same data (Table 1), BUFRG researchers have found it difficult to compare the survival and growth of planted trees re-inventoried three to five years after planting. Most basically, we cannot calculate survival and growth (our primary outcomes) in every city. One of our partner cities does not record the individual planting location of each tree, and so our re-inventory team had a very difficult time locating planted trees to re-inventory or assess survival. In another city, we lacked size data at planting (without initial size, we cannot calculate growth rates).

In addition, without the same at-planting data, we cannot evaluate the impact that decisions made at the time of planting have on tree outcomes across all five cities. Ideally, we would compare trees from all five cities and see if at-planting characteristics, like packaging and nursery, influence survival and growth (this proved to be the case in Indianapolis in a separate study by Vogt et al. 2015). Differences between cities make these comparisons impossible. Furthermore, even within a single city and organization, the type of data collected for a particular



BUFRG 2014

The Bloomington Urban Forestry Research Group developed the Planted Tree Re-Inventory Protocol (Vogt and Fischer 2014; Vogt et al. 2014), which contains detailed instructions and illustrations that an ordinary citizen could use to collect data on recently planted trees.

Table 1. Not all nonprofit tree-planting organizations collect and keep the same data about the trees they plant.

Parameter	Atlanta, GA	Detroit, MI	Indianapolis, IN	Philadelphia, PA	St. Louis, MO
Individual tree location	X	X	X	X	
Tree species (and/or cultivar)	X	X	X	X	X
Nursery of origin			X		X
Planting packaging type			X	X	X
Size-at-planting[z]		X	X	X	X
Exact planting date	X	X	X		X
Season of planting only				X	

[z] Size-at-planting data varies between organizations, with some keeping track of caliper for all trees and others keeping less systematic records (which might include planting height or container size instead of caliper).

at-planting variable may vary between trees or across years. For instance, size-at-planting may be recorded as caliper size, diameter at breast height (dbh), container size (i.e., #5, 3 gal/11.36 L), or even tree height; and, one or more (or none) of these pieces of data may exist for each tree within a planted cohort. So even comparisons of trees within a single city are difficult to make.

Inconsistencies in at-planting data (particularly size-at-planting) may be due to differences in what data each supplying nursery kept track of, differences in nonprofit data management systems or capacities, or other factors. Regardless of the reasons, these differences make comparing tree outcomes between cities like comparing apples to oranges.

The Need to Standardize At-planting Data

If we want to compare cohorts of trees across time or across cities, and want to know about the many factors that influence the survival and growth of, and ecosystem services provided by, the trees we plant, we need to standardize not only the monitoring and inventorying we do after trees have been planted; we also need to standardize the data we collect about trees at the time of planting.

We suggest that those who plant trees and maintain records on planted trees collect data for the short list of variables presented in Table 2 at the time of planting. Additional information that might be useful, depending on specific planting practices, include at-planting maintenance performed (e.g., root pruning, crown thinning, mulching, fertilizing), planting area dimensions, type of substrate or fill (e.g., structural soil), or any number of other factors depending on data collection capabilities or the interests of stakeholders in the tree planting.

It is important to note here that data gathered at-planting differs from data gathered during a conventional tree inventory. In a full or partial inventory, the data gathered on the tree population are useful, for instance, in determining maintenance priorities or species-specific pest risk for a population of trees. At-planting data, in contrast, may be useful only at the end of an entire planting season, or for entities planting a small number of trees at a time, after several planting seasons, when data on a sufficiently large number of planted trees have been gathered and larger patterns become visible.

We recognize that collecting and maintaining data on trees requires additional time and resources. However, we believe that this effort would yield a worthwhile return on investment in the form of:

1. Facts about the survival and growth rates of young trees (that can inform decisions about planting, as well as provide information to report back to funders of particular tree plantings, or help solicit external funding for future tree planting activities);
2. Better information on tree planting locations (to facilitate future inventories and planting decisions);
3. Information about species distribution, and at-planting characteristics, like packaging type, which can be used to inform future planting decisions; and
4. The potential for collaboration between practitioners and researchers to investigate the ecological and social outcomes of planting activities.

In conclusion, conducting tree inventories months or years post-planting is only half the story. In order to make the most of post-planting inventories, the work begins at the time of planting. We need to collect data about tree location and at-planting characteristics at the same time as we plant trees in the landscape. And in order to compare trees planted in different cities across the world, at-planting data collection methods should be standardized.

Additional Reading

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Table 2. We suggest collecting the following data about each tree at the time the tree is planted in the landscape.

Variable	Details
Individual tree location	The precise location where each individual tree is planted in the landscape is crucial for re-locating the tree after planting. Ideally, this information is in the form of GPS coordinates that can be mapped in a computerized geographic information system. If GPS/GIS capabilities are not available, a street address-based numbering system or other method of unambiguously identifying the precise tree location should be used. See the UTGL Minimum Data Set for instructions specifying how to keep track of individual tree location.
Tree species/cultivar	The specific species and cultivar planted can be useful in later assessing the success of different types of trees in different planting scenarios. See the UTGL Minimum Data Set for instructions specifying how to collect data on tree species.
Caliper-at-planting (either caliper class or measured)	Caliper-at-planting is frequently provided by nurseries as a convenient way to record tree size class during transplant and sale. When keeping track of caliper-at-planting, it should be noted whether the value recorded is the caliper class by which the tree was sold from a nursery (an estimated value, like "1-inch caliper") or a more accurate value that was actually measured at 6 inches (15 cm) above the first lateral root using a caliper tool or diameter tape (a precise value, like "4.6 cm caliper"). This information is key to calculating growth rates of planted trees.
Date of planting	Knowing the exact date the tree was planted is helpful for later determining post-transplant tree growth rates, and for identifying any periods of drought or other stress (i.e., nearby road construction) the tree may have undergone post-planting.
Nursery of origin	The nursery from which the tree was purchased or obtained should be recorded. This allows you to calculate survival rates and examine tree condition by nursery to see whether these are comparable to any guarantees made by the nursery.
Planting packaging type	Planting packaging type should be recorded in as much detail as possible (e.g., balled-and-burlapped, bare root, container, nylon root bag). This will allow you to see which types of planting packaging perform best (i.e., yield highest survival or best condition) in different types of planting settings (e.g., park-like settings versus street trees).
Planting packaging size	Packaging size (i.e., container size) should also be recorded, separate from packaging type and tree size-at-planting. For instance, the container size in volume (gallons/liters) or the container class specification (e.g., #3) might be recorded. Ideally, it is best to keep the packaging size consistent for all trees planted.

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TREE Fund Names New President/CEO

The TREE Fund recently welcomed its new President/CEO, J. Eric Smith, who took the reins of the Naperville, Illinois, U.S. nonprofit this past August.

Smith, a South Carolina native, is a graduate of the U.S. Naval Academy and the University at Albany's Rockefeller College of Public Affairs and Policy. He served for ten years with the Navy's Nuclear Propulsion Program and the Department of Energy. Since leaving Federal service, he has spent 30 years in the public sector in fundraising, communications, PR, operations and executive management, most recently as the executive director of the Salisbury House Foundation in Des Moines, Iowa, U.S.

"I am excited by the opportunity to help the industry address the challenges to the urban forest posed by climate change, urbanization, and other ongoing social and scientific changes," Smith commented. "There are few things more powerful than knowledge, and I believe that the types of primary research and education programs that the TREE Fund makes possible can and should be widely communicated and leveraged to benefit as many communities, businesses, citizens, and industries as possible."

The TREE Fund (www.treefund.org) is a nonprofit foundation dedicated to the discovery and dissemination of new knowledge in arboriculture and urban forestry. Since 2002, the TREE Fund has distributed nearly USD $2.6 million in research grants, scholarships, and funding to advance the science, practice, and safety of tree care. **A•N**