OPTIONS IN STREET TREE INVENTORIES

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ABSTRACT. Many options are available for street tree inventories to meet the unique needs and budgets of most municipalities. Goals and objectives must be clearly defined, type and longevity of inventory decided on, and data collection specifications clearly developed. The purpose and size of the inventory will determine whether to computerize the information. Available options are outlined and discussed.

Résumé. *Plusieurs options sont disponibles pour un* inventaire des arbres de rues afin de satisfaire les besoins et les budgets particuliers de la plupart des municipalités. Les buts et les objectifs doivent être clairement définis, le type et la durée de l'inventaire déterminés, et les spécifications pour la prise de données bien développées. Le but et l'envergure de l'inventaire déterminera la pertinence d'informatiser l'information ou non. Les options disponibles sont présentées et discutées.

During the 1970s there was s surge of interest in street tree inventories (9), mainly due to availability of Federal urban forestry funds. Although some of these inventories are still in use, most have been discarded, primarily because of problems accessing, understanding and updating the data. Interest in tree inventories has increased again in the mid-1980s. Most of these inventories are paid for by the cities from their general revenue funds. The common motivations for conducting inventories are the desire to manage trees more efficiently and to reduce potential liability resulting from tree failure. If an urban forest management information system is to be useful now and in the future, the data needed for management decisions must be identified and inventory options reviewed. In this paper, we discuss these options and raise questions which will help cities to obtain an inventory that will be useful in improving their urban forestry program.

Why do an Inventory?

Before conducting an inventory, the goal or purpose of that inventory must be identified (12). You must clearly define which trees you are interested in and why you want information about them. Not until the 'why' has been clearly defined can you identify the specific information to collect for each tree.

There are numerous reasons why a tree inventory should be conducted (11). The first is to **determine the need for a tree management program.** Are trees growing well with little need for pruning, planting or removal? An inventory can help make this determination. If all trees are growing well and streets are well stocked, then a program may not be needed. Numerous mature trees with dead limbs, standing dead trees and/or areas with no trees, indicate that a program is definitely needed.

Secondly, knowledge of **tree values** or total value of the tree resource can be used to justify the need for, or existence of, a tree management program. Realtors often tout the value of trees since trees often increase the value of residential property. Municipal decision makers can more easily evaluate urban forestry programs, when they know current investment in trees and cost/benefits of proposed programs. Tree values can be determined for each tree or can be projected from a representative sample of trees.

An inventory can also **identify and prioritize tree work to be done.** An inventory can identify trees that need pruning or removal, and sites to be planted. With the total quantity of work determined, plans can be made to accomplish that work. Good inventory data make it possible to project budgets for routine tree maintenance work.

Increasing work efficiency is another major benefit of a tree inventory. Inventories that determine maintenance requirements of each tree make it possible to prioritize work. Hazardous trees may be identified so work can be efficiently scheduled and routed. If weather interferes with one type of work (e.g. large tree climbing/pruning) alternative work types (e.g. small tree training) can be located in nearby areas so crews do not have to waste time.

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Inventories can also be useful in **public information and education.** Information on tree species, value, hazard potential, planting priority, canopy cover and density may all be extracted from an inventory. This information can be used to educate citizens as to the need for, and benefits from, well managed trees. This information can aid in planning for development. Tree species can also be evaluated to prepare planting recommendations for use in-house and for distribution to interested citizens and local nurseries.

Inventory Type

Defining the objective of the inventory makes it possible to determine the type of inventory, i.e. how much data will be collected and how it will be updated for future use.

Specific Problem Inventories collect information about one problem or condition. The information can be used to prepare contracts or schedule work. These inventories collect minimal data, and can be completed quickly and inexpensively. Hazardous tree surveys, Dutch elm disease inspections, stump inventories, and planting site inventories are common examples.

Hazardous tree surveys are conducted annually in many cities, and collect the absolute minimum information that all cities should have. Typically, an observer in a vehicle looks for potentially threatening conditions and records the problem and address. Marking hazardous trees during the inventory is no longer recommended since this may increase liability problems.

Partial Inventories involve data collection from a sample or small portion of the city. Depending on the percentage of the tree population sampled, partial inventories can be completed rapidly and inexpensively while driving or walking. When using the "windshield" option, the observer records data from the vehicle, thus spends little time with each tree. The address is usually not recorded, as other parameters are of primary interest. Ten percent of the tree population is typically examined in a windshield partial inventory.

In "on-ground" partial inventories, more data are collected on each tree, usually including the address. On-ground inventories are most often used to prepare tree work contracts. If representative areas are sampled with either option, results can be statistically extrapolated to the entire population. Inventories that include tree location may be expanded until the inventory is complete. With tree location, partial inventories are useful only for statistical generalizations.

Complete Inventories examine the entire tree population and may include all municipally owned trees or all trees in an area. Typically, crews walk to each tree and record the required information. Aerial photographs can be used to determine tree location and condition (5). This type of inventory is extremely labor intensive, and thus, time consuming and expensive. Complete inventories can, however, provide the most accurate and most useful information about the urban forest. Complete inventories are routinely used to project budget needs, to prioritize management activities, and to achieve most other inventory goals.

Cover Type Surveys are used extensively to characterize commercial forest lands. Recently, they have been used in urban areas to quantify canopy cover and to monitor changes in urban vegetation (7,8). This type of survey is very useful for examining the entire tree population, not only publicly owned trees. Since data on individual trees are not collected, it is better suited for use in long-term land use planning rather than to plan for work and prepare contracts. Cost is relatively low if existing aerial photographs can be used.

Inventory Longevity

Inventory longevity is the projected length of time that the inventory data will provide useful information. Periodic inventories provide a "snapshot" of the urban forest and are useful for decision making and short term work planning. If repeated, they can provide information on changes in the urban forest. An alternative to the periodic inventory is the continuous inventory. After data are initially recorded, changes are recorded to update the inventory. A complete updating of continuous inventories is required after five to ten years if information has not been collected routinely by work crews or if areas have not been serviced. Updated information includes diameter, condition, damage and maintenance. It is relatively easy to update a well maintained inventory. Corrections can be made on a printout of all trees in the city by street address (or other

locating system) in the field thus eliminating the time-consuming recording of location, species and site information.

Data Management

Information for small tree populations (less than 1,000) such as those in parks, may be maintained in a card file. For most cities, however, a computer is required to efficiently manage the massive amounts of information.

There are many variations in computer programs used to manage tree inventory data (2). Two categories of computer programs can be recognized: those that run on mainframe computers; and those that run on the increasingly popular microcomputers.

The earliest programs, many of which are still useful, were written for the data processing mainframe computers (9). These programs can sort and summarize large amounts of information quickly. This is especially important in a city with more than 100,000 trees in the inventory. If a city uses special assessments to fund tree work, processing the tree information on the same computer as taxes allows referencing each property by its tax number, thus facilitating billing. There are however some potential problems when managing tree information on the city's accounting computer. Access to the computer can be a problem when the city is processing utility bills or payroll. Developing a mainframe computer program may be too costly for the forestry budget. Usually it is less expensive to purchase existing urban forestry management software, if a package is available for the city's make of mainframe computer.

Microcomputer programs are probably the most cost-effective means of managing tree data for cities with up to 150,000 trees per management area. The capacity and speed has increased greatly, while costs have decreased. For less than $1500, a city can purchase a computer and a printer. With this equipment, and a computer program for managing tree inventory data, the data can be entered into a computer and answers obtained about the trees. Tree inventory computer programs are available from many private firms and universities (10). Before purchasing any program, make sure that it meets your needs. If it does not, it is not worth *any* price. Ask for a demonstration on your system before purchasing it. Price alone should not be a consideration; many higher priced programs provide additional features such as printing work orders and maintaining crew productivity records.

What Data Should Be Collected?

After the goals of the inventory have been determined and type of inventory decided on, decisions must be made on the data to be collected. Keep in mind that the more data collected on each tree, the greater the inventory cost. All data collected must relate to the goals of the inventory.

Species. The most commonly collected information is the tree name. The genus and species can be recorded, or codes can be used. Field identification of cultivars is often difficult, and requires experienced crews. Numeric codes used extensively to record names tend to be confusing, and may result in mistakes that are difficult to detect. The best option appears to be alphabetic species codes composed of part of the common or scientific names. Regardless of the method, provide a complete list of names and/or codes to those collecting data at the start of the inventory so uniform terminology is used throughout.

Size. Information on tree size is usually collected. At least four measures of tree size have been used: diameter, circumference, height and spread. Diameter and circumference are virtually interchangeable; diameter at breast height (dbh) is used most often. Where diameter is recorded in one or two inch classes, tree values can accurately be determined and regression equations can be developed to predict tree height and crown spread, thus eliminating the need to measure these parameters in the field and store them in a data base. Diameter classes may be as small as one inch or as large as six inches. For most managers, six inch classes provide adequate information on large trees. Small trees are usually measured more accurately than large trees. Diameter classes of 0-3", 3-6", 6-12", 12-18"... are frequently used.

Condition. Physical condition of each tree can be evaluated to determine health or monetary value of the population. Condition does not

necessarily reflect the maintenance needs of the tree. Many different methods have been used to evaluate condition, although some inventories do not evaluate condition. If condition information is required, the following classifications may be used:

Alive or dead
Considered hazardous
Good, fair, poor, dead/dying
Life expectancy - estimated number of years before removal will be required
Percentage factor - for use in the ISA (CTLA) valuation formula

Life expectancy of a tree can only be determined by someone with a great deal of experience. Results vary greatly so this type of classification is not recommended. The International Society of Arboriculture formula for tree valuation, rates conditon as a percentage with 100% as perfect and 0% as dead (1).

Damage or Injury. Information on existing tree injuries or damage can be collected in order to predict tree decline or to define the cause of future tree problems. Presence or absence of different types of injury may be recorded (Table 1), or the severity of the injury may be rated. Severity ratings reflect the degree to which the tree has been injured. Data on damage or injuries may be recorded in a separate field, or in a history or remarks field. Information about insects, diseases and other injuries is often collected, but not used. Why collect it? If no management action will be taken, there is little advantage to recording the information in the inventory. One approach to consider is recording insects and diseases only when they require some specific management action. Then it may be beneficial to record the maintenance needed or required rather than the specific pest. For example, instead of recording that fire blight is present, record the need for sanitation pruning. If dealing with a widespread pest, like aphids on Norway maples, simply use the inventory information to identify all susceptible trees rather than recording the need for a dormant oil application for each tree.

The inventory, which collects information about trees, differs from pest surveys, which detect pests and gather information about present and potential pest populations (4). Surveys should be ongoing, while even a continuous inventory is relatively static. Pest survey information is needed to determine when management is needed, and to develop strategies to reduce pest impact.

Management/Maintenance Needs. Management needs are perhaps the most important part of an inventory designed for use as a management tool. This information is useful in preparing budgets, scheduling work and assigning crews. Required management can be recorded by the type of work (Table 2) or by the equipment need-

Table 1. Classifications of injuries commonly used in tree inventories.

Mechanical injury
Branches
Utility or improper pruning damage
Breakage due to wind, snow, lightning or people
Trunk
Mower
Auto
Construction
Vandalism
Fire
Lightning
Roots
Sidewalk replacement
Underground utilities
Construction
Pest injury
Insects
Diseases
Decay/Cavity
Dieback
Mistletoe
Rodents
Bird
Environmental injury
Mineral deficiency
Leaf scorch
Herbicide damage

Table 2. Categories of work requirements commonly used in tree inventories.

Pruning
Tree removal
Stump removal
Sidewalk repair needed
Vacant planting sites
Cabling or bracing
Guying
Fertilization
Pest management
Wound repair

ed and/or time of year to do the work.

If the type of work is recorded, code specific types of pruning: small tree training, dead wood removal, hanging branch removal, sucker removal, lifting lower limbs, sign or light clearance, and pruning pest infested branches (sanitation). The combination of tree size information and management requirements makes it possible to prepare accurate budgets and to allocate equipment.

Pruning, and other management needs, may alternatively be coded by equipment and/or personnel needed and the time of year the operation should be done. This allows scheduling all the work in an area that requires a bucket truck, or all work that should be done in April. This type of management-need coding requires well trained crews so that the correct work is done to each tree.

Tree Location. Many methods have been used to determine tree location. Street address is probably most useful, especially when the data will be used to respond to resident requests. When there are several trees on a lot, they can be separated by: mapping exact location; measuring the distance from the lot line (or driveway) to each tree; numbering (or assigned a letter) from the lot line; or dividing the lot into numbered cells and recording cell number for each tree. Other methods of determining tree location include numbering trees from an intersection of two streets, measuring the distance from the intersection of two streets to each tree, using property tax numbers to identify each lot, using a grid system for the entire city, or mapping trees using aerial photography. Morsink and Burridge (6) maintained information about each tree in order from low to high house number on each street, recording the distance from the curb as each tree was encountered. Other sequential tree numbering systems may not work well when trees are planted or removed. Almost any method can be used to schedule work as long as crews can locate each tree. If dealing with the public, the street address must be linked to each tree. When planning an inventory, consider the time to locate a tree versus the need for accuracy. Other information collected for the tree, most notably species and diameter, may help identify the desired trees on a lot.

Site Characteristics. Site characteristics determine the species or type of tree that can be successfully grown in a location. One of the most important factors is space available for the root system. For example, if there is only two feet between street and sidewalk a large species should not be planted on that site. Overhead wires are also a major limiting factor in species selection. Recording the presence, or better yet, the height of wires greatly assists in determining species or cultivar to plant and maintenance requirements after planting. Most utilities maintain a 10 foot clearance in all directions from wires, and mature trees should not infringe on this clearance area. Underground utilities may restrict the use of trees sensitive to root damage. Land use information can help identify high priority areas for tree planting and other maintenance. Residential, commercial, industrial, park, or other categories all provide useful information when planning for tree planting and maintenance.

Parking Restrictions. To conduct pruning, removal, or spraying operations, parked cars must be moved prior to crew set-up. This may simply require posting 'No Parking' signs days before work is to be done or asking residents to move cars once the crew arrives. Several large cities, including New York City, have regularly scheduled periods of restricted parking to allow for tree and other maintenance services. It is very important in those cities to record restricted parking days and times so that work may be scheduled for times when cars are not present. If neighborhoods allow parking on an even/odd basis, this should also be noted.

Other Information. Other data collected should relate directly to the management needs, inventory goals, and inventory type. Information which will not be used slows data collection, and increases inventory cost. Information concerning the historic or aesthetic value of trees helps to identify trees of significant historic value or "key" trees in locations where more intensive management is warranted, and is often used to justify the inventory.

Budgeting for an Inventory

Funding often dictates many decisions. The major cost of any inventory is field data collection.

Collecting only basic information requires that an average college student spend one to three minutes at each tree. More time is required by less experienced students.

When planning the labor requirements for a tree inventory, consider data collection time, transportation time, quality control/supervision time, time required to enter data into the computer and verification time. Quality control requires field checks on a sample of the data. If problems are found, more extensive checking or recollection is required. Verification involves checking data entered into the computer. For each hour allocated to collecting data in the field, allow at least 1/2 hour for data entry and verification and 1/4 hour for quality control. Data entry time can be reduced greatly by using hand-held data recorders in the field. Shock-resistant, waterproof dataloggers, and the relatively fragile, portable, battery-operated microcomputers have both proven useful. Data are transmitted into the microcomputer and are instantly available for use. While the cost of field data collecting equipment may be quite high, ($1000-3000) costs may compare favorably with those involved with manual data entry.

Transportation to the inventory area and between trees can be a major expense. With a windshield inventory one to five miles can be covered each hour when collecting minimal information on streets with many trees. An inventory of specific problems can cover five to ten miles each hour, unless the problem is widespread. Walking between trees in well forested cities typical of the midwest or east may require 30 seconds to two minutes. In cities with fewer trees, bicycles or mopeds will reduce long walks between trees.

It is best to inventory several typical blocks to determine the time required to collect data and move from tree to tree before preparing a budget. A projection can then be made for the entire inventory unit.

Urban forestry consultants will bid on inventories by street mile, as a lump sum, or by the tree. The most common method is to bid a fixed amount for each tree or planting site inventoried. This method reduces the risk to the consultant of underestimating the tree population. The other methods allow for more certainty in municipal budgeting. Consultants currently charge between $1.80 and $2.50 per tree, depending on location and the amount of information to be collected. Computer data entry and verification are usually included in this charge. If a grid system is used and exact tree locations are required, the price may more than double.

Funding an inventory is simplest if it can be included in the tree maintenance or public works budget, but there are other options. Another city department, such as public safety, may share the expense since results, especially regarding traffic signs and lights, are useful to them. Utilities may partially fund the examination of trees under their wires. Most utilities spend millions of dollars each year trimming interfering trees, and there can be considerable savings if an inventory helps reduce trimming. The state government may have its own urban forestry budget or pass on urban forestry funds from the USDA Forest Service. Check with your state urban forester. Federal funds from the Summer Youth Employment Program (formerly part of CETA) have been used in several cities to hire youth to collect data. These funds are usually controlled by the local Private Industry Council for Job Training Partnership Administration. Private donations of time or money can also be used for tree inventories. An organizer or fund raising committee is needed to prepare and present project proposals. Contact large companies in the city to determine the availability of grants for civic projects.

How to do the Inventory

After setting inventory goals, deciding what data to collect, and planning for data management, a decision must be made on who will collect the data. Personnel, budget and time available for the inventory will influence this decision. Options for data collection and computer entry include:

- Hiring a consulting firm to perform all or part of the inventory
- Hiring additional full time or summer help
- Reassigning existing personnel
- Using community volunteers
- Using youth in the SYEP program

Many cities choose the first or second option because their personnel have other responsibilities. When hiring additional people or using

volunteers, remember that they must be trained and supervised. The crews must be able to identify city trees, and must also recognize maintenance requirements and tree condition. Contracting with consultants can avoid the need for extensive training or supervision. Consultants are also available to train existing or summer staff and to supervise disadvantaged youth during data collection. Graham (3) discusses some of the advantages and disadvantages associated with the use of volunteer labor.

When to do an Inventory

Inventories have traditionally been conducted during summer months when students are available and there is favorable weather. Foliage may easily be evaluated and condition classified. Data collection when trees are dormant has several advantages because trees can more easily be examined for dead wood, hanging limbs and other conditions that may be obscured by leaves. Personnel may have more time for the inventory because their workload may be reduced during the winter. Many professionals successfully conduct winter inventories.

Conclusions

There are many types of tree inventory systems available to the urban forester. No one system is suitable for all cities. To determine which set of options is best adapted to an individual city, the goals of the city's urban forestry program must be defined. The ways in which an inventory can assist in reaching these goals become the objectives of the inventory. The costs and benefits of the inventory options must be assessed. Collect only data that will be used. Planning the use of the inventory data prior to data collection will reduce the collection of unnecessary information and ensure the collection of pertinent data.

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