Conducting a Community Tree Inventory

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This publication provides an introduction to the community tree inventory. Individuals who may be interested in a community tree inventory include mayors, city council officials, urban planners, urban foresters, Master Gardeners, and residents who desire to improve their community through natural resource management. When addressing the community tree inventory, it is important to remember that community forests include urban parks and woodlands, street and yard trees, vacant lots, river and coastal natural areas, wetlands, and shelter belts of trees found in and around cities, suburbs, and rural towns. These are dynamic ecosystems that increase the livability of communities—something most people value and want to improve.

What Is a Community Tree Inventory?

A community tree inventory has three primary functions:

1. As a ***database*** consisting of information about individual trees. This information includes tree location, diameter, height, canopy width, condition, and hazards. The inventory enables documentation of significant trees (for example, those that have cultural and historical importance to residents, as well as those that are dead or in poor condition). The inventory indicates if tree condition is based on species or a specific location in the community. For example, all ash trees in a community may be in poor condition if emerald ash borers are present. By comparison, construction zones can negatively affect the condition of various species of trees. As part of an inventory, the risk assessment rates hazard trees that are prone to failure, have a defect, or have a target nearby. Severe- and high-risk trees should be removed as soon as possible. For example, a heavy, broken, decayed limb of a storm-damaged street tree should be removed to prevent it from falling on a passing vehicle or person.
2. As a ***maintenance tool***, the community tree inventory enables managers to identify trees that need to be pruned, staked, fertilized, cabled, or removed. Community forest managers use the inventory to periodically review trees that have been identified as hazards.
3. As a ***management tool***, the inventory enables aggregation of individual tree data to provide information about a tree population—also known as the community forest. Tree population information includes species distribution and canopy cover. A tree map enables community forest managers to identify and prioritize community canopy goals, while accounting for the condition of the community forest (dead, critical, poor, fair, good, very good, or excellent).

Tree population information can be used to plan tree planting and maintenance activities in specific areas in the community. For example, some neighborhoods have less tree canopy than others and may deserve special attention. In addition, it is often necessary to assess the community forest according to tree diameter class because areas of the community are planted in stages. Newly developed areas have young trees (small diameter), while established neighborhoods have older (and dying), larger diameter trees. Community forest management must account for a healthy forest that has diverse species and age characteristics.

Different community geographies and populations are exposed to different hazards (wind, ice, flooding), and some tree species resist damage better than other species. Tree managers use inventories and geographic information systems (GIS) to identify trees that may be exposed to severe hazards based on their location. In this way, city managers can model the ways increasing and decreasing tree canopy impacts stormwater flow. Maps enable projects to be adapted for specific sites, such as shade trees in school yards or trees planted as a stream buffer.

Additional Uses of an Inventory

1. ***Create ordinances***. In addition to risk assessment and prioritizing tree planting activities, the community tree inventory can be used to establish local ordinances to mitigate risk and protect and promote urban ecology. Tree ordinances can help make the preservation of the community's canopy a priority concern for development. For example, an ordinance may allow the removal of trees only when they are in the footprint of a development's impervious surfaces and only with a permit. Other objectives of tree ordinances may be to reduce the number of parking spaces in large lots, promote pervious surfaces in developments, and ensure acceptable replacement of trees that are removed during development.

2. ***Determine value***. Creating a visual map of how community forest benefits are distributed across the landscape is known as benefit mapping. A key aspect of benefit mapping is applying a dollar value to trees based on their individual characteristics. In this way, managers can use computer software to calculate a monetary value for pollution removal (ozone, sulfur dioxide, nitrogen dioxide) by the community forest. For example, one national study found that community trees removed almost 800 million tons of air pollution annually, which represents a value of $3.8 billion (Nowak et al. 2006). Another study found trees can save about $2 billion annually in reduced energy costs (Donovan and Butry 2009). In addition, the software can estimate a monetary value for energy use and related carbon dioxide emissions while averaging the effects for region heating and cooling. A third common valuation technique using the community forest inventory is to apply a dollar value to carbon stored and sequestered by trees. Trees have been found to store as much as 770 million tons of carbon, which is a value of more than $14 billion (Nowak and Crane 2002).
3. **Leverage for funding**. A community tree inventory provides baseline data that can be used to leverage funding for community tree maintenance and management. This is important because the primary obstacle for Mississippi municipalities in managing their forests is lack of funding (Grado et al. 2013).

In summary, the community tree inventory is a management tool used to—

- improve planning and management;
- address the specific needs of the community forest;
- coordinate and conduct management activities efficiently and cost effectively;
- ensure adequate and consistent funding;
- educate the public and elected officials about the value of community forests and the need to manage them;
- empower residents to advocate for their community forest;
- help the community comply with environmental regulations such as the Clean Water Act.

Types of Inventories

Community tree inventories can be conducted top-down or bottom-up. Although they can be conducted separately, both strategies used together are valuable for setting appropriate goals, planning for costs, determining timing of planting, planning species mix, and measuring success.

Top-down inventories use aerial or satellite imagery. Specialists draw polygons based on reflection of light from different species and surfaces to determine the amount of canopy cover. Some imagery such as Google Earth and Mississippi's MARIS are free or low cost. Other high-resolution cover imagery can cost thousands of dollars but can be 90 percent accurate. Photo interpretation is less costly than high-resolution imagery but can have considerable error through poor image quality and human miscalculations. A free tool, i-Tree Canopy, can be used to photo interpret cover using Google Earth.

Another alternative is the National Land Cover Database (NLCD), a satellite-based 30-meter resolution dataset that is freely available for download. Because the resolution is coarse (difficult to read), NLCD data is better suited for state or regional analysis. It provides spatial reference and area information for land surface characteristics (for example, urban, agriculture, forest, impervious surface, tree canopy cover) for each pixel. The NLCD consists of 29 land cover classifications with the latest data from 2006. A major disadvantage of the data is that it typically underestimates tree cover by as much as 10 percent.

i-Tree Vue, a software program produced by the U.S. Forest Service, uses NLCD data to calculate carbon storage, carbon sequestration, and pollution removal in short tons and dollar value. The effects of planting scenarios can also be modeled. Users can make regional adjustments to canopy and impervious estimates based on research. Like the NLCD, i-Tree Vue is free to download and use.

A bottom-up inventory generates primary data from on-the-ground inventory methods. This approach requires a process of measuring individual tree characteristics and quality assurance/control. Field data collection requires extensive planning, management, and time. Although it can be somewhat costly, the results can contain more information than possible through top-down analyses. For these reasons, it is recommended to perform a bottom-up inventory at some stage of the community tree inventory.

Tools for a Bottom-Up Inventory

Investment of time and money are the major considerations before initiating a community tree inventory. Precision, accuracy, and efficiency increase with improved technology. However, project leaders must account for cost, which also tends to increase with improved technology. Here, several basic tools needed to implement a community tree inventory are identified according to relative cost and corresponding task. These tools can be found at a forestry supply retailer.

Conducting the Bottom-Up Inventory

Data collection and analysis can be accomplished using volunteers, municipal staff (e.g., public works), or contractors. Each method has advantages and disadvantages.

Using volunteers requires minimal economic investment by municipal governments and few in-house resources. It also develops local commitment and a sense of community through resident engagement. Potential tree inventory volunteers may include Master Gardeners, Boy and/or Girl Scouts, a city tree board, high school students, and local garden club members. However, volunteers typically take longer to complete the project. Often, various groups are necessary to complete the inventory, resulting in multiple training sessions that slow the data collection process and reduce data quality. In some cases, volunteers must be compensated for transportation costs to collect data. Data quality may be lower than when using professionals; therefore, someone experienced with inventory techniques must implement project oversight using a quality assurance plan. On the other hand, quality control may increase because professionals may have to complete more checks on volunteer-based inventories.

Use of municipal staff may improve data quality since these individuals are paid employees and may be certified arborists. However, they may require overtime pay if they are occupied with tasks other than the inventory. Competing responsibilities of municipal staff is a major consideration, and data collection efficiency may decline.

A contractor potentially can provide the most accurate data of the three methods. A contractor who is a certified arborist may have the most experience and knowledge when it comes to conducting the inventory. In contrast to using municipal staff, a contractor will not compete with in-house resources. However, contractors may be expensive. Many rural communities in Mississippi may need to seek grant funding to complete a tree inventory with contractors.

Quality Assurance Plan

Regardless of who collects the data, all inventories should incorporate a quality assurance plan with quality control and assurance (QA/QC) procedures. This may entail additional costs associated with contracting a certified arborist. The quality assurance plan involves hot and cold checks on a variety of field plots (e.g., plots with low/no tree cover, plots with few trees, and plots with many trees). Approximately 5 percent of the plots must be checked with more cold than hot checks (e.g., 70 percent cold and 30 percent hot). Hot checks entail a trainer working with the crew as they conduct measurements. As such, errors can be corrected as they are made. Cold checks are implemented in randomly selected plots by an inspector at regular times throughout the field season after the crew has completed plot measurements. Any errors encountered during the cold check must then be corrected. Tree inventory software user manuals can provide more detailed information on developing a quality assurance plan.

Scope of the Bottom-Up Inventory (How Much Is Enough?)

Determining the scope of the survey depends on available resources and goals. Inventory projects have ranged from parks to small neighborhoods to cities to counties. DeSoto County commissioned an inventory using 200 one-tenth-acre random plots measured over 3 months using paid university students. The inventory was used to estimate 19 million trees over 27 percent of the county with a pollution removal value of $40.5 million per year. A minimum number of 200 points in any given geographic scope is typically needed for benefit mapping. Fewer points may be appropriate for a small area, but a greater number of points decreases error in the sample.

Software for the Bottom-Up Inventory

Several inventory software packages are available. Some are freeware (license to use is free of charge), while others can be fairly expensive. The Michigan Department of Natural Resources (2013) lists and discusses several tree inventory programs (see References). It is important to note that some of the programs are applicable to specific regions of the United States.

Inventory software should have some basic data entry fields such as GPS coordinates and species. Preferably, additional entry fields would include tree height, diameter, crown width, crown missing, dieback, and land use and ground cover attributes. Canopy measurements are needed to conduct a canopy inventory. Detailed descriptions of inventory software can be found in *Comparison of Urban Forest Tree Inventory and Management Software Systems* (Andreu et al. 2009) and *Tree Inventory and Management Software* (USDA Forest Service 2013a).

One of the most commonly employed programs is the USDA Forest Service's i-Tree, available at ***www.itreetools.org***. i-Tree is a software suite produced with the collaboration of private and public partners. Currently, there are six applications: Eco, Streets, Hydro, Vue, Design, and Canopy. A comparison of several i-Tree inventory approaches can be found in *A Guide to Assessing Urban Forests* (USDA Forest Service 2013b). Each application focuses on specific objectives. For example, Eco provides a broad spectrum of data fields that, when combined with air pollution and meteorological data, quantifies community forest structure and environmental effects and applies a monetary value to tree benefits. By contrast, Hydro simulates the effects of changes in tree and impervious cover characteristics on stream flow and water quality.

The i-Tree software suite is peer-reviewed, public domain (freeware), easy-to-use software that allows for scalable analysis. In other words, results can be generalized from individual tree to neighborhood to city levels based on a reliable sample. The premise of the software is to apply a dollar value to functions (benefit mapping) of the community forest based on its structure. Functions include pollution removal, energy use and related carbon dioxide emissions, and carbon stored and sequestered. From this information, users can make management recommendations such as species selection, address invasive species, and perform storm damage assessment.

Conclusion

The community forest inventory provides the baseline information needed for maintenance and management of the community forest. An inventory is the first step toward fully understanding the ecosystem benefits of the community forest. Several types of inventories exist and fall into two general categories: bottom-up and top-down. The type of inventory to be employed depends on a community's available human and economic resources, as well as the ultimate goal of the inventory results. For more information about community forest inventories, contact your county Extension office.

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