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City Tree Inventory: The Experience of a Small Town

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Introduction

Trees in a city are a critical component of the green infrastructure. They provide shade, windbreaks, storm water runoff reduction, filters for water seeping into rivers and lakes, production of oxygen, and filtration of certain air pollutants (Southern Center for Urban Forestry Research & Information. 2004, American Forests 2000). Human nature attaches a pleasing attribute to the presence of trees; they increase the property values and create a feeling of less stress in the neighborhoods (Husak and Grado, 2005). People often form a personal attachment to trees, especially ones that they or loved ones have planted (ISA 2005).

Trees are subject to many stress factors in a city (Casey 2003b). They are subject to air pollution from passing autos, physical damage by vehicles, compaction of soil around their roots, reduced water availability due to concrete and pavement, poor nutrient conditions, excessive pruning and various types of injury from human activity including carving of initials, damage by lawn mowers, and attachment of objects using nails and other fasteners.

As a result, certain street trees can become a hazard to the community property and public safety. Large rotting limbs can fall on pedestrians. Hazard trees often fall causing damage to houses and cars and injuries to people and pets. It is desirable to manage these trees to maximize their benefits and minimize their threat.

When faced with the responsibility of managing street trees, it is important to conduct a tree inventory to record what trees are out there and the current condition of the trees. With an inventory, one can analyze change in condition over time, work out maintenance schedules, develop tree planting schedules and create an overall management plan. The focus of this article is on the tree inventory process, recording what trees are out there and their condition. We will present a brief overview of the tree inventory concept followed by a case study of the tree inventory conducted by the city of Ruston, Louisiana.

What is a Tree Inventory

A tree inventory is the systematic gathering of information about the urban forest and organizing it into usable information for tree management. Information about the species of tree, its health, size, and location are recorded for each tree. Maps can be made of the location and health of each tree allowing a good baseline for sound management plans. A tree inventory is part of a sound management plan.

There are several different kinds of inventory that can be taken depending on the objective of the city's urban forestry program. Some of the common types are (UConn 2006):

- Specific Problem inventory: Gathers data about a specific problem or condition for work contracts or work schedules. For example, "A survey of hazard trees" and "The extent of Dutch elm disease" are specific problem inventories. It is important to hire an ISA certified arborist especially in these cases, for it takes special skills in identifying and controlling diseases (International Society of Arboriculture 2007). Metzger (2007) provides tips on how to hire an arborist. Note that every community should conduct a yearly survey of hazardous trees. (Marking hazardous trees is not recommended since doing so may increase liability.)
- Partial Inventory: Gathers data from a sample (or samples) and information is extrapolated to apply to the whole forest. The survey is completed by an observer walking or driving and is generally used for long-term planning and management and to obtain a general idea of the state of the urban forest.
- Complete Inventory: Surveys the entire tree population. It is especially useful in intensively managed areas such as parks and campuses but is time consuming and costly in time and labor. An alternative is to select specific areas for complete tree inventory such as city parks or trees along city streets.
- Cover-type Survey: Information is gathered by at least partial use of aerial photographs and sometimes with a geographical information system (GIS). This type of survey is used increasingly in urban areas to examine the entire tree population in order to plan long-term land use. Again, the costs can be high depending on the level of detail, however, the remote sensing and GIS technology can save a tremendous amount of field work. Trained professionals are needed for this type of inventory and a system of ground truthing is required.

Other types of tree inventories are possible including hybrids of the above. There is no best method. Each community must work out a survey plan that best fits their situation and objectives.

Why Should We Do a Tree Inventory

Tree inventories provide information for a number of tasks in street tree management. First, they determine the level of management needed for a community forestry program. If the inventory reveals no current problems, then the forestry program might shift its emphasis to other issues such as education and communication. However, a community forestry plan should still be developed to address future issues involving city trees. A tree inventory is the basis for developing this forestry plan; a plan for developing and maintaining a quality environment for life.

If an inventory reveals the existence of hazardous trees then a remediation program should be initiated along with a program for replacing trees that are removed. The tree inventory can help in the plan for prioritizing treatments, organizing work flows, and achieving the desired community forest condition. The inventory can also serve as documentation that the city is actually striving to remediate hazardous conditions. This can be valuable in a court of law if a municipality is sued for damages from a fallen tree.

Tree inventories also provide a method of educating the citizens about the benefits of trees and the importance of maintenance. The city of Washington DC created an educational program through the Casey Trees Endowment Fund to allow citizens to view the status of trees in their own neighborhood. The interactive map allows a person to zoom in to his or her neighborhood and view the tree inventory data: tree species, health, size, and even spaces available for planting of new trees (Casey 2003b). This type of interactive information is helpful for explaining why a certain tree might need to be cut down, or to educate on the best species to plant/replant.

How Do You Do a Tree Inventory

In the case of the Ruston, Louisiana tree inventory explained below, the inventory consisted of individuals or small crews of people who went from tree to tree along the streets recording the desired information. Tree inventories have been successfully done with professional foresters and arborists and with trained volunteers. Casey Trees of Washington DC conducted an inventory of 955 miles of streets in 2002 using volunteers (Casey 2003b).

For the Ruston, Louisiana project, one or two people in a crew worked well, however, larger crews attract more attention and can help in the promotion of the program. Everyone wore a uniform or bright colored vest to identify them as an inventory taker and to make them highly visible to nearby traffic. Some form of identification such as ID cards may be necessary if local property owners become wary of people measuring their trees. Advanced publicity of the event helps alleviate this problem.

Since tree inventories can be expansive and time-consuming, only data that will be used should be collected. The following are some of the more pertinent items collected in an inventory (UConn 2006):

- Tree height and diameter (sometimes short, medium, tall may be sufficient for height and for diameter: <12”, 12-24”, >24”).
- Tree species (scientific name is best, but for practicality it may be necessary to use tree groups such as oak, maple, pine, etc).
- Condition: Is the tree a hazard? Should it be removed, pruned? Is the tree damaged? Are there rotten limbs? Has it been attacked by insects? Evaluating tree condition requires training and experience. The community should hire someone who is qualified for this type of work to perform this function.
- Maintenance need: Does the tree need pruning or fertilizer? Does the sidewalk or curb need repair from damage by the tree roots? Is there an old stump that needs removal?
- Planting spaces: Record spaces that could support a tree but do not have a tree at the present.
- Site characteristics: Size of space for the root system, soil characteristics, presence of overhead obstructions and power lines, possibility of the tree blocking the view of traffic.
- Special characteristics of the trees: historic value, record size, special scenic value.

Help in Conducting an Inventory

Many aids to tree inventories have been developed. Olig and Miller (1997) list and describe 13 different software packages that have been developed. The Northeast Center for Urban & Community Forestry site has several free downloadable software packages (http://www.umass.edu/urbantree/forest.shtml). Many commercial software packages have been developed to help in tree inventories and management of the urban forest (WCA 2006). Some software organizes the inventory and provides a friendly user-interface and even provides sample pictures of tree species. The software includes forms for recording maintenance records, updating inventories information, and links to a GIS and master street tree plan.

The US Forest Service has developed a peer-reviewed public domain software package called i-Tree (USFS 2006). It provides tools for community forestry analysis, and benefits assessment. One of the modules is a tree inventory system called Mobile Community Tree Inventory (MCTI). Depending on the resources of the city: paper tally sheets, a desktop computer program, and a data collection system can be used. A PDA (Personal Digital Assistant) system is particularly useful since data can be easily recorded in digital form in the field and transferred to a computer in an efficient and cost effective manner (Bloniarz 2001). Bloniarz (et. al 2003) further describe the use of PDSs in tree inventories.

Cornell University has developed a tree inventory template for PDAs which can be output to a simple spreadsheet or database (Cornell 2003). It can be freely downloaded at http://www.hort.cornell.edu/commfor/inventory/download.html. The net site also has information on community forestry planning, conducting a street tree inventory, and resources for implementing a street tree master plan.

Watershed and Other Protections

Ruston, Louisiana, population 21,676 hired a vegetation management specialist in 2001to work with Ruston Light & Power to manage trees under power lines. Slowly the specialist began working for other departments such as water utilities and public works and became known as the urban forester. When the vegetation management specialist started work it was clear that the main problem area was the downtown historic district. Water Oak trees are common in this district, providing shade and great esthetic value. However, at their age they have become over mature and have a high prevalence of heart rot. The trees that are prized in the historic district have become dangerous (figure1).

After several years of maintenance it became evident that a map of the trees and their condition was necessary for efficient dispatching of the pruning crews. A tree inventory would

Figure 1. Prized trees in the Historic District have become overgrown

also be valuable in case a law suit came up against the city for damages from falling limbs and trees. Since a tree inventory is the first step for methodical tree maintenance, the city felt that one was necessary to show the courts that they are attempting to address the problem trees. Funding for the tree inventory was received from the Louisiana Department of Agriculture and Forestry for $9,000 with $11,000 city matching funds. The original plan was to inventory only the street trees, but with excess funds near the end of the project, the inventory was extended to include trees in city parks and other city-owned property.

Objectives

The tree inventory was implemented to be the basis for management decisions. It would provide basic information for the creation of a strategic plan for Ruston's urban forestry program. In addition, it would provide data necessary to support the effort of "Ruston Green", a new community-based program to promote Ruston's natural environment that includes local garden club members, the city forester, the city's planning and zoning department, city officials, and representatives and and Louisiana Tech University.

Immediate needs for the inventory included location of the most dangerous trees so that a removal schedule could be established and the location of all trees that may have an effect on the power lines. By locating the hazardous trees and creating a map, the city forester would be able to present a case for removal because many city residents disapproved of the removal of street trees because of their beauty and added value to the property.

Process

The city of Ruston conducted a complete tree inventory, but only of trees on city managed property. The inventory included trees in Ruston's rights-of-way, easements, city parks, and other city property. Approximately 18.2 square miles of land fell within Ruston's city limits. Originally the plan was to hire six Louisiana Tech University students to perform the inventory over a 16 week period. They would work in crews of 2 with flexible hours to accommodate their school schedules. It turned out that two students did most of the work. They worked faster than expected and completed the project ahead of schedule.

The city forester decided that a simple inventory with few data attributes would be sufficient for the cities needs. The following data was collected for each tree:

Measurements were kept simple. For example, tree heights were divided into 3 categories. These categories approximated the heights of overhead wires above the ground. Thus, a person could quickly es-

Figure 2. GPS readings were averaged from opposite sides of each tree.

timate tree height by observing its height relative to overhead wires. A tree that is lower than the phone lines would fall in the 17-40 feet category and a tree that was higher than the power lines would be > 80 feet tall.

	Value Ranges					
Tree Height	12-16	17-40	41-80	>80 feet		
Diameter (DBH)	8-12.9	13-17.9	18-22.9	23-27.9	28-31.9	>31.9
Tree Health	Great	Fair	Poor	Dead		

Location of each tree was recorded using a GPS (Global Positional System). To record the inventory attribute data, the city forester created a data log for a Trimble GPS GeoXT. The students collected GPS coordinates by finding the average of readings on opposite sides of each tree (figure 2) and recorded tree height and condition attributes in the GPS device. At the end of each day, they uploaded the GPS data to the city's computer. The GPS time stamp on each data recording allowed the process to be monitored from the office. In order to keep track of what had been done and to organize the daily work, the GIS Tech created a set of 30 maps covering the city. Each map covered a small

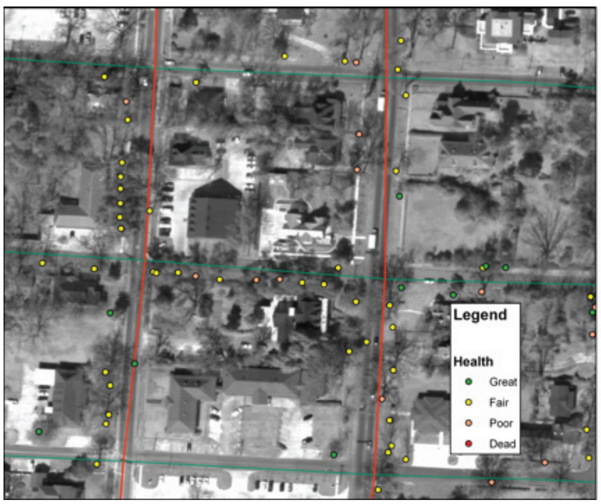

Figure 3. GPS errors can be quickly observed if overlaid on a GIS road layer or photo

part of the city in great enough detail for the students to mark their progress by highlighting the streets completed. Maps of the most critical sections of town were given to the crews first. When they finished inventorying the trees on one map, the students turned in the map to the forester and received a new one. This allowed the forester to guide the direction of the inventory through the city.

The inventory started in the city's downtown historic district and moved to the outer city limits. The historic district is the "high risk" area due to the fact that the trees are the oldest in the city. Because of the age of the homes and size of the trees, this area is greatly valued by the citizens of Ruston.

The city forester created maps of the progress of the project as data was uploaded by the students. Spot checks were made to insure data accuracy. The GPS tree locations were plotted on the city road system for a visual inspection of the accuracy of tree placement. Any trees that were erroneously plotted in the road were revisited to correct the coordinates (figure 3).

Results

The tree inventory was finished ahead of time and under budget. The actual cost was $16,000. It took five months to complete the street tree inventory with students working part time. This left sufficient time and money to complete the inventory of all city property including city parks. In all, 6,749 trees were inventoried. This included 195 miles of roads in the18.2 square mile city. The inventory took 760 man hours for an average of 6.8 minutes per tree or 3.9 miles per hour. The latter number is high because many of the roads have no trees large enough to be inventoried and thus did not have to be traversed.

The healthiest trees were found to be in the newer parts of town, while the trees in the old, downtown section were the worst. These trees are very old and are prone to disease and damage from ice storms and high winds.

By far the largest number of trees inventoried was Pine, which is logical since Ruston is situated in the middle of the Pine belt. The second largest species count was Water Oak. These are large, fast growing trees that have a practical life span of about 50 years. After that they become dangerous with large rotten limbs. Unfortunately, at this stage they are beautiful, large trees with high esthetic value to the community. Good planning calls for the planting of trees that live longer without posing a threat when they mature.

The logistics of the project went very well with no major problems. The workers were kept busy with very little data problems. The largest drawback to using the GPS system was on days when the reception was poor from the satellites. There were times when the crew couldn't work for an hour or two while the constellation of satellites needed for GPS recording was unfavorable. Thanks to the flexible work schedule, the students could modify their time of work to the best GPS reception times.

Summary

This project showed that a tree inventory doesn't have to be a cumbersome and expensive process. The student workers did a great job. The city got a valuable inventory for planning and the students received a flexible job compatible with their study schedule. Every one benefited. By keeping the data attributes simple, the inventory was completed with little problem.

Figure 4. Close-up of an intersection in the Historic District in leaf-off season. Road centerlines from a GIS are overlaid on the image.

This situation could have been different, though, if the city had opted to go high tech.

The city had access to high resolution air photos which could be used for the inventory (figure 4). Both orthophotos and oblique photos of the town were captured in 2005 by a company headquartered in Rochester, New York. Using their proprietary software, a tree could be viewed from any of four sides allowing accurate digitizing of the base of the tree

Figure 5. Two of the pine trees in the upper right of Figure 2 have been cut down since the imagery was captured.

in a Geographic Information System (GIS). This would create an accurate map of the location of each tree along the street. Using GIS tools, one could create buffer zones along both sides of each street to identify the trees within the right-of-way. Then a map could be made showing the location of each tree to be inventoried. It would eliminate the need for GPS work and time-consuming measurements to determine if a tree is within the right-of-way or not. Height measurements could also be made directly from the photos, eliminating another step in the field work of the inventory.

Figure 6. Damage to trees and signs of rot are best viewed on-site.

This would require specialized training of the inventory staff and the use of an already overworked city GIS department. The photos were of very high quality, however, due to the age of the photos, many changes could have occurred since their acquisition forcing the inventory crew to deal with inconsistencies between the GIS developed from the photos and the real conditions on the ground (figures 4 and 5). Also, a person would still have to go to each tree to record its diameter and condition (figure 6). In the city of Ruston, the width of the right-of-way changes from block to block. Creating a buffer in the GIS would be complicated and prone to errors.

In order to avoid these issues, the city forester decided to do the inventory by hand, without using the air photos. Each tree was visited with a GPS that recorded the latitude and longitude position. As one member of the crew collected the GPS coordinates, the second member measured tree diameter. The two discussed and agreed on tree condition. This process turned out to be quite efficient.

The inventory showed that about 8% of the trees in Ruston are in poor shape or dead. These 8% are the high priority trees for management. The city forester knew where the potential problem trees were before the inventory, but now they are documented, and the maps provide a base for making decisions. The GIS database is currently being updated as trees are removed or new trees planted. Eventually, the city forester will print small maps from this database as a part of the work tickets for the tree crews.

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