STRATUM Case Study Evaluation in Minneapolis, Minnesota

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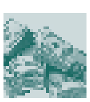

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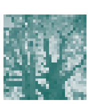

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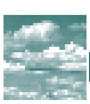

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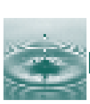

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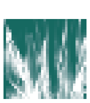

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Volunteers in Minneapolis take a break from collecting tree inventory data

Executive Summary

The USDA Forest Service has developed STRATUM (Street Tree Resource Analysis Tools for Urban Forest Managers) as part of their i-Tree software suite to be released in 2006. i-Tree provides communities of all sizes with affordable and easy-to-implement inventory, analysis, and forecasting tools to quantify ecosystem services produced by city trees and develop management plans. The goal of this study was to improve STRATUM by applying lessons learned from a pilot city demonstration. During the summer of 2004, the Tree Trust coordinated and trained 89 volunteers to inventory street trees in Minneapolis, Minnesota. We evaluated the recruitment, training, and organization of volunteers; usability of maps and PDAs (Personal Digital Assistants), and the accuracy of data collected on 4,577 trees from a random sample of 405 street segments.

Four surveys and a series of interviews captured information from the volunteers before, during, and after the inventory, as well as from their coordinators and trainers. Our analysis of the data resulted in recommendations that effect most aspects of volunteer training and management. In addition, we suggested ways to improve the PDA software and streamline the data collection process.

We compared the accuracy of 431 trees inventoried by volunteers and professionals and found that volunteers correctly rated leaf condition (81%), tree by species (80%), and tree size (diameter at breast height) (77%). Volunteers and professionals agreed less frequently on the condition of each tree's wood (69%), tree root-sidewalk conflicts (66%), recommended maintenance (49%) and priority task (9%). We concluded that the trained volunteers were a valuable resource for acquiring information on tree numbers, species, and sizes. However, without improved training, their assessments of tree maintenance needs were less reliable. Key suggestions to improve volunteer training, management and efficiency included:

- Estimate the amount time required to conduct the inventory (average of 6 minutes per tree in Minneapolis), then recruit a sufficient number of volunteers, remembering that asking for more than 8-12 hours may reduce participation. Clearly communicate your time expectations to the volunteers.
- Train volunteers on use of the PDA, maps, and tree assessment in one 6-hour day. Conduct a separate 3-4 hour session on tree iden-

tification. Have a “dress rehearsal” during this session. Use the maps, PDAs and data collection kits to locate and survey all trees in one street segment.

- Focus tree identification on key distinguishing features of commonly mistaken trees among the 10-15 most abundant species.
- Develop a slide library that shows trees with different maintenance needs and condition ratings. Use this during training and include it in the training manual.
- Demonstrate how to troubleshoot PDAs during training, and cover their maintenance and downloading.
- Determine before training via questionnaire which volunteers want to survey trees in their neighborhoods, allow them to self-select teammates, and form teams early during the training session so they can network.
- Cover streetside safety tips during training and in the manual.
- Conduct a windshield survey of each street segment to verify its existence, extent, and clear designation on the map. Have replacement street segments ready for each zone.
- Develop a formal troubleshooting process before deploying volunteers so that people in the field know who can answer specific types of questions.
- Have a “refresher session” soon after data collection begins to review solutions to the most common questions and problems.

Our findings have already resulted in changes to STRATUM that will increase accuracy and reduce volunteer time. Changes include: (1) eliminating time-consuming data fields, 2) clarifying language for the remaining data fields, (3) adding time-saving hold buttons between entries on the PDAs, and (4) improving the training manual by including safety tips and clarifying data collection protocols.

This project involved multiple partners including USDA Forest Service Research and State & Private Forestry, Davey Resource Group, Tree Trust, University of California Davis, University of Minnesota, Minneapolis Parks & Recreation Board, City of Minneapolis, and the Minnesota Department of Natural Resources.

Chapter 1: Introduction

Communities are increasingly faced with declining budgets, and urban forest managers are seeking new approaches to developing sound urban forest management plans. A good management plan is contingent upon measurable objectives. A city cannot effectively manage what it has not measured. This report examines several aspects of this issue: the recruitment, organization and training of volunteers to collect a tree inventory, and the accuracy of data collected by the volunteers. By using trained volunteers, tree inventories can be more affordable while engaging residents in their community forest.

Many city residents cherish their trees and feel motivated to help maintain them for future generations. Many residents connect with the feeling of psychological well being they receive from trees, but are less aware of the functional benefits trees provide (Bassett 1978). One way residents can help renew their connection with trees is to volunteer to inventory their city trees.

This study evaluates the conduct of a sample street tree inventory by 89 trained volunteers during the summer of 2004 in Minneapolis, MN. After training sessions, inventory data were collected using a new software application called i-Tree by entering data into a PDA (personal digital assistant). Volunteers provided ideas for improving the inventory process and valuable feedback on the training they received, enhancing effectiveness of the PDA software. Additionally, data collected by the volunteers were compared to a 10% sub-set of data collected by professionals to measure accuracy.

Minneapolis residents cherish their trees and enjoy their shade biking and inline skating

This study will also produce recommendations that will improve a new software tool currently in development called STRATUM. STRATUM (Street Tree Resource Analysis Tool for Urban Forest Managers) is one component of the i-Tree software suite (see www.itreetools.org for more information). i-Tree integrates STRATUM with two other urban forest software tools, UFORE (Urban Forest Effects model) and MCTI (Mobile Community Tree Inventory). The goal of i-Tree is to provide easy-to-implement tools free of charge to communities of all sizes to collect and analyze data on their community forests in order to promote and strengthen management efforts (McPherson 2005).

This study is not the first of its kind to use trained volunteers to collect tree inventory data. A similar study was conducted in 1997 for the MCTI application. The level of accuracy of data collected by volunteers was compared to data from three groups of certified arborists. The results were favorable: volunteers could collect valid data at an accuracy level of 80% or better compared to certified arborists (Bloniarz 1998). This important finding was the impetus for numerous volunteer inventory projects that followed.

This study differs from the MCTI study in several ways: software, training structure, tools for acquiring volunteer feedback, and the comprehensiveness of the evaluation. The Minneapolis Pilot focuses on collecting data for the STRATUM (Street Tree Resource Analysis Tools for Urban Forest Managers) application;

STRATUM differs from MCTI in that different fields of information are collected. In this study, STRATUM used a sampling procedure, whereas MCTI has used full inventories. Finally, MCTI has been applied in smaller cities, where the recruiting, training, and logistical challenges were substantially less than they were in Minneapolis, a city containing approximately 200,000 street trees.

This study seeks to answer two key questions:

> *How accurate are data collected by trained volunteers?*
>
> *What did we learn about how to best recruit and train volunteers, manage data collection and processing, and improve the overall process?*

This study will focus on analyzing three specific objectives: (1) the methods and results of volunteer recruitment, organization and training; (2) the usability of maps and personal digital assistants (PDAs); and (3) the accuracy of volunteer data collection. These objectives guide the methodology and format of the study design as well as the discussion of results.

Study Design

This pilot study takes a multifaceted approach to assess volunteer involvement in the i-Tree study. Two groups of volunteers, technical and community volunteers, were administered four surveys to acquire feedback on their initial involvement, training, PDA use and data collection. Volunteers were termed “technical volunteers” if they attended the training session and “community volunteers” if they were not able to attend the training and joined a group or team of technical volunteers for the duration of data collection. Also, interviews were conducted with project coordinators and trainers to evaluate their involvement in the training and data collection. A 10% sub-set of field data collected by professionals was compared with data collected by volunteers to evaluate accuracy.

The City of Minneapolis, Minnesota was chosen for this study because a citywide street tree inventory was underway. The Minneapolis Parks and Recreation Department had cataloged approximately 25% of their estimated 200,000 trees *(Fig. 1).* This partial inventory provided the base data for a reference city analysis for the STRATUM project.

A second reason for selecting Minneapolis as the pilot city was the presence of the Tree Trust. The Tree Trust is one of the country’s premier nonprofit tree groups, with a 30-year history of leading local urban forestry efforts. Because of its experience and expertise, the Tree Trust was well positioned to organize a large group of volunteers to conduct a sample street tree inventory.

Figure 1 City of Minneapolis Parks and Recreation tree inventory completion map

i-Tree Management Teams

Four teams were identified to manage and implement the i-Tree pilot study. The Project Management Team (PMT) oversaw the volunteer component of the pilot study at large. This team consisted of Greg McPherson (USDA Forest Service, Center for Urban Forest Research), Dave Bloniarz (USDA Forest Service, Northeast Research Station), Jill Johnson (USDA Forest Service, State and Private Forestry), Janette Monear (Tree Trust) and Gail Nozal (Tree Trust). The Training Team (TT) consisted of those who prepared the training materials and directly trained the volunteers on August 14, 2004. They were Dave Bloniarz, Jill Johnson, Gail Nozal, Kirk Brown (Tree Trust), Gary Johnson (University of Minnesota), Dave Hansen (University of Minnesota), and Don Mueller (Minnesota Department

Figure 2 Neighborhood-scale map showing street segments where trees would be inventoried

of Natural Resources). The Volunteer Coordination Team (VCT) was composed of those involved in specific components of volunteer recruitment, organization and data collection supervision: Gail Nozal and Rebekah Van Wieren (Tree Trust). Finally, the Software Technology Team, involved in the development and application of the integrated software suite, i-Tree, included Greg Ina (Davey Resource Group), Dave Bloniarz, Dave Nowak (USDA Forest Service, Northeast Research Station) and Scott Maco (Davey Resource Group).

Timeline

In March and April of 2004, the Tree Trust was contacted to facilitate the recruitment and organization of volunteers and coordination of the volunteer training. Between April and July, multiple conference calls and telephone interviews were conducted between the Tree Trust representatives, i-Tree collaborators, and the software programmer to coordinate the pilot city study implementation.

Throughout June and July 2004, the Tree Trust staff recruited volunteers and began to organize materials for training and implementing the inventory. They contracted with GIS developer with Interactive Graphics to design the 20 neighborhood-scale maps (*Fig. 2*) showing where street segments were located for sampling. They organized speakers, each with a unique specialization in one component of the training. Throughout this time period, the four survey instruments were developed and pretested. Statistical tests were conducted to verify that the samples were of an adequate size. Protocols for tree sampling and implementing the questionnaires were developed.

On July 22, 2004, an open house was organized for potential volunteers by the Tree Trust. Twenty of the 21 attendees participated in the training and subsequently, in data collection. Final programming changes were made to the PDAs up to the day prior to the training.

The training was conducted on August 13, 2004. Seven trainers spent a full day with 57 volunteers covering material on tree identification, assessing tree size, health, and maintenance needs, and use of the PDAs.

Tree data collection began on August 18, 2004, and was nearly completed on September 13, 2004. Fifty volunteers were organized into 20 teams to collect STRATUM-specific data from street segments throughout Minneapolis. Seven volunteers collected tree data in the Southeast Como neighborhood for the MCTI application. Volunteer teams began collecting data from neighborhoods of their choosing. Several teams did not finish their collection by the September 13 deadline. Some teams had scheduling conflicts or began late. In one case, members of a team that finished early completed the street segments for another team that was not able to finish.

All the data were downloaded to computers and transferred to Microsoft Access for quality assurance and quality control (QA/QC). Data collection and processing were officially completed by the end of October 2004. The Tree Trust held an i-Tree Fall Harvest Celebration and Volunteer Recognition ceremony for all the volunteers and collaborators on October 23, 2004. The volunteers were estimated to contribute over 2,400 hours to this project.

Tree inventories are the backbone of a city's urban forest management operations.

Chapter 2: Literature Review

Much has been written and researched about volunteer participation in urban forest projects. The literature can be divided into six categories: tree inventories, tree inventory software, tree inventory data collection, tree planting and monitoring, volunteer motivations, and effective volunteer management.

Tree Inventories

An overview of tree inventories sets the stage for discussing volunteer involvement in tree inventory data collection. A tree inventory is a tool for collecting and maintaining information about the urban forest resource. Inventories can also assist in allocating limited funds more objectively (Kielbaso et al. 1988). Most modern inventories are collected and stored using computer-based applications. Capabilities of various applications on the market vary considerably, but the primary functions are the same. Planting, maintenance and tree removal information are collected and maintained, generating an overview of species composition and structure. This inventory information can then be used to inform management decisions, prioritize crew and pruning schedules, and forecast budgets.

Tree inventories are the backbone of a city's urban forest management operations. Bassett (1978) stated, "Inventories are essential to provide a current record of resources being managed; to plan, schedule, and monitor maintenance tasks; and to assist in making management decisions, particularly when developing budgets."

Without a tree inventory, a city often operates on a service-request or emergency basis, caring for only the trees for which removal has been requested or that have been diagnosed as hazard trees (Tschantz and Sacamano 1994). To transition from reactive work to planned work (e.g. programmed tree planting, maintenance and removal), it is necessary to have a detailed inventory of the urban forest (Thompson and Ahern 2000). Miller (1997) discusses four primary factors in determining the need and appropriateness of an inventory system for a city: size of the community, amount of tree work to be processed, work processing, budget and staffing (Miller 1997; Matheny and Clark 2004).

The importance of having an inventory has been widely recognized, "A tree inventory is one of the primary components of a systematic and structured management program" (Ottman and Kielbaso 1976 quoted in Olig and Miller 1998). Obtaining a full inventory is often a daunting and expensive task. Full inventories are quickly outdated if they are not regularly updated. Updating requires a commitment of substantial resources to train staff and to maintain the database continuously. Many cities have conducted full inventories thinking that they will become day-to-day management systems, only to abandon the idea once they realize the level of effort involved.

For some cities, a sample inventory is an economical alternative to a full inventory. A sample inventory may be defined as a randomly selected proportion of trees from a total population used to determine the structure and composition of the whole population. "As a means of data reduction, sampling by definition provides estimated summaries and means of parameters measured" (Miller 1997). Miller (1997) indicated the gradual method of this process: "This system should be of a progressive nature, designed to provide inexpensive preliminary information to identify management priorities, including how much tree information will be needed to manage the tree population." Although procuring a full inventory is the goal toward which most cities aspire, a sample inventory can provide basic information needed to develop a management plan.

In 1989, only 5 % of U.S. cities had effective tree management programs with updated tree inventories (Andresen 1989). In a 1997 statewide survey of urban forest managers throughout California, 40% of respondents had tree inventories (Thompson and Ahern 2000). A report conducted by the New Jersey Forestry Service found: "An alarming 75 percent of our street trees are in need of maintenance … and are under extreme stress and are threatened" (New Jersey Forest Service 1995). Since benefits of the urban forest have begun to be quantified and publicly endorsed, there is more need now than ever to realize these benefits through modernized urban forest management practices.

Surveys by Bernhard and Swiecki (1992) found that resource limitations are the fundamental problem faced by urban and community forestry programs charged with maintenance and enhancement of urban forests (quoted in Thompson 2000). As the bulk of tree inventory costs are for data collection, rather than software, volunteer-driven inventories are an appealing option.

A recent study in Davis, California, demonstrated how a resource-limited city without a tree inventory could quantify the structure, benefits and costs of its street tree population. This study reported that nearly 24,000 street trees provided $1.2 million in net annual environmental and property value benefits, with a benefit-cost ratio of 3.8:1 (Maco and McPherson 2003). The Davis study used a statistically based sampling method (Jaenson et al. 1992). Whereas previous "sample" inventories had depended on large sample sets (e.g., 50% of trees or every other tree within a particular region), Jaenson et al. found a much smaller number of trees would serve (Jaenson et al. 1992, Miller 1997). His technique involved a sampling method to estimate the species composition of an urban street tree population by collecting just 2,000 to 2,300 trees (Jaenson et al. 1992). When Jaenson's technique was applied to the four cities in his study, he found the sample-based estimates of tree numbers were accurate to within 10% of numbers from the complete street tree surveys.

Maco and McPherson (2003) combined Jaenson's sampling method with tree benefit data to quantify the structure, function, and value of Davis's urban forest resource. The Davis study was the impetus for the development of STRATUM, which provides an easy-to-use, computer-based program that allows any community to conduct and analyze a street tree inventory (for more information see www.itreetools.org). Two years and many improvements later, STRATUM joined the MCTI and UFORE applications to create the i-Tree suite.

Tree Inventory Software

Olig and Miller (1998) analyzed 12 inventory software applications. In 2004, four of these had been discontinued, but six new programs had been developed, STRATUM and MCTI among them (Matheny and Clark 2004). Eight inventory applications have been in use for over ten years. Olig and Miller tested the applications by collecting data on a minimum of 400 trees in Steven's Point, Wisconsin. They used the same collection methods for each of the software applications. Because they were tested collection methods, they did not conduct a sample inventory, nor did they discuss capabilities of the software to process sample inventories. They did note that six of the 12 applications were GIS compatible in 1998, the other six were not. In the 2004 analysis, most applications were GIS compatible.

Each tree inventory software product has its good and bad qualities. Some are regionally specific (e.g. Midwestern, Southern, or eastern), and some are less expensive than others. Most tout their "ease of use" as a primary feature. However, all programs require a certain amount of data to analyze the tree resource. Common data fields outlined by Olig and Miller (1998) include date, street, address, tree site number, tree location (front or side), species, DBH (diameter at breast height), tree height, condition, location, overhead utilities (presence/absence), crown diameter, maintenance suggestions and comments. Both STRATUM and MCTI contained most or all of these fields.

Olig and Miller (1998) discuss the importance of carefully selecting a tree inventory software package that is appropriate to your management goals and your computer's ability to run the programs you need: "Your software determines what you need for hardware." They also mention consequences of not making the proper considerations before purchasing an inventory software program. These include over-expenditure and excessive functionality, a program that will not work with your operating system, or a program that will not meet your management needs.

Involving Volunteers in Tree Inventory Data Collection

Volunteers offer a tremendous potential for cost savings when a city is faced with inventorying thousands or even tens of thousands of municipal trees. Yet there is still the question of their ability to collect reliable data. Since taxpayer dollars are resting on the results of their decisions, it is reasonable to question the quality of their estimates. What is the risk to the city if the margin of error is unacceptably high? Should there be concern about liability if their errors affect management decisions, such as not specifying removal for a tree that is likely to fail?

Some urban forest managers believe volunteers have a place in urban forestry projects such as tree planting or collecting non-essential data. However, they feel volunteers should not collect tree inventory data for management and relocation purposes (such as when it is necessary to find the tree again based on description, map notation or GPS [Global Positioning System]) (North Carolina Division of Forest Research 2005). Additionally, Lindhult and Ryan (1988) believe, "The use of amateurs for an inventory could prove to be very costly in the case of a liability claim." They believe only professionally trained persons who have a background in arboriculture should be utilized in order to produce a more dependable inventory (Lindhult and Ryan 1988).

Using volunteers to collect tree data can be a cost effective method for a city to build an inventory

Three important studies conducted by David Bloniarz (1996) demonstrate volunteers are as capable as certified arborists of collecting tree inventory data. He conducted two neighborhood-scale studies, which culminated in a PhD dissertation testing the cost-effectiveness of using volunteers and the degree to which volunteers could collect inventory data and use the MCTI application. In case studies in Brookline and Springfield, Massachusetts, he found: "[1] community volunteers can conduct urban forest resource inventories with acceptable levels of accuracy, [2] indirect benefits, ranging from community empowerment to political advocacy were attained, and [3] the cost of completing an inventory with community volunteers can be competitive with inventories undertaken by professional arborists...their use can reduce the costs associated with actually collecting data in the field" (Bloniarz 1996).

Prior to Bloniarz's study, many city foresters were skeptical about using volunteers to collect data upon which their management decisions will be based. Since its publication, there has been much interest from mid-Atlantic, and more recently, Midwestern communities in using volunteers to collect tree inventories. Bloniarz created a training manual that more than twenty cities and non-profit organizations have used to train volunteers (Bloniarz 2005). These cities include New York; Boston; Brattleboro, Massachusetts; Springfield, Stanford and New Haven, Connecticut; and Keene, New Hampshire.

Other authors assert "participation by trained volunteers in urban forest inventory and monitoring can provide benefits beyond extending the ability of forest agencies…and data collected by amateur scientists can be every bit as accurate as data collected by professionals" (Tretheway et al. 1999). Directors of both the Norwalk Tree Alliance in Norwalk, Connecticut, and Environment Hamilton near Toronto, Canada, felt that tree inventory data collected by their volunteer teams had "very consistent results" when spot-checked for accuracy. David Tracy, President of Norwalk, CT Tree Alliance, responded to an email question on volunteer accuracy by stating, "They [the professionals] probably do better on IDs, in most cases, although volunteers sometimes spend a lot of time trying to get the ID right and may sometimes get things right which a pro might gloss over" (Tracy 2005). An informal survey of several nonprofit organizations found that respondents felt that volunteer-collected data could be accurate to a level of about 90 percent, with less accuracy for species identification (Hamilton 2004; Pennsylvania Impact Report 2005; Tracy 2005).

A study conducted by Buchanan (1991) points to the benefits of using volunteers, and compares the effectiveness and ability of four different groups of data collectors: professionals, interns and students, trained volunteers and high-school youth. She found that "Experienced urban forestry technicians can routinely collect data on 200 to 400 trees per day depending on the amount of complexity of information collected on each tree...volunteers are estimated to survey between 50 and 150 trees per day" (Buchanan 1991). She also asserted, "Besides cost, there is another consideration for not having the entire inventory performed by an outside professional consultant. This is called the 'silver platter' phenomenon and has to do with the psychology of involvement in a project" (Buchanan 1991).

The literature suggests that volunteer involvement leads to a greater amount of ownership and awareness of the importance of trees and overall health of their urban environment (Makra 1990; Matz 1993; McPherson 1993; Westphal 1993; Sommer 1996; Tretheway 1999). Ryan in particular notes, "The psychological benefits that the volunteers themselves receive from their involvement in these efforts… [insure that they] continue volunteering" (Bloniarz and Ryan 1995). Bloniarz (1996) points out that 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. Inventories have more recently been conducted using trained volunteers in 81 municipalities throughout Pennsylvania; Hartford, Connecticut and the Greater Boston Urban Forest Inventory (Brokopp 2004). Three towns in Canada near Toronto have also used volunteer initiatives in collecting their tree inventory data (Bloniarz 2004).

A large-scale example of a tree inventory project occurred in 2003 when 35 paid interns and 500 community volunteers counted and assessed the health and circumstances of every street tree in the District of Columbia. On behalf of the Eugene B. Casey Foundation, philanthropist Betty Casey endowed $50 million dollars to fund urban forestry in the District of Columbia (Barker 2003).

Cities are increasingly willing to consider volunteer-based inventories as a valid means of collecting tree inventory data. The two most populous East Coast cities, Boston and New York, are presently conducting perhaps the largest regional scale inventories to date. These cities recognize that involving volunteers builds public support for urban forestry. As of August 2005, a census of trees in New York City was being done with the help of 1,050 volunteers. They are expected to finish a full survey of all street trees in late September 2005. The Greater Boston Urban Forest Inventory is also underway. They anticipate 500–1,000 community volunteers to complete a full inventory of trees on approximately 800 miles of roads throughout the area. The significance of the number of volunteer participants confirms that volunteers can be instrumental in collecting inventory data. These cities are willing to recognize the tradeoffs: data may not be completely accurate, but at least there is a base inventory from which management efforts can be directed more effectively.

Involving Volunteers in Tree Planting and Monitoring

For many decades, the traditional role of volunteers in urban forestry projects has been as tree planters. This role has expanded with public education and outreach efforts to include small-tree pruning and monitoring in a number of cities throughout the country. Within just the past decade, volunteers have taken up duties with increasing amounts of responsibility. They are stewards of their urban forests and participate

Volunteers have traditionally been involved in tree planting (photo courtesy of Tree Trust in increasingly complicated tasks. Understanding the extent to which the roles of volunteers have changed over time is important. However, there is a much more substantial body of literature associated with volunteer tree-planting efforts as opposed to their involvement in subsequent tasks such as tree inventories. It is important to recognize the roots of volunteerism in the field of urban forestry.

Volunteer efforts in tree planting are well documented (Evans 1983; Berry 1993; Skiera 1993; Iles 1998). In cities where re-greening efforts are particularly necessary, citizens have harnessed the energy of community members and youth by showing them how to plant and care for the trees, meanwhile nearly eliminating vandalism (Cole 1979). Increasing public awareness about a community's trees through citizen involvement is particularly essential to long-term involvement in sustaining the urban forest resource (Makra 1990; Matz 1993; Probart 1993).

Once trees are planted, steps must be taken to ensure their success. McPherson (1993) discusses volunteer-based monitoring in addition to planting in order to sustain healthy community forests. He postulates, "Volunteer based monitoring will promote continued public involvement and support in community forestry." Turner (2003) believes, "Volunteer based citywide surveys offer high visibility, efficient means to acquire data unobtainable by other methods, presenting great potential to advance ecology and [urban forestry]." Volunteers reaching out and improving the quality of life in their communities and involving themselves in tree planting and other related activities is essential to long-term urban forest success.

Volunteer Motivations

Understanding why volunteers are motivated to participate in urban forest projects is important. Nonprofits groups, city public works departments and urban forest managers need to understand why volunteers are interested in their projects. More precisely, they need to know how to recruit, train, supervise and ultimately retain the same volunteers for future projects.

As cities continue to grow, funding is more thinly spread, and therefore increasingly limited to sustaining levels of management necessary to maintain newly planted and aging populations of trees. "Urban forestry programs are facing new challenges due to dwindling municipal budgets, fewer trees, planting of smaller trees, and declining government support" (McPherson quoted in Bradley 1997). However, due to these budget restrictions, urban forest managers are recognizing the importance of volunteer citizen involvement in quantifying the benefits and restoring their urban forests.

Studies conducted by numerous authors (Westphal 1993; Sommer 1996; Bloniarz 1996) point to the benefits of involving volunteers. These benefits include increased stewardship, awareness of environmental issues, and new social outlets. Volunteers support their communities with a passion and desire to protect and improve the health of their urban forests. In return, city officials and foresters receive valuable information, assistance and feedback from the citizenry.

Volunteers are motivated to assist in improving and sustaining their community's resources for reasons such as having a tangible connection to their environment, creating a closer-knit community, and reconnecting with nature. Often, motivation for continued tree stewardship is seeded early on, and vandalism is reduced when elementary students plant trees in their neighborhoods or for school enhancement projects (Cole 1979).

Adults of all ages, socio-economic and ethnic backgrounds, volunteer for the betterment of their urban environment. Outreach efforts involving resource-limited communities, especially in inner-city neighborhoods are often criticized as under-representing certain communities in relation to their urban forest needs. Advocacy for including volunteers from ethnic groups who have not been as active in urban forestry efforts is increasing in importance. Iles (1998) asserts "Enlisting the support of nontraditional audiences can only enhance urban and community forestry programs and strengthens the argument for increased funding needed to sustain this valuable resource."

A study conducted by Buchanan (1991) found that younger volunteers, such as high school students, collecting tree inventory data required more supervision. The younger volunteers' results were less accurate than those of well-trained adults. However, inclusion of students of this age is likely to create a larger, better educated advocacy group as they mature into citizens of their cities. Probart (1993) feels strongly about the inclusion of youth in urban forestry programs: "Education aimed directly at our youth cannot be emphasized strongly enough." Additionally, motivated youth are far more likely to develop into motivated adults who volunteer in their communities.

But is motivation enough? Critics argue that providing an arena for learning and making the most of a volunteer's experience through effective volunteer management is absolutely critical. Without good management strategies, morale and motivations drop and retention is significantly diminished. Ball notes "The major stumbling block to working with volunteers is that few urban foresters have the training in this area of management. Working with volunteers requires different skills" (Ball 1986).

Effective Volunteer Management

Although many volunteers are motivated to "help the environment" it takes effective volunteer management from well-trained foresters and volunteer coordinators to make the experience of the volunteers rewarding and successful (Monear 1993; Probart 1993). Effective volunteerism, as defined by Probart (1993) is "more than just getting a group of people together to plant a tree…[it is] achieved by developing strong liaisons with public agencies and can provide community education, trained hands-on participation, volunteer coordination, and expanded programs." Westphal (1993) asserts, "In order to be most effective, it is important that urban foresters receive appropriate training and have the necessary time and commitment to work with volunteers." Finally Monear outlines the seven Cs of success in working with volunteers: commitment, coordination, communication, cooperation, compromise, consensus and congratulations. She emphasizes that working effectively with volunteers is a great responsibility and, "Acknowledgement is volunteer pay; its lack can quickly deflate enthusiasm" (Monear 1993).

The Tree Trust has a history of outstanding volunteer management. It was founded in 1976 when Minneapolis and St. Paul, Minnesota began losing their American elm (*Ulmus americana*) trees to Dutch elm disease (Tree Trust 2004). To retain the "green canopy" the elms once provided, a massive replanting effort was conducted to maintain beauty and continue the functional benefits a healthy urban forest provides. This effort was paired with a social improvement initiative employing youth and disadvantaged adults to assist in the replanting efforts. Additional epidemics of Dutch elm disease have wrecked havoc on many of the remaining elms. To illustrate the devastation, over 10,000 American elms were removed during the summer of 2004 in the city of Minneapolis alone. Despite this loss, the Tree Trust has planted countless numbers of trees throughout the Minnesota Twin

Cities Metropolitan area with the help of thousands of hired youth and adults, and local volunteers. This and other examples of organizations that can effectively manage volunteers provide models that cities or nonprofit tree groups can use to manage volunteers on a variety of scales.

The story of Oakland ReLeaf provides another example of a successful community-based tree group. Neighborhood “activists” in Oakland, California, saw a huge discrepancy between tree-lined streets in neighboring cities and tree-less streets in Oakland. A small group of volunteers formed a non-profit in 1998; a revival of a similar organization in the 1970s. They began replanting trees in vacant lots and empty planting basins in and across from parks and schools. Oakland ReLeaf has planted over 6,000 street trees with hired youth and

A beloved American elm in Minneapolis

volunteers and has given away 8,500 shade and fruit trees to Oakland residents. Approximately 500 people volunteer per year. With a high level of local volunteer involvement and careful maintenance by residents of "their trees," the annual mortality rate has been less than 1% for six years. Trees planted and maintained throughout the urban core of Oakland are transforming the city. Executive Director Kemba Shakor says "It's power to transform a block."

Chapter 3: Research Methodology

The goal of this evaluation is to produce recommendations that will improve the STRATUM software application when it is publicly released. Study objectives are to analyze (1) the methods and results of volunteer recruitment, organization and training; (2) the usability of maps and PDAs, and (3) the accuracy of volunteer data collection. This chapter outlines the data collection and analysis procedures for each objective.

The research methodology used in this study maximized the breadth of data acquired. Four surveys were analyzed: the tree identification survey, the post-training questionnaire, the volunteer pre-study survey, and the volunteer post-study survey. The volunteers, volunteer coordinating team (VCT), and trainers were interviewed during the study. Also, a statistical analysis compared the accuracy of tree inventory data collected by volunteers and professionals for a 10% sub-set of all street segments sampled. The discussion of methodology identifies the key questions asked, the survey instruments that were used and how were they administered, and what statistical tests were applied to analyze the data. A brief description of each survey instrument follows.

Survey Instruments

Pre-study survey

The pre-study survey was administered at the volunteer training (*Table 1*, see *Appendices A* and *B* for an exact copy of the survey). Fifty-seven of the 58 participants completed the survey. (The one who did not was visiting a participant and would not be involved in the data collection process.) Information from the pre-survey was compared with data from the post-study survey to gauge changes in the quality of the volunteers' experiences. Demographic information helped to understand the makeup of the volunteer body and neighborhood representation. Technical volunteers, who were previously trained as Tree Care Advisors, were asked three questions about their level of comfort in a leadership role.

USDA Forest Service statistician Jim Baldwin designed a tailored survey transfer program, DataDoc, for this study. The program transfers survey data from Word to Excel. After all responses were hand

Table 1 *A sample of questions from the pre-study survey for community and technical volunteers. For the complete survey, see Appendices A and B*

- Name
- Age
- Ethnicity
- City
- How did you find out about this tree inventory project? (i.e.: flyer, volunteer organization, Tree Care Advisors, friend, other)
- Why do you want to volunteer for this project?
- What do you expect to learn?
- Do you know the Latin or botanical names of any trees?
- I value urban trees because they ...(i.e.: bring nature closer, provide shade, reduce stormwater runoff, provide spiritual values, fall color, please the eye, reduces noise, increase sense of community, lower costs for heating/cooling, improve air quality, provide habitat for wildlife, are good for the environment, increase property value)
- Any additional comments?

transferred into automated survey boxes in Word, they were "Data-doced" together into an Excel spreadsheet for summary and comparison. Mean and standard deviations were obtained for all numerical responses. Comment data were grouped according to key words for similarity unless there were so few that each answer could stand on its own. A general rule was devised such that comments greater than six were grouped.

Post-study survey

The post-study survey, which provided critical feedback on various aspects of the data collection process, was put in kits passed out to the volunteers before data collection. Completed surveys were returned to the Tree Trust in the data collection kits at the end of the study (*Table 2*, see *Appendices C* and *D* for exact copies of the surveys). Open-ended questions were included to allow as much feedback from volunteers as possible. A total of 48 surveys were returned (81%).

The majority of questions on the post-study survey were answered yes or no, allowing analysis with simple descriptive statistics. The percentage of yes and no answers were calculated. A higher percentage of "yes" answers demonstrated a higher satisfaction/experience/usability level among the respondents, whereas a higher percentage of "no" responses constituted dissatisfaction. A "yes" answer was tallied as a 1 and a "no" answer as a 0.

Table 2 *A sample of questions from the post-study survey for community and technical volunteers. For the complete survey, see Appendices C and D*

- What did you learn?
- Did you have a good group dynamic with your team?
- Was the data collection well organized and run smoothly and professionally?
- Was the (PDA) easy to use while collecting tree data on your street segments?
- Were the neighborhood maps easy to read and understand?
- Did you have any difficulties locating your street segments?
- Did you have any difficulties locating which trees to sample on the street segments?
- Did you collect tree data from any trees in your own neighborhood?
- If not, do you wish you had?
- Was downloading the PDA onto the computer straightforward or complicated?
- Did your team receive the support it needed when you had questions about a tree or PDA data field?
- Did participating in the inventory increase your awareness of your urban forest?
- Please rate your overall experience on a scale of 1-5?
- Would you be interested in participating in other Tree Trust projects again?
- If you could pass on a word of advice to the next group of volunteers in another city doing their inventory, what would it be?
- Any additional comments?

Post-training questionnaire and interviews

The post-training questionnaires and interviews were designed to illicit immediate feedback on the quality of the training (*Table 3*, see *Appendix E* for a copy of the exact survey). The questionnaire was administered directly at the conclusion of the training session. Participants were given plenty of time to finish their surveys. Fifty-seven of the 58 participants completed the survey.

Trainers and members of the VCT were interviewed to determine if the training met their overall goals and if the volunteers were prepared for data collection. Four of the seven trainers were interviewed directly after the training, while the other three were interviewed via email and telephone. One of the two members of the VCT who participated in the training was interviewed the day after the training.

Descriptive statistics were used to analyze responses to the post-training questionnaire. Responses were recorded on a five-point Lichert-scale, as yes/no (1/0), and open-ended. The DocData program was used to transfer data from the surveys into Excel for analysis.

Table 3 *A sample of questions from the post-training questionnaire. See Appendix E for the complete survey*

- Did you feel like you learned something new?
- Was the protocol manual covered thoroughly?
- Was the explanation of how to use the PDAs covered thoroughly?
- On a scale of 1-5, please rate the following for content & usefulness: **A**. Tree characteristics **B**. Software & PDA **C**. Identification
- Was the training too technical?
- Was there any section of the training that was too long?
- Was there any section of the training that seemed rushed?
- What was your favorite part of the training?
- Was the facility chosen a good location for this training?
- What recommendations would you make for how the training could be improved?
- Did the training meet your expectations?
- Additional Comments?

Tree identification survey

To identify the level of knowledge that the volunteers had prior to the training, 43 of the 57 volunteers were administered a tree identification survey (see *Appendix F*) before entering the building where the training was held. With pen and survey, they walked the perimeter of the parking lot where five trees were labeled 1–5. They were instructed to record each tree's common name, botanical name, or any other type of identifying information, such as whether it was evergreen or deciduous.

To evaluate tree identification knowledge gained during the study, the percentages of correctly identified trees were compared for the pre-training survey and post-study results. To derive post-study results, data for five species were combined into totals for the genera ash and maple. The five inventoried maple species were: Norway (*Acer platanoides)*, silver (*Acer saccharinum*), sugar (*Acer saccharum)*, red (*Acer rubrum)*, boxelder (*Acer negundo*) and generic "maple" (*Acer* spp.). The ash were green (*Fraxinus pennsylvanica)*, white (*Fraxinus americana)*, and generic "ash" (*Fraxinus* spp.). To evaluate knowledge gained, the percentage of correctly identified maple and ash were compared for the one maple and one ash tree identified during the pre-training survey with results for all maple and ash inventoried by the volunteers and professionals. The other three trees in the pre-training identification survey were not used because they were not well-represented in the population (Ohio buckeye [*Aesculus glabra]*, river birch [*Betula nigra*] and plum [*Prunus* spp.]). The pre-

Table 4 *A sample of interview questions to trainers and VCTs. See Appendix G for a complete list*

- Did the training meet your overall goals?
- Did you feel that the training was well organized and smoothly conducted?
- Were you satisfied with your presentation?
- Was there any material that you did not feel like you had received sufficient training on prior to having to present it?
- Were there any comments or reactions that any volunteers vocalized directly to you after your presentation?
- Do you think the volunteers are ready for data collection?
- Do you feel like they are prepared to use the PDA's without making mistakes, becoming confused, or getting frustrated in the field?
- On a scale of 1-10, how would you rate their preparedness to gather data at an 80 percent accuracy level or better?
- Any additional comments?

training identification survey contained data from 43 training participants (2 trees). The inventoried data was recorded by 33 volunteers (217 trees).

Interviews

Eight interviews were conducted with trainers and members of the VCT (*Table 4*, for more information see *Appendix G*). Directly after the training, four of the seven trainers were interviewed about the successes and limitations of the sessions they presented and the training overall. The remaining two were interviewed a few days later in a telephone interview and via questions in an email. Two of the three members of the VCT were interviewed the day after the training. The third did not participate in the training to the same degree and so was not interviewed.

Questions to members of the VCT differed slightly from those asked to the trainers. Closed-ended responses to questions asked during the interviews were recorded using a 5-point Lichert-scale where 1 = very easy and 5 = difficult. Open-ended questions were recorded individually unless they could be grouped based on like responses.

Objectives and Tasks

Objective 1: Evaluate volunteer recruitment

Understanding the methods used by the Tree Trust to recruit volunteers for the i-Tree inventory is important for those interested in improving their recruitment efforts.

Two key questions were asked of all volunteers:

- How were you recruited?
- Why were you interested in participating in this project?

This information was acquired with the volunteer pre-study surveys administered at the training session. Percentages, means, and standard errors were calculated in Excel using statistical functions.

Objective 2: Evaluate volunteer organization

Key questions regarding the organization of the volunteers were:

- How were the volunteers organized into teams?
- How were the teams distributed throughout the area?
- Did volunteers collect tree data from trees in their own neighborhood? If not, did they wish they had?
- How well organized was the scheduling of data collection days?
- Was the data collection itself well organized and run smoothly and professionally?
- Did volunteers in the field get questions answered in a timely manner?
- Was there a good group dynamic within the team? If not, why?
- How much influence did team dynamics have on the volunteers' experience?

Volunteer organization was evaluated based on results of the post-study survey responses and interviews conducted with the VCT and volunteers in the field.

Objective 3: Evaluate volunteer training

The day-long training session was intended to prepare volunteers to collect tree inventory data for both the STRATUM and MCTI applications. A description of the training session sets the stage for describing key research questions and methods.

The training session

The training was conducted on August 14, 2004 at the Minneapolis Parks and Recreation Board (MPRB) Headquarters office in the main conference room. The location was chosen for several reasons. The

MPRB was a participating partner in the i-Tree project and offered the Tree Trust the use of the building free of charge. The facility had plenty of smaller rooms for breakout sessions. It was centrally located, easily accessible from principal freeways, and offered ample parking. This site was used for the tree identification walks, as it is planted with a wide variety of tree species.

When the volunteers first arrived at the MPRB training location, they were greeted and asked to register. They picked out their name-tags and were given an agenda for the day. Coffee, tea, orange juice, bottled water, pastries and fruit were provided for morning refresh-ments. Surprisingly, a large number of volunteers arrived at least half an hour early. Those who arrived more than ten minutes before the 9:00 start time were given a tree identification survey. They were asked to go to the parking lot and write the name and check off the condition for five trees in the parking lot, numbered #1 to #5.

Gail Nozal welcomed the volunteers to the training and spoke briefly about the Tree Trust, its role in the i-Tree project and reviewed the agenda for the day. Dr. Bloniarz followed with an introduction and overview of i-Tree by giving a brief PowerPoint presentation of the partners, their goals and the role of the volunteers in this national study. With 15 minutes left open, Dr. Bloniarz decided to ask all 60 participants to introduce themselves. Learning names, places of resi-dence, and why they were partici-pating in this project was interest-ing, but fairly time consuming (more than 15 minutes). The pre-study survey was administered to the volunteers, completed and returned prior to a break.

The training was divided into four sections. Dave Hanson led the volunteers through the basics of tree identification. He covered the differences between entire and serrate leaves, opposite and alter-nate leaf-branching patterns, and passed out three leaf samples. He walked volunteers through the process of keying out a species

Volunteers learn to enter data into the PDA during a training session

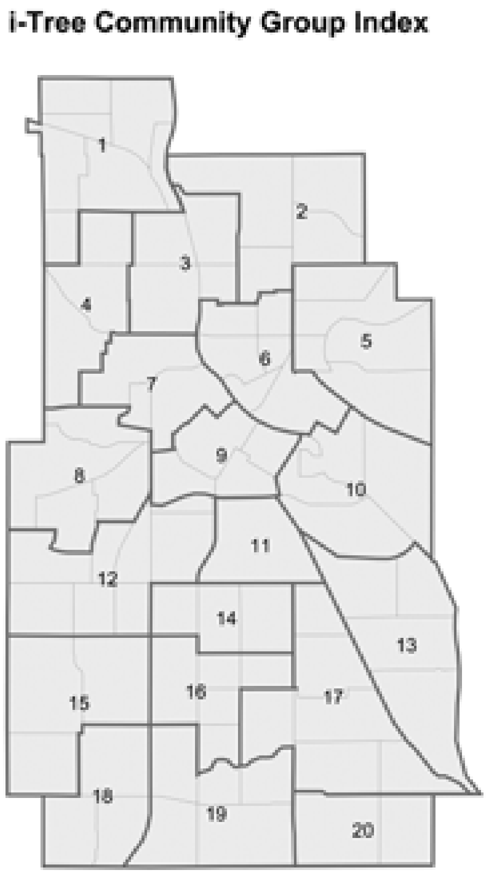

Figure 3 Twenty inventory areas for sampling trees in the city of Minneapolis

using the key in the Minnesota Trees Guide (Rathke 1995).

Following a break, volunteers were asked to meet at one of three locations based on a color sticker on their nametags. The three breakout sessions were Tree Identification, PDA and Software Overview, and Tree Conditions. The outside Tree Identification session covered identifying characteristics of approximately 15 common street trees. Although many specimens were small, their foliage was healthy. A few trees were in poor condition, providing helpful examples. Volunteers were broken into four small groups for a detailed review of the PDA and software. In small groups, volunteers had plenty of time to ask questions as they went through the screens one by one. Some took notes in their training manuals, but most did not. The PDA session leaders thought that walking volunteers through the training manual would be too time-consuming. Dr. Bloniarz took a separate group of volunteers from the Como neighborhood and led them through a session specific to the MCTI data fields. All the other breakout groups learned how to use the PDA for STRATUM. During the Tree Conditions session with Professor Johnson and Kirk Brown, volunteers learned to assess healthy or unhealthy wood, roots and leaves, measure the trunk and crown diameter of a tree, and measure trees with multiple trunks.

Near the end of the training session, a city map and twenty neighborhood zone maps were placed on the walls around the main conference room and all volunteers were asked to walk around and find the neighborhood they would like to sample *(Fig. 3)*. When volunteers found the neighborhood they wanted to work in, they were asked to stand next to that map and meet the other members of their team. They exchanged contact information and began to schedule their field work.

Following this last session, volunteers filled out post-training questionnaires. It was announced that some volunteer teams would gain new “community volunteers” as they were recruited.

Team members picked up data collection kits at the Tree Trust office several days after the training session. At this time they learned the names of new recruits. The kits contained a number of items:

- Map with their street segments highlighted in purple
- A table to the right of the map specified the street name, start address, and had a comment section
- PDAs and their chargers
- Cell phone and charger
- Tree Trust card with contact information
- Three handouts explaining how to assess tree conditions more specifically than provided in the training manual
- Pre-study surveys for two or three community volunteers who might be joining their team
- Technical volunteer post-study surveys for those who had attended the training
- Three tree identification quick guide sheets intended to clarify the difference between commonly confused tree species
- Extra t-shirts for additional team members
- Abbreviated STRATUM data collection forms (see *Appendix H*)

Key questions and methods for evaluating training

Key research questions included:

- What amount of tree identification knowledge did volunteers have prior to the training?
- Was eight hours enough time to train volunteers without prior knowledge of arboriculture?
- Which topics were the most useful to volunteers?

To acquire volunteer feedback a post-training questionnaire was administered at the conclusion of the one-day training. Volunteer teams were interviewed while in the field collecting data. Each trainer was interviewed individually directly after the training.

Objective 4: Evaluate volunteer satisfaction

Several questions were designed to gauge the volunteer's level of satisfaction with their experience:

- Volunteers, what do you expect to learn, and what did you learn?

Increase(d) my abilities to identify pruning/management needs
Increase(d) my tree identification abilities
Understand urban forestry more thoroughly
Learn(ed) to use a new technology: PDA
Other

- Trainers: Were your goals for the training met?
- VCT: What were your goals for data collection? Were they met?

Pre-study and post-study surveys were used to determine if the volunteers' original learning objectives were met. They were administered before and after the training session. Interviews were conducted with the trainers at the end of the training. Final interviews were conducted with members of the VCT on September 12 and 13, 2004, after the majority of data had been received.

Before-and after-responses were compared for the same questions. If the volunteer checked a box on their pre-study survey and the same box on their post-study survey, a 1-to-1 match indicated that their goal was met. If they did not check a box on the pre-survey but did on their post-survey, a 0-to-1 non-match meant they learned something new that they did not expect to learn. Conversely, if they checked a box on their pre-survey, but did not check the same box on their post-survey, a 1-to-0 non-match meant they expected to learn something that they did not learn.

Objective 5: Evaluate usability of maps and PDAs

Good maps are essential for a successful sample tree inventory because they help volunteers find their street segment quickly and accurately. Sample segments for this pilot study were randomly selected using TIGER line files by the science team in Davis, California. These sample segments were mapped by a GIS developer with Interactive GeoGraphics under contract with the Tree Trust.

PDAs can reduce the amount of time and error associated with transferring data from tally sheets to the computer. Each volunteer team had one PDA that had been programmed to contain the STRATUM data fields.

The key questions were:

- Were the maps easy to use? If not, why?
- Were the PDA's easy to use?

Responses to these questions were acquired from the post-study surveys and in-field interviews with 18 of the 20 teams. “Yes” or “no” responses for each question were computed and comments were grouped for similarity.

Objective 6: Evaluate the accuracy of volunteer data collection

This study quantified the accuracy and precision of tree inventory data collected by volunteers compared to professionals. Twenty volunteer teams collected inventory data from a random sample of street segments throughout Minneapolis. Their data were compared to a 10% random sample subset of street segments re-inventoried by professionals (Steve Gilbert, certified arborist with the Minneapolis Forestry Section and Shauna Cozad, CUFR).

Key questions regarding the type and accuracy of data collected by volunteers were:

- What variables could volunteers collect at a high level of accuracy?
- What factors might have contributed to inaccurate assessments?
- Did volunteers and professionals sample the same number of trees, and if not, why not?
- How variable was the accuracy of volunteer sampling among teams?

Sample and sample sub-set

In Minneapolis, a 3% sample of all street segments was targeted for purposes of statistical accuracy. Using U.S. Census Bureau Tiger Line Files *(Fig. 4),* 13,499 street segments were created from 1,093 total miles of roads. The randomly selected 3% sample yielded 405 street segments. The total sample length was 32.8

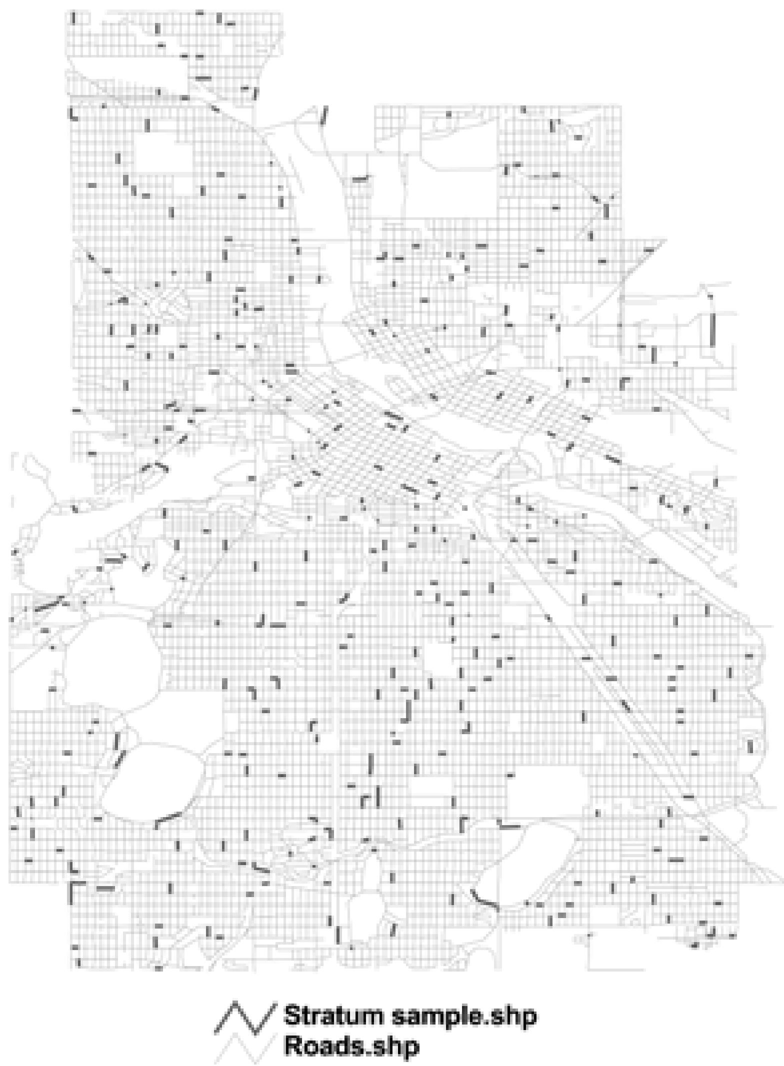

Figure 4 Randomly selected street segments (405) in the city of Minneapolis used to measure accuracy of volunteer-collected data

miles, with an average street length of 0.081 miles. Based on casual observation, street tree density was estimated to be 163 per mile and volunteers were anticipated to sample approximately 5,333 trees for the study.

A second randomized 10% sample was drawn from the 405 street segments, resulting in 40 segments to be re-sampled by professionals. Of the 40 street segments in the professionals' sample, hereafter referred to as the sample sub-set, twelve (30%) were eliminated. One could not be found on the map; it most likely ended up in the Como neighborhood inventoried by volunteers collecting MCTI data. Seven segments did not contain any trees as they were in downtown or industrial areas, or on freeway ramps. On four additional street segments, the volunteers did not inventory any trees, whereas the professionals inventoried one or two trees per street segment. On yet another street segment, both teams collected data on three trees, but none of the data matched. After systematic comparison of tree species, sizes, conditions, and locations, it was apparent that the teams had not sampled the same segment.

For the 28 matching street segments, volunteers surveyed 450 trees and the professionals surveyed 460 trees. Of these trees, 431 matched and were used for this analysis. Although 20 volunteer teams collected data, the randomly drawn sample sub-set included segments sampled by only 15 teams.

To determine the accuracy of data collected by volunteers it was first necessary to match trees so that results reflect data recorded on the same tree by volunteers and professionals. The tree-to-tree match of 431 trees was accomplished by first matching street segment, then address, then genus, species, and dbh. If the volunteer and professional teams did not begin collecting their inventory data at the same address on the map, then trees were matched using other variables: genus, species, and dbh.

Because it was not always clear where the volunteers began their inventory or the direction they followed down the street, the professionals' data sets sometimes required re-arranging so that the order of the species and other characteristics matched the volunteers as closely as possible *(Tables 5a and 5b, Fig. 5)*. Volunteers did not always record correct starting or ending addresses. For example, if their map indicated they should begin at 2701 Maple St., but there was only one address, 2705 on the odd side of the street, some volunteer groups would enter 2701 as the start address whereas others would enter 2705. Other groups may have entered 2700 for that block segment.

Data collected by the professionals followed the same protocols as the volunteers. The two-person team finished all but five segments together. They did the remaining five separately, but double checked their answers. They disagreed on only 31 of 1,125 total entries, mostly due to discrepancies measuring crown diameter parallel and perpendicular to the road.

STRATUM inventory fields

Volunteers and the two professionals recorded information in the PDAs for the following fields:

TreeID: A unique number assigned to each tree.

Zone: A number that represents the management area or zone in which the tree is located.

StreetSeg: A number that defines the particular block or segment within a management zone where the tree is located.

CityManaged: A numeric code to distinguish trees owned by the city and those privately planted and managed .

SpCode: An alphanumeric code consisting of the first two letters of the genus name and the first two letters of the species name followed by two optional letters or numbers to distinguish two species with the same four-letter code.

LandUse: A numeric code to designate the primary land use adjacent to where the tree is growing: single or multi-family residential, small commercial, industrial/institutional/large commercial, park/vacant/other.

LocSite: A numeric code to distinguish the site in which the tree is located: front yard, planting strip, cutout, median, backyard and other maintained and un-maintained locations.

DBH: numerical categories representing a range of DBH or diameter at breast height (4.5 ft [1.37 m]) sizes to the nearest inch (e.g. 1 = trees in the 0–3 in DBH size class, 2 = 3–6 in, 3 = 6–12 in, etc.).

Table 5a *Data for one street segment as it was originally collected*

Volunteers			Professionals		
Tree no.	Species	DBH	Tree no.	Species	DBH
1	Sugar maple	3	1	Elm	7
2	Sugar maple	4	2	Norway maple	2
3	Sugar maple	3	3	Honeylocust	3
4	Honeylocust	3	4	Sugar maple	3
5	Norway maple	2	5	Sugar maple	4
6	Elm	7	6	Sugar maple	3

Table 5b *Data for one street segment rearranged so that trees are properly compared*

Volunteers			Professionals		
Tree no.	Species	DBH	Tree no.	Species	DBH
1	Sugar maple	3	6	Sugar maple	3
2	Sugar maple	4	6	Sugar maple	4
3	Sugar maple	3	4	Sugar maple	3
4	Honeylocust	3	3	Honeylocust	3
5	Norway maple	2	2	Norway maple	2
6	Elm	7	1	Elm	7

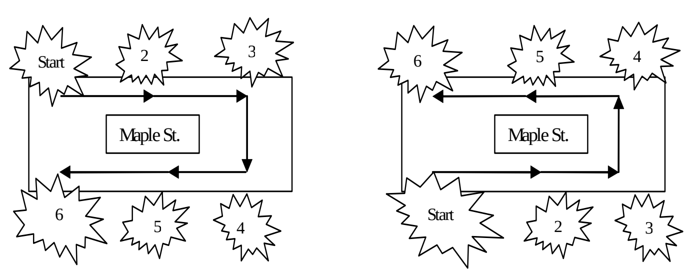

Figure 5 Inventory situation requiring reordering of data. Volunteers inventoried trees clockwise around a street segment (*left*) while professionals inventoried trees counterclockwise (*right*)

MtncRec: A numeric code to describe the recommended maintenance for the tree: none, young tree (routine or immediate), mature tree (routine or immediate), critical concern (public safety).

MtncTask: A numeric code to describe the highest priority task to perform on the tree: none, staking/training, crown cleaning, raising, reduction/thinning, removal and treat pest/disease.

SwDamg: A numeric code to describe the amount of sidewalk damage or lift caused by tree roots: none (< 1/4 inch lift), low (1/4–1/2 inch) , medium (1/2–3/4 inch) and high (>3/4 inch).

WireConflict : A numeric code to describe utility lines that interfere with or are present above a tree: no lines, present and no potential for conflict, present and conflicting, present and potential for conflicting.

CondWood: A numeric code to describe the health of the tree's wood (its structural health) as per adaptation of the Council of Tree and Landscape Appraisers (CTLA) tree appraisal standards: dead/dying, poor, fair, and good.

CondLvs: A numeric code to describe the health of the tree's leaves (its functional health) as per adaptation of CTLA tree appraisal standards: dead/dying, poor, fair, and good.

Tree inventory data were entered into the PDAs throughout the data collection process. After the team leader returned the PDA with data, Tree Trust staff uploaded the data to a central computer. They also checked the PDA storage device cards to make sure that data were not missing. Separate computers were set up for STRATUM and MCTI data to ensure data would not be mingled. Cumulative data from all volunteer teams using STRATUM were compiled. The first compilation of volunteer data was subjected to quality control analysis. The remainder of the data were combined with the first set, burned onto a CD and mailed to CUFR. By mid-October all volunteer data had been received and checked. The final data set included 326 street segments and 4,577 trees.

The accuracy of data collection was calculated for each variable and summarized statistically in Excel on a tree-to-tree basis. The accuracy was compared (1) between each team and the professional team and (2) among the teams.

Chapter 4: Results

This chapter presents findings for each of the study's objectives and tasks. Background information on demographics of the volunteers is discussed first.

Volunteer Demographic Analysis

The Tree Trust was successful in recruiting 89 volunteers for the study. Although this was a sufficient number to complete the study, it was less than the Tree Trust anticipated. Eighty percent were homeowners and 16% were renters, 4% did not respond. The average homeowner had lived at his or her current residence for 13 years. Seventy-three percent of all volunteers were Caucasian, and 8% had other ethnicities, including African American, Mexican American, Asian American or multiracial. Nineteen percent chose not to indicate their ethnic background. Over 66% of the volunteers were Minneapolis residents, and 34% lived outside of Minneapolis in neighboring St. Paul, Eagan or Edina. One volunteer worked in Minneapolis, lived in a suburb half an hour away, yet wanted to get to know the trees in and around her work environment. Volunteers ranged in age from 14 to 67 years, with an average age of 46 years. Fifty-six volunteers were female (62%) and 33 were male (37%).

Objective 1: Evaluate Volunteer Recruitment

Volunteers were recruited by the Tree Trust using a variety of methods: newspaper ads, email flyers to past participants of Tree Trust projects, corporate sponsors of volunteer service days, and through other environmentally related organizations. Eighty-one of 89 volunteers completed a pre-study survey and indicated the method by which they were contacted. Fourteen percent were contacted by the Tree Trust email flyer, 37% by neighborhood representative or organization via email, 22% by a friend and 25% from a volunteer organization other than the Tree Trust. Twenty-two percent listed contact by "other" means, such as the local newspaper, Extension services or a family member.

It is important to note that 51% of the volunteers were contacted through email. This form of communication has become the best means of recruiting volunteers for most projects.

On the post-study survey, volunteers were asked whether or not they would be interested in volunteering again for future Tree Trust projects. Seventy-five percent said yes, only one said no and twenty-five percent wrote in maybe.

It is particularly important to understand why volunteers are motivated to become involved in a particular project. On the pre-study survey, volunteers were asked why they wanted to volunteer for this project. Of 81 respondents, 75% wanted to get involved in a local community project to help beautify and support the community. An equal number of volunteers cited their primary reason for volunteering as "doing their part to help out the environment." "Becoming an advocate for trees" (67%) and meeting people with similar interests (32%) were important, yet not dominant reasons for volunteering. In the category "other," 32% of the volunteers listed their own reasons for volunteering. Responses included learning how to identify trees, professional development, helping the urban forest, learning more about Dutch elm disease, fulfilling Tree Care Advisor hours, being part of a real statistical research project to share with my [high school] students, spending more time with my dear wife and having fun. (Note that cumulative responses do not add to 100% because more than one answer could be selected.)

Tree care advisors

Originally, the Tree Trust planned to recruit approximately 20 Tree Care Advisors (TCAs). One TCA was to lead each of the 20 teams. However, only 11 TCAs volunteered for this project. Of these 11, three ended up on the same team, and the remaining eight were divided among six other teams. The average TCA had participated in the TCA program for four years, and had volunteered over 100 hours. When asked what their greatest strength was, 55% checked "good educator," 44% said "good at tree identification" and 66% listed "motivated to help others learn about trees."

Although TCAs had prior tree identification knowledge, discussion with Tree Trust staff unearthed an interesting fact: TCAs felt their greatest weakness was tree identification. Many voiced an interest in participating in this pilot project to improve this skill.

Objective 2: Evaluate Volunteer Organization

A number of criteria were examined to evaluate how successful the Tree Trust was in organizing its volunteers and what could be learned from the experience. Criteria included grouping of volunteers into teams, deploying teams to neighborhoods for the tree survey, and the level of support volunteers received from the Volunteer Coordinating Team.

Grouping and deploying volunteers

Grouping TCAs and volunteer teams was problematic. For example, it was not clear if TCAs would accept being placed in a region of the city where they did not live, or agree to lead teams. In fact, three TCAs chose to work together in one team instead of dividing themselves evenly among neighborhoods.

Another issue was whether to let volunteers self-select the neighborhoods they sampled, or direct them so that all neighborhoods were covered. Initially, volunteers were to be distributed throughout the city working with a TCA in each of the 20 neighborhoods. As volunteers RSVP'd for the open house and training, they were asked about their neighborhood preference. The Tree Trust wanted to allow volunteers to inventory their own neighborhood if desired. This approach resulted in 18 of 20 neighborhoods covered.

The Tree Trust needed to recruit volunteers for the remaining two neighborhoods, which were deemed less safe than others. They obtained a police report for these neighborhoods that indicated where violent behavior and thefts occurred and times of day that were most dangerous. Through contact with local garden clubs in those neighborhoods, they were able to recruit volunteers who were comfortable and knowledgeable about the neighborhoods.

To gauge how important it was for volunteers to collect tree inventory data from their neighborhoods, we asked two questions. First, "Did you collect tree data from any trees in your own neighborhood?' and second, "If not, do you wish you had?" Fifty-one percent of the volunteers collected data from their neighborhoods and 45% did not. Of the 45% that did not collect tree data from their neighborhoods,

A group of volunteers inventorying trees on a street segment

Table 6 *Interview responses to the question "On a scale of 1–5, how would you rate your team dynamic?" N=18 teams*

Rating	Excellent	Good	OK	Mediocre	Poor	Total
No. of responses	13	7	0	0	0	20
Percentage	69%	35%	0%	0%	0%	100%

Table 7 *Post-study survey responses to the question "Did you have a good group dynamic with your team?" on the technical and community post-surveys. N = 20 teams*

Good group dynamic?	Yes	No	No answer
Technical volunteers (*N*=48)	92%	8%	0%
Community volunteers (*N*=22)	86%	9%	5%

almost one-half said they wish they had, and approximately one-third said it did not matter to them.

Although volunteers were allowed to self-select where they would sample trees, some ended up in neighborhoods that were not their own, and this was not to their liking. From conversations with volunteers at the training, a few decided to inventory neighborhoods that they wanted to get to know better. For some volunteers, inventorying their own neighborhood was very important. "One member decided not to show when he couldn't do his own block." Another volunteer mentioned that she wanted to, "learn what the street trees are in [her] neighborhood."

Allowing volunteers to self-select their teams also did not ensure that they would have compatible schedules for field work. In fact, on the post-study survey, 43% of the volunteers mentioned that it was difficult to schedule time to go out as a group, and wished teams could have been arranged differently.

Two questions were asked to discover if teams were organized in ways that fostered harmony. All teams reported excellent or good dynamics when interviewed in the field *(Table 6),* suggesting that teams were well-organized for compatibility.

One might expect volunteers to be more candid on their private post-study surveys than when questioned among teammates in the field. This appeared to be the case. None of the volunteers reported having an OK to poor experience when asked directly in an interview. Yet, when given a yes or no option on their post-surveys, about 8% said they did not enjoy their team *(Table 7).*

Support

Volunteers received support from the VCT, other Tree Trust staff, and their team leaders. Eighty percent of the volunteers reported that they received sufficient support throughout the project. Because most of the technical volunteers attended the training session, they had less need for technical support than volunteers who missed the training. Of the community volunteers who did not attend the training, 68% said they received sufficient support. Community volunteers were asked if they felt their team leader helped them learn what they felt was important to know about trees. Nearly the same number, 64% said yes and 14% said no.

Volunteers were asked on the post-study survey if they thought data collection was run smoothly and professionally. Ninety percent of community and technical volunteers felt data collection was well-organized. Five percent of volunteers felt it was not run smoothly, and another 5% chose not to reply. Critical comments included, “Plan on 25+ hours of work – we were told only 8–10! Have substitutes. Drive by the mapped out area first to implement your game plan” and “Be sure to get complete details as to what is expected of you.”

Objective 3: Evaluate Volunteer Training

Training provided knowledge that was fundamental to implementation of the tree survey. For this reason, a great deal of emphasis was placed on evaluating each component of the training. Coordinators, trainers and volunteers were interviewed to acquire initial feedback at the conclusion of the training session, as well as during data collection. Three aspects of the training are discussed in terms of the (1) tree identification survey, (2) post-training questionnaires, and (3) comments from interviews with the VCT and the trainers.

Tree identification survey

The tree identification survey provided a baseline for evaluating the extent of knowledge gained during the project. An added benefit of this survey was that it gave the volunteers who arrived to the training session early something active and social to do.

The tree identification survey results indicated that 77% of the volunteers could correctly identify a maple and 53% could identify an ash to the genus level. Nineteen percent of the 43 volunteers who took the test were able to identify all five trees correctly by common name while 7% knew all five by botanical name (*Table 8*). Five of the eight volunteers who correctly identified all five trees by common name also knew at least one of the trees’ botanical names.

During the field survey, volunteers were found to correctly identify 97% of the maples and 90% of the ashes. This finding suggests that formal and on-the-job training increased the volunteers’ ability to correctly identify species belonging to these genera.

Table 8 *Pre-training tree identification survey results*

	Trees identified correctly	**No. of volunteers**
Botanic name	5	3
	4	1
	3	0
	2	0
	1	1
	0	38
Common name	5	8
	4	5
	3	7
	2	8
	1	7
	0	8

Table 9 *Comparison of volunteer abilities to identify trees. Results are compared for this study before and after training and for a 1996 study carried out in Brookline, MA*

Study	Maple (*Acer*)	Ash (*Fraxinus*)
Pre-training tree ID survey: this study N=43 volunteers Maple trees = 1 Ash trees = 1	77%	53%
Field data collected: this study N = 33 volunteers Maple trees = 174 (5 species) Ash trees = 48 (3 species)	97%	90%
Field data collected: MCTI study (Bloniarz 1996) N = 97 volunteers Maple trees = 182 (2 species) Ash trees = 29 (1 species)	95%	96%

These results are in general agreement with those reported by Bloniarz (1996) for Brookline, MA. A higher percentage of maples was accurately identified by volunteers in Brookline than Minneapolis (*Table 9*). Volunteers in both studies had more difficulty correctly identifying ash by genus and species.

Post-training questionnaire

The purpose of the post-training questionnaire was to acquire immediate feedback from the volunteers on the quality of the training. Overall, 86% of the respondents felt that the training session met their expectations.

Responses to the most pertinent questions asked on the post training questionnaires are summarized here.

Learning objectives met

- 98% of volunteers felt that they had met their learning objectives

Coverage of training manual

- 51% of volunteers said the training manual was well covered and 41% disagreed. These results are surprising since the training manual was not covered in the training

Level of technicality

- 97% said the training was not too technical, they were happy with the pace and they felt that the PDAs were covered thoroughly.

Usefulness of training material and content

Volunteers rated the usefulness of the material covered for the three training sessions:

- Tree characteristics: 73% checked very useful, 22% checked useful, and 3% said somewhat useful.
- Software and PDA session was rated as very useful (69%) and useful (29%).

- Tree identification received the highest and lowest ratings with 76% of volunteer checking very useful, 17% marked useful and 34% of volunteer said somewhat useful. (Some volunteers chose more than one option.)

Duration of training

- 83% did not think any one session was too long.
- 22% thought at least one section was too long:

  Welcome and introduction (15%)

  Tree identification (5%)

  Software and PDA (2%)

- 54% percent of volunteers said the pace of the training was fine, but 41% disagreed. Areas they felt were rushed were:

  Tree identification (31%)

  Tree characteristics (14%)

  Software and PDA (5%)

Favorite part of training

- Volunteers rated their favorite parts of the training: tree identification (56%), tree characteristics (49%) and software and PDA (20%).

Facility

- Most all volunteers felt the facility chosen for the training was good (95%).

Expectations

- The majority of volunteers (86%) indicated that the training met their expectations. Five volunteers (9%) voiced that it far exceeded their expectations.

Volunteer recommendations

Volunteer recommendations ranged from more training on tree identification, condition ratings and tree characteristics, to having smaller groups, and being able to take the tree identification book home with them to study.

Post-training interviews with trainers

Although all six trainers were very satisfied with the quality of the volunteers and their receptivity to training, they were less optimistic about the upcoming inventory than the volunteers.

Did you meet your training goals?

Eighty six percent of the trainers responded that they did meet their training goals, but several added comments:

- "Show that there are no easy answers and that it takes a lot of practice to respond to different situations."
- "Convey the fact that tree biology is not black and white, and that educated judgments are commonly made."
- "Volunteers wondered why they had to learn pacing, and did not feel confident [when evaluating] tree health/condition."
- "Someone said that it was nice to get their hands on the [leaf] samples [when keying out trees]."

Overall, how did you feel about the training?

All trainers responded that they thought the training went very well. Additional comments included:

- "I thought we should have spent a lot more time on condition classes and have [volunteers] directly relate them to what the PDA gave as options."
- "They're just going to have to spend time reviewing [the training manual]."
- "When they get their hands on the PDAs and play with them, they will understand a lot more."
- "I thought [the training] was well attended. Folks seemed conscientious and receptive to what we were teaching them. Overall they seemed very enthusiastic."

Do you think the volunteers are ready for data collection?

Half the trainers responded to this question "yes, but with some reservations."

- "I think they'll be much more proficient after practicing a bit."

- “Data [collection using the PDAs], yes. Making judgments regarding tree health/condition, no.”
- “The [volunteers would have more difficulty on the] subjective [data fields, lending to] subjective valuation,” but “That's why you do a pilot study.”
- When asked, “On a scale of 1–10, how would you rate their preparedness to gather data at an 80 percent accuracy level or better?” two trainers said 7, two others said 8. The most optimistic said 8 or 9.

Final comments

One trainer captured the essence of feelings shared by the others.

- “I think the inventory is off to a good start. The volunteers seemed enthusiastic and excited. They have a basic knowledge base that they need to build upon through the inventory experience. After several hours [collecting data, they will] become more positive and confident as they gain more experience by the hour.”
- “My only concern is about the people who have not attended any of the training, which I don't like to see.”

Safety concerns and training

Safety measures were discussed in phone interviews with Tree Trust staff and by Dr. Bloniarz, designer of the training manual, prior to the training. However, since training time was limited, it was decided that safety precautions would be reviewed with volunteer team leaders when they picked up their packets. Trainers provided quick safety tips and information. Volunteers were provided with mobile phones for inventory questions and safety-related concerns and very bright “safety-green” t-shirts, designed to be highly visible and used in place

Data collection methods sometimes required volunteers to be in the street, a potential safety concern

Table 10 *Responses to the statement: "Please rate your overall experience" during in-field interviews and in post-study surveys. Interviews conducted by Shauna Cozad and Rebekah Van Weiren in the field during data collection with 18 of the 20 volunteer teams*

Overall experience	Excellent	Good	OK	Mediocre	Poor
In-field interviews	37%	58%	5%	0%	0%
Post-study survey	21%	38%	14%	22%	5%

of standard orange safety vests. These shirts provided visibility for the Tree Trust and doubled as a professional "uniform" so volunteers could be recognized by the community and seen as legitimate data collectors.

Results from the post-study surveys indicated that only 7% of the respondents felt competent in having reviewed the safety protocols and 8% felt somewhat or not at all competent in their review of safety protocols. Fifty-seven percent chose "N/A" or not applicable, indicating that many volunteers did not receive any training on safety measures. Additionally, safety protocols were supposed to be in the training manual, but were not included in the final version.

Objective 4: Evaluate Volunteer Satisfaction

Interviews in the field and post-study surveys were used to assess volunteers' satisfaction with their experience. Ninety-five percent of the interview respondents indicated that their experience was excellent or good *(Table 10)*. Only one team said it was just OK. This team was interviewed on their first day of data collection.

Post-survey results indicated a lower level of volunteer satisfaction than reported via interviews. Fifty-nine percent of the volunteer respondents had an excellent or good experience collecting tree inventory data, while 28% had a mediocre to poor experience. Based on the post-study survey comments, lower levels of satisfaction were largely due to the longer than expected amount of time it took to collect the data. A VCT noted, "The amount of time [the inventory] would take was a big issue." However, another member added, "We do a lot of workshops and projects and have not gotten the turnout that we got for this project. They [volunteers] were intrigued by this type of project. This type of turnout really says a lot. [These were] different people than the typical tree/gardener types of people who usually show up for those types of workshops."

Initially, the Tree Trust anticipated recruiting a minimum of 125 volunteers. They ended up with 66 volunteers collecting STRATUM data, and 23 volunteers collecting MCTI data. As a result, STRATUM volunteers needed to inventory approximately twice the number of street segments as expected.

Volunteers were told that they were expected to volunteer a minimum of 8 hours, but organizers did not anticipate that the actual amount of time would exceed 20 hours per person for most teams. In some cases, interest lagged, morale waned, frustrations rose and overall satisfaction suffered accordingly.

Table 11 *Percentage of volunteers (mean ± SD) who expected to gain knowledge in each area (pre-study survey) and reported gaining knowledge (post-study survey)*

	Technical volunteers		Community volunteers		Total	
	Pre	Post	Pre	Post	Pre	Post
Identify trees	89.4±31.1	86.8±34.2	77.7±42.7	88.8±32.3	83.5±36.9	87.8±33.2
Identify condition problems	44.7±50.3	65.7±48.0	55.5±51.1	44.4±51.1	50.1±50.7	55.0±49.5
Understand urban forestry	71.0±45.9	57.8±50.0	77.7±42.7	55.5±51.1	74.3±44.3	56.6±50.5
Learn new technology	0	55.2±50.3	27.7±46.0	44.4±51.1	27.7±46.0	49.8±50.7
Other	0	65.7±48.0	11.1±32.3	16.7±38.3	11.1±32.3	41.2±43.1

Volunteers are motivated to participate in projects for a variety of reasons. One important one is to learn something new. Of the 81 volunteers who returned the surveys, 56% checked answers on both the pre-study and post-study surveys relating to whether or not their learning objectives were met *(Table 11).*

- 84% expected to learn how to identify trees, and 88% felt they did.
- 50% of volunteers expected to identify tree problems and 55% felt they did.
- 74% percent of volunteers initially expected to get a good base understanding of urban forestry, but only 57% felt they did in the end. A definition of the urban forest was provided during the training session, but little time was devoted to providing an overview of urban forestry as a context for the tree sampling effort.
- 28% of volunteers anticipated learning a new technology or the PDA, and 50% felt they learned how to use it well.
- 75% said that they would be interested and willing to volunteer in another Tree Trust project. The remaining 25% said maybe. Most cited issues relating to an amount of time they would be willing to volunteer again.

Sixty-five percent of the technical volunteers provided final comments on what they learned from their i-Tree experience in the category for “other” on the post-study survey. Written comments included "importance of teamwork," "found out how much I don't know," and "increased my ability to recognize trees and their state of health."

Although most volunteers were not dismayed by the technical problems they experienced, a number of recurring themes arose during interviews and the post-study surveys. These were team dynamics, scheduling difficulties, particularly an unawareness of a much more extensive time commitment than originally anticipated, uncertainty when determining genus and species of a tree, and how to assess the condition of the tree.

Objective 5: Evaluate Usability of Maps and PDAs

Maps

When asked during the in-field interviews to rate the usability of their maps, volunteers responded that the maps were excellent (28%), good (28%), OK (43%) and mediocre (1%). When asked on the post-study surveys if the maps were easy to read and understand, 57% of volunteers said yes, and 33% disagreed. Ten percent did not respond. Thirty-four percent said they had difficulty locating their street segments, but 63% did not have any trouble; 12% had difficulties locating which trees to sample on their street segments, and 86% did not. During an interview, a VCT member noted, "Most of the comments to me were that the maps were off, [but expressed] that they knew issues like this come along with a pilot study."

These results indicate that the maps were not as useful as they could have been. There were several reasons that the maps were flawed. Street segments were taken from outdated U.S. Census Bureau Tiger Line Files. Certain street segments had been made into a golf course, were pedestrian and bicycle over-

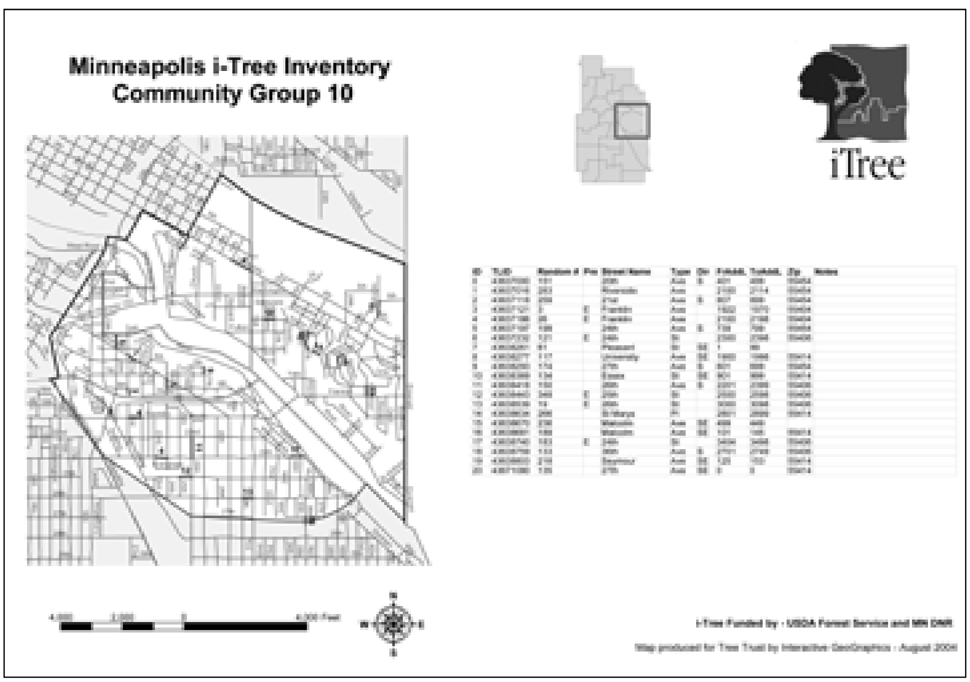

Figure 6 Example of maps distributed to groups for inventorying trees. Street segments are highlighted on map and described in table on right

passes, did not exist or had been renamed.

Map reading was not reviewed during the training session. In order to fit in all of the sessions, Tree Trust organizers determined that reviewing the maps should be done when team leaders came to pick up their data collection packets. In some cases, packets were hurriedly checked off and handed over with only a cursory review of the maps. Teams did not locate each street segment prior to data collection, as requested during training. As a result, questions such as, “Where do we start” and “How do I read the map” were called in during the initial days of data collection.

The maps, which were generated on short notice by the GIS developer, were difficult to read for many volunteers. Due to size constraints of the printed maps, address information was included in a table to the right rather than being included in the map itself. More usable maps could have been produced with more time and a better idea of the information that needed to be presented *(Figure 6)*.

PDAs

Most volunteers (95%) found entering data into the PDA either very easy (65.6%) or easy (30.3%) to do. This entailed physically using the stylus to touch the screen, scroll up and down, open and close the keyboard function and make data entries into the PDA. A couple of volunteer teams commented that the screen had a certain amount of glare and was difficult to read in bright sunlight. Volunteers made a number of suggestions for improving the PDAs and data entry process.

During an interview with the VCT it was noted that, “The PDA issues [they called in about] specifically were maintenance of gear, downloading data onto the SD card, keeping them charged, maintenance task and priority task [data field] questions.” The VCTs tried to remedy these problems by posting the volunteers’ questions on the internet, sending out answers via email and putting hardcopies in their packets. This approach was quite successful.

Other concerns that arose during field interviews included the “hold” function, which was programmed into the PDAs to maintain repeated entries such as tree species and location. These did not work as planned, resulting in time wasted reentering the same data for each tree in a row.

Table 12 *Accuracy of volunteer data compared to professionals. Data are percent correct (mean ± SD)*

Variable	**Accuracy**
Species code	80.2±39.8
City tree	97.9±14.3
DBH	76.5±42.4
Crown diameter perpendicular	53.7±49.9
Crown diameter parallel	57.2±49.5
Land use	78.8±40.8
Location	94.4±22.9
Maintenance recommendation	48.7±50.0
Maintenance task	9.0±28.7
Sidewalk damage	65.6±47.5
Wire conflict	74.4±43.6
Condition wood	69.3±46.1
Condition leaves	80.5±39.6

Objective 6: Evaluate the Accuracy of Volunteer Data Collection

The accuracy of volunteers in collecting data was determined by comparing their results with those of tree professionals for two categories: on a tree-by-tree basis and by team.

Tree-to-tree comparison

Using data from the 431 trees sampled by both the volunteers and professionals, the volunteers correctly identified 80% of the trees by genus and species *(Table 12).* Nearly all volunteers (98±14%) were able to identify a city tree versus a private tree and properly determine the correct location (e.g., front yard, planting strip) of the tree (94±22%). DBH was slightly more difficult (77±42%). Inaccuracies may be due to where measurements were taken on the trunk, difficulty measuring trunks (e.g., multi-stemmed, or on the other side of a backyard fence) or different entries for borderline measurements (e.g., 12-inch DBH entered in the 6–12 inch or 12–18 inch category). Crown diameter measurements proved to be challenging for volunteers (54±50% and 57±50%, perpendicular and parallel to road, respectively). Discrepancies likely arose from differences in stride length and inclusion of erratic branches in the measurements. Also, pacing crown diameter proved to be very time consuming and sometimes hazardous.

Volunteers did fairly well rating whether or not there was a wire conflict (74±44%), determining the adjacent land use (79±41%) and assessing the condition of the leaves (81±40%). They made less accurate determinations of the condition of the wood (69±46%) and the amount of sidewalk damage (66±48%). They did poorly when recommending the type of future maintenance or pruning the tree would need (49±50%). They very rarely made a correct assessment of the highest priority maintenance task required (9±29%).

Variability among teams

There was a fair amount of variability in accuracy among the 15 teams of volunteers *(Table 13).* In an initial data analysis, Team 7 scored the lowest across all 13 variables, with a mean score of only 52% correct compared to the professional team. Team 7 scored highest for identifying city trees (100%) and lowest for maintenance task (10%). They did well on identifying the location (90%) and species

(81%) of their trees. Team 8, on the other hand, scored the highest of all teams with a mean accuracy of 77%. On street segment 4, for instance, which included 13 trees, there was perfect agreement between Team 8 and the professionals for land use and location code; they performed well in identifying species as well (92%). Their lowest score in street segment 4 was for crown diameter (54%).

Table 13 *Accuracy (%) of data collection teams, by team and street segment for 13 categories, compared to results from professionals*

Teams	Trees / street segment	Species code	City tree	DBH	Crown diam perp	Crown diam par	Land use	Location	Maint rec	Maint task	Sidewalk damage	Wire conflict	Condition wood	Condition leaves
T1ss4	11	90.9	90.9	81.8	63.6	54.5	100.0	81.8	100.0	45.5	27.3	72.7	63.6	100.0
T1ss5	21	71.4	100.0	100.0	38.1	19.0	95.2	100.0	71.4	33.3	71.4	100.0	85.7	85.7
T1ss9	19	100.0	100.0	89.5	63.2	52.6	100.0	94.7	68.4	31.6	78.9	84.2	63.2	84.2
T2ss13	8	100.0	100.0	50.0	25.0	50.0	100.0	100.0	37.5	12.5	50.0	50.0	50.0	60.0
T4ss1	9	77.8	100.0	66.7	11.1	55.6	100.0	100.0	55.6	11.1	55.6	66.7	77.8	100.0
T4ss20	22	54.5	100.0	81.8	59.1	68.2	100.0	90.9	22.7	4.5	54.5	86.4	59.1	86.4
T5ss0	15	53.3	100.0	73.3	60.0	33.3	100.0	100.0	86.7	6.7	33.3	93.3	80.0	86.7
T6ss0	9	100.0	100.0	100.0	66.7	77.8	66.7	100.0	33.3	0.0	100.0	77.8	33.3	44.4
T6ss2	7	100.0	100.0	71.4	57.1	71.4	57.1	100.0	28.6	0.0	42.9	100.0	100.0	100.0
T7ss1	21	81.0	100.0	42.9	19.0	38.1	33.3	90.5	14.3	9.5	61.9	52.4	66.7	66.7
T8ss1	7	57.1	100.0	100.0	57.1	71.4	71.4	42.9	71.4	0.0	100.0	100.0	71.4	100.0
T8ss2	11	100.0	100.0	90.9	63.6	81.8	100.0	100.0	72.7	0.0	54.5	100.0	90.9	90.9
T8ss4	13	92.3	100.0	84.6	69.2	53.8	100.0	100.0	92.3	7.7	69.2	84.6	76.9	76.9
T11ss4	21	66.7	95.2	71.4	76.2	71.4	42.9	100.0	23.8	9.5	81.0	23.8	61.9	52.4
T11ss11	9	44.4	100.0	77.8	66.7	100.0	33.3	100.0	0.0	0.0	77.8	55.6	22.2	66.7
T12ss4	21	100.0	95.2	95.2	57.1	66.7	52.4	100.0	57.1	4.8	71.4	71.4	66.7	71.4
T12ss11	7	100.0	100.0	100.0	100.0	100.0	85.7	51.1	0.0	42.9	100.0	14.3	0.0	100.0
T13ss5	23	95.7	100.0	39.1	26.1	39.1	73.9	100.0	34.8	8.7	82.6	78.3	78.3	82.6
T13ss14	11	90.9	90.9	90.9	90.9	100.0	100.0	90.9	54.5	9.1	0.0	0.0	54.5	100.0
T13ss15	8	100.0	100.0	75.0	37.5	37.5	100.0	100.0	25.0	0.0	0.0	0.0	75.0	87.5
T15ss6	10	80.0	100.0	90.0	70.0	70.0	100.0	100.0	20.0	30.0	60.0	40.0	100.0	90.0
T15ss12	10	100.0	100.0	100.0	50.0	90.0	100.0	100.0	20.0	0.0	90.0	90.0	80.0	80.0
T17ss2	27	66.7	100.0	70.4	40.7	37.0	100.0	100.0	25.9	3.7	55.6	92.6	77.8	88.9
T16ss8	11	100.0	90.9	100.0	90.9	90.9	100.0	36.4	81.8	0.0	72.7	81.8	45.5	72.7
T18ss1	1	0.0	100.0	100.0	100.0	100.0	0.0	0.0	0.0	0.0	100.0	100.0	0.0	100.0
T19ss11	13	100.0	100.0	92.3	61.5	84.6	84.6	100.0	92.3	0.0	84.6	46.2	61.5	92.3
T19ss16	48	54.2	95.8	52.1	35.4	37.5	37.5	97.9	50.0	2.00	85.4	91.7	77.1	72.4
T19ss18	38	92.1	97.4	86.8	68.4	57.9	100.0	100.0	57.9	0.0	55.3	100.0	78.9	86.8

Team designations above include team number and street segment. For instance, *T19ss18* is Team 19, street segment 18

Volunteers previously involved in urban forest projects can be a valuable source of help for tree inventorying (photo courtesy of the Tree Trust)

Chapter 5: Discussion and Recommendations

This chapter discusses the results in terms of the six objectives.

Objective 1: Evaluate Volunteer Recruitment

The Tree Trust used tried and tested means of recruiting volunteers for the i-Tree inventory project. These techniques procured a much larger volunteer group than recruitment efforts for tree planting events. Suggestions to improve recruitment efforts for future inventory projects are to combine the following approaches:

- Email outreach to neighborhood, academic, environmental and club affiliates.
- Personal outreach to past volunteer participants.
- Write newspaper articles about upcoming meetings/trainings.
- Recruit volunteers at Arbor Day events.
- Public radio announcements.
- Street banners near community gathering areas/major intersections.

These are only a few of the many ideas that nonprofit organizations use for volunteer recruitment.

Objective 2: Evaluate Volunteer Organization

During interviews the VCT described a few things they would have done differently.

"I assumed that volunteers would always stay in their groups and always go out together. Instead they split up. If we spent the time to go out and see each group the first or second time they went out [collecting data in the field] it would have cleared up so [many scheduling issues]."

"A formal trouble-shooting process…would have been better than just giving out our number and having them call in with questions."

"I think if I did it again - midway through data [collection] I'd have a refresher session where I'd have everyone get together and go through questions. [I'd] be able to give them information all together instead of a piece here and there."

Suggestions related to safety include:

- A concentrated effort should be made during the training to spend sufficient time reviewing safety protocols in a manner that does not offend the volunteers' life experiences.
- Basic safety tips should be included in the training manual.
- Each city should specify potential dangers specific to neighborhoods in which volunteers will be inventorying.
- Advise volunteers to do the following: bring sunscreen, water, comfortable walking shoes; take periodic breaks; use caution when dogs are present in yards; recognize the signs of heatstroke; watch for staples, nails and poison ivy (where applicable) when measuring the DBH of trees; and have a third person keep watch for traffic if team members need to stand in the road while assessing a tree.

Objective 3: Evaluate Volunteer Training

Suggestions for improving training sessions are presented by session topic. One general recommendation is to allocate time for volunteers to use information learned in the sessions by going to an actual street segment to apply mapping skills, then inventory the trees on this segment using the PDAs and training materials. This real world example will stimulate questions and increase confidence of the volunteers.

Tree identification session

- An overview of urban forestry and the inventory project and breakout sessions for "Learning to Use the PDA", "Assessing Tree Conditions", and "Logistics" should all be covered in one 6-hour day.
- A separate 3–4 hour day should be planned at an arboretum, or the like, focusing specifically on tree identification.
- Place emphasis on distinguishing similar tree species for volunteers without a background in tree identification.
- Trainers should cover keying out of basic leaf arrangements: simple, palmate, pinnate, alternate, opposite, and whorled leaves, by using examples for the most common 10–15 tree species.
- Allow volunteers to see actual leaves next to each other. Have

enough samples so each volunteer can take a leaf sample home for each of the most common 10–15 species.

- Focus on commonly mistaken or easily identifiable clues: different types of flowers (ash clusters), seeds, fruits, nuts, differences in shapes of maple samaras, etc.

PDA session

- Have separate STRATUM and MCTI data explanation sheets or "cheat sheets" available for volunteers to use while in training.
- Volunteers should have an opportunity to mark their training manuals and ask questions as they proceed through the series of PDA screens.
- Small groups of 6 or fewer worked best.
- The PDA session trainer should review common PDA malfunctions and "what if" situations during the training.
- If troubleshooting begins in the classroom, volunteers will be more likely to know how to deal with PDA problems on their own in the field.
- Have extra PDAs available, programmed and ready, in case of unforeseen problems.

Tree characteristics session

- Have trainers read the portion of the training manual that they will be responsible for 1–2 weeks in advance.
- Training should not be an overview of everything that is important about their training subject, but specifically, how to make determinations of condition with examples of each.
- Review of most common situational "what ifs" should be included. Ex: "What if there is a large wound (>30%) on the side of the trunk, but it is healing nicely?"

Additional comments by VCT members during interviews included:

"The steps [and the DBH measurements portion of the] tree characteristics session needed a little clarification."

"If we had more of a budget, I would have gotten DBH tapes that were bigger [and had only one side displaying inches instead of two sides, one with inches, the other with centimeters].”

Map breakout and grouping session

- Have the map break-out session in the beginning of the training. This way, volunteers can meet their teammates beforehand to help ensure that their group will work.

Objective 4: Evaluate Volunteer Satisfaction

- Allow volunteers to choose teammates first by region, then by scheduling availability
- Coordinators should respond quickly to data collection problems that arise in the field
- State the anticipated time commitment for the inventory project to volunteers up front

Objective 5: Evaluate Usability of Maps and PDAs

Glare on the PDA was one problem mentioned by data collection volunteers

Suggestions for improving mapping and PDAs include:

- Dedicate a half hour session to the review of maps during the training.
- Try to acquire a donation of AAA or city maps and distribute them to volunteers during training. An alternative would be to have them bring in their own maps.
- Give the volunteers 5 minutes during training to compare the maps and a few minutes afterward to ask questions.
- Cross-reference maps drawn from Tiger Files with current maps.
- If not too technically complicated, make sure all streets are labeled on the maps.
- If possible, eliminate odd streets from the sample: freeway off and on ramps, or streets with one side on a parkway or unmaintained area, especially along freeway corridors.
- Check known construction areas to see if streets have been eliminated, or new streets have been created.
- Request that each team do a windshield survey by driving by each of their street segments before beginning their inventory. Emphasize that this process will save time and provide more accurate

results. Volunteers should confirm streets and avenues are identified correctly (e.g. 2nd Ave vs. 2nd St.).

- During training, draw a street segment on a board, and explain how trees should be inventoried on both sides of the street.
- An additional 1 to 2% of street segments should be selected as replacements.
- Identify the number of PDAs needed, factoring in that larger teams may decide to split into smaller groups.
- PDA problems included glare, maintenance of gear, saving data onto the SD card, and keeping them charged. Make sure that these topics are covered during training and in the training manual.

Objective 6: Evaluate Accuracy of Data Collection

This section investigates potential reasons that volunteers made the determinations they did while collecting tree inventory data. This section also includes an analysis of the i-Tree volunteer training manual, and discussion of reasons for inaccurate tree measurements and assessments by data field.

Training manual

The training manual used for the i-Tree volunteer inventory was predominately based on the MCTI manual designed for use in East Coast inventories. It should be noted that the Tree Trust received the Volunteer Manual only one week before the training. They did not have time to rewrite it or adapt the training to provide complete information on STRATUM. The manual had four chapters or modules. These were (1) an overview of the purpose and types of tree inventories, (2) tree characteristics, (3) terms and techniques for aiding in tree identification and (4) a PDA-based overview of tree inventory data collection.

The module on tree characteristics outlined methods for making determinations on tree health by identifying signs of weakness or decline such as conks, cankers, weak forks or crown dieback. Additional information covered how to measure the DBH for single and multi-stem trees, basic criteria for determining the tree condition, and reasons for pruning.

Modifications to the original MCTI manual included an acknowledgement page and the final module on inventory data collection. This chapter walked users through an ordered series of visuals volunteers would see on their PDA screens. Data fields specific to the MCTI, but not the STRATUM application were included, such as weak fork, percent deadwood, cavity, crown height, GPS latitude and longitude, evaluation and consultation options. This made using the training manual as a reference guide for STRATUM confusing.

During the training session, information on the MCTI data fields was well-covered, but some STRATUM data fields were not discussed. Volunteers were asked to read over the training manual and email or call with any questions. However, until they were in the field with the PDAs collecting data, they did not have a reference point from which to ask their questions. For this reason, there were many calls and emails during the first week of data collection.

Information on STRATUM data fields that was not in the training manual and omitted during the training session affected the accuracy of volunteer data collection. These issues are discussed in more detail for each data field with accuracy less than 80%.

CondWood: Condition of the wood (69% accuracy)

The structural (woody) health of tree was assessed as per adaptation of CTLA tree appraisal using the following categories:

4 = No apparent problems = Good
3 = Minor problems = Fair
2 = Major problems = Poor
1 = Extreme problems = Dead/dying

The training site did not have a good selection of trees with each of the four ratings: good, fair, poor, or dead/dying. The trainer had difficulty finding trees in fair or poor condition to show volunteers. He described issues of girdling roots, and decay in cavities as potential areas in which to downgrade a healthy tree from good to fair. Since STRATUM volunteers were to look only at the present, above ground portions of the trunk and branches to make a determination, the additional information for MCTI volunteers about projecting future tree health was confusing. He also showed a few examples of trees that could be rated as either fair or poor depending on a number of additional factors. He impressed upon the volunteers that making assessments is subjective to some extent, and you need to use your best judgment to make an assessment. Since volunteers are novices in determining the condition of the wood, many commented afterward that they would have liked to see specific examples of one tree for each rating. The manual contained an outdated statement, "If volunteers have concerns about the condition that require consultation, then a mark should be made in the box noted as 'consult'." Conflicting information and unclear parameters were responsible for relatively inaccurate ratings of the condition of the wood.

Suggestions for future training efforts include the following:

- Identify clear examples of trees that match each rating in order to give volunteers a point of reference from which to compare other trees.
- A number of "what if" situations should also be reviewed prior to data collection.
- Projected images or good photographs should be incorporated into the tree characteristics section.
- Photographs and explanations should also be posted or accessible through a website if too costly to include in a training manual.

Existing and potential future conflicts between trees and power lines were evaluated

WireConflict: Wire conflict (74% accurate)

Potential conflicts with existing utility lines were assessed as:

0 = no lines
1 = present and no potential conflict
2 = present and conflicting
3 = present and potential for conflicting

Many questions arose as to what the different wire conflict categories meant. Most volunteers did not have trouble assessing whether or not there were lines present, but they did have problems with the extent of conflict. It was not clearly stated during the training that volunteers were to assess the here and now, not in a month, or two years time. For this reason, many volunteers questioned if they should list "present and potential for conflicting" or "present and no potential conflict" when a branch was growing under or toward a utility line. Questions from volunteers included, "Potential within how many years?" and "Is it present and conflicting if it passes freely through lower, well-established branches?"

Suggestions for future training efforts include the following:

- Give a five minute presentation during the training of a series of visual examples of each option. These would provide a point of reference for volunteers.

SwDamg: Sidewalk damage (66% accurate)

Sidewalk damage caused by the tree was assessed as:

1 = None
2 = Low = 1/4 to 1/2 inch
3 = Medium = 1/2 to 3/4 inch
4 = High = > 3/4 inch

Volunteers were asked to measure sidewalk heave (vertical lift) if it was caused by the tree they were assessing. The Tree Trust did not have sufficient funding to purchase rulers for each team, and so asked them to use their DBH tapes to measure heave. From observations of 18 teams in the field, all but one team eyeballed the amount of sidewalk lift. Although the difference between 1/4 inch, 1/2 inch and 3/4 inch may seem quite obvious while standing up, 1/4 inch increments are very slight and easily mistaken from each other.

Suggestions for future training efforts include the following:

- Check with city personnel to find out what the sidewalk repair and replacement standards are for your city when determining increments of sidewalk lift caused by tree roots.
- Have volunteers mark the PDA stylus with incremental ticks or tape to gauge the amount of lift.
- Request that they physically measure the amount of lift if any is present.

MtncTask: Maintenance task (9% accurate)

The highest priority task that should be performed on the tree was identified as:

0 = None
1 = Stake/train
2 = Clean
3 = Raise (branches <14 ft above road, 7 ft above sidewalk)
4 = Reduce
5 = Remove
6 = Treat pest/disease

Determining the highest priority maintenance task was reviewed briefly during the PDA training session. Volunteers were referred to the training manual for further explanation. The training manual did provide descriptions for four types of maintenance: staking or training, clean crown, raise crown and reduce crown. It did not describe when to choose “none” or what to look for when evaluating a tree to be treated for pests or disease and for removal.

“Crown raise” height requirements for pedestrian and vehicle clearance as defined by the Minneapolis Parks and Recreation Department were 7 ft above sidewalks and 14 ft above roads. However, the training manual listed the guidelines as 8 ft above sidewalks and 18 ft above roads. Only one volunteer team, collecting MCTI data, carried a long pole with them. The rest of the volunteers had to estimate what they thought was 14 ft above the road.

The majority of volunteers chose either “clean” or “raise” as the most important priority, but often quite haphazardly, since nearly all trees could use one or the other. Another problem was that about one-third of the PDAs did not have the “0 = none” option programmed into them. For this reason, some volunteer teams chose to leave this field blank when they felt the tree did not need maintenance. Other volunteer teams faced with this programming error just chose a task, even if they felt it was not needed. Volunteers had to figure many of the maintenance task options out for themselves. When taken together, these issues accounted for the surprisingly low scores for this data field.

Suggestions for future training efforts:

- Clarify that volunteers will be prioritizing the task that is most important.
- Explain the difference between cleaning and pruning as most volunteers are familiar with the term “prune,” not “clean.”
- Explain that they will almost always be entering “clean,” “raise,” or “none” (depending on the city).
- Specify the difference between “raise” and “reduce.”
- Present clear images during training of each of the above determinations for maintenance task.

MntcRec: Maintenance recommendation (49% accurate)

Maintenance recommendations for the trees were classified as:

0 = none
1 = young tree (routine)
2 = young tree (immediate)
3 = mature tree (routine)
4 = mature tree (immediate)
5 = critical concern (public safety)

Volunteers had difficulty with the terms “mature” and “young” trees. Additionally, all trees in Minneapolis undergo routine maintenance. Most volunteers knew this. For this reason, many had difficulties determining if a tree that was already receiving routine maintenance really needed it now. If the tree had a couple of dead twigs and branches, but looked pretty good, volunteer teams interviewed in the field were split between recommending "mature tree (routine)" or "none." Very few trees were designated as needing immediate pruning, and only one was determined to be a public safety hazard. Also from interviews, volunteers had a particularly difficult time distinguishing for unhealthy young trees in between "young tree (immediate)" or "critical concern." Most unhealthy young trees were small and in areas where they posed little danger.

Volunteer comments such as, "What's a mature tree? Not intuitive," and "Some of the 'young trees' are fruiting trees which I would consider mature" demonstrate their confusion about these terms. Uncertainty about these terms led to inaccurate assessments.

The primary suggestion for this field is to clarify the language used for maintenance recommendations.

- Replace "young" and "mature" with "small (<18 feet tall, can be reached from the ground with a pole pruner)" and "large (< 18 ft tall, requires an aerial lift or climbing to prune)."

One volunteer paces off the crown diameter while another enters the data in a PDA

CrnDia: Crown diameter parallel and perpendicular (57, 54%)

The crown diameter perpendicular (and parallel) to the street was identified according to numerical categories defining a range of crown diameter sizes:

01 = 0–10 ft
02 = 10–20 ft
03 = 20–30 ft
04 = 30–40 ft
05 = 40–50 ft
06 = 50–60 ft
07 = 60–70 ft
08 = 70–80 ft
09 = >80 ft

Several things influenced the accuracy of measurements of crown diameter parallel and perpendicular to the road, including inadequate training and the effects of variations in the physical environment upon the measurements.

Information on how to calibrate the distance of one's pace and then to pace crown diameter were not in the training manual. Belatedly, these tasks were added to the training session. It took longer than expected (a minimum of fifteen minutes) to train each group of volunteers to measure their pace. This reduced the amount of training time allotted for determining tree characteristics.

No time was spent during training to show volunteers how to determine where the edge of the tree crown is located. As a result, some volunteers measured to the end of the farthest branch, while others measured to the average edge of the crown, disregarding erratically long or short branches.

Physical variations in terrain led to a number of possible miscalculations in measuring crown diameter. Many front yards had moderate to steeply inclined hills or berms that decreased a person's standard pace. Barriers such as fences, parked cars or vegetation occasionally prevented volunteers from pacing the entire crown diameter. Similarly, busy intersections, overpasses, or dangerous streets prevented volunteers from measuring in the street. In these cases, volunteers visually estimated crown diameter to the best of their abilities.

Pacing tree crown diameter was time consuming. One volunteer commented that measuring crown diameter took at least half the time required to assess each tree. Due to the time and difficulty of making these measurements it is suggested that this field be dropped. STRATUM uses average crown diameter to calculate tree canopy cover. However, canopy cover can be modeled in STRATUM using previously measured relations between DBH and crown diameter for each of the 22 predominant tree species in Minneapolis. Although results may be less accurate because they are not based on each tree's measured crown diameter, this is offset by reduced risk of injury and a substantial reduction in time spent at each tree.

Other Findings

Volunteers value urban trees

Studies conducted within the last decade or so have provided insight into how and in what ways citizens value trees. In a 1992 study by Westphal, volunteers involved in Chicago's TreeKeeper program

Table 14 Comparison of what respondents value most in trees from three studies

Value	Ranking, this study	Ranking, Westphal 1992	Ranking, Lohr et al. 2004
Trees provide shade	1	4	1
Trees improve air quality	2	-	3
Tree are good for the environment	3	3	-
Trees are pleasing to the eye	4	2	-
Trees bring nature closer	5	1	7

ranked what they believed to be the most valuable and annoying attributes of trees. Another study conducted by Lohr et al. (2004) surveyed the public's shared beliefs and attitudes toward trees. In both surveys respondents did not place a high value on problems associated with trees. "People in metropolitan areas also recognized that there are problems associated with trees, but they generally considered these problems to be inconsequential" (Lohr et al. 2004).

Lohr et. al (2004) referred to one survey in which "people attributed great significance to the positive emotional feelings evoked by trees…but the environmental, leisure, and functional benefits were less recognized (Hull, 1992 quoted In Lohr et. al 2004). In Westphal's survey, volunteers most valued trees because they bring nature into the city and are attractive *(Table 14)*. However, in this study and Lohr's survey, respondents listed "provides shade" as the most important value. Also, they ranked "improve air quality" highly. It is beyond the scope of this study to assess whether this difference in how residents rank the services trees provide represents a profound shift in the way the public thinks about trees, or is merely a result of different survey techniques and populations.

Time and productivity comparison

It is useful to compare this STRATUM sample survey with data presented by Bloniarz (1995) for the MCTI volunteer inventory in Brookline, MA *(Table 15)*. Time and productivity statistics were surprisingly similar for the two studies: average number of trees inventoried per team (225 vs. 230); average number of trees (67 vs. 70) and street segments inventoried per day (13 vs. 12); average trees per street segment (18 vs. 19) and total project hours per team (20 vs. 22). However, the projects differed in two ways: scale and data collection process. Brookline, Massachusetts, has a population of 57,000 residents, while Minneapolis, Minnesota, has a population of approximately 375,000 residents. Volunteers collecting sample tree inventory data for the MCTI study gathered data on concurrent street segments within neighborhood boundaries. Volunteers collecting STRATUM data inventoried trees on randomly dispersed street segments within a much larger region, doing extensive map reading to find their street segments and driving from one to the next. Only one STRATUM team collected most of their data on bicycles.

Table 15 *Comparison of volunteer efficiency between two studies*

	MCTI study (Bloniarz 1996) N = 97 volunteers in ~32 teams	**This study *N* = 89 volunteers in 20 teams**
Trees inventoried	225	230
Trees per day	67	70
Trees per street segment	13	12
Street segments	3	6
Time per street segment	25 minutes	1.25 hours
Hours per day	3.5	6.75
Days to complete inventory	6	3.3
Minutes per tree	2	6
Project hours per team	20	22

MCTI volunteers collected five extra fields of data per team, including height, percent decay of wood, longitude and latitude using a GPS feature and percent deadwood. However, they did not measure the crown diameter. Although MCTI volunteers collected more information per tree, travel time was less than in Minneapolis because the trees were closer together and volunteers could walk between them. Therefore the MCTI volunteers required less time per tree.

In Minneapolis, the average three-person team collecting STRATUM data recorded 230 trees on 19 street segments over 3 1/3 days, assuming an 8-hour day. They averaged 70 trees on six street segments with 12 trees per segment per day. From this we can infer that it took the average team approximately 6 minutes to assess each tree or 1 hour and 15 minutes per street segment. Driving time between street segments and locating the starting address are included in the 6 minute per tree calculation.

Next steps

This project was a learning experience for the Tree Trust, and as comments below by the VCT members suggest, it has opened new doors for collaboration with other communities in the area of volunteer-based tree inventory and management.

"I think the project was intensive but...will lead us into integrating volunteers to help quantify the urban forest and help policy."

"It's a great opportunity to bridge volunteers into [inventory projects]. We're going to be able to have volunteers look at private lands as well as public lands."

"This project will clarify how we do this in the future. [We'll be able to] share with others [the lessons we learned from this study]. It's a great tool! Quite honestly, the investment was small compared to what we'll see as a large return."

Chapter 6: Conclusion

The purpose of this study was to improve STRATUM through pilot testing with trained volunteers in Minneapolis. Not surprisingly, we found that the accuracy of data collected by volunteers was related to the training they received, and levels of volunteer satisfaction were related to levels of coordination, organization, and support.

Portions of the study that were less successful were often due to poor communication, such as not providing the training team with exact information on STRATUM data fields. From this study, we learned the importance of communication at all levels, from the research teams to the Tree Trust professionals, trainers and volunteers.

We compared the accuracy of 431 trees inventoried by volunteers and professionals and found that volunteers correctly rated leaf condition (81%), species (80%), and tree size (diameter at breast height) (77%). Volunteers and professionals agreed less frequently on the condition of each tree's wood (69%), tree root–sidewalk conflicts (66%), recommended maintenance (49%), and priority task (9%). We conclude that trained volunteers can be a valuable resource for acquiring information on tree numbers, species, and sizes. However, their assessments of tree maintenance needs, condition, and conflicts were less reliable, due largely to the level of training they received. For example, the training manual was not updated to differentiate between STRATUM and MCTI variables. Trainers were not informed that they needed to present information specific to STRATUM data fields to certain volunteers and not others. Information on how to collect STRATUM data was unevenly presented, resulting in low accuracy ratings for fields that were not clearly explained. We believe that with a more focused training regime, volunteers can make reliable determinations regarding tree condition and management needs for purposes of management planning. It should be recognized that data from a sample street tree inventory are not intended to be applied on a tree-by-tree basis, but rather to guide prioritization of management needs on a neighborhood and citywide basis.

From surveys and interviews we found several recurring themes. These themes included scheduling difficulties within teams, the much more extensive time commitment than originally thought, difficulty determining genus and species of a tree, and frustrations with inadequate information on how to assess the condition and management needs of a tree. In this report we have offered a myriad of suggestions to address these concerns, with key points summarized below:

- Estimate the amount time required to conduct the inventory (average of 6 minutes per tree in Minneapolis), then recruit a sufficient number of volunteers, remembering that asking for more than 8-12 hours may reduce participation. Clearly communicate your time expectations to the volunteers.
- Train volunteers on use of the PDA, maps, and tree assessment in one 6-hour day. Conduct a separate 3-4 hour session on tree identification. Have a "dress rehearsal" during this session. Use the maps, PDAs and data collection kits to locate and survey all trees in one street segment.
- Focus tree identification on key distinguishing features of commonly mistaken trees among the 10-15 most abundant species.
- Develop a slide library that shows trees with different maintenance needs and condition ratings. Use this during training and include it in the training manual.
- Demonstrate how to troubleshoot PDAs during training, and cover their maintenance and downloading.
- Determine before training via questionnaire which volunteers want to survey trees in their neighborhoods, allow them to self-select teammates, and form teams early during the training session so they can network.
- Produce a training manual or separate manuals that clearly address the different data fields for STRATUM and MCTI.
- Cover streetside safety tips during training and in the manual.
- Conduct a windshield survey of each street segment to verify its existence, extent, and clear designation on the map. Have replacement street segments ready for each zone.
- Develop a formal troubleshooting process before deploying volunteers so that people in the field know who can answer specific types of questions.
- Have a "refresher session" soon after data collection begins to review solutions to the most common questions and problems.

Our findings have already resulted in changes to STRATUM that will increase accuracy and reduce volunteer time. Changes include: (1) eliminating time-consuming data fields, 2) clarifying language for the remaining data fields, (3) adding time-saving hold buttons between entries on the PDAs, and (4) updating the training manual to include safety tips and clarify data collection protocols.

Lessons learned and recommendations presented in this study may apply to a broader audience than i-Tree users. For example, groups that monitor watershed health are also concerned with the efficient use of volunteers as citizen scientists. Other cities or not-for-profit organizations that are planning to embark on similar volunteer-based projects may benefit from the lessons learned in this study.

Citations Referenced

Andresen, John W. "Tree City USA: Volunteer Urban Forestry." Arboriculture Journal 13.4 (1989): 333-43.

Barker, Karlyn. "After Decades of Decline, Trees Blossoming Anew $50 Million Donation, Push by City Pay Off." (2003).

Bassett, John, B. Vegetation Inventories: Need and Uses. Proceedings from the National Urban Forest Conference. Syracuse: SUNY, 1978. 632-44.

Berry, Rhonda. "Nature and Culture: Building Community from the Ground Up." American Forest (1993): 226-28.

Bloniarz, David V. The Use of Volunteer Initiatives in Conducting Urban Forest Resource Inventories. PhD Thesis. University of Massachusetts, Amherst, Massachusetts. (1996). 137 p.

Bloniarz, David V.; Ryan, Dennis P. "Urban Forest Resource Inventories: A Community Based Approach." (1995). http://www.umass.edu/urbantree/saf.pdf. Accessed March 22, 2004.

Bloniarz, David V.; Ryan, Dennis P. "The Use of Volunteer Initiatives in Conducting Urban Forest Resource Inventories." Journal of Arboriculture 22.2 (1996): 75-82.

Borg, Walter R.; Gall, Meredith Damien. Educational Research: An Introduction. 1979.

Brokopp, Sherri K.; Castronovo, Denise; Silvera, Georgia N.; Bean, Brian. "The Greater Boston Urban Forest Inventory: An Integrated Approach to Managing the Urban Forest." Southern Forestry RGIS (2004).

Buchanan, E.L. Who Should Conduct Street Tree Inventories. (1992 In American Forests (ed.). 5th National Urban Forest Conference, Los Angeles, California. pp. 155-158.

Cole, Dana W. "Oakland Urban Forestry Experiment: A Cooperative Approach." Journal of Forestry 77 (1979): 417-19.

Evans, Lydia. "People Empowerment through Trees: ShadeMakers. "American Forest (Ed.). (1983): 135-36.

Iles, Jeffery K. "Inclusive Urban and Community Forestry Programs: Using All of Your Community's Cultural Resources." Journal of Arboriculture 24.6 (1998): 316-21.

Kielbaso, James J; Beauchamp, Bonnie S.; Larison, Kenneth F; Randall, Carolyn J. Baseline Data Report: Trends in Urban Forestry Management. Washington, D.C.: International City Management Association, 1988.

Maco, Scott E., McPherson, E. Gregory. "A Practical Approach to Assessing Structure, Function, and Value of Street Tree Populations in Small Communities." Journal of Arboriculture 29.2 (2003): 84 - 87.

Makra, Edith M.; Anderson, John W. "NeighborWoods: Volunteer Community Forestry in Chicago." Arboriculture Journal 14.2 (1990): 117-27.

Matheny, N. and J. Clark. In preparation. " ISA Certified Arborist -Municipal Arborist Specialization Study Guide." International Society of Arboriculture. Champaign IL., 2004.

Matz, James R. "Organizing Citizen Involvement." American Forest (Ed.). (1993): 46-48.

McPherson, E. Gregory. "Monitoring Urban Forest Health." Environmental Monitoring and Assessment 26 (1993): 165-74.

McPherson, E. Gregory. 2005. STRATUM: Linking Urban Forest Benefits, Costs and Management. Internal Report. USDA Forest Service, Pacific Southwest Research Station, Center for Urban Forest Research. 2p. 6.20.05.<http://cufr.ucdavis.edu/products/cufr_485_itree_profile.pdf>.

Mezger, Stephen. "UC Davis Urban Forest Inventory and Management." Ed. Environmental Horticulture 100: Urban Forestry. Davis, CA, 2004. lecture.

Miller, Robert W. Urban Forestry: Planning and Managing Urban Greenscapes. Second ed. Upper Saddle River, New Jersey: Prentice Hall, 1997.

Monear, Janette. "Volunteer Pro's and Con's: The Seven C's of Success." American Forest, (Ed.) (1993): 132-34.

New Jersey Forest Service. "Trees in Crisis: A Statewide Assessment of New Jersey's Street Trees." (1995). New Jersey Forest Service, Community Forestry Program, Trenton, NJ

North Carolina Division of Forest Research. "Factors to Consider When Doing a Tree Inventory". 2005. <http://www.dfr.state.nc.us/urban/urban_inv.htm >.

Olig, Gene A.; Miller, Robert W. A Guide to Street Tree Inventory Software. Stevens Point, WI: USDA Forest Service Center for the Midwestern States, 1999.

Probart, Suzanne. "Effective Volunteerism." American Forests (Ed.) (1993): 49-50.

Rathke, David M. Minnesota Trees. Regents of the University of Minnesota, 1995.

Skiera, Robert W. "Building Urban Forestry Structure in a Community." American Forest (Ed.). (1993): 246-47.

Sommer, Robert. "The Value of Resident Participation in Tree Planting." Arborist News (1996): 43-44.

Thompson, Richard P., Ahern, James J. The State of Urban and Community Forestry in California; Status in 1997 and Trends since 1988. San Luis Obispo: Urban Forest Ecosystems Institute, California Polytechnic State University, 2000.

Tracy, David. "Tree Inventory Volunteers". 2005. Accessed 2.3.05 2005. <http://norwalktreealliance.org >.

Tretheway, Raymond; Simon, Mark; McPherson, E. Gregory; Mathis, Sabrina. "Volunteer-Based Urban Forest Inventory and Monitoring Programs." (1999): 1-33.

Tschantz, Barbara, A., Sacamano, Paul L. Municipal Tree Management in the United States: The International Society of Arboriculture Research Trust and the USDA Forest Service, 1994.

Westphal, Lynne M. "Urban Forestry Volunteers and Effective Outreach." Society of American Foresters 1993 National Convention Proceedings (1993): 436-41.

Appendix A *Pre-study survey for community volunteers*

iTree Community Volunteer Pre-Survey iTree

Thank you for participating in this important national tree inventory study. This survey will help us gauge our outreach strategies, and learn why you are interested in supporting the health of your urban forest. Thank you for volunteering for the Minneapolis Tree Inventory Project.

Name: Age: Ethnicity: Check One: ☐ Homeowner ☐ Renter

City: If in Minneapolis, which neighborhood?

1. How long have you lived at your current residence? Year(s)

2. How did you find out about this tree inventory project? (Check one):
   ☐Volunteer Coordinator at work ☐ Flyer was sent to me ☐ My Neighborhood Representative ☐ Friend
   ☐Volunteer Organization (which?) ☐Email…From who? ☐Other

3. Why do you want to volunteer for this project? (Check all that apply)
   ☐Get involved in a local community project to beautify/maintain the health of our city
   ☐Become a more educated advocate for trees
   ☐Do my part to help out the environment
   ☐Meet people with similar interests
   ☐Other:

4. Do you have any prior experience working with trees? ☐No (This is my first time) ☐Yes (If yes, check below)
   ☐Tree Planting at home ☐Neighborhood Planting Project ☐Tree Trust Workshop ☐Other:

5. What do you expect to learn? (Check all that apply)
   ☐Identify trees in my neighborhood/city
   ☐Identify problems with my own trees so I can take better care of them
   ☐Get a good base understanding of urban forestry
   ☐Learn to use a new technology: Personal Digital Assistant (PDA)
   ☐Other

6. How have you learned about trees? ☐Tree ID Class ☐Pruning Class ☐Tree Service ☐Tree Trust Workshop
   ☐Hobbyist (learn from books) ☐Docent Program at the Arboretum ☐Service Project ☐Other

7. Do you know the Latin or botanical names of any trees?…………………………………………☐Yes ☐No
   If yes, please name a couple:

8. Have you planted or cared for trees at your current residence? ……………………………………☐Yes ☐No
   In what form? ☐ Prune ☐Plant ☐Fertilize ☐Water ☐Other

9. Has caring for a tree(s) made you more aware of other trees in your neighborhood? ……………………☐Yes ☐No

10. I value urban trees because…….. (Number your **top 5** choices 1 through 5. 1 = most important…2, 3, 4…5 = 5th most important).

Brings nature closer	Provides shade	Stormwater reduction	Provides spiritual values	Fall color
Pleasing to the eye	Reduces noise	Increases sense of community	Lower costs for heating/cooling	
Improves air quality	Wildlife habitat	Good for the environment	Increases property value	

11. Any additional comments?

Appendix B *Pre-study survey for technical volunteers*

Technical Volunteer Pre-Survey

Technical Volunteer Pre-Survey

Thank you for participating in this important national tree inventory study. This survey will help us gauge our outreach strategies, and learn why you are interested in supporting the health of your urban forest.

Name: Age: Ethnicity: Check One: ☐ Homeowner ☐ Renter

City: If in Minneapolis, which neighborhood?

1. How did you find out about this tree inventory project? (Check one):
   ☐ Flyer was sent to me ☐ Tree Advisor email list serve ☐ Email (from Who?)
   ☐ Friend ☐ Neighborhood Rep. ☐ Volunteer Org. (Which?) ☐ Other:

2. Why do you want to volunteer for this project? (Check all that apply):
   ☐ Get involved in a local community project to beautify/maintain the health of our city
   ☐ Become a more educated advocate for trees
   ☐ Do my part to help out the environment
   ☐ Meet people with similar interests
   ☐ Other:

3. What do you expect to learn? (Check all that apply):
   ☐ Increase my abilities to identify pruning/maintenance needs
   ☐ Increase my tree identification abilities
   ☐ Learn more about the benefits of our urban forest
   ☐ Understand urban forestry more thoroughly
   ☐ Learn to use a new technology: Personal Digital Assistant (PDA)
   ☐ Other

If you are a Tree Care Advisor, please answer #'s 4-6:

4. How long have you been one? # Months/Years (circle one)
5. How many hours have you volunteered as a Tree Care Advisor? # Hours (guess if you're not sure)
6. What is your greatest strength as a Tree Care Advisor that you think you will bring to this inventory project? (Check one):
   ☐ Good educator ☐ Good at Tree ID ☐ Motivated to help others learn about trees ☐ Other:

=OVER=

7. Do you know the Latin or botanical names of any trees?.. ☐ Yes ☐ No

   If yes, please name a couple:

8. I value urban trees because…….. (Number your **top 5** choices 1 through 5. 1 = most important 5 = 5th most important).

   Brings nature closer   Provides shade   Stormwater reduction   Provides spiritual values   Fall color

   Pleasing to the eye   Reduces noise   Increases sense of community   Lower costs for heating/cooling

   Improves air quality   Wildlife habitat   Good for the environment   Increases property value

9: Any additional comments?

Appendix C *Post-study survey for community volunteers*

Community Volunteer Post Survey

iTree iTree

Your Name:

1. What did you learn? (Check all that apply)
   - ☐ Identified trees in my neighborhood/city
   - ☐ Identified problems with my own trees so I can take better care of them.
   - ☐ Got a good base understanding of urban forestry
   - ☐ Learn to use a new technology: Personal Digital Assistant (PDA)
   - ☐ Other
2. Did you have a good group dynamic with your team? ☐ Yes ☐ No
   If not, why?
3. Did your team leader help you learn what you felt was important to know about trees? ☐ Yes ☐ No
4. Was the data collection well organized and run smoothly and professionally? ☐ Yes ☐ No
5. If you used the PDA, did you find it easy to use while collecting tree data? ☐ Yes ☐ No
6. Were the maps easy to read and understand? ☐ Yes ☐ No
7. Did you have any difficulties locating your street segments? ☐ Yes ☐ No
8. Did you have any difficulties locating which trees to sample on your street segments? ☐ Yes ☐ No
9. Did you collect tree data from any trees in your own neighborhood? ☐ Yes ☐ No
10. If not, do you wish that you had? ☐ Yes ☐ No
11. Were you involved in downloading the PDA's onto the computer? ☐ Yes ☐ No
    If so, did you find it straightforward or complicated? ☐ Straightforward ☐ Complicated
12. Did your team receive the support it needed when you had questions about a tree or PDA data field? ☐ Yes ☐ No ☐ N/A

=OVER=

13. Do you wish you had attended the training? ☐ Yes ☐ No
    Why, or why not?
14. For the activities in which you participated, what level of competence do you think you achieved?

	Level of Competency: Not at all competent 1	2	3	4	Very Competent 5	N/A
14a. I feel competent using the DBH tape to measure the diameter of trees.	☐	☐	☐	☐	☐	☐
14b. I felt competent finding trees on the street segments by using the maps.	☐	☐	☐	☐	☐	☐
14c. I felt competent using the pull down menus to enter data using the PDA.	☐	☐	☐	☐	☐	☐
14d. I felt competent backing up the data on the PDA to the storage card.	☐	☐	☐	☐	☐	☐
14e. I felt competent identifying 5-10 of the most common trees that we encountered.	☐	☐	☐	☐	☐	☐
14f. I felt competent determining the condition of branches/trunk (wood) of a few trees.	☐	☐	☐	☐	☐	☐
14g. I felt competent determining the condition of the leaves of a few trees.	☐	☐	☐	☐	☐	☐
14h. I felt competent determining the crown diameter of a few trees.	☐	☐	☐	☐	☐	☐
14i. I felt competent determining the maintenance needs of a few trees.	☐	☐	☐	☐	☐	☐
14j. I felt competent reviewing the safety protocols.	☐	☐	☐	☐	☐	☐

15. Based on your team dynamic and data collection, rate the quality of your overall experience on a scale of 1-5;
    Circle one. (1=excellent…5=poor) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
16. What recommendations would you make for how your experience participating in this inventory could have been improved?
17. If you could pass on a word of advice to the next group of volunteers in another city doing their inventory, what would it be?
18. Additional Comments:

Appendix D *Post-study survey for technical volunteers*

Technical Volunteer Post-Survey

Technical Volunteer Post-Survey

Your Name:

1. What did you learn? (Check all that apply)
   - ☐ Increased my abilities to identify pruning/management needs
   - ☐ Increased my tree identification abilities
   - ☐ Learned more about the benefits of our urban forest
   - ☐ Understand urban forestry more thoroughly
   - ☐ Learned to use a new technology: Personal Digital Assistant (PDA)
   - ☐ Other
2. Did you have a good group dynamic with your team? .... ☐ Yes ☐ No
   If not, why?
3. Was the data collection well organized and run smoothly and professionally?........ ☐ Yes ☐ No
4. Was the Personal Digital Assistant (PDA) easy to use while collecting tree data on your street segments?........ ☐ Yes ☐ No
5. Were the neighborhood maps easy to read and understand? .... ☐ Yes ☐ No
6. Did you have any difficulties locating your street segments?........ ☐ Yes ☐ No
7. Did you have any difficulties locating which trees to sample on the street segments?........ ☐ Yes ☐ No
8. Did you collect tree data from any trees in your own neighborhood? .... ☐ Yes ☐ No
9. If not, do you wish that you had? .... ☐ Yes ☐ No
10. Was downloading the PDA onto the computer straightforward or complicated? .... ☐ Straightforward ☐ Complicated ☐ N/A

=OVER=

11. Did your team receive the support it needed when you had questions about a tree or PDA data field? .... ☐ Yes ☐ No ☐ N/A
12. Did participating in the inventory increase your awareness of your urban forest? .... ☐ Yes ☐ No
13. Please rate your overall experience on a scale of 1-5; circle one. (1=excellent…5=poor)........ ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
14. Would you be interested in participating in other Tree Trust projects again? .... ☐ Yes ☐ No
15. If you could pass on a word of advice to the next group of volunteers in another city doing their inventory, what would it be?
16. Any additional comments?

Appendix E Post-training questionnaire

iTree

Post-Training Questionnare

iTree

Your Name:

1. Did you feel like you learned something new?…………………………………………………………☐Yes ☐No

   a. What specifically?

2. Was the protocol manual covered thoroughly?…………………………………………………………☐Yes ☐No

3. Was the explanation of how to use the Personal Digital Assistants (PDA's) covered thoroughly?……………☐Yes ☐No

Break Out Sessions:

4. **Tree Characteristics** - Gary Johnson

	1=Very useful/Excellent	**2**	**3**	**4**	**5 = Not useful/Poor**
a. Content of the material covered:	☐	☐	☐	☐	☐
b. How useful was the session?	☐	☐	☐	☐	☐

5. **Software & PDA** (Personal Digital Assistant) – Dave Bloniarz, Jill Mahon, Gail Nozal & Shauna Cozad

	1=Very useful/Excellent	**2**	**3**	**4**	**5 = Not useful/Poor**
a. Content of the material covered:	☐	☐	☐	☐	☐
b. How useful was the session?	☐	☐	☐	☐	☐

6. **Tree Identification Part II** – Dave Hanson & Don Mueller

	1=Very useful/Excellent	**2**	**3**	**4**	**5 = Not useful/Poor**
a. Content of the material covered:	☐	☐	☐	☐	☐
b. How useful was the session?	☐	☐	☐	☐	☐

7. Was the training too technical?……………………………………………………………………☐Yes ☐No
   If yes, why?

8. Was there any section of the training that was too long?……………………………………………☐Yes ☐No
   If so, which section? ☐ Welcome & Introduction ☐Tree ID ☐Tree Characteristics ☐Software &PDA

9. Was there any section of the training that was too short or seemed rushed?…………………………☐Yes ☐No
   If so, which section? ☐ Welcome & Introduction ☐Tree ID ☐Tree Characteristics ☐Software &PDA

10. What was your favorite part of the training (excluding the pizza lunch)?
    ☐ Welcome & Introduction ☐Tree ID ☐Tree Characteristics ☐Software &PDA

11. Was the facility chosen a good location for this training? …………………………………………☐Yes ☐No

12. What recommendations would you make for how the training could be improved?

13. . Did the training meet your expectations? ……………………………………………………………☐Yes ☐No
    If not, why?

14. Additional Comments?

Appendix F *Pre-training tree identification survey*

Directions: Visit trees labeled #1 - #5. For each tree, write the name to the best of your abilities (Ex: Fraxinus pennsylvanica or Pine, Oak, Ash, Deciduous, Conifer, etc.). Then check the box that seems to apply to that tree in each of the three columns.

Name of Tree #1:

Condition of tree (branches/trunk)	Condition of Leaves	Maintenance Recommended
☐ Good = no apparent problems	☐ Good = no apparent problems	☐ None
☐ Fair = minor problem	☐ Fair = minor problem	☐ Routine
☐ Poor = major problems	☐ Poor = major problems	☐ Immediate
☐ Dead/Dying = Extreme Problems	☐ Dead/Dying = Extreme Problems	☐ Public Safety

Name of Tree #2:

Condition of tree (branches/trunk)	Condition of Leaves	Maintenance Recommended
☐ Good = no apparent problems	☐ Good = no apparent problems	☐ None
☐ Fair = minor problem	☐ Fair = minor problem	☐ Routine
☐ Poor = major problems	☐ Poor = major problems	☐ Immediate
☐ Dead/Dying = Extreme Problems	☐ Dead/Dying = Extreme Problems	☐ Public Safety

Name of Tree #3:

Condition of tree (branches/trunk)	Condition of Leaves	Maintenance Recommended
☐ Good = no apparent problems	☐ Good = no apparent problems	☐ None
☐ Fair = minor problem	☐ Fair = minor problem	☐ Routine
☐ Poor = major problems	☐ Poor = major problems	☐ Immediate
☐ Dead/Dying = Extreme Problems	☐ Dead/Dying = Extreme Problems	☐ Public Safety

Name of Tree #4:

Condition of tree (branches/trunk)	Condition of Leaves	Maintenance Recommended
☐ Good = no apparent problems	☐ Good = no apparent problems	☐ None
☐ Fair = minor problem	☐ Fair = minor problem	☐ Routine
☐ Poor = major problems	☐ Poor = major problems	☐ Immediate
☐ Dead/Dying = Extreme Problems	☐ Dead/Dying = Extreme Problems	☐ Public Safety

Name of Tree #5:

Condition of tree (branches/trunk)	Condition of Leaves	Maintenance Recommended
☐ Good = no apparent problems	☐ Good = no apparent problems	☐ None
☐ Fair = minor problem	☐ Fair = minor problem	☐ Routine
☐ Poor = major problems	☐ Poor = major problems	☐ Immediate
☐ Dead/Dying = Extreme Problems	☐ Dead/Dying = Extreme Problems	☐ Public Safety

Appendix G *Interview questions for training team*

Interview Questions for Training Team:

1. Did the training meet your overall goals (remind them what they had listed as their goals)
2. Did you feel that the training was well organized and smoothly conducted?
3. Were there any last minute changes that made the training stressful?
4. Were you satisfied with your presentation?
5. Do you feel like you were able to effectively communicate to the volunteers your training goals?
6. Do you feel that they were receptive?
7. Did you sense energy of excitement among the volunteers?
8. Was there any material that you did not feel like you had received sufficient training on prior to having to present it?
9. Were there any unexpected surprises during the training?
10. Were there any comments or reactions that any volunteers vocalized directly to you after your presentation?
11. Overall, how did you feel about the training?
12. Do you think the volunteers are ready for data collection?
13. Do you feel like they are prepared to use the PDA's without making mistakes, becoming confused, or getting frustrated in the field?
14. On a scale of 1-10, how would you rate their preparedness to gather data at an 80 percent accuracy level or better?
15. Are you feeling confident that all the problems have been hashed out with the Active Sink downloading program and that the technology transfer will run smoothly?
16. Any additional comments?

Appendix H *STRATUM cheat sheets for use by volunteers in the field*

LandUse
1 = single home family residential
2 = multi-family residential (duplex, apts., condo)
3 = industrial/Lg commercial
4 = vacant/other (agric., unmanaged areas of greenbelts, park)
5 = small commercial

Location
1 = front yard
2 = planting strip
3 = cutout = root growth restrict. on 4 sides
by hardscape within dripline
4 = median
5 = other maintained locations
6 = other un-maintained locations
7 = backyard

DBH
1 = 0-3 in
2 = 3-6 in
3 = 6-12 in
4 = 12-18 in
5 = 18-24 in
6 = 24– 30 in
7 = 30-36 in
8 = 36-42 in
9 = >42 in

Definitions:
Young tree: Top can be reached by 12 ft pruning pole or total height < 18 ft
Clean: selective removal of one or more of the following items: dead, dying, diseased, weak branches and watersprouts from tree's crown
Raise: removal of the lower branches of a tree in order to provide clearance
Reduction/reduce: reduces the height and/or spread of a tree. Considerations should be given to the ability of a species to sustain this type of pruning
Remove: remove the tree entirely

CrDiaPar = crown diameter parallel to street
01 = 0 - 10 ft
02 = 10 - 20 ft
03 = 20 - 30 ft
04 = 30 - 40 ft
05 = 40 - 50 ft
06 = 50 - 60 ft
07 = 60 - 70 ft
08 = 70 - 80 ft
09 = >80 ft

CrDiaPerp = crown diameter perpendicular to st.
01 = 0 - 10 ft
02 = 10 - 20 ft
03 = 20 - 30 ft
04 = 30 - 40 ft
05 = 40 - 50 ft
06 = 50 - 60 ft
07 = 60 - 70 ft
08 = 70 - 80 ft
09 = >80 ft

Sidewalk Damage - amount of sidewalk heave
1 = None
2 = Low - 1/4 to 1/2 inch
3 = Medium - 1/2 to 3/4 inch
4 = High - >3/4 inch

Number of Feet	Write Your No. of Paces
01 = 0 - 10 ft	
02 = 10 - 20 ft	
03 = 20 - 30 ft	
04 = 30 - 40 ft	
05 = 40 - 50 ft	
06 = 50 - 60 ft	
07 = 60 - 70 ft	
08 = 70 - 80 ft	
09 = 80 - 90 ft	
10 = 90 - 100 ft	

Wire Conflict - interfere w/ or appear above a tree
1 = no lines
2 = present and no potential conflicting
3 = present and conflicting
4 = present and potential for conflicting

CondWood - Structural (woody) health - trunk, branch, twig
1 = Dead/dying = Extreme problems
2 = Poor = Major problems
3 = Fair = Minor problems
4 = Good = No apparent problems

CondLvs - functional (foliage) health
1 = Dead/dying = Extreme problems
2 = Poor = Major problems
3 = Fair = Minor problems
4 = Good = No apparent problems

MtncRec - the recommended mtce for tree
1 = none
2 = young tree (routine)
3 = young tree (immediate)
4 = mature tree (routine)
5 = mature tree (immediate)
6 = critical concern (public safety)

MtncTask - highest priority task to perform on tree
1 = none
2 = stake/train
3 = clean
4 = raise (Branches <14 ft for road, 7 ft above sidewalk)
5 = reduce
6 = remove
7 = treat pest/disease

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