CONTINUING EDUCATION UNIT

TREE INVENTORIES PART 1

Objectives and Tactics

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The following article is part one of an excerpt from ISA's Best Management Practices: Tree Inventories, *the latest in a series of best management practice guides. Part two will be published in the August issue of* Arborist News.

A tree inventory is a record of the location, characteristics, and assessment of individual trees within a well-defined group.

LEARNING OBJECTIVES

The arborist will be able to

- understand how to set priorities and functional needs in order to establish objectives for a tree inventory.
- discuss the resource requirements and options for conducting a tree inventory.
- explain how the objectives established and the quality of the inventory are integral to the ultimate usefulness and reliability of the product.

A tree inventory is a record of the location, characteristics, and assessment of individual trees within a well-defined group. However, inventory scale and complexity vary by the specific needs, goals, and resources of the local context. Inventories are typically accompanied by an analysis of the population—an *inventory report*. The urban forest can be separated into categories such as species or size classes, and assessments are made of their quantity and quality. In its simplest form, such analysis comprises a series of charts, tables, or maps from which the user can retrieve information. A more sophisticated form or inventory report is a *management plan* in which the implications of the data analysis are laid out in detail.

Historically, inventory media included index cards, ledger books, and paper maps, which made searching, manipulation, and analysis difficult. Most inventories now are electronic, greatly facilitating these tasks. Similarly, field data collection is now commonly carried out on handheld electronic devices.

Goals and Objectives

The first step in the inventory process is establishing its goals and objectives. Managers need to carefully consider their needs and priorities, because data collection and inventory software can entail a significant investment of time and financial resources.

Safety

The number one concern for most urban forest managers is risk management. This concern follows from the obligation for prudent care that lies at the heart of liability. Tree inventories need to identify trees requiring pruning and removal for safety concerns. When this information is prioritized, long-term policies can be implemented, resources for remediation allocated, and future periodic monitoring scheduled.

Population Identification and Characteristics

Inventories count the tree population and, in many cases, the sites available for tree planting. This enumeration process is a key objective in most inventories. Tree characteristics such as species, size, and health rating are normally included, as well. These factors will enter into work planning, budget preparation, policy development, and program review.

Maintenance Assessment

Planning for maintenance is much more efficient when suitable data are available. Maps of geographic areas or lists of sites can be combined with work needs to develop budgets for work and assign work to crews. Long-term management issues such as prioritizing maintenance, maintaining species diversity, and training young trees can also be readily addressed.

Work History

Inventories can be used as the basis for tracking the work history of each tree. This information helps in addressing service requests, determining when an individual tree is near the end of its useful life, and supplying critical data to evaluate species performance.

Longevity and Utility

The longevity of the inventory is another factor that must be determined in advance and incorporated as an objective. Inventories can be one-time events that provide a snapshot of the urban forest, or they can be used as an ongoing basis for management. If an inventory is to be ongoing, a data management system that achieves this goal is essential.

Benefits of Using an Inventory

The overarching benefit of a tree inventory is that it allows the manager to change from a predominantly *reactive* position—always "putting out a fire"—to a *proactive* position, where a significant portion of daily work occurs within the framework of information, planning, and policy.

Increased Efficiency

Once an inventory has identified the work to be done, a manager can use it to execute that work in a much more efficient manner than before. Scheduling all work in a given area to be done at the same time, for instance, has been shown to result routinely in substantial savings in travel and setup time. There is also increased efficiency in the office created by the ability to quickly locate and manipulate records, select and schedule work, and write summary reports.

Improved Community Relations

Tree inventories can usually be used to record service requests, link them with individual tree records, and prepare inspection lists. Tree inventories are also useful educational tools. Data, maps, significant individual trees, and summary reports can be distributed in print or on a Web site. In this way, the community can gain a better understanding of the urban forest and its management—and become more willing to provide support.

Emergency Preparedness

Tree inventories provide a powerful management tool when a disaster strikes. Knowing the forest's size-class distribution, for instance, allows appropriate allocation of resources without waiting for a complete assessment to be made. Furthermore, good information about the forest *before* the disaster puts application for restoration funds on a sound footing.

Justified Budgets

Up-to-date tree inventories provide the data needed to project specific levels of funding that will be necessary for tree maintenance and planting over a multiyear period. With accurate data, the tasks and associated costs can be clearly spelled out and supported by detailed lists. An inventory may report a dollar value for the urban forest following methodologies developed by the Council of Tree and Landscape Appraisers or the USDA Forest Service (STRATUM and UFORE). Finally, a good inventory can compare the cost of implementing different future strategies, as well as provide a solid basis for grant applications.

Documented Actions

Tree managers are frequently asked to provide documentation of their actions. This documentation can range from work accomplished to a contractor's costs per tree, from a removal list to a particular service request. In the rare instance of litigation involving a tree, an inventory documents that policy has been implemented. Much time and frustration can be spared through the use of a good inventory and data management package for documentation.

Resources Required for Inventories

Office Personnel

The urban forest manager and staff must, of course, understand and support the tree inventory process and outcome. But, in addition, an office member must be designated to take responsibility for maintaining the data. That person should be involved in program choice and office setup. Also, the ongoing work of data entry required to maintain an inventory must be acknowledged and budgeted.

Data Collection Personnel

The cost, accuracy, and efficiency of data collection vary with the nature of the personnel. Table 1 summarizes the options, but it is not a comprehensive list.

Data Collection Equipment

Data collection equipment ranges from paper and pencil to various handheld devices such as personal digital assistants (PDAs) to pen tablets displaying a geographic information system (GIS). The choice depends primarily on local resources and personnel. Electronic equipment is useful because it is fast, accurate, and does not require office data entry. But it does require acceptance, investment, training, and maintenance—so it would be time-consuming and risky to go that route without technical support.

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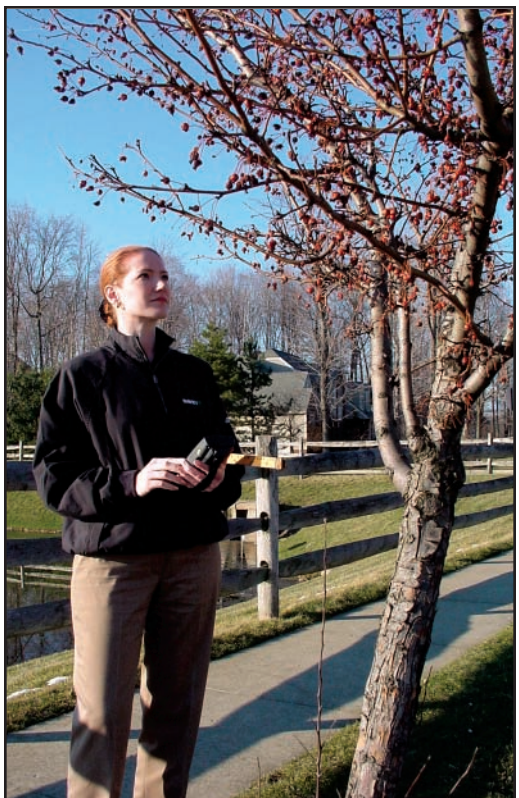


Inventories count the tree population and, in many cases, the sites available for planting.

Table 1. Options for data collection personnel.

Personnel	Labor cost	Accuracy	Comments
Volunteers	Low	Poor–Good	Need high level of training and supervision to obtain good data
Temporary or part-time staff	Low–Medium	Fair–Good	Need medium amount of supervision and training
Full-time staff	Medium–High	Good–Excellent	Need low amount of supervision and minimal training
Contractors	Medium–High	Good–Excellent	Need low amount of supervision and no training; have own equipment

Computing Needs

What hardware is required and where will it reside? Most of the time, it will be on a local computer, although some software vendors offer the option of hosting the data on a remote computer accessed with a browser. If a local host will be used, it is important to identify the exact computer that will be used and determine whether its configuration is equal to the task. Some networking will typically be required.

Software Compatibility

Are the data and software flexible enough to work with other systems? If older inventory data exist, for instance, then it is critical that data categories, structures, and definitions can be correlated if comparisons are to be made. Software options range from adapting off-the-shelf spreadsheets or databases to purchasing one of the many different commercial products available. Dialogue between the tree manager and the local IT department is imperative for a good choice.

GIS Compatibility

Traditional paper maps are increasingly being replaced by the use of a geographic information system (GIS), especially for trees that are not nicely lined up in front of buildings. If suitable, universal location data can be collected along with other tree information through the use of global positioning system (GPS) units or pen tablet computers. This allows trees to be represented in a GIS, enabling easy production of accurate, up-to-date maps and reports, as well as advanced analyses. GIS systems are often already at work elsewhere in the municipal organization, offering potential data-sharing and cost-reducing opportunities.

Budget

The costs of an inventory can be broken into three main areas: data collection, software, and maintenance. An inventory (data collection using software) can be carried out within almost any budget, but higher-quality inventories generally cost more. It is worth keeping in mind that *cost* is not the same as *value*. The optimal strategy is to weigh data and software features and quality against actual needs and budget.

Data collection equipment ranges from paper and pencil to handheld devices displaying a geographic information system.

Inventory Types

Sample Tree Inventories and Surveys

Random sampling is a cost-effective way of obtaining a large-scale picture of the urban forest and its needs, from which a strategic plan can be developed. A small percentage of street blocksides or a specified mileage or area is randomly drawn and used to provide estimates that are accurate to within about 10 percent. The minimal sample size to achieve this level of accuracy is 3 to 6 percent, depending on how much variation there is from site to site. New GIS-based sampling tools are available from the iTree Web site (www.itreetools.org).

For greater accuracy, the sampling process can further involve "stratification" that divides the inventory area into meaningful subareas, such as by land use (for example, new subdivisions, historic district, and industrial areas).

Surveys can focus on one or a small number of factors over the entire urban forest. One common example is a hazard tree survey. In this survey, all streets are driven, but the survey team stops to record data only for trees that appear to present a hazard as defined within the specifications.

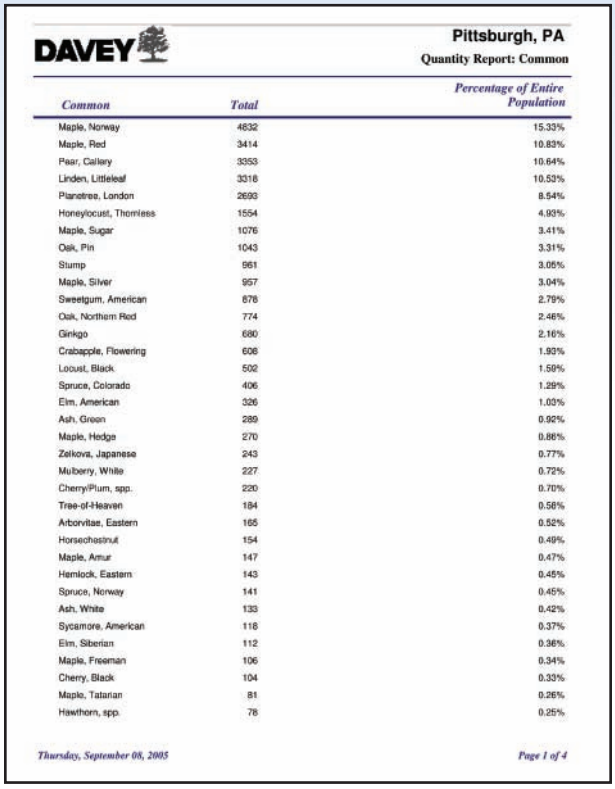
Partial Tree Inventories

Partial tree inventories allow the acquisition of information about a portion of the population or area that is perceived as critical. It may be desirable, for instance, to inventory a single area where trees are older and population density is greater. When budgets are limited, such an approach can provide an effective and affordable management tool. This same procedure

can be used to spread the work out over multiple years by moving sequentially through divisions of the area (wards, districts, neighborhoods, etc.).

Complete Tree Inventories

A complete, or 100 percent, tree inventory includes all the trees (and empty planting sites) in an urban forest. Typically, in a municipal environment, that means all the street trees in the public right-of-way and, in many cases, the municipal parks and other municipally owned land. For managed private tree populations, this type of inventory includes all trees within the defined geographic limits.



DAVEY

Pittsburgh, PA

Quantity Report: Common

Common	Total	Percentage of Entire Population
Maple, Norway	4832	15.33%
Maple, Red	3414	10.83%
Pear, Callery	3353	10.64%
Linden, Littleleaf	3318	10.53%
Planetree, London	2693	8.54%
Honeylocust, Thornless	1554	4.93%
Maple, Sugar	1076	3.41%
Oak, Pin	1043	3.31%
Stump	961	3.05%
Maple, Silver	957	3.04%
Sweetgum, American	878	2.79%
Oak, Northern Red	774	2.46%
Ginkgo	680	2.16%
Crabapple, Flowering	606	1.93%
Locust, Black	502	1.59%
Spruce, Colorado	406	1.29%
Elm, American	326	1.03%
Ash, Green	289	0.92%
Maple, Hedge	270	0.86%
Zelkova, Japanese	243	0.77%
Mulberry, White	227	0.72%
Cherry/Plum, spp.	220	0.70%
Tree-of-Heaven	184	0.58%
Arborvitae, Eastern	165	0.52%
Horsechestnut	154	0.49%
Maple, Amur	147	0.47%
Hemlock, Eastern	143	0.45%
Spruce, Norway	141	0.45%
Ash, White	133	0.42%
Sycamore, American	118	0.37%
Elm, Siberian	112	0.36%
Maple, Freeman	106	0.34%
Cherry, Black	104	0.33%
Maple, Tatarian	81	0.26%
Hawthorn, spp.	78	0.25%

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Tree managers can use inventory data to help achieve species diversity.

Quality

The final, and possibly most neglected, inventory topic is quality. Urban forest managers should take all steps possible to ensure they have a reliable and useful product. If practical, the manager should ask for a dry run to make sure that he or she gets data and software that meet inventory needs.

Contracting out a tree inventory is no different from that of any other service, and standard consumer cautions should be used:

- Match local needs to service.
- Evaluate equivalent vendors and products.
- Ask for and consult references.
- Do a hands-on test of the software that will be used.
- Write detailed requirements and specifications for bidding.
- Solicit recommendations and reviews from other urban forest managers.
- Check product specifications, history, and usage.

These standard procedures provide a good base for evaluating the quality of tree inventory services.

In addition, steps can be taken to maximize quality, no matter which method or vendor is chosen. These steps can be divided into questions of data quality and data integrity.

Data Quality

Features

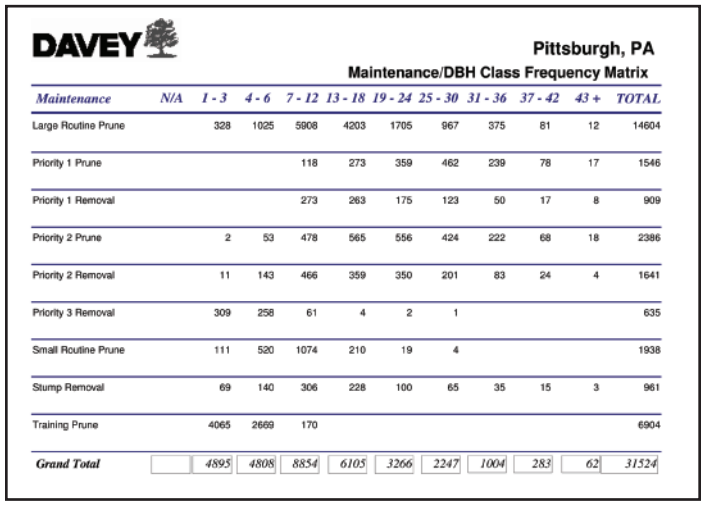
- Provide all information required so that the crew will include all managed trees. Doing so may require maps, right-of-way information, and other indications of inclusion.
- If no existing criteria exist, give the data collectors clear written directions on how to proceed.
- Spell out the criteria (check local code, if relevant) for determining when a marginal or boundary line tree will be included (for example, any part in, mid-point in, entire tree in).
- Ask for details on options with regard to tree location equipment and available map data.
- Make sure that an explicit method exists for dealing with unrecognized species. The method should include sampling, labeling, and subsequent identification efforts.

Attributes

- Examine attributes carefully to make sure that all necessary data are collected, that nothing is included that will not be used, and that the attributes make sense in the local context.
- Specify in writing a maximum percentage of unknowns (for example, 1 percent).

Values

- Specify the level of accuracy required for tree diameter, and verify how unusual cases will be handled.
- Examine the condition system (categories, definitions, and codes) carefully, and make sure it can be understood and used.



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Maintenance/DBH Class Frequency Matrix

Maintenance	N/A	1 - 3	4 - 6	7 - 12	13 - 18	19 - 24	25 - 30	31 - 36	37 - 42	43 +	TOTAL
Large Routine Prune		328	1025	5908	4203	1705	967	375	81	12	14604
Priority 1 Prune				118	273	359	462	239	78	17	1546
Priority 1 Removal				273	263	175	123	50	17	8	909
Priority 2 Prune		2	53	478	565	556	424	222	68	18	2386
Priority 2 Removal		11	143	466	359	350	201	83	24	4	1641
Priority 3 Removal		309	258	61	4	2	1				635
Small Routine Prune		111	520	1074	210	19	4				1938
Stump Removal		69	140	306	228	100	65	35	15	3	961
Training Prune		4065	2669	170							6904
Grand Total		4895	4808	8854	6105	3266	2247	1004	283	62	31524

Condition reports can be generated from the data collected.

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- Where feasible, require a list to be submitted showing that data collectors doing risk assessment are ISA Certified Arborists or the equivalent.
- Make sure that the fields and the values within them are (1) clear and (2) mutually exclusive so that data analysis will be effective and reliable.
- Require an explicit statement of field data quality control from the vendor. The statement should include level and timing of review by the project manager.
- Where feasible, select a random segment of data early in the process and have it reviewed by a qualified member of the manager's own staff for accuracy and consistency.

Data Integrity

Data Entry Errors

- If electronic media are not being used for data collection, require a written procedure for quality control of data entry (such as double keypunch).
- If electronic media are being used, ask how field data are being backed up during collection.
- Check that drop-down lists are used throughout the system so that the data will be recorded in a consistent format and without spelling errors.
- Inquire about error-checking methods that will be applied to field data.
- Make sure that permission to alter the actual database is appropriately limited.

Software

- If using an off-the-shelf spreadsheet or database, be sure that sufficient professional help is available locally for support.
- Obtain an explicit statement of level and duration of support for commercial packages, including response to bugs.
- Try to get free subversion maintenance releases (for example, 1.0 to 1.2) of commercial packages and ask for the update policy, frequency, and costs.

Storage

- Adopt an explicit policy of regular scheduled backups, as well as mandatory local backup after data entry.
- Establish a method and schedule for regular off-site storage.
- Establish backup policies in cooperation with local IT people.

Selected References and Additional Information

American Nursery and Landscape Association. 2004. *American Standard for Nursery Stock* (Z60.1-2004). American Nursery and Landscape Association, Washington, DC.

Bloniarz, David (Coordinator). 2002. *Volunteer Training Manual: Count Trees Because Trees Count.* USDA Forest Service, Northeast Center for Urban and Community Forestry, Amherst, MA.

Bloniarz, David V., and H. Dennis P. Ryan III. 1996. The use of volunteer initiatives in conducting urban forest resources inventories. *Journal of Arboriculture* 22(2):75–82.

Council of Tree and Landscape Appraisers. 2000. *Guide for Plant Appraisal* (9th edition). International Society of Arboriculture, Champaign, IL.

Husch, Bertram, Thomas W. Beers, and John A. Kershaw, Jr. 2003. *Forest Mensuration* (4th edition). Wiley, New York, NY.

Matheny, Nelda P., and James R. Clark. 1994. *A Photographic Guide to the Evaluation of Hazard Trees in Urban Areas* (2nd edition). International Society of Arboriculture, Champaign, IL.

Miller, Robert W. 1997. *Urban Forestry: Planning and Managing Urban Greenspaces* (2nd edition). Prentice Hall, Upper Saddle River, NJ.

Olig, Robert, and Robert W. Miller. 1997. *A Guide to Street Tree Inventory Software.* www.na.fs.fed.us/spfo/pubs/uf/streettree/toc.htm. USDA Forest Service Urban Forestry Center for the Midwestern States, Madison, WI.

Tree Care Industry Association. 1998. *American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Maintenance—Standard Practices (Fertilization)* (A300, Part 2). Tree Care Industry Association, Manchester, NH. 9 pp.

Tree Care Industry Association. 2000. *American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Maintenance—Standard Practices (Support Systems a. Cabling, Bracing, and Guying)* (A300, Part 3). Tree Care Industry Association, Manchester, NH. 29 pp.

Tree Care Industry Association. 2001. *American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Maintenance—Standard Practices (Pruning)* (A300, Part 1). Tree Care Industry Association, Manchester, NH. 9 pp.

Tree Care Industry Association. 2002. *American National Standard for Tree Care Operations—Tree, Shrub, and Other Woody Plant Maintenance—Standard Practices (Tree Lightning Protection Systems)* (A300, Part 4). Tree Care Industry Association, Manchester, NH. 9 pp.

Characteristics such as species, size, and health are normally included in an inventory.