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## CHAPTER 1

### THE PROBLEM

#### Scope and Delineation of This Study

The use of community volunteers to gather inventory data on urban forest resources has not been adequately examined or documented, therefore this study was initiated to more clearly define the role of trained volunteers in the development of effective and economical urban forest management programs. This study provides an analysis of the use of trained volunteers in performing street tree inventories in two Massachusetts communities, Brookline and Springfield. Further the study examines the accuracy and usefulness of data collected by volunteers as compared to data collected by Massachusetts Certified Arborists.

#### Questions Addressed By The Study

Several important questions were answered by this study, to more clearly define the role of trained community volunteers in conducting urban forest resource inventories. The following questions were addressed in this study:

- 1.) Can trained volunteers be used to accurately gather data on urban street trees?
- 2.) How does the accuracy of data collected by trained volunteers compare with the accuracy of data collected by Certified Arborists?
- 3.) Is it cost-effective to utilize trained volunteers to perform street tree inventories?

4.) What additional benefits are obtained by utilizing community volunteers to complete urban forest resource inventories?

### Significance of This Study

Gathering accurate information on the urban forest is important in order to develop effective urban forest resource management strategies. Up-to-date inventory data that reflects the size, condition, and quality of the urban forest is of critical importance if urban forest resources are to be managed in a manner which addresses the environmental, economical, and social needs of the urban ecosystem.

In many cases fiscal constraints have limited or eliminated entirely the ability of urban forest managers to gather adequate information on forest resources, resulting in ineffective management of the urban forest. The hypothesis of this study is that the ability of a community to gather data on urban forest resources may be increased through the use of trained volunteers. However, because their use has not been adequately examined, it will be the purpose of this study to closely examine the quality, usefulness, and effectiveness of urban forest inventories obtained by volunteers, and to provide findings and recommendations that can assist urban forest resource managers make more informed decisions as to the role of trained volunteers in their community.

### Urban Forest Resource Inventories and Management Strategies

Chapter One describes the problem of ineffective management of urban forest resources, due to a lack of information from which sound management strategies

can be developed. The chapter presents a discussion of the issues related to the management of urban forest resources and outlines the role of street tree inventories in the development of economical and effective urban forest management programs. The importance of inventory data in the development of sound management programs is detailed and various methods for the acquisition of inventory data are outlined. Economic considerations are discussed and the costs of various inventory techniques are described. Chapter One is intended to summarize key concepts that describe the present status of urban forest resource management programs and to outline the role of inventories in strategic planning, operational planning, and in the development of effective urban forest management programs.

#### A Lack of Information on the Urban Forestt

Today, the management of urban forests, in many cases, relies on a reactive rather than a proactive approach. The urban ecosystem, containing urban forests, are often managed without direction, focus, or determination of need, and often times receive no management at all (Kielbaso, 1989; Kielbaso, 1990; Macie, 1993; Tschantz & Sacamono, 1994). Indeed, the urban forests are often not viewed as resources to be managed, but are looked at as places that exist with or without managed planning, care or maintenance. Street trees, being the most visible component of the urban forest, receive care, but poor planning, budget constraints, and ineffective management is negatively impacting the quality of the street tree population in many larger urban centers. The problems of management are further compounded for lack of data regarding the overall resource: its general condition and the qualities of the components such as occurrence of dead wood and cavities. Additionally, effective inventory methods for describing the overall

condition of urban forests or urban ecosystems have only been used sporadically to catalog and describe the natural systems found in cities. The lack of effective implementation of accurate and timely inventory programs is a prime factor that has reduced the effectiveness of urban resource management.

Budget cutbacks, financial instability, and municipal austerity programs have resulted in a decrease in the amount of budgeted money spent on urban tree care over the past several years, resulting in less regular maintenance of the urban trees. (Kielbaso, 1989; Kielbaso, 1990; Tschantz & Sacamono, 1994;) The results of this reduction in care can be seen when examining the condition of street trees in many cities and towns. Through an accurate and concise inventory, the decline of a city or town's street trees or urban forest can be quantifiably determined and serve as the basis for developing methods to slow the decline or reverse the trend.

An accurate measure of the health of the urban forest can be made and this assessment can be examined on a temporal basis to uncover trends, patterns, or models in the urban forest. Analysis of the condition of the urban forest can be made at any time if an ongoing inventory program is in place. One such application of this type of analysis is an annual appraisal of urban forest health, that can be updated yearly and include a description of the condition, quality, and overall health of the urban forest. The health of individual street trees can also be recorded over time, and used as the basis for determining the condition of the street tree stock found in a community. Records for each tree can be analyzed by any number of factors that can provide an indication of the condition of the individual tree. These records can be updated as maintenance occurs and the ongoing inventory provides the information for a yearly analysis.

The data on individual trees can be combined in order to evaluate or measure overall urban forest health. These trees can act as components of a permanent plot system that can monitor the condition of urban forests for cities, states or specific regions. The establishment of permanent plots can incorporate data from ongoing street tree and urban forest inventories in the development of urban forest and urban ecosystem monitoring systems. For example, a possible scenario for ecosystem monitoring would use data that is compiled for individual street trees, becoming the basis for establishing the health of the urban forest, and that data can, in turn, provide valuable information for evaluating the entire urban ecosystem. Individual street tree inventory procedures can assess the condition of the ecosystem, utilizing inventory procedures that are already in place for street tree and urban forest management practice. Incorporating the inventory information on street trees or urban forests with data on wetlands, conservation land, hydrology, hydrography, geology, protected open space, and other data, enables an accurate and timely description of the urban ecosystem to be made. The development of Geographic Information Systems (GIS), that combine computerized mapping and database capabilities, is presently being initiated in some municipalities, providing the opportunity for increased effectiveness and usefulness of urban forest inventory data in implementing more effective urban forest management strategies (Daniel, Grove, & Hohmann, 1993; Grove & Hohmann, 1992; Langley, 1991; Laverne, 1992; Laverne, 1993a; Laverne, 1993b; McLean, 1995; Moll & Kollin, 1993; Miller, 1995; Petit, 1994).

Another use of street tree inventory data is to establish a value of the street tree stock in a community. Likewise, the dollar value of the entire urban forest ecosystem can be calculated based on the completeness and accuracy of the information in a municipality's GIS database. Beginning with a complete street tree

inventory, the dollar value of the street trees can be calculated and used as the basis of determining the value of other urban forest areas. The accurate and complete inventory of the street trees enables an accurate accounting of how much the street trees add to the overall assets of a community. In addition to individual property values, the benefits provided by the street trees to the physical and psychological health of the community can be quantified (Dwyer & Schroeder, 1994; Dwyer, Schroeder, & Gobster, 1991; Gobster, 1991; Hull, 1992; Kollin, 1991; Schroeder & Lewis, 1991; Schroeder, 1990; Schroeder & Cannon, 1987; Sommer, 1991; Wileke, 1989). Aesthetic value, improvements to the streetscape, and environmental improvements can be determined through a complete and accurate inventory.

The expenditure of funds by municipalities on urban forests is most often inadequate to meet the maintenance and management needs of a communities tree program (Kielbaso, 1989; Kielbaso, 1990; Macie, 1993; Mason, 1993; Tschantz & Sacamono, 1994; Wileke, 1989). This results in urban forest practice that simply responds from crisis to crisis, rather than implementing any type of management strategies that can improve the condition or quality of the urban forest. It is difficult for these municipalities to develop any kind of ongoing programs that provide benefits to the urban forest, and likewise to the city or town's residents. Effective inventory procedures can assist in the development of mechanisms that facilitate the development of long range plans and implementation of urban forestry management strategies. Towns that presently spend very little on urban forest care or maintenance can use an inventory to determine a dollar value on their urban forest, and use this a mechanism to lobby for increased funding of the tree care programs. By determining the dollar value of a community's street trees and urban forests, cost/benefit ratios can be

established, and used to request increased funding for urban tree care and maintenance programs.

For example, a municipality may place a value of \$12 million on their street trees, using formulas that take into account the species, age, and condition of the street trees. This figure can then be compared to the annual dollar expenditure on the street trees, which then gives a good indication of the dollars spent maintaining a \$12 million asset. In this example, say only \$100,000 (less than 1%) is spent on maintenance of the street tree population, the urban forest manager can lobby to increase the dollars allocated to tree care to a more realistic figure, especially if the manager can show that the inventory demonstrates that, say, 10% of the trees are in peril, and property values and/or marketability will decline as a result. Additionally, through the use of accurate street tree inventory data, the urban forest manager can place a per tree dollar value on street tree maintenance by determining the exact number of street trees, and comparing the number of trees with the amount of money expended for their care. Through the use of an accurate and current inventory database, budgeting requests can be more realistic and accurate, and can be placed in perspective with other items in a municipal budget. By incorporating complete, accurate, and useful data on urban forest resources in budget requests, it becomes easier to present a valid argument for increased funding for urban forest management and maintenance programs.

#### Importance of Inventory Data

The implementation of inventory practice into the management of urban ecosystems is important in order to accurately and efficiently determine the content of the ecosystem. It is important that the manager not only have an understanding of how the components of the urban ecosystem interact with each other, but what

the exact make-up of the system includes. Effective and proactive management can only take place if the system is accurately detailed and understood (Daniel *et al*, 1993; Kielbaso, 1994; Laverne, 1992; Laverne, 1993a). The use of inventory procedures including mapping, databases, and field observation are critical in the development of accurate assessments of the make-up of the urban ecosystem. The use of Geographic Information Systems (GIS) enables a streamlining of inventory information and enables the manager to more efficiently plan and manage the urban ecosystem. The use of GIS technology is very well established in many areas of resource management, although its use by urban ecosystem managers is just emerging. The use of GIS technology as a tool for the management of street trees is currently being implemented in some communities, but its use has not been incorporated in the day to day activities of most street tree managers or municipal arborists. The ability of a GIS to store, retrieve, and manipulate spatial data makes the system ideal for the inventory and management of a community's street tree population, since it can incorporate the street tree as an integral component in the infrastructure of an urban area. While street trees represent only a portion of the entire urban forest ecosystem, effective management of this component is critical in order to reduce damage to physical infrastructure, protect the public's safety, aesthetically increase the quality of the streetscape, and to improve the overall health of the urban ecosystem.

Street trees play a crucial role in the make-up of the entire urban ecosystem and improvements in the health, vigor, and quality of street trees provide benefits to the overall condition of the urban forest and ecosystem. It is important that the health of existing street trees be protected and planning for new plantings include the selection of the proper species, choosing appropriate planting locations, and implementing effective management strategies to encourage successful

establishment of street tree stock. The development and implementation of inventory procedures that address the management needs of the individual street trees, as well as apply to the management of the entire urban forest and urban ecosystem, are important in order to ensure sustainability of the urban systems and to provide for improved livability of urban areas. The use of methods that accurately and completely inventory, map, and store data on street trees will enable urban tree managers to increase their ability to implement management strategies that improve the overall condition of the urban forest.

The day to day care of street trees in urban areas often includes only reactive care, resulting in removing trees or branches that have fallen during storms or as a result of natural stand decline. Programmed pruning, maintenance, or hazard removal does not take place in many municipalities, thereby reducing the quality of the urban forest and increasing the risk of injury to people or damage to property (Architects for Social Responsibility, 1991; Boerner-Ein, 1991; Dwyer *et al*, 1991; Ebenreck, 1989; Grove & Hohmann, 1992; Hoesterey, 1991; Kielbaso, 1989; Kielbaso, 1990; Macie, 1993; Macie & Skiera, 1991; Mason, 1991; McNeil, 1991; Moll, 1989; Urban, Sievert, & Patterson, 1989; Wileke, 1989). The use of an inventory to determine the condition and health of the urban forest is extremely valuable in determining maintenance needs of the urban forest and to establish a mechanism to increase maintenance activities. In cities and towns that do perform regular maintenance on the street trees, an accurate and up-to-date inventory enables more effective management decisions to be made. The updating of an inventory is critical, since it is important that regular changes in the urban forest due to disease, damage, maintenance and planting activities be documented. In these communities, the use of a GIS can enable inventory data to be updated and shared with other infrastructure managers. For example, removal of trees by a tree

maintenance crew can be easily recorded and the trees deleted from the database, while adding the locations to the list of possible planting sites. This updated information can then be combined with other digital information for use by other municipal departments, utilities, and infrastructure managers. Linking the computerized inventory information with infrastructure data enables more efficient and effective management of all urban infrastructure. By acknowledging street trees, urban forests, and urban ecosystems as critical components of urban infrastructure, more effective management approaches can be utilized, ensuring a more livable and sustainable urban environment.

The practice of urban forestry requires that the profession be a component of the total management of the urban ecosystem, as well as be part of the infrastructure management of a community. (Nowak, 1994; Schoeneman & Ries, 1994) The planning, planting, and care of trees in the urban forest must be looked at as part of the process of sustainable management of the urban environment. Each tree that is planted, or grows in a city, is a part of several other systems, and cannot be managed from a single purpose. The urban forester must address not only the needs of trees, but also the needs of other systems that the trees impact or influence. For example, street trees cannot be managed on an individual basis, treating each one as a single element, but must be understood as components in several other systems, including the urban ecosystem, physical infrastructure, and green infrastructure. Street trees that impact sewer lines, utility distribution systems, or create public safety issues cannot be looked at only by the urban forester, but must be addressed by other town officials. This is important, because trees are such an important part of urban ecosystems, that their use must be properly planned and managed in order to maximize their benefit and lessen their impact on the systems around them. Likewise, it is important for the urban

forester to protect the trees from influences brought about by adjoining and competing systems. The urban tree is susceptible to the impacts of many influences, and it is necessary for the urban forester to have the ability to identify negative impacts and be prepared to offer solutions or alternatives.

### Deciding What Data To Gather

It should be recognized that the more information included in an urban forest inventory, the more costly the inventory will be. Determining the data that should be included in a street tree or urban forest inventory is important in order to maximize its utility. It is important to consider how the information will be used and how much is necessary in order to effectively manage the street trees or the urban forest. The urban forester may need specific information on a particular tree and, whereas the utility provider can utilize the same information, the engineering department may require different or additional information. It is important that decisions be made before data acquisition occurs in order to effectively implement data acquisition procedures. Because urban foresters have often managed on a reactive basis, they may not be aware of the information they need to effectively manage the urban forest. Management decisions made prior to the completion of an inventory may have been a response to a crisis or a non-comprehensive approach to the overall management of the urban forest. A determination of the specific items that should be included in an urban forest inventory will vary between municipalities, but basic information is useful for all situations; what this basic standard should be remains to be determined.

Review of existing inventory and successful programs and personal interviews with program administrators is useful to establish requirements for the acquisition of inventory data. Establishment of standard items for inclusion in the inventory can

be accomplished by gathering information from successful urban forest management programs. Through an interview process with leading urban foresters, a consensus on the most useful information needed to manage the urban forest may be established. Good urban forest management programs initiate effective methodologies, enabling successful management practice to take place. Many successful programs also have inventory systems in use, therefore the information used in these inventories can be important in establishing standards for urban forest inventories in other communities. Discussion with practicing professional urban foresters can give insight and direction leading to development of more effective inventory and management systems. A survey of urban foresters in a region can be useful in the establishment of inventory criteria. Although the survey might include urban foresters in communities with ineffective urban forest management programs, it is possible to survey respondents on their thoughts on optimal situations they have encountered. For example, a survey might determine that many urban foresters in an area are not interested in a street tree inventory unless it was computerized. Additionally, urban foresters could be surveyed as to the survey attributes they feel would be most useful in the management of street trees. This information, combined with the information gathered from personal interviews, could contribute to the establishment of a standard set of inventory attributes that many cities and towns could use.

## Urban Forest Resource Inventory Methods

In-House Program. The use of in-house professional staff to complete an urban forest inventory, is a survey method that can be employed to accurately take stock of the trees found in a community. An inventory using in-house staff allows for flexibility in completion of the inventory. It also enables data to be collected by professional personnel who are familiar with the community. Using personnel who know the road networks and understand the conditions found in the municipality permits increased logistical effectiveness. City personnel might be assigned free time to the project, or may complete it as scheduling permits. A further benefit of using in-house personnel to complete the inventory is that it frees the staff to examine every tree in the community, increasing their awareness of the overall condition of the municipality's street tree stock. A realistic assessment will determine personnel resources, and continuity of employment on the inventory. Other alternatives may, however, be more appropriate.

Professional Consultation. The use of professional urban forest inventory specialists is another method that a municipality can use to complete an inventory. In most cases, this method involves a contract between the municipality and a private firm for the acquisition of data on specific urban forest resources found in the municipality. The professional inventory specialist firm will provide personnel and equipment necessary to complete the inventory. Determination of the data to be collected will be part of the contract and the method of acquisition of the data will be included. The specific needs of each community must be assessed and a proper inventory program designed for that community. This is important when using professional forest inventory firms, since the cost of completing the inventory is dictated by the method and amount of information that will be collected.

Since many firms provide urban forest inventory services, there is opportunity for competitive bidding, in order to keep costs at an affordable level. Acquisition of the data is usually completed using computerized recording methods permitting data to be useful for many types of management systems including GIS or traditional database programs. Professional urban forest inventory firms have the expertise to design or tailor an inventory program to a specific community, thereby increasing the usefulness of the inventory information to the town, while reducing costs due to only gathering information valuable to the management needs of the municipality. To keep costs down, it is important to develop an inventory program that will provide ample information to be used to effectively implement management strategies and policy, while avoiding the acquisition of needless data. Communication with the professional urban forest inventory specialist create specifications that will meet the needs of the municipality.

Volunteer Programs. Another method of urban forest inventory is using trained volunteers for data collection. The use of volunteers for inventory can be effective and accurate (Buchanan, 1991). Proper training of volunteers is critical to ensure the quality and usefulness of the data gathered. Some professional urban foresters have suggested that the information gathered by volunteers is not accurate and should not, therefore, be used for urban forest management programs (Wade, 1993). Others suggest that with proper training, inventory data gathered by volunteers is as valid as the information gathered by professional urban foresters (Buchanan, 1991). Verifying the accuracy of data collected by volunteers is necessary in order to gain acceptance of volunteer urban forest inventories. If volunteers can be successfully used for urban forest activities such as planting and pruning, there seems to be no reason, therefore to discourage their

participation in urban forest management, so long as it can be proven that the volunteer inventory data is valid, accurate, and useful.

The Cost of Volunteer Programs. Although, at first sight, the use of volunteers appears to present an opportunity to gather a large amount of information for little or no cost, this is too simplistic a view in most instances. The urban forester may anticipate an army of volunteers canvassing a city or town and bringing back useful information, at no cost to the town, but this is not likely to occur. Recruitment, training, and mobilization of volunteers requires a substantial effort, and an expenditure of funds.

The costs associated with the use of volunteers must be calculated and the entire process should undergo a cost/benefit analysis. It may prove to be more cost effective to complete an inventory with in-house personnel, or it may be possible to hire outside consulting firms to complete the inventory. On the other hand, the value of getting community involvement in an urban forest management program must be factored into the analysis, since the use of volunteers usually results in the development of a conservation awareness and effective tree advocacy within a community (Dwyer & Schroeder, 1994; Johnson, 1995; Westphal & Childs, 1994). An ongoing citizen advocacy group may result from the inventory operation, and present long term benefits to the community, such as the development of on-going volunteer forest health monitoring programs, the development of citizen pruning programs, or the organization of greenspace alliances. Annual inventories may be planned to increase the amount of the urban ecosystem that is inventoried, thereby spreading the costs of recruitment and training out over several years. Additionally, costs incurred in the recruitment and training of volunteers may be paid for by corporate and business enterprises in a

community. Individual donations may help offset the cost of a volunteer program, and increase urban forest advocacy within the community. Additionally, grants may be available for the completion of inventories, and the development of volunteer programs relating to urban forestry. Finally, utility providers and other departments or agencies can benefit by the volunteer efforts if some of their data acquisition needs can be met at the same time. While the volunteers are in the field, it may be worthwhile for another agency or utility to have other information gathered, at the same time, that can address their management needs at a relatively low cost. Although the costs associated with a volunteer effort may be substantial, including the recruitment and training of the volunteers, opportunity exists for offsetting the costs and completing the inventory in a cost effective manner, making the volunteer effort much less costly than professional or in-house methods. Cooperation with other agencies, departments, and utilities may prove to be beneficial and increase the likelihood of reducing inventory costs.

The following chapters of this paper will more closely examine the urban forest issues introduced here, discuss in detail the use of urban forest resource inventories, and present the findings and recommendations for the effective establishment of urban forest resource inventories utilizing community volunteers.

## CHAPTER 2

### LITERATURE REVIEW

This chapter presents a review of the literature that pertains to urban forest resource inventories and management. Additionally, examination of street tree inventories, methods used for acquisition of data, costs of completing inventories, and the use of volunteers in urban forest initiatives is provided. The focus of the chapter is to present a complete discussion of these subjects and the state-of-the-art as relating to community volunteerism. Areas needing additional study will be identified, and the literature review presents a point of departure for discussion of the role of trained volunteers in the development of urban forest resource inventories and management strategies.

#### Urban Forestry and Management

##### History and Background

Urban forestry has been described as one of “the most dynamic and evolving dimensions of our profession today...a well-managed urban forest using principles in context with traditional forestry will demonstrate to the public the value and worth of the forestry profession” (Leston, 1992). But Willeke (1987) suggests that the urban forest cannot be managed using a single profession approach, but must incorporate the expertise of a wide range of professionals and especially if its condition is to be improved. Hull (1992) points to “the need to promote public awareness of certain benefits of the urban forest” including environmental benefits, the leisure benefits, and the functional benefits,” because he explains “the role of urban forests as symbols of cherished meanings and memories needs to be

emphasized as a major benefit derived from urban forestry.” Urban forest management must address the needs of not only the forest, but the entire urban ecosystem, including its human inhabitants. “Although most of the costs associated with the urban forest have been well documented, the greatest benefits, especially the global ones still need to be measured” (Kollin, 1991). MacPherson *et al* (1993) describe the use of computerized models to analyze the cost and benefits of the urban forest over a 30-year period and describes the heating and cooling energy savings associated with urban tree plantings, and examined additional benefits provided by the urban forest. “Increased property values and other social benefits were found to be the single greatest benefit item, with energy savings and hydrologic benefits next in importance.”

Miller (1988) describes the initial incorporation of the tree into American urban design following the Revolution when “Americans sought to create a new identity for themselves.” Thomas Jefferson believed in a country governed by sturdy yeoman farmers and regarded the city dweller with a certain amount of suspicion. “This attitude was embraced by the populace and influenced early attempts to incorporate nature in the urban design as well as identifying nature as a source of moral virtue” (Miller, 1988). This was followed in the mid-nineteenth century with the City Beautiful movement, including, according to Miller, “the introduction of trees on streets and construction of city park and civic centers. The city park movement, led by Frederick Law Olmsted, had as its goal the introduction of naturally landscaped parks into rapidly growing industrial cities. Olmsted, designer of New York’s Central Park stated: “The park should, as far as possible, complement the town...what we want is a simple, broad, open space with sufficient play of surface and a sufficient number of trees about it to supply a variety of light and shade” (Miller, 1988).

During this same period, a sanitary reform movement began which resulted in a large investment in municipal infrastructure. At that time, “most cities in the United States ripped up their streets to install new sewer and water lines.” Large public parks were built in cities across North America and Europe, intended as “lungs of the city; part of a comprehensive effort to improve the health, safety, and welfare of city residents through the alteration of the physical environment” (Spirn, 1984). The incorporation of street trees as part of this new urban order was undertaken, but at the same time the emergence of suburban and greenbelt communities, resulting in the urbanizing of the rural outskirts of the major urban cores, began. There was an effort to continue the spirit of romanticism into these communities, through the use of tree lined streets and parks, however this was not to be the rule during the early twentieth century, when rampant suburban development and sprawl stifled emergence of the romantic, Victorian greenbelt communities. The value of the tree as part of the community faded as an important asset, becoming forgotten as the rapid and insensitive pace of suburban sprawl continued.

It was not until the third quarter of the twentieth century that existing urban centers started forestry programs to plant and maintain their street and park trees. While at the same time, suburban expansion neglected to include trees as part of the new expansion of the American city. Only in the last twenty-five years have a few suburban communities initiated programs to ensure the health of their.

Spirn (1984) states “city dwellers have demonstrated a sustained interest in nature throughout history. Today that interest has been heightened by a growing consciousness across society of the costs to health and welfare exacted by continued environmental degradation. It is time to expand what has been a

romantic attachment to the ornaments of nature into a commitment to reshape the city in harmony with the workings of nature.”

### Present Status

Urban forestry is a new profession that according to Leston, can “trace its own roots to the early 1970’s with the advent of federal programs supported by federal money” (Leston, 1992). As described by Greene (1990), “since the early 1960’s the Forest Service has promoted “the concepts of urban and community forestry, but it wasn’t until 1978 that Congress passed Public Law 95-313 which formally authorized the Secretary of Agriculture to provide funds for a program,” that encouraged the development of an urban forestry initiative in the U.S. The law linked State Foresters and the USDA Forest Service in order” to provide technical and financial assistance to local governments and citizen’s groups to plant and maintain active programs.” Amendments to Public Law 95-313, as a result of the 1990 Farm Bill, “expanded the authority of the Forest Service to work with states in developing and implementing urban and community forestry and provide both structure and support for a national effort authorizing the formation of the Natural Urban Forestry Advisory Council” (Laverne, 1992). Additionally, “urban forestry provides an opportunity to improve the quality of life in the nation’s cities and towns and draws on diverse elements to provide community benefits through natural resource management (Laverne, 1992). As described by Richards (1992), the term “urban forest has political value to emphasize the tree resources in urban areas, but is confusing as a technical or management term because it conflicts with standard definitions of forests. By various definitions, forests are generally characterized or dominated by trees, whereas urban area are characterized by density of people and structures, with trees hopefully complementing these.”

According to Coelho-Hudson (1987), “the urban forest is a people-oriented forest designed to enhance the quality of life aesthetically, ecologically, and economically. The urban forest consists of public plantings, parkways, neighborhood parks, traffic median plantings, public parking lot landscaping, and landscape elements.” Lee *et al* (1990) state that “the forest community -- including practicing foresters, forestry educators, and researchers -- must expand its concern to understand and articulate the multiple functions of forests.” Grove and Hohmann (1992) expand upon this function of urban forestry, and state “forestry in urban areas provides foresters with a number of challenges that extend beyond either the production of pulpwood and sawlogs or the maintenance and care of trees. Urban forestry activities can include a variety of goods, benefits, and services -- from stream conservation areas, to local tree nurseries, to agroforestry projects on reclaimed abandoned lots”

### Benefits of the Urban Forest

Kielbaso (1990) describes the importance of urban forests by showing that “it would require the planting of 1.5 billion trees in rural forests to equal the direct and indirect benefits of planting 100 million trees in cities; a 15 to 1 ratio.” The costs and benefits of urban forests have been documented by Dwyer *et al* (1992) and Kollin (1991), and the value of urban greenspace has been calculated (Moll, 1989b; Moll & Young, 1992). However “assigning costs or benefits becomes difficult because the impacts can effect an individual, a community, or the entire planet. Of course a dollar value cannot be placed on the aesthetic, ephemeral, and spiritual benefits of trees, but this does not diminish their significance to the community” (Kollin, 1991). According to MacPherson *et al* (1993) “Policy makers, natural resource planners,

and greenspace managers have recognized that urban vegetation can improve the quality of life in our cities.” MacPherson *et al* (1993), have used computerized modeling to examine the cost-benefits of urban trees and conclude that new tree plantings “will result in environmental, social, and economic benefits that are far greater than their costs.” Social benefits are outlined by Gobster (1991) who examines increased biodiversity in the urban forest, and examines the importance of urban landscape in aesthetics, recreation, safety and education. The psychological benefits and costs of the urban forest have been extensively examined and findings presented (Dwyer, Schroeder, & Gobster, 1991; Dwyer & Schroeder, 1994; Schroeder & Lewis, 1991; Schroeder, 1990; Schroeder & Cannon, 1987,) and Schroeder and Lewis (1991) propose that the positive “psychological impact of trees on people’s moods, emotions and enjoyment of their surroundings may in fact be one of the greatest benefits” of urban forests. Ecological benefits of the urban forest have also been discussed by Rowntree (1989) and the economic value of trees have been presented by Kielbaso (1990) and others (Schoeneman & Ries; Tschantz & Sacamano, 1994), serving to strengthen the multi-dimensional value of the urban forest. “Urban forests can enhance the city environment by influencing temperature, wind, humidity, rainfall, soil erosion, flooding, air quality, scenic quality, and plant and animal diversity. Each of these influences has significant implications for the well-being of urbanites” (Dwyer *et al*, 1992). “Urban forests help mitigate problems typical of dense human population centers. Well-designed and maintained urban ecosystems can and do improve air and water quality and social, recreational, and ecological environments” (Schoeneman & Ries, 1994). Kielbaso (1990) estimates that the value of street trees in the United States alone, amount to \$30 billion. While “we continue to learn about the urban forest and how it is intricately related to broader

global environmental issues...funding continues to be a serious problem, but there seems to be a public awareness that trees are an important resource in urban areas.” The problem of funding the care of urban forests presents a serious threat to the sustainability of the urban ecosystem and, as described by Elmendorf (1993), “resource management generally takes a back seat to issues such as revenue enhancement, police services and education; thus, when municipal funds decrease, the urban forestry budget is often first in line for cuts.”

## Urban Forest Management Strategies

### Components and Approaches

Management strategies for urban forests are described in texts authored by Miller (1988), Grey and Deneke (1986), and Moll and Ebenreck (1989). Miller (1988) suggests that public attitudes and professional expertise play an important role in the success of urban forest management programs and that a good management program “involves development of a master street tree plan, selecting and planting trees, tree maintenance, tree removal and replacement, task scheduling, and sources of funding.” Mason (1993A) suggests that urban forest management goes beyond those tasks described by Miller, and says the goal of urban forest management “is to work with nature instead of against it, looking at the interactions and needs of the natural systems in balance with the communities’ needs, and exploring strategies in which natural areas can be managed to meet multiple objectives.” Macie and Skiera (1991) suggest that the role of urban forest management “must be centered around planning to make the city conform to the forest; building with necessary understanding, resolve, and partnerships; and establishing quality trees in the right places to realize the urban forest of the future.” Hudson (1991), however, suggests that “urban foresters tend to focus on the

physical aspects or urban forestry management” and that there is a real “need to build public consensus and alliances into the total urban vegetation management process.” A practical application of this consensus building effort is described by Sommer *et al* (1992) in which the evaluation of street trees by arborists, gardeners, and landscape architects is outlined and a suggested methodology for reaching a consensus on street tree selection is described. Wellman and Tipple (1989) describe the examine the role of the urban forester and the organizational dimensions of urban forestry programs. They suggest that “the urban forestry literature exhibits only an intuitive hunch that understanding the social and political context of administration is important” and that “the literature for urban forestry administration is very limited.” Additionally they also suggest that “technical competence is a necessary but insufficient condition for successful urban forestry program management” and that “the urban forester’s job is a challenging balancing act, calling for both technical and social-political skill.”

Giedraitis (1991) describes levels of management required for effective urban forest management, placing the role of the urban forester in a different perspective than a traditional forester. “Technical training may not be as important as the ability to organize government resources to provide leadership to citizens, nonprofit groups, and businesses who are looking for a way to make a positive impact on the environment. If you can combine your technical training with community leadership, then trees will be the answer in your community.” According to Wellman and Tipple (1989), “urban foresters “are not only the technical experts about urban trees and related vegetation, but they are also program mangers acting in complex and turbulent social and political environments.”

Examples of cities that have effectively implemented successful urban forest management programs have been outlined (Mason, 1991; Urban, Sievert, & Patterson, 1989), and the development of urban forest ordinances, that propose, plan, or protect urban forests have been completed in many communities (Reynolds, Herberger, Hudson, Morgan, & Cullen, 1986; USDA Forest Service, 1991). The design of ordinances offers an opportunity “to integrate biological/ecological concepts with the reality of political/regulatory processes in practical, ongoing projects at the community level” (Reynolds *et al*, 1986). Urban *et al* (1989), describe the use of successful efforts to integrate urban forest management principles into practice. Cleveland, Milwaukee, and Seattle are cited as examples of communities that incorporate management principles into the design and urban planning . “Major changes need to be made in the philosophy of designing and building our cities” and new technologies must be utilized in order to ensure the success of long term sustainable urban forests. The incorporation and protection of urban forest resources through a comprehensive plan that addresses the needs of the urban ecosystem is advocated and the development of “techniques that support natural systems need to be promoted by planning agencies and embraced by the development community” (Moll, 1989a).

## Street Tree Management

Laverne (1993b) states that “most data collected on urban trees have come from street tree inventories”, because from a municipal management standpoint, “it is important to have information on the resources in your jurisdiction.” Although publicly maintained trees usually comprise only 10% of the total population of a mid-sized city, the management of street trees is a critical component of the development of an overall urban forest management program that addresses the needs of the urban forest on an ecosystem basis. The use of computerized management of street trees has been proposed as an effective tool that can assist in implementing urban forest management strategies (Wagar, 1991) and several commercial urban forestry firms have been utilizing this technique for the management of municipal street trees (Davey, 1994; Miller, 1988; Tschantz & Sacamano, 1994; Wagar, 1991). Mahoney (1991) outlines the implementation of a computerized inventory in Los Angeles, and describes how “tree inventories can be much more than a tree count, and include computerized data collection, on-line records management, and in-field use of computer technology.” Classic inventory principles used in urban forestry have been outlined and reviewed (Bassett & Lawrence, 1975; Miller, 1988; Ziesemer, 1978). Mason describes the use of urban forest inventories as a tool that assists in urban forest management planning. “Inventory development should be one of the first steps in formulating and evaluating the goals and objectives of an urban forestry program” (Mason, 1993b). While Mason (1993b) suggests that “all public trees should be individually inventoried and assessed for condition and value” which “provides the basis for the day-to-day and year-to-year management” of the urban forest, Wagar (1991) describes a sample-based inventory that “provide a quick and inexpensive ‘snapshot’ of the number, characteristics, and needs of a community’s trees.” Using stratification techniques similar to stratified random sampling used

traditional forest management , the overall composition of the urban forest can be estimated, presenting a “powerful way to forecast the condition and needs” of the urban forest (Wagar, 1991). An overview of resource inventories is provided by Lund and Aronoff (1992) in which they outline changes in information needs and resource inventories, and describes the “development of new technology to collect data and to share information” in an effort to manage all resources, including urban forests.

Although the urban forest includes all of the trees and vegetation found in an urban environment, nationally amounting to about 69 million acres (Grey & Deneke, 1986), street trees are one of the basic components that resource managers are responsible for. Kielbaso (1990) states, that “fully 80-85% of our U.S. cities have no plan in place” for managing the urban forest. He estimates that the total number of street trees in the urban forest within the United States is over 61 million, and that is only the trees found within the street right-of-way. He does not include park or trees on private property. Kielbaso concludes that 66.7 million more trees are needed to obtain 100 percent stocking at 50 foot spacing between street trees. Management and maintenance of street trees amount to over 61 percent of the budget allocations of municipal urban forest expenditures.

Survival of newly planted street trees is limited as a result of the inimical urban conditions in which the trees are planted. The mortality rate of street tree plantings in the United States is up to 10.5% the first year, and 6.3% in the second year, reducing the effectiveness of street tree plantings in urban areas (Kielbaso, 1990). Ware (1990) discusses problems associated with the alkalinity of urban soils as a result of runoff from concrete and limestone surfaces, while Craul (1991) outlines problems resulting from elevated soil temperatures and interrupted nutrient cycling,

and offers methodologies for mitigating the problems resulting from these occurrences.

Urban soils are, in most cases, physically disturbed, compacted, or chemically altered, reducing the survivability rate of newly planted street trees (Kelsey & Hootman, 1988). Watson (1989) offers in-depth discussion of the importance of soil in the ability of a tree to develop roots and reach maturity, and outlines measures for “protecting and managing the root system in the ‘underground forest’” and describes methodology that can increase the survivability rate of urban and street trees (Watson, 1994). Selection of trees for establishment in urban areas requires more than just providing space for a tree canopy, but “tree placement must take into account above ground and underground utilities, space for root development, drainage, and soil physical and chemical properties” (Kelsey & Hootman, 1988). Gilman (1988) outlines methodology for predicting root spread from trunk diameter and branch spread, in order to assist in the selection of planting species and locations.

In addition to poor soils and inadequate planting space, urban trees often do not survive because of improper planting technique and lack of first year maintenance (Urban *et al*, 1989). “Proper planting is one of the first steps of ensuring quick establishment and low maintenance over both the short- and long-run” and “planting is the first step in root management that leads to a long and healthy life” (Coder, 1991). Additionally, the selection of an inappropriate species or a tree that is intolerant of urban conditions leads to mortality (Urban *et al*, 1989). Selection of appropriate species can lead to increased establishment of healthy trees in urban areas (Gerhold, 1990). Guidebooks and manuals are available that can assist in the selection of appropriate tree species for urban locations (Bassuk,

1991; Gerhold, Wandell, & Lacasse, 1993) and improved planting techniques have been outlined for a variety of urban conditions (Urban, 1989).

### Urban Ecosystems

In recent years a new philosophy and approach to natural resource management has been used by federal, state, and local agencies, affecting urban and community forestry programs. “Natural resources, whether in an urban or rural setting, cannot be managed in isolation” , therefore an ecosystem approach, providing the opportunity for more sustainable and responsible management, has resulted. “An ecosystem approach means maintaining trees, forests, and natural areas to reduce energy consumption, to curb air pollution, to mitigate urban heat islands, to reduce storm water runoff, to provide food and shelter for wildlife, to provide a connection between people and nature, and to provide human comfort” (Lyons, 1993). Macie (1993) concludes that in order to effectively manage the urban forest using an ecosystem approach, “we must convince our elected officials and city administrators that our urban forest resources are part of the public infrastructure, and that the survival of our cities and towns is dependent upon the livelihood of this resource.

Additionally, a renewed focus on people must take place as part of an ecosystem approach to urban forest resource management. “Today’s problems demand a broader perspective, one that incorporates our concept of ‘ecological whole’ within sociocultural factors: the human populations of the world and the cultures in which they transmit from generation to generation” (Howenstine, 1993). Lyons (1993) concludes that by “ensuring all ages, cultures, and races have access to our natural resources, we enable individuals and groups to determine and derive these benefits for themselves.” He also states that “we must build the human

infrastructure, create the human capital, that will make urban forestry work: through activism and community leadership and through the political support necessary to ensure that urban forestry and urban resource programs remain a priority.”

Kielbaso (1990) states that a large majority of U.S. cities have no plan in place for managing the urban forest. As described by Dwyer *et al* (1992), “Past planning and management efforts have not been as effective as they might have been because planners and managers have underestimated the potential benefits that urban trees and forests can provide, and have not understood the planning and management efforts needed to provide those benefits, particularly the linkages between benefits and characteristics of the urban forest and its management.” An ecosystem approach to management of urban forests has been proposed, presenting a multi-disciplinary approach to urban ecosystem management (Architects for Social Responsibility, 1991; Boerner-Ein, 1991; Dwyer *et al*, 1992; Mason, 1993a; McNeil, 1991; McPherson, 1991; Schoeneman, Hudson, Hoefler, & Macie, 1992; Schoeneman & Ries 1994). McNeil (1991) describes the incorporation of “natural green space into the urban fabric on a sustainable basis” and offers a methodology to guide municipalities planning and development strategies. Mason (1991) outlines “practical ways that urban forestry can help in creating and maintaining sustainable cities.” The importance of the development of urban forest master plans, that assist in the establishment of a sound ecological community are outlined, and the implementation of how “a well coordinated plan can provide the framework for the planning and design of all open spaces in a community, including parks, schools, streetscapes, greenbelts and trail systems” is described (Mason, 1993a). The management objectives of an urban forest are quite broad “as compared to commercial forest lands where the goal is to maximize income through wood

production”, and the use of an ecosystem strategy enables the use of a system that “the inter-relatedness of the different components of natural systems as well as how man has affected the system” (Hoesterey, 1991).

The management of urban ecosystems brings an opportunity for creating partnerships that can assist in providing opportunities for the implementation of improved urban forest management strategies. “Urban ecosystem management can bring people, politicians practitioners, and the private sector together to create new opportunities for business, new jobs, better water conservation and storm water management, opportunities for environmental education and the rebuilding of individual and community self-esteem, self-worth, and societal stability” (Lyons, 1993).

## Urban Forest Inventories

### Reasons for Completing Inventories

Mason (1993b) describes the importance of urban forest inventories for establishing an “informational baseline” necessary to effectively manage the urban ecosystem. Additionally, he states that “a sound inventory is a prerequisite for making sound decisions regarding urban forest resources and their management.” Any inventory system that is used in an urban forestry program should contain common components that include planning, implementation, operational phase, and maintenance. “Inventory methodology ranges from simple windshield observation to computerized databases which locate all trees individually by address.” Miller (1988) offers a detailed overview of inventory methodologies that include windshield surveys, sampling, and complete inventories of street trees. Additionally, discussion of urban natural resource inventories is presented as

applied to urban ecosystems including tree canopy analysis, soil surveys, aesthetic surveys, wildlife habitat inventories, and general cover type inventories. Smiley and Baker (1988) outline and discuss options available for street tree inventories, while Tate (1985) illustrates “ways data from properly planned street tree inventories can be used to create an urban tree management programs.”

Crossen (1989), Maggio (1986) and Lindhult (1987) describe computer applications of street tree and urban forest inventory data. Wagar (1991) outlines the use of computers in performing urban tree inventories, and discusses improvements to urban forest management that are provided by computerized inventories. Langley (1991) and Congalton *et al* (1991) describe advances in resource inventories and outline how “resource management has evolved from rudimentary resource maps, compiled from data collected on the ground or from aerial photographs, to very sophisticated thematic maps generated from satellite data and computer based geographic information systems.” Laverne (1992) describes “the applications of aerial photography as an inventory tool for comprehensive management of urban forests and the use of geographic information systems (GIS) in assembling data” on urban forests. Moll and Kollin (1993) discuss advancements in urban resource inventories and describe how urban foresters “are utilizing sophisticated computer equipment to more easily arrive at a dollar value” of the urban forest ecosystem. “Mapping methods as old as the Civil War are being combined with state-of-the-art computers to create a new image of the urban forest.” There are many computer inventory systems that are available from professional urban foresters that are specifically designed for the inventory of street trees, offering options in the methods used in order to “meet the unique needs and budgets of most municipalities” (Smiley & Baker, 1988). Lindhult (1987) and Maggio (1986) both outline the use of geographically

referenced inventory data allowing “for storage, retrieval, and portrayal of both characteristic and locational data” (Maggio, 1986).

Kelibaso *et al* (1994) state that “new approaches to urban forest inventories must provide a three-dimensional view of the urban forest ecosystem; they must tell much more than the numbers of trees.” In addition to providing information necessary to implement effective urban forest management programs, information gathered on the urban forest can be utilized by urban designers, planners, and municipal managers. According to Grey *et al* (1994) “urban forest data should demonstrate the multiple functions of urban forests and how they contribute to the viability of other aspects of the urban environmental system.”

Laverne (1992) describes the importance of “integration of natural resource data into municipal information pools” that can be linked by computerized databases and geographic information systems in an effort to make urban forest information accessible to a wider audience including planners, engineers, developers, researchers and utility companies.” Langley (1991) presents an overview of the use of spatial data and geographic information systems (GIS) as a tool for integrated resource management. Ripple (1989), Burrough (1989), and Star and Estes (1990) provide an overview of GIS applications in resource management. Macie (1989) proposes that “it would be ideal for the governing agency to conduct a detailed natural resource inventory of its jurisdiction to include specimen trees (stands), water resources, wetlands, soils, wildlife, and geologic and historic features.” Additionally, Macie (1993) suggests that “these inventories can be facilitated and made publicly accessible with a Geographic Information System.” Grove and Hohmann (1992) describe the application of GIS in social forestry, which will “help foresters meet the challenge of integrating biophysical and

sociocultural information by identifying the complex interactions between people and their environment.”

### Overview of Existing Inventory Methods and Programs

Avery and Burkhart (1994) outline the use of fixed area sample strips or sample plots to complete traditional forest inventories and measure changes over time, while Laverne (1992) discusses, “modifying this approach in an urban area”, enabling the urban forester to “measure urban tree growth, health, mortality and regeneration (planting) on public and private lands” Laverne outlines the use of continuous urban forest inventory plots (CUFI) that are randomly located within all land use types of an urban area, and are measured and remeasured on a regular basis. Changes in urban forest composition and health are made possible by the resampling of the urban forest. Jaenson *et al* (1992) demonstrate a “statistical sampling method that can be used to estimate the composition of an urban street tree population quickly and accurately” based on using a stratified random sampling method. The literature contains a large amount of information on vegetation and resource inventory procedures, but Miller (1988) outlines techniques specific to urban vegetation inventories including the Graham cover type mapping, line transects, quadrat sampling, and point sampling.

Miller (1988) and Smiley *et al* (1988) offer a detailed overview of inventory methodologies used in the acquisition of data on street trees. Wager *et al* (1992), Smiley *et al* (1988), and Davey (1994) outline computerized methods for using computerized databases for the organization and use of data collected while performing street tree inventories. ACRT, Davey Tree, UTMS, Natural Path, and The National Arbor Day Foundation’s Tree Keeper all provide computerized database management programs for use with street tree inventories. The

University of Minnesota has developed Inventree Community Tree software that is also used to manage collected street tree data.

D'Errico (1993) outlines a program used in New Jersey for the acquisition of street tree data based on using a sample plot methodology in which four sample plots are taken per town. The information that is collected on each plot is used in an effort to assist in the "planning, design, and management of vegetation on public lands in and around communities to maximize their visual, social, economic, and environmental contributions to the community." Although the data collected is done only for sampled plots, the methodology for acquisition may be applied to street tree inventories. As described by D'Errico (1993), "in order to manage the trees, the community forester must have an idea of what is in our communities." The methodology outlines techniques and describes specific data that can be collected when performing a street tree inventory.

### New Approaches

Daniel, Grove and Hohmann (1993) outline a methodology for creating a Geographic Information System (GIS) based urban forest resource inventory that examines components of the urban ecosystem using various remote sensing techniques. They demonstrate that such a GIS-based inventory "allowed foresters and planners to examine the urban forest in a different perspective, and provides a more powerful and useful tool for the examination of data on the urban forest. They describe a method to identify individual street trees using aerial photography and outline a methodology for field acquisition of data on the individual trees. Daniel *et al* (1993) include a sample inventory sheet describing the data that they propose be collected on individual street trees. Included in this are attributes ranging from species, size, crown and trunk condition, root condition, conflicts and

surface shading. No findings are presented nor is there an analysis of the success of the described methodologies. Included are procedures that examine the urban forest on a larger scale using various remote sensing techniques ranging from satellite imagery to aerial photography.

Laverne (1993a) outlines an ecosystem approach to the development of “methodologies for mapping and interpreting the urban forest from a comprehensive and ecological perspective, and introduce them to mainstream management.” Included in this comprehensive approach, is a description of procedures used to complete a street tree inventory in Ann Arbor, Michigan in which street tree species, diameter, health, maintenance needs and available planting locations were identified. By combining the street tree data with other inventoried components of the urban ecosystem the use of the data is “immediately valuable as management tools yet address long term issues to maximize the benefits of urban forests” (Laverne, 1993a).

Laverne (1993b) concludes that ground based inventories account for only about ten percent of an average city’s trees, and “to completely understand the full range of benefits provided by the urban forest, a more comprehensive view is needed, a view which encompasses the full set of natural resources in a city.” Organization of the data in a manner that makes it accessible to a wide range of users will enable natural resources to be viewed as an integral component of the urban infrastructure.

## Data Acquisition

### Background

The acquisition of data for urban forest resource inventories using three methodologies is outlined in the following sections. The use of in-house personnel, professional consultants, and trained community volunteers is described and discussion of the advantages and disadvantages of each is provided. The costs associated with the implementation of each methodology is described, and a discussion of the requirements for the effective implementation of each program, as discussed in the literature, is provided.

Table 1 provides a summary of the costs associated with the completing of an urban forest resource inventory using the three methods described in the remainder of this chapter:

Table 1 - Costs of inventory activities

	Training of Personel	Organization	Supervision	Data Collection	Database Mangement
In House	Medium/High	Low	High	High	Same
Consultant	Low	High	Medium	High	Same
Volunteer	High	Low/Medium	Medium	Low	Same

The following sections review each of the inventory and data acquisition methods outlined in the literature, and describe the advantages and disadvantages of each technique.

### In-House

Miller (1988) and Ziesemer (1978) outline methods for conducting urban forest resource inventories and Miller asserts that “the most effective inventory system is one that is tailored or adaptable to the specific needs of a community.” Additionally he states that “startup costs will be high and must include training so that the personnel will use the system accurately and efficiently.” Miller (1988) discusses the sizing of crews used to complete inventories and concludes that “the most efficient means of data collection for an initial inventory or reinventory is using one-person crews.” Miller also states that “the best personnel affordable should be hired” to complete an inventory.

DeVries (1993) outlines efficient management of collected data and other information that is normally part of the daily work routine of a municipal tree maintenance program. “Not only can the program provide detailed information out each tree in the inventory, it can also furnish a chronological record of any work that has been done or scheduled for the tree.” He also concludes that updating of the inventory throughout the use of a “work order” system, enables timely and accurate information to be available and provided as part of the daily work routine of an house maintenance program.

Advantages of using in-house personnel may include a working knowledge by the staff of the physical layout of the community, a reduction in orientation of the personnel as to the existing urban forest management program, and the development of more highly trained staff that will remain after completion of the inventory. Disadvantages of using the in-house staff include the costs of hiring and training the staff on inventory procedures and the ability to adequately schedule timely acquisition of the inventory data. The more skilled the staff is in tree

identification, tree condition assessment, and the identification of hazard trees, the more cost effective the implementation of an inventory program will be.

Costs associated with the acquisition of data on street trees vary in each community depending on the number of data attributes that are to be collected. The more in depth the inventory is, the higher the cost will be. This is true for any urban forest resource inventory, no matter who collects the actual attribute data. Costs associated with completion of the inventory using in-house staff will include training, data acquisition, and data interpretation, storage, and the development of procedures to utilize the data for more effective urban forest resource management. Costs for training the in-house staff will be higher than if a professional consulting firm is used, but may be less than the costs of training community volunteers to perform the same inventory procedures. The costs of using any of these methods should be examined prior to making a decision on urban forest resource inventory procedures.

#### Professional Consultation

A second option for data acquisition on urban forest resources is using professional firms, who have the expertise to design or tailor an inventory to a specific community, thereby increasing its usefulness and reducing overall costs. Quality of the data collected is a major consideration and Buchanan (1991) concludes that “the advantage of using professional data collectors is a high degree of accuracy and the ability to meet performance deadlines” and increases the quality control of the data. Tate (1985) provides a comprehensive overview of street tree inventory methodologies and presents a model that outlines a “logical sequence to be considered before the inventory is designed, funding is sought, and data collection crews are hired.” Additionally, Buchanan (1991) suggest that

“no matter who performs the inventory, a well planned, comprehensive training program for data collectors is necessary if experienced urban forestry technicians are not used.”

The cost of collecting inventory data on a professional level is estimated by inventory consultants to be between \$1.50 and \$2.80 per tree , depending on the specific data to be collected and the complexity of the inventory procedures (Mason, 1993b). Buchanan (1991) estimates that “experienced urban forestry technicians can routinely collect data on 200 to 400 trees per day”, depending on the number of data attributes that are surveyed. Mason (1993a) concludes that “even though the profession of community forestry is relatively new, a standard format for collecting inventory data is being developed” and should increase usefulness of urban forest resource inventories.

The primary disadvantage of using professional consultants is the cost. Additionally, hidden costs, such as orienting the professional firm to the physical layout of the community as well as the operation of the urban forestry program in the city or town, may occur. Although specific training of the professional staff is not formally required, costs associated with providing corollary information, maps, records, photographs, etc. must be considered when determining what type of method to utilize for urban forest resource inventories. The cost of data manipulation, storage, and the development of procedures to utilize the data for more effective urban forest resource management will likely not be reduced.

### Volunteers

Dwyer and Schroeder (1994) and Westphal and Childs (1994) discuss volunteer partnerships and community participation in urban forestry initiatives. Lipkis (1990) and Berg *et al* (1990) outline volunteer initiatives in urban forestry, primarily addressing the implementation of tree planting programs within communities. Skiera (1993), Evans (1993), and Westphal and Childs (1994) describe the development of volunteer initiatives in developing effective urban forestry programs and to assist tree care programs, including inventories. Buchanan (1991) discusses options available for the completion of urban forest inventories. Professionals, staff and intern, volunteers and high school youth are identified as sources of options for personnel to conduct these inventories. Buchanan (1991) proposes that “restricted funding is a major reason professional-level personnel are not used for tree inventory data collection.” As described by Buchanan (1991), a benefit of using “trained, experienced data collectors is a guaranteed, documented quality control.” Street tree inventory programs have been completed using volunteers in a number of locations in the country, including Kent, Ohio; Rockford, Illinois; and Detroit, Michigan. Monear (1993) outlines successful management methodologies for volunteer initiatives. While Buchanan (1991) estimates that “experienced urban forestry technicians can routinely collect data on 200 to 400 trees per day depending on the amount and complexity of information collected on each tree”, volunteers are estimated to survey between 50 and 150 trees per day. In this case it would cost approximately \$1.00 to \$2.00 per tree if the data was collected by professionals based on an average of \$50.00 per hour, while the cost of utilizing volunteers is more difficult to determine, since costs of recruitment, training, supervision, and logistics must be factored into a cost/benefit analysis. These costs will vary for each community that utilizes

volunteers, therefore careful analysis of the projected costs/benefits must be made prior to determining a method for completing an urban forest resource inventory.

Buchanan (1991), Evans (1993), Monear (1993), Probart (1993), and Matz (1993) all describe successful strategies for utilizing volunteers to perform urban forest resource inventories. According to Probart (1993), "effective volunteerism provides the community with unique opportunities that are generally unavailable to them", enabling communities to identify and fulfill their environmental goals, including urban forest resource management. "Volunteers are often in touch with their community's needs and wants and can be an effective gauge of public sentiment" (Westphal, 1994). Empowerment of community citizens to partake in the betterment of their own community is one of the primary benefits of utilizing volunteers to partake in an urban forest resource inventory. "Successful urban forest programs are those that break down the boundaries between concepts and roles that traditionally have created a dualism of culture and nature. They work because they create ways for citizens to play an important role in shaping their environment" (Berry, 1993). Lipkis (1990) states that "If we invite people to share their dreams of what a city can be, if we give them the tools, teach them the process, they can cross the bridge from dreams to reality."

While the benefits of empowerment and community involvement are difficult to quantify, it is possible to place a value on the urban forest resource data that is collected by community volunteers. A cost/benefit analysis can be used to compare the use of volunteers with in-house staff or professional consultants. Costs associated with the recruitment, training, mobilization and supervision of the volunteers must be considered when considering the use of community volunteers. While these costs can be calculated, it is more difficult to determine the

benefits associated with the development of a group of urban forest advocates that have been empowered to partake in the management of their urban forest. However, these benefits must be considered in order to make an intelligent decision as to the method that will be used to complete an urban forest resource inventory in a community.

While the literature suggests that volunteers can be used to complete urban forest resource inventories, there is a lack of information that describes the accuracy of the data that is collected by volunteers. Strategies for utilizing volunteers in tree care programs including planting have been closely examined and documented in the literature, as well as descriptions of the merits of using volunteers in completing urban forest resource inventories, but there is little or incomplete information concerning the validity and accuracy of the data collected by volunteers.

#### Research Hypotheses

Based on the previous review, the following summarizes the predictions of the research outlined in this study:

$H_{a_1}$  : There is no significant difference between the condition scores of street trees as rated by Volunteers and Certified Arborists.

$H_{a_2}$  : There is no significant difference between the assessment of the management needs of street trees as rated by Volunteers and Certified Arborists.

$H_{a_3}$  : There is no significant difference between the occurrence of weak crotches, cavities or dead wood in street trees as rated by Volunteers and Certified Arborists.

$H_{a_4}$  : There is no significant difference between the assessment of the root zone cover material of street trees as rated by Volunteers and Certified Arborists.

The next chapter of this paper outlines a proposed methodology for testing the validity of the predicted findings, including examination of the accuracy of urban forest resource data collected by trained community volunteers. Subsequent chapters detail the field implementation of the planned methodology, summarize and discuss the findings of the research, and propose recommendations for improvements in the methodology used to implement volunteer assisted urban forest resource initiatives.

## CHAPTER 3

### RESEARCH METHODOLOGY

This chapter presents an overview of the research methodology that was employed in this study. The focus of the chapter is to provide background on the processes used in examining the usefulness of utilizing volunteers for completion of urban forest resource inventories. The chapter outlines the methods used in this study and describes the focus and scope of research.

#### Background and Overview

##### Background

This study was intended to assess the usefulness and accuracy of urban street tree inventory data that was collected by trained volunteers. Additionally, the effectiveness of a training curriculum that was developed to train volunteers in methods of obtaining urban street tree data was examined, and discussion of the coincident benefits of using community volunteers is provided.

The utilization of volunteers to gather data on urban street trees is being considered by many communities, as a method for collecting urban forest resource data, but the accuracy of the collected data has not been adequately addressed. The research, outlined here, provides a determination as to the validity and usefulness of this method of data acquisition, and provides an analysis of the ability of Certified Arborists to reach consensus agreement on specific characteristics of trees found in an urban area. Data analysis and interpretation was completed using

methods established in consultation with the University of Massachusetts at Amherst Statistical Consulting Center (Sutherland, 1995).

The research was intended to provide, both, practical and statistical findings that could be used to assess the validity of utilizing community volunteers in an urban forest resource inventory program. Assessment of the practical results of the study were used to establish the relative accuracy of the volunteer initiative, while the statistical analysis primarily examined the statistical difference in the data collected by Volunteers and Certified Arborists.

### Model of Volunteer Initiative

The implementation of a volunteer based urban forest resource inventory required the development of a model that would meet the needs of a community's urban forestry program while at the same time address the educational, organizational, and logistical requirements of the volunteer effort. Figure 1, shown below, provides an organizational abstract of the model that was developed for use in Brookline and Springfield.

The components of the volunteer inventory methodology primarily addressed in this paper are indicated in the shaded areas of Figure 1. The figure provides the contextual organization of the volunteer inventory process, illustrating the key components of the volunteer model, including feedback loops which enable modification and enhancement of the various components of the inventory process. A more detailed abstract of the steps included in the organizational model is presented in Appendix B.

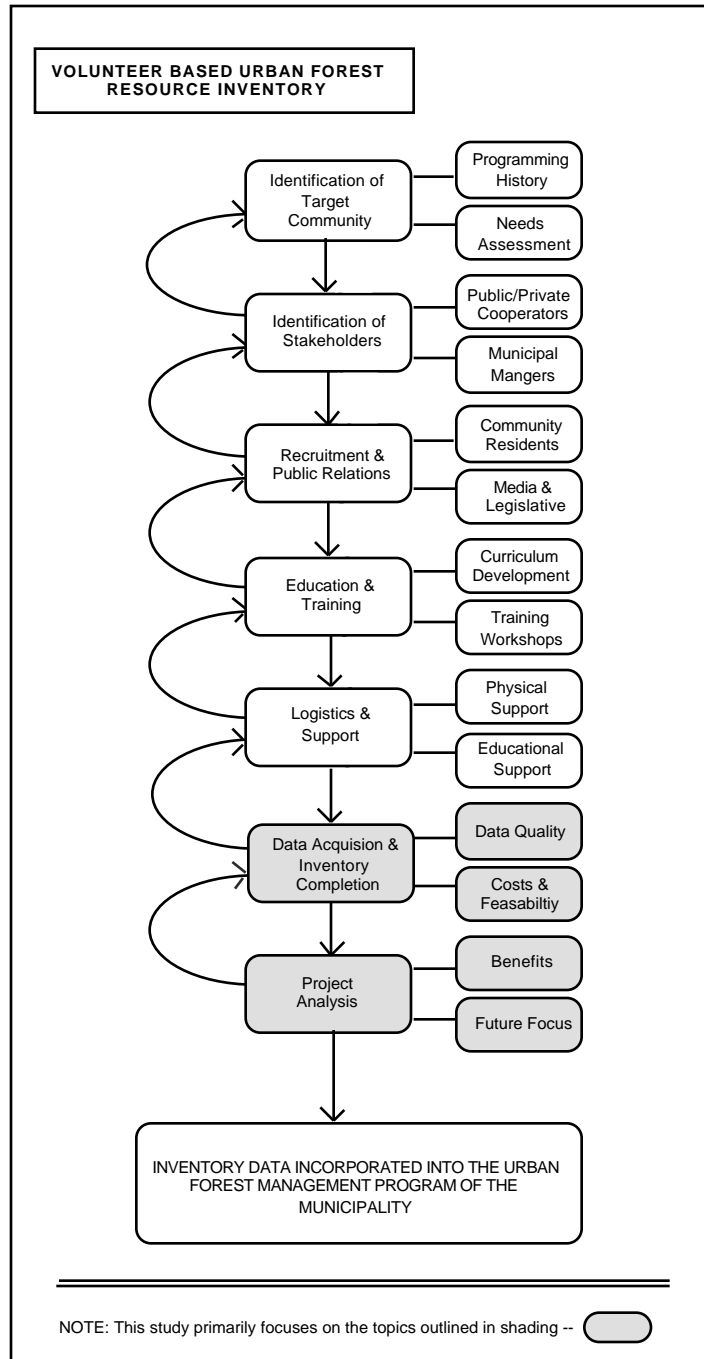


Figure 1- Organizational abstract of volunteer based urban forest inventory model

This paper primarily examines the phases of the model that encompass data acquisition and project analysis, including determination of data quality and an examination of the benefits of utilizing community volunteers to complete urban forest resource inventories.

### Overview

Two communities in Massachusetts were used for this study, Brookline and Springfield. Each had street tree inventories completed by trained volunteers from the particular community. The volunteers received training by Certified Arborists on the specific steps needed to complete an urban street tree inventory, and received instruction on a series of items ranging from tree identification and condition assessment, to map reading skills and data entry procedures. The volunteers were recruited from each community using a variety of methods including media exposure, personnel appeal, mailings to target environmental organization members, and presentation in public forums.

The volunteers in Brookline completed a training program consisting of 10 contact hours with Certified Arborists from the University of Massachusetts Department of Forestry and Wildlife Management and the Arnold Arboretum of Harvard University. Volunteers performing the inventory in Springfield completed five hours of classroom and field instruction, under the direction of Certified Arborists from the University of Massachusetts. Volunteers utilized a published training manual, containing all of the materials covered in the training program, as well as logistical information about the inventory program and its focus. Classroom and field work was incorporated into the training, and volunteers were expected to complete all phases of the training. The specific topics presented in the training

program are shown in the training manual's Table of Contents , included in Appendix A.

In Brookline, data was collected from all public shade trees found along the 104 miles of roadways in the community. In Springfield, a smaller pilot study was conducted, gathering data on trees found along 12 miles of roadway in the Metro-Center downtown neighborhood. Springfield has a total of 414 miles of public streets in the community. Additionally, all public parks <1/4 acre in size were included in both inventories. Data on the same variables was collected from the trees in both communities. The specific variables examined in the inventory are shown in Figure 2.

- |  |   |
|--|---|
| <ul style="list-style-type: none"><li>• Species</li><li>• Diameter at Breast Height (DBH)</li><li>• Condition</li><li>• Root Zone Cover Material</li><li>• Identification of Weak Crotches</li></ul> | <ul style="list-style-type: none"><li>• Presence of Overhead Wires</li><li>• Presence of Deadwood in Tree Crown</li><li>• Presence of Cavities</li><li>• Determination of Street Tree or Park Tree</li><li>• Identification of Management Needs</li></ul> |
|--|---|

Figure 2 - Street tree inventory variables

In addition to the acquisition of the data, the location of each tree was determined and mapped using techniques outlined in the training manual and demonstrated in the training program.

Volunteers worked in teams of 2 or 3 persons and inventoried about one roadway mile, per person. This resulted in each team collecting data on two or three linear miles of roadway in their particular target community. A random sample of the trees inventoried in each community was re-surveyed by a team of two Massachusetts Certified Arborists (MCA/2), in order to collect information on the

trees' variables, for use in analyzing the data collected by trained volunteers. In Brookline, 473 trees were randomly selected and re-examined by the team of two Certified Arborists (MCA/2), and in Springfield, 30 trees underwent the same re-assessment.

As part of the study, data on another random set of urban trees in Amherst, Massachusetts, independent of any other trees examined by the volunteers, was collected by ten Certified Arborists (MCA/10) and by the team of two Certified Arborists (MCA/2). This data was used to analyze differences among data collected by Massachusetts Certified Arborists, and to establish baseline or threshold levels of agreement amongst Certified Arborists.

The same data attributes examined by the volunteers were used in this phase of the study. The data was collected by ten Massachusetts Certified Arborists (MCA/10) and a team of two Certified Arborists (MCA/2), each surveying the same trees on the same day. This enabled the establishment of a baseline level of agreement between Certified Arborists (MCA/10 and MCA/2), demonstrating their ability to come to a consensus as to the type, size, condition, and assessment of the management needs of urban street trees. This baseline was used to establish a level of agreement between the volunteers and the Certified Arborists (MCA/2), in phase two of the study, using data from the randomly sampled trees in Brookline and Springfield.

The research conducted in this study can be divided into three separate areas, and the following sections describe the make-up of each phase.

### Phase One - Data Acquisition by Certified Arborists

#### Background

In the first phase of this research, a comparison of data collected by a group of ten Massachusetts Certified Arborists (MCA/10) and data collected by two other Massachusetts Certified Arborists (MCA/2), was completed. The purpose of this phase of the study was to establish a baseline level of agreement for data collected by the two groups of Certified Arborists, as well as validate the abilities of the two Certified Arborists (MCA/2) for use in the next phase of the study. This enabled a threshold level of agreement to be established between data collected by the professionals, which could be used to analyze data gathered in Phase Two . Agreement matrixes or frequency tables were used to establish relationships between individual variables collected by the Certified Arborists (MCA/10 and MCA/2), and agreement scores were calculated for each variable.

#### Scope and Outline of Phase One

Figure 3 outlines the scope of this phase of the study and illustrates the variables on ten trees examined by the two groups of Certified Arborists.

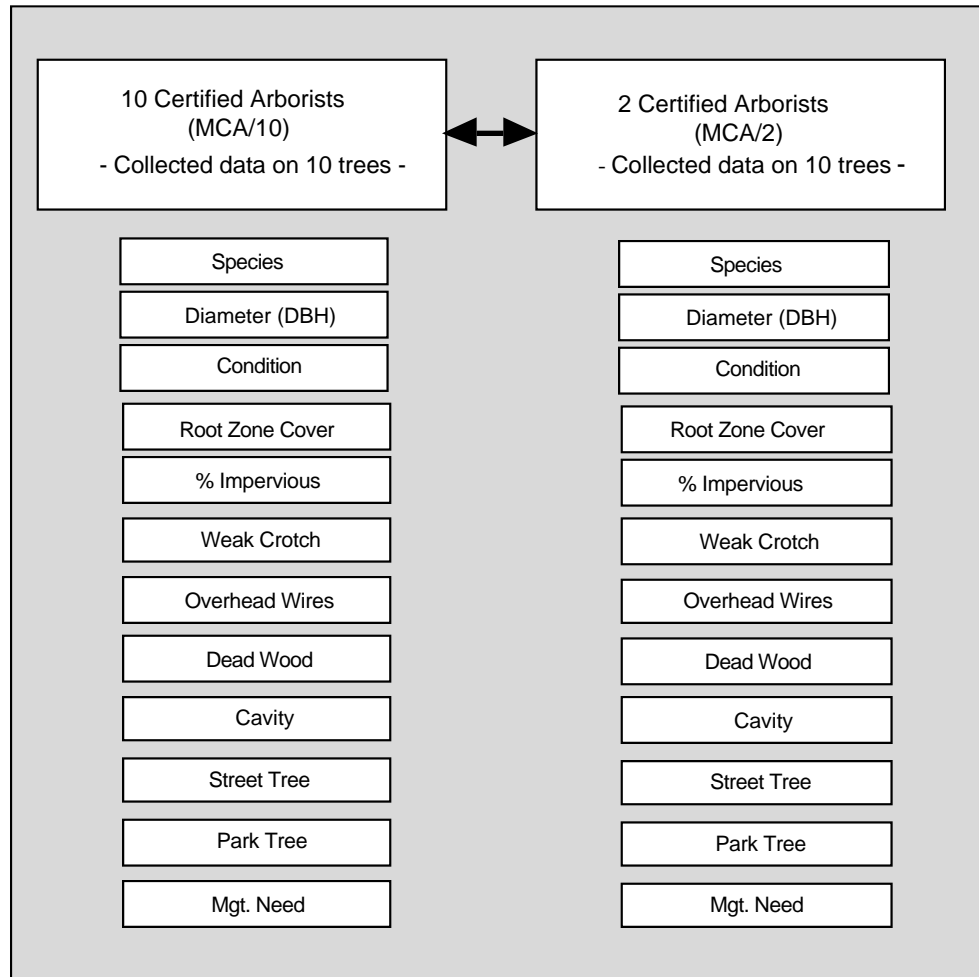


Figure 3 - Phase one data collection of variables by two groups of Certified Arborists (MCA/10) and (MCA/2)

As illustrated in the figure, variable data on a series trees was collected by Certified Arborist (MCA/10) and was compared to data collected by two other Certified Arborists (MCA/2). This comparison allowed for the determination of a threshold level of agreement or baseline, which was later utilized in analyzing the accuracy of data collected by trained volunteers.

### Research Methods and Analysis

Frequency counts and agreement scores, which showed how often the two groups (MCA/10 and MCA/2) agreed with each other, were used to examine the variables. Analysis of the specific variables that presented noticeable levels of disagreement between the two groups of Certified Arborists (MCA/10 and MCA/2) was completed to examine the relationship between the individual variables used in the street tree inventory. By examining where the Certified Arborists agree or disagree on particular characteristics of a tree, the research was able to closely examine the relationship between specific variables as they relate to the completion of a street tree inventory in a community. The agreement levels between the two Certified Arborists (MCA/2) and the other group of ten Certified Arborists (MCA/10) were established using a frequency table. These levels were then used as thresholds for analysis of data collected in Phase Two of the Study.

### Phase Two - Volunteer vs. Professional Data Acquisition

#### Scope of Study

The second phase of the study was used to answer the following questions:

- 1.) Can trained volunteers be used to accurately gather data on urban street trees?
- 2.) How does the accuracy of data collected by trained volunteers compare with the accuracy of data collected by professional arborists?

In this phase of the research, data on urban street trees was collected by trained volunteers, in Brookline and Springfield, that examined a variety of variables that were chosen to provide an overall indication of the street trees'

health, growing location, and surrounding infrastructure. In each community, teams of volunteers collected data on the same variables outlined earlier in this chapter. In Brookline, 104 miles of public roadway were surveyed, while in Springfield 12 miles of the city's 414 miles were inventoried. Additionally, all trees were examined in public parks <1/4 acre in size.

Data was collected using Husky Hunter 16 portable computerized data recorders, using a survey program developed specifically for this project. The data was gathered in text form and later incorporated into a Microsoft Excel 5.0 spreadsheet for analysis. The collected data in each municipality will ultimately become part of a Geographic Information System (GIS) database that will be used to assist in the management of urban infrastructure, facilities, and urban ecosystem resources in each community. Data was collected over a series of three consecutive weekends in Brookline during June 1994, and on one weekend in Springfield in September, 1994. This timing provided consistency in assessing the condition of each of the trees surveyed, since each was examined within a reasonable time frame. This reduced the chance that the condition of the trees would change over an extended period of time.

Simultaneously, the two Massachusetts Certified Arborists (MCA/2) utilized in the first phase of the study, performed the same inventory exercise on a sample of trees randomly selected from the surveyed population. In Brookline, 473 trees were re-surveyed, while in Springfield, 30 trees were re-examined by the two Certified Arborists (MCA/2). These samples represent about 5% of the total street trees surveyed by the volunteers in Brookline, and about 3% in Springfield.

### Study Outline

Figure 4, shown below, outlines the layout of Phase Two of the study and indicates the specific categorical data that was analyzed after collection by the volunteers and the Certified Arborists (MCA/2).

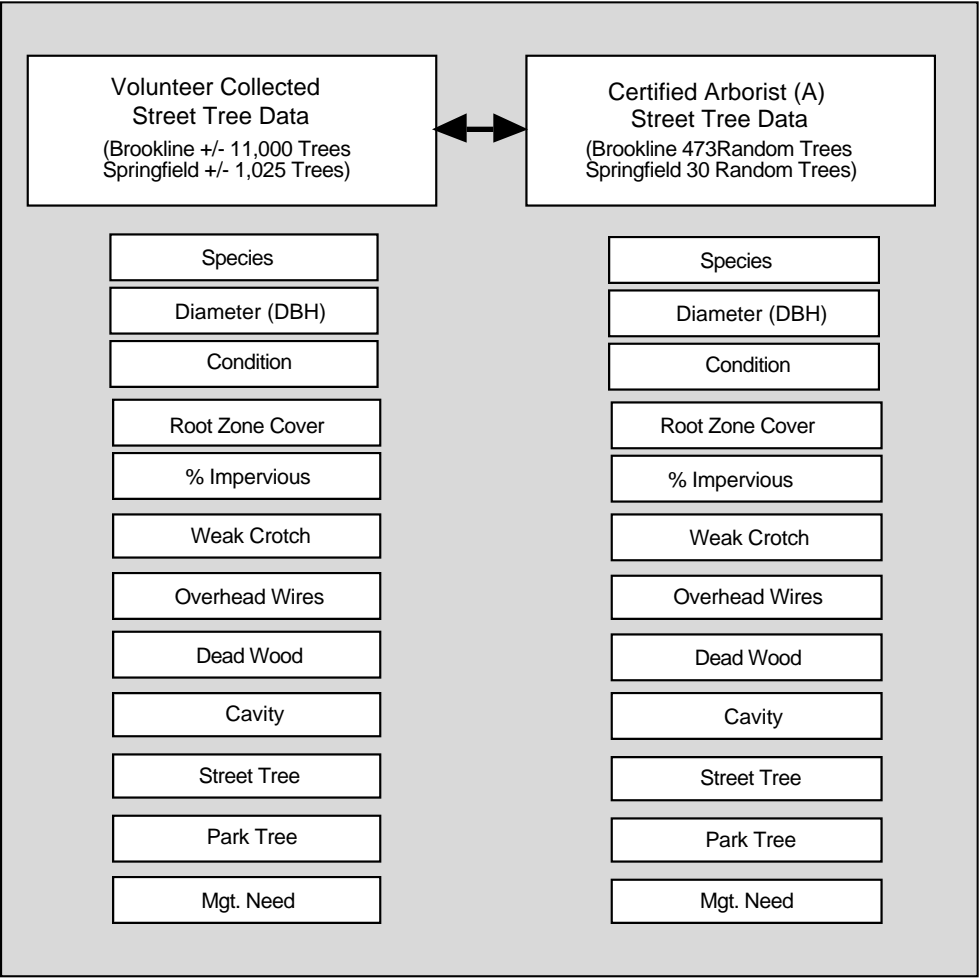


Figure 4 - Phase two data collection

Examination of the data collected by the volunteers also included examination of the association between the frequency scores of the volunteers and Certified Arborists (MCA/2). Determination of specific relationships between individual variables allowed for more detailed examination and analysis of the specific data that was collected.

### Research and Analysis

Examination of the sampled street trees by a team of two Massachusetts Certified Arborists (MCA/2) enabled the establishment of agreement matrices or frequency tables that allowed for analysis of the relationship and association between the various categorical data items. Calculation of agreement scores also allowed for examination of the relationship between selected variables within the total population, as collected by the Volunteers, as well as examination of the relationship between variables from population and from the sample data, as collected by the Certified Arborists (MCA/2).

From a practical standpoint, examination of the agreement matrices provided a very effective method for determining the accuracy of the volunteer effort. The findings allowed for a practical determination to be made as to where differences in variable data occurred between the Volunteers and Certified Arborists (MCA/2). The extent of these differences could be examined and presented in the form of simple percentages. These percentages could also be used for comparison with the findings established in Phase One.

It was also determined that an 80% agreement level between data collected by the Volunteers and the Certified Arborists (MCA/2) would be used as the threshold for useful data collection. If the data collected by the Volunteers and

Certified Arborists (MCA/2) agreed in more than 80% of the cases, then it was determined to be accurate and used in the street tree inventory.

Analysis of the data from each community was completed independently. Comparison of the findings between each community was also completed in order to establish in which community the volunteer group was more successful in gathering data that agreed with the Certified Arborists.

Statistical analysis and hypotheses testing was also conducted, using chi-square calculations. These tests were used to determine the statistical significance of the difference between the data collected by the Volunteers and Certified Arborists (MCA/2).

The practical findings are more useful to the urban forest professional in determining the accuracy of volunteer collected data and providing valuable information for potential improvements to the volunteer training curriculum. The statistical data provides a mathematical criteria for determining the differences between the data collected by Volunteers and Certified Arborists (MAC/2).

### Additional Discussion

#### Costs

In addition to the studies described above, the research also examined the costs associated with the development of a community volunteer street tree inventory in the two communities. Examination of the costs of volunteer programs versus professional consultation and in-house inventory programs was completed.

## Benefits

Examination and discussion of the benefits that can be obtained by utilizing community volunteers to complete urban forest resource inventories was completed. In addition to gathering the data on urban forest resources, the use of volunteers provides intrinsic benefits that were identified and are outlined in this study. The value of trained community volunteers was detailed and the social, political, and empowerment value of these types of programs was reviewed.

The following chapter presents the findings of this study and provides discussion of the validity, accuracy, and usefulness of utilizing community volunteers to complete an urban forest resource inventory.

## CHAPTER 4

### FINDINGS

#### Establishment of Thresholds for Evaluating Urban Forest Resource Data Collection

##### Background

In Phase One of this study a series of trees were examined by two Certified Arborists (MCA/2) and also by a control group of ten Certified Arborists (MCA/10) in order to determine how often the two groups agreed on specific variable criteria. Observations made by two Certified Arborists (MCA/2) were tested against observations made by the control group of Certified Arborists (MCA/10) in order to develop baseline criteria on which to test the accuracy of volunteer data acquisition, completed in Phase Two of the study.

By determining how often two Certified Arborists (MCA/2) and the control group of Certified Arborists (MCA/10) agreed on specific variables, it is possible to establish a threshold for the quality of data collected by Volunteers during Phase Two of the study. This ensured that the sample data collected by the Certified Arborists (MCA/2), in Brookline and Springfield, was representative of the quality of data collected by Certified Arborists in general, so that it could be used to determine the validity of data collected by the volunteers.

Table 2 summarizes the agreement levels between the two Certified Arborists (MCA/2) and the Certified Arborist Control Group (MCA/10) for the trees examined in study.

Table 2 - Agreement levels by tree variables

<u>Variable</u>	<u>Agreement Level *</u>
Genus	100%
Genus & Species	98%
Condition	89%
Management Need	86%
Weak Crotch	80%
Cavity	93%
Root Zone Cover Material	98%

\* 10 Certified Arborists (MCA/10) compared to 2 Certified Arborists (MCA/2)

Table 2 shows that, although, the two Certified Arborists (MCA/2) and the control group of Certified Arborists (MCA/10) were not entirely consistent in their levels of agreement for the variables examined, the average level of agreement between the two groups was 92%. Assessment of a tree's condition, management needs, and occurrence of weak crotches representing areas in which there was notable disagreement between the two groups, but none of the disagreement levels were determined to be significant, since all agreement levels were  $\geq$  80%.

Agreement between the Certified Arborists (MCA/2) and control Certified Arborists (MCA/10) on the trees' genus occurred in all cases (100%) and the two groups noted the same genus and species in 98% of the cases. Identification of root zone cover material was also consistent (98%) and occurrence of cavities in the examined trees was agreed upon in 93% of the cases.

Examination of Data Collection by Volunteers and  
Certified Arborists

In this phase of the study data collected by the volunteers was examined to determine how closely it agreed to data obtained by two Certified Arborists (MCA/2). Street tree data, collected by volunteers and Certified Arborists (MCA/2), in Brookline and Springfield, Massachusetts was used in this phase of the study. The findings of the research are presented in the following sections of the chapter, beginning with the results of the Brookline phase of the study, followed by the findings from Springfield.

Brookline Findings

The following outlines the findings obtained when several different variables were used as the criteria to examine the data collected by Volunteers and Certified Arborists (MCA/2) in Brookline. Data from a series of randomly selected street trees, as observed by the two groups, was used in this section of the study. Each variable was examined separately and the results of the data analysis are outlined.

Tree Identification. The first variable examined was tree identification. Tree species occurring >10 times were considered, representing over 84% of the trees found in the sample. The remaining 16% of trees occurred <10 times and were distributed among 33 different species of trees, with most species occurring only one or two times. Table 3 shows the species distribution of the trees used to examine tree identification accuracy.

Table 3 - Species distribution of sampled trees used to examine  
tree identification accuracy

<u>Tree Name</u>	<u>Number of Cases</u>
Acer platanoides	142
Acer rubrum	40
Fraxinus pennsylvanica	29
Gleditsia triacanthos	28
Platanus x acerifolia	11
Platanus occidentalis	27
Quercus palustris	19
Quercus rubra	41
Tilia cordata	55
Total	392

Frequency tables were calculated for each of the trees found in the sample and used to examine the levels of agreement between the tree identification responses of the Certified Arborists (MCA/2) and the Volunteers. The percentage of times the Certified Arborists (MCA/2) and the Volunteers agreed on the identification of a tree was calculated for genus and species. Table 4 provides a summary of the agreement percentages for the trees examined, arranged by genus.

Table 4 - Tree identification agreement percentages between  
Certified Arborist (MCA/2) and Volunteers

<u>Tree Type</u>	<u>Genus</u>	<u>Genus &amp; Species</u>
Acer	95.00%	90.00%
Fraxinus	96.00%	68.00%
Quercus	93.00%	70.00%
Platanus	92.00%	46.00%
Gleditsia	96.00%	96.00%
Tilia	91.00%	73.00%

Examination of agreement among genus shows that the agreement scores range between 91% and 96%, representing a high level of agreement. The average agreement percentage between Certified Arborists (MCA/2) and Volunteers was nearly 94%. The highest agreement levels are found in *Acer* and *Fraxinus* with the lowest among *Tilia*.

The average agreement level decreases to about 80% when identification of both genus and species were calculated, with the lowest levels occurring with the genus *Platanus*, *Fraxinus* and *Quercus*. This can be attributed to the similarity of the physical characteristics of this genus. Differentiation between *Platanus occidentalis* and *Platanus x acerifolia*, two of the most predominant trees found in Brookline, is difficult for even trained arborists and illustrates the likely cause of the lower agreement scores when species is considered. Likewise, the varieties of *Fraxinus* found can present identification difficulties, for even Certified Arborists, exemplifying the disparity that is found in the results. Knowing this, more time could be spent training volunteers on species that are difficult to identify.

Condition Assessment. Condition assessment is a critical component of a tree inventory, providing some of the most useful information to be used in the development of an effective urban forest management system. The following

provides a practical examination of condition assessment rated by the Volunteers and Certified Arborists (MCA/2):

Examination of the assessment of the condition of all 473 trees found in the sample, as completed by the Volunteers and Certified Arborists (MCA/2), was examined and the results scored and tabulated in a frequency table. Table 5 shows the calculated frequency table for condition assessment of the sample trees examined by the Certified Arborists (MCA/2) and the Volunteers.

The data shows that in 391 of the 473 cases (83%), the Certified Arborists (MCA/2) and the Volunteers agreed on the condition of the sampled trees. While the Certified Arborists (MCA/2) noted 441 trees in good condition; the Volunteers found only 394 trees, (89% of the 441) in the same condition,

Table 5 - Comparison of assessments by professionals and  
volunteers: All rating categories

Condition Class by Certified Arborist (MCA/2)	Conditon Class by Volunteers					<i>Total</i>
	Good	Fair	Poor	Dead	Hazard	
Good (441)	381	51	8	0	1	441
Fair (24)	12	6	4	0	2	24
Poor (4)	0	2	1	1	0	4
Dead (2)	0	0	0	2	0	2
Hazard (2)	1	0	0	0	1	2
Total	1	59	13	3	4	473
Summary						
	Conditon Class					Total
	Good	Fair	Poor	Dead	Hazard	
Cert. Arborists (MCA/2)	441	24	4	2	2	473
Volunteers	394	59	13	3	4	473

indicating a more cautious or idealistic approach to condition rating by the Volunteers in 11% of the cases. Of the 441 trees noted in good condition by the Certified Arborists (MCA/2), 60 (13%) were rated as being in less than good condition by the Volunteers, illustrating this conservative approach by the Volunteers. Exception to this cautious approach occurs when the assessment of hazard trees is examined. The Certified Arborists (MCA/2) assessed 2 trees as in hazard condition, while the Volunteers only found one in this condition and rated the other as in good condition.

The ranges of condition assessment can be collapsed into two coarser sets based on observations of Good/Fair , Poor and Dead/Hazard. Many street tree inventories use this range of condition assessment ratings. Table 6 shows the frequency table of the collapsed condition assessment.

Table 6 - Comparison of assessments by professionals and volunteers: Combined rating categories

Condition Class by Certified Arborist (MCA/2)	Conditon Class by Volunteers			<i>Total</i>
	Good/Fair	Poor	Dead/Hazard	
Good/Fair (465)	450	12	3	465
Poor (4)	2	1	1	4
Dead/Hazard (4)	1	0	3	4
Total	453	13	7	473

Summary	Conditon Class			<i>Total</i>
	Good	Fair	Poor	
Cert. Arborists (MCA/2)	465	4	4	473
Volunteers	453	13	7	473

Table 6 shows the level of agreement between the Volunteers and Certified Arborists (MCA/2) increases to 96% when the variables are combined into less specific categories. 450 of the 465 trees categorized as good/fair by the Certified Arborists (MCA/2) were also rated in this condition by the Volunteers. Of the 13

trees noted by the volunteers to be in poor condition, twelve were noted as being good/fair by the Certified Arborists (MCA/2).

Three of the four trees noted as dead/hazard by the Certified Arborists (MCA/2), were similarly rated by the Volunteers, indicating a discrepancy in specifically identifying hazard situations. The Volunteers rated one of the hazard trees to be in good condition, indicating at least some difficulty, on their part, in identifying hazard conditions.

The following provides a statistical examination of condition assessment rated by the Volunteers and Certified Arborists (MCA/2):

The data collected by the Volunteers and Certified Arborists (MCA/2) can be used to statistically evaluate agreement between the two groups using Chi-square. Chi square compares observed or actual frequencies with expected or theoretical frequencies; it is a non-parametric classifactorial process that offers some value in hypothesis testing in the absence of measurement data. The Chi square value was calculated, for both the collapsed observations and the entire data set, and used to support the likelihood of a difference existing between the data collected by the two groups of observers and test the null hypothesis. Table 7 outlines the Chi square test for condition assessment.

The following null hypothesis was used in this examination:

$H_0$  : There is no significant difference between the condition scores of street trees as rated by Volunteers and Certified Arborists (MCA/2).

Table 7 - Chi-square test results: All condition categories

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DF	Calculated Chi Square	Tabular Chi Square	Significance Level
16	75.177	39.252	0.001

As illustrated in Table 7, a Chi square table gives a value of 39.252 at the .001 level of significance with 16 degrees of freedom, and since the data from the study yielded a Chi square value of 75.177 we are able to reject the null hypothesis. The results suggest that significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when determination of a tree's condition, using all categories, is the criteria for review.

Table 8 outlines the Chi square test using collapsed categories.

Table 8 - Chi-square test results: Collapsed categories

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
4	31.216	18.467	0.001

Table 8 shows that a Chi square table gives a value of 18.467 at the .001 level of significance with 4 degrees of freedom, and since the data in the study yielded a Chi square value of 31.216 we are able to reject the null hypothesis. The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when determination of a tree's condition, using collapsed categories, is the criteria for review.

Although the findings presented here show a statistical difference in the ratings of a tree's condition by Volunteers and Certified Arborists (MCA/2), from a practical standpoint the data primarily falls within the predetermined 80% level, therefore it is determined to be accurate and significant.

Management Need. The following provides a practical examination of the management needs assessment rated by the Volunteers and Certified Arborists (MCA/2):

The management needs of the 473 sampled trees were assessed by the Certified Arborists (MCA/2) and the Volunteers. Table 9 shows the responses of the Certified Arborists (MCA/2) and Volunteers.

Certified Arborists (MCA/2) and Volunteers agreed in 75% of the cases, as shown in Table 9. Both groups agreed in 354 of 473, with discrepancies primarily noted in the areas of pruning and removal. The Volunteers determined that pruning was needed more often than was concluded by the Certified Arborists (MCA/2), with the Volunteers recommending pruning in 99 cases while the Certified Arborists (MCA/2) only observed 12 trees that needed trimming.

Table 9 - Comparison of assessments by professionals and  
volunteers: Management needs

Management Needs by Certified Arborist (MCA/2)	Management Needs by Volunteers				<i>Total</i>
	None	Prune	Remove	Consult	
None (456)	345	94	4	13	456
Prune (12)	7	5	0	0	12
Remove (4)	0	0	4	0	4
Consult (1)	1	0	0	0	1
<b>Total</b>	<b>353</b>	<b>99</b>	<b>8</b>	<b>13</b>	<b>473</b>
Summary					
	Management Need				<i>Total</i>
	None	Prune	Remove	Consult	
Cert. Arborists (MCA/2)	456	12	4	1	473
Volunteers	353	99	8	13	473

This finding reinforces the concept of the volunteers being more “idealized” in their assessment of the tree’s management needs. The Volunteers noted the need for pruning maintenance, when the practical and fiscal reality of the situation did not merit it. Subsequent review of the trees determined to be in need of pruning by the Volunteers, were observed to have some very minor dead wood in the crown, indicating that the Volunteers were very exact in their determination of the need for pruning. The difference in the evaluation of pruning needs between the Volunteers and the Certified Arborists (MCA/2) may be based on the fiscal reality that Certified Arborists face, realizing that not every municipal street tree can be given

the same level of maintenance and pruning that a tree growing at a private residence might receive.

The Volunteers noted 8 trees that needed removal, while the Certified Arborists (MCA/2) agreed in only 4 (50%) of the cases. The other 4 trees that the Volunteers suggested for removal were found, by the Certified Arborists (MCA/2), to need no management. This finding indicates a significant discrepancy between the two groups and the agreement level is unacceptable. Additional instruction to the Volunteers as to the need for tree removal is necessary during the training sessions and field instruction, in order to reduce this discrepancy.

Additionally, the two groups agreed in 92% of the cases in which consultation was deemed necessary by the Certified Arborists (MCA/2), with volunteers noting 13 trees that needed consultation by the Town Arborist, while the Certified Arborists (MCA/2) recommended only 1 tree for another professional opinion. This finding would be expected since the Volunteers were instructed to request consultation by the Town Arborist in any situation in which they questioned the specific management need of a tree.

The following provides a statistical examination of a tree's management needs assessment rated by the Volunteers and Certified Arborists (MCA/2):

Examination of the data found in the frequency tables can also establish the occurrence of a difference between the data collected by the Volunteers and Certified Arborists (MCA/2). The chi square value was calculated and used to determine differences between the data collected by the two groups of observers and test the null hypothesis. Table 10 outlines the Chi square test for management needs.

The following null hypothesis was used in this examination of the assessment of a tree's management needs:

$H_0$  : There is no significant difference between the assessment of a street tree's management needs as rated by Volunteers and Certified Arborists (MCA/2).

Table 10 - Chi-square test results: management needs assessment

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
9	38.934	27.877	0.001

Table 10 shows that a Chi square table gives a value of 27.877 at the .001 level of significance 9 degrees of freedom, and since the data in the study yielded a Chi square value of 38.934 we are able to reject the null hypothesis. The results suggest that there is significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when determination of a tree's management need is the criteria for review.

Although the findings presented here show a statistical difference in the ratings of the management needs of street trees as rated by Volunteers and Certified Arborists (MCA/2), from a practical standpoint much of the data falls near the predetermined 80% level, therefore it is determined to be accurate, although there is some discrepancy in the "idealized" ratings of the Volunteers.

Other Variables. The following provides a practical examination of several inventory variables as rated by the Volunteers and Certified Arborists (MCA/2):

Other variables, such as occurrence of cavities, weak crotches or deadwood in the crown of the sampled trees and type root zone cover materials, were examined to determine the agreement levels between the Certified Arborists (MCA/2) and the Volunteers. Table 11 summarizes the agreement levels between the two Certified Arborists (MCA/2) and Volunteers for these additional variables observed in the sample.

Comparison of scores between Arborist/Arborist and Arborist/Volunteers shows that the agreement level for each of the variables assessed is reasonable. Identification of cavities and weak crotches shows agreement levels at  $\geq 90\%$ , while identification of root zone cover materials and occurrence of dead wood in crowns show agreement levels at  $\geq 82\%$ .

Table 11 - Inventory variables and agreement levels

<u>Variable</u>	<u>Volunteers/Cert. Arborists (MCA/2) Agreement Level</u>
Weak Crotch	90%
Cavity	92%
Root Zone Cover Material	82%
Dead Wood in Crown	84%

Of the variables examined, the three that are most likely to impact the occurrence of a hazard condition in a tree are the occurrence of a weak crotch, cavities, and deadwood in the crown. These variables should be examined separately in order to determine the ability of the Volunteers to assess hazard potential in a tree. The data shows that the average level of agreement between the Certified Arborists (MCA/2) and the Volunteers, for these variables, is 89%. Identification of deadwood in the crown was agreed upon in 84% of the cases, which is reasonable, but indicates that the Volunteers were overly critical in their observations of the tree, likely noting small branches < 1/2" in size that would not be considered significant by the Certified Arborists (MCA/2). Cavities and weak crotches were found by both the Certified Arborists (MCA/2) and Volunteers in 90% of the cases indicating a high level of agreement for these variables.

Agreement on the type of predominant root zone cover material, by the Certified Arborists (MCA/2) and the Volunteers, shows that the two groups agreed in 82% of the cases. This level of agreement is lower than for the other three variables, but still lies within reasonable limits. This variable is used primarily

to project future growth habits of the tree and to provide information valuable in assessing the susceptibility of the tree to moisture stress.

The following provides a statistical examination of several inventory variables as rated by the Volunteers and Certified Arborists (MCA/2):

The data collected by the Volunteers and Certified Arborists (MCA/2) can be used to statistically evaluate agreement between the two groups using Chi-square. The Chi square value was calculated and used to examine differences between the data collected by the two groups of observers and test the null hypothesis. Each of the variables were examined and a series of tests were conducted. Table 12 outlines the Chi square test for weak crotches.

The following null hypothesis was used to examine data collected on the occurrence of weak crotches in street trees:

$H_0$  : There is no significant difference between the assessment of the occurrence of weak crotches in street trees as rated by Volunteers and Certified Arborists (MCA/2).

Table 12 - Chi-square test results: Weak crotches

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
1	20.633	10.827	0.001

Table 12 shows that a Chi square table gives a value of 10.827 at the .001 level of significance with 1 degree of freedom, and since the data in the study yielded a Chi square value of 20.633 we are able to reject the null hypothesis.

The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when the occurrence of weak crotches is the criteria for review.

Table 13 outlines the Chi square test for the occurrence of cavities.

The following hypotheses were used to examine data collected on the occurrence of cavities in street trees:

$H_0$  : There is no significant difference between the assessment of the occurrence of cavities in street trees as rated by Volunteers and Certified Arborists (MCA/2).

Table 13 - Chi-square test results: Cavities

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
1	25.461	10.827	0.001

Table 13 shows that a Chi square table gives a value of 10.827 at the .001 level of significance with 1 degree of freedom, and since the data in the study yielded a Chi square value of 25.461 we are able to reject the null hypothesis. The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when the occurrence of cavities is the criteria for review.

Table 14 outlines the Chi square test for root zone cover material.

The following null hypothesis was used to examine data collected on the type of root zone cover material:

$H_0$  : There is no significant difference between the assessment of the type of root zone cover material over street tree roots as rated by Volunteers and Certified Arborists (MCA/2).

Table 14 - Chi-square test results: Root zone cover material

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
1	35.409	10.827	0.001

Table 14 shows that a Chi square table gives a value of 10.827 at the .001 level of significance with 1 degree of freedom, and since the data in the study yielded a Chi square value of 35.409 we are able to reject the null hypothesis. The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when the identification of root zone cover material is the criteria for review.

Table 15 outlines the Chi square test for dead wood in a tree's crown.

The following null hypothesis was used to examine data collected on the occurrence of dead wood in a tree's crown:

$H_0$  : There is no significant difference between the assessment of the occurrence of dead wood in a tree's crown as rated by Volunteers and Certified Arborists (MCA/2).

Table 15 - Chi-square test results: Dead wood in crown

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
1	13.31	10.827	0.001

Table 15 shows that a Chi square table gives a value of 10.827 at the .001 level of significance with 1 degree of freedom, and since the data in the study yielded a Chi square value of 13.31 we are able to reject the null hypothesis. The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when the occurrence of dead wood in a tree’s crown is the criteria for review.

Although the findings presented here show a statistical difference in the ratings of several inventory variables of street trees as rated by Volunteers and Certified Arborists (MCA/2), from a practical standpoint the data primarily falls within the predetermined 80% level, therefore it is determined to be accurate and significant.

Springfield Findings

The following section of this chapter outlines the findings when the previously described tests were applied to data collected in Springfield. As completed in Brookline, several different variables were used as the criteria to examine the data collected by Volunteers and Certified Arborists (MCA/2) in Springfield.

Conclusions about the value of the data collected by the Volunteers were drawn.

Tree Identification. The first variable examined was tree identification.

Identification of thirty randomly sampled trees by the Volunteers and Certified Arborists (MCA/2) were examined in order to determine how often the two groups

agreed on determining the species of the sampled trees. Table 16 shows the species distribution of the trees used to examine tree identification accuracy.

Table 16 - Springfield species distribution of sample trees used to examine tree identification accuracy

<u>Tree Name</u>	<u>Number of Cases</u>
Acer saccharum	3
Acer platanoides	6
Celtis occidentalis	1
Gleditsia triacanthos	1
Malus x	1
Platanus x acerifolia	2
Pyrus calleryana	4
Quercus palustris	2
Quercus rubra	1
Tilia cordata	8
Ulmus americana	1
<hr/>	
Total	30

Frequency tables were calculated for each of the trees found in the sample and used to examine the levels of agreement between the tree identification responses of the Certified Arborists (MCA/2) and the Volunteers. The percentage of times the Certified Arborists (MCA/2) and the Volunteers agreed on the identification of a tree was calculated for genus and species. Table 17 provides a summary of the agreement percentages for the trees examined, arranged by genus.

Table 17 - Tree identification agreement percentages between Certified Arborists (MCA/2) and Volunteers

<u>Tree Type</u>	<u>Genus</u>	<u>Genus &amp; Species</u>
Acer	100%	100%
Celtis	100%	100%
Gleditsia	100%	100%
Malus	100%	100%
Platanus	100%	100%
Pyrus	75%	75%
Quercus	100%	100%
Tilia	100%	100%
Ulmus	100%	100%

Examination of agreement among genus shows that the agreement scores were very high, with most species showing 100% agreement in identification between the Volunteers and Certified Arborists (MCA/2). The average agreement percentage between Certified Arborists (MCA/2) and Volunteers was 97%. Agreement for all species was 100% except for Pyrus, in which only 3 of the 4 sampled trees were identified correctly by both Volunteers and Certified Arborists (MCA/2).

The agreement levels remain consistent when identification of both genus and species were calculated, with very high levels of agreement recorded for all species except Pyrus. In all cases, except for one, there is complete agreement on genus and species between the two groups of observers. In the Pyrus case, the Volunteers identified one of the 4 sampled trees as *Tilia cordata*, resulting in the discrepancy in the agreement level.

The high level of agreement between the Volunteers and Certified Arborists (MCA/2) indicate that the Volunteers were able to identify the sampled trees in Springfield with very little difficulty and within very acceptable accuracy thresholds.

Condition Assessment. Examination of data on the assessment of the condition of the 30 sampled trees, as completed by the Volunteers and Certified Arborists (MCA/2), was completed and the results scored and tabulated in a frequency table. The following provides a practical examination of condition assessment rated by the Volunteers and Certified Arborists (MCA/2):

Table 18 shows the calculated frequency table for condition assessment of the sample trees in Springfield examined by the Certified Arborists (MCA/2) and the Volunteers.

The data shows that in 27 of the 30 sampled cases (90%), the Certified Arborists (MCA/2) and the Volunteers agreed on the condition of the trees. While the Certified Arborists (MCA/2) noted 25 trees in good condition, the Volunteers found only 22 trees (88% of the 25) in the same condition, indicating a more cautious or conservative approach to condition rating by the Volunteers in 12% of the cases. Of the 25 trees noted in good condition by the Certified Arborists (MCA/2), 3 (12%) were rated as being in less than good condition by the Volunteers, illustrating this conservative approach by the Volunteers. One tree was rated in poor condition by the Volunteers, while the Certified Arborists (MCA/2) assessed its condition as good.

Table 18 - Comparison of assessments by professionals and  
volunteers: All rating categories

Condition Class by Certified Arborist (MCA/2)	Conditon Class by Volunteers			<i>Total</i>
	Good	Fair	Poor	
Good (25)	22	2	1	25
Fair (5)	0	5	0	5
Poor (0)	0	0	0	0
<b>Total</b>	<b>22</b>	<b>7</b>	<b>1</b>	<b>30</b>

Summary	Conditon Class			Total
	Good	Fair	Poor	
Cert. Arborists (MCA/2)	25	5	0	30
Volunteers	22	7	1	30

When the ranges of condition assessment are collapsed into two coarser sets based on observations of good/fair and poor conditions, the observations of the Volunteers and Certified Arborists (MCA/2) become much closer in their assessment of the condition of the sampled trees. Table 19 shows the frequency table of the collapsed condition assessment.

Table 19 - Comparison of assessments by professionals and volunteers:

Combined rating categories

Cert. Arborists (MCA/2)	Volunteers		Total
	Good/Fair	Poor	
Good/Fair (30)	29	1	30
Poor (0)	0	0	0
Dead/Hazard (0)	0	0	0
	29	1	30

Table 19 shows the level of agreement between the Volunteers and Certified Arborists (MCA/2) increases to 97% when the variables are combined into less specific categories. 29 of the 30 trees categorized as good/fair by the Certified Arborists (MCA/2) were also rated in this condition by the Volunteers. The one tree noted by the volunteers to be in poor condition, was assessed as being good/fair by the Certified Arborists (MCA/2).

The following provides a statistical examination of condition assessment rated by the Volunteers and Certified Arborists (MCA/2):

Examination of the data found in the frequency tables can also be used to statistically evaluate agreement between data collected by the Volunteers and Certified Arborists (MCA/2). The chi square value was calculated, for both the collapsed observations and the entire data set, and used to examine differences between the data collected by the two groups of observers and test the null hypothesis. Table 20 outlines the Chi square test for condition assessment.

The following null hypothesis was used in this examination of the assessment of a tree's condition:

$H_0$  : There is no significant difference between the condition scores of street trees as rated by Volunteers and Certified Arborists (MCA/2).

Table 20 - Chi-square test results: All condition categories

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
2	18.658	13.815	0.001

Table 20 shows that a Chi square table gives a value of 13.815 at the .001 level of significance with 2 degrees of freedom, and since the data in the study yielded a Chi square value of 18.658 we are able to reject the null hypothesis. The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when

determination of a tree’s condition, using all categories, is the criteria for review.

Although the findings presented here show a statistical difference in the ratings of a tree’s condition by Volunteers and Certified Arborists (MCA/2), from a practical standpoint the data primarily falls within the predetermined 80% level, therefore it is determined to be accurate and significant.

Management Need. The following provides a practical examination of the management needs assessment rated by the Volunteers and Certified Arborists (MCA/2):

The management needs of the 30 sampled trees were also assessed by the Certified Arborists (MCA/2) and the Volunteers. Table 21 shows the responses of the Certified Arborists (MCA/2) and Volunteers as they assessed the management needs of the sampled trees in Springfield.

Table 21 - Assessment of management needs

Mgt. Need	Mgt. Need -- Volunteers			Total
Cert. Arborists (MCA/2)	None	Prune	Consult	
None (25)	14	8	3	25
Prune (5)	0	5	0	5
Consult (0)	0	0	0	0
	14	13	3	30
Summary				
	None	Prune	Consult	Total
Cert. Arborists (MCA/2)	25	5	0	30
Volunteers	14	13	3	30

Certified Arborists (MCA/2) and Volunteers agreed on the management needs in 19 of the 30 (63%) sampled cases, as shown in Table 21.

Discrepancies in the assessment of management needs, by the two groups,

occurred primarily in the areas of pruning and consultation. Both groups of observers noted 14 of the 30 sampled trees as in need of no management.

The Volunteers determined that pruning was needed more often than was concluded by the Certified Arborists (MCA/2), with the Volunteers recommending pruning in 13 cases while the Certified Arborists (MCA/2) only observed 5 trees that needed trimming. This finding reinforces the concept of the volunteers being more “idealized” in their assessment of the tree’s management needs. Review of the specific trees determined to be in need of pruning by the Volunteers, were observed to have some small dead branches in the crown, indicating that the Volunteers were idealistic in their determination of the need for pruning, noting that pruning was needed in trees with only minor dead wood occurrences. As in Brookline, these findings are most likely a result of the fiscal reality that Certified Arborists faces, realizing the fiscal constraints of municipal forestry.

The Volunteers noted 3 trees that were in need of consultation, while the Certified Arborists (MCA/2) did not find any that needed another opinion. This finding was anticipated, since the Volunteers were instructed to note any tree that they were uncertain about or had a question. Neither the Volunteers or the Certified Arborists (MCA/2) noted any trees, in the sample, that needed removal.

The following provides a statistical examination of a tree’s management needs assessment rated by the Volunteers and Certified Arborists (MCA/2):

Examination of the data found in the frequency tables can also statistically evaluate agreement between the two groups using Chi-square. The chi square value was calculated, for both the collapsed observations and the entire data set, and used to determine levels of agreement existing between the data collected by the two groups of observers and test the null hypothesis.

Table 22 outlines the Chi square test for assessment of a tree's management needs.

The following null hypothesis was used in this examination of assessment of a tree's management needs:

$H_0$  : There is no significant difference between the management needs assessment of street trees as rated by Volunteers and Certified Arborists (MCA/2).

Table 22 - Chi-square test results: Management needs assessment

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
2	9.71	9.21	0.01

Table 22 shows that a Chi square table gives a value of 9.21 at the .01 level of significance with 2 degrees of freedom and since the data in the study yielded a Chi square value of 9.71 we are able to reject the null hypothesis. The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when determination of a tree's management need is the criteria for review.

Although the findings presented here show a statistical difference in the ratings of the management needs of street trees as rated by Volunteers and Certified Arborists (MCA/2), from a practical standpoint much of the data falls near the predetermined 80% level, therefore it is determined to be accurate, although there is some discrepancy in the "idealized" ratings of the Volunteers.

Other Variables. The following provides a practical examination of several additional inventory variables as rated by the Volunteers and Certified Arborists (MCA/2):

Other variables were examined to determine the agreement levels between the Certified Arborists (MCA/2) and the Volunteers for data collected on trees found in Springfield. These variables included occurrence of cavities, weak crotches or deadwood in the crown of the sampled trees and type root zone cover materials. Table 23 summarizes these agreements.

Table 23 - Inventory variables and agreement levels

<u>Variable</u>	Volunteers/Cert. Arborists (MCA/2) <u>Agreement Level</u>
Weak Crotch	93%
Cavity	97%
Root Zone Cover Material	100%
Dead Wood in Crown	100%

Comparison of scores between Arborist/Arborist and Arborist/Volunteers shows that the agreement level for each of the variables assessed very acceptable. Identification of cavities and weak crotches shows agreement levels at 93%, while identification of root zone cover materials and occurrence of dead wood in crowns shows 100% agreement.

Of the variables examined, the three directly related to the occurrence of a hazard condition in a tree are the occurrence of a weak crotch, a cavity or deadwood in the crown. These variables can be examined separately in order to determine the ability of the Volunteers to assess hazard potential in a tree. The data shows that the average level of agreement between the Certified Arborists (MCA/2) and the Volunteers, for these variables, is 97%. Cavities and weak crotches were

found by both the Certified Arborists (MCA/2) and Volunteers in 93% of the cases indicating a high level of agreement for these variables.

In all cases the Volunteers and Certified Arborists (MCA/2) agreed on the type of root zone cover material and the occurrence of dead wood in the crown. In both of these cases, the two groups agreed on these two variables in every case.

The following provides a statistical examination of several inventory variables as rated by the Volunteers and Certified Arborists (MCA/2):

Examination of the data found in the frequency tables can also determine the differences between the data collected by the Volunteers and Certified Arborists (MCA/2). The Chi square value was calculated and used to examine differences between the data collected by the two groups of observers and test the null hypothesis. Each of the variables were examined and a series of tests were conducted. Table 24 outlines the Chi square test for occurrence of weak crotches in a tree.

The following null hypothesis was used to examine data collected on the occurrence of weak crotches in street trees:

$H_0$  : There is no significant difference between the assessment of the occurrence of weak crotches in street trees as rated by Volunteers and Certified Arborists (MCA/2).

Table 24 - Chi-square test results: Weak crotches

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
1	9.151	6.635	0.01

Table 24 shows that a Chi square table gives a value of 6.635 at the .01 level of significance with 1 degree of freedom, and since the data in the study yielded a Chi square value of 9.151 we are able to reject the null hypothesis. The results suggest that there is significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when the occurrence of weak crotches is the criteria for review.

Table 25 outlines the Chi square test for cavities.

The following null hypothesis was used to examine data collected on the occurrence of cavities in street trees:

$H_0$  : There is no significant difference between the assessment of the occurrence of cavities in street trees as rated by Volunteers and Certified Arborists (MCA/2).

Table 25 - Chi-square test results: Cavities

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
1	5.996	5.412	0.02

Table 25 shows that a Chi square table gives a value of 5.412 at the .02 level of significance with 1 degree of freedom, and since the data in the study yielded a Chi square value of 5.996 we are able to reject the null hypothesis. The results suggest that there is statistical difference in the frequency scores of the Volunteers

and Certified Arborists (MCA/2) when the occurrence of cavities is the criteria for review.

Table 26 outlines the Chi square test for root zone cover material.

The following null hypothesis was used to examine data collected on the type of root zone cover material:

$H_0$  : There is no significant difference between the assessment of the type of root zone cover material over street tree roots as rated by Volunteers and Certified Arborists (MCA/2).

Table 26 - Chi-square test results: Root zone cover material

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
1	23.56	10.827	0.001

Table 26 shows that a Chi square table gives a value of 10.827 at the .001 level of significance and since the data in the study yielded a Chi square value of 23.56 we are able to reject the null hypothesis. The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when the identification of root zone cover material is the criteria for review.

Table 27 outlines the Chi square test for dead wood in a tree's crown.

The following null hypothesis was used to examine data collected on the occurrence of dead wood in a tree's crown:

$H_0$  : There is no significant difference between the assessment of the occurrence of dead wood in a tree's crown as rated by Volunteers and Certified Arborists (MCA/2).

Table 27 - Chi-square test results: Dead wood in crown

DF	Calculated Chi Square	Tabular Chi Square	Significance Level
1	14.696	10.827	0.001

Table 27 shows that a Chi square table gives a value of 10.827 at the .001 level of significance with 1 degree of freedom, and since the data in the study yielded a Chi square value of 14.696 we are able to reject the null hypothesis. The results suggest that there is a significant statistical difference between the frequency scores of the Volunteers and Certified Arborists (MCA/2) when the occurrence of dead wood in a tree's crown is the criteria for review.

Although the findings presented here show a statistical difference in the ratings of several inventory variables of street trees as rated by Volunteers and Certified Arborists (MCA/2), from a practical standpoint the data primarily falls within the predetermined 80% level, therefore it is determined to be accurate and significant.

Summarizing Data Collection by Volunteers and  
Certified Arborists (MCA/2 and MCA/10)

In this phase of the study, data from the first two portions of the study was summarized for comparison of the agreement levels obtained by the Volunteers and Certified Arborists (MCA/2) in Phase Two (pp. 58–60) with the threshold levels established in Phase One (pp. 56–58) by the two groups of Certified Arborists.

Table 28 shows a comparison of findings found in Phase Two data for Brookline and Springfield with the results of Phase One.

Table 28 - Summarized agreement levels

	Phase One Results		Phase Two Results	
	Cert. Arborists (MCA/2) / Cert. Arborists (MCA/10)	Brookline		Springfield
		Volunteers / Cert. Arborists (MCA/2)	Volunteers / Cert. Arborists (MCA/2)	Volunteers / Cert. Arborists (MCA/2)
Genus	100%	94%	97%	
Genus & Species	98%	80%	97%	
Condition	89%	83%	90%	
Management Need	86%	75%	63%	
Weak Crotch	80%	90%	93%	
Cavity	93%	92%	97%	
Root Zone Cover Material	98%	82%	100%	

The results show that, in most cases, the agreement levels found in Phase Two are acceptable when compared to the threshold limits established in Phase One of the study, and most are above the 80% level of significance that was established for the study. In Brookline the average level of agreement between Volunteers

and Certified Arborists (MCA/2) for all categories was 85.14%, and in Springfield the average for all categories was 91%. This compares with an average threshold level of agreement of 92% found between the two groups of Certified Arborists examined in Phase One of the study.

Overall, in Brookline, the agreement level (85.14%) is 6.86% below the threshold level (92%) established by the two groups of Certified Arborists. The highest discrepancy in agreement levels occurs in the identification of combined genus and species (-18%), identification of root zone cover material (-16%), and identification of weak crotches (+10%). In the remaining categories the levels of agreement were within 10% of the thresholds established in Phase One.

In Springfield, the overall agreement level (91%) is 1% below the threshold level (92%) achieved by the two groups of Certified Arborists, but well above the 80% significance level established for the study. The highest discrepancy in agreement levels occurs in the assessment of management needs (-23%), and identification of weak crotches (+13%). In all other categories the levels of agreement were within 4% of the thresholds established in Phase One.

Chapter 5 presents discussion of the findings presented here and provides additional conclusions and recommendations based on the results of the study. The implementation urban forest resource inventories utilizing properly trained community volunteers will be outlined and the benefits of using a community's residents will be discussed.

## CHAPTER 5

### DISCUSSION AND RECOMMENDATIONS

#### The Accuracy, Benefits and Costs of Utilizing Community Volunteers to Complete Urban Forest Resource Inventories

The results of this study indicate that, with adequate training and supervision by a Certified Arborist, community volunteers can conduct urban forest resource inventories within acceptable levels of accuracy. In addition to gathering useful and accurate data for use in urban forest management programs, other benefits were achieved. The primary goal of having community volunteers gather useful, accurate data on the type, location, and condition of street trees in Brookline and Springfield was realized. Secondly, indirect benefits, ranging from community empowerment to political advocacy were attained. Finally, the study shows that the cost of completing an inventory with community volunteers can be competitive with those undertaken by professional Arborists.

#### Data Collection

The development of effective strategies for the management of urban forests, including street tree populations, can be facilitated through the collection of data on the various components that make up the urban ecosystem. Street trees are an important segment of the urban environment and are one of the primary recipients of urban forest management initiatives in many communities. These management programs can be more successful if inventories are completed, in order to gain an accurate assessment of the condition of the trees that line a community's roadways.

The inventory data can be used to develop management strategies that address the specific size, condition, and type of street tree population. Although the gathering of data on street trees has traditionally been completed by professional Arborists, this study shows that the use of community volunteers is a realistic alternative, and that the data collected by these individuals compares favorably with data obtained by Certified Arborists.

Accuracy and Baseline Agreement Levels. Establishment of baseline levels of agreement, or accuracy, were completed and showed that Certified Arborists do not uniformly agree on the identification or assessment of a tree's specific variables. Although the Certified Arborists achieved an average agreement level among themselves of 92%, only the identification of a tree's genus was unanimous. Identification of weak crotches, assessment of condition and the determination of a tree's management needs were at levels <90%. Although none of the levels of agreement were <80%, there was some obvious disagreement between Certified Arborists in several areas. This indicates that even professionals are likely to disagree with each other when looking at the same tree, thereby adding a degree of subjectivity to the identification and assessment processes.

From a practical standpoint, since professionals cannot always agree on the variables that they are examining, it would be unreasonable to expect that trained volunteers would be without disagreement when examining a tree's variables. In this study, the agreement levels between Certified Arborists were used as the baseline, and the accuracy of trained volunteers was assessed by comparing the data they collected with data collected by Certified Arborists.

In most cases examined in this study, the data collected by trained community volunteers compares favorably with the results obtained by Certified Arborists, and falls within the 80% significance level established for the study, making the data

acceptable for inclusion in a street tree inventory database. The data that was collected by the volunteers is useful for development of a street tree inventory and can be considered valid because of the favorable agreement levels achieved by the volunteer teams.

The results indicate that in several instances the volunteers were more conservative in their assessment of the condition, the need for pruning, and the identification of dead wood in a tree's crown. The responses of the volunteers were often more critical than those of the Certified Arborists, resulting in disagreement between the two groups. Although these results show disagreement, the findings should not be completely discounted, since they do provide confirmation that the data collected by the volunteers presents a conservative or cautious approach on their part. Had the results shown that the volunteers were providing information that showed trees in better condition than was noted by the Certified Arborists, or did not contain dead wood in the crown when it actually existed, then the findings would be suspect and far less valid or useful.

The levels of disagreement that err on the side of caution, indicate a positive value to the data collected by the volunteers. The value of a cautious or conservative approach by the volunteers is that many trees would be noted as in need of attention and would be reviewed by a Certified Arborist, who could still make a final judgment on the condition, management need, or deadwood occurrence. This would ensure that most questionable trees would be reviewed, since the volunteers would have noted even marginal trees. Additionally, the volunteers flagged trees, for review by a Certified Arborist, that they had any question on. This step provided a mechanism to ensure that questionable trees

would be examined by a Certified Arborist before the data would be included in the inventory database.

Although statistical differences occur between the data collected by Volunteers and Certified Arborists (MCA/2), from a practical standpoint, the data is accurate and is useful for inclusion in a street tree inventory database. The data collected by the volunteers shows a >80% accuracy level in most instances. For practical purposes, the differences that occur can be guarded against through improvements in the training and education curriculum, focusing primarily on the assessment of a tree's management needs.

#### Benefits of Volunteer Initiatives

The utilization of community volunteers to conduct a street tree inventory provides additional benefits, beyond just useful data acquisition. Involvement of interested individuals into the process of urban forest management occurs, providing a useful perspective that otherwise might be missing. Empowerment of individuals is achieved by providing them with a sense of pride, accomplishment, and contribution. The volunteers feel that they are assisting in an important process and become part of the process itself. A constituency of active and concerned citizens is developed, providing a political force that can assist in advocating urban forest issues and increasing awareness on the part of appointed and elected officials. The training of volunteers enables the development of a more informed public and provides individuals with skills and increased knowledge of tree identification, urban forest management, and the urban ecosystem. Additionally, the work of a municipal forester or tree warden can be made more effective through the development of a cadre of educated and active community volunteers.

New Perspectives. Urban forest management efforts can be enhanced through the use of community volunteers by providing new perspectives that can

add to the overall quality of an urban forestry program in a community. In many instances, the management of street trees, public open space, and other components of the urban forest fails to address the needs of the community and stakeholders of these green components of urban infrastructure. By giving citizens an advisory role in the decision making process, program development and management strategies can benefit. The involvement of community volunteers can provide a new and fresh perspective to programs that are lacking in community outreach, citizen input, and social responsibility. New ideas may be introduced by volunteers that can assist in the decision process, and bring a more comprehensive approach to management decisions. Addressing the needs of the community is critical, and the volunteers are able to assist in the identification and prioritizing of the needs of the residents who are most impacted by these management decisions. Diverse perspectives may be provided by the volunteers and mirror the diversity of the population that makes up a community.

Empowerment and Involvement. A sense of pride, accomplishment, and contribution is evoked through involvement in a volunteer street tree inventory. A feeling of knowing that you are making a difference is achieved, adding to the positive value of the community effort, and providing a realization of empowerment. Self-pride, a feeling of achievement, and a sense of responsibility are achieved when individuals become involved in a volunteer effort. In this instance, knowing that the data that they collect will be used as a tool for more effective management of the street trees in their neighborhood, brings this sense of empowerment into tangible terms. Through the process of involvement, the community volunteer's efforts become more engaging than simply tree identification, condition assessment, and recommended maintenance. The volunteer becomes part of the process, providing useful information for use in an

inventory database, while at the same time becoming empowered to make a difference in their community. This sense of empowerment extends beyond the limits of urban forestry and becomes part of the social mosaic of a community.

By becoming involved, residents and volunteers can become an integral component of the process of urban forest management in their community. They can become one of the key players in the management process by providing a reliable and useful source of inventory personnel who can gather information on the size, type, location, condition, and quality of the urban forest in a municipality. Volunteers can also be trained to assist with other tasks that otherwise would have to be completed by in-house personnel or contracted to professional firms. This could include services such as planting, light pruning and trimming, identification of proposed planting locations, watering and fertilization, and acting as field inspectors within the neighborhood for the municipal forester, identifying potential problems.

Advocacy. Volunteers can also become part of the decision making process through their involvement and advocacy of 'green issues' and providing a political voice that addresses the needs of the urban forest and municipal forestry. A unified voice of involved citizenry provides an opportunity to make a stronger political presence felt, enabling the advocacy of increased programming, funding and green infrastructure initiatives. By acting in an advocacy or advisory role, citizens can initiate increased awareness on the part of elected and appointed officials, enabling more informed decisions to transpire. Through organization of the volunteers into a cohesive and unified force, individual efforts can be strengthened into a stronger voice that is likely to capture the attention of decision makers, and build a constituency beyond just the community volunteers.

Education and Skill Development. The training of community volunteers increases the overall knowledge base that a community draws upon to make

informed decisions. Not only does training of community volunteers increase the volunteer's personal skills and abilities, it provides an opportunity for these skills to be carried out into the community by the volunteers. By increasing the volunteers understanding and awareness of a community's urban forest and ecosystem, it provides tangible benefits to the individual's intellect, as well as provides an opportunity for others in the community to benefit by the increased skills of neighbors and friends.

Through the training curriculum that is provided to the volunteers and by the experience that is gained during the inventory process, volunteers gain confidence in their abilities and skills, providing an opportunity for increased community benefit. After completing the training curriculum and working out in the field for a number of hours, confidence and attitude increase, allowing the volunteer to more closely examine the purpose of their effort and place it in perspective with the entire urban forest ecosystem. This increased awareness and understanding allows for the volunteers to bring a more informed knowledge back into their community at many different levels, ranging from grass roots organization to formal educational settings. Transmittal of information about the urban forest can be brought to a wide range of individual beyond the original target volunteer group. During the inventory work in Brookline, one volunteer commented that, after participating in the training and inventory process, she would never walk down the street looking at trees in the same way again. She expressed her excitement of having gained new knowledge and skills that she would be able to make part of her everyday urban experience.

Political Empowerment. The work of a municipal forester or tree warden can be facilitated and made more effective through the development of a team of qualified volunteers, who can assist in many facets of urban forest management. Utilizing

their skills and knowledge of street trees and urban forests, the volunteers can act as the “eyes and ears” of the municipal forester, assisting in the timely identification of situations that may need attention or action. Identification of hazard conditions, disease and insect infestation, and other problems make the volunteer a useful asset that can assist the municipal forester in making strategic and operational management decisions. By providing the municipal forester with information that otherwise might be overlooked or not found in a timely manner, the volunteer furnishes valuable information that can assist management decisions.

The political empowerment of the volunteers enables the municipal forester to utilize their unified voice to enhance the standing of a community’s forestry program in the organization of municipal government. The political power of the volunteers can be used by the municipal forester to facilitate funding, legislative, and organizational decisions that are made that impact the urban forest. The political prowess of a municipal forester will determine the effectiveness that can be provided by a unified group of community volunteers, but the potential for positive initiatives is enhanced through these volunteer efforts.

### Costs

The cost of surveying each tree in Brookline was \$1.02 and was .80¢ per tree in Springfield. These costs per tree compare very favorably with services that would be provided by a professional arboriculture firm. Post-inventory evaluation of the projects have identified several areas that could be streamlined in order to reduce the amount of overhead and support costs, thereby enabling future inventories to be performed at lower costs. Production costs, including printing, advertising, and recruitment can be reduced through the soliciting of donated and in-kind services from local businesses and organizations. This reduction would make

the use of community volunteers for conducting a street tree inventory even more attractive from a financial point of view.

Many of the costs associated with completing an urban forest resource inventory remain constant, no matter who is used to collect the data. These costs are dependent upon the type of inventory undertaken, and vary greatly between the various methods. The development of a street tree inventory based on utilization of a Geographic Information System, adds to the cost of a simple database system, but these costs would be incurred no matter who collects the data. Simple, non-GIS inventory databases also have fixed costs that are present, regardless of data collection personnel.

The use of community volunteers does not reduce the amount of fixed costs that any inventory method may incur, but their use can reduce the costs associated with actually collecting data in the field. The volunteers are unpaid, therefore reducing the overall costs of field personnel used to complete an inventory. The volunteers do not require an hourly wage or salary, nor do they require additional expenditure of funds for taxes, unemployment, or workmen's compensation insurance. Although recruitment, training, supervisory and support staffing is required, the costs associated with these roles is offset by the value of the contributed services of the volunteers.

The subsequent benefits of utilizing community volunteers, as discussed above, adds greatly to the value of the volunteer effort and far outweighs any costs associated with training, supervisory, or support personnel. The costs associated with completing a volunteer effort can parallel the cost of contracting services out to a professional arboriculture firm, but the benefits of utilizing the resident's of a community provide benefits that make their use very desirable and offer an alternative to traditional survey methods.

It is recommended that specific examination of the associated benefits of utilizing community volunteers be completed in a subsequent study, and that cost/benefit analyses be performed, in order to fully quantify the benefits that are provided by volunteer initiatives.

### Recruitment, Training and Curriculum Development

#### Background

The results of this study indicate that the training provided to the community volunteers in Brookline and Springfield was adequate to obtain acceptable levels of accuracy on the part of the volunteers. Volunteers were recruited from the community using a variety of methods including the media, mailings to target environmental organizations, and presentation in public forums. The goal of the training curriculum was to introduce critical aspects of an urban forest resource inventory to the volunteers and to develop skills in tree identification, maintenance requirements, hazard determination, and assessing the overall condition of a tree. In each community, the training program was designed to specifically address the make-up of the street tree population found along its roadways. The training curriculum was also intended to provide consistency in data acquisition by the volunteers, so that the information collected would utilize the same criteria in the assessment process.

#### Recruitment

The recruitment of community volunteers utilized various methods in order to enlist broad base support from the resident's of the two communities. In an effort to recruit a wide range of people, from diverse backgrounds, involved in the process, information was disseminated using various public relations techniques

including television and radio media, newspapers, mailings, networking, and door to door canvassing of the community with informational and recruitment literature.

It is recommended that recruitment efforts utilize this broad base approach so that a diverse volunteer force can be established. Involvement by neighborhood residents is useful in order to facilitate the data acquisition, and to develop grass root support for the effort. Any method that provides positive exposure of the program and offers the opportunity for volunteer recruitment should be utilized.

### Curriculum Goals and Composition

The training materials gave a comprehensive introduction to street tree management and provided the volunteers with an overview of street tree inventories and their importance in developing sound urban forest ecosystem management strategies. Topics provided a broad overview of basic horticultural and cultural methodology necessary to identify and assess street trees, and the results of this study indicate that this consistent and comprehensive approach was successful. The training curriculum was designed specifically for each community, focusing on the specific genus and species, roadway type, and planting regiment used in Brookline and Springfield. This custom design is recommended for each community in which a volunteer effort would be undertaken.

The findings indicate that strengthening of the training program in some areas is advised, and most likely would lead to improved data acquisition. Additional emphasis is necessary in assessing the management needs of street trees and in determining the specific species of a tree. Focus on species with similar characteristics present identification challenges and additional instruction is merited. Assessment of management needs, including pruning and removal issues, should be discussed in further detail and more examples provided in order to reduce inconsistent findings. The training curriculum should include classroom and field

instruction in order to acquaint volunteers, firsthand, with trees growing along the streetscape and the exceptional cases that are likely to occur.

### Custom Programming

In each community the training program and curriculum should be designed to accommodate the specific situations found in that community. Manuals, lectures, and field visits should focus on the make-up of the urban forest in each community, and develop skills that will enable participants to gather the most accurate data possible for that specific community. Instruction should present a broad overview and introduction to urban ecosystems, urban forestry, and arboriculture in order to provide volunteers with an informed perspective of green infrastructure and to place the role of an inventory in effective urban forest management initiatives.

The training manuals and materials should reflect the vegetation found in the specific community, focusing on the forest composition that is likely to be found. Sampling or pre-screening of the street tree population will enable development of materials that are geared to the specific trees found in the community. It is important to provide skills to the volunteers that will assist them in providing accurate and valid data on the specific type of vegetation found in their municipality's urban forest. For the purposes of the inventory process, it is not advantageous to provide instruction on additional genus and species that do not occur in a particular community. This can lead to the acquisition of data that is not accurate, since species similar to what occurs in a community, but are not actually present, are introduced to the volunteers. It would be useful to introduce the volunteers to the fact that there are other kinds of trees occurring in the urban landscape, but for the purposes of conducting a volunteer street tree inventory, a plant palette limited to only the trees found along a community's roadways is advisable.

### Data Acquisition Consistency

The training curriculum was intended to provide instruction to increase consistency in data acquisition by the volunteers, so that the information collected would be based on uniform assessment criteria. Condition assessment, management recommendations, and species identification were areas in which the training was aimed at providing standard criteria was used in the inventory process. Classroom and field instruction provided examples of a variety of situations that were likely to be found during the inventory, and demonstrated the processes used to identify, rate, or assess the particular circumstances that would occur. This practical instruction outlined procedures that provided improved data acquisition consistency.

In both Brookline and Springfield, support personnel in the form of undergraduate arboriculture students and Certified Arborists, worked with the volunteer teams at the start of the inventory for one to two hours. This provided hands on instruction that was intended to ensure a consistent approach to the process, by the volunteers teams. The support personnel were able to provide instruction as well as supervision, so as to improve the consistency of data acquisition procedures. The use of supervisory personnel to furnish some field instruction, is important in order to provide the volunteers with procedural instruction so that each team will utilize the same approach to identification and assessment of the street trees.

### Value of the Findings

The findings presented here should be used to provide the basis for the increased use of community volunteers as participants in urban forest management programs. The results of this study indicate that the data on street trees collected

by volunteers is valid and accurate, and can be used as a strategic component in compiling a database for use in developing more effective urban forest management strategies. The use of volunteer initiatives should be expanded in communities in order to provide wide range of benefits to the community, the volunteers, and the municipal urban forestry program in municipalities that utilize this type of volunteer strategy. This study provides the basis for this needed expansion.

Volunteer initiatives can provide an opportunity for increased economic, social, and environmental benefits to a community, and the use of volunteers presents an opportunity for empowerment of a diverse aggregation of residents. Although volunteers cannot provide a substitution for sound municipal urban forest management, under the direction of a Certified Arborist, the use of volunteer initiatives should be encouraged, based on the findings presented in this study, and should become a component of every municipal urban forestry program, no matter the size of the municipality. Involvement of a community's residents provides an opportunity for enhancement of programming, compiles valuable and accurate information in an economically competitive manner, and increases the political capacity of a municipality's urban forestry program. The results of this study provide a catalyst for change in urban forest management practice, addressing the fiscal, ecological, and social needs of a community's management programs, and provides vision for increased community involvement, empowerment, and citizen participation in community forestry.

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## APPENDIX B

### ORGANIZATIONAL ABSTRACT OF THE VOLUNTEER BASED INVENTORY

#### Background

As stated in Chapter 3, this study presents only a small portion of the research that was completed in the development of volunteer based urban forest resource inventories in Brookline and Springfield. The following pages outline the organizational model that was developed for the volunteer based initiatives in Springfield and Brookline.

The use of community volunteers to complete an urban forest resource inventory requires a large amount of organizational effort in order to ensure that the initiative succeed. Although each step can be treated independently, it is important to consider the entire process, so that the contextual components effectively relate to each other and address the needs of total project.

Figure 5 outlines the process that was completed in Brookline and Springfield in order to carry out the volunteer initiatives. A series of steps was completed in order for the inventory programs to be successful.

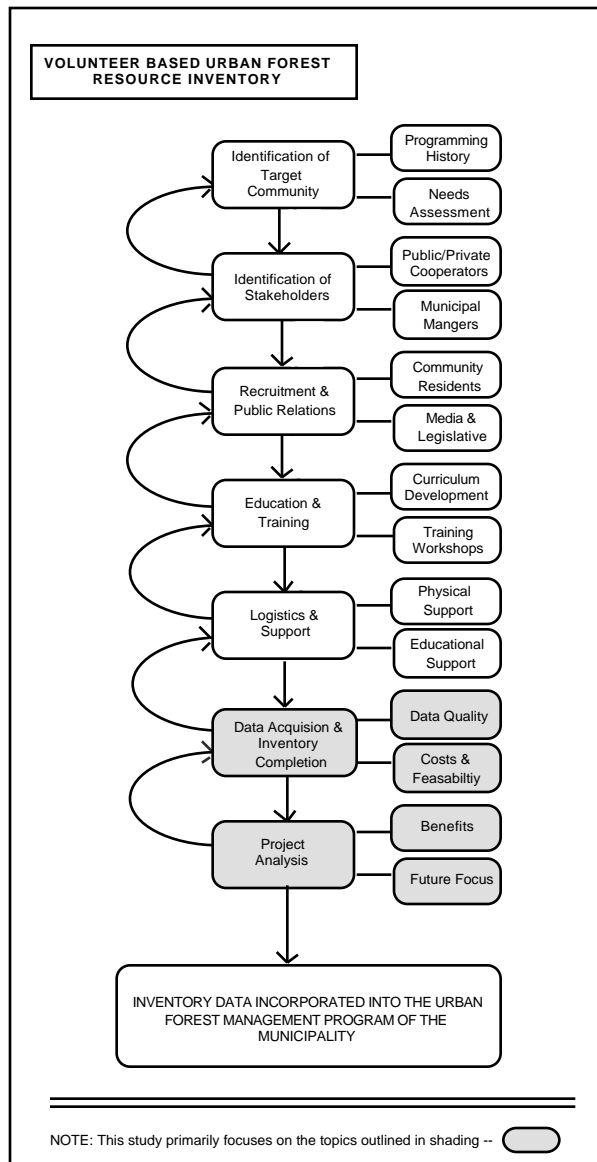


Figure 5 - Organizational layout of volunteer based urban forest resource inventory

Note the feedback loop that enables review of each step contained in the model, so as to ensure the incorporation of the most effective methods in each phase of the process. Each of steps is outlined in the following organizational abstract of the research model.

### Identification of Target Community

Assessment of a community's needs and a review of its urban forestry program should be considered when determining whether to conduct an urban forest resource inventory in a community. Examination of existing programs, past initiatives, and organization of its urban forestry program should be completed, as well as a review of a city or town's community involvement volunteer efforts should be considered. The use of a volunteer inventory program requires that there be a need for the urban forest data as well a reserve of interested residents. If each of these criteria are met then further review of the municipality's urban forestry program should be undertaken and a final determination made as to whether or not this type of program makes sense economically, socially, and logistically.

### Identification of Stakeholders

The identification of the key stakeholders, or interested participants and supporters, is critical in order for a volunteer based inventory program to be successful. Private/Public cooperation, cooperation between municipal agencies and departments, as well as support from the media, community organizations, and other interested individuals is important for the program to be successful. Support may also come from educational institutions, environmental organizations, neighborhood councils, and other nearby communities.

An organized and cooperative effort is critical in order for the program to gain momentum and become a reality. The identification of the key stakeholders at the outset is important in order to develop continuity in the program and ensure a sustained effort. Logistical support, financial contributions, media exposure, and in-

kind services may be provided by the key stakeholders and their representative organizations.

### Recruitment and Public Relations

Recruitment of the community volunteers who will participate in the inventory program is one of the most critical components of the organizational model. There are many methods that can be used to recruit volunteers, many of which may come from the organizations that have previously been identified as stakeholders. For example, the Brookline Greenspace Alliance was a key cooperator in the Brookline effort and many of the volunteers were members of that organization.

Publicity about the volunteer based effort can be obtained from local medial outlets including radio, television, and newspapers, as well as through neighborhood newsletters, corporate correspondence, and other direct canvassing of a community's neighborhoods. Involvement by a few key residents can assist in getting the word out to other potential contributors and participants.

It is also beneficial to gain legislative support for the volunteer effort from municipal elected and appointed officials. Councilors, Mayors, Town Managers, Committee Chairs, and other such government officials can be very beneficial in the recruitment and public relations effort.

### Education and Training

Training of the volunteers is, perhaps, the most important component of the organizational process. The development of a training curriculum appropriate for the skills of the volunteers is important in order for the education process to be

effective. Additionally, the training must be comprehensive in order to provide participants with a basic understanding of urban forest issues, municipal forestry practice, identification of hazard conditions, and knowledge of the type, condition and size of trees likely to be found in their survey area.

The training program should include written reference materials that the volunteers can use in the training session as well as when performing the inventory. The written materials should be placed in a loose leaf binder so that the participants can add their own supplemental materials and notes.

Training must be completed by experienced educators with a good background in municipal forestry. It is preferred that the instructors be Massachusetts Certified Arborists and that they have teaching experience. The training should consist of classroom and field instruction that teaches the fundamentals of the training curriculum and provides an opportunity for in the field practice and review.

The training sessions can be arranged in various ways, but the number of contact hours between instructors and the students should range from 6-8 hours, in order to provide an adequate understanding of the training topics. Additionally, the volunteers should be expected to spend 1-2 hours on their own in review and field examination. As an example, in Brookline, instructors from the University of Massachusetts Amherst and from the Arnold Arboretum of Harvard University provided the training. It consisted of 4 hours classroom and 4 hours field instruction, and a 2 hour optional field test of the inventory methodology.

### Logistics and Support

In order for the inventory to be completed efficiently it is important to provide logistical support to the volunteers at every point in the process. Field support personnel should be assigned to travel to the inventory participants in the event of a question or problem. Radio communication between the volunteer teams and a base station is recommended. Additionally, it is useful for the instructors to visit with each team, at some point during the inventory, in order to offer suggestions for streamlining their field methodology. This also provides reassurance to the volunteers and increases moral.

If it is inclement weather, it makes sense to postpone the inventory to a more feasible day. In Brookline, rain forced the postponement of one day of the inventory. Volunteers should be instructed to dress for the weather conditions and to wear comfortable shoes. They also should bring water, snacks, and lunch in order to keep them in good spirits.

### Data Acquisition and Inventory Completion

The specific information that is to be collected during an inventory should be considered in order to make the most effective use of the volunteer initiative. It does not make sense to gather information that is superfluous and will not be used in the development of a more effective urban forestry program in a community.

Additionally, the accuracy of the volunteer data must be reviewed. The majority of this paper has dealt with this topic, and the specific methods that can be utilized have been outlined. In the event of inaccurate data collection, it a review must be made in order to prevent future errors and to correct the errant information.

The costs associated with the volunteer effort must also be analyzed in order to make a determination as to how to reduce the expense in future efforts. It is

important to keep costs to an optimal level so as to ensure data accuracy while not wasting funds on the collection of unneeded data.

### Project Analysis

A post inventory review of the volunteer based inventory program should be made after completion of the project, so as to determine its effectiveness and to determine areas that need revision or change. This review will enable future inventories to more effective, more enjoyable for the volunteers, and provide the manager with useful and accurate information for inclusion into the urban forest management program in a community.

A survey or questionnaire should be sent to all volunteer participants in order to determine their satisfaction with the process and to obtain possible commitment for future initiatives. The results of the questionnaire should be carefully reviewed in order to ensure the incorporation of appropriate suggestions in future programs. Also the future focus of volunteer initiatives can be established based on the response of the participants.

Additionally, feedback from the instructors, support personnel and all key contributors and supporters should be obtained in order to keep communication avenues open and to provide a sense of accomplishment and closure to the project. Thank you letters to everyone involved should be made part of the process, and it is appropriate to have a final gathering or reception for all of the volunteers in order to provide them with a personal thank you. They can also be provided with certificates of appreciation as well as be presented with summary findings of the data that they collected.

## Summary of Abstract

This abstract of the organizational model that was used in this study outlines many of the important points that should be reviewed when a volunteer initiative is being considered in a community. The projects undertaken in Brookline and Springfield contained many aspects not discussed in the abstract, and present the opportunity for continued review and revision of the inventory process. As more communities become involved in volunteer based urban forest resource inventories this model will be redefined in order to incorporate the most effective and useful methods into the process. Continued research in this area should be encouraged, expanding on the scope of this study.