THE ECONOMICS OF URBAN TREE INVENTORY SYSTEMS: FORT WORTH, A CASE STUDY

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Abstract. Costs associated with establishing a computerized urban tree inventory system are estimated using data developed during the establishment of METRIS in Fort Worth. Economic efficiency measures are identified and applied to system development. The question of economic feasibility for the development and use of such systems is addressed.

Several recent studies have outlined the methodology for establishing a computerized urban tree inventory system. Some such studies have addressed the general principles of urban inventory systems (Bassett 1976, Ottman 1976), while others have described the methodologies applied to specific inventories (Johannsen 1975, Chen 1978). Economic feasibility considerations require that the benefits from such applications at least equal the costs of their implementation and operation. Thus, it is necessary to ask, "How well does such a system need to perform in order to be economically feasible?"

The present paper addresses the problem of evaluating the economic feasibility of establishing a computerized urban tree inventory system. The establishment of such an inventory for the trees within the City of Fort Worth, Texas is used as the source for data. The first section briefly describes the organization of, and the data collection for the system. The second section uses the time requirements for the Fort Worth application to estimate costs for the establishment of a hypothetical 10,000 tree urban forest. The third section identifies economic efficiency measures appropriate for evaluating urban inventory applications, and for illustration applies these measures to the Fort Worth application.

The Fort Worth urban inventory system uses an urban tree management information system called METRIS to store and retrieve information on the urban forest (Massey 1978). The data for this system were collected as follows: Two persons collected specified data on each tree being inventories, recording them in a key-punch compatible format. The location of the tree was marked on an aerial photo. In the lab, a digitizer was used to convert the location on the photo to six digit X and Y coordinates using the USGS Plane Coordinate System (U.S. Department of Commerce 1950). The completed data were then key-punched and entered onto disk storage in the computer.

During the summer and fall of 1978, data were collected on over 23,000 trees in Fort Worth for a little over $0.47 per tree. It was found that data from an average of 210 trees per day could be collected. The maximum number of trees inventoried in any one day was 390. Travel to the beginning point in the morning averaged 15 minutes. Time to digitize each tree's location averaged 30 seconds while key-punching averaged 15 seconds.

Based on the data collection and computer entry labor requirements found for the Fort Worth project it is possible to project the labor requirements for any given size urban tree population. Table 1 presents the labor requirements for the data collection and computer entry for a hypothetical 10,000 tree population. The computation procedure can be expressed in formula form as follows:

$$L = 8 + .0942N$$

and $LC = WL = 8W + .0942WN$

where,

L = labor in person-hours,

N = population of trees being inventoried,

W = hourly wage rate, and

LC = labor cost in dollars.

Thus, as indicated in Table 1, the labor required

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for conducting an inventory of 10,000 trees would be 950 person-hours. If the labor paid the workers was \$5.00 per hour (including indirect component of the wage), then the total cost would be \$4,750 or \$0.48 per tree. Of course, the differences between METRIS and other inventory systems could result in a change in these projected values. But, the similarity between existing systems makes this \$0.48 projection fairly reliable. For example, a 1976 study found a per tree cost of \$0.39 (Bassett 1976). Both the increased costs of inventory and the economy's inflation could account for this difference.

Once the costs have been identified, it is necessary to assess the economic efficiency of establishing an urban tree inventory. One useful approach to this assessment lies in applying the economic "with versus without" principle. Using this principle, the benefits and costs associated with urban tree management using the system are compared to the management costs without the system. The economic feasibility of the system relies on the system's capability for allowing more tree management work to be completed using the same work force as would be used without the system. The Fort Worth experience serves to illustrate the approach to such an assessment.

It is estimated that a total to \$26,000 will be spent during the first year to establish and maintain METRIS in Fort Worth. Without the inventory, the City has spent approximately \$13 for each tree serviced (1977 data). If the system is required to pay for itself in the first year of implementation, then an additional eight trees per day need to be serviced using the same labor force. The underlying assumption is that each additional tree service is worth \$13, the amount which the city has paid to service trees in the absence of the system. The eight tree requirement was calculated using the formula,

$$\text{Additional tree management} = \frac{\text{Additional expense per period}}{\text{Expense per tree}}$$

$$= \frac{(\$26{,}000/\text{yr})/(260 \text{ work days/yr})}{\$13/\text{tree}}$$

$$= 7.7 \text{ trees/day}$$

Table 1. Calculated Labor for Establishing a Computerized Inventory for 10,000 Trees Using Data Developed from Fort Worth Study

Item	*Person-hours (PHRS)*	*PHRS PER Tree*	*Labor Cost of \$5.00/hr. wage*
Pre-inventory training time for data collection persons (2 persons × 4 hours/person)	8	.0008	\$0.004
Travel to and from beginning and end of data collection (½ hr/day × 2 persons × 48 days)	48	.0048	0.024
Labor required to record data on data collection sheets (48 days × 8 hrs/day × 2 persons)	768	.0768	0.384
Labor required to digitize information (30 sec/tree × 10,000 trees ÷ 3600 sec/hour)	84	.0084	0.042
Labor required to key-punch data (15 sec/tree × 10,000 trees ÷ 3600 sec/hour)	42	.0042	0.021
TOTAL	950	.095	0.475

Similarly, if we allow the system two years to pay off and assume a $1,000 operating cost the second year, then an additional 4 trees per day need to be serviced.

The source for the additional work performed is in the system's identification of trees in the neighborhood of trees that would be serviced with or without such a system. Fort Worth, like many other large- and medium-sized cities, bases a significant portion of its daily work load on call-in complaints from its residents. The urban inventory can be used as a source for identifying urban trees in the neighborhood of the call-in complaints from its residents. Thus, during one trip, the work crew services the tree that was identified by the call-in and then those trees that the system identified in the area. This approach is currently being implemented and tested in Fort Worth.

Last, it should be pointed out that it is difficult, if not impossible, to quantify all the benefits from an effiently run urban tree maintenance department. Tree health and vigor have a value to the residents to a community which can't be restated easily in monetary terms. Other values, such as property value, home heating and air conditioning savings, and soil retention have economic values which haven't been addressed to a point where monetary values can be expressed confidently. In addition, a program which reduces tree mortality will also have an effect on the tax base in the long run. As property values change, the tax base shifts in response.

Thus, standard economic procedures can be applied first to determine the cost of a proposed inventory, and then to build a case for its usefulness in monetary terms. After the decision to develop a system has been made, actual implementation and operating costs can aid in evaluating both the system's performance and the performance of the tree maintenance department, itself. Sophisticated systems are currently being established for the urban forest. The continuation of these and new systems relies on the urban manager's demonstrating that such systems fill a need, and fill that need economically.

Literature Cited

Bassett, John R. 1976. Tree-Inventory Systems for Human Settlements. International Union of Forestry Research Organizations. Pl. 05 Project Group on Arboriculture and Urban Forestry. Edited by John W. Andresen. Centre for Urban Forestry Studies, University of Toronto Press, Toronto, Ontario. pp.2-14.

Chen, Franklin J. and G. Cartwright. 1978. *Tree Management Aided by Computer*. J. Arboriculture, 5(1): 16-20.

Johannsen, Hans J. 1975. *Municipal Tree Survey and Urban Tree Inventory*. J. Arboriculture 1(4): 71-74.

Massey, Joseph G. 1978. Composite Systems Urban Tree Inventory: An Examination of the Fort Worth Application. National Urban Forestry Conference Proceedings (in press). Sponsored by the State University of New York and the USDA-Forest Service.

Ottman, Kenneth A. and J. James Kielbaso. 1976. Managing Municipal Trees. Urban Data Service Report 11/76. International City Management Association. Washington, D.C. 15pp.

U.S. Department of Commerce. 1950. Coast and Geodetic Survey. Plane Coordinate Projection Tables: Texas (Lambert). Special publication No. 252. U.S. Government Printing Office. 64 pp.

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ABSTRACT

Lofgren, D.E. 1979. **Men versus machines.** Grounds Maintenance 14(4): 74, 76, 78.

Use/cost studies often reveal that a company is paying more for production than it would have to if employees were better equipped. These tables provide an easy method of determining whether or not additional equipment is worth the cost. Table 1, an equipment justification table, gives the minutes per day required to justify equipment cost. Table 2, an equipment amortization table, gives costs to justify the equipment shown in cents per hour. These are to be added to employees' wage rates. These two charts provide the kind of data essential for quick, safe decisions on equipment purchases.